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16. Abstract The opening of a major traffic generator in the San Antonio area provided an opportunity to develop and implement an extensive traffic monitoring system to analyze local, area, and regional traffic impacts from the generator. Researchers reviewed the technical literature and the experiences of other areas with major traffic generators. Twenty-nine new traffic data collection sites were installed as part of the monitoring system, including two sites with new radar-based technology. This provided the Texas Department of Transportation with the opportunity to test new traffic data collection equipment. Researchers combined historical traffic data from the study area, travel time runs, commuter surveys, and data from new sites to measure impacts. The major generator created small impacts at or in the vicinity of its location in the study area. Changes recorded in the data from roadways further out from the major generator were found not related to activities from the generator. The process of developing and implementing a monitoring system is transferable to other cities and regions and depends on available resources and agency interest.					
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**AN ASSESSMENT OF A TRAFFIC MONITORING SYSTEM FOR A  
MAJOR TRAFFIC GENERATOR TO IMPROVE REGIONAL  
PLANNING: TECHNICAL REPORT**

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## **DISCLAIMER**

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The researcher in charge of the project was Todd B. Carlson.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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# CHAPTER 1: INTRODUCTION

## BACKGROUND

When a new, large traffic generator is constructed in an area, local and regional traffic patterns are impacted. Regional planners and engineers need accurate, adequate data in order to understand the location and magnitude of the impact. Regional urban planning is an important function which has been strengthened with recent federal transportation legislation through the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. Regional planning helps regional policy makers adopt various policy and program decisions to expand, maintain, and manage the various transportation infrastructures within the region, and meet other federal requirements such as attainment of clean air standards. The results form the Metropolitan Transportation Plan and the Transportation Improvement Program.

Interest in freight planning or goods movement is increasing at the national level. This is due in part to the focus placed on this topic by federal transportation legislation. Metropolitan planning organizations (MPOs) are increasingly finding intermodal issues to be very important. Trucks disproportionately contribute to pavement wear and damage. Over time, a higher level of truck traffic will result in greater maintenance activity and investment. Trucks contribute to congestion on choked roadways because they consume more physical space compared to passenger cars and must allow greater headways to advance vehicles while allowing for safe following distances. Finally, heavy-duty trucks contribute significantly to an area's mobile source emissions based on current emission modeling frameworks.

This project focused on a single, new major traffic generator in the San Antonio metropolitan area. The city gained a Toyota Motor Corporation automobile manufacturing facility in the southern area of its metropolitan region. The opening of this facility provided an opportunity to analyze the impact on transportation in the immediate area and region wide. Since the new traffic generator is located in an isolated area where traffic volumes are light, researchers could more easily monitor changes in traffic characteristics and apply lessons learned to other future mega-traffic generator sites.

## LITERATURE REVIEW AND STATE OF THE PRACTICE

The research team conducted a comprehensive review of the technical and academic literature along with telephone interviews with practitioners in areas with major traffic generators. Staff members at several Texas MPOs were interviewed to garner their understanding and analysis of special traffic generators. Several transportation research databases were mined along with Internet searches by keyword. The review is divided into a discussion of special and major traffic generators, their context in regional planning, and the traffic monitoring process.

### Special Traffic Generators

There is no strict definition of a special traffic generator in the literature. A general description provided is a facility, business, industry, or other land use that

generates large amounts of traffic (1). Examples include schools, shopping centers, hospitals, airports, public service buildings, military installations, prisons, landfills, regional recreation facilities, and regional malls.

Researchers conducted telephone interviews with planning officials in the State of Texas to find local definitions of special traffic generators. The Corpus Christi MPO defines a special traffic generator as anything significant occurring outside of normal weekday traffic (Ed Molitor, Corpus Christi MPO, September 2005). Brownsville MPO considers international bridges, hospitals and high school events to be special traffic generators (Mark Lund, Brownsville MPO, October 2005). The Beaumont-Port Arthur MPO defines special generators as its travel demand model does (Bob Dickinson, Southeast Texas Regional Planning Commission, October 2005).

For travel demand model purposes, special generators are large facilities that generate irregular traffic patterns in the course of a day. These are primarily hospitals, universities, and airports, but not industrial sites. These types of facilities are coded based on the expected trip generation rate and incorporated into the travel demand model. The Dallas-Fort Worth Regional Travel Model considers three types of special generators:

- Regional shopping malls with greater than 500,000 square feet,
- Universities and colleges with over 1500 students enrolled, and
- Hospitals with over 300 service employees (Aresh Mirzaei, North Central Texas Council of Governments, October 2005).

## **Major Traffic Generators**

The definition of a major traffic generator varies widely and is relative to each community. Broad definitions found refer to concentrated land use resulting in high traffic demand. National Cooperative Highway Research Program (NCHRP) Report 548 defines a major traffic generator as “[a] land use that generates a high traffic volume to and from the site, usually defined in terms of vehicles per hour or vehicles per day. Volumes used to differentiate major versus minor vary widely” (2). Another definition provided within 23 Code of Federal Regulations (CFR) 470A [Appendix A](#) states a major highway traffic generator “means either an urbanized area with a population over 100,000 or a similar major concentrated land use activity that produces and attracts long-distance interstate and statewide travel of persons and goods. Typical examples of similar major concentrated land use activities would include a principal industrial complex, government center, military installation, or transportation terminal” (3). The State of New Hampshire’s Code of Administrative Rules regarding transportation conformity defines a major traffic generator as “any establishment which generates or is projected to generate traffic which significantly lowers or could adversely affect the current level of service of a state highway” (4).

State or municipal codes provide a more quantitative threshold for defining “high traffic demand.” For example, the New Jersey State Highway Access Management Code defines a major traffic generator as the use or uses which generate a total of 500 or more vehicle trips per day directly accessing a state highway to and from the use or uses (5). In the city of Clearwater, Florida, community development code, a major traffic generator means a facility that generates in excess of 1,200 vehicle trips per day (6). The city of Colleyville, Texas, defines major generators as internal to the city, and all identified are schools, shopping centers, or public facilities (7).

Traffic impact analyses (TIAs) are conducted by municipalities for major developments including those expected to generate significant increase in traffic. The threshold for a TIA varies across municipalities and agencies as evidenced above. TIAs are used to predict traffic changes and effects on level of service and recommend roadway and safety improvements to the nearby and adjacent intersections or roadways in response to the major traffic generator being developed. The TIA study looks at development size and use and determines the effect of that use on the existing roadway system. This should lead to a roadway system that accommodates the proposed land use and may recommend mitigation measures to foster efficient traffic flow around the proposed site.

TIAs are not typically integrated into the regional plan. They are used primarily as part of the approval process at the local municipal level. For TIAs to be included in a regional plan, the project would be a large-scale development.

## **REGIONAL PLANNING**

Regional planning involves the inter-coordination of several different governments and agencies to address and solve issues within a metropolitan area. The key problem in planning for a metropolitan region is political. Local governments, by themselves, are inadequate to effectively address metropolitan area problems. Traffic flows do not respect municipal boundaries in a metropolitan region. However, the local level is where the power and responsibility for implementation of regional policies lie.

The main planning issues that allow for a more regional approach are:

- Transportation
- Environmental
- Water supply, sewage, solid waste disposal
- Economic development
- Housing

Transportation is the issue that is more amenable to regional planning. A major impetus for this is federal transportation legislation beginning with the Intermodal Surface Transportation Act of 1991 (ISTEA). The role of councils of government (COG) and MPOs was strengthened to a lead role in metropolitan planning and transportation decisions (8).

Urban transportation planning is defined as the process of identifying problems, proposing alternatives, evaluating potential solutions, and selecting preferred actions that meet community goals in a manner that includes all feasible transportation modes. It involves managing the transportation supply, transportation demand, and managing land use (9). The relationship among land use, economic activity, and transportation investment is one of the most important to decision makers and to the planning process.

A primary tool to assist governments or agencies in providing an adequate transportation system at an acceptable cost is the travel demand model. It involves modeling the behavior of the present system, estimating future travel demand, and estimating how changes in the system will affect travel behavior and operation of the system in the future (8).

The basis for travel demand models is the division of the urban area into traffic analysis zones (TAZs), which may correspond to census tracts, and the representation of a network of transportation facilities connecting the zones. The network is described by the time and cost of travel, for each mode, between each pair of zones. Inputs include proposed future transportation networks and forecast population and employment characteristics by zone. A four-step process is then used to forecast travel:

- *Trip generation* - Total trips generated by persons that start and end in each zone are predicted, based on the population, employment, household characteristics, and other factors of the zone;
- *Trip distribution* - The trips are distributed among pairs of zones, usually based on a gravity model which distributes trips in inverse proportion to the distance between zones;
- *Mode choice* - The trips are allocated among the available travel modes, based on relative characteristics (usually time and cost) of the modes; and
- *Network assignment* - The trips are assigned to specific links (road segments) in the transportation network, generally based on the shortest time path between two zones.

The different stages of the four-step process may include both aggregate and disaggregate behavior models. These models have sometimes been modified to incorporate additional travel behavior factors, such as feedback from later steps to earlier steps or variations in travel by time of day.

In the context of this research project, the movement of trucks is of paramount concern. In the last decade, analysis of the movement of freight has taken on importance. Techniques for freight transportation planning, especially at regional levels, have not been as well developed as for passenger movements. To some degree, this can be attributed to the greater complexity of the freight transportation system in terms of the spatial and temporal diversity of freight generation activities and movement. Freight transportation demand modeling must also address the multi-dimensional nature of freight transportation, which is not a consideration in passenger transportation modeling. In freight transportation, factors like volume, weight, and trips come under the control of a number of decision-makers (dispatchers, drivers, freight forwarders), operation regulations, and restrictions (10).

In the literature pertaining to truck modeling or freight modeling, statewide or regional analysis is the basis for much of the discussion. Different methodologies are presented to derive commodity flows, but data collection or monitoring is presented as a necessary step in the analysis process without specific techniques or requirements given. Furthermore, truck/freight modeling would only provide one piece of the overall traffic component, albeit a large part, of a new major or special generator. It would not address the lower FHWA vehicle classifications that are expected to be part of the traffic growth from the special generator.

Special traffic generators will have an impact on the local and regional transportation system. The extent of this effect is subjective to the scale of the generator and the size of the metropolitan area. The most basic effect is intersection and roadway capacity improvements. In many instances, infrastructure improvements to the roadway system are part of the development package offered by the area hoping to attract the



major generator. Researchers confirmed this through telephone interviews with several officials at agencies around the country who had major traffic generators in their area.

In eastern Alabama, the state department of transportation constructed road improvements along Interstate 20 as part of the development agreement with American Honda Motor Company for an auto plant in the area (David Norris, West Alabama Regional Council, September 2005). Even if not part of a development package, improvements to the roadway system would in all likelihood be made. In the Princeton, Indiana, area, the state department of transportation (DOT) signalized several intersections near a new Toyota automobile manufacturing plant (John Curry, Indiana DOT, October 2005). Again, the scale and location of the major traffic generator is crucial to the extent of improvements. If located along a major corridor in a metropolitan area, the required improvements could be costly and extensive. If in a more rural location, needed expansion in capacity or operations could be less.

Indirect impacts of major traffic generators in an area include changes in land use and development of supporting services for employees of the generator. Researchers noted observations from agency officials during telephone interviews that changes in the immediate vicinity of several automobile plants under discussion in this project proved to be slow in forming. Princeton, Indiana, has yet to see some of the expected impacts from construction of a Toyota plant in the city. Employees have tended to live in towns and cities further out from the plant than expected. The cities around the Saturn plant in Tennessee saw development come to fruition seven years after the plant opening (John Curry, Indiana DOT, October 2005). Economic development activity around the Honda plant in Lincoln, Alabama, has proven slow, but this was expected based on discussions by local officials with other towns with new automobile manufacturing facilities (Jack Plunk, East Alabama Regional Commission, September 2005).

## **TRAFFIC MONITORING**

Monitoring of activity on the transportation system in all areas of the state is a basic task for state departments of transportation. Traffic varies over time and place. It is necessary to understand and be able to monitor all of these activities and changes in travel to make correct decisions about the design, operation, and maintenance of roadways. The State of Texas has an extensive traffic monitoring network. Analysis of this collected data serves many purposes for officials at state and local agencies.

Volume is the total number of vehicles passing a point on a transportation facility during a given time period, usually expressed as annual, daily, hourly, peak or off-peak traffic volumes. Short duration volume counts are traditionally the primary focus of most statewide traffic monitoring efforts. Traffic count programs are used to compute annual vehicle distance traveled (AVDT), which is useful for describing system-wide vehicular travel and trend tracking purposes. Volume counts are performed manually and automatically. The three main elements to traffic volume counts are a limited continuous count element (CCE), highway performance monitoring system (HPMS) data collection, and special needs and short-term counts. HPMS counts are conducted to meet federal reporting requirements. They provide a statistically valid statewide estimation of AVDT (11).

Automatic traffic recorders (ATR), mostly using inductance loop detectors, are used to monitor traffic at specific locations and produce the factors applied to short

duration traffic volume counts in order to estimate annual average traffic volume. ATR data are commonly stored on site as hourly volumes by lane and are downloaded periodically to a central location. At the central location, the data are checked for quality, summarized, and stored for later use. The summary and raw values are then made available to data users within the DOT (11).

Vehicle classification allows the monitoring of changes in truck volumes and changes in vehicle fleet mix (the percentage of travel by specific vehicle types) to be tracked over time. Vehicle classification is obtained through both automatic and manual techniques. Each method is collected separately. The vehicles are classified using the TEXAS6 vehicle classification scheme. As with volume counts, the monitoring cycle is annual. The monitoring period is 48 hours for automatic vehicle classification (AVC) and 24 hours for manual collection. Classification is separated by direction and stratified using HPMS functional classes and area type. Vehicle classification is scheduled regionally due to the size of the state, moving from south to north during the monitoring cycle (11).

Automatic vehicle classification uses lane sensor devices to record vehicle data. The processing unit aggregates data from each sensor and interprets the data as a particular class of vehicle passing over the site. AVC equipment provides reliable vehicle classification at locations with typical roadway speeds of 45 MPH or faster. AVC data are manually retrieved from the field once a year by connecting the field equipment to a computer module on which the data are stored. The computer module is then taken to the TxDOT Technical Services office where the data are then copied to an AVC machine similar to machines used in the field. By linking the AVC machine with a desktop computer, the data are converted from a binary file format to an ASCII file format. The data are then sent to the Data Management Section and converted into the same format used for analysis of manual count data and subjected to a preliminary review by Data Analysis Section staff (11).

Manual vehicle classification data are provided to TxDOT from contractors who collect visual classification data manually in the field. Data are initially recorded by handwriting the results on forms that are then manually inputted to an electronic computer file for easier data analysis. The data are then forwarded to Technical Services staff where they undergo quality assurance checks. Once the data are accepted, they are then forwarded to TxDOT Data Analysis staff for further analysis.

Variability in visual classification during manual data collection can occur. Field collectors must make split-second decisions concerning which of the various vehicle class categories a particular vehicle should be classified. Of the 13 available vehicle class categories, 10 involve different variations of trucks. The human classifier must perceive, process, classify, and record several vehicles in a very short period of time. It creates an environment for data collection error, especially in high traffic volume areas (11).

The portable equipment used to collect traffic volume and classification data is very similar. The counters consist of pneumatic tubes or other types of sensors placed directly across an entire roadway or across a single lane. The difference between the two is the layout of the sensors on the roadway. Vehicle classifiers consist of two-axle sensors while using the same equipment as volume counters; therefore, classification equipment can also be used to count traffic volumes (11).

Permanent traffic volume counters and vehicle classifiers have the same relationship as their portable counterparts. Traffic volume counters typically consist of an inductive loop embedded in the pavement. Permanent vehicle classification equipment consists of inductive loops or piezoelectric sensors, or a combination of the two. AVC sites store vehicle classification information by specific lane or for all lanes of a roadway (11).

Weigh-in-motion (WIM) data collection is intended to accurately measure the dynamic traffic loads that are being applied to particular pavement sections over time. Weight data are necessary for converting truck volumes into the axle load estimates needed as an input to pavement design and maintenance procedures. Highway WIM systems are capable of estimating the gross weight of a vehicle as well as the portion of the weight that is carried by the axle and axle group on the vehicle. WIM requires the most sophisticated data collection sensors of all monitoring site technologies, the most controlled operating environment, and the most costly equipment set up and calibration. WIM data are also the most important in that they provide a greater range of data than volume counts and classification (11).

In addition to pavement design, truck weight data can be used for a wide variety of tasks. These tasks include:

- Pavement maintenance;
- Bridge design;
- Pavement and bridge loading restrictions;
- Determination of the need for and success of weight law enforcement actions;
- Determination of the need for geometric improvements related to vehicle size, weight, and speed;
- Determination of the economic value of freight being moved on roadways; and
- Determination of the need for and effect of appropriate safety improvements.

Roadway intercept surveys are another technique to monitor major traffic generator sites. They can provide a greater level of detail than machine traffic counts can, assuming drivers are willing to provide the information. A roadway intercept survey can determine a vehicle's previous origin and future destination. All data elements can be collected, clarification and follow-up to responses can be done immediately, and data are available sooner. These surveys are more expensive, however, due to high staff resources at multiple locations and required traffic control measures to ensure safety of staff and respondents. Greater coordination between authorities and agencies is required, and the survey is weather sensitive (11).

Location of the major generating facility is a factor in using an intercept survey. In a less dense or rural setting, roadside intercept surveys can be safely and efficiently conducted if attention is given to the specific location, coordination with authorities, costs and resources for the survey. In denser, more urban locations, a more flexible approach is needed in light of potential physical conditions at the survey site. Research has found that weigh stations, rest areas, and truck stops are conducive to surveying commercial vehicles on high-volume facilities in the State of Texas (12).

The majority of the works reviewed do not address traffic monitoring at or in the vicinity of a major or special generator. Several works, especially in the travel demand

modeling context, mention data gathering for these generators but only in a general way. Traffic data collection is presented as a necessary step in the process to account for major generators, but specific types of data, duration, and location are not discussed or any systemic advice proffered.

Traffic monitoring at or near special generators was described in some works reviewed. In Solano County, California (Sacramento region), ground counts at the entrance/exits of special generators are used to derive vehicle trip-rates for the travel demand model. Examples of special generators in the county are an Air Force base and a state prison (13). Waco MPO has utilized a consultant to conduct travel surveys of selected special traffic generators within McLennan County. The survey data are used to help develop the travel demand forecast model (14).

Alabama DOT requested and received information from Honda Motor Co. pertaining to the expected number of employees and the number of trucks servicing the new complex in Lincoln, Alabama. The department conducted manual and machine counts along major routes in the area of the plant before its opening. Alabama DOT has seen an expansion of truck traffic after the plant opened. According to DOT staff, the percentage of trucks on IH 20 is now 40 percent. It is the only instance found of special counts conducted prior to a major traffic generator being constructed.

An exception in the literature regarding data in travel demand modeling is a work that analyzes whether travel demand estimates can be improved through the subdivision of certain TAZs for the future year projection period. Would increasing the number of zones improve the resulting regional forecast and aid in project-specific demands on the system? Comparing the original demand model, the reconfigured model (subdivided), and ground counts, the researcher found no exhibited improvement between the models. In fact, the reconfigured (subdivided TAZ) model showed a lesser ability to replicate ground counts (15).

In constructing a TRUCKSIM model for truck traffic at a seaport, Palmer et al. identify the data needs and sources. Gate operations and arrival rates are garnered from terminal records and field observations. Destinations and routes are defined through interviews with terminal and trucking companies and through truck driver surveys. Background traffic volumes are obtained from “available or collected traffic counts” (16). Roadway usage such as speed, acceleration/deceleration, delays, etc., is field collected by a car with sensors that follows trucks repeatedly along routes from the port under a variety of traffic conditions. Again it should be noted that this data collection is in the context of travel demand or truck modeling and not within a regional planning context.

Other types of data collected for analysis of special generators within the demand model and commodity flow context include employment data, land use data, and commercial facility data disaggregated to the TAZ level. However, the specific types of data within these categories are not stated nor is a collection methodology provided, much less evaluated (17).

No example was found in the literature or practice of a traffic monitoring process specific to a major traffic generator after construction and once operational. The traffic generated was captured as part of the normal traffic count process.

## **CHAPTER 2: DEVELOPMENT OF THE TRAFFIC MONITORING SYSTEM**

### **RECOMMENDATIONS FOR EQUIPMENT AND SITE LOCATIONS**

The first year of the project focused on defining the study area around the manufacturing plant, estimating the data collection sites required for an effective monitoring system, and equipment purchase and installation. TTI staff presented recommendations for equipment for multiple scenarios. The report was developed cooperatively between TTI staff and Transportation Planning and Programming (TPP) Division staff over two field visits to the Toyota plant study area. TTI staff also identified and reviewed San Antonio's City South Community Plan for relevancy. These field visits and documents provided a basis for future development wishes in the area and also documented existing land uses and the transportation system in place prior to the plant construction and opening.

The project study area was defined through the professional judgment of TTI researchers and TPP personnel. The study area had to be large enough to measure potential impacts from the major traffic generator, but small enough to allow for the available resources. The Toyota plant was bounded by four major roadways at an acceptable distance from the plant.

Twenty-nine sites around the Toyota plant were identified within the study area boundary for installation of permanent data collection sites. The site locations also indicated whether continuous volume or continuous vehicle classification would be collected.

In coordination with the Project Management Committee, the Texas Transportation Institute/University of Texas at San Antonio (TTI/UTSA) research team developed recommendations on traffic data collection equipment to be used in the research project. The primary data collection devices would be loop/piezoelectric equipment that collect vehicle volume, speed, and classification. TPP Division agreed to assist the research team in acquiring this equipment.

Two secondary data collection devices were co-located with the loop/piezoelectric equipment. These are radar-based traffic monitoring devices. The additional equipment facilitated a comparison between the selected traffic data collection devices and their associated communications media.

Communications solutions for delivering data from all these sites were accomplished with leased telephone lines and wireless technology. It was recommended that all the data collected from the loop/piezoelectric devices be transmitted to TPP via leased telephone lines, as per TPP's standard practice. The research team recommended that data from the Wavetronix radar-based devices be retrieved via code-division multiple access (CDMA) wireless communication.

[Appendix A](#) identifies salient characteristics of the recommended sites and data collection equipment. Each "classification" and "volume" site was equipped with loop/piezoelectric equipment and communications were accomplished with leased telephone lines. Two of these same sites (Site 4 and Site 21) were also equipped with the radar-based traffic monitoring equipment and communications were accomplished with

CDMA devices. Figures 1 and 2 illustrate the general locations of the data collection sites relative to the Toyota plant.

### EXPERIMENTAL DESIGN

The research team prepared “An Assessment of a Traffic Monitoring System for a Major Traffic Generator to Improve Regional Planning: The Experimental Design.” The team explored different methods of measuring the transportation and development impact that a new manufacturing facility has on a region using the new Toyota manufacturing plant as a case study. The experimental design was created in context of project timing, funding, and organizational resources. The plant is located in the south part of San Antonio (see Figure 1). The plant is expected to change traffic patterns and to generate an increase of both truck and automobile traffic.

The largest increase in traffic volume was expected to be at or near the plant. The impact on traffic patterns is expected to diminish corresponding to the distance of the roadway from the plant.

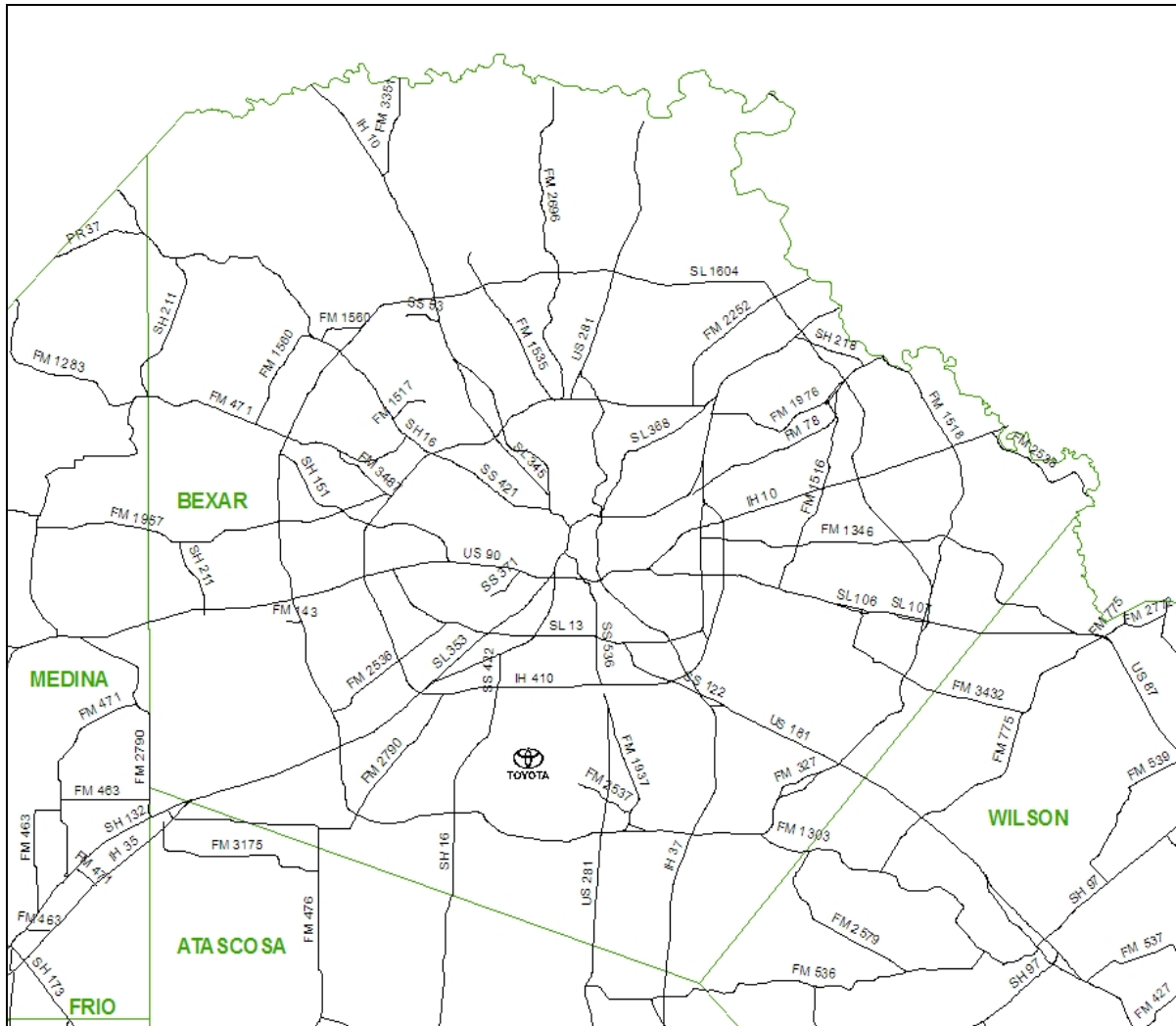
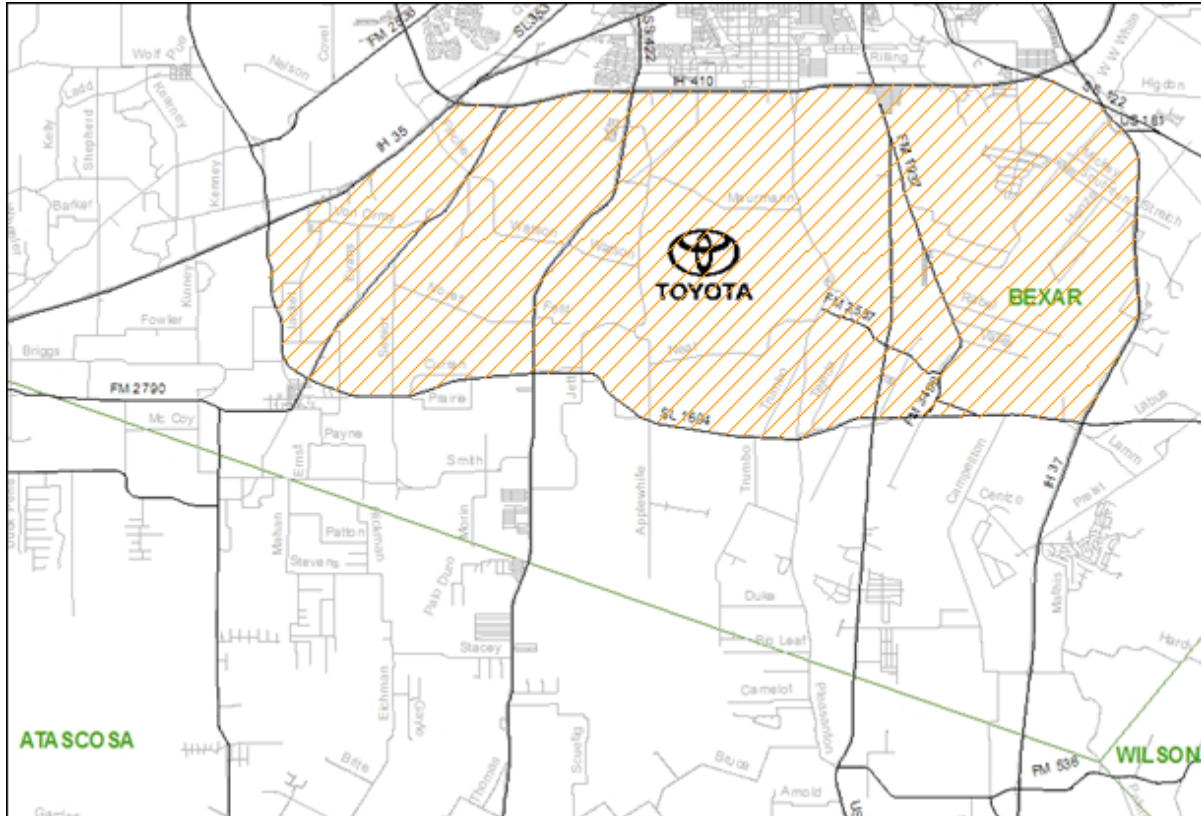


Figure 1. Toyota Manufacturing Plant within Bexar County.

The outer limits of the study area are marked by four highways. The north, east, south, and west limits are interstate highway (IH) 410, IH 37, Loop (LP) 1604, and IH 35, respectively. The area most affected within those boundaries is bordered on the north by IH 410, on the east by US 281, on the south by LP 1604, and on the west by SH 16. [Figure 2](#) shows the study area.



**Figure 2. Study Area.**

## **Land Use Changes**

After a major traffic generator is developed (e.g., new manufacturing plant, large employment centers, large retail or residential centers), other companies that support and/or facilitate the new business also begin to develop. Therefore, the surrounding area is likely to develop and land uses change. Aerial photography and building permits can be used to document what land use changes take place. Building permits, utility hook-ups and available economic data can also be used to identify increased development.

### *Aerial Photography*

Aerial photography, or photos, can be used to observe the physical changes occurring, such as new buildings, building density, changes in green space, an increase in the number of lanes of a particular roadway, or roadway density. The limitations of using aerial photos are the availability of photos from the past, that similar techniques were

used in collecting these photos (i.e., altitude, photographic method), acquiring these photos, and that these photos are applicable to the study time frame.

MPOs, TxDOT, the TxDOT district or large municipalities are likely sources for aerial photos. The City of San Antonio (COSA) contracts out the aerial photography service. COSA had collected aerial photos since January 2004 and plans to continue on an annual basis (excepting 2005). Their images are processed and made available for public use on COSA's website, <http://maps.sanantonio.gov>. Current aerial photos are available online, but historical photos are not. Historical photos can be requested for comparative purposes. Hardcopy photos are preferred for making comparisons.

To compare current land use activity to past activity, a uniform grid can be placed upon each aerial photo. For this study, the grid squares would each represent one square mile (640 acres). The grid would be placed such that the intersection of IH 35 and IH 410 is the origin and be aligned along the intersection of IH 37 and IH 410. The percentage of land use and/or roadway improvements could then be measured per square mile and compared. Careful examination could reveal changes in commercial/retail use, industrial use, residential uses (single family and multi-family could be disaggregated), institutional usage (i.e., public schools, hospitals), and roadway improvements. For each corresponding square on both past and present maps, the usage is calculated by area and a percent of the square mile is determined. The percentages from before and after are then compared to see if there is any change.

### *Building Permits*

Building permits can be used to observe changes in building activity within an area. Building permits are used by municipalities to regulate conformance to building codes. These permits are granted through the local municipality and/or the county where the new major traffic generator is established.

The COSA publishes city-wide permit data on its website and, by use of a public information request, data can be stratified to the zip code and street level. Building permits give some indication of construction or development activity; however, permits issued do not imply construction occurs.

The application of permit data is influenced when portions of the study area are in different jurisdictions: partly in city limits, part outside of city limits, and part in limited-control city limits. Regulation of building permits may differ in each part. Permits may not be required outside of city limits. The COSA generally does not issue building permits outside its city limits. This can have an adverse impact on a comparative study.

When announced, the Toyota plant was planned to be built in the extraterritorial jurisdiction of COSA. In late December 2005 and early January 2006, COSA implemented a "limited purpose" annexation. A home-rule city with a population of more than 225,000 may annex an area for the limited purpose of applying its own planning, zoning building health and safety ordinances in the area to prevent incompatible land uses. This ensures sound and safe habitable structures and protects environmental resources. The area must be within the city's extraterritorial jurisdiction and contiguous to the boundaries of the city. Limited purpose annexation does not extend the city's extraterritorial jurisdiction. The limited purpose annexation area in south San Antonio is governed by COSA's building permitting process.



The limited purpose annexation by COSA was initiated after the project start date. The study area location was then inside the limited purpose annexation area in which COSA does issue building permits. As a result, the recording of building permits in this area also began post-project initiation. Prior to the study area being annexed, there was no record of building permits because none were issued by the county. No comparisons can be made of current history of building permits to past history.

### *Utility Hook-Ups*

Utility hook-ups such as electricity or water could also allow observation of new business activity within an area. Water connectivity would be less useful given that water is supplied to a building (single or multiple tenant), whereas electricity is supplied to each tenant in the building as tenants lease space. Similar problems to those discussed regarding building permits can arise when the study area is in multiple jurisdictions. Adding to the complexity, in the era of electric utility deregulation if more than one electricity provider is available, then collecting the number of electricity hook-ups from each electricity provider could prove to be a challenge.

### *Economic Data*

Economic data from the State of Texas data collection agencies may be an indicator of a number of businesses segregated into North American Industrial Classification System (NAICS) codes. Many of these agencies provide data online for public use. An open records request or a call to the appropriate agency can provide refinements of the data (e.g., stratification by zip code, or county, or region). In this case, the most recent NAICS information was reported in 2002. The next release of data was scheduled for 2007.

### **Travel Impacts**

Travel patterns will change when a major traffic generator is developed. Traffic volumes, types of vehicles, travel times, travel purpose, and number of incidents can all be affected in the area surrounding the traffic generator. In order to assess the changes for this study, a monitoring system needs to be in place to record the before and after travel patterns.

Traffic counters must be in place in order to observe traffic volume changes. The data may come from both existing count locations and additional stations installed to increase count coverage. For this study, TxDOT has a statewide monitoring system that uses short-term and long-term count stations to collect traffic volume and vehicle classification (VC). TxDOT annual counts are adjusted for seasonality (monthly or seasonal factor) and traffic mix (axle factor). TxDOT saturation counts, collected every five years, are short-term volume counts with axle counts divided in half and are not seasonally adjusted.

Bexar County, Texas, also has short-term volume count stations in place for areas not within city limits. The Bexar County short-term counts are axle counts divided in half and are not seasonally adjusted. The historical data from these traffic monitoring

programs could give a picture of the travel patterns previous to the construction and opening of the Toyota plant.

In addition to the historical sites, 24 continuous vehicle classification and six continuous volume sites were installed for this study based on a previous team recommendation. Figure 3 displays the new traffic monitoring sites. Two Wavetronix radar-based data collection machines were also installed for this study. The Wavetronix equipment collects both classification data (based on vehicle length into a small number of bins) and traffic volumes. Figure 4 through Figure 7 show the location of available historical traffic count sites within the study area and in relation to the new traffic monitoring sites.

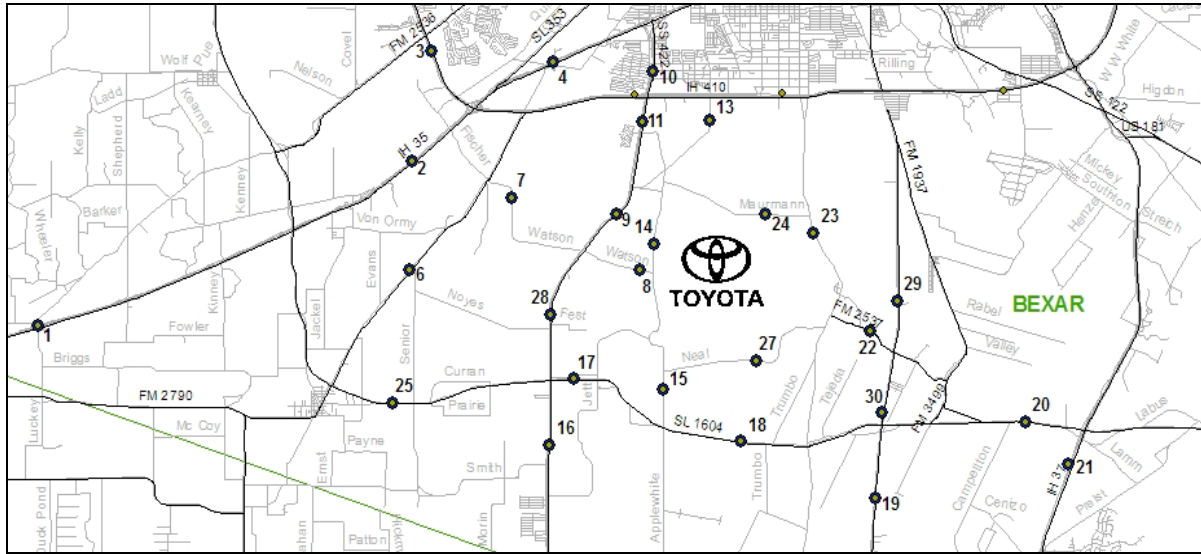


Figure 3. New Traffic Monitoring Sites within the Study Area.

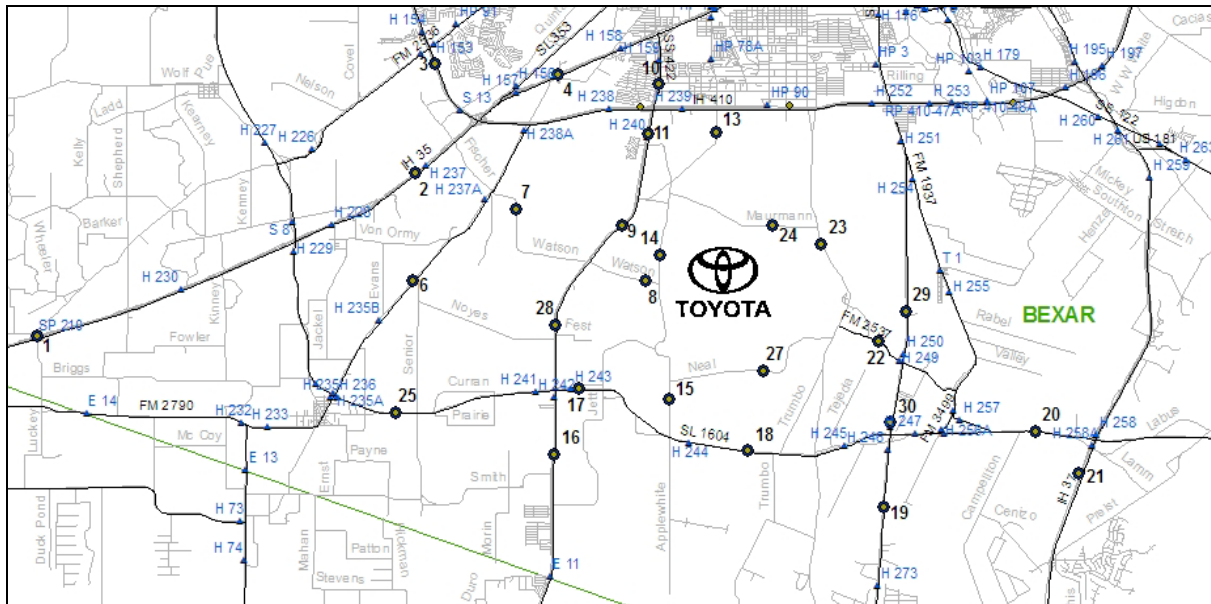


Figure 4. TxDOT Annual Count Locations within Study Area.

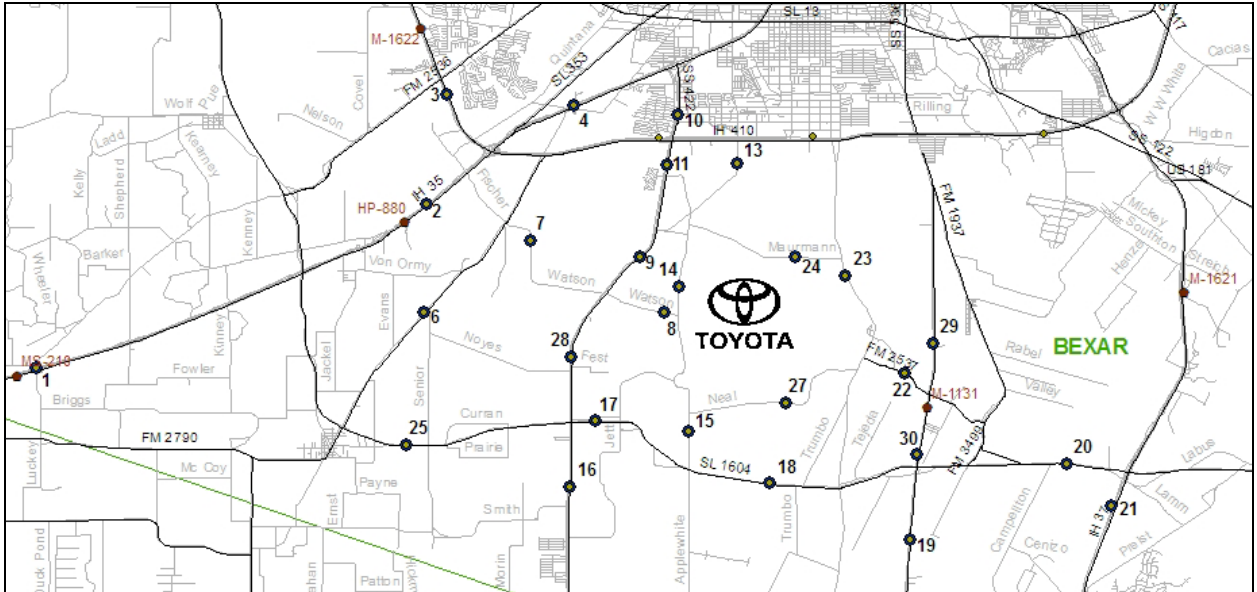


Figure 5. TxDOT Annual Vehicle Classification Counts within Study Area.

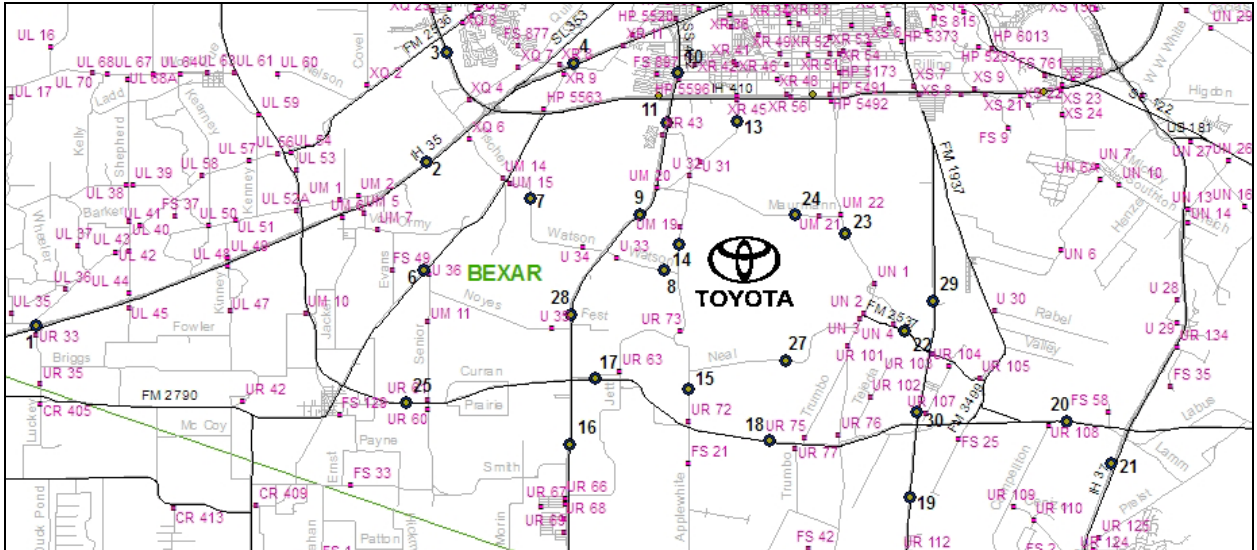
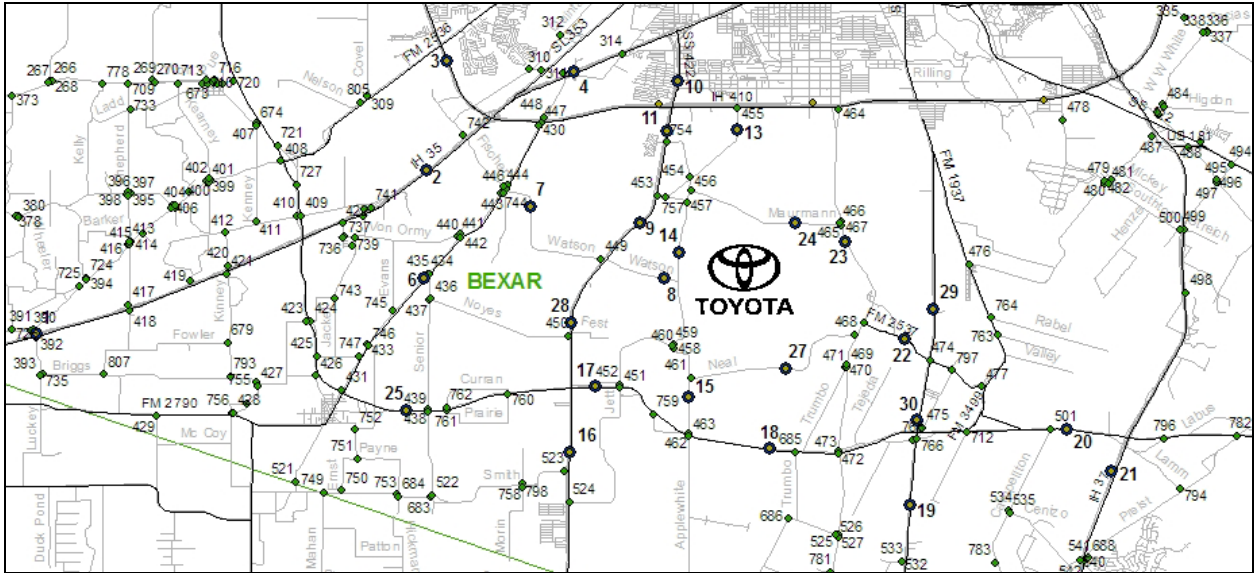


Figure 6. TxDOT Saturation Counts within Study Area.



**Figure 7. Bexar County Traffic Count Sites within Study Area.**

Table 1 displays the new traffic monitoring sites installed in and around the limited purpose annexation area to measure the impact upon traffic due to the Toyota plant. Also listed are the corresponding historical volume sites, classification sites, saturation count sites, and Bexar County count locations. Each new site has one or more locations to which comparisons could be made.

**Table 1. Traffic Monitoring Sites Installed for the Toyota Case Study and Corresponding Historical Traffic Monitoring Sites Already in Place.**

SITE	Roadway	VC	Annuals	Annuals 2	Urban 1	Urban 2	Bexar
Site 1	IH 35 Near Lytle	MS 210	H 230		UR 33		
Site 2	IH 35 between IH 410 and LP 1604	HP 880	H 237				
Site 3	IH 410 between Pearsall Rd and IH 35	M 1622	S 13	H 154			
Site 4	IH 35 between IH 410 and SS 422		H 157	H 158			
Site 5	IH 410 West of SH 16		H 238				
Site 6	FM 2790 between IH 410 and LP 1604 @ Senior		H 235B	H 237A			434
Site 7	Watson Rd between FM 2790 and SH 16				UM 15	U 34	<b>444</b>
Site 8	Watson Rd between SH 16 and Applewhite Rd				U 33		
Site 9	SH 16 between Zarzamora and Watson Rd		H 240				
Site 10	SS 422 between IH 35 and IH 410		H 159				
Site 11	SH 16 between IH 410 and Applewhite Rd		H 240				
Site 12	IH 410 between Zarzamora and Pleasanton Rd near RR tracks		H 239	H 252			
Site 13	Zarzamora between IH 410 and Applewhite Rd				XR 45	U 31	454, 455
Site 14	Applewhite Rd North of Watson Rd				UM 19		457
Site 15	Applewhite Rd between Neal and LP 1604				UR 72		462
Site 16	SH 16 South of LP 1604		H 242				
Site 17	LP 1604 West of SH 16		H 243				
Site 18	LP 1604 between Applewhite Rd and Trumbo		H 244	H 245			
Site 19	US 281 South of LP 1604		H 246	H 273			
Site 20	LP 1604 between Campellton and IH 37		H 256A				
Site 21	IH 37 South of LP 1604	M 1621	H 258A				541
Site 22	FM 2537 East of US 281		H 249				680
Site 23	Pleasanton Rd South of Maurmann				UM 22	UN 1	469
Site 24	Maurmann East of Pleasanton Rd				UM 21		456, 466
Site 25	LP 1604 East of Senior		H 236				
Site 26	IH 410 between Southern Pacific RR and Presa		H 253				
Site 27	Neal between Applewhite and Pleasanton Rd						461, 468
Site 28	SH 16 between Watson Rd and Fest		H 242				
Site 29	US 281 FM 1937 and FM 2537	M 1131	H 250				
Site 30	US 281 North of LP 1604	M 1131	H 248				

Because San Antonio is a growing city in population and numbers of businesses, regional travel patterns change in response to this growth even without the addition of a new major traffic generator. Normal analysis procedure calls for several additional historical sites to be randomly selected from within Bexar County to track volume changes and/or traffic mix related to these regional changes. These random sites should be selected from those roadways with similar area type and functional class to serve as a control group. For this case study, there were very few historical sites available for a random sample to be selected. All the available historical sites will be used to differentiate the changes in travel patterns due to a growing city and those changes due to the Toyota plant. [Table 2](#) lists the sites to be used as controls.

**Table 2. Historical Continuous Volume Traffic Monitoring Sites.**

<b>VC Site</b>	<b>Roadway</b>
S 146	IH 410, 1.1 mi SW of SH 16
S 160	US 181, 0.6 mi SE of LP 1604
S 184	IH 10, 0.6 mi E of IH 35
S 185	IH 37, 0.3 mi S of IH 35
S 188	US 281, 1.0 mi S of IH 410 (Northside)
S 206	IH 10, 1.4 mi SW Kendall County Line
S 207	IH 10, 0.4 mi E of FM 775 (Seguin)
S 210	IH 35, 1.8 mi N of Atascosa County Line, S of LP 1604
S 45	IH 10, SE of SS 421

After the data have been collected, comparisons can be made using three methods:

- (1) The data collected from the new traffic monitoring sites in the study area before the Toyota plant opens for business can be compared to the data collected afterwards;
- (2) The data collected from existing traffic monitoring sites associated with new traffic monitoring sites can be compared using data before and after the plant opens; and
- (3) The data collected from the new and existing traffic monitoring sites in the study area can be compared to traffic monitoring data collected from control sites outside the study area.

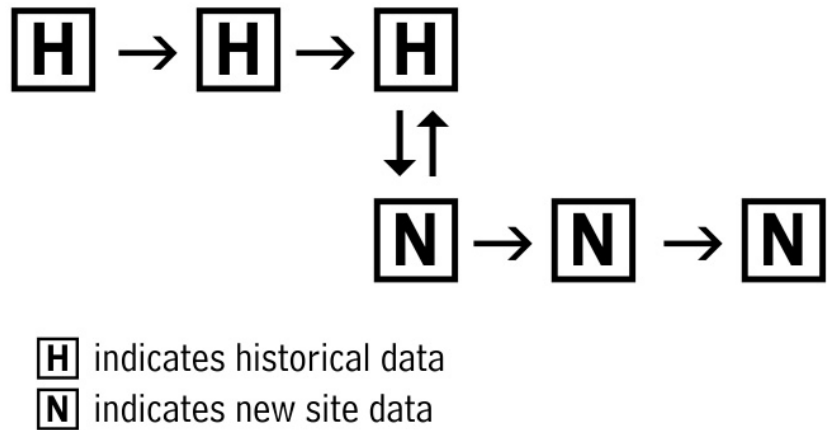
### **Traffic Volume: Changes at New Sites Only**

This method allows for direct comparison at the same location using volume data. For determination of a significant difference in volumes, a paired t-test is sufficient. The data collected before and after implementation can be paired by location and a test for significant difference between before and after counts can be performed. For the case study, most of the newly installed sites lacked a history of counts. The few sites with more than six months of data could be analyzed with the consideration that these few sites may not be enough to be representative of the study area.

### **Traffic Volume: Changes at New Sites using Historical Existing Site Data**

A paired t-test would be sufficient to test for the detection of a significant difference in the before and after implementation volumes at the historical locations. As noted previously, in this case study, the new sites have little or no history. Determination of equivalency of collected data is needed between new site and the associated historical site in order to answer the question, “Are the new site and the associated historical site collecting equivalent data?” [Figure 8](#) displays the concept. The boxed H represents historical data. There are three boxes to represent the data collected over a number of years. The new site, N boxes, comes online and starts collecting data. If the boxed H and the boxed N are equivalent, then data collected from the new site can be associated with the historical data. This is important since many of the new data sites collect continuous

classification data as well as continuous volumes, whereas many of the historical sites collect only one 48-hour period each year.



**Figure 8. Illustration of Equivalency between Historical Data and Data Collected from New Sites.**

Three considerations follow from this: point estimates of average daily traffic (ADT) volume, 24-hour distribution of volume, and coverage.

*Point Estimates of Volume*

A point estimate of volume is ADT collected at a given point in time, namely data collected on a particular day. The idea is to determine if there is a significant difference in the volume collected by the new data site versus volume data collected by the associated historical site. To perform a test of significance, volumes need to be simultaneously collected on both sites over a 24-hour period for a number of days. These observations are restricted to Tuesdays, Wednesdays, and Thursdays to avoid abnormal traffic patterns. Between 10 to 30 days are needed for observation. The data can then be paired by location (same link of roadway), and a test for significant difference between the counts can be performed. If the test shows no significant difference at a site pair, then historical data can be used for the before and after comparison. If the test shows a significant difference, historical data may not be used for before and after comparison at the new traffic monitoring site.

*24-Hour Distribution of Volume*

A 24-hour distribution of volume is 15-minute counts over a 24-hour period. The idea is to determine if there is a significant difference in the volume distribution collected at the new traffic monitoring site versus volume data collected by the associated historical traffic monitoring site. To perform a test of significance, the distributions need to be collected on both sites over the same 24-hour period for a number of days. These observations are restricted to Tuesdays, Wednesdays, and Thursdays. A minimum of five days' observation is needed. The data can be paired by location (same link of roadway),

and a test for significant difference between the distributions can be performed using the Kolmogorov-Smirnov test. The Kolmogorov-Smirnov is a distribution-free test for general differences in two populations. This test is used to see if the distributions are significantly different. If the new traffic monitoring site is not significantly different to the associated historical site, then the data collected by the new site can be compared against the historical data.

### *Coverage*

The last consideration is coverage. Given that there are approximately 30 new sites, 10 sites should be selected for equivalency testing. The 10 sites should be selected from both in the immediate area of the plant and further away from it. Initial testing of these 10 sites could give an indication whether to test the remaining sites.

### **Traffic Volume: Control Comparison**

A third method measures the change in volumes outside the study area, which is most likely to not be affected by the Toyota plant. The percent change measures for the control group can then be compared to the percent change measures for the new and existing locations in the study area. Because the impact on traffic patterns is assumed to be correlated to the proximity of the plant, the percent change measures for the new and existing locations in the study area should be stratified by distance from the Toyota plant, and comparisons can be made for each stratum to the control group.

### **Traffic Mix: Changes at New Sites Only**

This method allows for direct comparison at the same location using classification data. For a determination of a significant difference in vehicle class distribution at the new sites, a  $\chi^2$  test may be implemented with categories associated with each vehicle class or class grouping. Grouping can be achieved by collapsing classes into groups using the Traffic Monitoring Guide (TMG) traditional categories<sup>1</sup>:

- Passenger vehicles (cars and light pick-ups)
- Single unit trucks
- Single combination trucks (tractor trailer)
- Multi-trailer trucks

Most of the newly installed sites in the study area lacked a history of counts. The few sites with more than six months of data can be analyzed with the consideration that these few sites may not be enough to be representative of the study area.

### **Traffic Mix: Changes at New Sites using Historical Existing Site Data**

Similar to the previous method, a  $\chi^2$  test may be implemented with categories associated with each vehicle class or class grouping to test for the detection of a

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<sup>1</sup> Federal Highway Administration. *Traffic Monitoring Guide*. pp. 4-10



significant difference in the before and after implementation volumes at the historical locations. The determination of equivalency as discussed in the *Traffic Volume: Changes at New Sites using Historical Existing Site Data* section above applies to the classification data as well. This is important since most of the new traffic monitoring sites collect continuous classification data, whereas most of the historical sites do not collect any classification data. Again, if the new site is equivalent to the associated historical site, then the data collected by the new site will provide information for comparative analysis.

There are five historical VC sites in the study area. They are located on the outer highway boundaries of the area. Within the study area, there were no VC sites near the plant or on non-highway roadways. Table 3 displays the historical VC sites and the new sites near the classification locations. Given the distribution of the VC sites, the historical sites may not be representative of the traffic mix in the study area.

**Table 3. New Traffic Monitoring Sites and Associated Historical Vehicle Classification Monitoring Sites.**

SITE	Roadway	VC	Annuals	Annuals 2
Site 1	IH 35 Near Lytle	MS 210	H 230	
Site 2	IH 35 between IH 410 and LP 1604	HP 880	H 237	
Site 3	IH 410 between Pearsall Rd and IH 35	M 1622	S 13	H 154
Site 21	IH 37 South of LP 1604	M 1621	H 258A	
Site 29	US 281 FM 1937 and FM 2537	M 1131	H 250	
Site 30	US 281 North of LP 1604	M 1131	H 248	

### Traffic Mix: Control Comparison

The final method measures the change in volumes and distributions outside the study area, which is most likely to not be affected by the Toyota plant. Table 4 displays the vehicle classification locations to be used as a control group. The percent change measures in the various classes for the control group can then be compared to the percent change measures for the new and existing locations in the study area. Because the impact on traffic patterns is assumed to be correlated to the proximity of the plant, the percent change measures for the new and existing locations in the study area should be stratified by distance from the Toyota plant, and comparisons can be made for each stratum to the control group.

**Table 4. Control Group of Vehicle Classification Monitoring Sites.**

VC Site	Roadway
MS 160	US 181 SE of LP 1604
M 1624	IH 10 E of FM 1518
M 1315	IH 35 at Bexar/Comal County Line
HP 883	IH 10 NW of LP 1604
MS 206	IH 10 at Bexar/Kendall County Line
M1245	LP 1604 between SH 16 and FM 1560
M 1230A	FM 471 at FM 1560

## Travel Times

Given the expectation of a change in travel patterns due to a major traffic generator, travel times can be expected to change. The purpose of travel time data collection is twofold:

- (1) To generate a speed profile for the corridor per direction (usually peak direction) at a given time of day, and
- (2) To determine instantaneous speeds at given checkpoints or mile-marks along the corridor.

### *Corridors*

In order to assess changes in travel times for priority corridors in the affected area, frequency of corridor timings and corridor priority needed to be selected. Once corridor selection occurs, corridors located outside the study area need to be chosen for comparison purposes. Within the study area, corridors that were likely to be impacted are listed from highest to lowest priority in [Table 5](#). Corridors outside the study area selected for comparison purposes are shown in [Table 6](#).

**Table 5. Travel Time Corridors and Priority.**

ID	Corridor	From	To
1	Applewhite/Zarzamora Rd	LP 1604	IH 410
2	Watson Rd	IH 35 (mark FM 2790)	Applewhite Rd
3	SH 16	LP 1604	IH 35
4	LP 1604	IH 35	IH 37
5	IH 410	FM 2536	IH 37
6	US 281	LP 1604	IH 410
7	FM 2790	LP 1604	IH 410
8	IH 35	Lytle	SP 422
9	IH 37	LP 1604	IH 410

**Table 6. Control Travel Time Corridors.**

ID	Corridor	From	To
1	SH 16	LP 1604	SH 46
2	US 87	LP 1604	SH 46
3	LP 1604	SH 16	US 90
4	US 87	LP 410	LP 1604
5	SH 471	LP 1604	SH 211
6	Pinn Rd	SH 151	US 90
7	Potranco Rd (SH 1957)	LP 1604	SH 471
8	IH 10	LP 1604	SH 46

### *Monitoring Periods*

In consideration of time and costs, monitored time periods of the day need to be carefully selected. The traffic volume during morning and afternoon peak periods may

change due to a major traffic generator as well as mid-day or overnight periods. A major traffic generator can cause the volume peaks to shift.

A distance measuring instrument (DMI) can be used to develop both speed profiles and instantaneous speed rates for each corridor under study. The DMI is an electronic unit installed into a vehicle which polls the transmission for the speed of the vehicle. The vehicle is then driven along the corridor of interest. A crew of two is used to collect the data: one to drive and the other to operate the computer. Travel time information is usually collected during peak periods, ranging from 6 a.m. to 9 a.m. and 4 p.m. to 7 p.m. At least three travel time runs in peak direction are desired. This also generates at least two travel time runs in non-peak direction as well. Assuming two crews of personnel, a schedule for a.m. and p.m. peak periods is shown in [Table 7](#).

**Table 7. Travel Time Departures per Peak Period.**

AM Peak	PM Peak
0600 to 0630	1600 to 1630
0630 to 0700	1630 to 1700
0700 to 0730	1700 to 1730
0730 to 0800	1730 to 1800
0800 to 0830	1800 to 1830
0830 to 0900	1830 to 1900

*Other Considerations*

The number of crews needed depend on the length of the corridor and the amount of congestion present. If the corridor is less than five miles in length, then one crew is sufficient. If the length is between five and ten miles, then one or two crews are needed depending on anticipated congestion. For longer than ten miles, two crews are needed to make at least three travel times along that corridor.

For comparison purposes, travel times should be taken previous to the implementation of a major traffic generator, shortly after implementation, and some time thereafter. This should enable measurement of the impact of the major traffic generator. In this case study, the Toyota plant was scheduled to be at full production in summer 2007. Measurement of travel times in April 2007, late summer 2007, and April 2008 were desired to accomplish the comparison. The same time intervals for measurement are needed. Suppose data are collected for a given corridor at 4:15 p.m., 5:30 p.m., and 6:15 p.m. in April 2007; then the same travel time runs for late summer 2007 and April 2008 are needed. Run times need to be selected with an anticipated change in traffic patterns.

Standard procedures for collecting travel times indicate Tuesday, Wednesday, and Thursday as the best days to collect the data. Travel times are not collected on days with incidents (accidents, stalled cars, etc.), inclement weather (rain or ice), and major construction. Standard procedures also call for the floating car method to be used when collecting data. The rule to follow is “pass the same number of vehicles that pass you doing as little or no lane changes as possible.”

For comparisons, travel times need to be collected a minimum of one day previous to implementation and a minimum of two days on the corridor after

implementation of the major traffic generator. Each day would consist of travel time measurement for each peak period.

### *Costs*

Costs associated with collecting travel times are as follows:

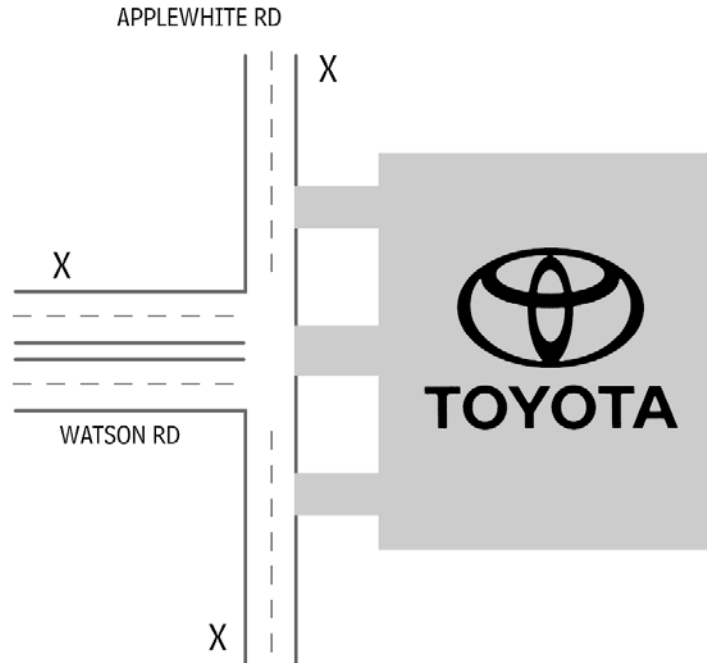
- Five hours for two persons per crew
- Time to/from site (approximately one hour)
- Testing time (approximately three hours)
- Mileage/gas
- Field prep time [mileage of roadway to be traveled and identify mile points for each checkpoint (over/underpasses or apexes of entrance/exit ramps); collection equipment needs to be calibrated]
- Office prep time (one to two hours) and data reduction (one to two hours)
- Staff time for office time and field prep time
- Out of town expenses

For the purposes of the San Antonio case study, two vans outfitted with DMI and two global positioning satellite (GPS) units were available to conduct travel time assessments. Also available were a GPS unit from TTI in College Station and possible units from San Antonio and Houston. Using the same data collection methodology, stop watches were purchased to collect information.

### **Travel Purpose**

With the addition of a new major traffic generator, a change in driver motives can affect a change in traffic patterns in the surrounding area. These motives may include a new job, new business opportunities, food, and other purposes. Origin-destination (O-D) data collected from workers at the major generator and commercial trucks can be useful in understanding the purpose, trip origin and route, and trip destination and route.

In this project, O-D data collection could have been performed by intercepting the vehicular traffic leaving the plant. Intercepting traffic leaving the plant is most likely to have the least impact on the plant operations (i.e., shift workers are not impeded from arriving on time for work). The site configuration allows for three collection sites, which include an intercept point on Applewhite Rd traveling north beyond the northernmost plant driveway, on Applewhite Rd traveling south beyond the southernmost plant driveway, and an intercept point on Watson Rd. [Figure 9](#) illustrates placement of the surveyors to collect information. A letter **X** marks the location of each surveyor as the traffic moves away from the Toyota plant. The data collection would start after the Toyota plant begins operations.



**Figure 9. Roadside Survey Points.**

Data collected can be categorized into commercial, employee, and other. Questions to be answered by the collection process include:

- Where are you traveling from?
- Where did you travel from to reach the Toyota plant and which route did you take?
- Where are you headed now and which route do you plan to take?

### **Trip Generation Rates**

New major traffic generators will increase the number of trips within a region. In this case study, Toyota's new manufacturing plant will generate new employment, thereby generating new trips within or to the region. Raw materials and finished goods are needed in the manufacturing process to produce cars, thereby increasing truck and rail transport trips into the region. The finished product (light duty trucks) will need to be transported to the intended sales destinations, also increasing truck and rail traffic from the region. With the new plant, other business may increase in the immediate area or region to help support plant operations or to serve the employees. Other business will also cause an increase in trips. Current trip rates may be documented to assess differences in the future number of trips.

### **Incident Data**

As more traffic volume is generated and traffic patterns change, the likelihood of crashes can increase. Conducting a comparison between past and current incident data

may be problematic. Limiting factors to conducting a successful incident comparison include the following:

- Fender benders are not likely reported, thereby giving an incomplete picture;
- The past crash data may not be geo-coded very accurately;
- The summary data may not be reliable; and
- The data likely to be on paper records require substantial staff effort to review, select, and record.

### **Modes of Travel**

Other modes of travel such as water, rail, or air may increase use with a new major traffic generator. An increase of freight by rail can induce increased maintenance and/or upgrade to existing rail facilities. More trains can cause an increase in traffic delays at at-grade rail crossings. The Toyota plant in this study has a connection to a Union Pacific rail line. Data comparison of rail freight before and after the plant completion would take into account the following:

- Number of trains
- Freight tonnage
- Length of trains
- Number of at-grade crossings

Greater usage of other modes of travel can increase traffic delays and can affect travel time runs.

### **Air Quality**

Environmental impacts of a major traffic generator will need to be determined. Regional air quality will improve, maintain, or decrease, with a decrease most likely. Air pollution may increase as a result of normal operations. An increase in auto and truck traffic comes with a corresponding increase in vehicle emissions. An increase in air freight or rail freight also increases emissions. Delays caused by increased usage of other travel modes, increased volume, and changes in traffic patterns will increase vehicle emissions as well. The effects will be diffused throughout the region.

Regional monitors are not recommended because of the great difficulty of identifying one location (such as the Toyota plant in the case study) as the sole impact or tracing pollutants back to their originator. Localized effects cannot be determined without a significant investment.

## **CHAPTER 3: DATA COLLECTION**

### **TRAFFIC DATA**

The research team worked with TxDOT TPP and San Antonio District personnel in the design, construction, and testing for 29 new vehicle monitoring sites in the study area. For TPP, this was the first time contractors were used to install permanent data sites for their monitoring network and a first to include many off-system locations in the TPP statewide monitoring network.

The phasing for this site installation work was much more involved than researchers initially anticipated during proposal development. The earliest data were available from the newly installed sites was September 2006, several months after the plant opened. As a result, true “before/after” analysis of traffic data at or near the generator was prevented. Once the sites were established, data were received from TxDOT monthly by TTI researchers and checked for format, consistency, and validity. They were then placed in a central file accessible by the research team for analysis.

The project also provided an opportunity to test new data collection technology. Two site locations on the east and west borders of the study area were designated to be collected using Wavetronix microwave radar sensors mounted adjacent to the travel lanes. Researchers manually polled the two sites at their physical location, as travel permitted.

### **TRAVEL TIMES**

The research team completed mobility measurements using travel time data collection in May of 2007 and 2008. Data were collected over the two-week period leading to the Memorial Day weekend. Data were collected Tuesday through Thursday. These days of the week typically represent typical traffic conditions and are not influenced by weekend traffic patterns. Twelve corridors were measured. Nine corridors were located within the study area. Three were control corridors located in west/northwest San Antonio on like functional class roadways and in similar area types.

Travel times were collected in the morning and evening. In the morning, data were collected, typically, at 20-minute intervals from 6:00 – 9:00. Afternoon measurements were taken between 2:00 – 7:00, also typically at 20-minute intervals. Only a few corridors were so long that they required measurements at 30-minute intervals.

Drivers of test vehicles used the floating car technique to collect data. Generally, this technique requires the driver to pass as many vehicles as pass the driver. Resources and time were limited, so only two test vehicles were used within each corridor. Each of the two vehicles was positioned to start at each corridor end point separate from each other. Drivers departed their assigned endpoint/turnaround so that they would reach the first checkpoint as near the run time as possible (e.g., depart the endpoint one to two minutes in advance of the first checkpoint).

Drivers manually recorded the time at each checkpoint on custom data collection form. Additionally, drivers recorded times when they entered a queue at a signalized intersection. TTI staff manually entered these data in June 2007 and 2008. As part of the

analysis, travel rate indices were calculated for each corridor and links within the corridors.

TTI staff also collected supplemental short-term volume counts at various locations on study corridors from May 14-18, 2007.

## **COMMUTER TRAVEL SURVEY**

The TTI/UTSA research team gathered data capturing travel patterns of the Toyota plant. Data were collected on employee commuting, commercial truck operations, and driveway use. The research team developed a two-page abbreviated travel survey. This survey is provided in [Appendix D](#). It asks questions for travel that recently occurred for their trip to the plant and anticipated travel for when they leave the plant.

The survey was applied through cooperation of Toyota management. Surveys were distributed to Toyota line supervisors and given to employees on Wednesday, May 23, 2007. Toyota had coordinated with the research team to distribute surveys on Monday, May 21, 2007, but Toyota management changed the distribution date on Friday, May 18, 2007.

At the beginning of the work day, the line supervisors included the survey in their daily briefing and required line workers to return the survey before going to work. Other suppliers are located on-site, but employees for these companies were not included in the survey. The majority of the site employment is with Toyota. The research team decided this was a sufficient sample.

Of the 2,000 commuter surveys distributed to Toyota supervisors and the employees, 1,050 surveys (52 percent response) were returned to the research team. In June 2007, the research team reported to the Research Monitoring Committee (RMC) 2 panel that 43 percent of the surveys were returned. Additional surveys were returned to the research team after that presentation. The UTSA team input the returned surveys.

For commercial truck operations, Toyota management provided the research team the truck's origin, the route to Toyota, and its expected arrival  $\pm$  30 minutes. Toyota management indicated that the schedules are very consistent, as well as the route taken to the plant.

Finally, driveway volumes and vehicle classification were recorded on Monday, May 21, 2007 – the original day planned for the commuter survey distribution. Research staff recorded vehicle classification data from 5:00 a.m. – 7:00 p.m., in 15-minute intervals. Pneumatic tubes were used to collect axle counts. Axle counts were collected on all three driveways – north, central (intersecting with Lone Star Pass), and south – from noon on Friday, May 18, to 8:00 a.m. on Wednesday, May 23, 2007.

Research staff recorded vehicle classification for in/outbound traffic. The vehicle classification categories used were:

- Car/pick-up/motorcycle
- Truck, single unit
- Truck, semi-trailer
- Truck, tractor no trailer
- Truck, multi-trailer



## CHAPTER 4: DATA ANALYSIS AND ARCHIVING

Analysis of the data was threefold. Travel times, traffic and truck volumes, and the commuter travel survey were collected to understand the impact on the traffic patterns surrounding the Toyota plant. All newly installed sites collected volume data on a daily basis. Most of the sites also gathered VC data. In May 2007 and May 2008, travel times were recorded. In May 2007, a commuter travel survey was also instituted.

### VOLUME AND VEHICLE CLASS DATA

For the project, the new sites initiated collection of volume and VC data at different start dates due to phased installation dates. Volume and VC data were published beginning in September 2006. The VC data were important in understanding changes in truck movement in the study area.

In developing the traffic monitoring system for the Toyota plant, researchers and TxDOT staff were interested in comparing the data received by the Wavetronix radar-based sites with those received from the standard inductive loop sites. The Wavetronix machines were sidfire radar systems, solar-powered, and used cellular communication for downloading data.

TTI researchers compared the data received from the two different technologies located at the same sites. The data from both technologies very closely matched with the Wavetronix data recording. The main difference in volume counts occurred at peak periods with the Wavetronix machines recording up to 5 percent more vehicles than the inductive loop site. The full analysis is provided in [Appendix B](#).

### TRAVEL TIME RUNS

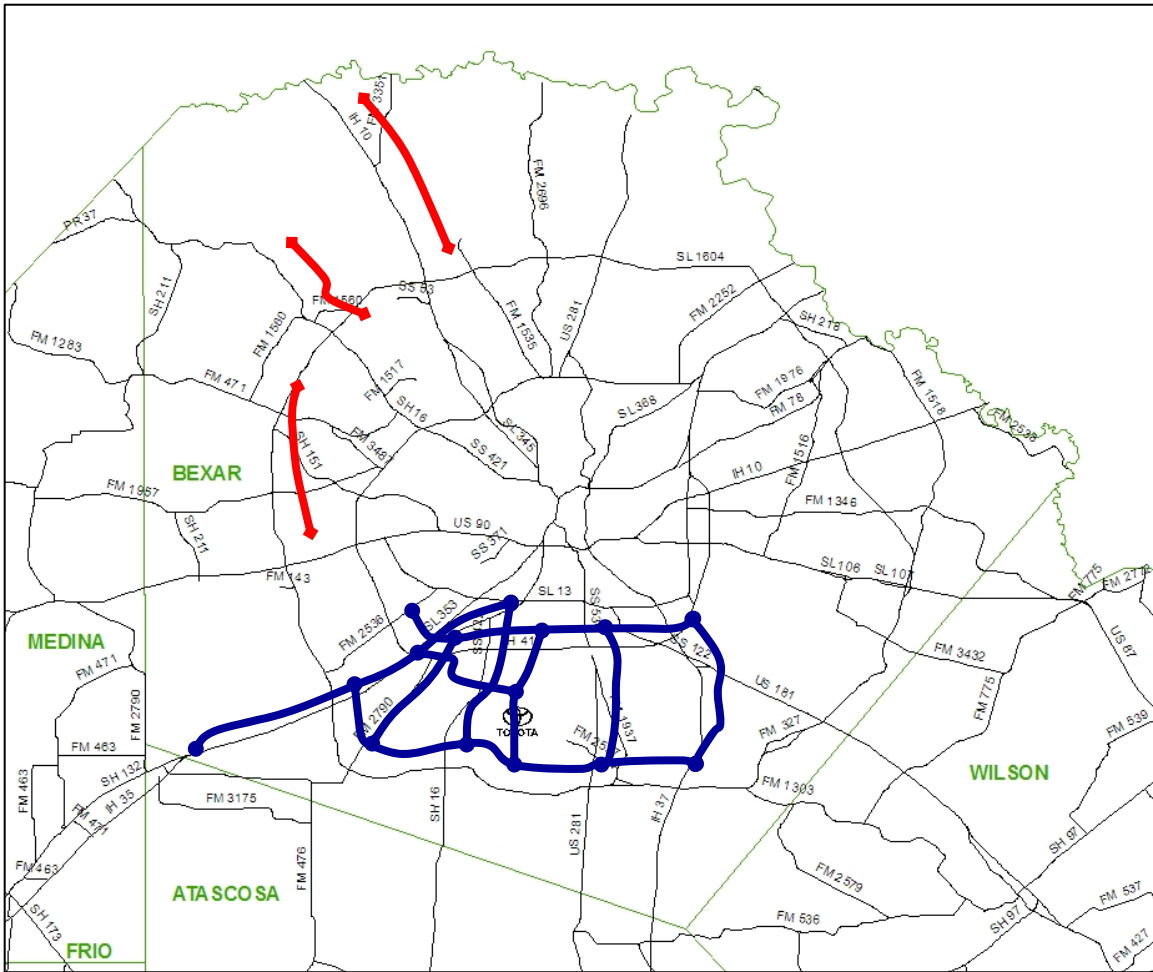
[Table 8](#) displays the nine corridors that were determined to be analyzed using travel time data. These corridors form the basis of the network monitoring system.

**Table 8. Travel Time Corridors.**

ID	Corridor	From	To
1	Applewhite/Zarzamora Rd	LP 1604	IH 410
2	Watson Rd	IH 35 (mark FM 2790)	Applewhite Rd
3	SH 16	LP 1604	IH 35
4	LP 1604	IH 35	IH 37
5	IH 410	FM 2536	IH 37
6	US 281	LP 1604	IH 410
7	FM 2790	LP 1604	IH 410
8	IH 35	Lytle	SP 422
9	IH 37	LP 1604	IH 410

[Figure 10](#) provides an overlay of the corridors in the study area and the three control corridors outside the area.

**Figure 10. Travel Time Corridors.**



Corridors outside the study area selected for comparison purposes are shown in Table 9. Due to funding and time constraints, only the first three corridors were actually measured.

**Table 9. Control Travel Time Corridors.**

ID	Corridor	From	To
1	SH 16	LP 1604	SH 46
2	US 87	LP 1604	SH 46
3	LP 1604	SH 16	US 90
4	US 87	LP 410	LP 1604
5	SH 471	LP 1604	SH 211
6	Pinn Rd	SH 151	US 90
7	Potranco Rd (SH 1957)	LP 1604	SH 471
8	IH 10	LP 1604	SH 46

## DATA ANALYSIS

Within each corridor under study, travel times for both peak periods were collected and each travel direction was also monitored. Each travel time run was twenty to thirty minutes depending on the length of the corridor, with most of the runs being twenty minutes in length. Travel times were recorded in both the second and third weeks of May in 2007 and 2008.

The data were collected in both directions of each corridor in the morning and afternoon peaks of the day. The morning peak was from 6:00 a.m. to 9:00 a.m. and the afternoon peak was identified as 3:00 p.m. to 7:00 p.m. The peak periods coincided with shift changes at the Toyota plant. The first shift began at 6:30 a.m. and ended at 3:15 p.m. The second shift started at 6:00 p.m. and ended at 2:15 a.m.

The travel time data were converted into travel rate indices. A travel rate index is defined as a ratio for the time observed during the travel time run to the travel time expected from free flow of traffic. Therefore, an index of 1.0 indicates that the time observed was equal to free flow travel time. The closer the index is to 1.0, the closer to free flow observed.

Please note that the smallest travel rate index equals 1.0. Each graph associated with the travel rate indices has a vertical scale starting at 1.0.

The analysis was conducted by corridor and follows this structure:

- Morning Peak
  - South/East Direction
    - Travel times,
    - Total vehicle volumes,
    - Total truck volumes,
  - North/West Direction
    - Travel times,
    - Total vehicle volumes,
    - Total truck volumes,
- Afternoon Peak
  - South/East Direction
    - Travel times,
    - Total vehicle volumes,
    - Total truck volumes,
  - North/West Direction
    - Travel times,
    - Total vehicle volumes, and
    - Total truck volumes.

The graphs below illustrate the highlights of the analysis. Major changes from year-to-year for each data type observed are displayed and discussed. Corridors 1, 2 and 3 are closest to the Toyota plant and are where the impacts from the major traffic generator were found. Analysis for the other corridors is provided along with relevant graphics.

[Appendix C](#) presents the data analysis for each corridor. For example, Corridor 1 has a graph of travel rate indices for each segment of the corridor for each direction (northbound and southbound) and for each cluster of peak hours (morning and

afternoon). The appendix also contains the graphs for total vehicle volumes, as well as truck volumes, for each data collection site in the corridor for both direction and peak hours.

### **Corridor 1: Applewhite Rd/Zarzamora St from SL 1604 to IH 410**

Travel times were collected in both the north and south directions of this corridor during the morning and afternoon peak periods. Volume data and vehicle class data were collected at two sites along this corridor, one site north of the Toyota plant and one south of it. Corridor 1 was expected to have significant changes from one year to the next given that the corridor is the closest north-south route to the Toyota plant and all entrances to the plant can be accessed from Applewhite Rd. Corridor 1 is defined in linked segments as follows:

- (A) Zarzamora St from IH 410 to Applewhite Rd
- (B) Applewhite Rd from Zarzamora St to Lone Star Pass (*Lone Star Pass leads into the middle gate of the Toyota plant*)
- (C) Applewhite Rd from Lone Star Pass to Old Applewhite Rd
- (D) Applewhite Rd from Old Applewhite Rd to Neal Rd
- (E) Applewhite Rd from Neal Rd to SL 1604

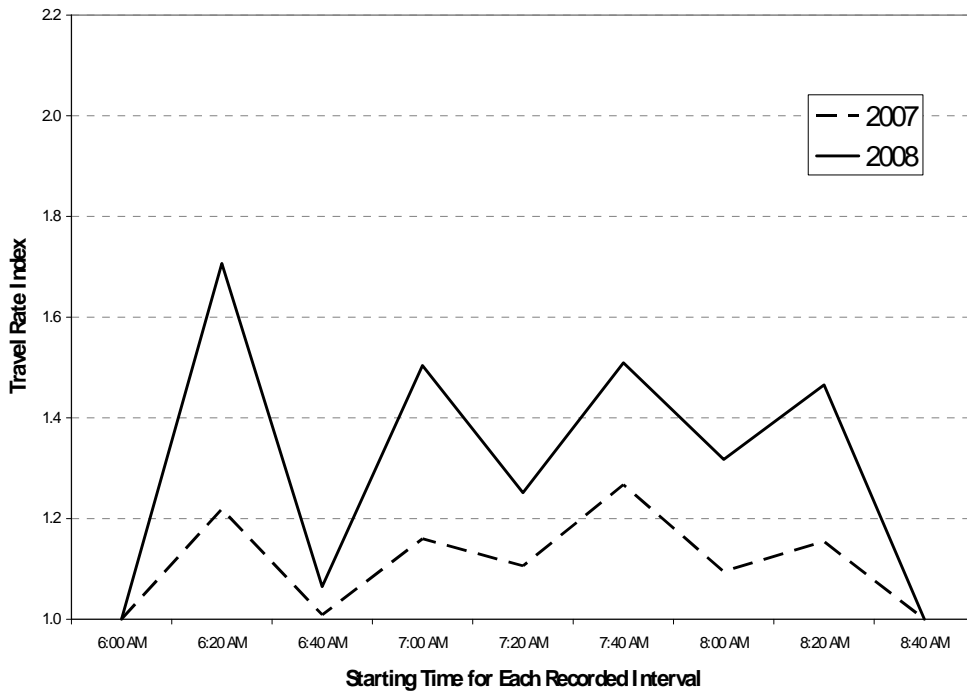
For Corridor 1, the morning peak hours were divided into 20-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:40 a.m. The afternoon peak hours were divided into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 6:40 p.m.

#### *Travel Time Runs, Southbound Direction, Morning Peak*

Figure 11 through Figure 29 show the travel rate index comparisons for each segment of the corridor in southbound direction. Each graph displays a dashed line for data collected in 2007 and a solid line for data collected in 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the morning peak period divided into 20-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:40 a.m. A travel rate index is calculated for each interval.

Figure 10 displays the indices observed for the morning peak in the southbound direction for segment B listed above. Segment B accesses the northernmost Toyota plant gate and ends at Lone Star Pass. The intersection of Applewhite Rd and Lone Star Pass leads to another Toyota plant gate.

The solid line (2008) is noticeably higher than the dashed line (2007) in most time intervals. The highest peak for 2008 occurs from 6:20 a.m. to 6:40 a.m. at a travel rate index of 1.7, 70 percent longer than free flow traffic times. The 2007 indices are much shallower than 2008, indicating that traffic takes longer to travel the same segment of roadway in 2008 than 2007.

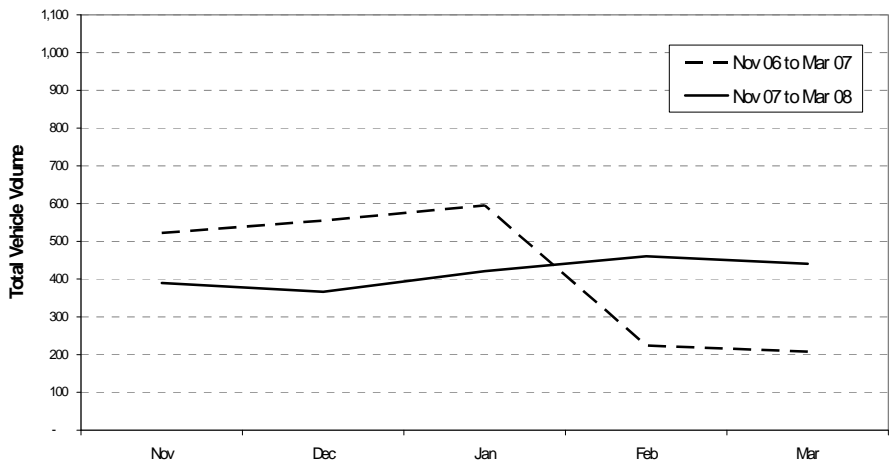


**Figure 11. Applewhite Rd (AM Peak), Zarzamora St to Lone Star Pass, Southbound.**

*Total Vehicle Volumes, Southbound Direction, Morning Peak*

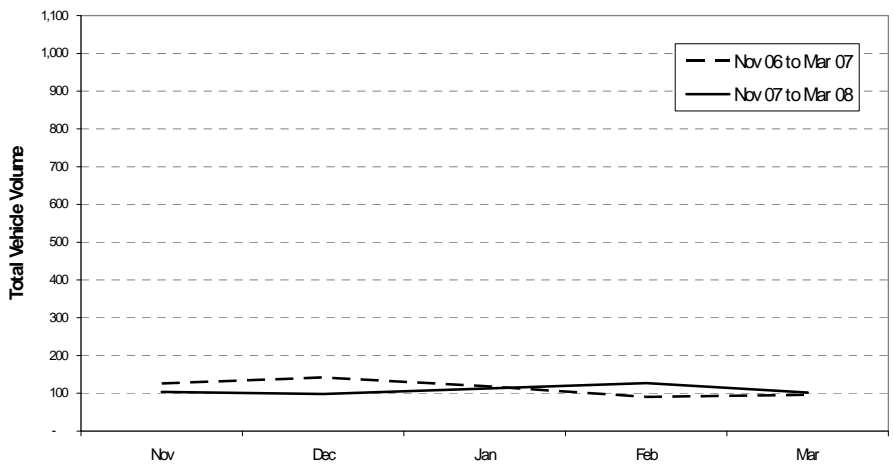
Figure 12 through Figure 15 show the southbound traffic volume comparisons for site 314 located on Applewhite Rd, between Zarzamora St and Lone Star Pass. The graphs show vehicle volumes for each hour of the morning peak period, 6 a.m. to 9 a.m. Each graph displays a dashed line for data collected during November 2006 to March 2007 and a solid line for data collected in November 2007 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months November to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month.

Figure 12 shows the southbound traffic volume comparisons for site 314 during the 6 a.m. to 7 a.m. hour. The volume for the older data (dashed line) is higher during November through January and drops to near 200 for February and March. Toyota instituted a shift change in February 2007 which may account for the drop in volumes. The newer volumes (solid line) are fairly steady and higher than February and March of 2007.



**Figure 12. Total Vehicle Volumes, Site 314 Southbound, 6 AM to 7 AM.**

Figure 13 shows the southbound traffic volume comparisons for site 314 during the 7 a.m. to 8 a.m. hour. The volumes are low and steady for both dashed and solid lines, indicating no change from year-to-year.

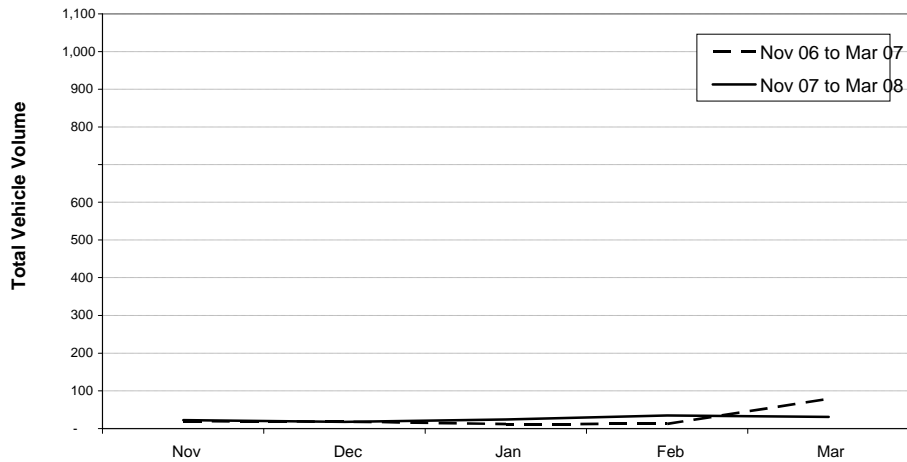


**Figure 13. Total Vehicle Volumes, Site 314 Southbound, 7 AM to 8 AM.**

*Truck Volumes, Southbound Direction, Morning Peak*

Figure 14 shows the southbound truck volume comparisons for site 314 during the 8 a.m. to 9 a.m. hour. The volumes for the older data (dashed line) increased in March

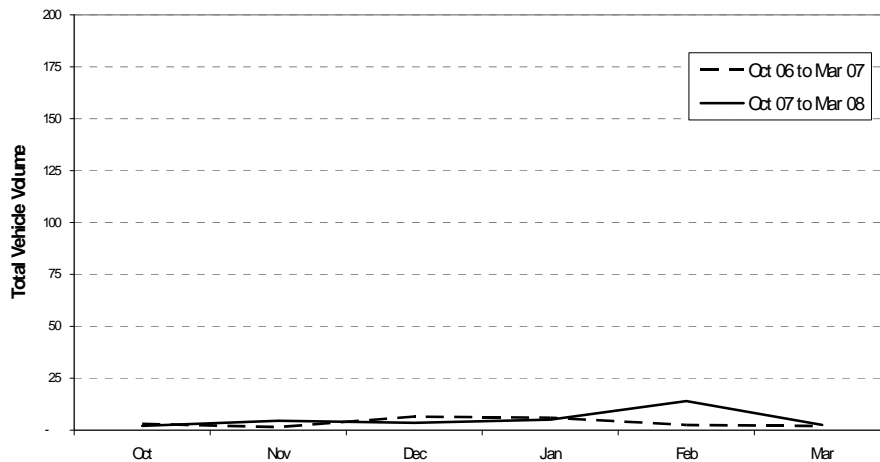
2007 from February 2007; otherwise, the volumes were steady and low. Toyota instituted a shift change in February 2007 which may account for the change in truck volumes. The newer volumes (solid line) are steady and low. There is a little difference from year-to-year.



**Figure 14. Total Truck Volumes, Site 314 Southbound, 8 AM to 9 AM.**

Figure 15 shows the southbound truck volume comparisons for site 315 located on Applewhite Rd between Neal Rd and SL 1604. The graphs show truck volumes for each hour of the morning peak period, 6 a.m. to 9 a.m. Each graph displays a dashed line for data collected during October 2006 to March 2007 and a solid line for data collected in October 2007 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months October to March and the vertical axis shows total truck volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month.

Figure 15 shows the southbound truck volume comparisons for site 315 during the 8 a.m. to 9 a.m. hour. For both time periods, the truck volumes are steady and fairly low. There is a little difference from year-to-year.



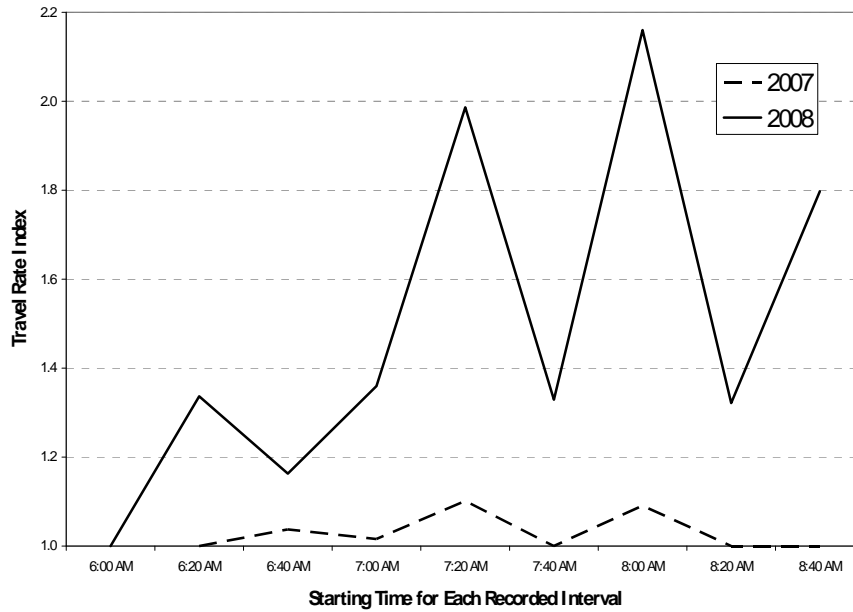
**Figure 15. Total Truck Volumes, Site 315 Southbound, 8 AM to 9 AM.**

*Travel Time Runs, Morning Peak, Northbound Direction*

Figure 16 displays the indices observed for the morning peak in the northbound direction for segment B listed above. This segment of Applewhite Rd has the northernmost gate into the Toyota plant. On the south end of the segment, the intersection of Applewhite Rd and Lone Star Pass leads to another Toyota plant gate. The 2007 observation for 6:00 a.m. to 6:20 a.m. was not collected. The north end of the segment has a stop sign at Zarzamora St. Signals were installed at the intersection in 2008, but were not yet operational.

The solid line (2008) is considerably higher than the dashed line (2007) in almost all time intervals. The 2007 observations are all near free flow conditions. The 2008 observations peak near 120 percent higher than free flow conditions, which is more than twice as long. In general, the 2008 travel rate indices are considerably higher than 2007 indices.

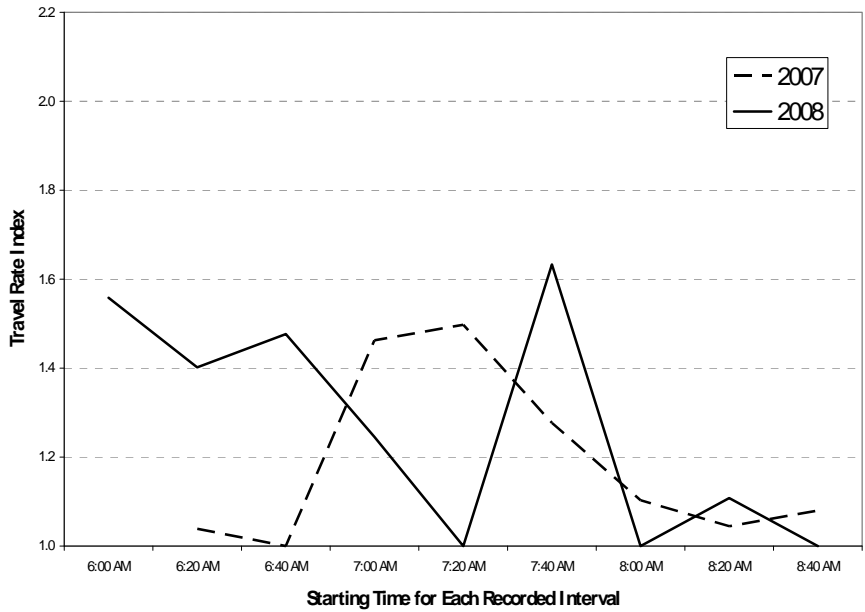




**Figure 16. Applewhite Rd (AM Peak), Lone Star Pass to Zarzamora St, Northbound.**

Figure 17 displays the indices observed for the morning peak in the northbound direction for segment A listed above. The 2007 observation for 6:00 a.m. to 6:20 a.m. was not collected.

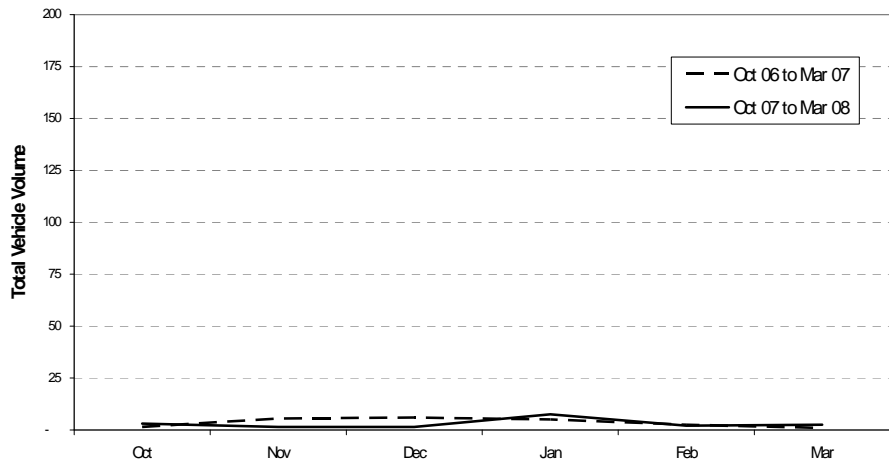
The 2007 indices peak during 7:00 a.m. to 7:20 a.m., 7:20 a.m. to 7:40 a.m., and 7:40 a.m. to 8:00 a.m. intervals with near free flow conditions for the other intervals. The 2008 indices peak during the 6:00 a.m. to 6:20 a.m., 6:20 a.m. to 6:40 a.m., and 7:40 a.m. to 8:00 a.m. intervals. Generally, when the 2007 indices are high, then the 2008 indices are low and vice versa.



**Figure 17. Zarzamora St (AM Peak), Applewhite Rd to IH 410, Northbound.**

*Total Vehicle Volumes, Northbound Direction, Morning Peak*

Figure 18 shows the northbound traffic volume comparisons for site 315 during the 6 a.m. to 7 a.m. hour. For both time periods, the truck volumes are steady and fairly low. There is a little difference from year-to-year.

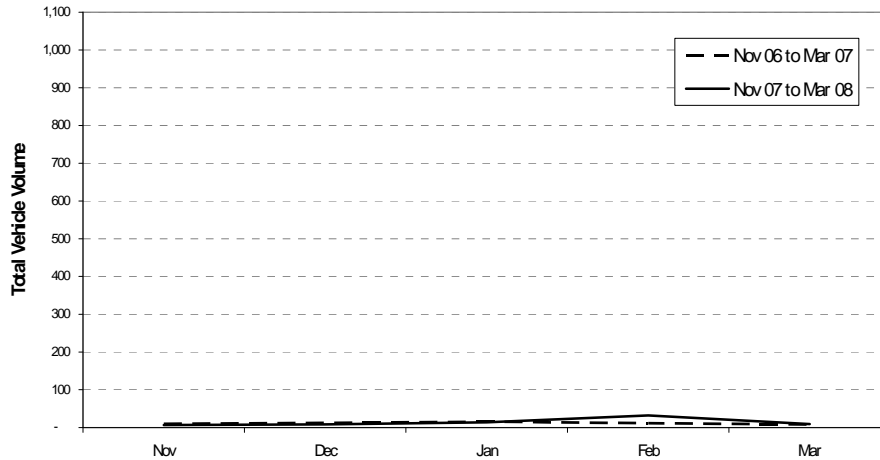


**Figure 18. Total Vehicle Volumes, Site 315 Northbound, 6 AM to 7 AM.**

*Truck Volumes, Northbound Direction, Morning Peak*

Figure 19 shows the northbound truck volume comparisons for site 314 located on Applewhite Rd between Zarzamora St and Lone Star Pass. The graphs show truck volumes for each hour of the morning peak period, 6 a.m. to 9 a.m. Each graph displays a dashed line for data collected during November 2006 to March 2007 and a solid line for data collected in November 2007 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months November to March and the vertical axis shows total truck volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month.

Figure 19 shows the northbound truck volume comparisons for site 314 during the 8 a.m. to 9 a.m. hour. The older volumes (dashed line) and the newer volumes (solid line) are very low and steady and show very little difference from year-to-year.



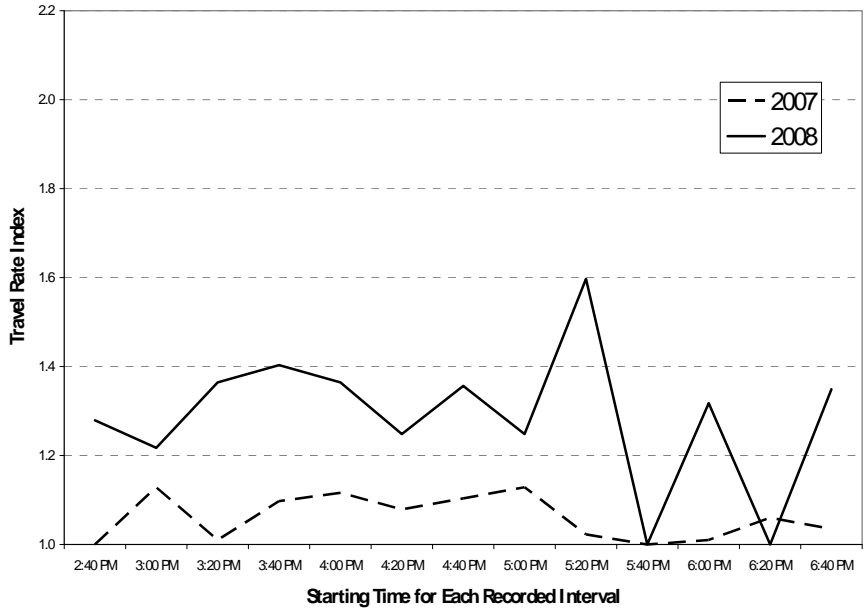
**Figure 19. Total Truck Volumes, Site 314 Northbound, 8 AM to 9 AM.**

*Travel Time Runs, Afternoon Peak, Southbound Direction*

Figure 20 and Figure 21 show the travel rate index comparisons for each segment of the corridor in southbound direction. Each graph displays a dashed line for data collected in 2007 and a solid line for data collected in 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the afternoon peak period to be split into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 7:40 p.m. A travel rate index is calculated for each interval observed.

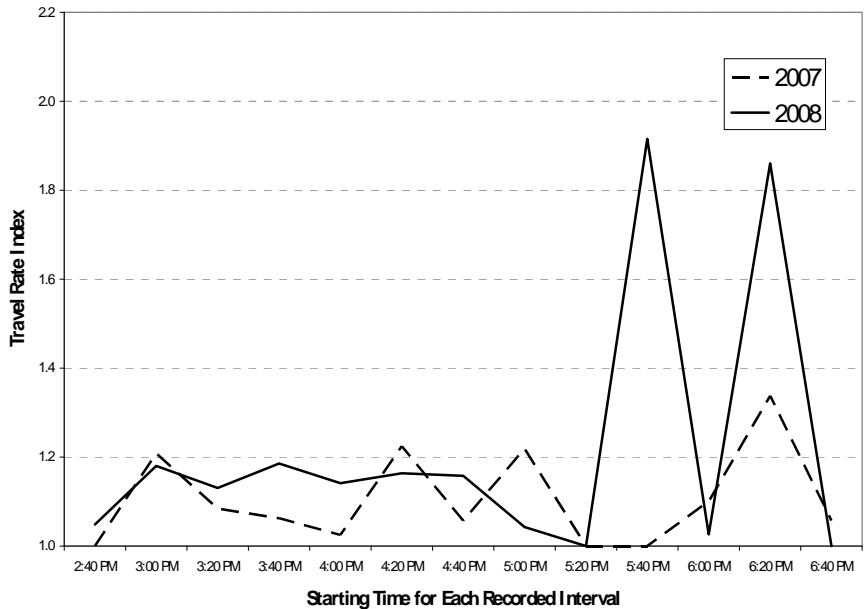
Figure 20 displays the indices observed for the afternoon peak in the southbound direction for segment A listed above. The solid line (2008) is above the dashed line (2007) in most time intervals observed. The peaks of the solid line are between 1.2 and 1.6, indicating that the travel time observed is between 20 percent and 60 percent longer

than free flow traffic. The 2007 traffic was between 1.0 and 1.2 during the same time intervals. The graph of the solid line (2008) is visually higher, indicating that it took longer to travel this corridor in the afternoon during May 2008 than in May 2007.



**Figure 20. Zarzamora St (PM Peak), IH 410 to Applewhite Rd, Southbound.**

Figure 21 displays the indices observed for the afternoon peak in the southbound direction for segment B listed above. Segment B accesses the northernmost Toyota plant gate and ends at Lone Star Pass. The intersection of Applewhite Rd and Lone Star Pass leads to another Toyota plant gate. The solid line (2008) and the dashed line (2007) are near 1.2 or less for the time intervals from 2:40 p.m. to 5:40 p.m. In 2008, two large peaks are observed during the 5:40 p.m. to 6:00 p.m. and 6:20 p.m. to 6:40 p.m. with travel rate indices of 1.9 and 1.85 respectively. During the late evening, this corridor takes longer to travel in 2008 than in 2007.

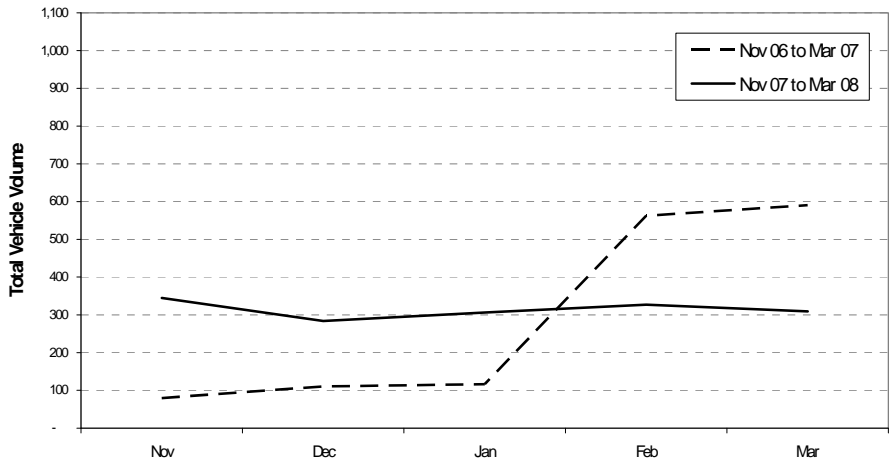


**Figure 21. Applewhite Rd (PM Peak), Zarzamora St to Lone Star Pass, Southbound.**

*Total Vehicle Volumes, Southbound Direction, Afternoon Peak*

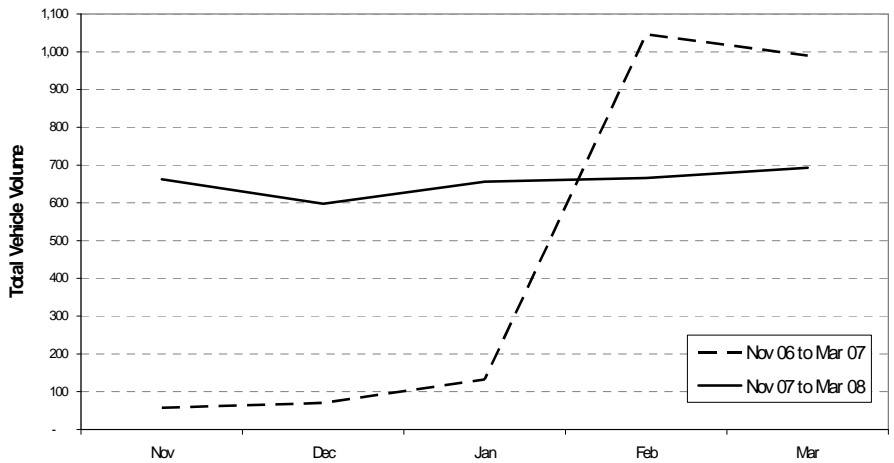
Figure 22 and Figure 23 show the southbound traffic volume comparisons for site 314 located on Applewhite Rd between Zarzamora St and Lone Star Pass. The graphs show vehicle volumes for each hour of the afternoon peak period, 2 p.m. to 7 p.m. Each graph displays a dashed line for data collected during November 2006 to March 2007 and a solid line for data collected in November 2007 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months November to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month observed.

Figure 22 shows the southbound traffic volume comparisons for site 314 during the 4 p.m. to 5 p.m. hour. The volume for the older data (dashed line) is lower during November through January and increases from 100 to near 600 for February and March. Toyota instituted a shift change in February 2007 which may account for the increase in volumes. The newer volumes (solid line) are steady at around 300 vehicles.



**Figure 22. Total Vehicle Volumes, Site 314 Southbound, 4 PM to 5 PM.**

Figure 23 shows the southbound traffic volume comparisons for site 314 during the 5 p.m. to 6 p.m. hour. The volume for the older data (dashed line) is lower during November through January and increases from 100 to near 1,000 for February and March. Toyota instituted a shift change in February 2007 which may account for the increase in volumes. The newer volumes (solid line) are steady at around 600 to 700 vehicles.

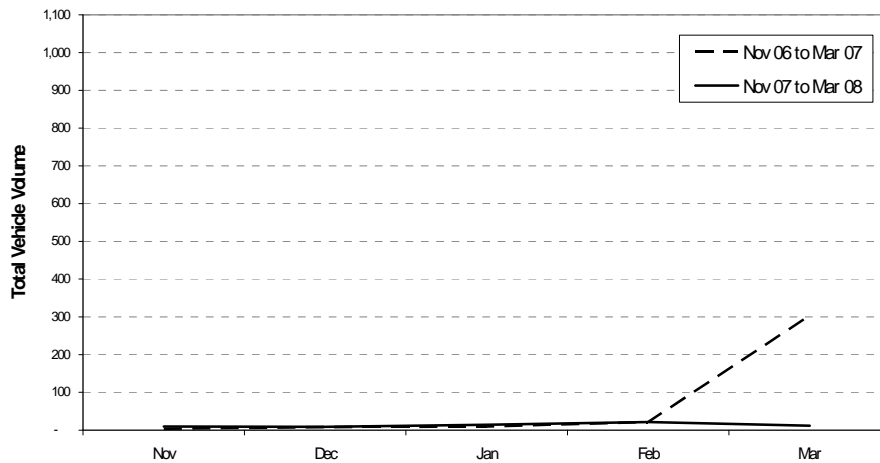


**Figure 23. Total Vehicle Volumes, Site 314 Southbound, 5 PM to 6 PM.**

*Truck Volumes, Southbound Direction, Afternoon Peak*

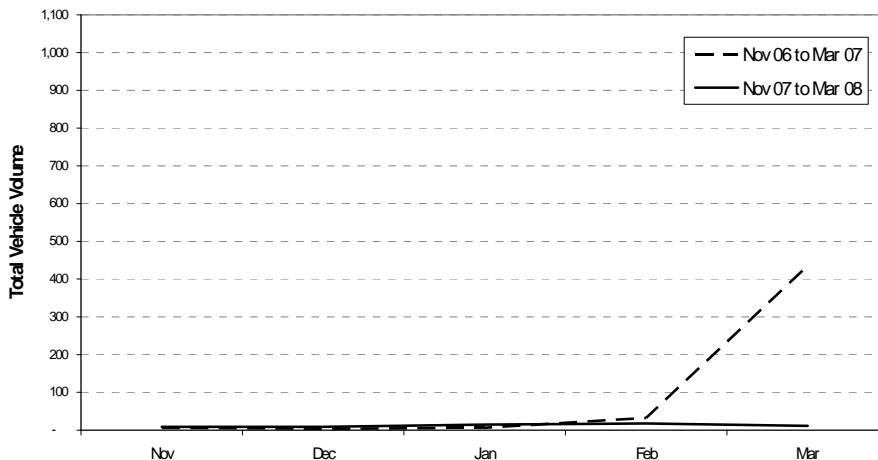
Figure 24 through Figure 27 show the southbound truck volume comparisons for site 314 located on Applewhite Rd between Zarzamora St and Lone Star Pass. The graphs show truck volumes for each hour of the afternoon peak period, 2 p.m. to 7 p.m. Each graph displays a dashed line for data collected during November 2006 to March 2007 and a solid line for data collected in November 2007 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months November to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month observed.

Figure 24 shows the southbound truck volume comparisons for site 314 during the 4 p.m. to 5 p.m. hour. The volume for the older data (dashed line) is lower during November through January and jumps from about 30 to near 300 in March. Toyota instituted a shift change in February 2007 which may account for the increase in March volume. The newer volumes (solid line) are steady and very low.



**Figure 24. Total Truck Volumes, Site 314 Southbound, 4 PM to 5 PM.**

Figure 25 shows the southbound traffic truck comparisons for site 314 during the 5 p.m. to 6 p.m. hour. Toyota instituted a shift change in February 2007 which may account for the increase in March volume from below 50 to over 400 trucks. The more recent volumes (solid line) are steady and very low.

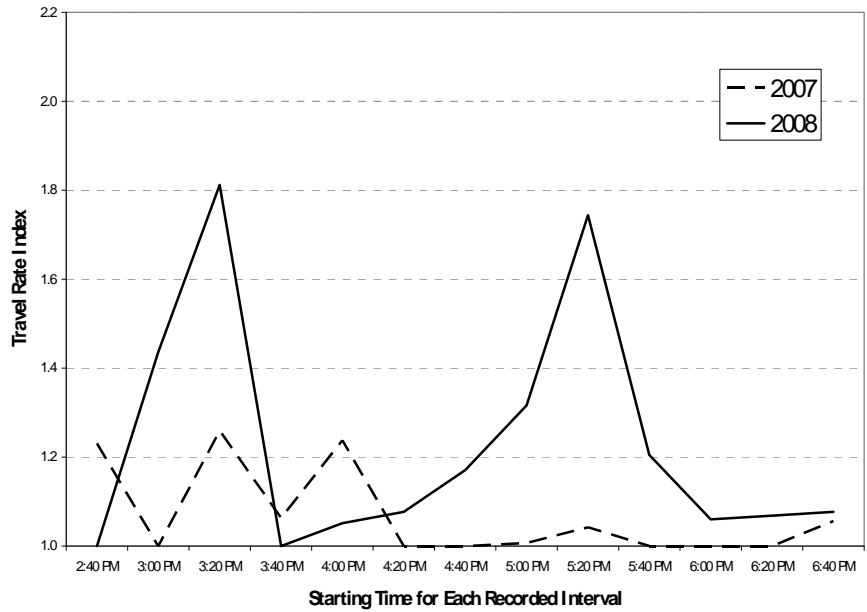


**Figure 25. Total Truck Volumes, Site 314 Southbound, 5 PM to 6 PM.**

Figure 26 displays the indices observed for the afternoon peak in the northbound direction for segment C listed above. This segment of Applewhite Rd has the southernmost gate into the Toyota plant. The intersection of Applewhite Rd and Lone Star Pass leads to another Toyota plant gate.

The solid line (2008) is above the dashed line (2007) in most time intervals. The 2008 travel rate indices for four time intervals are considerably higher than the 2007 observations, namely the 3:00 p.m. to 3:20 p.m., 3:20 p.m. to 3:40 p.m., 5:00 p.m. to 5:20 p.m., and 5:20 p.m. to 5:40 p.m. For the 3:20 p.m. to 3:40 p.m. time interval, the 2008 observation spikes above 1.8, indicating that more than 80 percent longer travel is needed than in free flow conditions. Note that the end of the first shift at the Toyota plant occurs at 3:15 p.m. In general, the 2008 travel times are longer than 2007 travel times and much longer than free flow conditions.

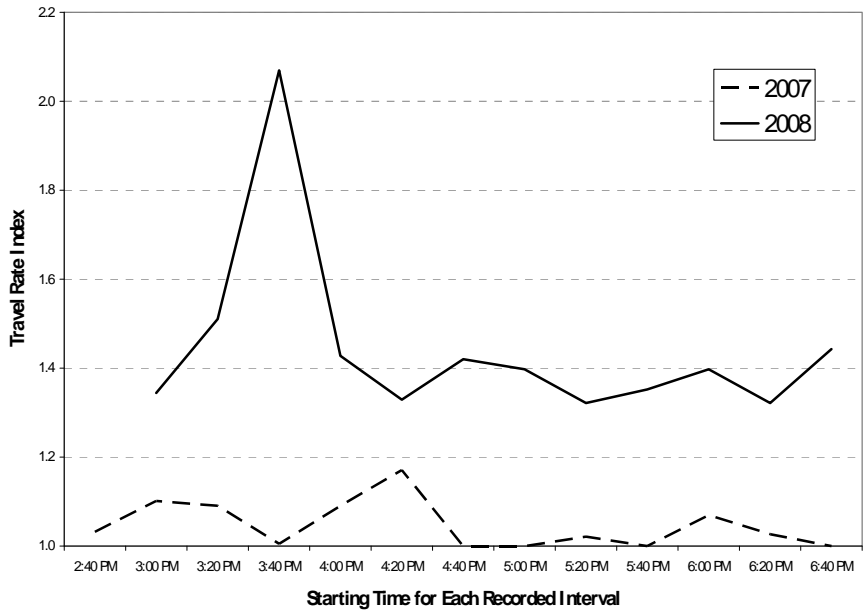




**Figure 26. Applewhite Rd (PM Peak), Old Applewhite Rd to Lone Star Pass, Northbound.**

Figure 27 displays the indices observed for the afternoon peak in the northbound direction for segment B listed above. This segment of Applewhite Rd has the northernmost gate into the Toyota plant. On the south end of the segment, the intersection of Applewhite Rd and Lone Star Pass leads to another Toyota plant gate. The 2008 observation for 2:40 p.m. to 3:00 p.m. was not collected. The north end of the segment has a stop sign at Zarzamora St. Signals were installed at the intersection in 2008, but were not yet operational.

The solid line (2008) is considerably higher than the dashed line (2007) in all time intervals. The 2007 observations are all near free flow conditions. The 2008 observations peak about 210 percent higher than free flow conditions, which is more than twice as long. This occurs during the 3:40 p.m. to 4:00 p.m. interval with the second highest index (1.5) occurring right before the 3:20 p.m. to 3:40 p.m. interval. The indices are most likely affected by the end of the second shift at 3:15 p.m. and the stop sign at Zarzamora St. In general, the 2008 travel rate indices are considerably higher than 2007 indices.

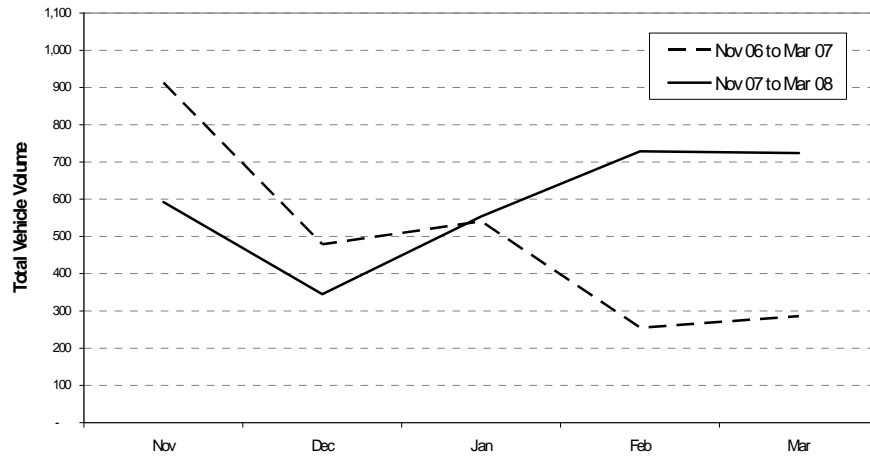


**Figure 27. Applewhite Rd (PM Peak), Lone Star Pass to Zarzamora St, Northbound.**

*Total Vehicle Volumes, Northbound Direction, Afternoon Peak*

Figure 28 shows the northbound traffic volume comparisons for site 314 located on Applewhite Rd between Zarzamora St and Lone Star Pass. The graphs show vehicle volumes for each hour of the afternoon peak period, 2 p.m. to 7 p.m. Each graph displays a dashed line for data collected during November 2006 to March 2007 and a solid line for data collected in November 2007 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months November to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month observed.

Figure 28 shows the northbound traffic volume comparisons for site 314 during the 3 p.m. to 4 p.m. hour. The older volumes (dashed line) display a negative trend and the newer volumes (solid line) show a slight positive trend from year-to-year.

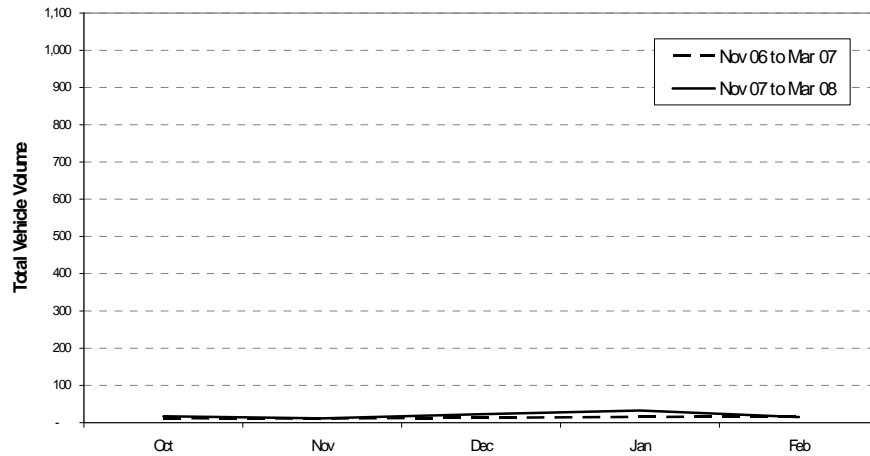


**Figure 28. Total Vehicle Volumes, Site 314 Northbound, 3 PM to 4 PM.**

*Truck Volumes, Northbound Direction, Afternoon Peak*

Figure 29 shows the northbound truck volume comparisons for site 314 located on Applewhite Rd between Zarzamora St and Lone Star Pass. The graphs show truck volumes for each hour of the afternoon peak period, 2 p.m. to 7 p.m. Each graph displays a dashed line for data collected during November 2006 to March 2007 and a solid line for data collected in November 2007 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months November to March and the vertical axis shows total truck volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month observed.

Figure 29 shows the northbound truck volume comparisons for site 314 during the 2 p.m. to 3 p.m. hour. The older volumes (dashed line) and the newer volumes (solid line) are very low and steady and show very little difference from year-to-year.



**Figure 29. Total Truck Volumes, Site 314 Northbound, 2 PM to 3 PM.**

### **Corridor 2: Fisher Rd/Watson Rd/Lone Star Pass from IH 35 to Applewhite Rd**

Travel times were collected in both the east and west directions of this corridor during the morning and afternoon peak periods. Volume data were collected at two sites along this corridor, site 308 near the intersection of Lone Star Pass and Applewhite Rd (near entrance to Toyota plant) and site 307 located on Watson Rd between FM 2790 and SH 16. Vehicle classification data were also collected at site 308. Lone Star Pass of Corridor 2 was expected to have some changes from one year to the next given that Corridor 2 is the closest east-west corridor to the Toyota plant and the Lone Star Pass ends at an entrance to the plant. Corridor 2 is defined in linked segments as follows:

- (A) Fisher Rd from IH 35 to FM 2790
- (B) Watson Rd from FM 2790 to SH 16
- (C) Lone Star Pass from SH 16 to Applewhite Rd (Lone Star Pass leads into the middle gate of the Toyota plant)

For Corridor 2, the morning peak hours were divided into 20-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:40 a.m. The afternoon peak hours were divided into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 6:40 p.m.

#### *Travel Time Runs, Eastbound Direction, Morning Peak*

Figure 30 through Figure 32 show the travel rate index comparisons for each segment of the corridor in the eastbound direction. Each graph displays a dashed line for data collected in 2007 and a solid line for data collected in 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the morning peak period divided into 20-minute intervals starting

at 6:00 a.m. with the last interval beginning at 8:40 a.m. A travel rate index is calculated for each interval.

Figure 30 displays the indices observed for the morning peak in the eastbound direction for segment A listed above for Corridor 2. The solid line (2008) is above the dashed line (2007) until the 8:00 a.m. to 8:20 a.m. interval, indicating that the 2008 travel times were longer for those intervals. The solid line peaks at the 6:40 a.m. to 7:00 a.m. interval. The 2007 travel times are generally longer after 8:00 a.m. The morning shift starts at 6:30 a.m., yet there is no significant difference from year-to-year in the 6:00 a.m. to 6:20 a.m. or 6:20 a.m. to 6:40 a.m. time intervals.

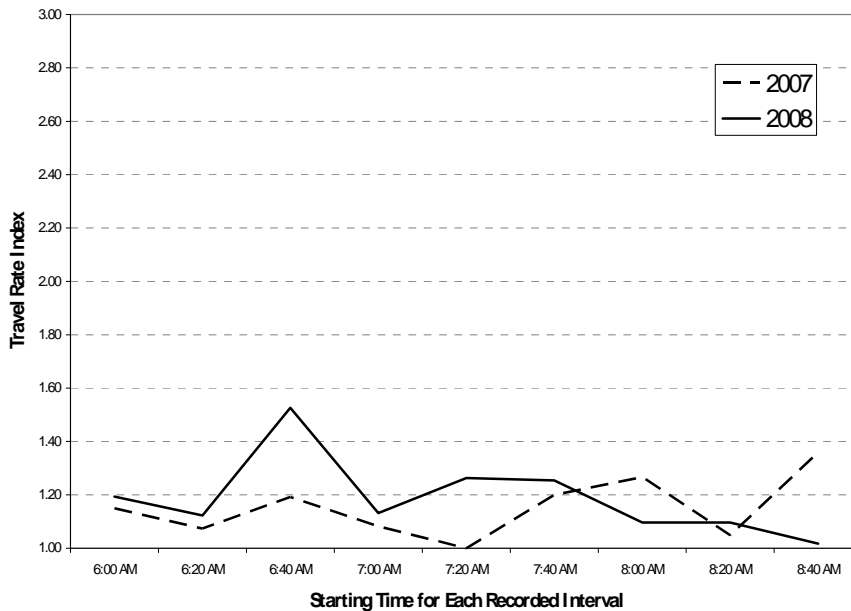
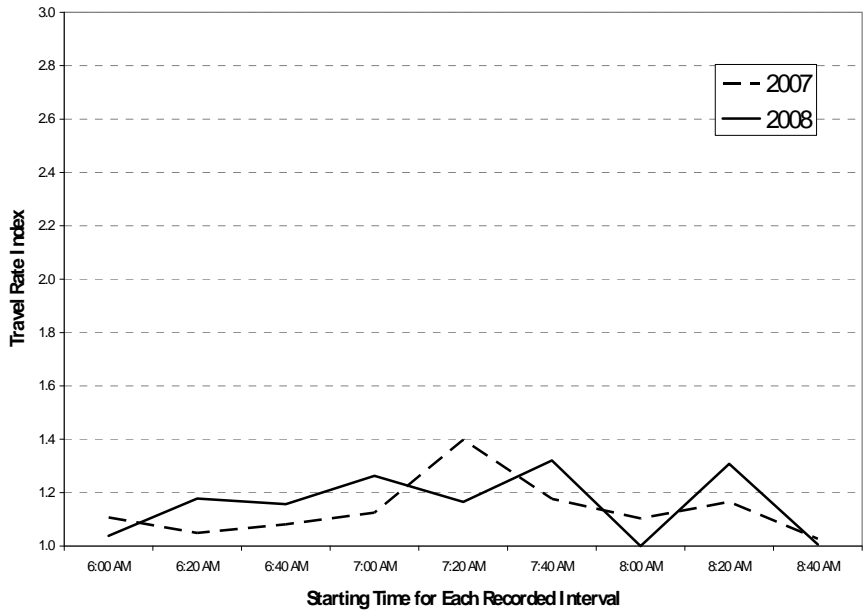


Figure 30. Fisher Rd (AM Peak), I 35 to FM 2790, Eastbound.

Figure 31 displays the indices observed for the morning peak in the eastbound direction for segment B listed above. There are no signs or traffic signals between the ends of this segment of roadway.

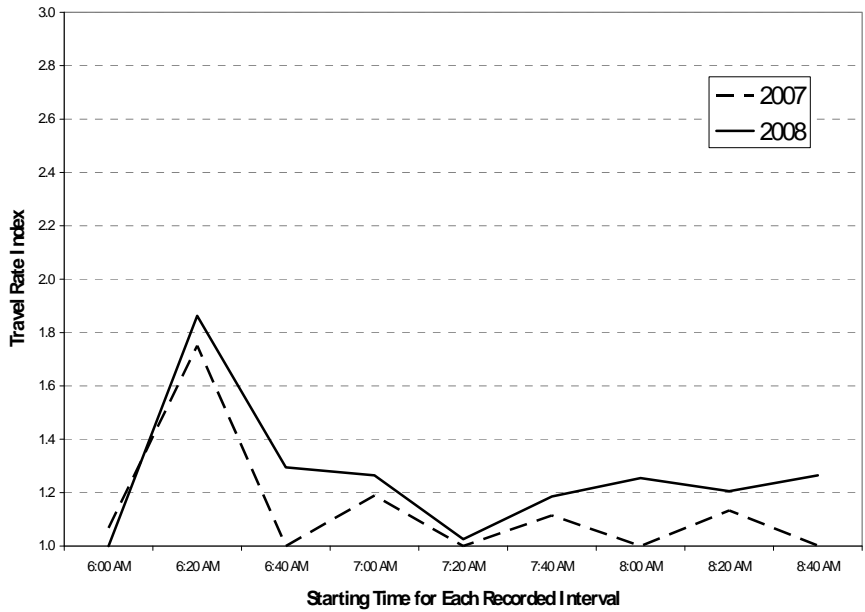
Both lines follow a similar trend across the time intervals. The solid line (2008) is higher than the dashed line (2007) in some time intervals, and the dashed line is higher in other intervals. There is not a consistent difference between the two lines. The morning shift starts at 6:30 a.m., yet there is no significant difference from year-to-year in the 6:00 a.m. to 6:20 a.m. or 6:20 a.m. to 6:40 a.m. time intervals.



**Figure 31. Watson Rd (AM Peak), FM 2790 to SH 16, Eastbound.**

Figure 32 displays the indices observed for the morning peak in the eastbound direction for segment C listed above. This segment of Applewhite Rd has the southernmost gate into the Toyota plant.

Both lines follow the same trend across the time intervals. The solid line (2008) is higher than the dashed line (2007) in almost all time intervals, but not noticeably so. The 2007 indices are a little lower than 2008, indicating that traffic takes a little longer to travel the same segment of roadway in 2008 than 2007. The morning shift starts at 6:30 a.m., yet there is no significant difference from year-to-year in the 6:00 a.m. to 6:20 a.m. or 6:20 a.m. to 6:40 a.m. time intervals.

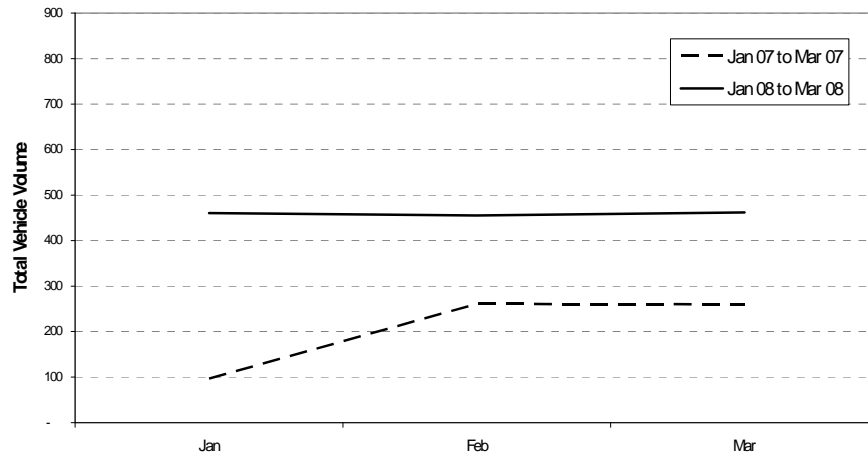


**Figure 32. Lone Star Pass (AM Peak), SH 16 to Applewhite Rd, Eastbound.**

*Total Vehicle Volumes, Eastbound Direction, Morning Peak*

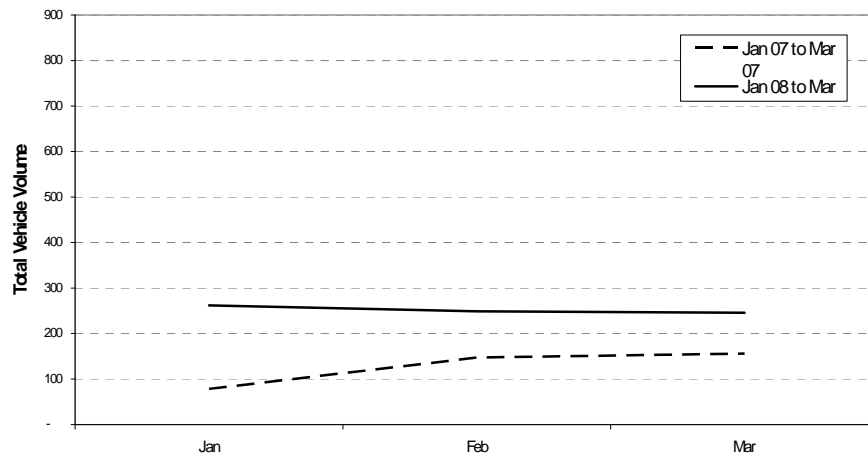
Figure 33 and Figure 34 show some of the eastbound traffic volume comparisons for site 308 located on Lone Star Pass near Applewhite Rd. The graphs show vehicle volumes for each hour of the morning peak period, 6 a.m. to 9 a.m. Each graph displays a dashed line for data collected during January 2007 to March 2007 and a solid line for data collected in January 2008 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months January to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month. For site 307, vehicle classification data were not collected.

Figure 33 shows the eastbound traffic volume comparisons for site 308 during the 6 a.m. to 7 a.m. hour. The volume for the newer data (solid line) is steady and clearly higher during January through March. Toyota instituted a shift change in February 2007 which may account for the increase in February 2007 volumes.



**Figure 33. Total Vehicle Volumes, Site 308 Eastbound, 6 AM to 7 AM.**

Figure 34 shows the eastbound traffic volume comparisons for site 308 during the 7 a.m. to 8 a.m. hour. The volume for the newer data (solid line) is steady and higher during January through March. Toyota instituted a shift change in February 2007 which may account for the increase in February 2007 volumes.



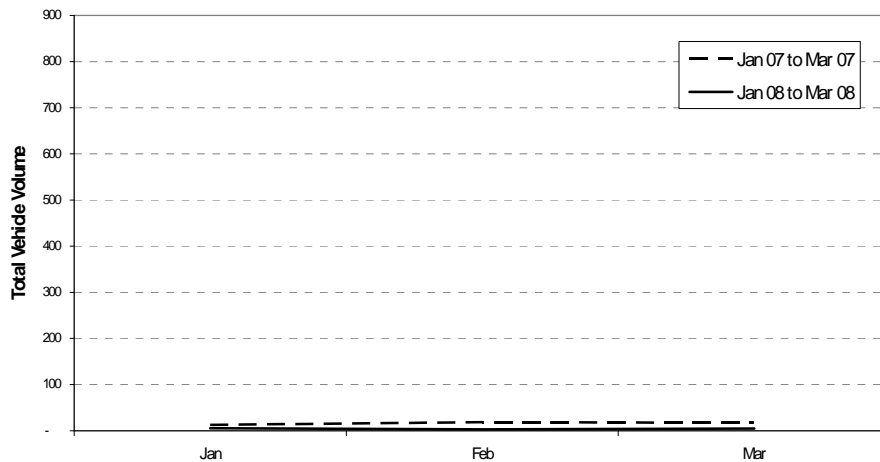
**Figure 34. Total Vehicle Volumes, Site 308 Eastbound, 7 AM to 8 AM.**



*Truck Volumes, Eastbound Direction, Morning Peak*

Figure 35 shows the eastbound truck volume comparisons for site 308 located on Lone Star Pass near Applewhite Rd. The graph shows truck volumes for each hour of the morning peak period, 6 a.m. to 9 a.m. The graph displays a dashed line for data collected during January 2007 to March 2007 and a solid line for data collected in January 2008 to March 2008 for a year-to-year comparison. The graph has the same vertical and horizontal scale. The horizontal axis shows the months January to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month.

Figure 35 shows the eastbound truck volume comparisons for site 308 during the 6 a.m. to 7 a.m. hour. The volumes were steady and low from year-to-year. The 7:00 a.m. to 8:00 a.m. and the 8:00 a.m. to 9:00 a.m. hours are very similar.



**Figure 35. Total Truck Volumes, Site 308 Eastbound, 6 AM to 7 AM.**

*Corridor 2, Westbound Direction, Morning Peak*

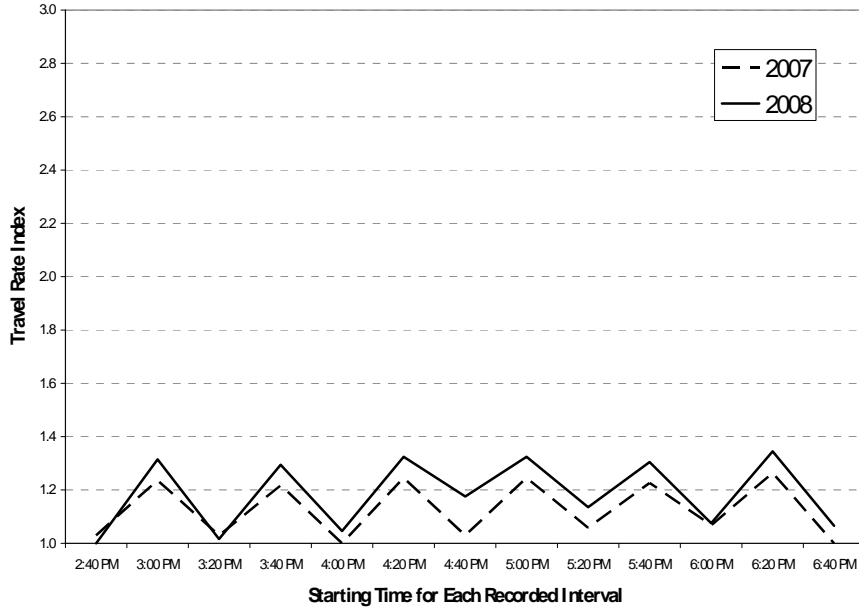
No significant year-to-year changes in total vehicle and truck volumes were noted in the analysis. In addition, no significant changes were noted in the travel time indices between 2007 and 2008. The main traffic movements on this corridor in the morning peak periods are eastbound towards the plant.

*Travel Time Runs, Eastbound Direction, Afternoon Peak*

Figure 36 shows the travel rate index comparison for the most notable segment of the corridor in the eastbound direction. The graph displays a dashed line for data collected in 2007 and a solid line for data collected in 2008 for a year-to-year comparison. The graph has the same vertical and horizontal scale. The horizontal axis shows the afternoon peak period to be split into 20-minute intervals starting at 2:40 p.m.

with the last interval beginning at 7:40 p.m. A travel rate index is calculated for each interval observed.

Figure 36 displays the indices observed for the afternoon peak in the eastbound direction for segment A listed above. The solid line (2008) is above the dashed line (2007) in most time intervals observed. The graph of the solid line (2008) is visually higher, indicating that it took longer to travel this corridor in the afternoon during May 2008 than in May 2007.



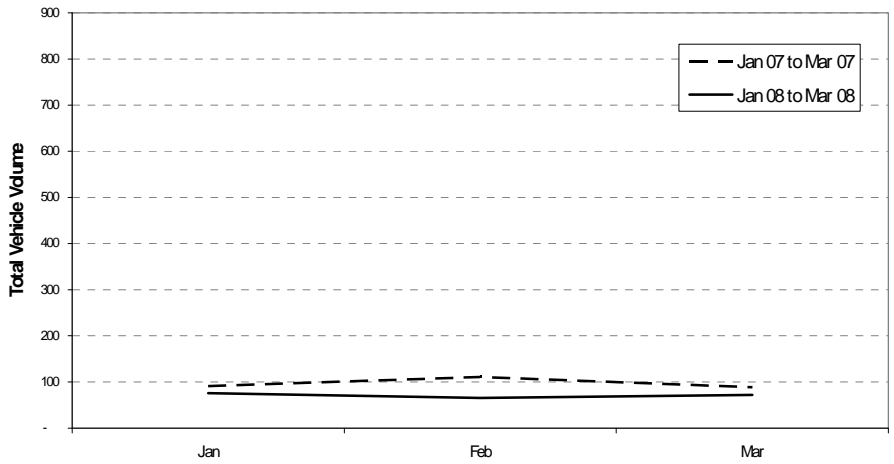
**Figure 36. Fisher Rd (PM Peak), I 35 to FM 2790, Eastbound.**

The travel rate indices for the other eastbound segments in the corridor show similar patterns of little or no increase in the travel rate indices year-to-year.

*Total Vehicle Volumes, Eastbound Direction, Afternoon Peak*

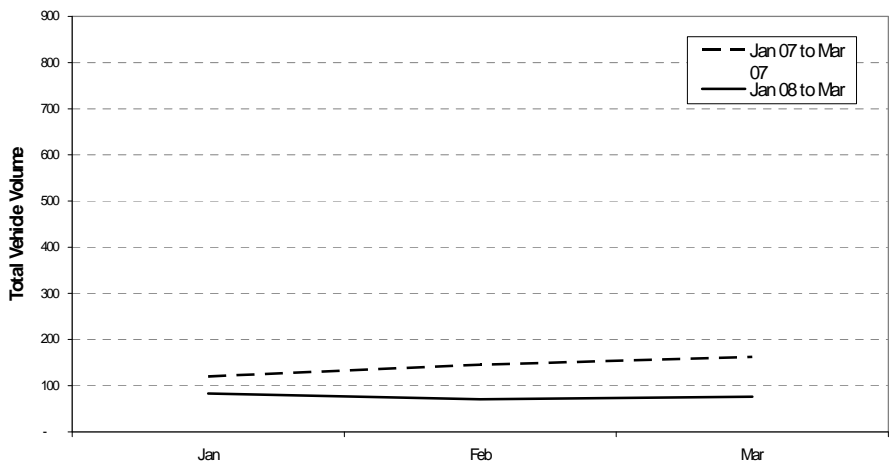
Figure 37 through Figure 41 show the eastbound traffic volume comparisons for site 308 located on Lone Star Pass near Applewhite Rd. The graphs show vehicle volumes for each hour of the afternoon peak period, 2 p.m. to 7 p.m. Each graph displays a dashed line for data collected during January to March 2007 and a solid line for data collected in January to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months January to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month observed.

Figure 37 shows the eastbound traffic volume comparisons for site 308 during the 2 p.m. to 3 p.m. hour. The volumes are low and steady for both dashed and solid lines with the 2007 (dashed) line slightly higher.



**Figure 37. Total Vehicle Volumes, Site 308 Eastbound, 2 PM to 3 PM.**

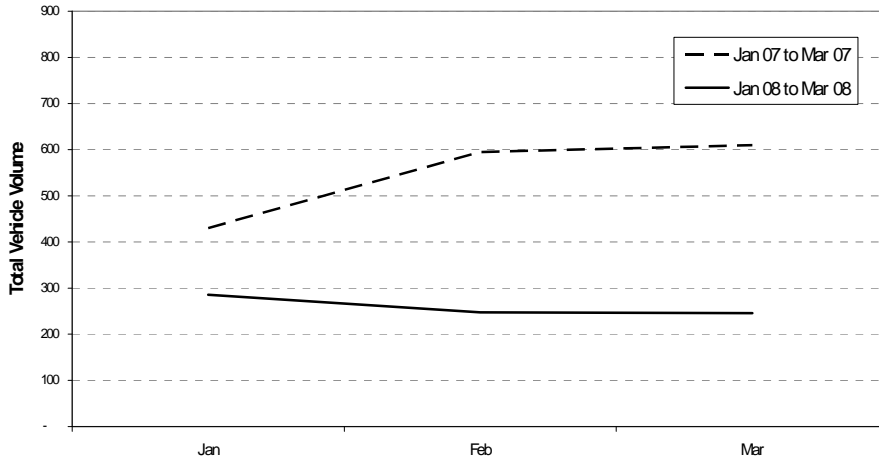
Figure 38 shows the eastbound traffic volume comparisons for site 308 during the 3 p.m. to 4 p.m. hour. The dashed line shows a slight positive increase from January to March 2007 with the dashed line slightly higher than the solid line. The volumes are low and steady for the solid line.



**Figure 38. Total Vehicle Volumes, Site 308 Eastbound, 3 PM to 4 PM.**

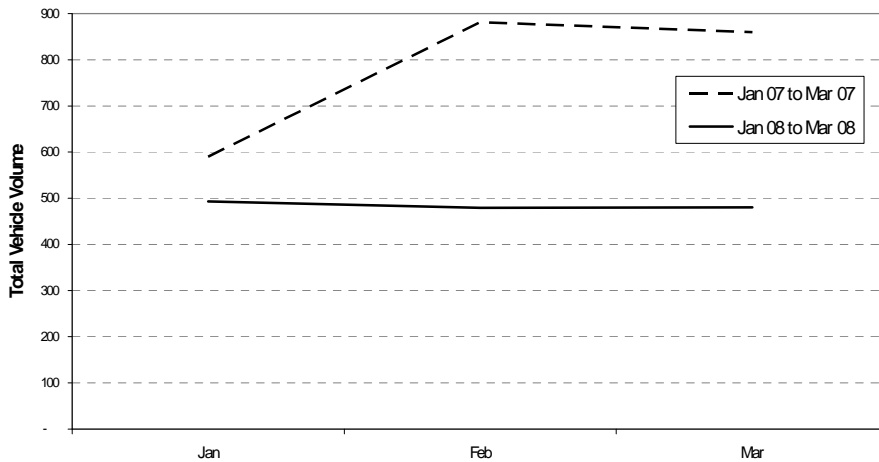
Figure 39 shows the eastbound traffic volume comparisons for site 308 during the 4 p.m. to 5 p.m. hour. Toyota instituted a shift change in February 2007 which may

account for the increase in 2007 volumes (dashed line) in February and March. The newer volumes (solid line) show a slight decline from just under 300 vehicles to fewer than 250 vehicles. The 2007 volumes are significantly higher than the 2008 volumes.



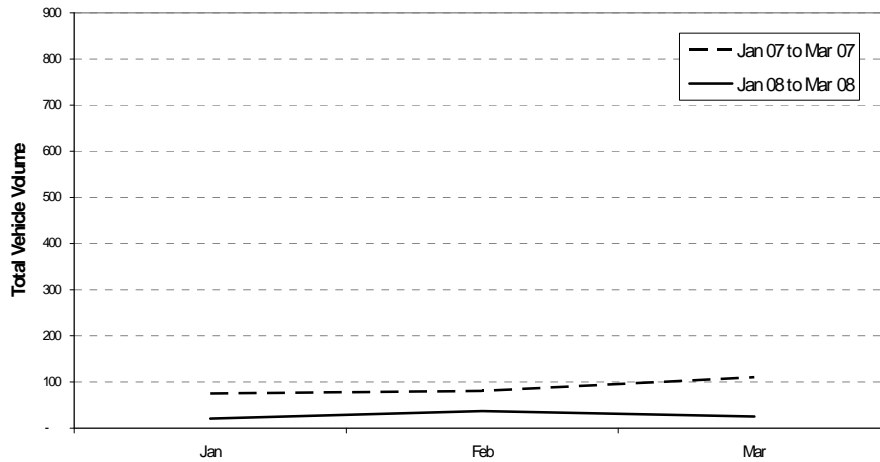
**Figure 39. Total Vehicle Volumes, Site 308 Eastbound, 4 PM to 5 PM.**

Figure 40 shows the eastbound traffic volume comparisons for site 308 during the 5 p.m. to 6 p.m. hour. Toyota instituted a shift change in February 2007 which may account for the increase in 2007 volumes (dashed line) in February and March. The newer volumes (solid line) are steady at just under 500 vehicles. The 2007 volumes are significantly higher than the 2008 volumes.



**Figure 40. Total Vehicle Volumes, Site 308 Eastbound, 5 PM to 6 PM.**

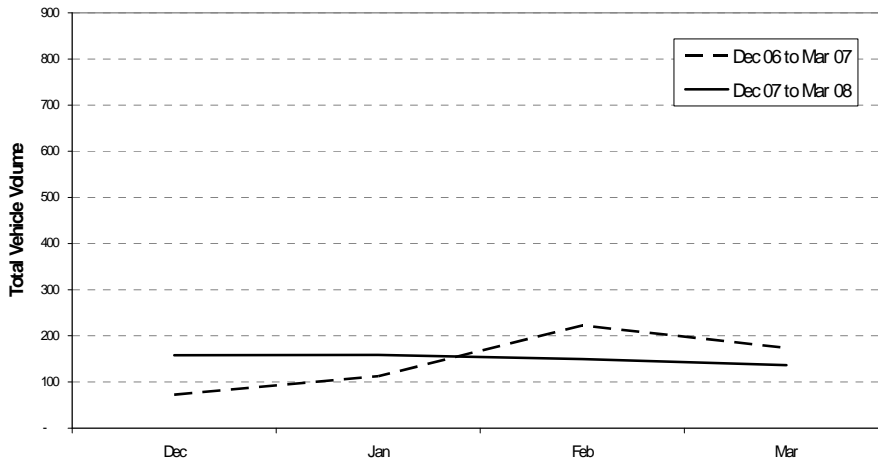
Figure 41 shows the eastbound traffic volume comparisons for site 308 during the 6 p.m. to 7 p.m. hour. The dashed line shows a slight positive increase from January to March 2007. The volumes are low and steady for the solid line with the 2007 (dashed) line higher for each month.



**Figure 41. Total Vehicle Volumes, Site 308 Eastbound, 6 PM to 7 PM.**

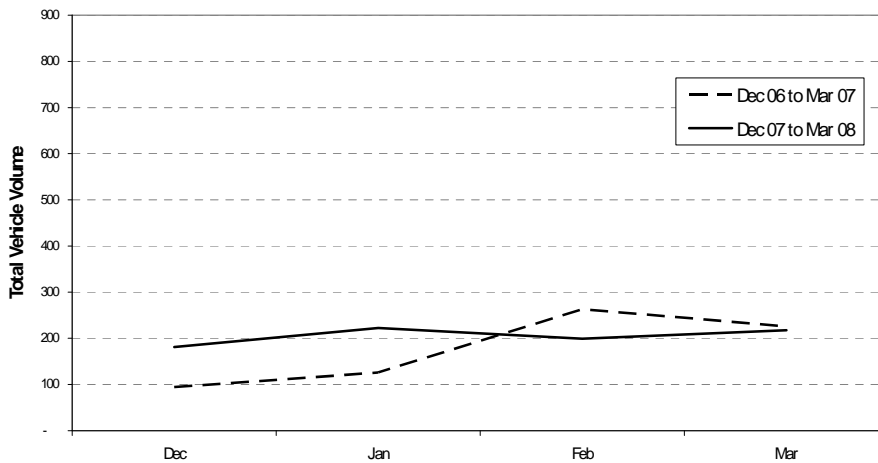
Figure 42 and Figure 43 show the eastbound traffic volume comparisons for site 307 located on Watson Rd between FM 2790 and SH 16. The graphs show vehicle volumes for each hour of the afternoon peak period, 2 p.m. to 7 p.m. Each graph displays a dashed line for data collected during December 2006 to March 2007 and a solid line for data collected in December 2007 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months December to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month observed.

Figure 42 shows the eastbound traffic volume comparisons for site 307 during the 4 p.m. to 5 p.m. hour. The 2008 (solid) line is steady at about 150 vehicles for this hour. The 2007 (dashed) line shows an increase from December to February with a slight decrease in March. Toyota instituted a shift change in February which may account for the decrease in March volumes.



**Figure 42. Total Vehicle Volumes, Site 307 Eastbound, 4 PM to 5 PM.**

Figure 43 shows the eastbound traffic volume comparisons for site 307 during the 5 p.m. to 6 p.m. hour. The 2008 (solid) line is steady at about 200 vehicles for this hour. The 2007 (dashed) line shows an increase from December to February with a slight decrease in March. Toyota instituted a shift change in February which may account for the decrease in March volumes. This follows a similar pattern to Figure 42.



**Figure 43. Total Vehicle Volumes, Site 307 Eastbound, 5 PM to 6 PM.**

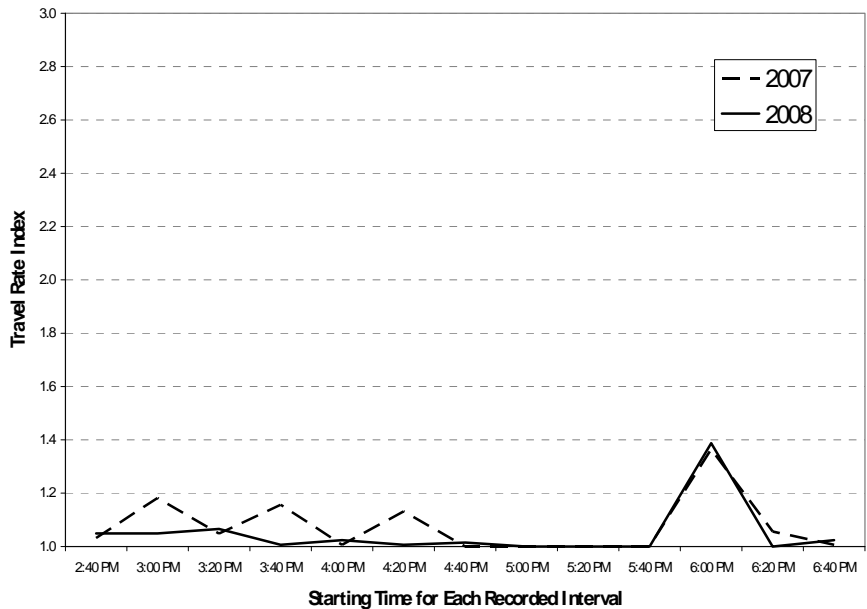
*Truck Volumes, Eastbound Direction, Afternoon Peak*

No significant truck traffic increases were noted in the analysis.

*Travel Time Runs, Westbound Direction, Afternoon Peak*

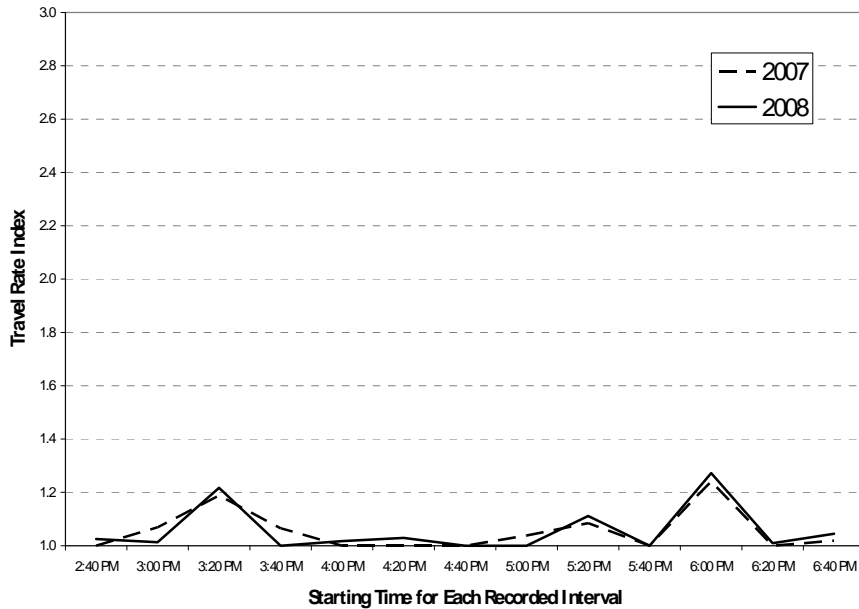
Figure 44 through Figure 45 show the travel rate index comparisons for each segment of the corridor in westbound direction. Each graph displays a dashed line for data collected in 2007 and a solid line for data collected in 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the afternoon peak period divided into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 6:40 p.m. A travel rate index is calculated for each interval observed.

Figure 44 displays the indices observed for the afternoon peak in the westbound direction for segment C listed for Corridor 2 above. The solid line (2008) is below the dashed line (2007) in most time intervals. Given that the first shift ends at 3:15 p.m., researchers expected to see an increase in the index in the time intervals between 3:20 p.m. to 4:00 p.m. for 2008, assuming an increased amount of traffic from year-to-year. In fact, 2008 data registered closer to free flow conditions for those intervals.



**Figure 44. Lone Star Pass (PM Peak), SH 16 to Applewhite Rd, Westbound.**

Figure 45 displays the indices observed for the afternoon peak in the westbound direction for segment B listed above, a little further out from the plant. The solid line (2008) and the dashed line (2007) follow the same trend throughout the afternoon peak period. There is very little difference from year-to-year.



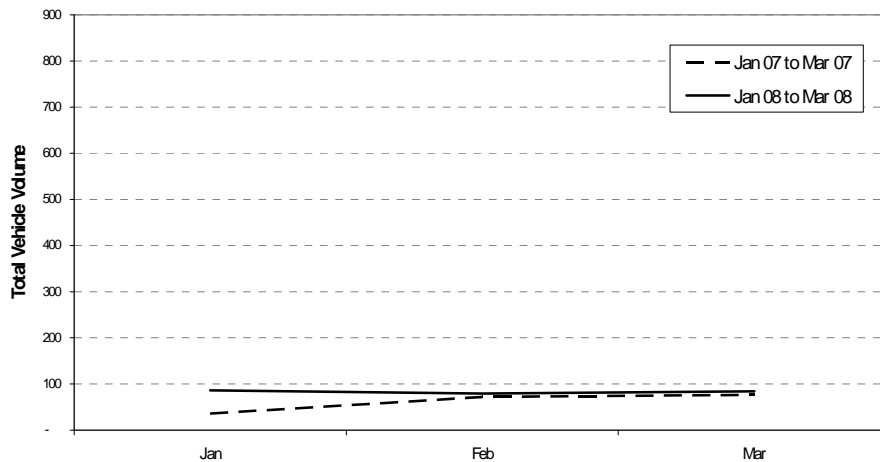
**Figure 45. Watson Rd (PM Peak), SH 16 to FM 2790, Westbound.**

*Total Vehicle Volumes, Westbound Direction, Afternoon Peak*

Figure 46 through Figure 50 show the westbound traffic volume comparisons for site 308 located on Lone Star Pass near Applewhite Rd. The graphs show vehicle volumes for each hour of the afternoon peak period, 2 p.m. to 7 p.m. Each graph displays a dashed line for data collected during January to March 2007 and a solid line for data collected in January to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months January to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month observed.

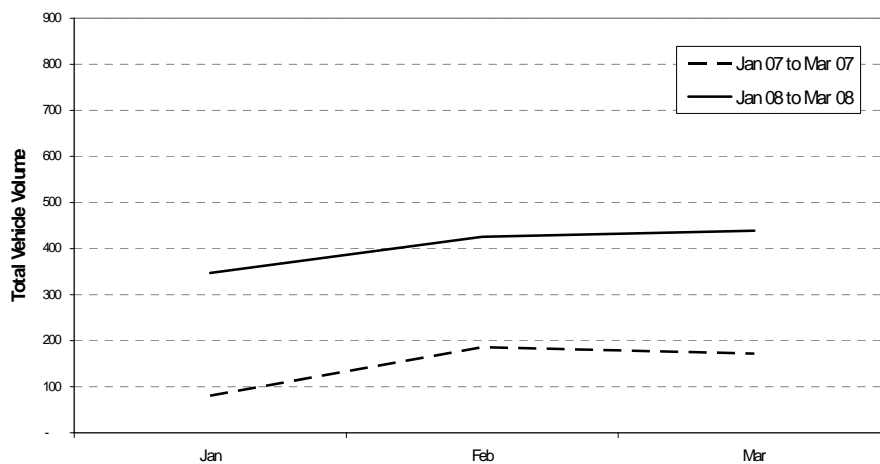
Figure 46 shows the westbound traffic volume comparisons for site 308 during the 2 p.m. to 3 p.m. hour. The older volumes (dashed line) and the newer volumes (solid line) are low and show very little difference from year-to-year.





**Figure 46. Total Vehicle Volumes, Site 308 Westbound, 2 PM to 3 PM.**

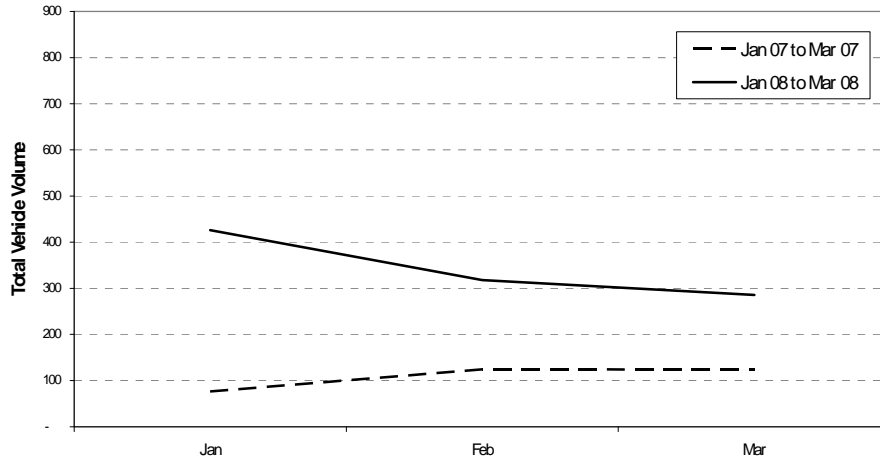
Figure 47 shows the westbound traffic volume comparisons for site 308 during the 3 p.m. to 4 p.m. hour. The 2008 volumes (solid line) follow the same trend as the 2007 volumes (dashed line). The 2008 volumes are roughly four times greater than the 2007 volumes for each month observed.



**Figure 47. Total Vehicle Volumes, Site 308 Westbound, 3 PM to 4 PM.**

Figure 48 shows the westbound traffic volume comparisons for site 308 during the 4 p.m. to 5 p.m. hour. The 2008 volumes (solid line) are roughly three to four times

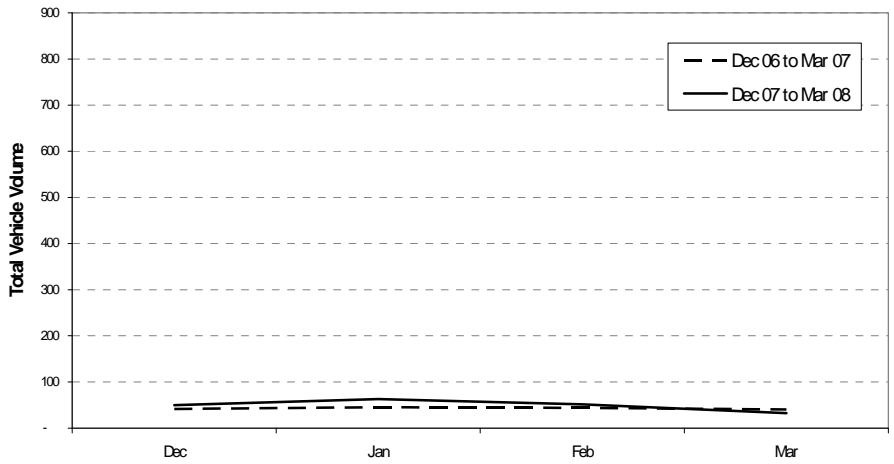
greater than the 2007 volumes (dashed line). The 2008 volumes have a decreasing trend while the 2007 volumes have a slight increasing trend.



**Figure 48. Total Vehicle Volumes, Site 308 Westbound, 4 PM to 5 PM.**

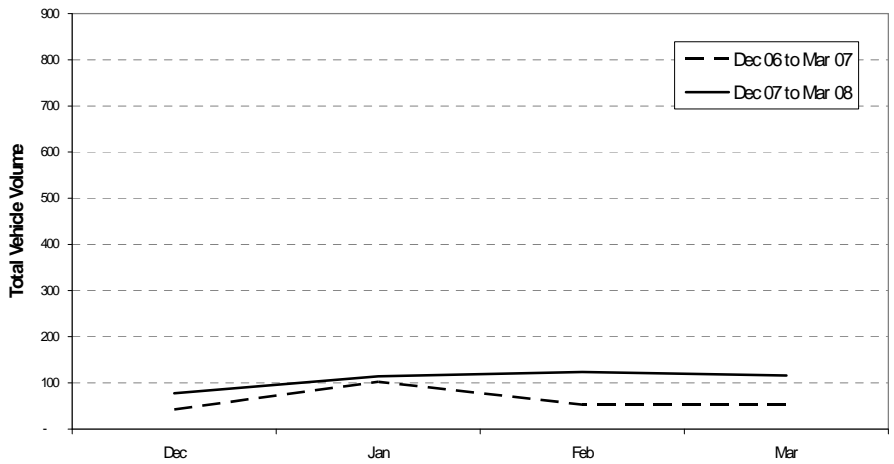
Figure 49 through Figure 50 show the westbound traffic volume comparisons for site 307 located on Watson Rd between FM 2790 and SH 16. The graphs show vehicle volumes for each hour of the afternoon peak period, 2 p.m. to 7 p.m. Each graph displays a dashed line for data collected during December 2006 to March 2007 and a solid line for data collected in December 2007 to March 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the months December to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month observed.

Figure 49 shows the westbound traffic volume comparisons for site 307 during the 2 p.m. to 3 p.m. hour. The older volumes (dashed line) and the newer volumes (solid line) are steady and show very little difference from year-to-year.



**Figure 49. Total Vehicle Volumes, Site 307 Westbound, 2 PM to 3 PM.**

Figure 50 shows the westbound traffic volume comparisons for site 307 during the 3 p.m. to 4 p.m. hour. The 2008 volumes (solid line) are slightly above the 2007 volumes (dashed line), but not a significant amount.



**Figure 50. Total Vehicle Volumes, Site 307 Westbound, 3 PM to 4 PM.**

### **Corridor 3: SH 16 from SL 1604 to IH 35**

Corridor 3 is the last of three closest corridors in the study area. Researchers expected to see some impact from the major generator in this corridor. Travel times were collected in both the north and south directions of this corridor during the morning and afternoon peak periods. Corridor 3 is defined in linked segments as follows:

- (A) SH 16 from IH 35 to Hunter Ave
- (B) SH 16 from Hunter Ave to Gillette Blvd
- (C) SH 16 from Gillette Blvd to W Villaret Blvd
- (D) SH 16 from W Villaret Blvd to IH 410
- (E) SH 16 from IH 410 to Kingsride Blvd/Appleswhite Rd
- (F) SH 16 from Kingsride Blvd/Appleswhite Rd to S Zarzamora St
- (G) SH 16 from S Zarzamora St to Lone Star Pass/Watson Rd
- (H) SH 16 from Lone Star Pass/Watson Rd to Noyes Rd
- (I) SH 16 from Noyes Rd to SL 1604

Volume data and vehicle class data were collected at five sites along this corridor:

- Site 309 located on SH 16 between Lone Star Pass/Watson Rd and Noyes Rd.
- Site 310 located on SP 422 between Gillette Blvd and W Villaret Blvd.
- Site 311 located on SH 16 between Kingsride Blvd/Appleswhite Rd and IH 410.
- Site 316 located on SH 16, south of SL 1604.
- Site 328 located on SH 16 between Lone Star Pass/Watson Rd and Noyes Rd.

For site 309, site 311, and site 328, both vehicle volume and vehicle class data were collected from October 2006 through March 2008. Vehicle volumes and truck volumes for these sites will be discussed throughout the analysis of the corridor.

For site 310, vehicle volumes and vehicle class data were collected from mid-October 2006 to mid-March 2007. For site 316, vehicle volumes and vehicle class data were collected from mid-February 2007 to March 2008. There were not enough data to draw conclusions concerning vehicle volumes or truck volumes for year-to-year comparisons at these sites.

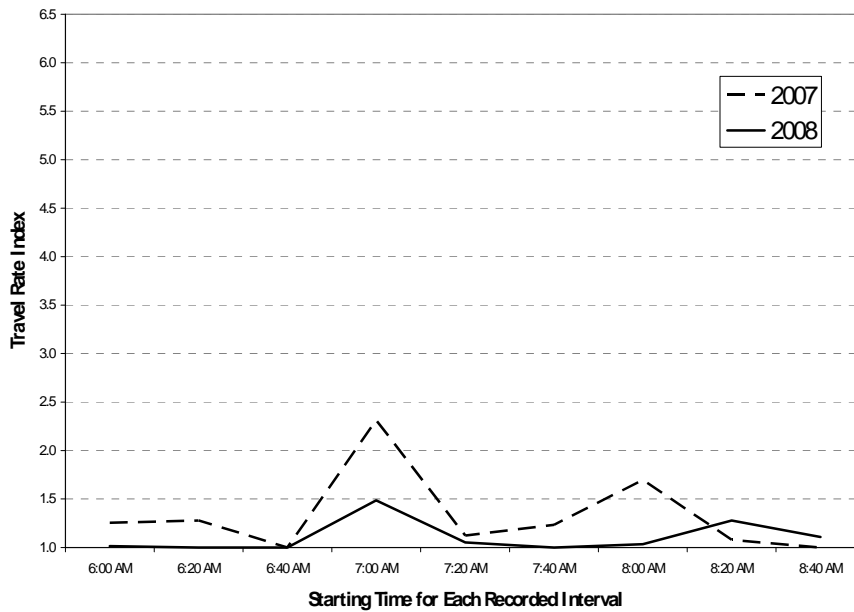
For Corridor 3, the morning peak hours were divided into 20-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:40 a.m. The afternoon peak hours were divided into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 6:40 p.m.

#### *Travel Time Runs, Southbound Direction, Morning Peak*

Figure 51 through Figure 55 show the travel rate index comparisons for each segment of the corridor in southbound direction. Each graph displays a dashed line for data collected in 2007 and a solid line for data collected in 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the morning peak period divided into 20-minute intervals starting

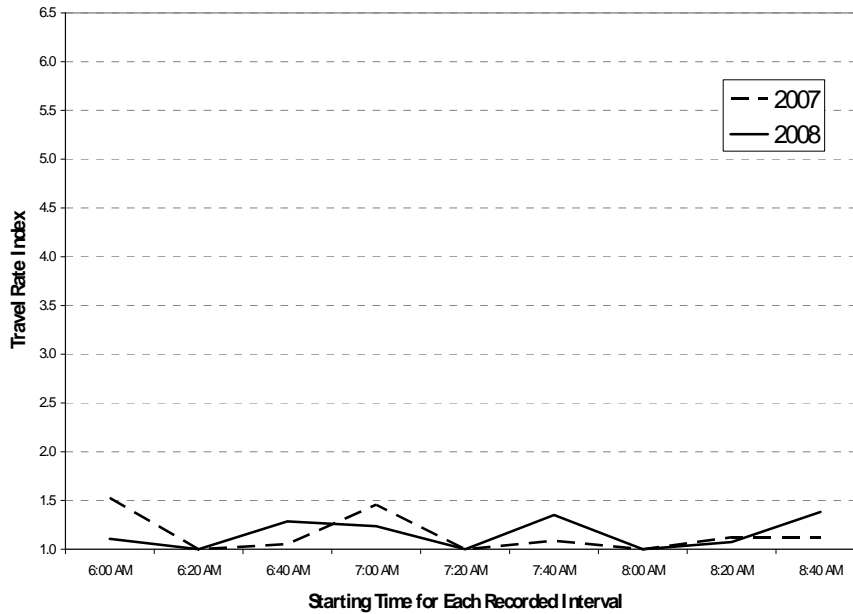
at 6:00 a.m. with the last interval beginning at 8:40 a.m. A travel rate index is calculated for each interval.

The northern segments in the corridor are between IH 35 and IH 410. The travel rate indices measured in 2007 and 2008 show no significant differences, and any increases cannot be related to Toyota plant activity. The congestion indicated by the indices shows normal, expected peak period congestion. Figure 51 displays the indices observed for the morning peak in the southbound direction for segment A listed above. In several time intervals, 2007 travel rate indices are significantly higher than those recorded for 2008. This means that 2008 travelers spent less time in this segment of the corridor. These results are typical for the other segments between the two interstate highways.



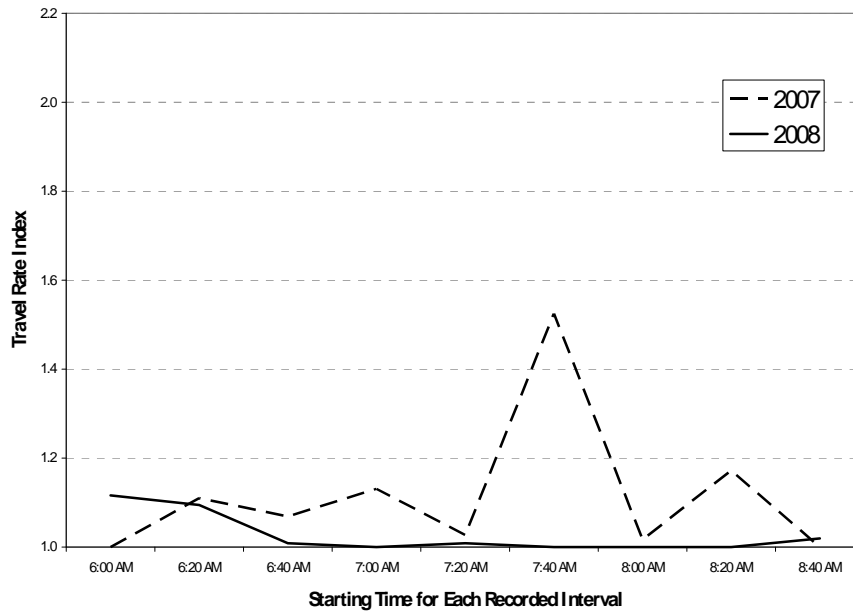
**Figure 51. SH 16 (AM Peak), IH 35 to Hunter Ave, Southbound.**

Figure 52 displays the indices observed for the morning peak in the southbound direction for segment E listed above. The following segments of the corridor are moving closer to the Toyota plant. The 2007 indices (dashed line) are about the same as the 2008 indices (solid line). Both years of data are near free flow conditions and not significantly different from one year to the next.



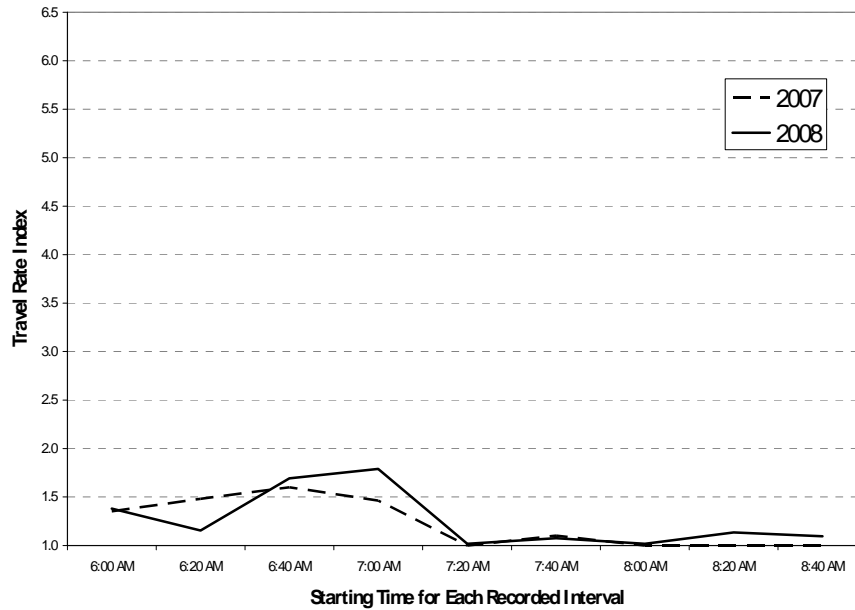
**Figure 52. SH16 (AM PEAK), IH 410 to Kingsride Blvd/Appleshwhite Rd, Southbound.**

Figure 53 displays the indices observed for the morning peak in the southbound direction for segment F listed above. Even though the 2007 indices (dashed line) are consistently higher than the 2008 indices (solid line), both years of data are near free flow conditions and not significantly different from one year to the next. The one exception is the 2007 peak at 7:40 a.m. to 8:00 a.m. where the travel rate index is 1.5.



**Figure 53. SH 16 (AM Peak), Kingsride Blvd/Appplewhite Rd to S Zarzamora St, Southbound.**

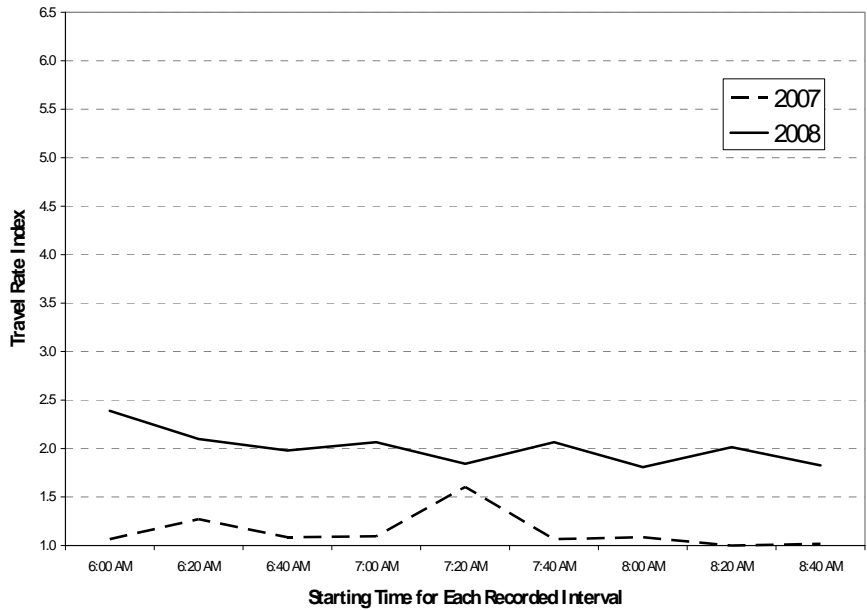
Figure 54 displays the indices observed for the morning peak in the southbound direction for segment G listed above. Both years of data are near free flow conditions and not significantly different from one year to the next. This segment is of note in that the increase in the travel rate index occurs after the beginning of the first shift at the plant. Furthermore, the index records are lower in 2008 in the 6:00 a.m. to 6:40 a.m. time period when increased congestion would be expected.



**Figure 54. SH 16 (AM Peak), S Zarzamora St to Lone Star Pass/Watson Rd, Southbound.**



Figure 55 displays the travel rate indices observed for the morning peak in the southbound direction for segment H listed above. The solid line (2008) is higher than the dashed line (2007) for all time intervals in this segment. Congestion has increased across all time intervals for this roadway segment; however, it is not within the shift change periods at the plant that would indicate impacts for the plant.

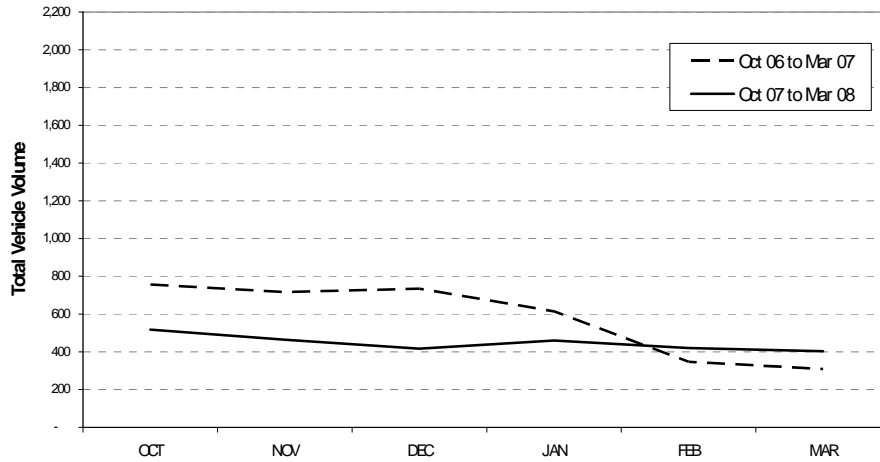


**Figure 55. SH 16 (AM Peak), Lone Star Pass/Watson Rd to Noyes Rd, Southbound.**

*Total Vehicle Volumes, Southbound Direction, Morning Peak*

The following graphs display a dashed line for vehicle volume data collected during October 2006 to March 2007 and a solid line for data collected in October 2007 to March 2008 for a year-to-year comparison. The horizontal axis shows the months October to March and the vertical axis shows total vehicle volumes. The volumes are calculated as an average of the second Tuesday and Wednesday of each month.

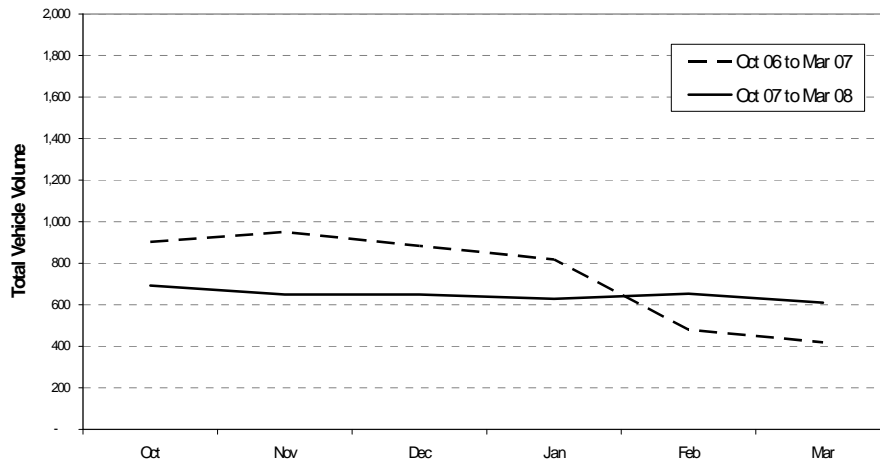
Figure 56 shows the southbound traffic volume comparisons for site 309 during the 6 a.m. to 7 a.m. hour. The graphs for the other morning hours are very similar in pattern and variance in the volumes. There is very little change from year-to-year in vehicle volumes.



**Figure 56. Total Vehicle Volumes, Site 309 Southbound, 6 AM to 7 AM.**

Figure 57 shows the southbound traffic volume comparisons for site 311 during the 6:00 a.m. to 7:00 a.m. hour. This site is located near IH 410, and this time period is when expected impacts in volume would occur. The first shift begins at 6:30 a.m. In 2007, traffic decreased in the time period as the shifts split at the plant. Within a year, total volume had increased, but at approximately 600 vehicles an hour, no significant impact is indicated at the site.

The graphs for the other morning hours are very similar in pattern and volumes, with the 8:00 a.m. to 9:00 a.m. hour with 60 percent of the volume of the other two hours. There is very little change from year-to-year in vehicle volumes.



**Figure 57. Total Vehicle Volumes, Site 311 Southbound, 6 AM to 7 AM.**

*Truck Volumes, Southbound Direction, Morning Peak*

No significant changes in year-to-year truck volumes were indicated for the southbound morning peak hours from data collected at the five sites on the corridor. The truck volumes are calculated as an average of the second Tuesday and Wednesday of each month.

*Travel Time Runs, Northbound Direction, Morning Peak*

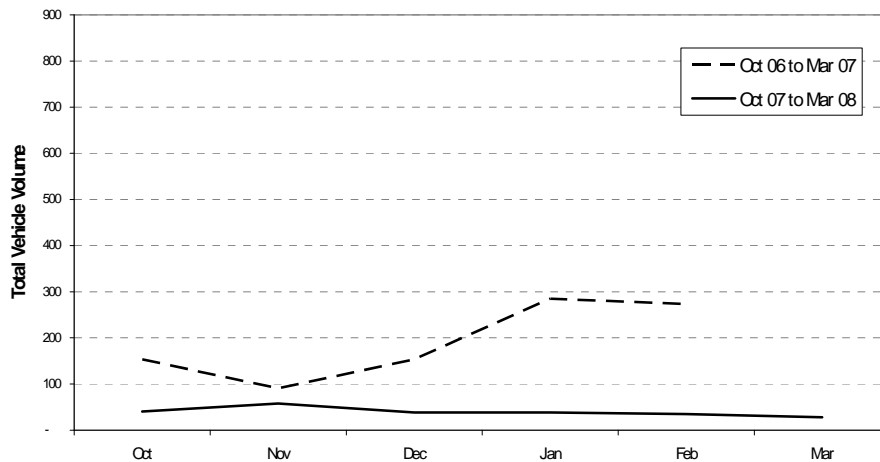
No significant changes in year-to-year travel rate indices were indicated for the northbound morning peak hours from data collected during the travel time surveys.

*Total Vehicle Volumes, Northbound Direction, Morning Peak*

No significant changes in year-to-year total vehicle volumes were indicated for the northbound morning peak hours from data collected at the five sites on the corridor. The volumes were calculated as an average of the second Tuesday and Wednesday of each month.

*Truck Volumes, Northbound Direction, Morning Peak*

Figure 58 shows the only significant change found in the truck volume data collected in the corridor for the northbound morning peak period. Truck volume comparisons for site 311 during the 6 a.m. to 7 a.m. hour are shown. The data indicate that truck volumes decreased in the year-to-year comparison. No data were collected for March 2007 at this site.



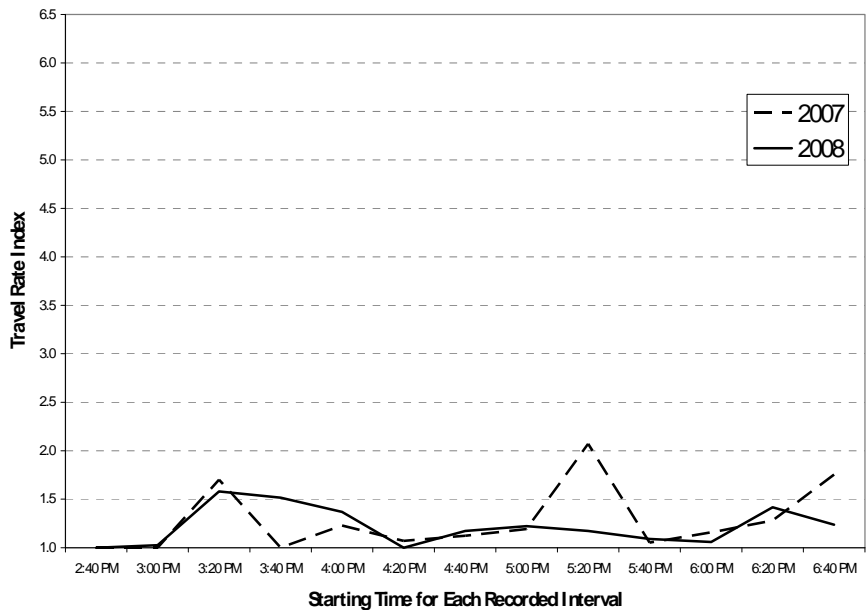
**Figure 58. Total Truck Volumes, Site 311 Northbound, 6 AM to 7 AM.**

*Travel Time Runs, Southbound Direction, Afternoon Peak*

The northern segments of the corridor again showed no significant changes between the 2007 and 2008 travel time runs. [Figure 59](#) through [Figure 62](#) show the segments of the corridor closest to the plant. These locations are where significant impacts were expected to be found by researchers.

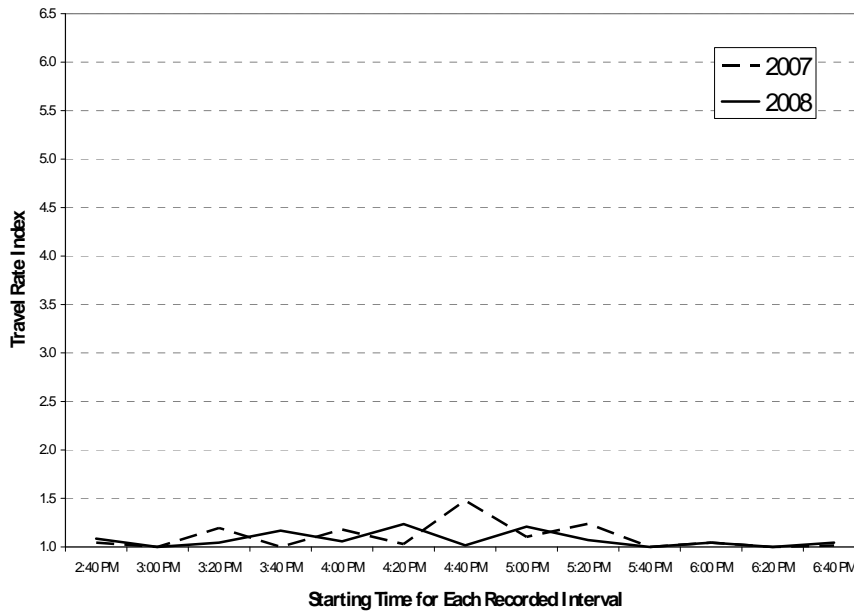
Each graph displays a dashed line for data collected in 2007 and a solid line for data collected in 2008 for a year-to-year comparison. Each graph has the same vertical and horizontal scale. For each figure, the horizontal axis shows the afternoon peak period to be split into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 7:40 p.m. A travel rate index is calculated for each interval observed.

[Figure 59](#) displays the indices observed for the afternoon peak in the southbound direction for segment E listed above. The dashed line (2007) is generally the same during most of the time intervals. The travel rate indices for both years are still close to free flow traffic, though in 2007, occasionally the travel times were a little longer than the travel times observed for 2008.



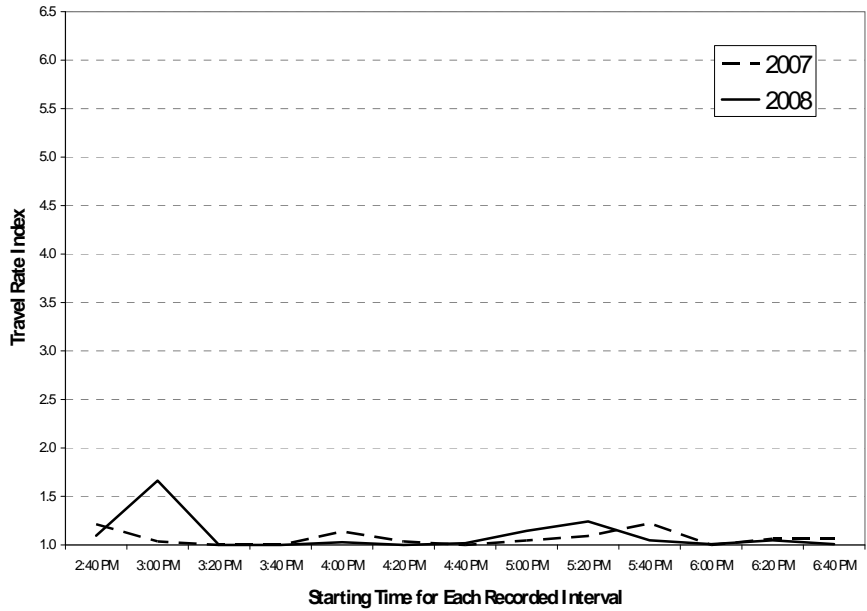
**Figure 59. SH 16 (PM Peak), IH 410 to Kingsride Blvd/Applewhite Rd, Southbound.**

Figure 60 displays the indices observed for the afternoon peak in the southbound direction for segment F listed above. Even though the 2007 indices (dashed line) are generally the same as the 2008 indices (solid line), both years of data are near free flow conditions and not significantly different from one year to the next.



**Figure 60. SH 16 (PM Peak), Kingsride Blvd/Appleswhite Rd to S Zarzamora St, Southbound.**

Figure 61 displays the indices observed for the afternoon peak in the southbound direction for segment G listed above. The 2007 indices (dashed line) are generally about the same as the 2008 indices (solid line), yet both years of data are near free flow conditions and not significantly different from one year to the next.



**Figure 61. SH 16 (PM Peak), S Zarzamora St to Lone Star Pass/Watson Rd, Southbound.**

Figure 62 displays the indices observed for the afternoon peak in the southbound direction for segment H listed above. On SH 16, this is the closest intersection to the Toyota plant. There is almost a doubling of congestion throughout most of the time intervals in the PM peak. The 2007 indices were close to free flow conditions through most of the PM peak. The increased congestion beginning in the 3:20 p.m. period is expected along with the 5:20 to 6:00 p.m. periods due to beginning of the second shift. However, the increases in the periods between these two cannot be explained by plant operations.

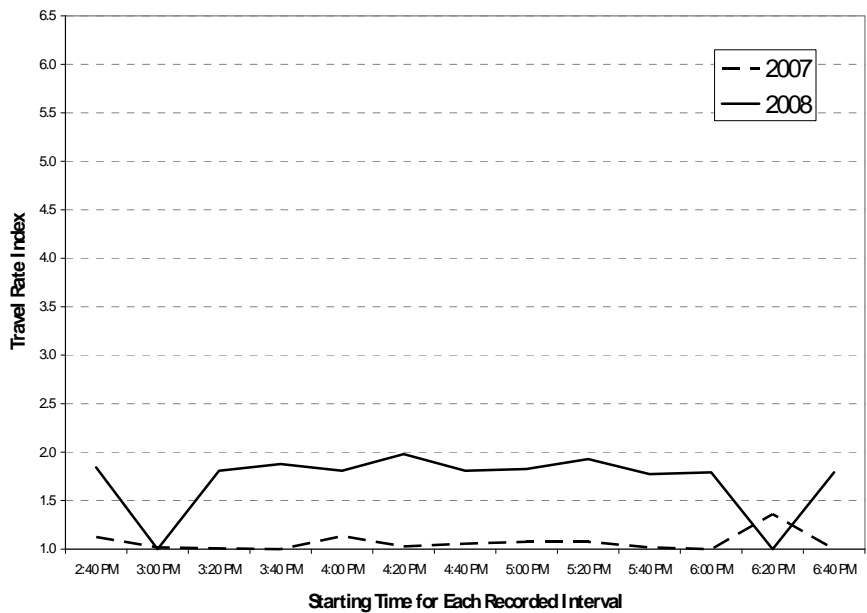


Figure 62. SH 16 (PM Peak), Lone Star Pass/Watson Rd to Noyes Rd, Southbound.



*Total Vehicle Volumes, Southbound Direction, Afternoon Peak*

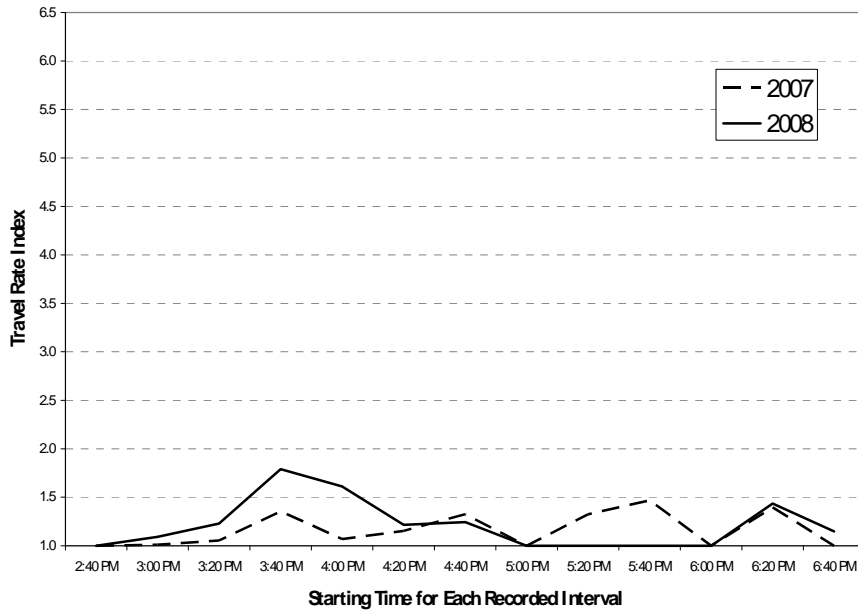
No significant changes in year-to-year total vehicle volumes were indicated for the southbound afternoon peak hours from data collected at the five sites on the corridor. The volumes were calculated as an average of the second Tuesday and Wednesday of each month.

*Truck Volumes, Southbound Direction, Afternoon Peak*

No significant changes in year-to-year truck volumes were indicated for the southbound afternoon peak hours from data collected at the five sites on the corridor. The truck volumes are calculated as an average of the second Tuesday and Wednesday of each month.

*Travel Time Runs, Northbound Direction, Afternoon Peak*

Figure 63 displays the only significant impact measured for travel times in the northbound direction in the afternoon peak period. The increase in the 3:40 p.m. time period would be expected due to plant operations. The first shift ends at 3:15 p.m., and northbound traffic on SH 16 in this segment registers increased congestion 30 minutes later. It should be noted that the indices for the corridor segment just south of this one do not indicate significant change in congestion year-to-year and, despite the increase, both years of data are near free flow conditions.



**Figure 63. SH 16 (PM Peak), Kingsride Blvd/Appplewhite Rd to S Zarzamora St, Northbound.**

### *Total Vehicle Volumes, Northbound Direction, Afternoon Peak*

No significant changes in year-to-year total vehicle volumes were indicated for the northbound afternoon peak hours from data collected at the five sites on the corridor. The volumes were calculated as an average of the second Tuesday and Wednesday of each month.

### *Truck Volumes, Northbound Direction, Afternoon Peak*

No significant changes in year-to-year truck volumes were indicated for the northbound afternoon peak hours from data collected at the five sites on the corridor. The volumes were calculated as an average of the second Tuesday and Wednesday of each month.

### **Corridor 4: SL 1604 from IH 35 to IH 37**

Travel times were collected in both the east and west directions of this corridor during the morning and afternoon peak periods. Corridor 4 is defined in linked segments as follows:

- (A) SL 1604 from IH 35 to FM 2790
- (B) SL 1604 from FM 2790 to Senior Rd
- (C) SL 1604 from Senior Rd to SH 16
- (D) SL 1604 from SH 16 to Applewhite Rd
- (E) SL 1604 from Applewhite Rd to SH 281
- (F) SL 1604 from SH 281 to IH 37

Volume data and vehicle class data were collected at four sites along this corridor:

- Site 317 located on SL 1604, east of SH 16.
- Site 318 located on SL 1604 between Applewhite Rd and Trumbo Rd.
- Site 320 located on SL 1604, west of IH 37
- Site 325 located on SL 1604, west of Senior Rd.

For site 317 and site 318, both vehicle volume and vehicle class data were collected from October 2006 through March 2008. Vehicle volumes and truck volumes for these sites will be discussed throughout the analysis of the corridor.

For site 320 and site 325, vehicle volumes and vehicle class data were collected from March 2007 to March 2008. There were not enough data to draw conclusions concerning vehicle volumes or truck volumes for year-to-year comparisons at this site.

For Corridor 4, the morning peak hours were divided into 20-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:40 a.m. The afternoon peak hours were divided into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 6:40 p.m.

No significant impacts were recorded in Corridor 4 in travel time runs, total vehicle volumes, or truck volumes in any segment in either direction in the morning and afternoon peak periods.

### **Corridor 5: IH 410 from FM 2536 to IH 37**

Travel times were collected in both the east and west directions of this corridor during the morning and afternoon peak periods. Corridor 5 is defined in linked segments as follows:

- (A) IH 410 from FM 2536 to IH 35
- (B) IH 410 from IH 35 to Somerset Rd
- (C) IH 410 from Somerset Rd to SH 16
- (D) IH 410 from SH 16 to Zarzamora St
- (E) IH 410 from Zarzamora St to Moursund Blvd
- (F) IH 410 from Moursund Blvd to IH 37

Volume data and vehicle class data were collected at three sites along this corridor:

- Site 303 located on IH 410, east of FM 2536.
- Site 305 located on IH 410 between FM 2790 (Somerset Rd) and SH 16.
- Site 312 located on IH 410 between Pleasanton Rd and US 281.

For site 303, vehicle volumes and vehicle class data were collected from February 2007 to March 2008. There were gaps in the data collection coverage such that there were not enough data to draw conclusions concerning vehicle volumes or truck volumes for year-to-year comparisons at this site.

For site 305, vehicle volumes and vehicle class data were collected from June 2007 to March 2008. There were not enough data to draw conclusions concerning vehicle volumes or truck volumes for year-to-year comparisons at this site.

For site 312, both vehicle volume and vehicle class data were collected from October 2006 through March 2008. Vehicle volumes and truck volumes will be discussed below.

For Corridor 5, the morning peak hours were divided into 30-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:30 a.m. The afternoon peak hours were divided into 30-minute intervals starting at 2:30 p.m. with the last interval beginning at 6:30 p.m.

No significant impacts from the major traffic generator were recorded in Corridor 5 in travel time runs, total vehicle volumes, or truck volumes for any segment in either direction in the morning and afternoon peak periods. Any changes recorded in the data could not be explained by activity generated by plant operations.

### **Corridor 6: US 281 from IH 410 to SL 1604**

Travel times were collected in both the north and south directions of this corridor during the morning and afternoon peak periods. Corridor 6 is defined in linked segments as follows:

- (A) US 281 from IH 410 to FM 1937
- (B) US 281 from FM 1937 to FM 2537
- (C) US 281 from FM 2537 to SL 1604

Volume data and vehicle class data were collected at three sites along this corridor:

- Site 319 located on US 281, south of SL 1604.
- Site 327 located on US 281 between FM 2537 to SL 1604.
- Site 329 located on IH 35 between FM 1937 to FM 2537, just north of Martinez-Losoya Rd.

For all three sites, vehicle volumes and vehicle class data were collected from mid-March 2007 to March 2008. There were not enough data to draw conclusions concerning vehicle volumes or truck volumes for year-to-year comparisons at this site.

For Corridor 6, the morning peak hours were divided into 20-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:40 a.m. The afternoon peak hours were divided into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 6:40 p.m.

No significant impacts from the major traffic generator were recorded in Corridor 6 in travel time runs, total vehicle volumes, or truck volumes for any segment in either direction in the morning and afternoon peak periods. Any changes recorded in the data could not be explained by activity generated by plant operations.

#### **Corridor 7: FM 2790 from SL 1604 to IH 410**

Travel times were collected in both the north and south directions of this corridor during the morning and afternoon peak periods. Corridor 7 is in the western half of the study area and is defined in linked segments as follows:

- (A) FM 2790 from IH 410 to Watson Rd/Fisher Rd
- (B) FM 2790 from Watson Rd/Fisher Rd to Old Somerset Rd
- (C) FM 2790 from Old Somerset Rd to Senior Rd
- (D) FM 2790 from Senior Rd to S Evans Rd
- (E) FM 2790 from S Evans Rd to Frank Hoffman Rd
- (F) FM 2790 from Frank Hoffman Rd to Rockport Rd
- (G) FM 2790 from Rockport Rd to SL 1604

Volume data and vehicle class data were collected along this corridor at site 306 located just south of Senior Rd. Vehicle volumes and vehicle class data were collected from April 2007 to March 2008. There were not enough year-to-year data to draw conclusions concerning vehicle volumes or truck volumes.

For Corridor 7, the morning peak hours were divided into 20-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:40 a.m. The afternoon peak hours were divided into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 6:40 p.m.

No significant impacts from the major traffic generator were recorded in Corridor 7 in travel time runs, total vehicle volumes, or truck volumes for any segment in either

direction in the morning and afternoon peak periods. Any changes recorded in the data could not be explained by activity generated by plant operations.

### **Corridor 8: IH 35 from FM 2790 to SP 422**

Travel times were collected in both the north and south directions of this corridor during the morning and afternoon peak periods. Corridor 8 is the westernmost boundary of the study area and is defined in linked segments as follows:

- (A) IH 35 from SP 422 to Somerset Rd
- (B) IH 35 from Somerset Rd to IH 410
- (C) IH 35 from IH 410 to Fisher Rd
- (D) IH 35 from Fisher Rd to SL 1604
- (E) IH 35 from SL 1604 to Kinney Rd
- (F) IH 35 from Kinney Rd to Shepherd Rd
- (G) IH 35 from Shepherd Rd to Lucky Rd
- (H) IH 35 from Lucky Rd to US 81
- (I) IH 35 from US 81 to FM 2790

Volume data and vehicle class data were collected at three sites along this corridor:

- Site 210 located along IH 353 near Lucky Rd.
- Site 302 located on IH 35 between Fisher Rd and SL 1604.
- Site 304 located on IH 35 between IH 410 and Somerset Rd.

For site 210, vehicle volumes and vehicle class data were collected from late March 2007 to July 2007. There were not enough data to draw conclusions concerning vehicle volumes or truck volumes for year-to-year comparisons at this site.

For site 302, vehicle volumes and vehicle class data were collected from mid-February 2007 to March 2008. There were not enough data to draw conclusions concerning vehicle volumes or truck volumes for year-to-year comparisons at this site.

For site 304, vehicle class data were collected from January 2007 through March 2007, but were not collected one year later. There were not enough data to draw conclusions concerning truck volumes for year-to-year comparisons at this site. Vehicle volumes will be discussed below.

For Corridor 8, the morning peak hours were divided into 30-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:30 a.m. The afternoon peak hours were divided into 30-minute intervals starting at 2:30 p.m. with the last interval beginning at 6:30 p.m.

No significant impacts from the major traffic generator were recorded in Corridor 8 in travel time runs, total vehicle volumes, or truck volumes for any segment in either direction in the morning and afternoon peak periods. Any changes recorded in the data could not be explained by activity generated by plant operations.

## **Corridor 9: IH 37 from IH 410 to SL 1604**

Travel times were collected in both the north and south directions of this corridor during the morning and afternoon peak periods. Corridor 9 is the easternmost boundary of the study area and is defined in linked segments as follows:

- (A) IH 37 from IH 410 to SH 122
- (B) IH 37 from SH 122 to Southon Rd
- (C) IH 37 from Southon Rd to SL 1604

Volume data and vehicle class data were collected along this corridor at site 321 located south of SL 1604. Vehicle volumes and vehicle class data were collected from March 2007 to March 2008. There were not enough data to draw conclusions concerning vehicle volumes or truck volumes for year-to-year comparisons.

For Corridor 9, the morning peak hours were divided into 30-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:30 a.m. The afternoon peak hours were divided into 30-minute intervals starting at 2:30 p.m. with the last interval beginning at 6:40 p.m.

No significant impacts from the major traffic generator were recorded in Corridor 9 in travel time runs, total vehicle volumes, or truck volumes for any segment in either direction in the morning and afternoon peak periods. Any changes recorded in the data could not be explained by activity generated by plant operations.

## **Control Corridors**

### *Control Corridor 1: SH 16 from SL 1604 to Reyes Canyon*

Travel times were collected in both the north and south directions of this corridor during the morning and afternoon peak periods. Control Corridor 1 is defined in linked segments as follows:

- (A) SH 16 from Whip O Will Way to Reyes Canyon
- (B) SH 16 from Scenic Loop Rd to Whip O Will Way
- (C) SH 16 from FM 1560 to Scenic Loop Rd
- (D) SH 16 from Hausman Rd to FM 1560
- (E) SH 16 from SL 1604 to Hausman Rd

For Control Corridor 1, the morning peak hours were divided into 20-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:40 a.m. The afternoon peak hours were divided into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 6:40 p.m.

The data from Control Corridor 1 indicated more variation year-to-year in travel time runs, total vehicle volume, and truck volume than any impacts registered near the Toyota plant.

*Control Corridor 2: SL 1604 from SH 151 to US 90*

Travel times were collected in both the north and south directions of this corridor during the morning and afternoon peak periods. Control Corridor 2 is defined in linked segments as follows:

- (A) SL 1604 from SH 151 to Wiseman Rd
- (B) SL 1604 from Wiseman Rd to Military Dr W
- (C) SL 1604 from Military Dr W to SH 1957
- (D) SL 1604 from SH 1957 to Marbach Rd
- (E) SL 1604 from Marbach Rd to US 90

For Control Corridor 2, the morning peak hours were divided into 30-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:30 a.m. The afternoon peak hours were divided into 30-minute intervals starting at 2:30 p.m. with the last interval beginning at 6:30 p.m.

The data from Control Corridor 2 indicated no significant change in travel time runs, total vehicle volumes, or truck volumes.

*Control Corridor 3: IH 10 from SL 1604 to Boerne Stage Rd*

Travel times were collected in both the north and south directions of this corridor during the morning and afternoon peak periods. Control Corridor 3 is defined in linked segments as follows:

- (A) IH 10 from Camp Bullis Rd to Boerne Stage Rd
- (B) IH 10 from SL 1604 to Camp Bullis Rd

For Control Corridor 3, the morning peak hours were divided into 20-minute intervals starting at 6:00 a.m. with the last interval beginning at 8:40 a.m. The afternoon peak hours were divided into 20-minute intervals starting at 2:40 p.m. with the last interval beginning at 6:40 p.m.

Changes in year-over-year data in travel times, total vehicle volumes, and truck volumes showed greater variation than the data gathered near the Toyota plant. Urban growth in the corridor provided a greater impact than the major traffic generator in the study area.

## Historical Data

Researchers were not able to capture true before/after data due to the timing of new site installation in the study area. The 29 new sites required more time to install and thus were not able to provide traffic data before the Toyota plant opening.

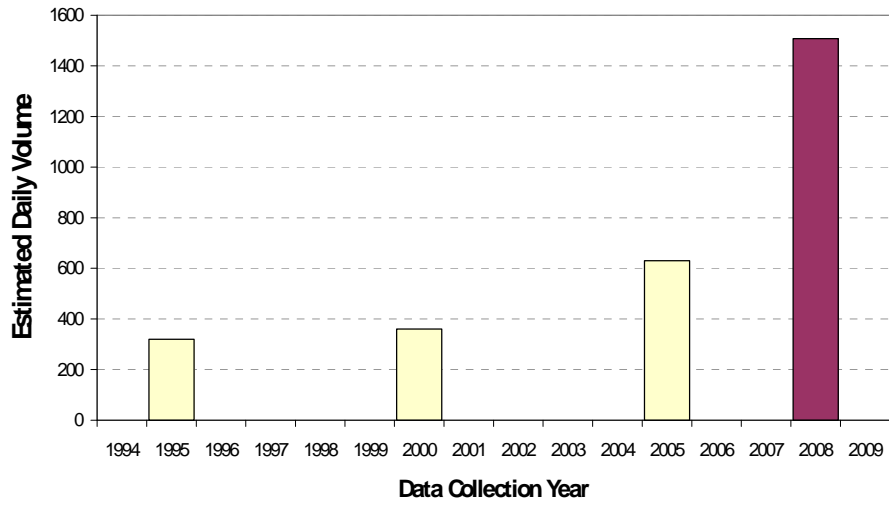
Historical traffic data that could provide some insight to conditions before the major traffic generator was operational were available to the team. Saturation and annual count data had been collected for many years within the study area. These counts are collected every five years, but not necessarily the same time of the year. The data collected had not been factored for axles or for seasonality. Researchers requested and received the historical data from local agencies and TxDOT and linked the data to one of the new data collection sites by location on the same roadway link.

Table 10 below lists saturation count stations and annual count stations. The first four rows are stations for saturation counts. Each station was matched with the newly installed ATR sites listed in the second column. The last ten rows contain data for the annual count stations. The annual count stations are on roads that carry more traffic. The table is followed by several graphs comparing the linked data sites and counts.

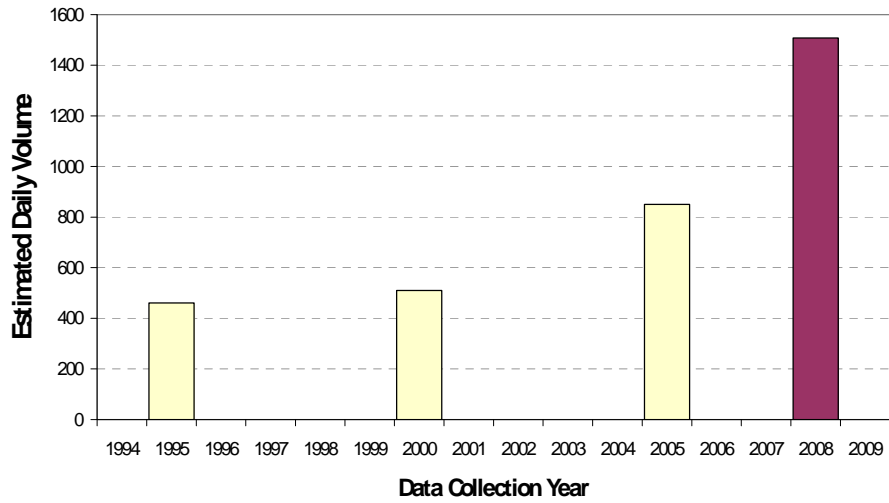
**Table 10. Data Collection Sites of Historical Data.**

Corridor	Site	Station	1995	2000	2005	2008
1	315	UR72	320	360	630	1,508
1	315	UR73	460	510	850	1,508
2	307	U34	960	1,460	1,580	2,118
2	307	UM15	1,010	1,460	1,840	2,118
3	311	H240		15,240	19,500	21,853
4	318	H244		3,200	3,620	3,945
4	325	H236		4,500	5,270	4,486
5	305	H238		33,010	30,270	29,332
5	312	H239		28,300	25,920	32,920
5	326	H253		35,640	24,970	33,945
7	306	H235B		4,100	3,690	3,730
7	306	H237A		5,300	4,950	3,730
8	302	H237		34,900	38,690	39,378
9	321	H258A		24,830	35,910	23,667

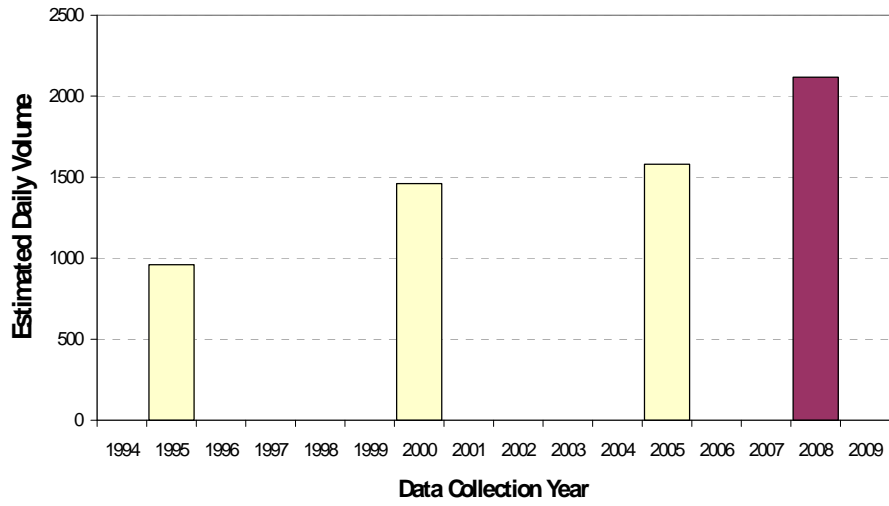




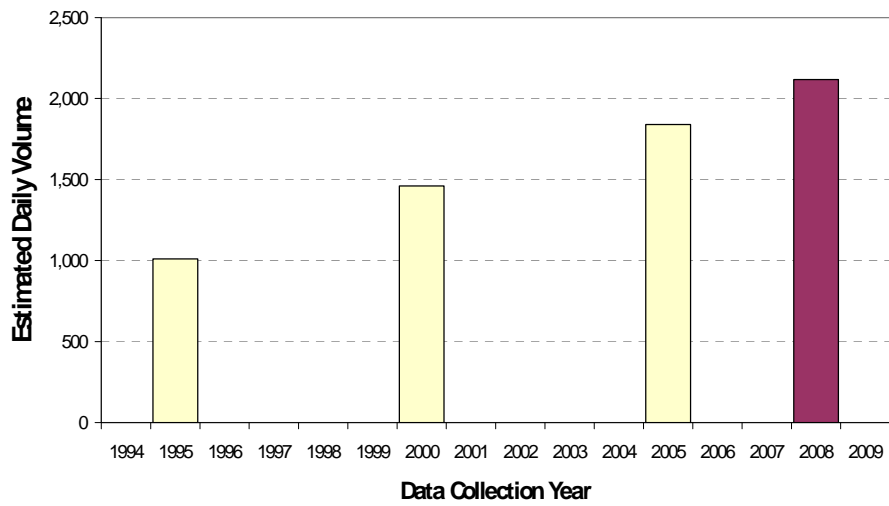
**Figure 64. UR72 Saturation Counts and Site 315 Volumes.**



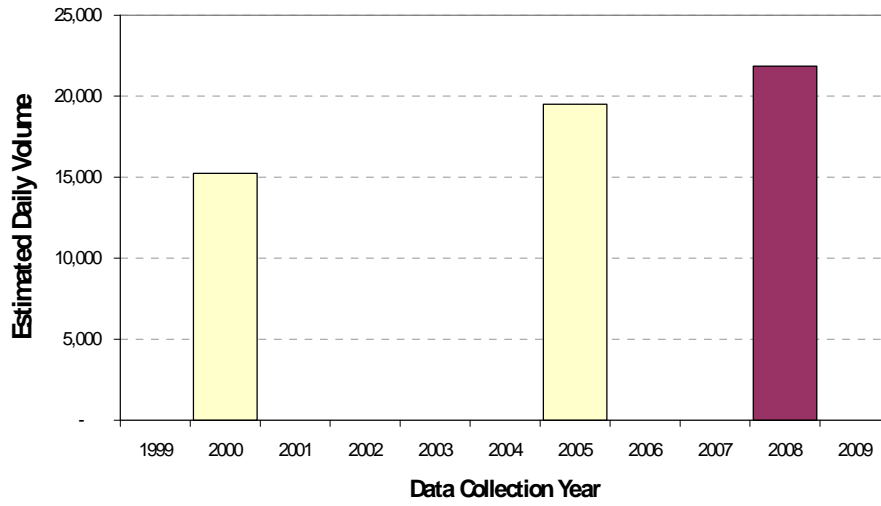
**Figure 65. UR73 Saturation Counts and Site 315 Volumes.**



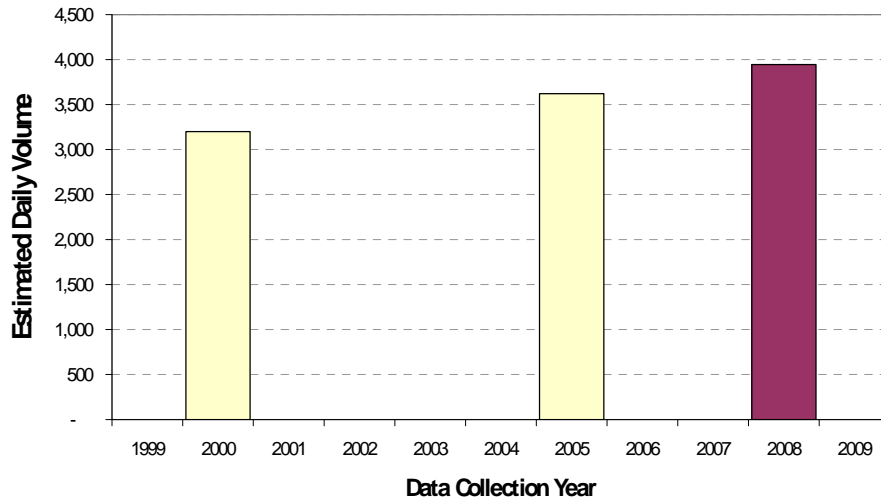
**Figure 66. U34 Saturation Counts and Site 307 Volumes.**



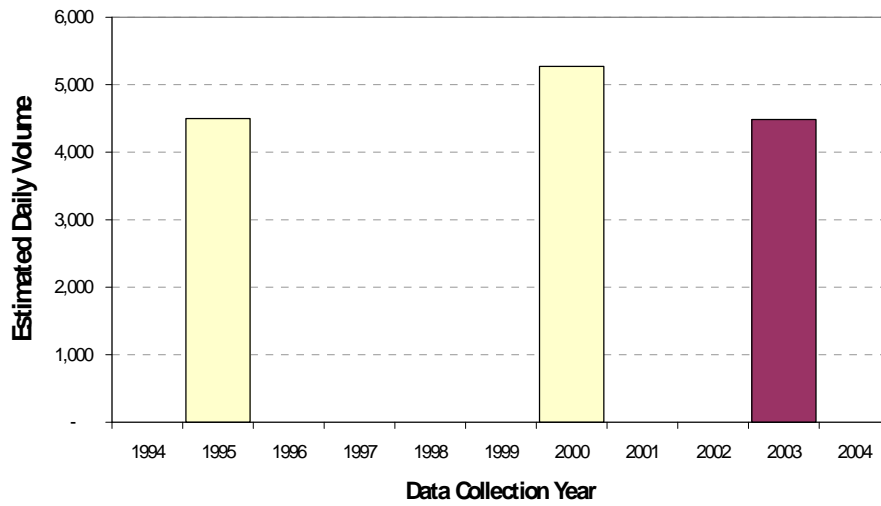
**Figure 67. UM15 Saturation Counts and Site 307 Volumes.**



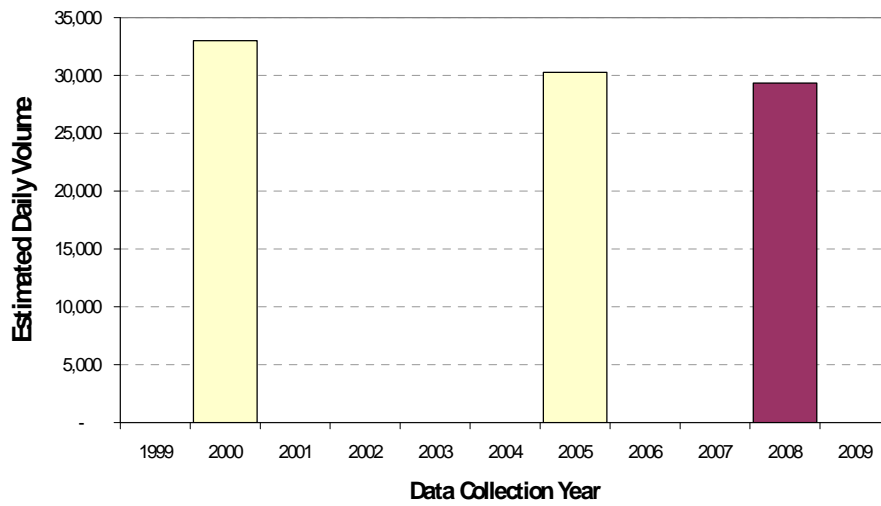
**Figure 68. H240 Annual Counts and Site 311 Volumes.**



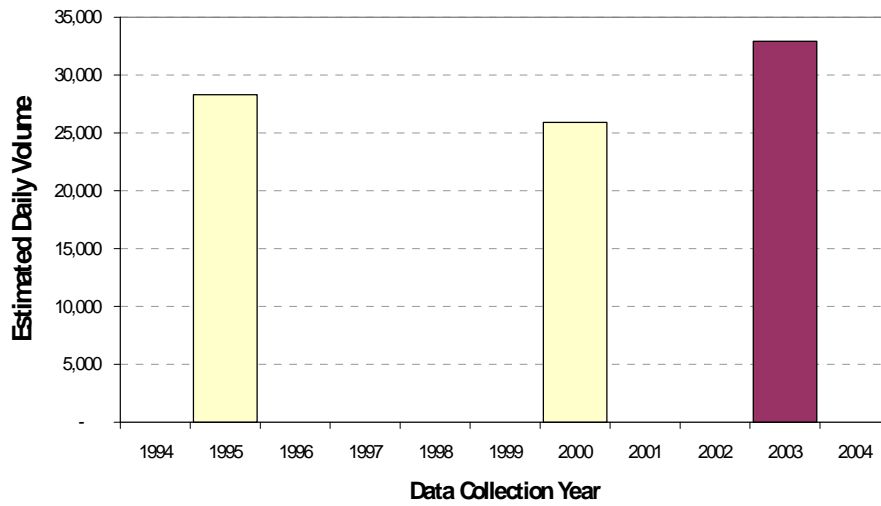
**Figure 69. H244 Annual Counts and Site 318 Volumes.**



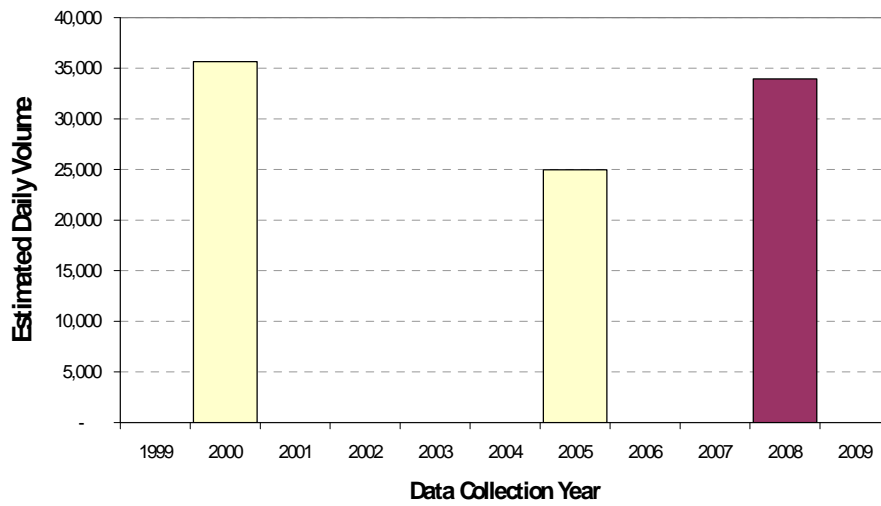
**Figure 70. H236 Annual Counts and Site 325 Volumes.**



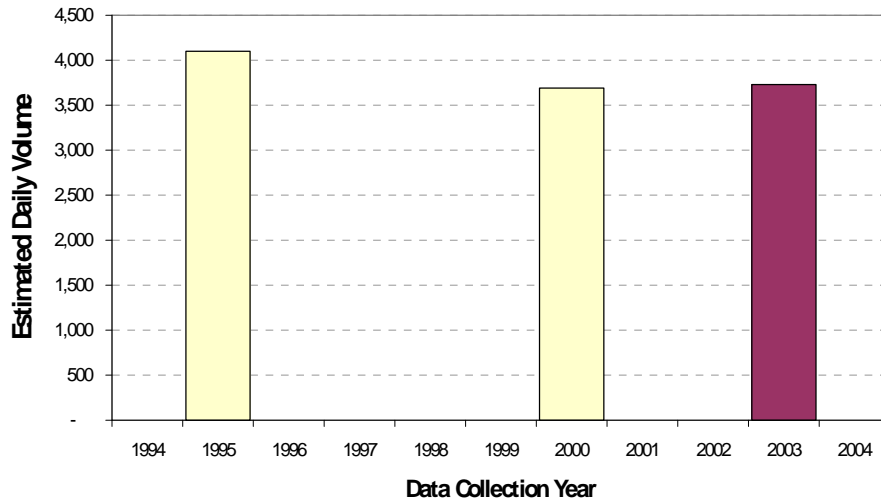
**Figure 71. H238 Annual Counts and Site 305 Volumes.**



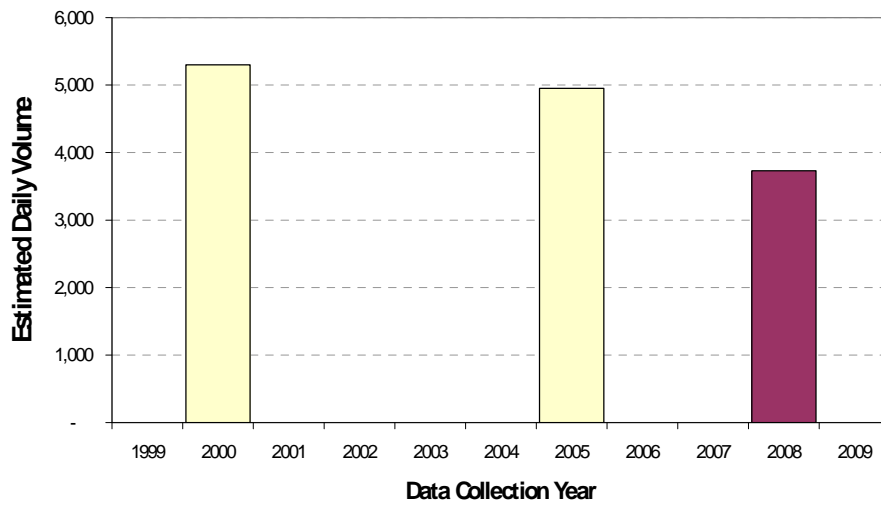
**Figure 72. H239 Annual Counts and Site 312 Volumes.**



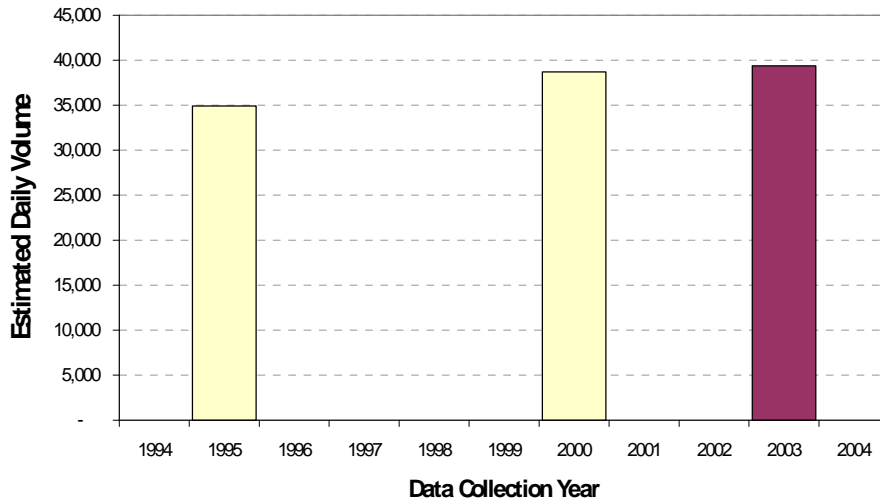
**Figure 73. H253 Annual Counts and Site 326 Volumes.**



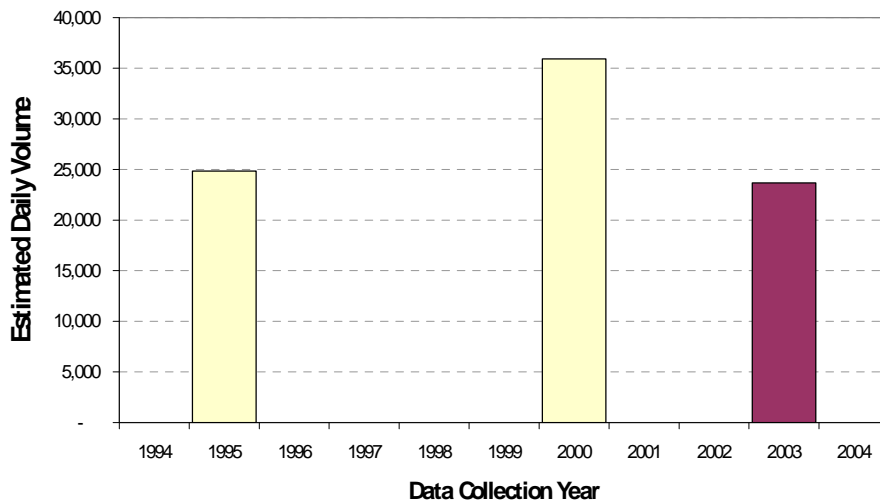
**Figure 74. H235B Annual Counts and Site 306 Volumes.**



**Figure 75. H237A Annual Counts and Site 306 Volumes.**



**Figure 76. H237 Annual Counts and Site 302 Volumes.**



**Figure 77. H258A Annual Counts and Site 321 Volumes.**

The table and figures above indicate that the historical traffic counts located near the Toyota plant show higher percentage differences in volumes from 2000 through 2008. The historical counts from sites a greater distance from the plant (Figures 69 to 77) indicate a general decrease in volume from 2000 through 2008. This confirms the observations from the travel time runs and the traffic data collected at new sites that the initial impacts from the new major traffic generator are in the immediate vicinity of the generator.

## COMMUTER SURVEY

The data were manually coded in an Excel spreadsheet and were later exported to Statistical Analysis for Science (SAS) for further statistical analysis. Results were then coded in a geographic information system (GIS)map for further visual analysis of the survey data.

Table 11 summarizes the number of surveys received by the research team classified by the date that the trip was taken. A total of 1,052 survey forms were received and coded by the team, with the bulk of the survey forms (90 percent) summarizing trips taken on May 23, 2007.

**Table 11. Number of Surveys Received.**

<u>Report Date</u>	<u>Frequency</u>	<u>Percent</u>
May 22, 2007	48	5%
May 23, 2007	946	90%
May 24, 2007	54	5%
May 25, 2007	4	0%
<b>Total 1,</b>	<b>052</b>	<b>100%</b>

Table 12 summarizes the answers by mode, with the majority of the respondents (98 percent) reaching the Toyota plant by automobile. Discrepancies in the table totals are due to missing or miscoded data in the survey forms.

**Table 12. Answers by Mode.**

<u>Mode</u>	<u>Frequency</u>	<u>Percent</u>
Automobile	1,023	98%
Motorcycle	16	2%
<b>Total 1,</b>	<b>039</b>	<b>100%</b>

Table 13 summarizes the number of riders per vehicle from the survey results. Ninety-three percent of the respondents were the single occupants of their vehicles.

**Table 13. Vehicle Occupancy.**

<u>Riders</u>	<u>Frequency</u>	<u>Percent</u>
0	3	0.29
1	955	92.63
2	55	5.33
3	6	0.58
4	6	0.58
5	3	0.29
6	1	0.1
7	1	0.1
11	1	0.1
<b>Total 1,</b>	<b>031</b>	<b>100</b>



## Geographic Distribution of the Surveys

In order to perform more detailed analysis of the survey, the researchers proceeded to group the surveys by zip code of origin of the respondent. Preliminary analysis of the data using zip codes did not lead to tangible conclusions.

Researchers decided to import the information into a GIS system, ArcMap. Once the information was imported into the GIS system, a better summary of the data could be visualized. Figure 78 depicts the survey data as represented by this GIS procedure.

Based on the percentage of survey respondents, the survey results were grouped by quadrant, with each quadrant defined by a group of zip codes, in such a way that the number of surveys could be later summarized by travel time and other indicators of trip characteristics. The procedure of defining quadrants and grouping zip codes was done manually inside the GIS system. As depicted in Figure 78:

- the West quadrant contains 43 percent of the survey respondents,
- followed by 22 percent in the South quadrant,
- 21 percent in the East quadrant, and
- 14 percent in the North quadrant.

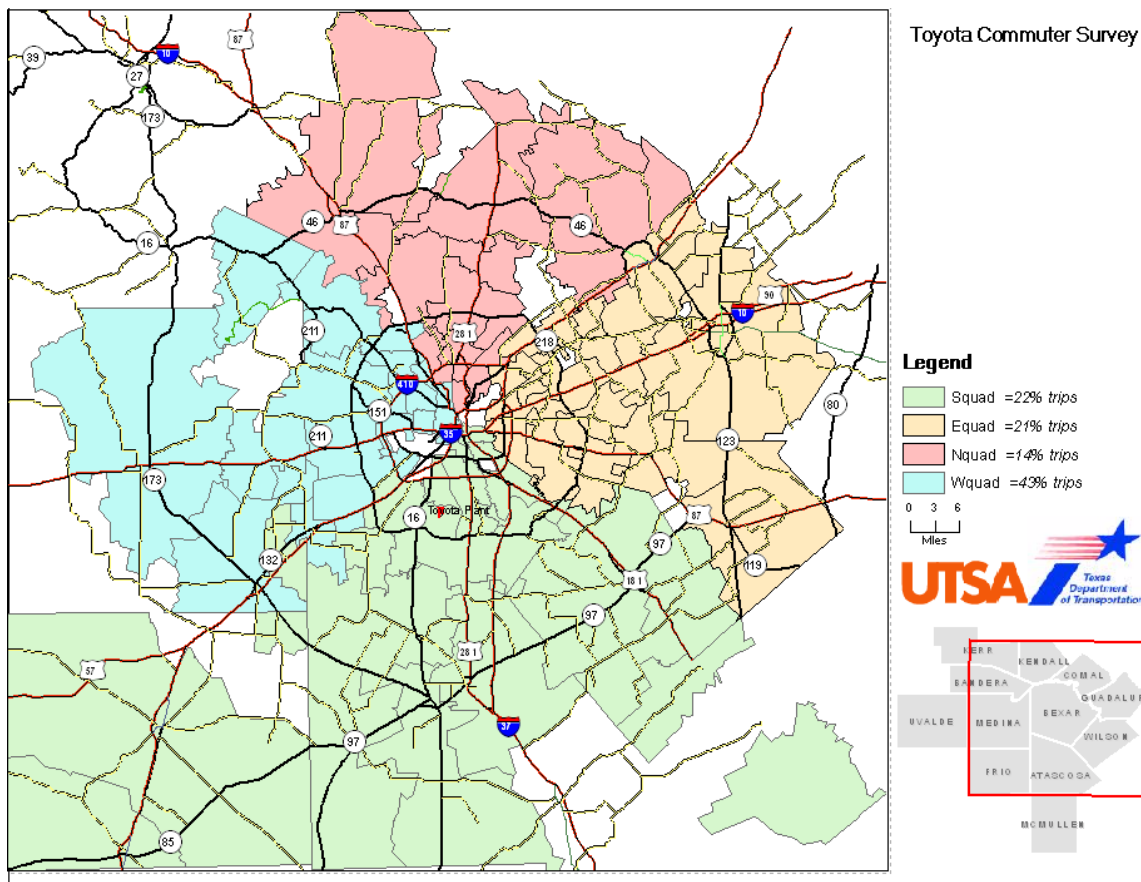


Figure 78. GIS Representation of the Quadrants for the Survey Results.

Four zip codes in the West quadrant accounted for 21 percent of the surveys (78245, 78250, 78251 and 78254) with a total of 194 surveys out of a total 943 usable surveys.

### Travel Time Summaries

The commuter travel times gathered from the commuter survey were summarized by zip code and coded into the GIS map. Responses were classified between first and second shifts based on the reported arrival time at the Toyota plant.

The median value for the first shift is around 0.5 hours, and the median value for the second shift is around 0.56 hours. It can be inferred by these values that both shifts are probably not being affected by congestion since the trips for the first shift are carried out at off-peak traffic times.

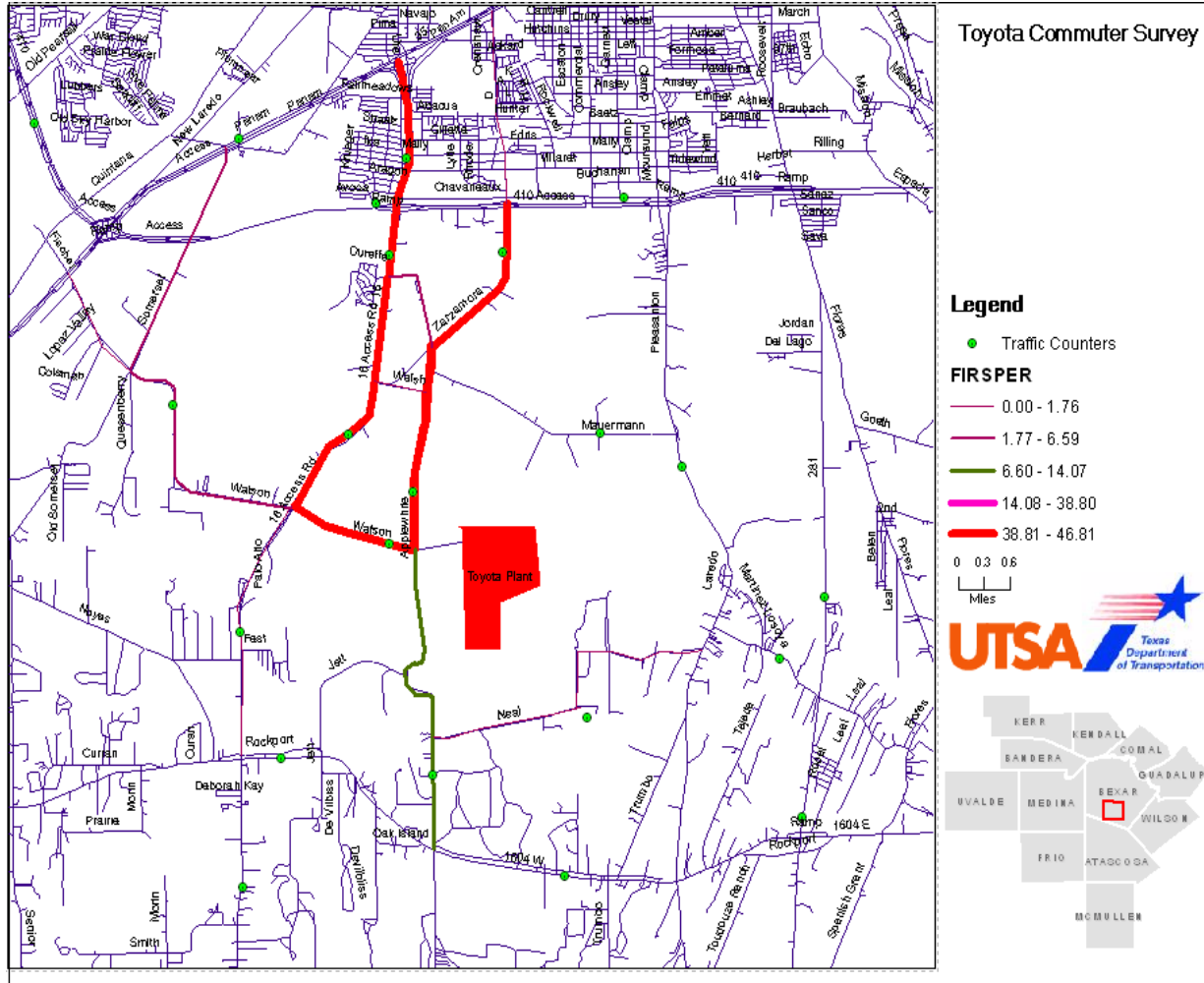
### Traffic in the Vicinity of the Toyota Plant

The data were sorted and inspected visually to determine the counts over 16 highway segments identified in the vicinity of the Toyota plant. This procedure is summarized in [Table 10](#), with survey counts being summarized by segment and by shift. The percentages are based on the survey responses that were usable – a total of 455 for the first shift and 450 for the second shift. These values are presented in GIS form by [Figures 7](#) and [8](#) for the first and second shifts respectively. This analysis was based on outbound trips.

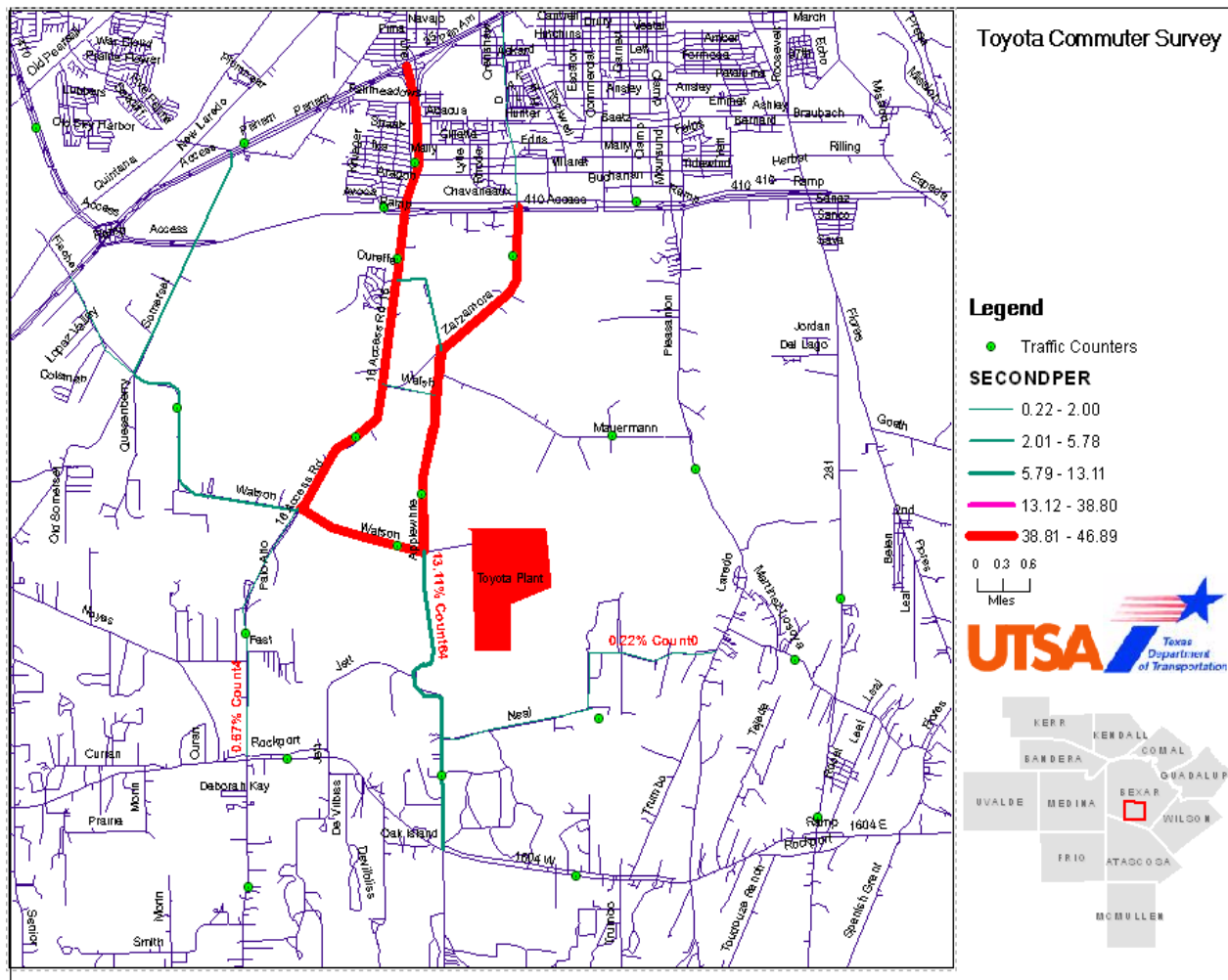
Inspection of the data in [Table 14](#), [Figure 79](#) and [Figure 80](#) shows that the majority of the respondents want to take the most direct route to IH 35 or IH 410. For the IH 35 destination, the segments in more demand are Watson and SH 16, containing over 42 percent of the outbound trips. For the IH 410 destination, the route includes both Applewhite Road and Zarzamora, with over 42 percent of the outbound trips.

**Table 14. Distribution of Responses for Segments in the Vicinity of the Toyota Plant.**

Segment Name	First shift count	First shift %	Second shift count	Second shift %
Applewhite from Zarzamora to 16	30	6.59	26	5.78
16 from Applewhite to 410	207	45.49	201	44.67
16 from 410 to 35	187	41.10	191	42.44
Applewhite from Watson to Neal	64	14.07	59	13.11
Applewhite from Neal to 1604	64	14.07	58	12.89
Neal from Applewhite to Pleasanton	0	0.00	1	0.22
Walsh from Applewhite to 16	2	0.44	3	0.67
Applewhite from Watson to Zarzamora	213	46.81	211	46.89
Zarzamora from 410 to 35	8	1.76	9	2.00
Watson to 16	208	45.71	206	45.78
16 from Watson to 1604	4	0.88	3	0.67
16 from Watson to Applewhite	177	38.90	175	38.89
Watson from 16 to Somerset	25	5.49	24	5.33
Watson from Somerset to Fisher	7	1.54	5	1.11
Somerset from Watson to 410	18	3.96	19	4.22
Zarzamora from Applewhite to 410	191	41.98	194	43.11



**Figure 79. Distribution of Responses for Segments Close to the Toyota Plant, 1<sup>st</sup> Shift.**



**Figure 80. Distribution of Responses for Segments Close to the Toyota Plant, 2<sup>nd</sup> Shift.**

### Statistics on Combined Trips

The survey form requested information on combined trips after commuters left the Toyota plant on their way back home. A frequency distribution of the results of this analysis is presented in [Table 15](#) and [Table 16](#) for the first and second shifts respectively. [Table 15](#) reports on first shift return trips and would be more likely to show combined trips on the route back home, since the first shift ends during business hours. However, an inspection of [Table 15](#) shows that the majority of the return trips (91.9 percent) had as destination the homes of the respondents, showing no indication of combined trips.

The return trips for the second shift also show that the vast majority of the respondents (96 percent) are returning directly home with no combined trips.

**Table 15. Distribution of Responses for Destinations on the Return Trip, 1<sup>st</sup> Shift.**

<b>Destination Frequenc</b>	<b>y</b>	<b>Percent</b>
Return Home	385	91.89
Work	4	0.95
Social / Recreation / Entertainment	3	0.72
Meal / Eat	1	0.24
Shop	1	0.24
Pick-up/Drop-off Passenger	8	1.91
Personal Business	7	1.67
Other	10	2.39

**Table 16. Distribution of Responses for Destinations on the Return Trip, 2<sup>nd</sup> Shift.**

<b>Destination Frequenc</b>	<b>y</b>	<b>Percent</b>
Return Home	454	96.19
Social / Recreation / Entertainment	3	0.64
Meal / Eat	2	0.42
Shop	3	0.64
Personal Business	2	0.42
Other	8	1.69



## CHAPTER 5: FINDINGS

There is no set definition of a special or major traffic generator, and the terms are often used interchangeably in the literature and practice. The vagaries of location, scale, and impact make a standard definition difficult and relative to the city and type of development. As a result, no standard is available to determine the need for pre- and post-construction traffic monitoring of major generator sites or areas. Monitoring of these special generators can be conducted if requested or warranted, but monitoring is simply integrated into the normal state traffic monitoring process after a major generator is operational.

There is no consensus on the analysis and monitoring of special generators for planning purposes. The travel demand model can easily, according to practitioners, incorporate new traffic sources into the model based on the type of employment and number of employees. Freight analysis can incorporate a large part of the expected traffic generated, especially at industrial sites using truck transport for supply. Freight analysis is still a complex process at the MPO level and may be difficult to integrate into planning. From a regional planning perspective, a new major traffic generator is the source of economic development, regional prestige, and should be factored in planning for future land use and impacts. Traffic impact analyses are conducted for major developments but are not integrated into the regional planning process.

### DATA COLLECTION

If traffic monitoring of a special generator is to be undertaken, mechanical and manual techniques are readily available. Roadside intercept surveys are a viable tool in this monitoring. Based on experiences at other automotive manufacturing sites, future impacts near the plant besides the immediate traffic effects are slow in developing and should be considered when developing a monitoring plan.

Collecting and warehousing the data are integral to the monitoring process. The data have to get from the collection site to a centralized access point such that an analyst or interested agencies can retrieve the data. This should be established at the beginning of the process. All agencies involved in the monitoring program should have access for analysis purposes. Before being made available, data should be checked for format, consistency, and validity. For example, a vehicle classification count may unexpectedly have zeroes for each record in one direction.

Several types of data are collected and then sent by modem to a receiving agency (i.e., state DOT). Other data types need to be downloaded from the collection site and carried to the receiving agency. The data received would then be formatted and compiled into a database or several databases depending on the variety of data sources used. This compilation of data can be characterized as a data warehouse. This data warehouse would then be made available to an analyst or other interested agencies.

Several issues can arise when setting forth to collect data. The data collection sites must be installed in a timely manner. For monitoring purposes, data should be collected previous to the installation of the major traffic generator to create a “before” picture of the traffic situation. This allows a “before” and “after” comparison of traffic surrounding the major traffic generator.

Data collection locations should be considered in light of future development plans. Also, locations should be considered in context of existing land uses.

Data collection locations must be sufficiently comprehensive to capture the “before” and “after” traffic movements. Sufficiency depends on size of the study area and resources available to purchase the necessary equipment and manpower. Other interested agencies may also make available the funds necessary to extend the size or increase the density of the monitoring net to further related agency interests.

Coordination between interested agencies is essential. The agencies must agree on several issues regarding the monitoring process, such as availability of funds, the locations of the collection sites, the types of data collected, the warehousing of the data, the personnel to analyze the resulting collected data, and the dissemination of the results.

Data types need to be chosen for availability and relevance. Choices of collected data are as follows: continuous volume counts, short-term volume counts, travel times, travel purposes, trip generations, incident data, aerial photographs, number of building permits, number of utility hook-ups, and economic data. Note that some data types may not be available for all areas.

## **DATA ANALYSIS AND REPORTING**

A traffic monitoring network can capture a variety of data types depending on the needs of the agency/agencies and the available funds. When analyzing the data collected from a monitoring net, the challenge is to match the various sources and types of data in order to measure changes on the road network. Typical matching scenarios can include:

- Short-term data with continuous data,
- Historical data with current data, and
- Travel time data and commuter surveys with traffic data.

Data collected for different purposes need to be aligned for analysis, such as aligning volume data with classification data.

There are numerous ways to report the data: graphs, GIS maps, tables, and presentations. Reports depend on the use of the results and the intended recipients of the results.

## **CASE STUDY**

The traffic monitoring system implemented in response to the development of a new major traffic generator in the San Antonio metropolitan area provided ample amounts of data, but the length of time required to install the new sites dedicated to the system prevented “before/after” analysis. Researchers were able to use historical traffic counts to provide some perspective on “before” conditions in the study area.

TTI researchers were able to compare the data received from the two different technologies used at two collection sites, inductive loop detectors and Wavetronix radar-based machines. The data from the Wavetronix sites’ inductive loop detectors’ technologies very closely matched the inductive loop detector data. The main difference in volume counts occurred during peak periods with the Wavetronix machines recording up to 5 percent more vehicles than the inductive loop site.



The data collected by the sites established for the project, combined with historical data, travel time runs, and the commuter survey, indicated that the road network around the Toyota plant successfully absorbed the traffic impacts created in the first three years of plant operation. Increases in peak period volumes and congestion in corridors adjacent to the plant were recorded, while corridors on the edge of the study area showed no significant increase in total vehicle volume, truck volumes, or congestion that could be linked to the major generator.



APPENDICES  
A, B, C, D, and E  
on CD

Located inside Back Cover of Report



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## APPENDIX A: Characteristics of Recommended Sites and Equipment

Table 1. Equipment Recommendations.

Site	Type	Highway	Proximity	Cross Section	Electrical Service	Telephone Service	Cell Phone Signal Strength*
1***	Classification	IH 35 S	Lytle, TX	4 Lane Divided**	Available	Available	7
2	Classification	12450 IH 35 S	S. of IH 35	4 Lane Divided**	Available	Available	7
3	Classification	IH 410 SW	N. of IH 35	4 Lane Divided**	Available	Available	7
4****	Classification	9395 IH 35 S	N. of IH 410	4 Lane Divided**	Available	Available	7
5	Classification	IH 410	W. of SH 16	4 Lane Divided**	Unknown	Unknown	Unknown
6	Classification	15700 FM 2790	S. of IH 410	2 Lane	Available	Available	7
7	Classification	13609 Fischer Rd	W. of SH 16	2 Lane	Available	Available	7
8	Classification	Spur 66	E. of SH 16	4 Lane Divided	Extension Required	Extension Required	unknown
9	Classification	13811 SH 16	N. of Spur 66	4 Lane Divided	Available	Available	7
10	Volume	9418 Spur 422	N. of IH 410	4 Lane Divided**	Available	Available	7
11	Volume	10642 SH 16	S. of IH 410	4 Lane Divided**	Available	Available	6
12	Classification	IH 410	E. of Zarzamora	4 Lane Divided**	Unknown	Unknown	Unknown
13	Classification	10578 Zarzamora	S. of IH 410	5 Lane, CTWLT	Available	Available	5
14	Classification	Applewhite Rd	N. of Spur 66	5 Lane, CTWLT	Available	Fiber Available	7
15	Classification	19425 Applewhite Rd	N. of Lp 1604	5 Lane, CTWLT	Available	Unknown	6

\* Signal Strength Scale: 1 (weak) to 7 (strong)

\*\* Plus Frontage Roads

\*\*\* Existing Weigh-in-Motion Site

\*\*\*\* Proposed Co-Located Radar-based Traffic Monitoring Site

**Table 1. Equipment Recommendations (Continued).**

Site	Type	Highway	Proximity	Cross Section	Electrical Service	Telephone Service	Cell Phone Signal Strength*
16	Classification	20712 SH 16 S	S. of Lp 1604	4 Lane Divided	Available	Available	6
17	Classification	3650 Lp 1604	E. of SH 16	2 Lane	Available	Available	7
18	Classification	1121 Lp 1604	W. of US 281	2 Lane	Available	Available	5
19	Classification	21810 US 281 S	S. of Lp 1604	4 Lane Divided	Available	Available	6
20	Classification	3491 Lp 1604	W. of IH 37	2 Lane	Available	Available	7
21****	Classification	21149 IH 37 S	IH 37 S	4 Lane Divided	Available	Available	6
22	Volume	1060 FM 2537	W. of US 281	2 Lane	Available	Available	5
23	Volume	14320 Pleasanton Rd	N. of FM 2537	2 Lane	Available	Available	7
24	Volume	802 Maurer Rd	W. of Pleasanton Rd	2 Lane	Available	Available	7
25	Classification	6715 Lp 1604	E. of FM 2790	2 Lane	Available	Available	7
26	Classification	IH 410	E. of US 281	4 Lane Divided**	Unknown	Unknown	Unknown
27	Volume	902 Neal Rd	E. of Applewhite Rd	2 Lane	Available	Available	7
28	Classification	17160 SH 16	N. of Lp 1604	4 Lane Divided	Available	Available	7
29	Classification	16700 Hwy 281 S	N. of FM 2537	4 Lane Divided	Available	Available	5
M-1131	Classification	US 281	N. of Lp 1604	4 Lane Divided	Available	Available	Unknown

\* Signal Strength Scale: 1 (weak) to 7 (strong)

\*\* Plus Frontage Roads

\*\*\* Existing Weigh-in-Motion Site

\*\*\*\* Proposed Co-Located Radar-based Traffic Monitoring Site

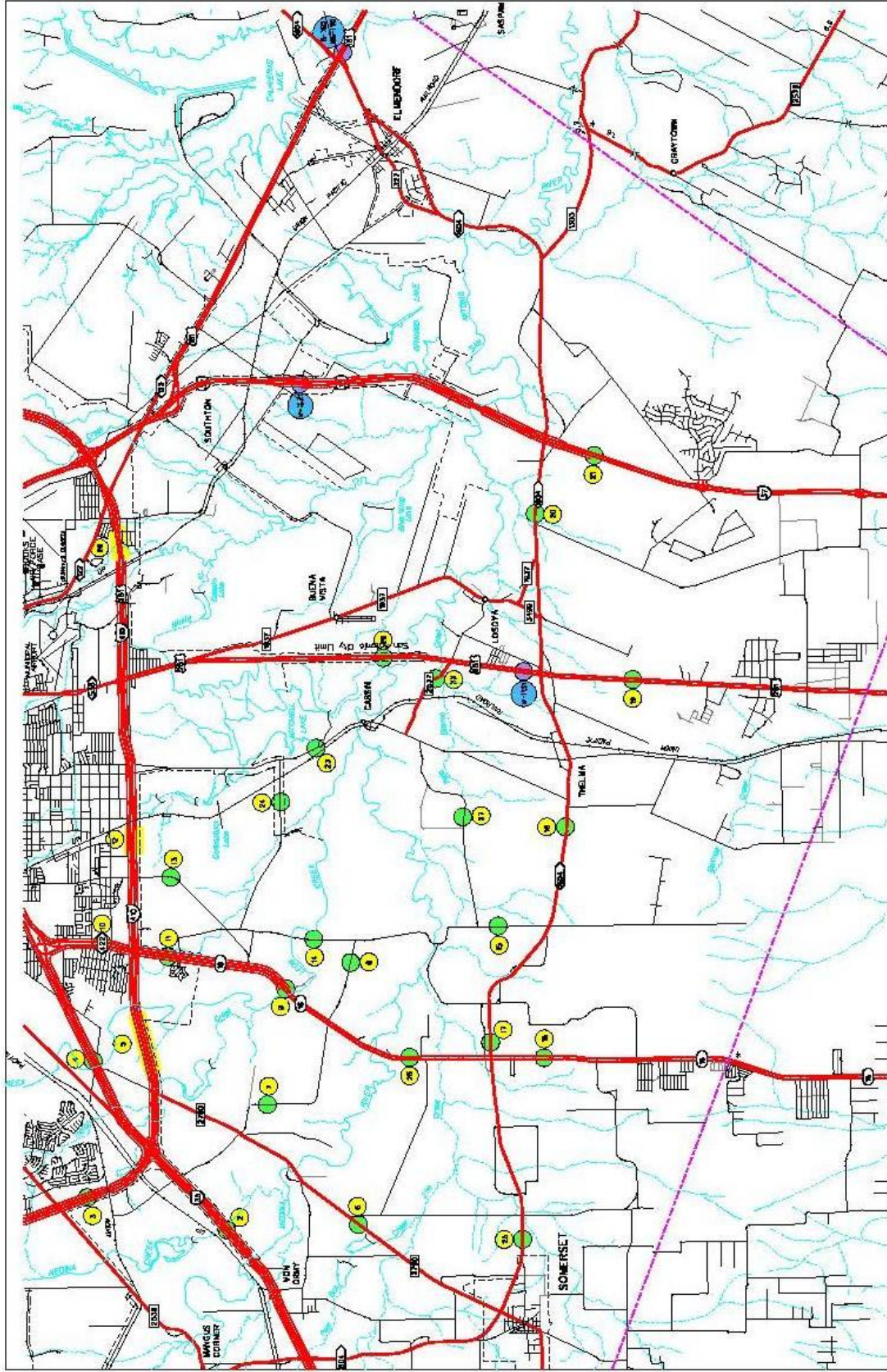
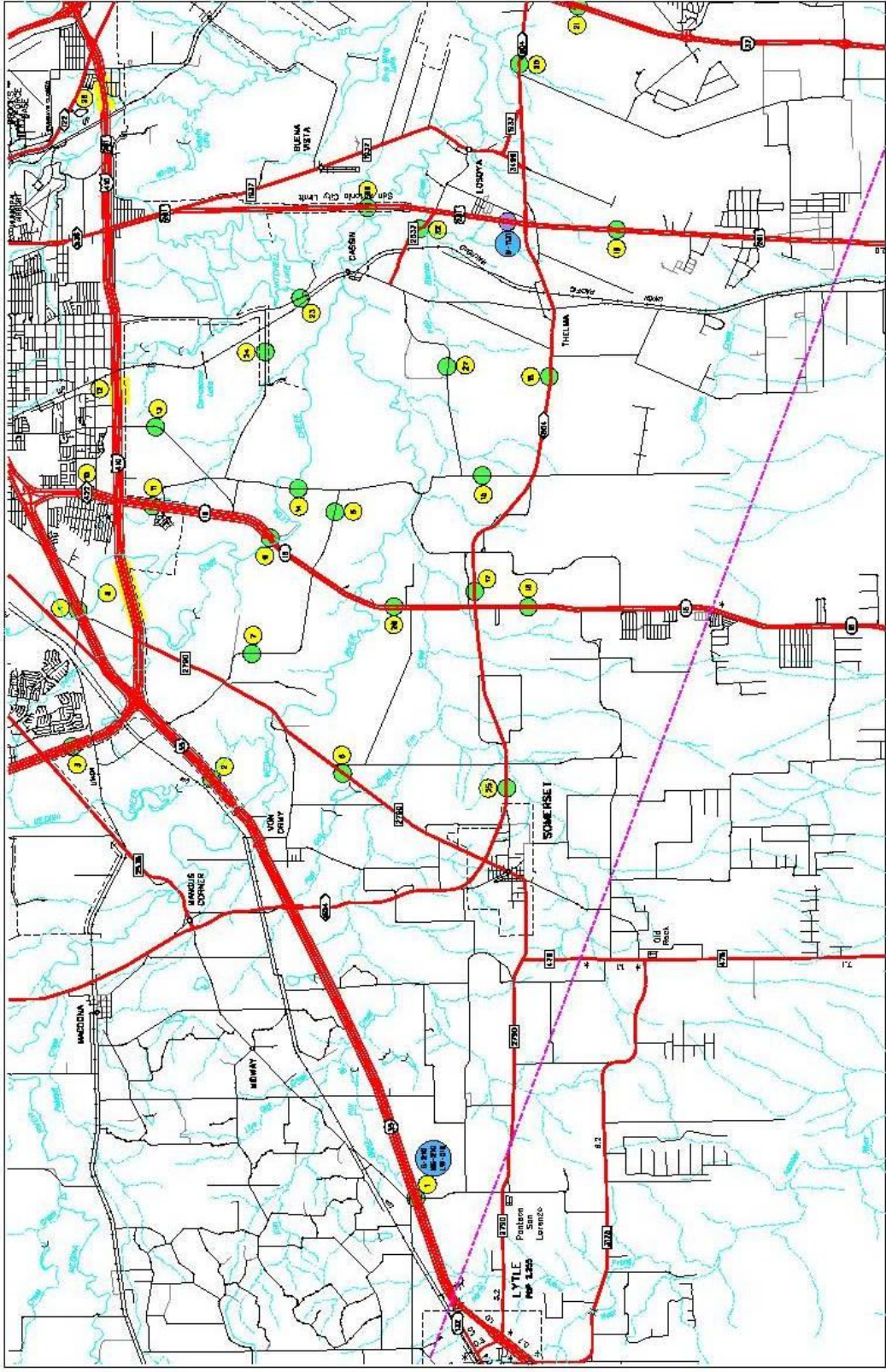


Figure 1. Recommended Data Collection Sites (East Area).



**Figure 2. Recommended Data Collection Sites (West Area).**

## APPENDIX B: Travel Time Data Collection Form

Figure 1 shows a data collection form. The first column, **CHECKPOINT**, indicates the endpoints and all the checkpoints in between where the clock time will be recorded. The DC starts from an endpoint for the corridor to be traveled. The DC will leave the endpoint to travel to the first checkpoint by the designated starting time indicated on the data collection form. The time of leaving the endpoint is noted by the DC on the data collection form. The DC continues through the corridor to the other endpoint. The DC writes down the time for each checkpoint crossed as well as the time when the other endpoint is reached in column four labeled **CHECKPOINT TIME**.

When the DC has to stop at an intersection because of a red light, the DC fills out column two **DELAY TIME STOP**, column three **DELAY TIME GO**, and column five **QUEUE LENGTH**. **DELAY TIME STOP** is recorded when the vehicle comes to a complete stop for the red light. **DELAY TIME GO** is recorded when the red light has turned green and the vehicle begins to move forward through the intersection on the green signal. Vehicles creeping forward during the red light does not indicate a **DELAY TIME GO** should be recorded. **QUEUE LENGTH** is the number of cars waiting for the light to change for the *through movement*. For **QUEUE LENGTH**, the DC counts all the vehicles that will go through the intersection in the same direction that the DC travels. Do not count vehicles that are in right-turn-only or left-turn-only lanes unless the DC passes through a turn-only lane. The DC records the **CHECKPOINT TIME** as the vehicle passes through the intersection.

If the delay is great enough at an intersection such that two or more “delay time stops” are recorded, place a circled number by the first “delay time stop.” Then in the comments section, write the circled number and the second “delay time stop” and “delay time go.”

The last two columns correspond to Incident (I) and Weather (W). If there is an incident (accident, construction signs, etc.) which causes delay, the DC writes a number in the **I** (sixth) column starting with one. When there is a road condition due to weather, a sequential number is written in the **W** (last) column. For each number written in the **I** and **W** columns, a corresponding comment is recorded in the Comments section at the bottom of the form. Make these comments after your travel time run is complete and the vehicle is not moving.

Name: \_\_\_\_\_

Corridor 5: I 410 from I 37 to FM 2536  
Direction: Westbound  
Period: 6:00 AM

CHECKPOINT	DELAY TIME STOP	DELAY TIME GO	(Mid-Intersection) CHECKPOINT TIME	QUEUE LENGTH	I	W
East Endpoint						
I 37 Overpass						
US 281 Underpass						
Pleasanton Rd Underpass						
Zarzamora Rd Underpass						
SH 16/Palo Alto Overpass						
Somerset Rd Overpass						
I 35 Underpass						
FM 2536 Overpass						
West Endpoint						

COMMENTS (Describe Incident, Weather, or other information that impacts the data collection):

**Figure 1 Data Collection Form**

Figure 2 shows an example data collection form for a travel time run through Corridor 5 at 6:00 AM. Corridor 5 is I 410 from I 37 to FM 2536, all highway. The DC filling out the example is Edward. Edward started from the endpoint at 5:58 AM and reached the first intersection (checkpoint) at the designated time of 6:00 AM. Then Edward filled out the time when the middle of the intersection of each checkpoint was reached. Edward noted an incident as he was approaching the SH 16 checkpoint. Edward wrote down the number **1** in the “I” column and a **2** in the “W” column both on the appropriate rows. In the comments section, Edward wrote down a description of the incident corresponding to number **1** and the weather corresponding to number **2**.

Figure 3 shows an example data collection form for a travel time run through Corridor 1 at 5:30 PM. Corridor 5 is I 410 from I 37 to FM 2536, all highway. The DC filling out the example is Edward. Edward started from the endpoint at 5:28 PM and reached the first intersection (checkpoint) at the designated time of 5:30 PM. Then Edward filled out the time when the middle of the intersection of each checkpoint was reached. As Edward approached Watson Rd, the light was red. Edward wrote down the **36:23** in the DELAY TIME STOP column. Edward then counted eight vehicles in both lanes of traffic and wrote down **8** in the QUEUE LENGTH column. The light turned green and Edward wrote **37:03** in the DELAY GO COLUMN. As he passed through the intersection, Edward then wrote down the **37:15** in the CHECKPOINT TIME column. Edward continued through the rest of the corridor recording the time for each checkpoint.

Name: **EDWARD**

Corridor 5: I 410 from I 37 to FM 2536

Direction: Westbound

Start Time: 6:00 AM

CHECKPOINT	DELAY TIME STOP	DELAY TIME GO	(Mid-Intersection) CHECKPOINT TIME	QUEUE LENGTH	I	W
East Endpoint			<b>58:10</b>			
I 37 Overpass			<b>0:00</b>			
US 281 Underpass			<b>4:04</b>			
Pleasanton Rd Underpass			<b>6:23</b>			
Zarzamora Rd Underpass			<b>8:00</b>			
SH 16/Palo Alto Overpass			<b>12:31</b>		<b>1</b>	
Somerset Rd Overpass			<b>15:03</b>			
I 35 Underpass			<b>17:48</b>			<b>2</b>
FM 2536 Overpass			<b>20:06</b>			
West Endpoint			<b>24:21</b>			

COMMENTS (Describe Incident, Weather, or other information that impacts the data collection):

**1 Accident on exit ramp caused some delay**  
**2 Road wet, possibly rain, but no rain falling**

Figure 2 Highway Example Data Collection Form



Name: **EDWARD**

Corridor 1: S Zarzamora St/Applewhite Rd

Direction: Southbound

Start Time: 5:30 PM

CHECKPOINT	DELAY TIME STOP	DELAY TIME GO	(Mid-Intersection) CHECKPOINT TIME	QUEUE LENGTH	I	W
North Endpoint			<b>28:19</b>			
I 410 Underpass			<b>30:00</b>			
Applewhite Rd TURN LEFT			<b>33:04</b>			
Watson Rd	<b>36:23</b>	<b>37:03</b>	<b>37:15</b>	<b>8</b>		
Old Applewhite Rd			<b>38:59</b>			
Neal Rd			<b>39:46</b>			
SL 1604			<b>42:17</b>			
South Endpoint			<b>42:22</b>			

COMMENTS (Describe Incident, Weather, or other information that impacts the data collection):

**Figure 3 Non-Highway Example Data Collection Form**

## APPENDIX C: Toyota Employee Travel Survey

### INTRODUCTION

The TTI/UTSA team distributed survey forms to the Toyota employees on May 2007. Sample of the survey forms are included at the end of this Tech Memo. The data was manually coded in an Excel spreadsheet and was later exported to SAS for further statistical analysis. Results were then coded in a GIS map for further visual analysis of the survey data. The Excel, SAS and GIS data are available in a CD companion to this Tech Memo.

[Table 1](#) summarizes the number of surveys received by the research team classified by the date that the trip was taken. A total of 1,052 survey forms were received and coded by the team, with the bulk of the surveys forms (90%) summarizing trips taken on May 23, 2007. [Table 2](#) summarizes the answers by mode, with the majority of the respondents (98%) reaching the Toyota plant by automobile. Discrepancies in the table totals are due to missing or miscoded data in the survey forms.

[Table 3](#) summarizes the number of riders per vehicle from the survey results. Ninety three percent of the respondents were the single occupants of their vehicles.

**Table 1 Number of Surveys Received.**

<u>ReportDate</u>	<u>Frequency</u>	<u>Percent</u>
May 22, 2007	48	5%
May 23, 2007	946	90%
May 24, 2007	54	5%
May 25, 2007	4	0%
<b>Total</b>	<b>1,052</b>	<b>100%</b>

**Table 2 Answers by Mode.**

<u>Mode</u>	<u>Frequency</u>	<u>Percent</u>
Automobile	1,023	98%
Motorcycle	16	2%
<b>Total</b>	<b>1,039</b>	<b>100%</b>

**Table 3 Vehicle Occupancy.**

<b>Riders</b>	<b>Frequency</b>	<b>Percent</b>
0	3	0.29
1	955	92.63
2	55	5.33
3	6	0.58
4	6	0.58
5	3	0.29
6	1	0.1
7	1	0.1
11	1	0.1
<b>Total</b>	<b>1,031</b>	<b>100</b>

### **GEOGRAPHIC DISTRIBUTION OF THE SURVEYS**

In order to perform more detailed analysis of the survey, the researchers proceeded to group the surveys by zip code of origin of the respondent. Preliminary analysis of the data using zip codes did not lead to tangible conclusions. The zip code data is scattered around the study area, as may be observed from the bar chart presented in [Figure 1](#).

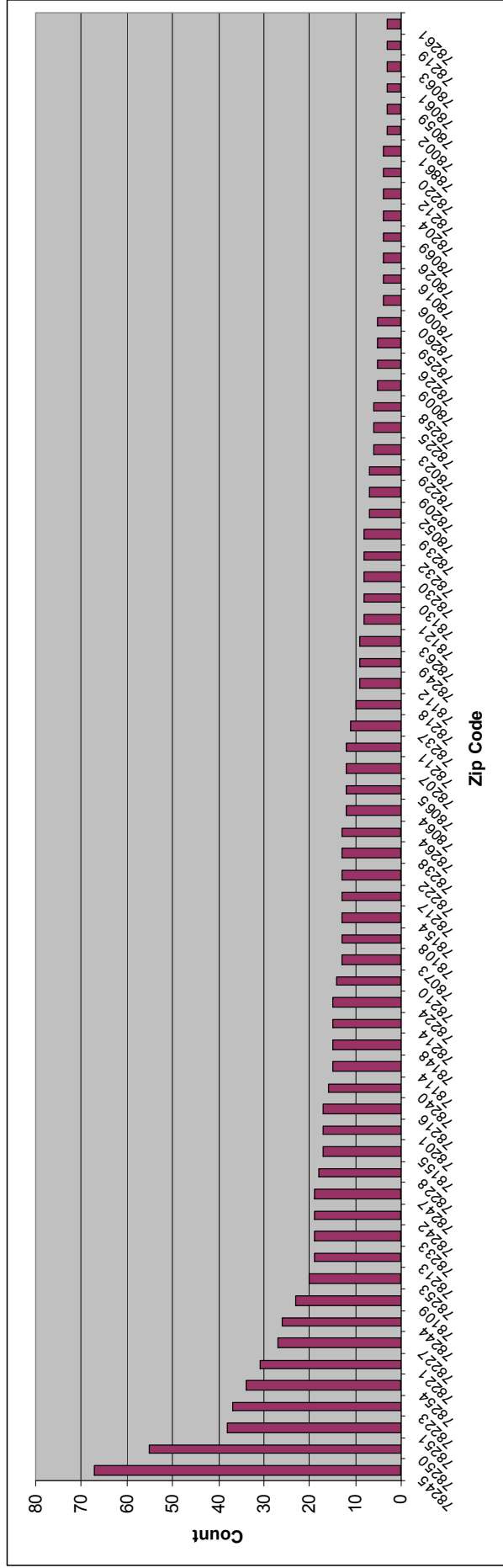
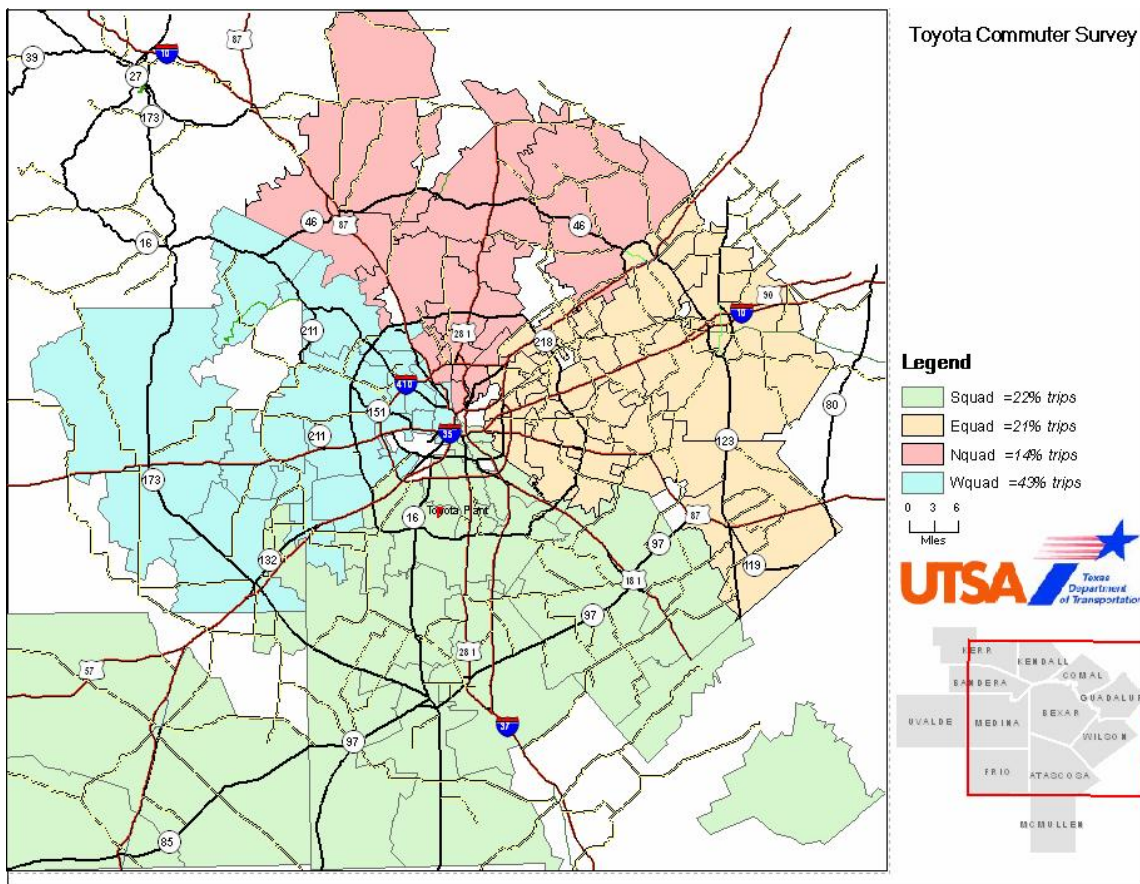


Figure 1 Distribution of Survey Respondents by Zip Code.



The distribution in [Figure 1](#) depicts Zip codes with frequencies of 3 or more for presentation purposes. The Zip code with the highest frequency of surveys is 78245, with 67 survey forms. This information is not enough to derive any conclusions on the distribution of the trips over the study area and it was decided to import this information into a GIS system like ArcMap. Once the information was imported into the GIS system, a better summary of the data could be visualized. [Figure 2](#) depicts the survey data as represented by this GIS procedure.

Based on the percentage of survey respondents, the survey results were grouped by quadrant, each quadrant defined by a group of Zip codes, in such a way that the number of surveys could be later summarized by travel time and other indicators of trip characteristics. The procedure of defining quadrants and grouping zip codes was done manually inside the GIS system. As depicted in [Figure 2](#), the West quadrant contains 43% of the survey respondents, followed by 22% in the South quadrant, 21% in the East quadrant and 14% in the North Quadrant.



**Figure 2 GIS Representation of the Quadrants for the Survey Results.**

Tables 4 and 5 list the Zip codes with the number of usable surveys grouped by quadrant and for which the graphical representation is presented in Figure 2. Four Zip codes in the West quadrant accounted for 21% of the surveys (78245, 78250, 78251 and 78254) with a total of 194 surveys out of a total 943 usable surveys. These high count zip codes are depicted by Figure 3.

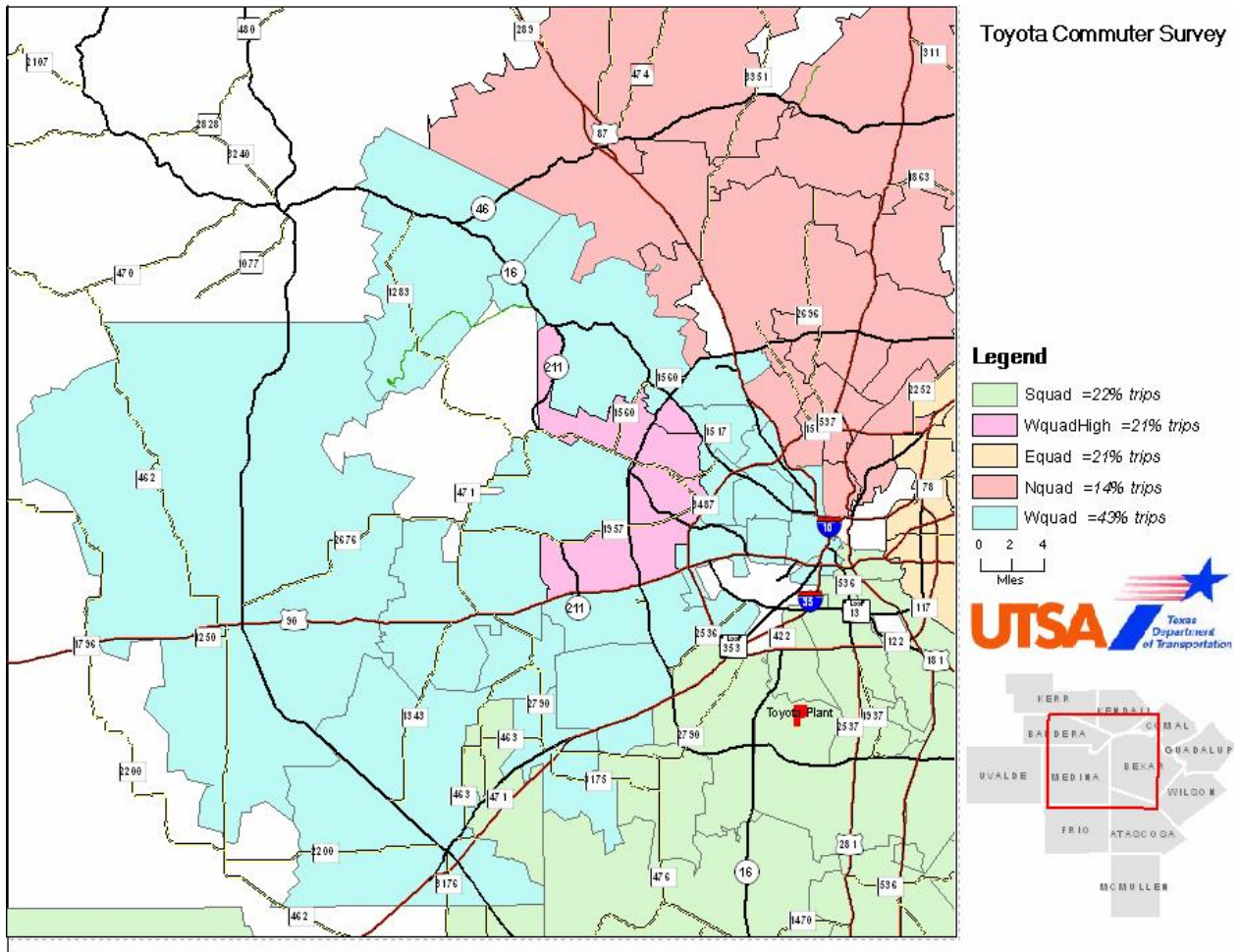
**Table 4. Distribution of Responses by Quadrant and Zip Code for the North and East Quadrants.**

North Quadrant		East Quadrant	
Zip	Count	Zip	Count
78006	4	78218	10
78015	1	78219	3
78070	1	78220	4
78209	7	78222	13
78212	4	78233	19
78213	19	78239	8
78216	17	78244	26
78217	13	78263	9
78230	8	78101	2
78231	1	78108	13
78232	8	78109	23
78247	19	78121	8
78248	2	78124	1
78255	2	78130	8
78257	1	78152	1
78258	6	78154	13
78259	5	78155	17
78260	5	78160	2
78261	3	78148	15
78163	2	<b>Total E Quad</b>	<b>195</b>
78133	1		
78132	2		
<b>Total N Quad</b>	<b>131</b>		

**Table 5 Distribution of Responses by Quadrant and Zip Code  
for the South and West Quadrants.**

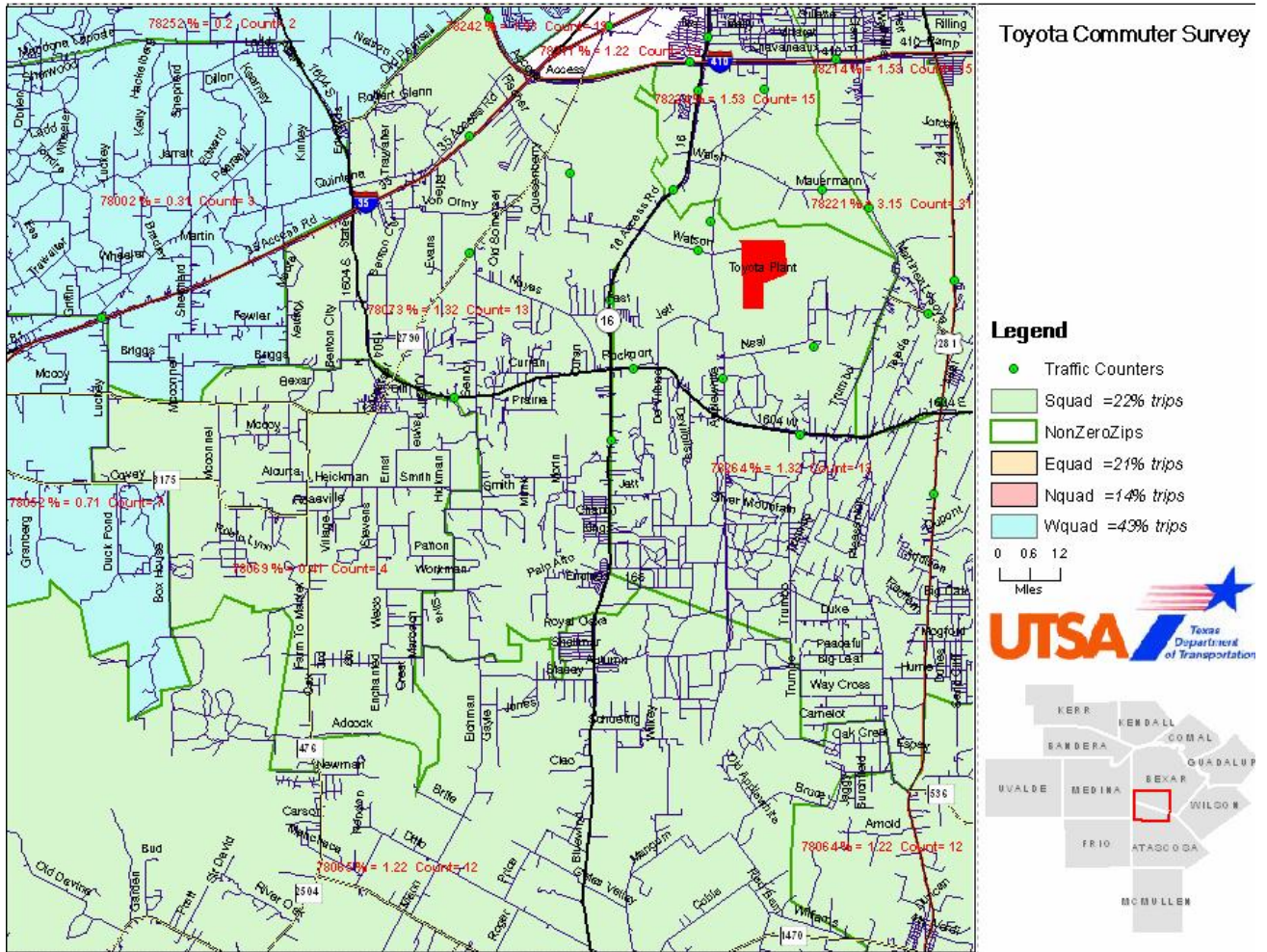
<b>South Quadrant</b>		<b>West Quadrant</b>	
<b>Zip</b>	<b>Count</b>	<b>Zip</b>	<b>Count</b>
78005	1	78861	4
78011	2	78002	3
78017	1	78009	5
78026	4	78016	4
78059	3	78023	6
78061	3	78039	2
78064	12	78063	3
78065	12	78052	7
78069	4	78201	17
78073	13	78204	4
78210	14	78207	12
78214	15	78225	6
78221	31	78227	27
78223	37	78228	18
78224	15	78229	7
78264	13	78237	11
78112	9	78238	13
78113	1	78240	16
78114	15	78242	19
78119	2	78245	67
78147	1	78249	9
<b>Total S Quad</b>	<b>208</b>	78250	55
		78251	38
		78252	2
		78253	20
		78254	34
		<b>Total W Quad</b>	<b>409</b>





**Figure 3 Highest Survey Count Zip Codes within the West Quadrant.**

Detailed information may be obtained using the GIS map developed for this research project. The user is able to zoom in down to the street level as depicted by [Figure 4](#). This GIS map is available in a companion CD to this Tech Memo and is compatible with ArcGIS versions 9 and later.

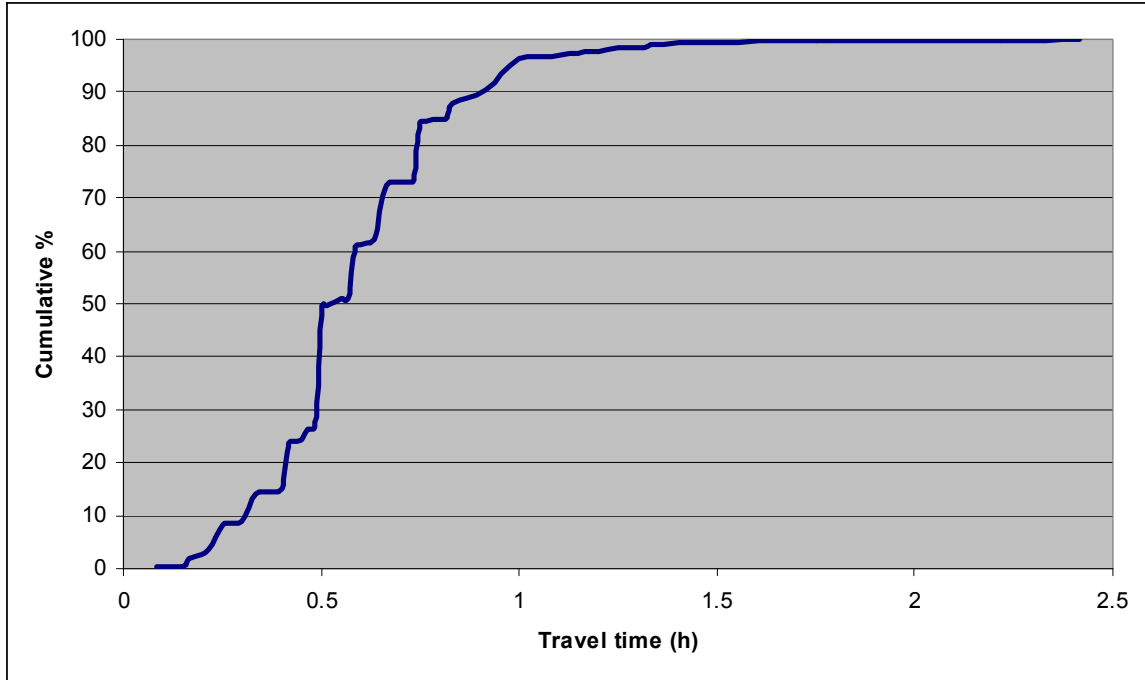


**Figure 4 GIS Representation of the Vicinity of the Toyota Plant.**

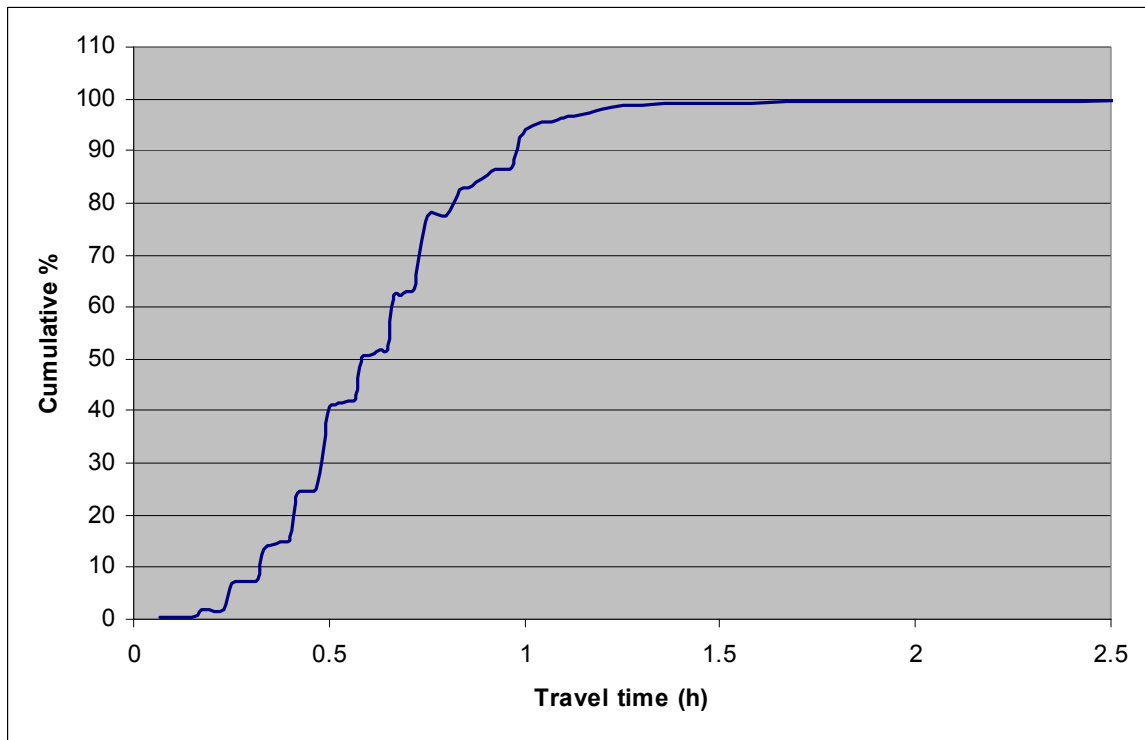
## TRAVEL TIME SUMMARIES

The travel times from the commuter survey were summarized by Zip code and coded into the GIS map. Some assumptions were made to classify the responses as belonging to the first or second shift at the Toyota plant. First shift was defined as being from 6:30 AM to 3:15 PM and second shift from 6:00 PM to 2:45 AM. Responses were classified between first and second shifts based on the reported arrival time at the Toyota plant.

Figures 5 and 6 present the cumulative distributions for the travel times for the first and second shift respectively. The median value for the first shift is around 0.5 hours and the median value for the second shift is around 0.56 hours. It can be inferred by these values that both shifts are probably not being affected by congestion since the trips for the first shift are carried out at off-peak traffic times.



**Figure 5. Cumulative Distribution of Travel Times for the First Shift.**



**Figure 6. Cumulative Distribution of Travel Times for the Second Shift.**

Tables 6 and 7 summarize the average travel times for the first shift by quadrant and Zip code for the North and East quadrants and for the South and West quadrants respectively. The total surveys received that reported on first shift trips that were usable for these summaries were 417. This total is obtained when one adds up the counts for all zip codes.

**Table 6. Distribution of Travel Time for the North and East Quadrants for the First Shift.**

North Quadrant			East Quadrant		
Zip	Average (h)	Count	Zip	Average (h)	Count
78006	1.15	3	78218	0.57	4
78015	0.00	0	78219	0.46	2
78070	0.00	0	78220	0.42	1
78209	0.53	5	78222	0.48	5
78212	0.33	1	78233	0.75	6
78213	0.59	10	78239	0.67	2
78216	0.69	10	78244	0.55	11
78217	0.54	4	78263	0.54	2
78230	0.69	4	78101	0.83	1
78231	0.00	0	78108	0.85	8
78232	0.61	5	78109	0.65	11
78247	0.76	9	78121	0.83	2
78248	0.83	1	78124	0.92	1
78255	0.83	1	78130	1.11	3
78257	1.50	1	78152	0.75	1
78258	0.72	4	78154	0.82	6
78259	1.00	1	78155	1.01	6
78260	0.83	2	78160	1.00	1
78261	0.83	1	78148	0.83	2
78163	0.96	2	<b>Total E Quad</b>		<b>75</b>
78133	1.17	1			
78132	0.75	1			
<b>Total N Quad</b>		<b>66</b>			

**Table 7 Distribution of Travel Time for the South and West Quadrants for the First Shift.**

South Quadrant			West Quadrant		
Zip	Average (h)	Count	Zip	Average (h)	Count
78005	0.00	0	78861	0.83	1
78011	0.58	1	78002	0.00	0
78017	1.17	1	78009	0.68	5
78026	0.83	2	78016	0.75	1
78059	0.75	1	78023	0.61	3
78061	0.92	1	78039	0.67	2
78064	0.77	5	78063	0.00	0
78065	0.44	6	78052	0.44	3
78069	1.06	3	78201	0.44	7
78073	0.19	6	78204	0.50	1
78210	0.61	9	78207	0.50	3
78214	0.42	7	78225	0.43	3
78221	0.27	15	78227	0.52	11
78223	0.53	13	78228	0.44	5
78224	0.43	4	78229	0.60	5
78264	0.53	6	78237	0.58	7
78112	0.49	6	78238	0.48	5
78113	0.75	1	78240	0.53	4
78114	0.73	8	78242	0.32	7
78119	0.00	0	78245	0.54	30
78147	0.00	0	78249	0.71	2
<b>Total S Quad</b>		<b>95</b>	78250	0.60	29
			78251	0.54	17
			78252	0.33	1
			78253	0.60	14
			78254	0.64	15
			<b>Total W Quad</b>		<b>181</b>

Tables 8 and 9 summarize the average travel times for the second shift by quadrant and Zip code for the North and East quadrants and for the South and West quadrants respectively. The total surveys received that reported on second shift trips that were usable for these summaries were 456. This total is obtained when one adds up the counts for all zip codes.

**Table 8 Distribution of Travel Time for the North and East Quadrants for the Second Shift.**

North Quadrant			East Quadrant		
Zip	Average (h)	Count	Zip	Average (h)	Count
78006	0.92	1	78218	0.63	6
78015	1.00	1	78219	0.50	1
78070	1.08	1	78220	0.50	2
78209	0.68	2	78222	0.55	8
78212	0.58	2	78233	1.11	11
78213	0.72	9	78239	0.72	6
78216	0.77	7	78244	0.65	13
78217	0.76	6	78263	0.76	6
78230	0.69	3	78101	0.67	1
78231	0.00	0	78108	0.90	5
78232	0.97	2	78109	0.65	11
78247	0.75	8	78121	0.75	5
78248	0.00	0	78124	0.00	0
78255	0.00	0	78130	0.98	4
78257	0.00	0	78152	0.00	0
78258	0.92	2	78154	0.77	6
78259	0.73	4	78155	0.97	7
78260	0.90	2	78160	0.00	0
78261	0.83	1	78148	0.78	12
78163	0.00	0		<b>Total E Quad</b>	<b>104</b>
78133	0.00	0			
78132	1.00	1			
	<b>Total N Quad</b>	<b>52</b>			

**Table 9. Distribution of Travel Time for the South and West Quadrants for the Second Shift.**

South Quadrant			West Quadrant		
Zip	Average (h)	Count	Zip	Average (h)	Count
78005	1.00	1	78861	0.97	3
78011	0.67	1	78002	0.47	3
78017	0.00	0	78009	0.00	0
78026	0.65	2	78016	0.64	3
78059	0.75	1	78023	0.88	2
78061	1.00	1	78039	0.00	0
78064	0.50	6	78063	1.17	2
78065	0.38	5	78052	0.56	4
78069	0.42	1	78201	0.57	8
78073	0.27	7	78204	0.75	1
78210	0.43	5	78207	0.46	9
78214	0.46	6	78225	0.39	3
78221	0.33	15	78227	0.69	15
78223	0.51	22	78228	0.66	10
78224	0.27	10	78229	1.04	2
78264	0.51	5	78237	0.46	4
78112	0.42	2	78238	0.53	8
78113	0.00	0	78240	0.72	10
78114	0.72	6	78242	0.52	10
78119	1.25	1	78245	0.50	33
78147	1.00	1	78249	0.83	7
<b>Total S Quad</b>		<b>98</b>	78250	0.78	22
			78251	0.61	20
			78252	0.50	1
			78253	0.61	6
			78254	0.64	15
			<b>Total W Quad</b>		<b>202</b>

## TRAFFIC IN THE VICINITY OF THE TOYOTA PLANT

The data were sorted and inspected visually to determine the counts over 16 segments identified in the vicinity of the Toyota plant. This procedure is summarized by [Table 10](#), with survey counts being summarized by segment and by shift. The percentages are based on the survey responses that were usable – a total of 455 for the first shift and 450 for the second shift. These values are presented in GIS form by [Figures 7](#) and [8](#) for the first and second shifts respectively. This analysis was based on outbound trips.

Inspection of the data in [Table 10](#) and [Figures 7](#) and [8](#) shows that the majority of the respondents want to take the most direct route to IH35 or IH410. For the IH35 destination the segments in more demand are Watson and SH16, with over 42% of the

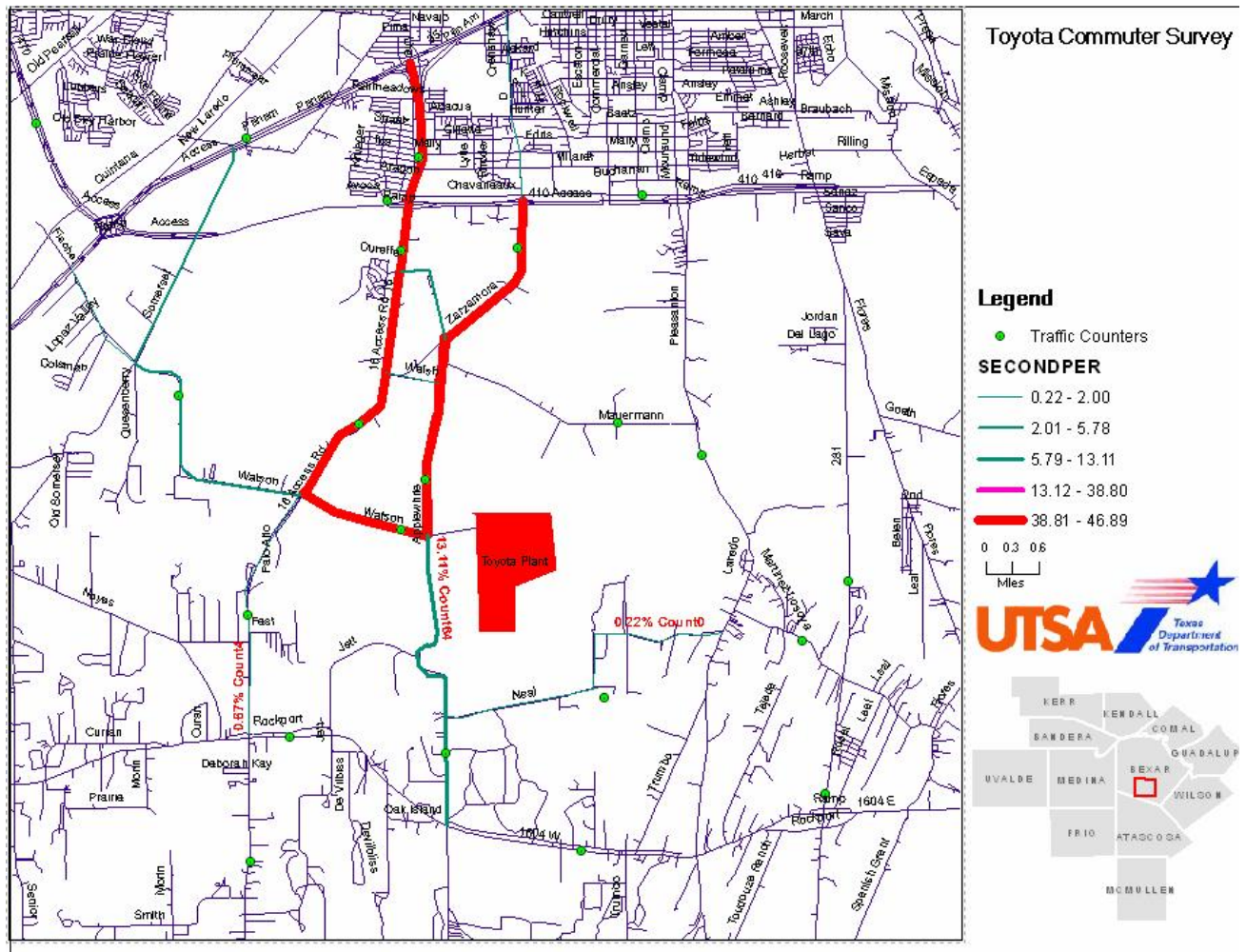
outbound trips. For the IH410 destination the route includes Applewhite Road and Zarzamora, with over 42% of the outbound trips. These observations should be further investigated using the data available from the traffic counters installed by this research project. The traffic counters installed in the vicinity of the Toyota plant are depicted in [Figures 7 and 8](#).

**Table 10. Distribution of Responses for Segments in the Vicinity of the Toyota Plant.**

<b>Segment Name</b>	<b>First Shift count</b>	<b>First Shift %</b>	<b>Second Shift count</b>	<b>Second Shift %</b>
Applewhite from Zarzamora to 16	30	6.59	26	5.78
16 from Applewhite to 410	207	45.49	201	44.67
16 from 410 to I35	187	41.10	191	42.44
Applewhite from Watson to Neal	64	14.07	59	13.11
Applewhite from Neal to 1604	64	14.07	58	12.89
Neal from Applewhite to Pleasanton	0	0.00	1	0.22
Walsh from Applewhite to 16	2	0.44	3	0.67
Applewhite from Watson to Zarzamora	213	46.81	211	46.89
Zarzamora from 410 to 35	8	1.76	9	2.00
Watson to 16	208	45.71	206	45.78
16 from Watson to 1604	4	0.88	3	0.67
16 from Watson to Applewhite	177	38.90	175	38.89
Watson from 16 to Somerset	25	5.49	24	5.33
Watson from Somerset to Fisher	7	1.54	5	1.11
Somerset from Watson to 410	18	3.96	19	4.22
Zarzamora from Applewhite to 410	191	41.98	194	43.11







**Figure 8 Distribution of Responses for Segments Close to the Toyota Plant, 2nd Shift.**

### STATISTICS ON COMBINED TRIPS

The survey form requested information on combined trips after commuters left the Toyota plant on their way back home. Field 8 in the survey form contains this information. A frequency distribution of the results of this analysis is presented in [Tables 11 and 12](#) for the first and second shifts respectively. [Table 11](#), which reports on first shift return trips, would be more likely to show combined trips on the route back home since the first shift ends during business hours. However, an inspection of [Table 11](#) shows that the majority of the return trips (91.9%) had as destination the homes of the respondents, showing no indication of combined trips.

The return trips for the second shift also show that the vast majority of the respondents (96%) are returning directly home with no combined trips.

**Table 11. Distribution of Responses for Destinations on the Return Trip, First Shift.**

<b>Destination</b>	<b>Frequency</b>	<b>Percent</b>
Return Home	385	91.89
Work	4	0.95
Social / Recreation / Entertainment	3	0.72
Meal / Eat	1	0.24
Shop	1	0.24
Pick-up/Drop-off Passenger	8	1.91
Personal Business	7	1.67
Other	10	2.39

**Table 12. Distribution of Responses for Destinations on the Return Trip, Second Shift.**

<b>Destination</b>	<b>Frequency</b>	<b>Percent</b>
Return Home	454	96.19
Social / Recreation / Entertainment	3	0.64
Meal / Eat	2	0.42
Shop	3	0.64
Personal Business	2	0.42
Other	8	1.69

# TRAVEL SURVEY FORM



## Survey on Commuting

Dear Toyota Team Member,

The Texas A&M University System's Texas Transportation Institute and the University of Texas at San Antonio are studying the traffic impacts from very large land developments like Toyota Motor Manufacturing Texas, Inc. We would appreciate your help by completing this survey to help us understand traffic impacts around large developments.

1. Date you are reporting \_\_\_\_\_ Day of Week \_\_\_\_\_
2. What time did you **begin** your trip to the Toyota complex today? \_\_\_\_:\_\_\_\_ AM PM
3. Where did your trip to work begin?

Home     Work     Other Location \_\_\_\_\_

Major intersection (for example: Maple Street at Elm Street)

Zip Code: \_\_\_\_\_

4. How method of transportation did you use to arrive at the Toyota complex today? (check one)
  - Car, van, truck       Motorcycle/Moped
  - Walk                       Commercial Service Vehicle
  - Bicycle                     Cargo Transportation Commercial Vehicle
  - Transit Bus

If you used a car, van, or truck for this trip were you the  Driver or  Passenger?

Including you, how many total people were in the vehicle? \_\_\_\_\_

**Please complete back side of sheet**



5. What time did you **arrive** at the Toyota complex today? \_\_\_\_:\_\_\_\_: \_\_\_\_ AM PM
6. What route did you take getting to work? (for example: On Elm Street to Michigan Avenue to Loop 410 to Zarzamora to Applewhite to Toyota driveway.)

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7. When will you leave the Toyota complex today? \_\_\_\_:\_\_\_\_: \_\_\_\_ AM PM

8. What will you do when you leave the Toyota complex today? (check all that apply)

- |  |  |
|--|--|
| <input type="checkbox"/> Return Home                         | <input type="checkbox"/> Shop  |
| <input type="checkbox"/> Work                                | <input type="checkbox"/> Pick-up/Drop-off Passenger                  |
| <input type="checkbox"/> Work Related                        | <input type="checkbox"/> Change mode of travel (example, car to bus) |
| <input type="checkbox"/> School                              | <input type="checkbox"/> Personal Business                           |
| <input type="checkbox"/> Social / recreation / Entertainment | <input type="checkbox"/> Other _____                                 |
| <input type="checkbox"/> Meal / Eat                          |  |

9. When you leave work today, what route will you take? (for example: On Elm Street to Michigan Avenue to Loop 410 to Zarzamora to Applewhite to Toyota driveway.)

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**WE APPRECIATE YOUR HELP!**

**FOR QUESTIONS, PLEASE CALL (210) 979-9411.  
REFER TO TOYOTA RESEARCH PROJECT.**

## **APPENDIX D: Wavetronix/IRD Data Comparison**

# Project Data Collection Sites

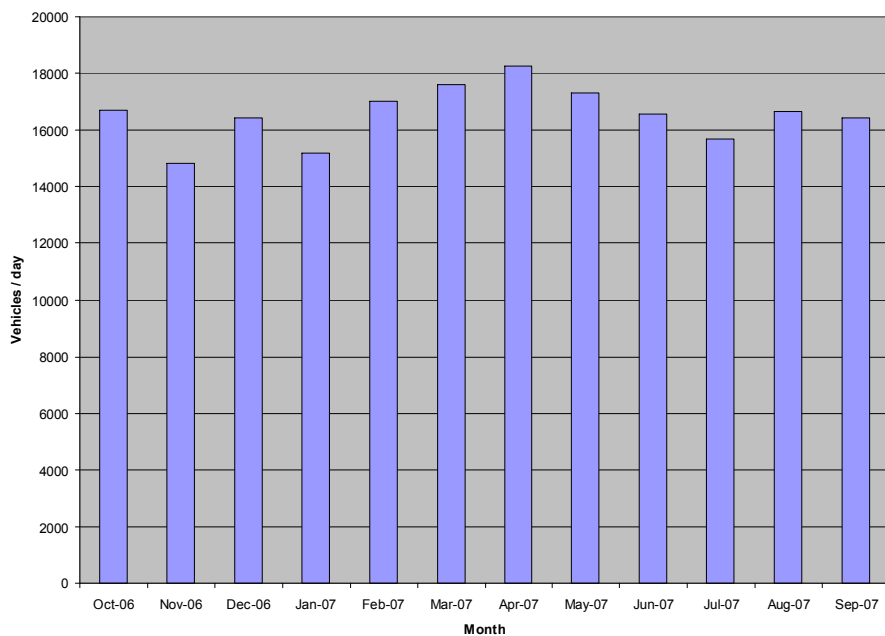
## Collection Technology Comparison

### Data Collection

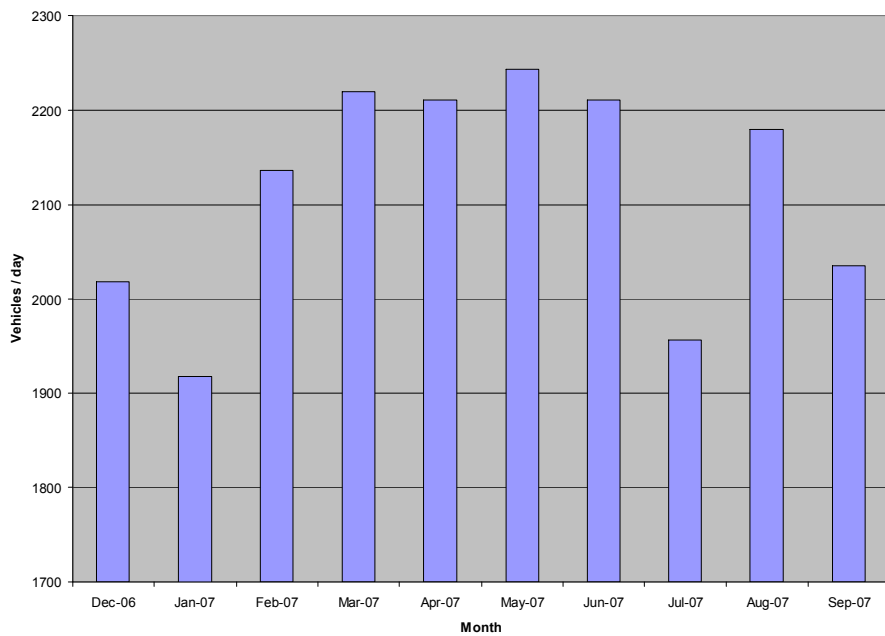
- 27 sites around the Toyota plant area
- Hourly class and volume by lane
  - 13 class/volume sites are relatively clean
  - 9 class/volume sites show data gaps
  - 5 sites are volume only
- Earliest data: Late September 2006  
Just now getting year over year data



SH 16 .9 mi. South of SPUR 66



WATSON RD .7 mi east of FM 2790





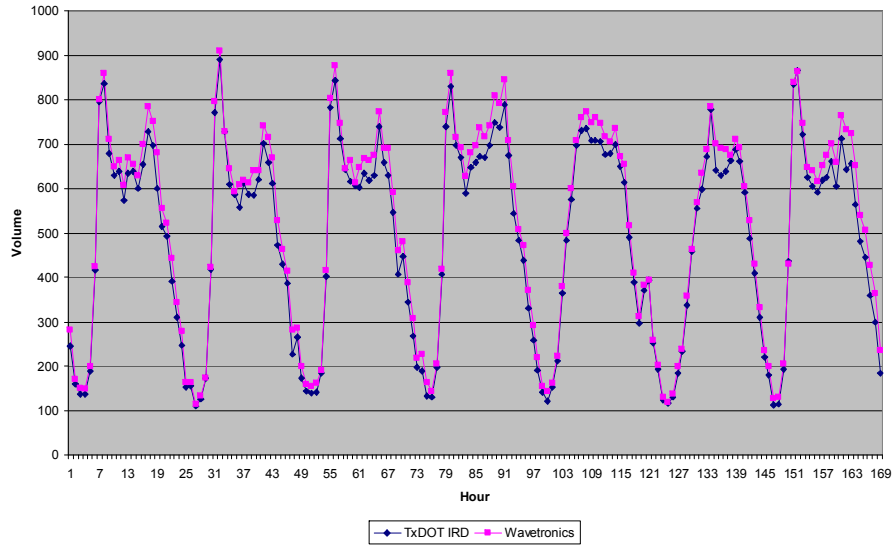
## Technology Comparison

- Sidfire radar (Wavetronics) vs. TP&P classifier (IRD inductive loops)
- IH35 and IH37 locations
- Solar powered
- Cellular communication

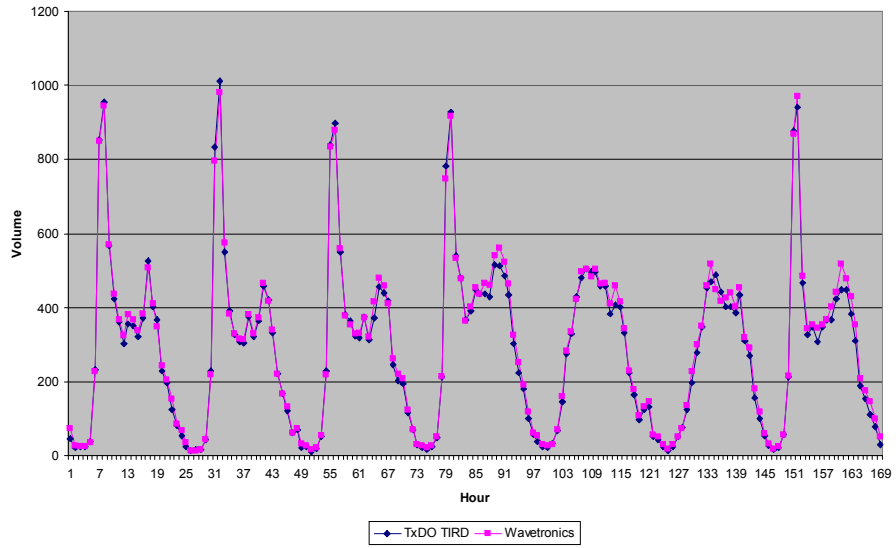
## IH 35 South of Loop 410

- 4 Lane with median
- Random 7 contiguous days of data compared
- Random 24 contiguous hours of data compared

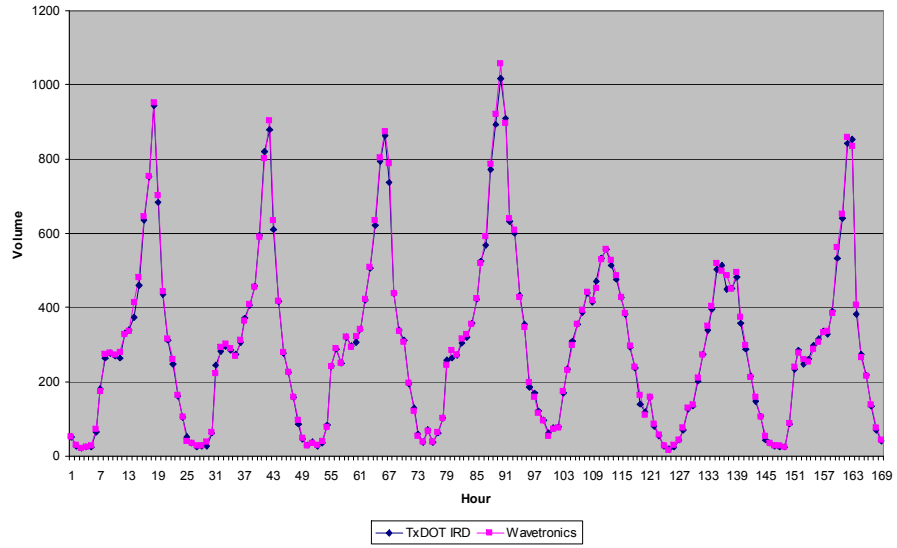
IH35 Lane 1 Hourly Volume - 5/1/2007 01:00 to 5/8/2007 00:00



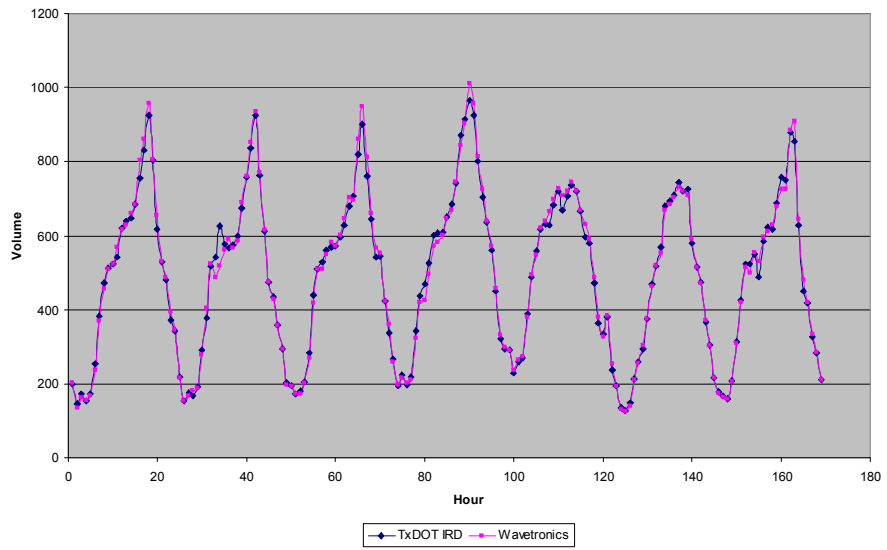
IH35 Lane 2 Hourly Volume - 5/1/2007 01:00 to 5/8/2007 00:00



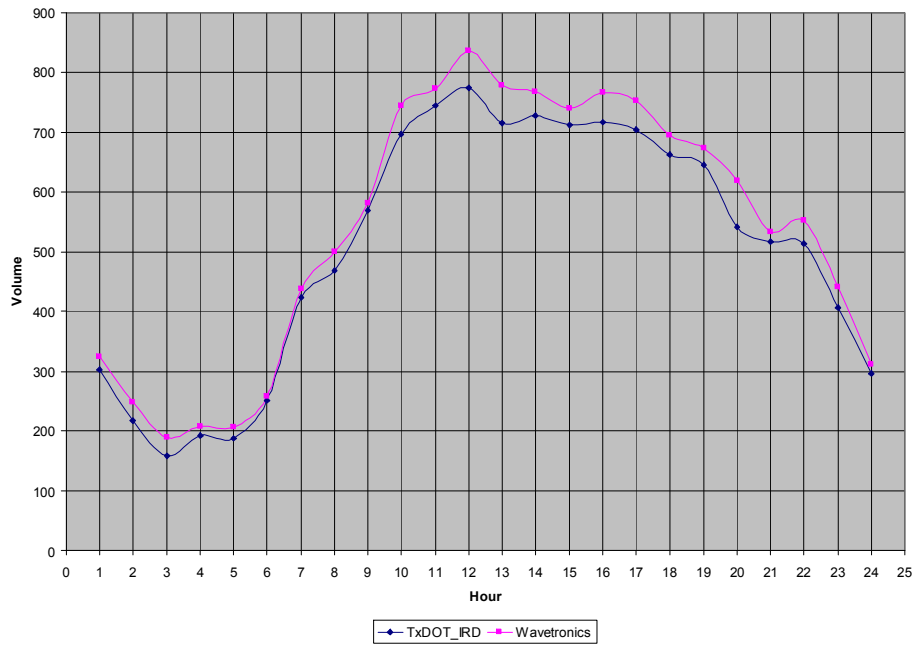
IH35 Lane 3 Hourly Volume - 5/1/2007 01:00 to 5/8/2007 00:00



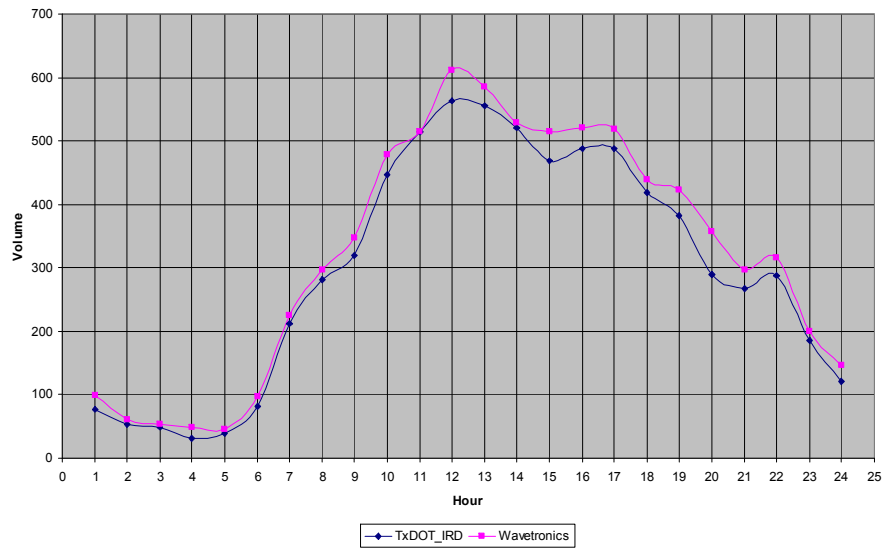
IH35 Lane 4 Hourly Volume - 5/1/2007 01:00 to 5/8/2007 00:00



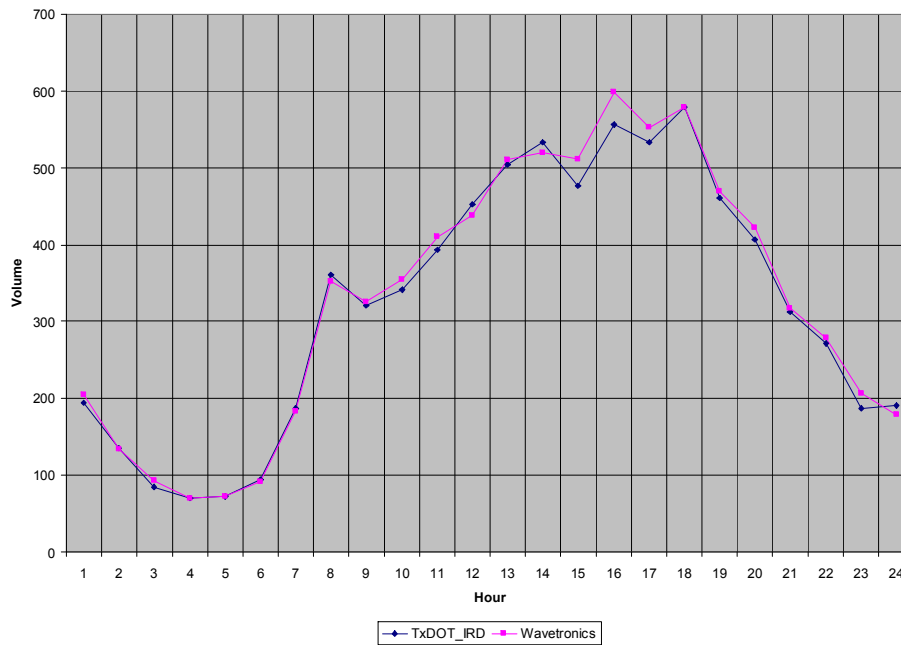
IH35 - Lane 1 - 6/2/2007



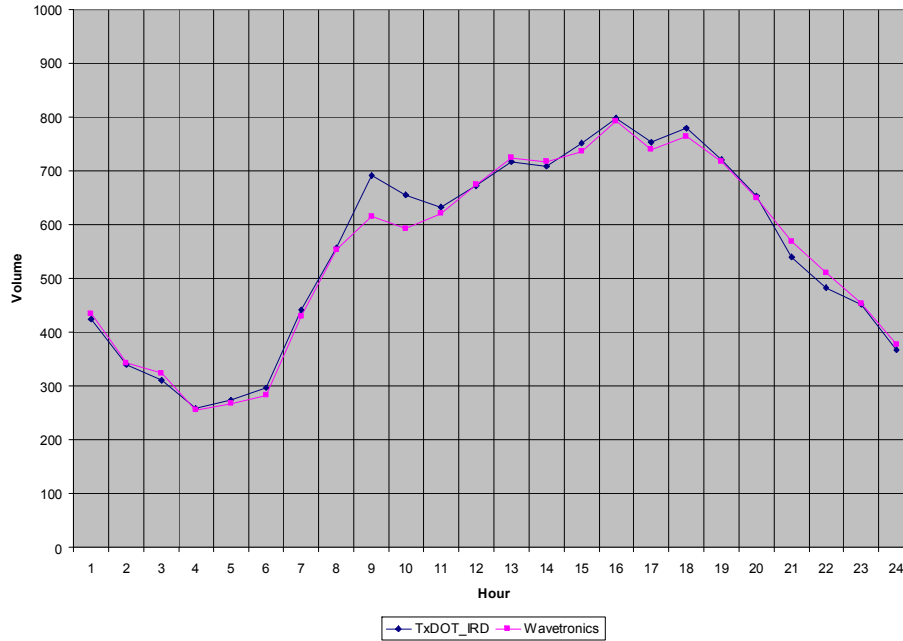
IH35 - Lane 2 - 6/2/2007



IH35 - Lane 3 - 6/2/2007



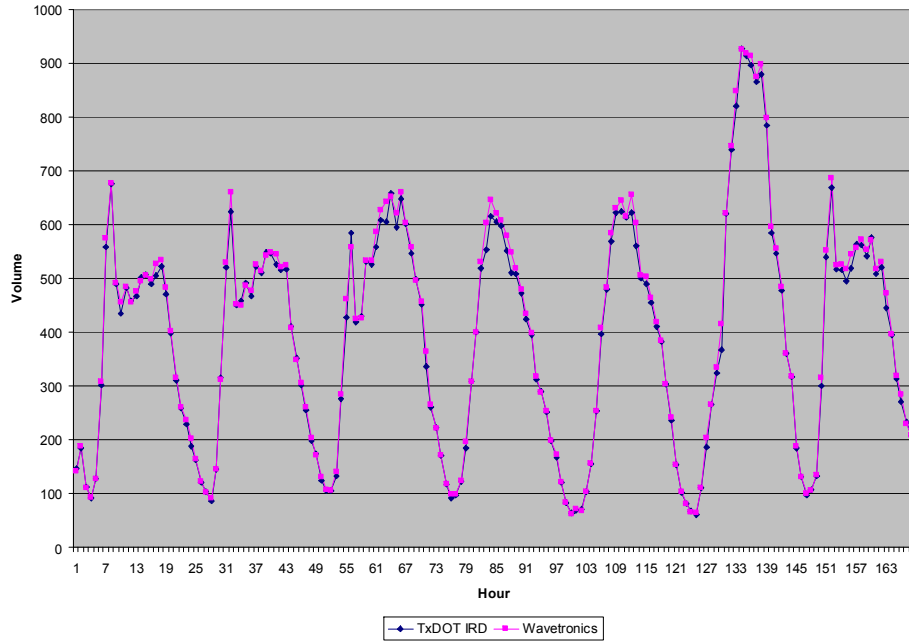
IH35 - Lane 4 - 6/2/2007



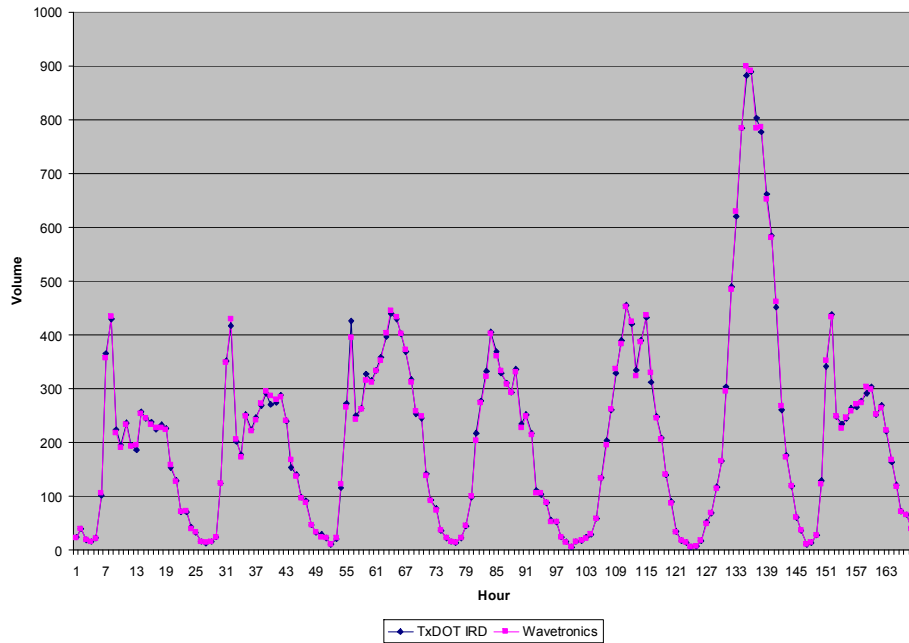
## IH 37 South of Loop 1604

- 4 Lane with median
- Random 7 contiguous days of hourly data compared
- Random 24 contiguous hours of data compared

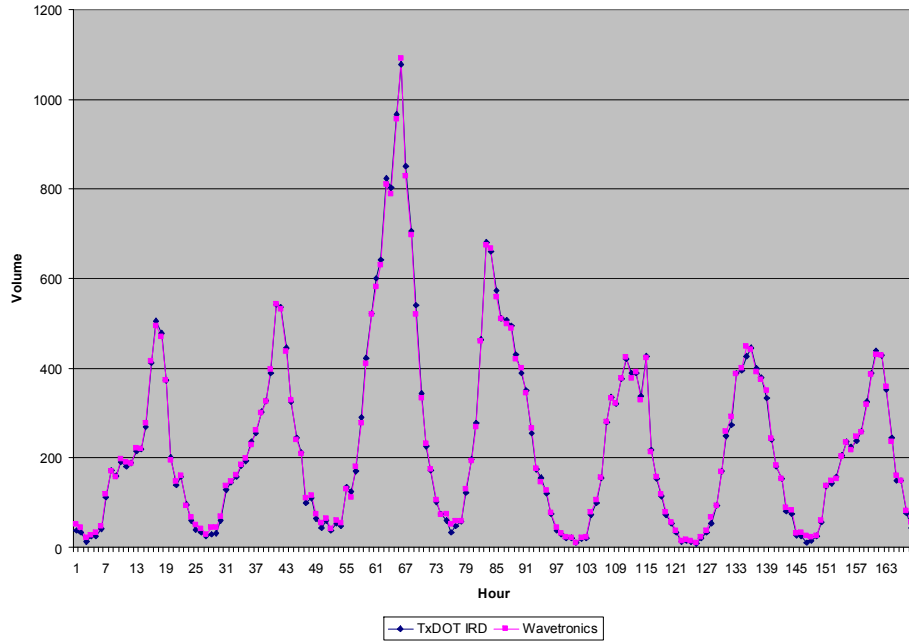
IH37 Lane 1 Hourly Volume - 5/23/2007 01:00 to 5/30/2007 00:00



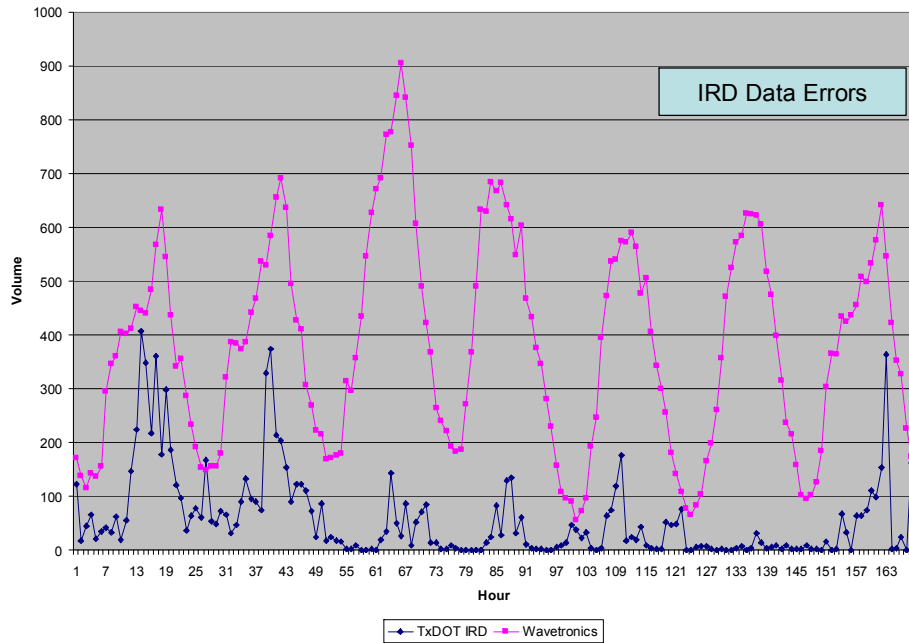
IH37 Lane 2 Hourly Volume - 5/23/2007 01:00 to 5/30/2007 00:00



IH37 Lane 3 Hourly Volume - 5/23/2007 01:00 to 5/30/2007 00:00

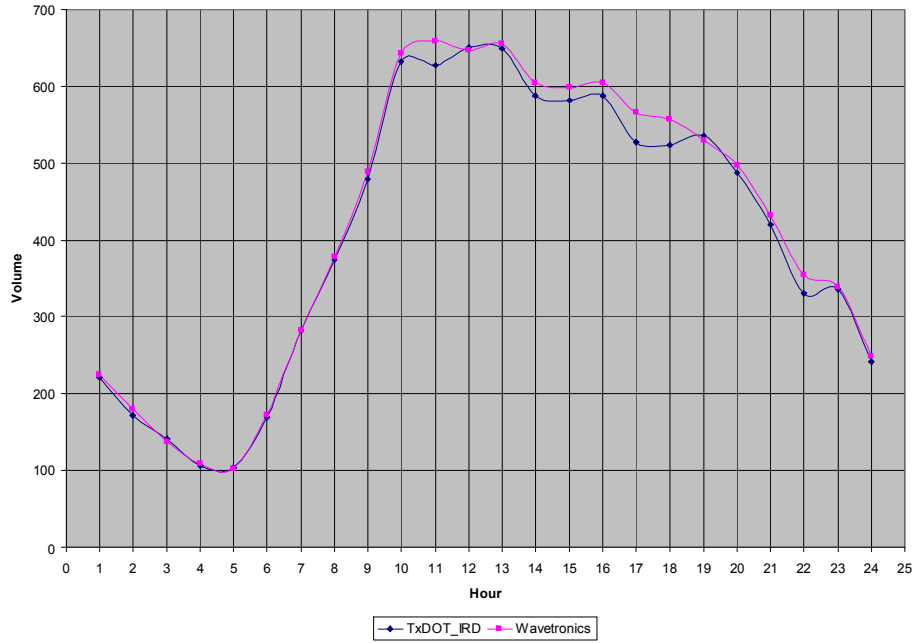


IH37 Lane 4 Hourly Volume - 5/23/2007 01:00 to 5/30/2007 00:00

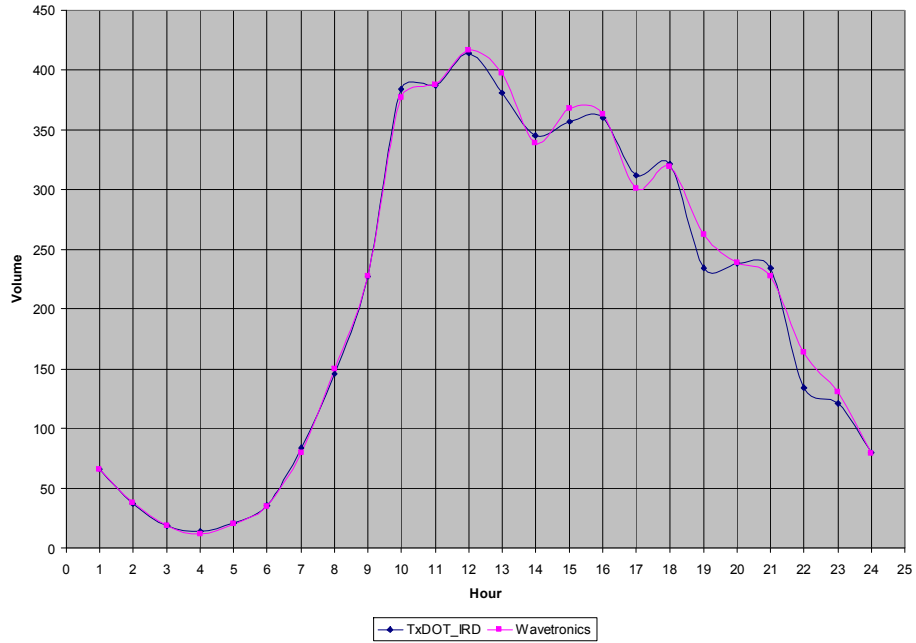




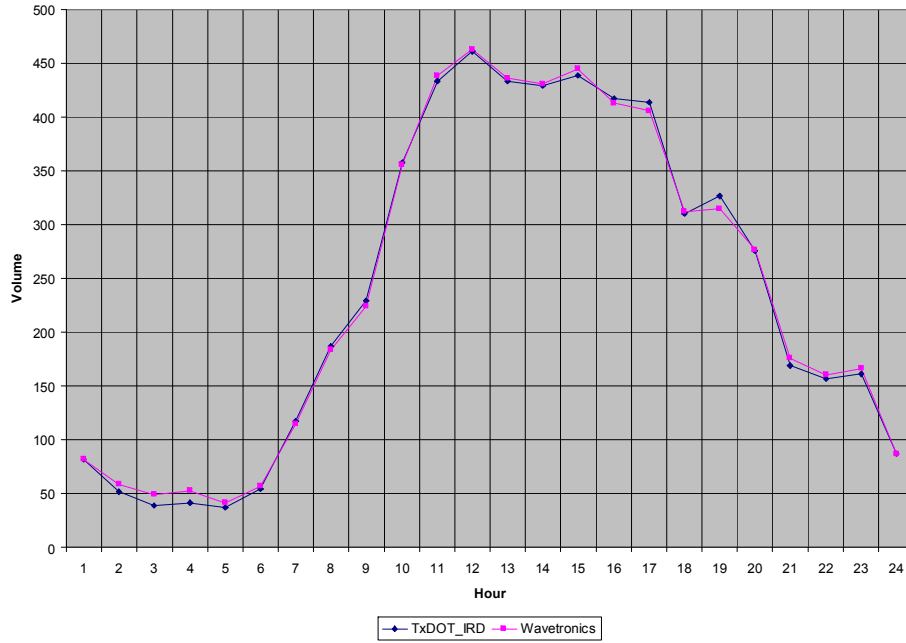
IH37 - Lane 1 - 6/2/2007



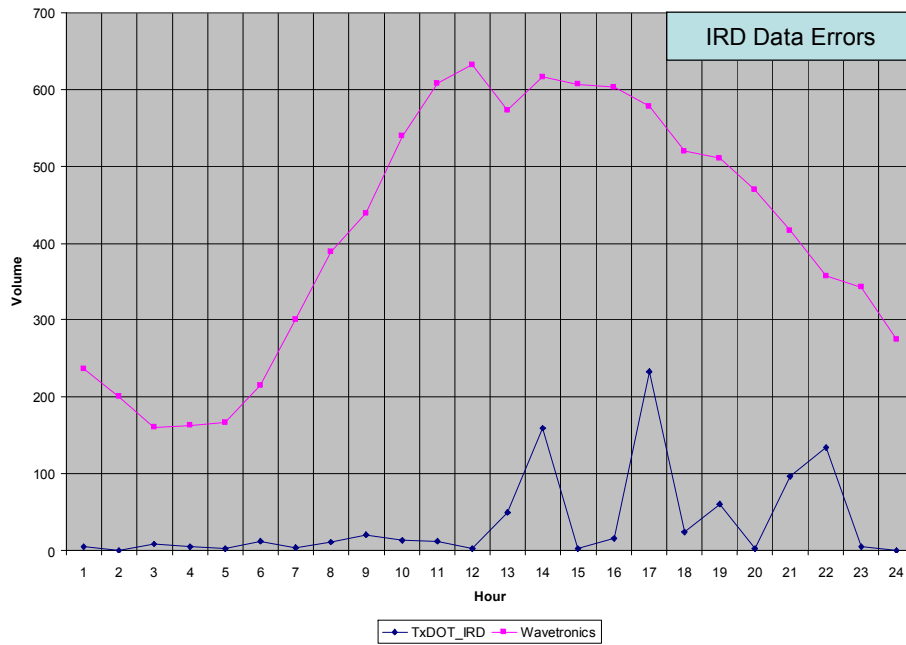
IH37 - Lane 2 - 6/2/2007



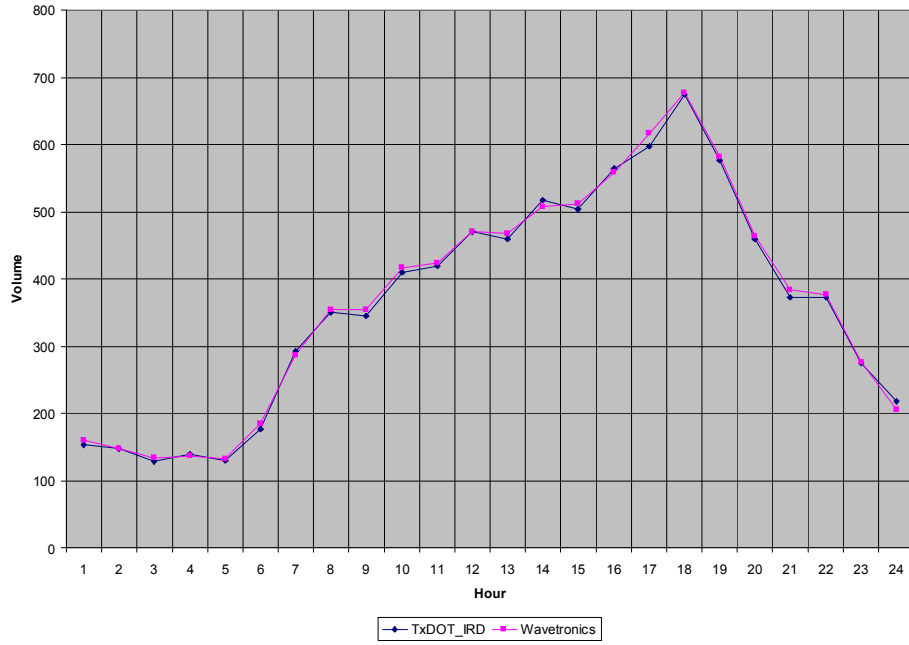
IH37 - Lane 3 - 6/2/2007



IH37 - Lane 4 - 6/2/2007



IH37 - Lane 4 - 6/13/2007



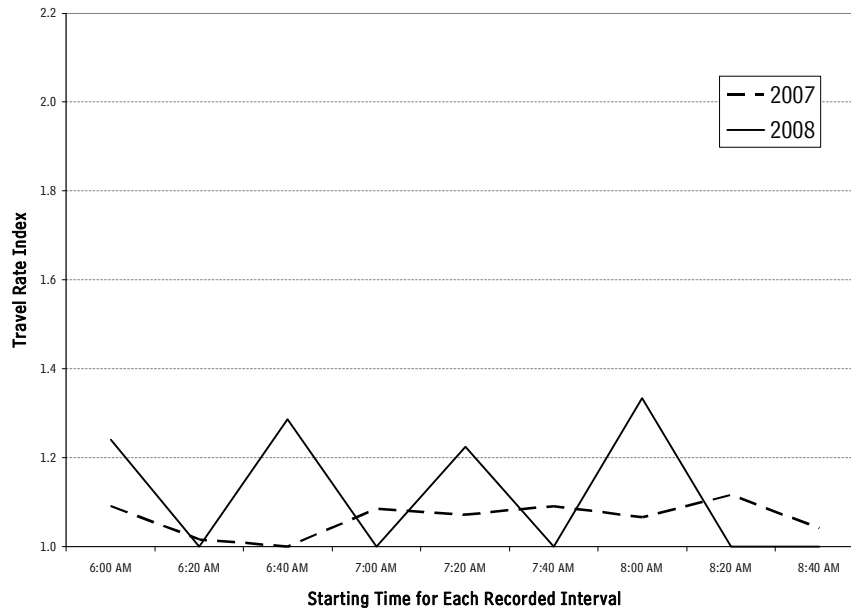
## APPENDIX E: Corridor Analysis

### Corridor 1: Applewhite Rd/Zarzamora St from SL 1604 to IH 410

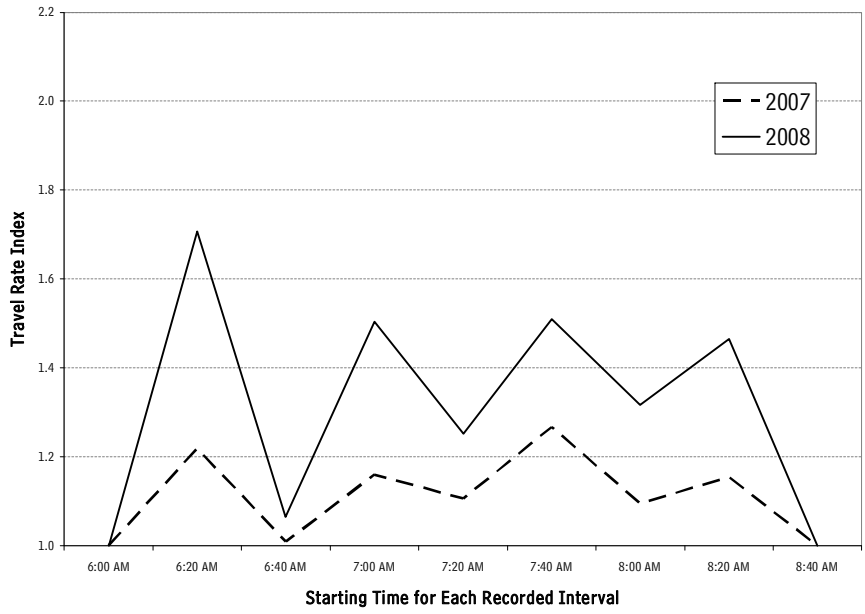
Corridor 1 is defined in linked segments as follows:

- (A) Zarzamora St from IH 410 to Applewhite Rd
- (B) Applewhite Rd from Zarzamora St to Lone Star Pass (Lone Star Pass leads into the middle gate of the Toyota plant)
- (C) Applewhite Rd from Lone Star Pass to Old Applewhite Rd
- (D) Applewhite Rd from Old Applewhite Rd to Neal Rd
- (E) Applewhite Rd from Neal Rd to SL 1604

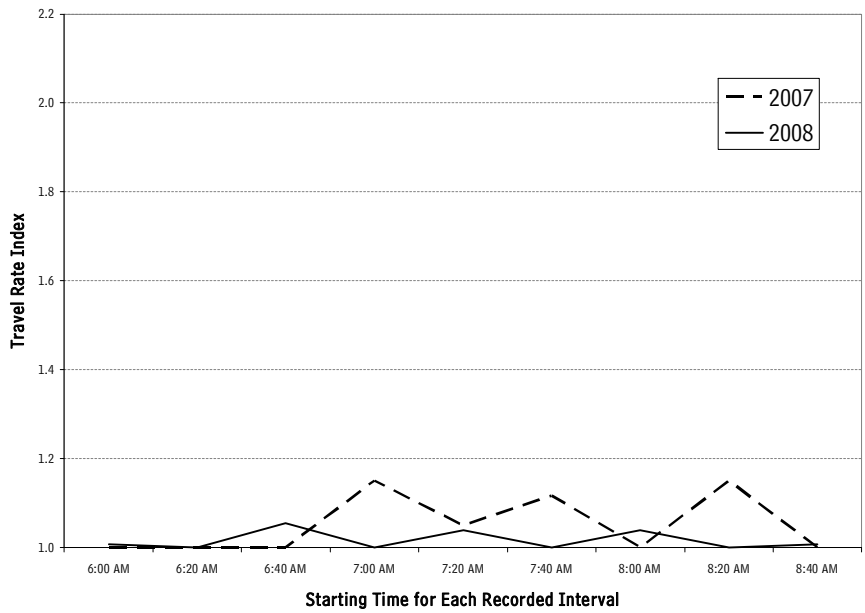
#### *Travel Time Runs, Morning Peak, Southbound Direction*



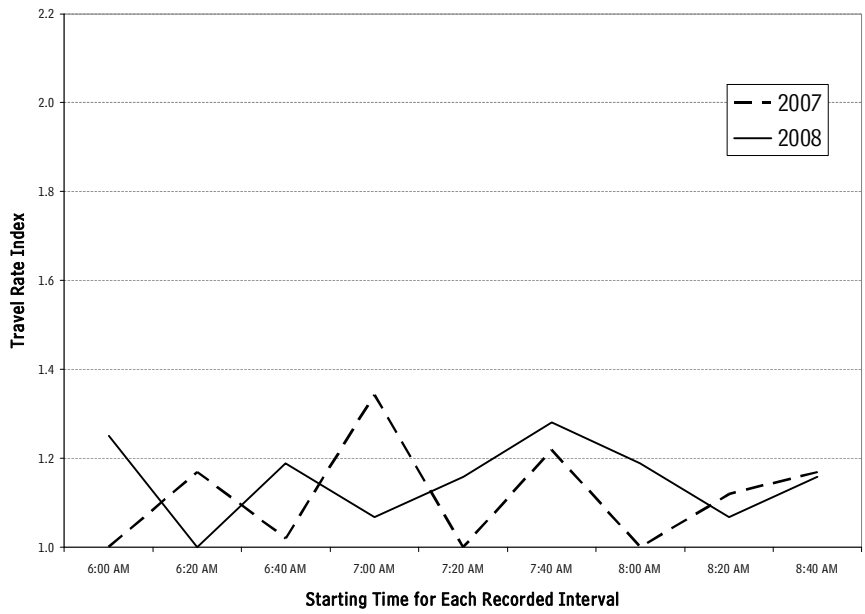
**Figure 4 Zarzamora St (AM Peak), IH 410 to Applewhite Rd, Southbound.**



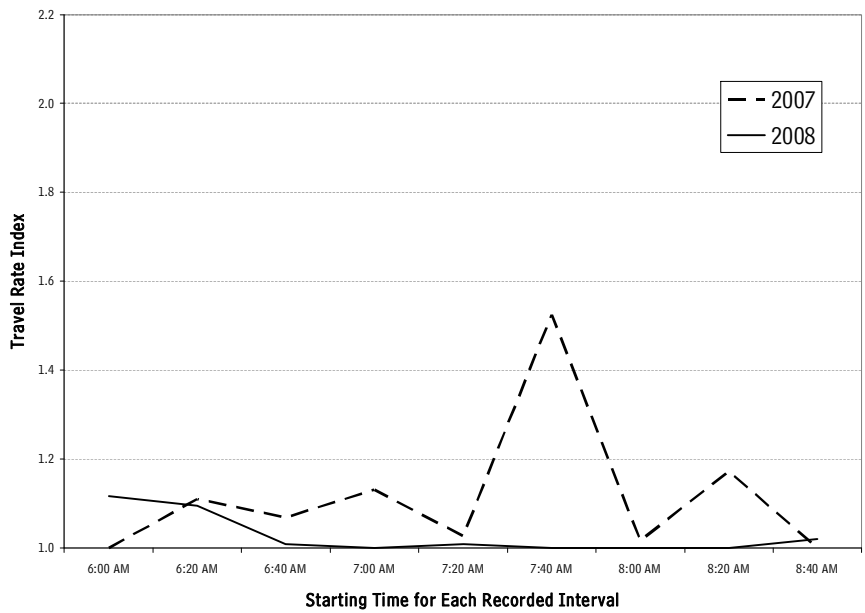
**Figure 5 Applewhite Rd (AM Peak), Zarzamora St to Lone Star Pass, Southbound.**



**Figure 6 Applewhite Rd (AM Peak), Lone Star Pass to Old Applewhite Rd, Southbound.**

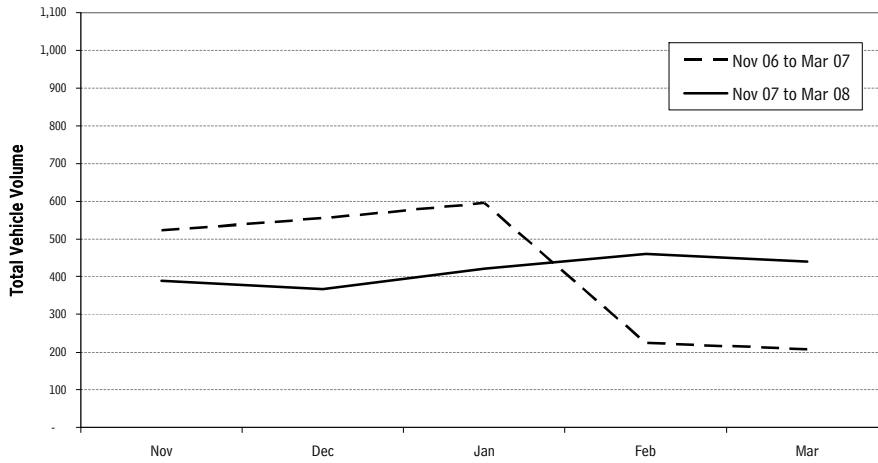


**Figure 7 Applewhite Rd (AM Peak), Old Applewhite Rd to Neal Rd, Southbound.**

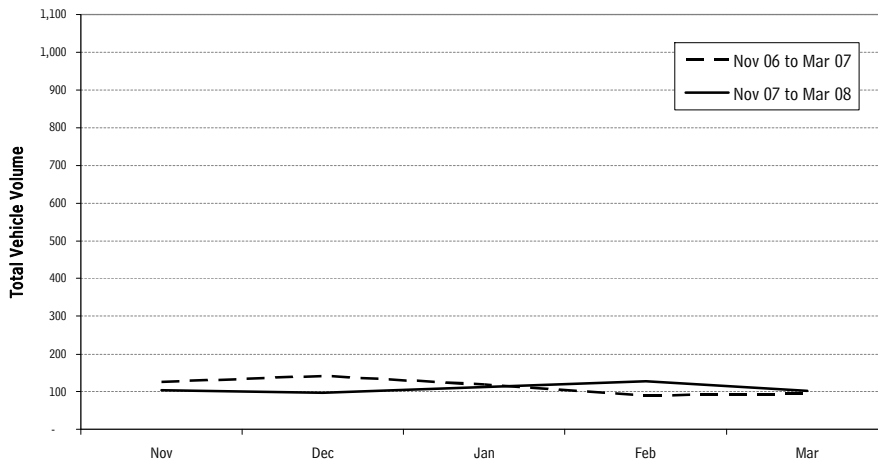


**Figure 8 Applewhite Rd (AM Peak), Neal Rd to SL 1604, Southbound.**

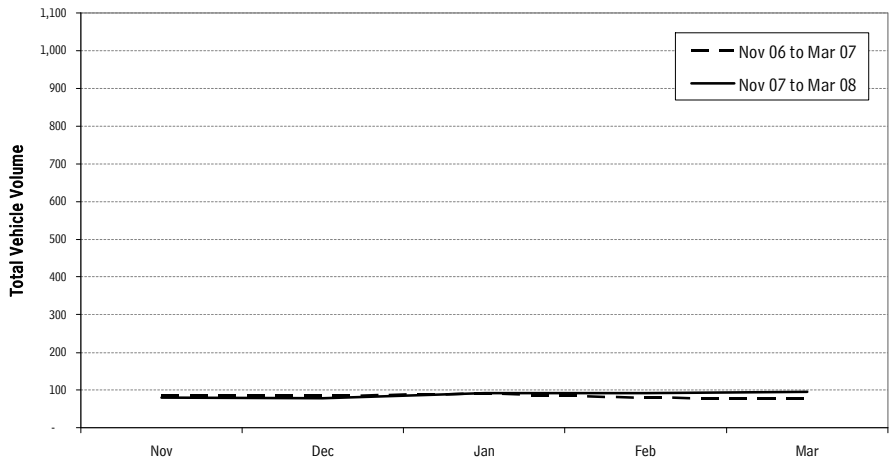
**Total Vehicle Volumes Southbound Direction, Morning Peak**



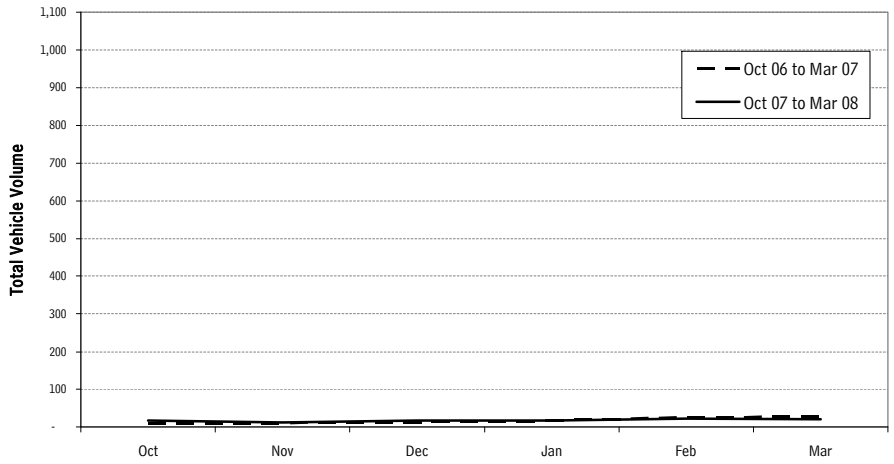
**Figure 9 Total Vehicle Volumes, Site 314 Southbound, 6 AM to 7 AM.**



**Figure 10 Total Vehicle Volumes, Site 314 Southbound, 7 AM to 8 AM.**

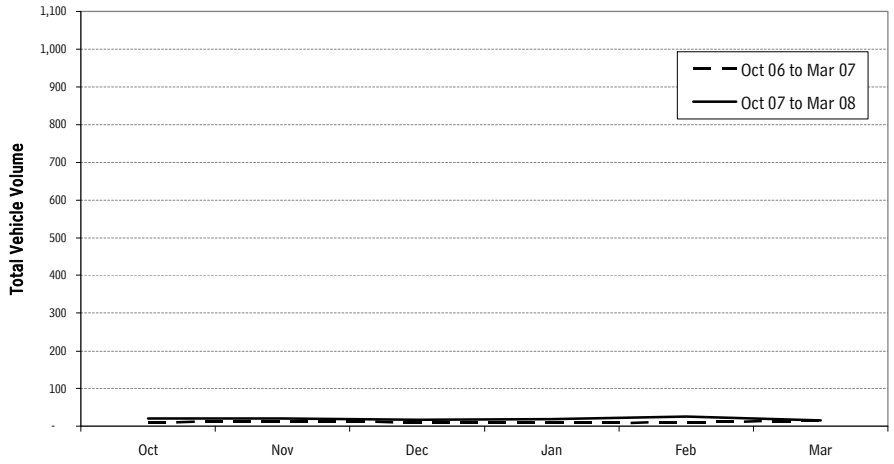


**Figure 11 Total Vehicle Volumes, Site 314 Southbound, 8 AM to 9 AM.**

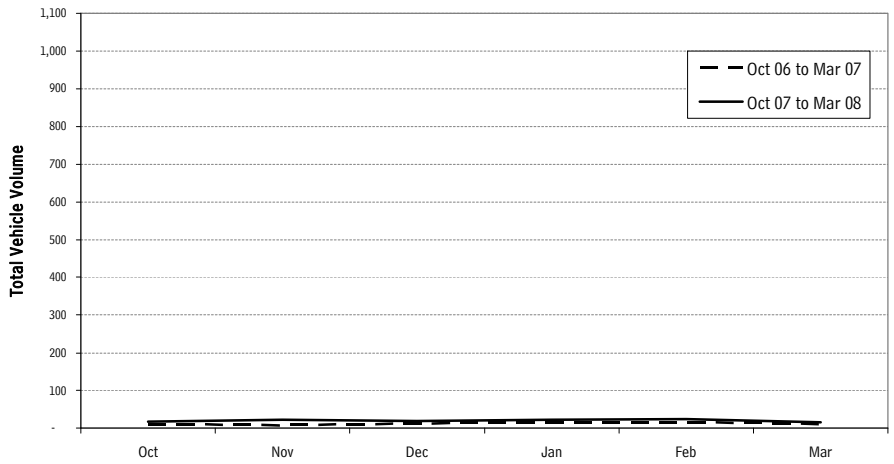


**Figure 12 Total Vehicle Volumes, Site 315 Southbound, 6 AM to 7 AM.**





**Figure 13 Total Vehicle Volumes, Site 315 Southbound, 7 AM to 8 AM.**



**Figure 14 Total Vehicle Volumes, Site 315 Southbound, 8 AM to 9 AM.**

## Truck Volumes Southbound Direction, Morning Peak

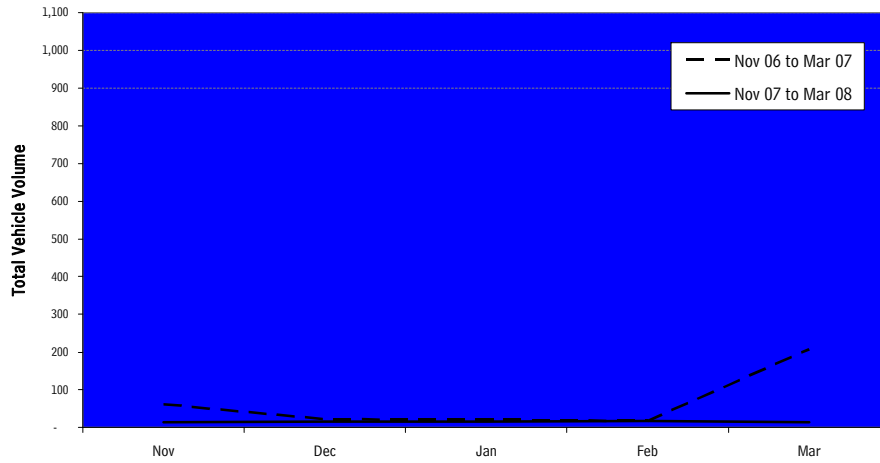


Figure 15 Total Truck Volumes, Site 314 Southbound, 6 AM to 7 AM.

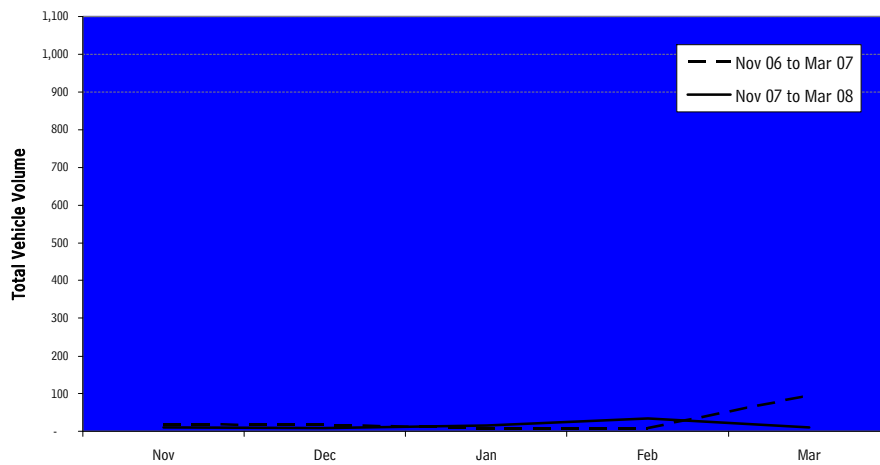
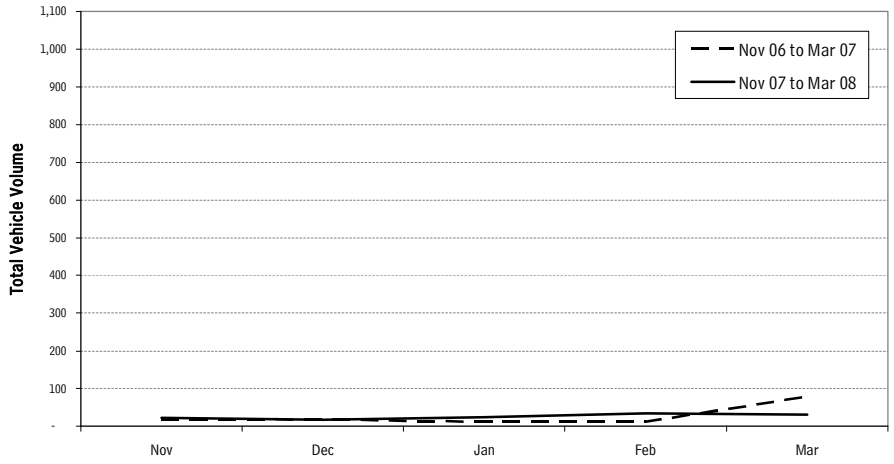
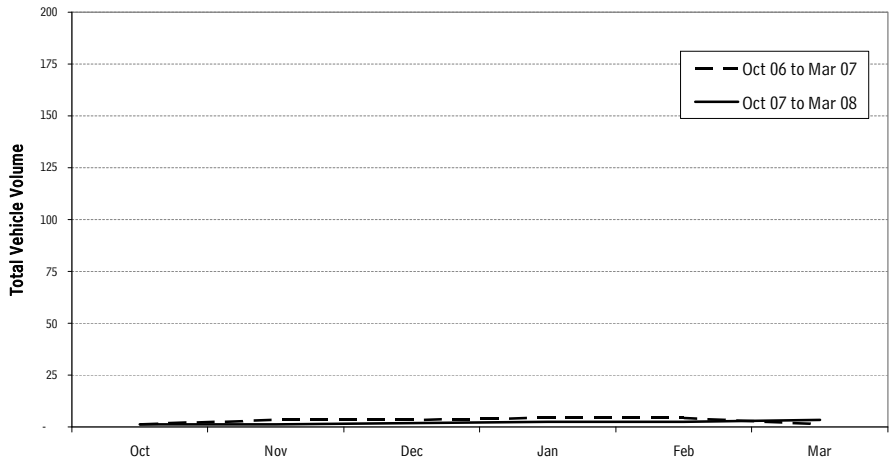


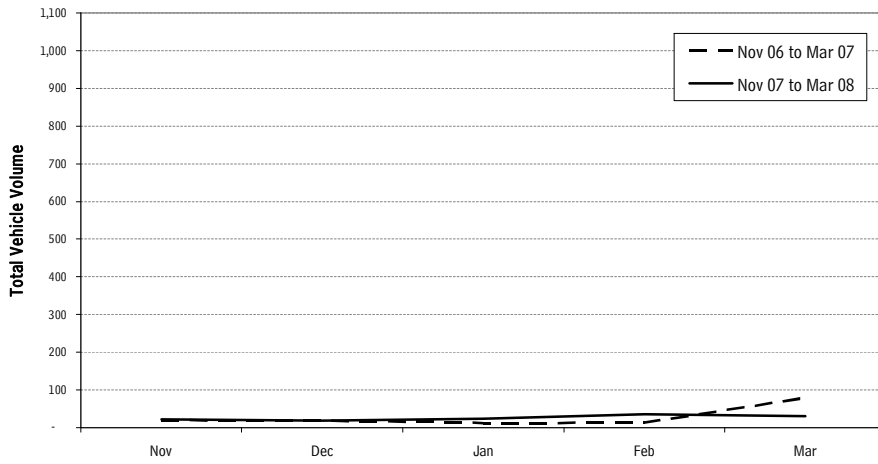
Figure 16 Total Truck Volumes, Site 314 Southbound, 7 AM to 8 AM.



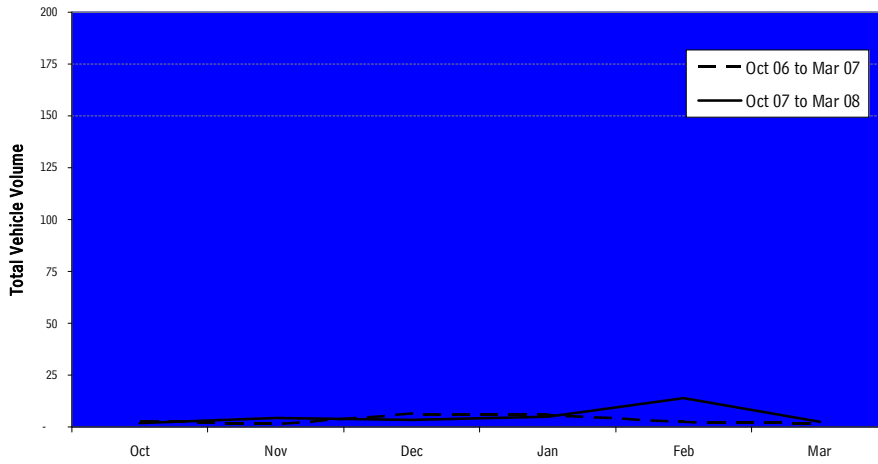
**Figure 17 Total Truck Volumes, Site 314 Southbound, 8 AM to 9 AM.**



**Figure 18 Total Truck Volumes, Site 315 Southbound, 6 AM to 7 AM.**

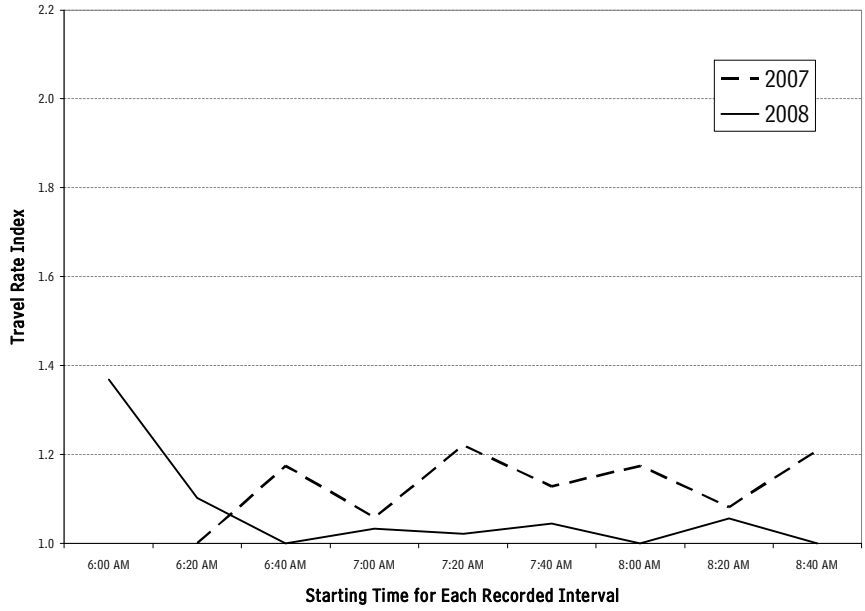


**Figure 19 Total Truck Volumes, Site 315 Southbound, 7 AM to 8 AM.**

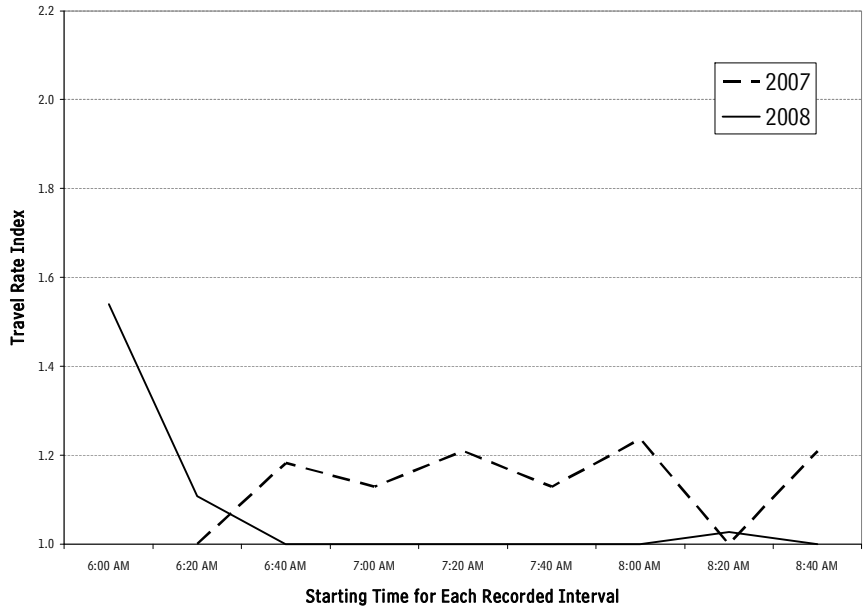


**Figure 20 Total Truck Volumes, Site 315 Southbound, 8 AM to 9 AM.**

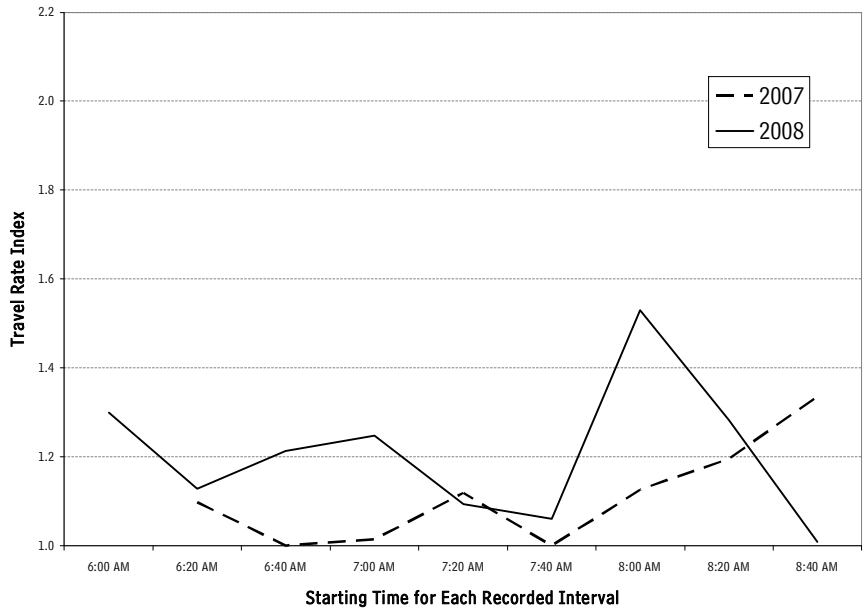
***Travel Time Runs, Morning Peak, Northbound Direction***



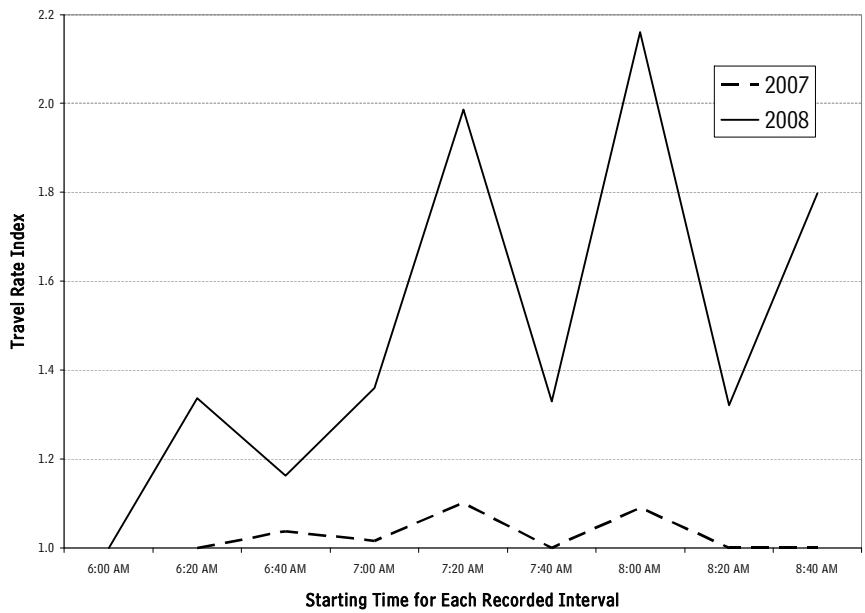
**Figure 21 Applewhite Rd (AM Peak), SL 1604 to Neal Rd, Northbound.**



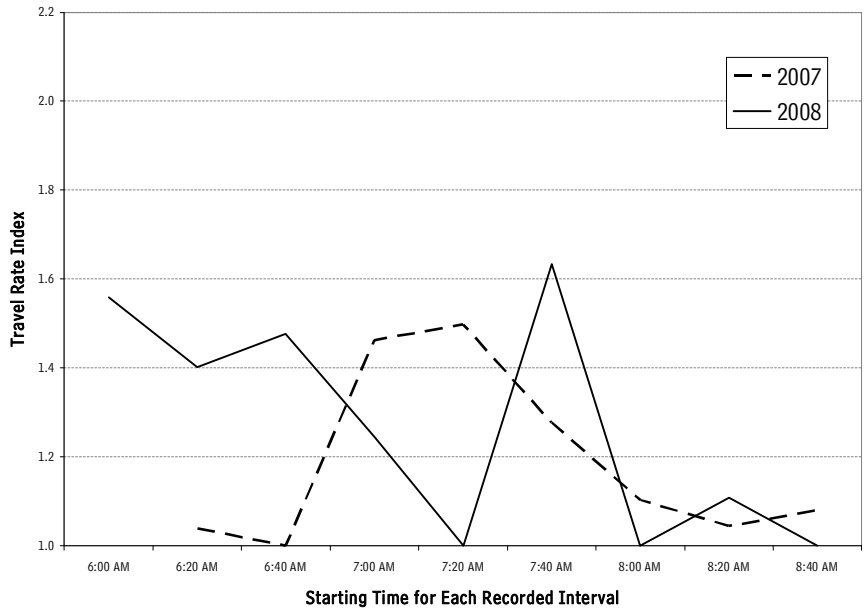
**Figure 22 Applewhite Rd (AM Peak), Neal Rd to Old Applewhite Rd, Northbound.**



**Figure 23 Applewhite Rd (AM Peak), Old Applewhite Rd to Lone Star Pass, Northbound.**

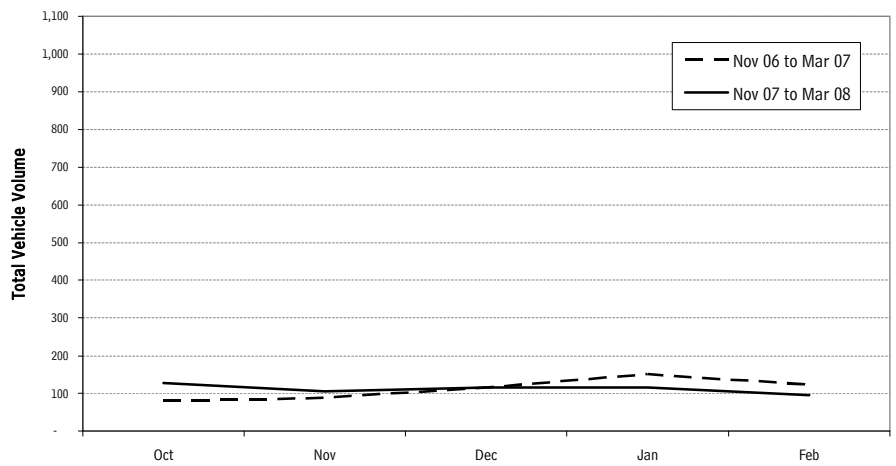


**Figure 24 Applewhite Rd (AM Peak), Lone Star Pass to Zarmamora St, Northbound.**

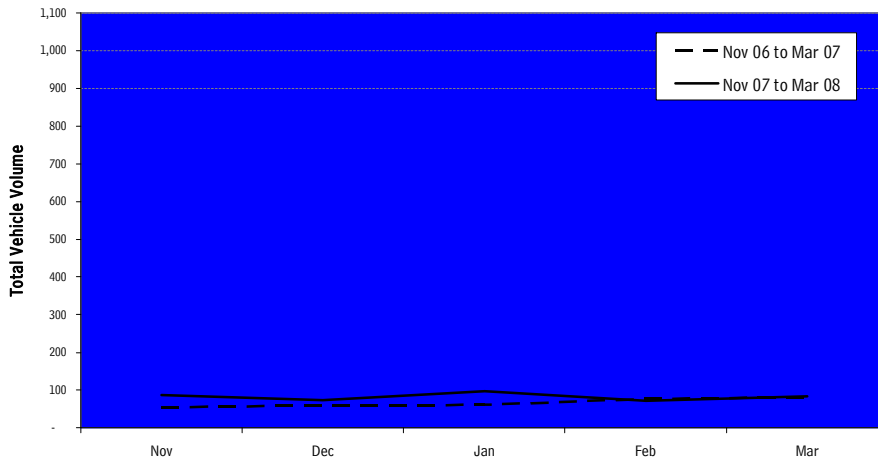


**Figure 25 Zarzamora St (AM Peak), Applewhite Rd to IH 410, Northbound.**

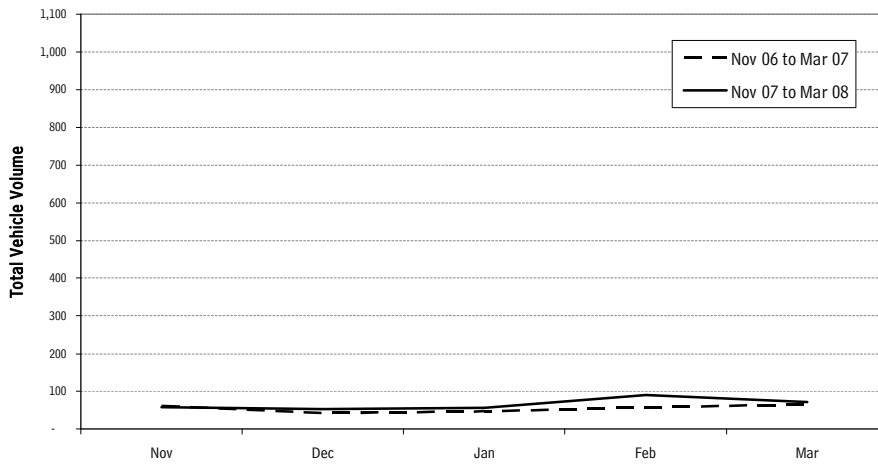
***Total Vehicle Volumes Northbound Direction, Morning Peak***



**Figure 26 Total Vehicle Volumes, Site 314 Northbound, 6 AM to 7 AM.**

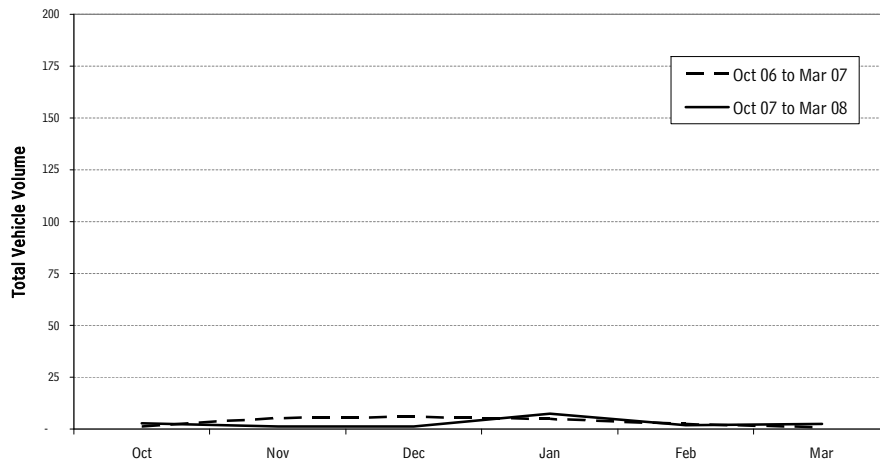


**Figure 27 Total Vehicle Volumes, Site 314 Northbound, 7 AM to 8 AM.**

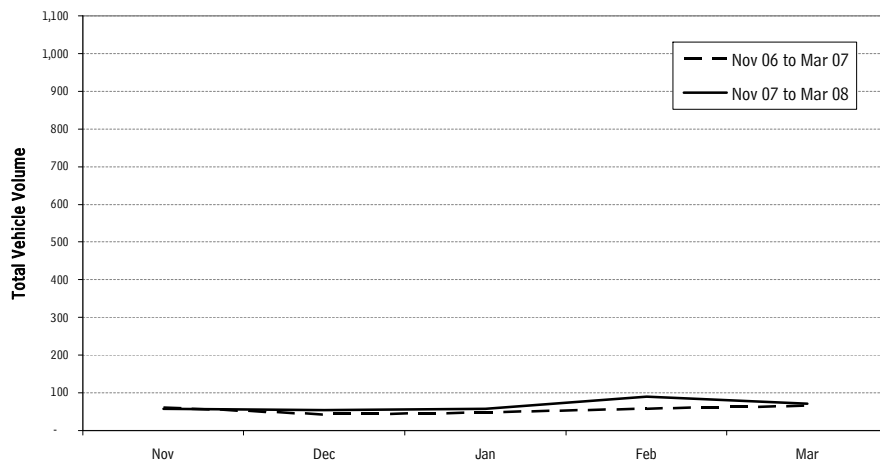


**Figure 28 Total Vehicle Volumes, Site 314 Northbound, 8 AM to 9 AM.**

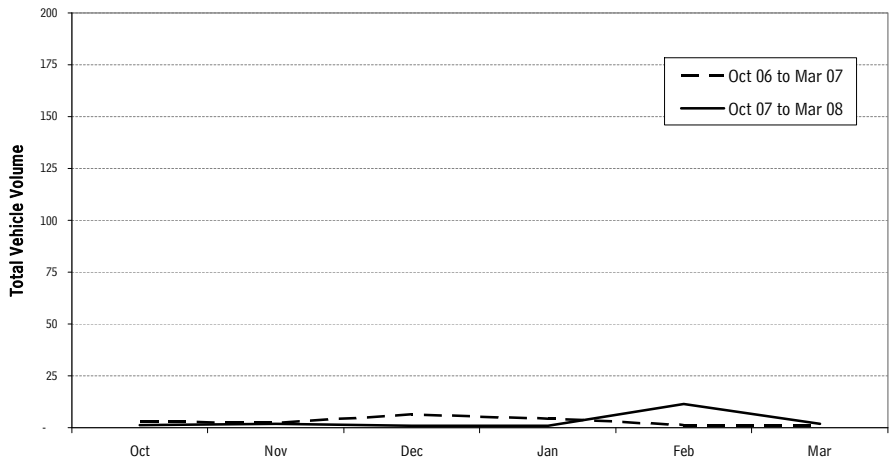




**Figure 29 Total Vehicle Volumes, Site 315 Northbound, 6 AM to 7 AM.**

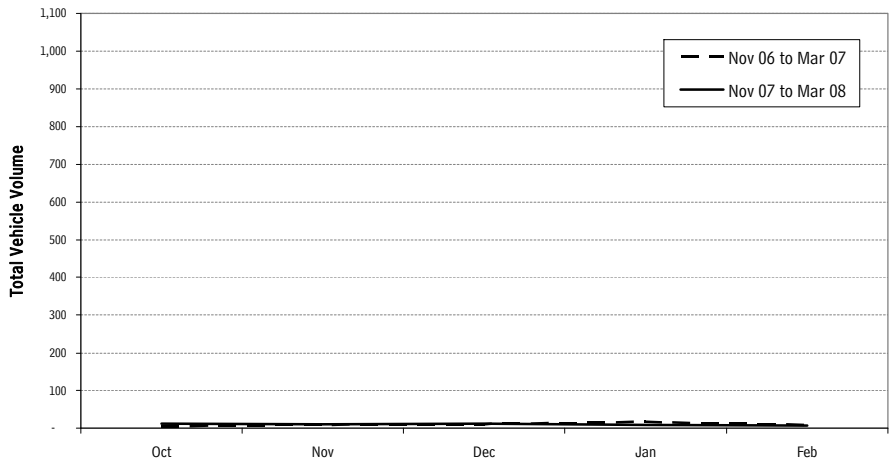


**Figure 30 Total Vehicle Volumes, Site 315 Northbound, 7 AM to 8 AM.**

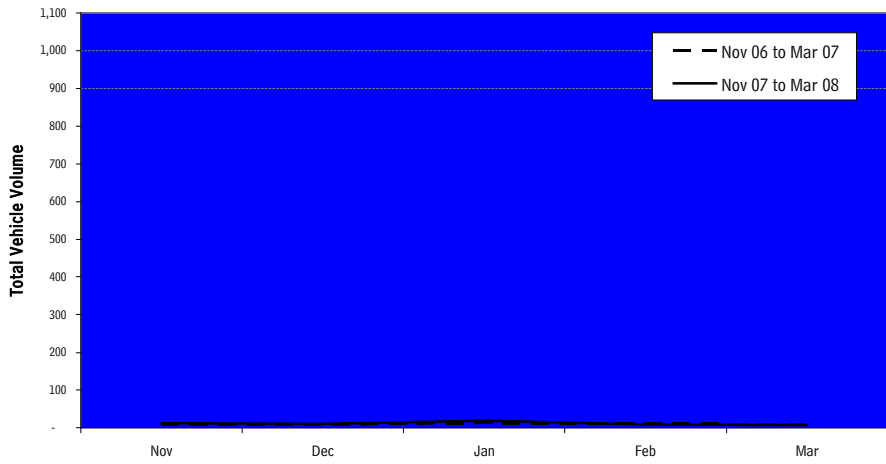


**Figure 31 Total Vehicle Volumes, Site 315 Northbound, 8 AM to 9 AM.**

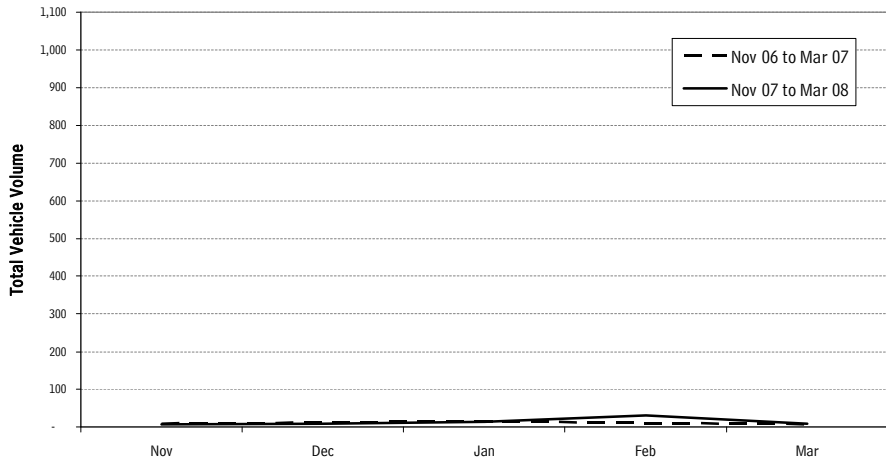
***Truck Volumes Northbound Direction, Morning Peak***



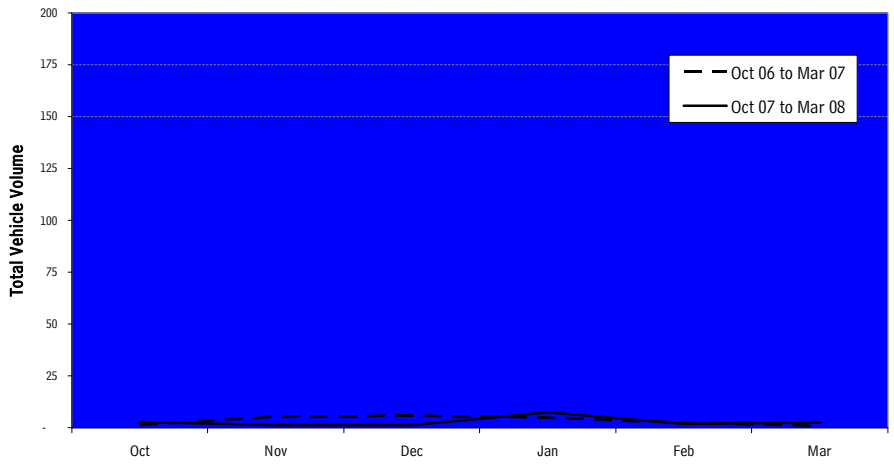
**Figure 32 Total Truck Volumes, Site 314 Northbound, 6 AM to 7 AM.**



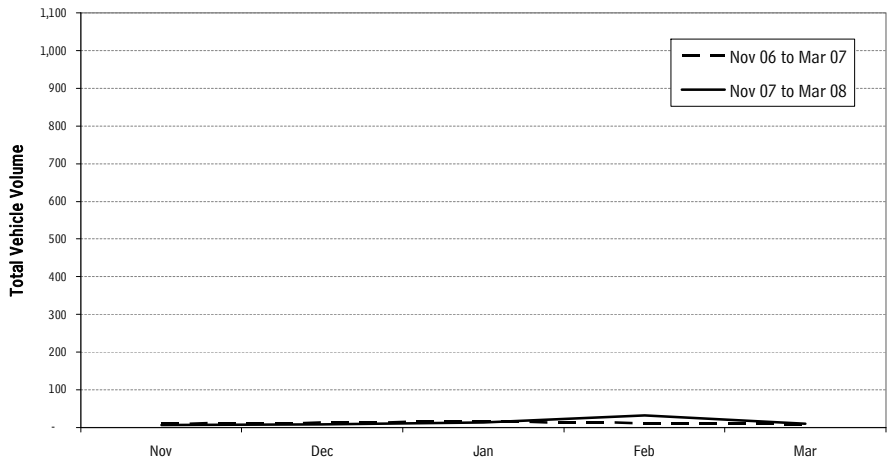
**Figure 33 Total Truck Volumes, Site 314 Northbound, 7 AM to 8 AM.**



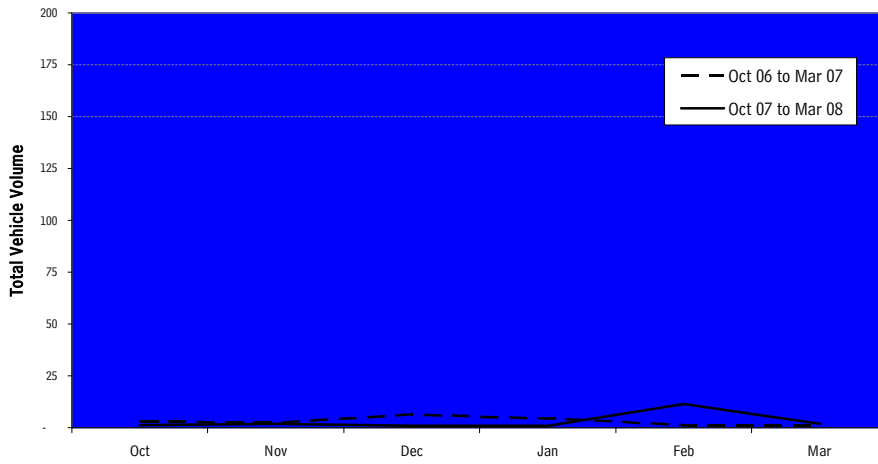
**Figure 34 Total Truck Volumes, Site 314 Northbound, 8 AM to 9 AM.**



**Figure 35 Total Truck Volumes, Site 315 Northbound, 6 AM to 7 AM.**

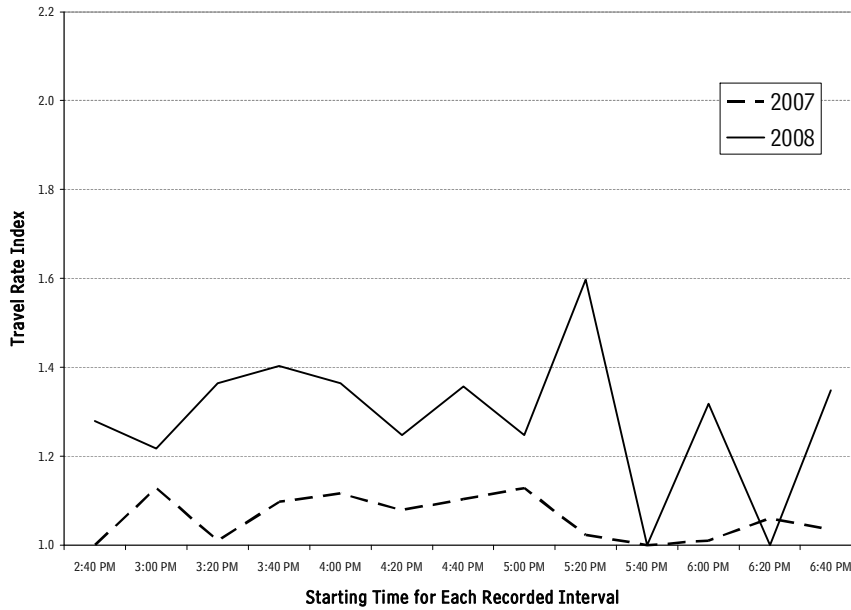


**Figure 36 Total Truck Volumes, Site 315 Northbound, 7 AM to 8 AM.**

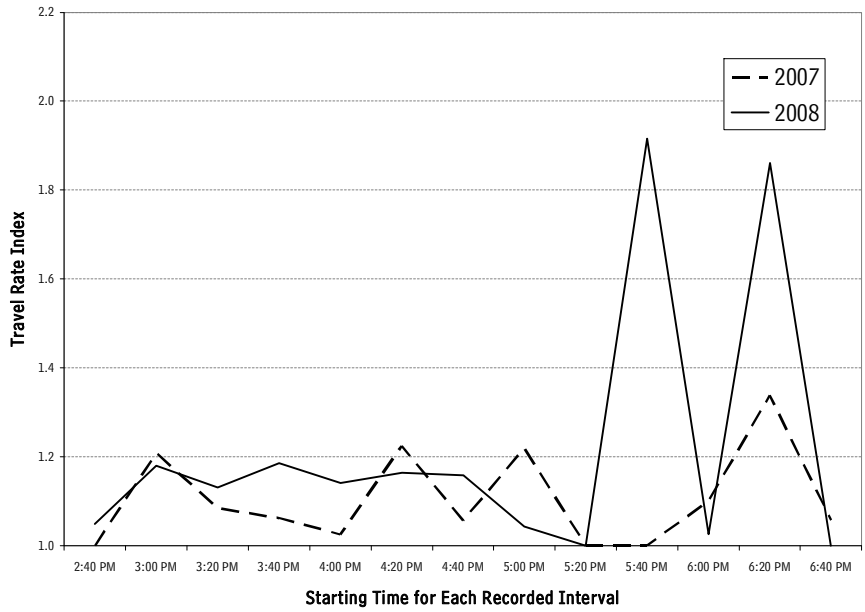


**Figure 37 Total Truck Volumes, Site 315 Northbound, 8 AM to 9 AM.**

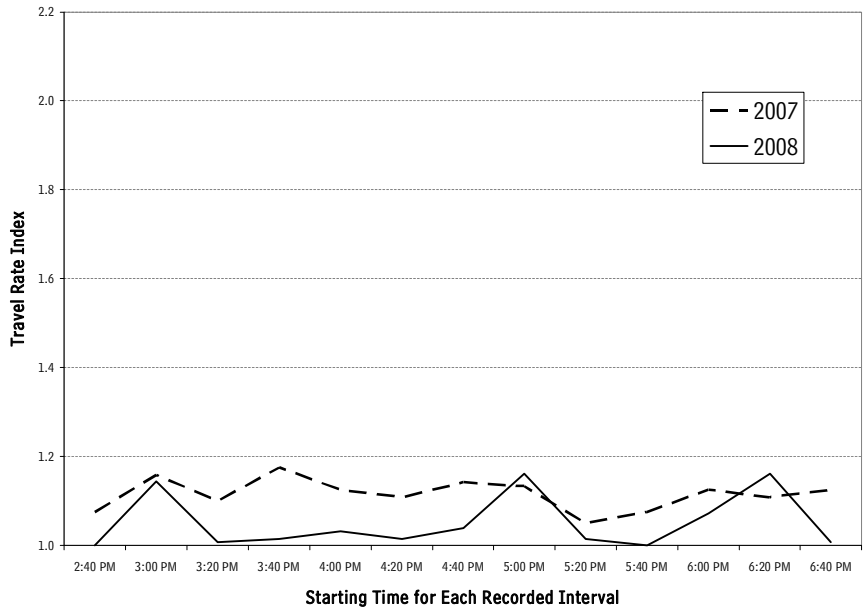
*Travel Time Runs, Afternoon Peak, Southbound Direction*



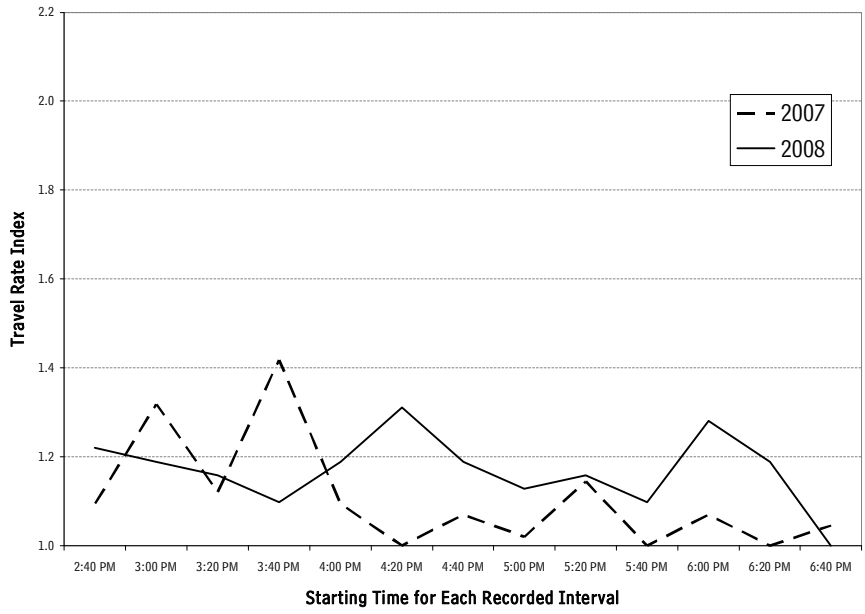
**Figure 38 Zarzamora St (PM Peak), IH 410 to Applewhite Rd, Southbound.**



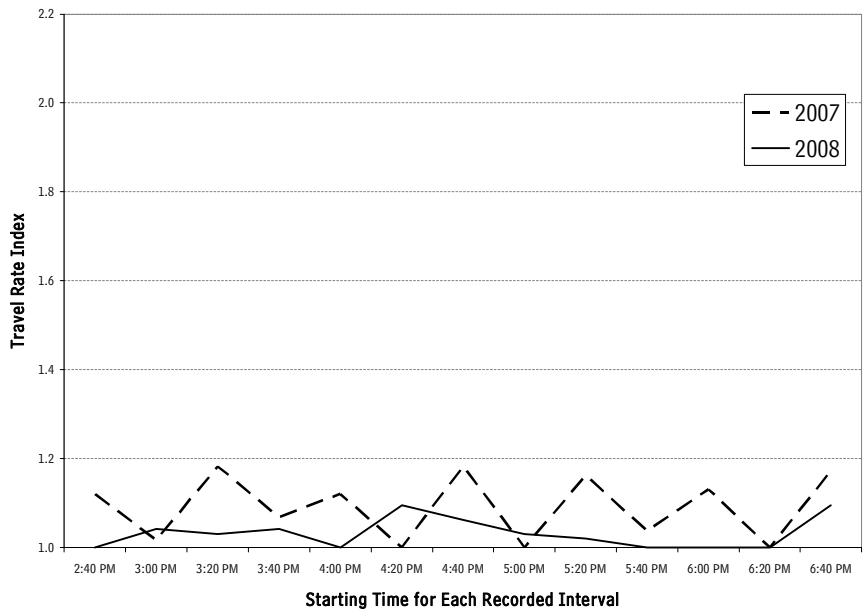
**Figure 39 Applewhite Rd (PM Peak), Zarzamora St to Lone Star Pass, Southbound.**



**Figure 40 Applewhite Rd (PM Peak), Lone Star Pass to Old Applewhite Rd, Southbound.**

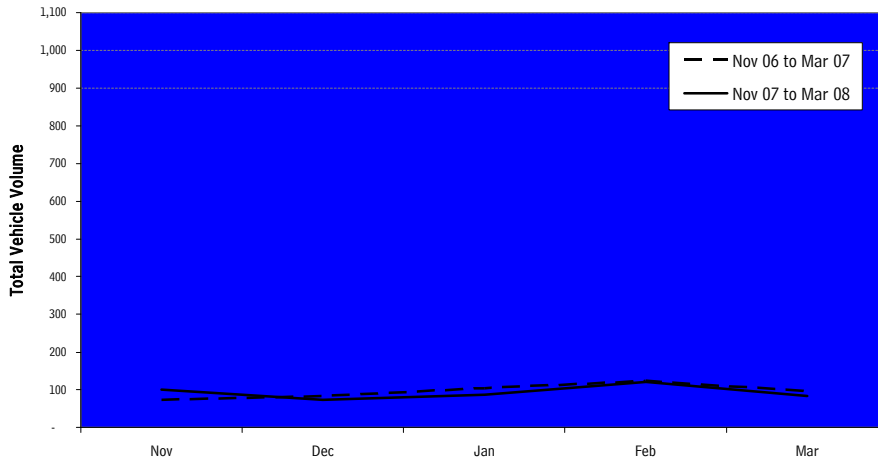


**Figure 41 Applewhite Rd (PM Peak), Old Applewhite Rd to Neal Rd, Southbound.**

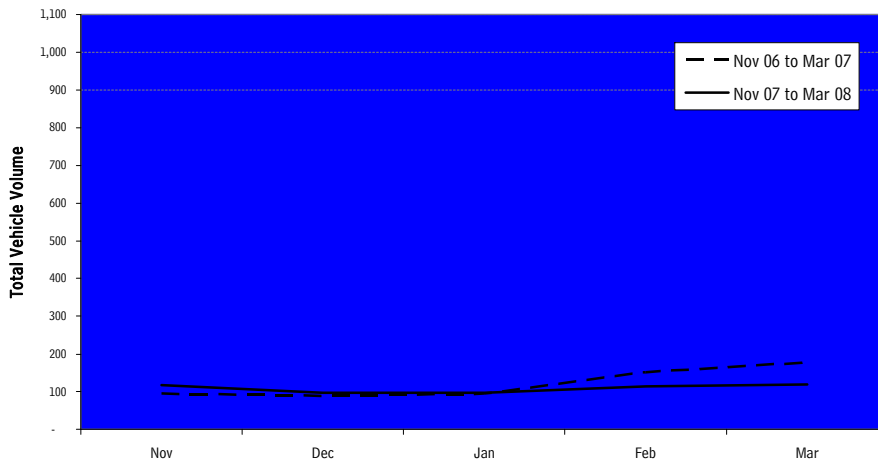


**Figure 42 Applewhite Rd (PM Peak), Neal Rd to SL 1604, Southbound.**

**Total Vehicle Volumes Southbound Direction, Afternoon Peak**

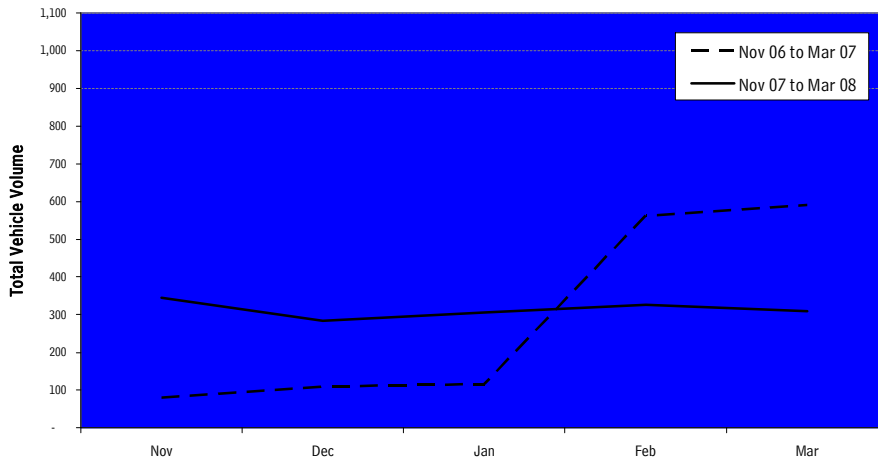


**Figure 43 Total Vehicle Volumes, Site 314 Southbound, 2 PM to 3 PM.**

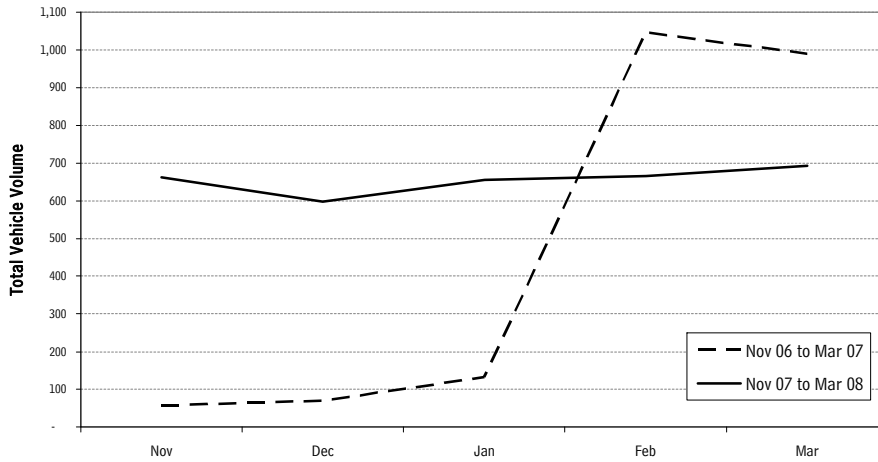


**Figure 44 Total Vehicle Volumes, Site 314 Southbound, 3 PM to 4 PM.**

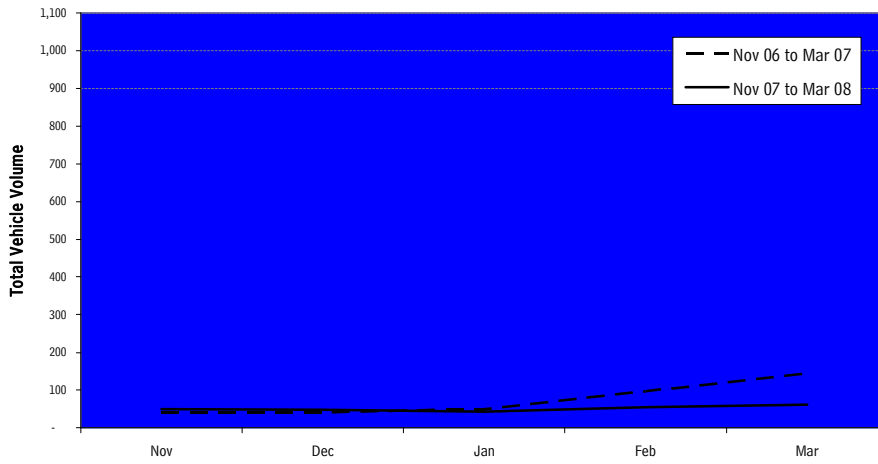




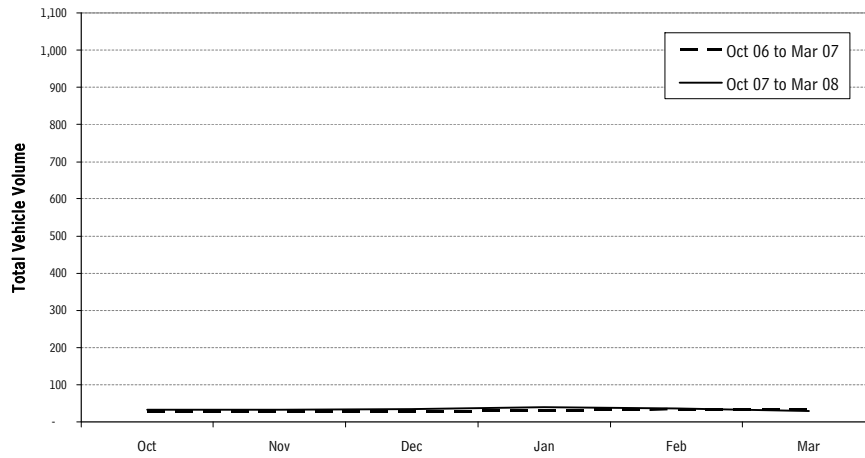
**Figure 45 Total Vehicle Volumes, Site 314 Southbound, 4 PM to 5 PM.**



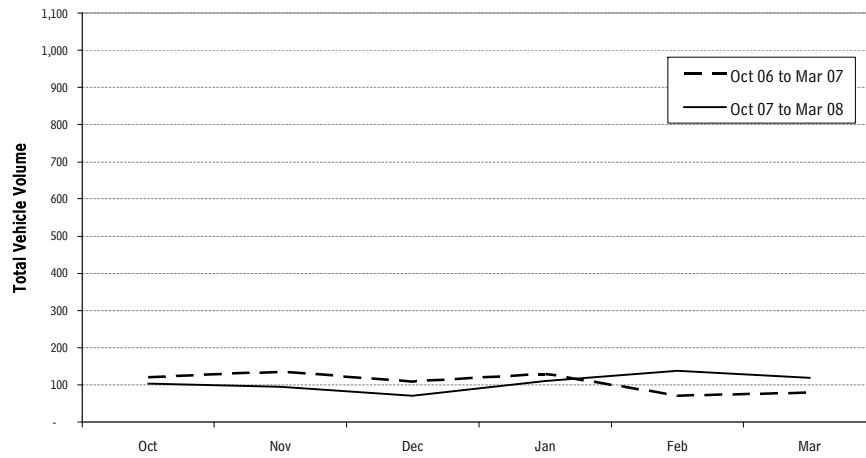
**Figure 46 Total Vehicle Volumes, Site 314 Southbound, 5 PM to 6 PM.**



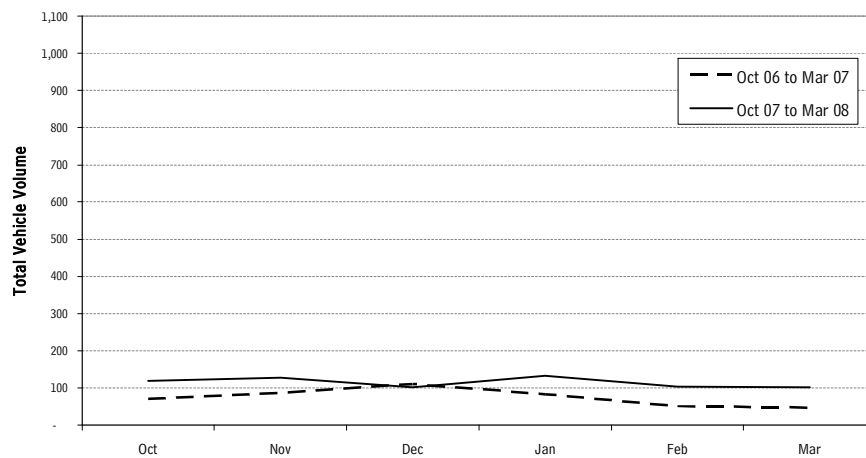
**Figure 47 Total Vehicle Volumes, Site 314 Southbound, 6 PM to 7 PM.**



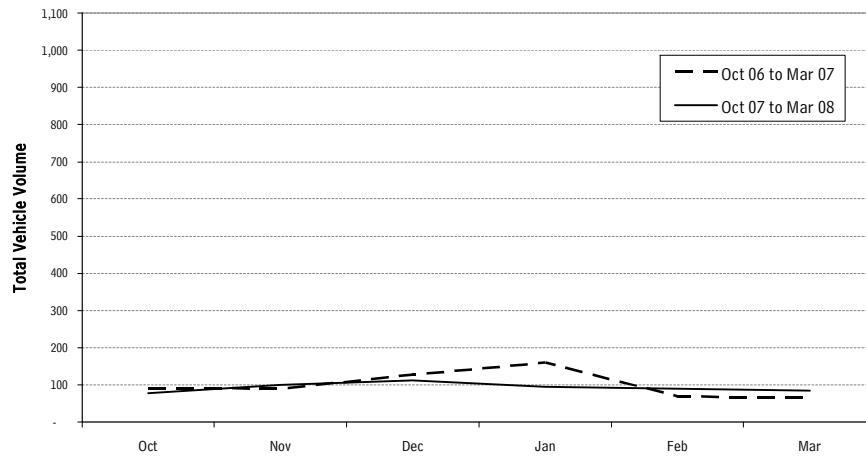
**Figure 48 Total Vehicle Volumes, Site 315 Southbound, 2 PM to 3 PM.**



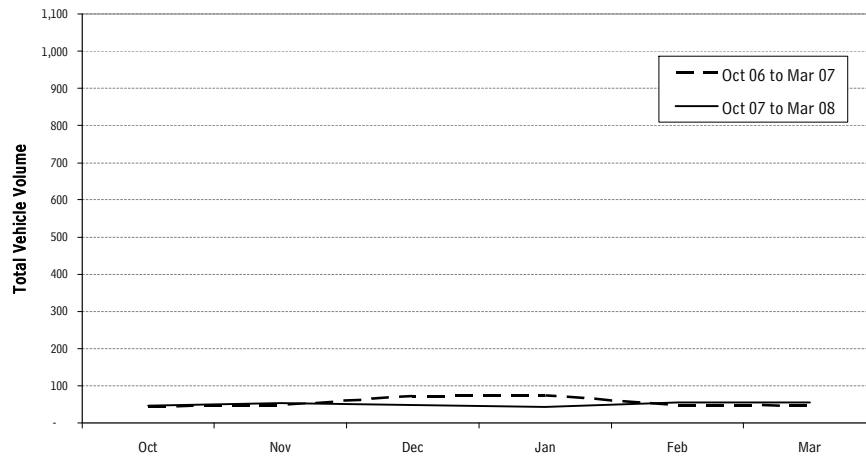
**Figure 49 Total Vehicle Volumes, Site 315 Southbound, 3 PM to 4 PM.**



**Figure 50 Total Vehicle Volumes, Site 315 Southbound, 4 PM to 5 PM.**

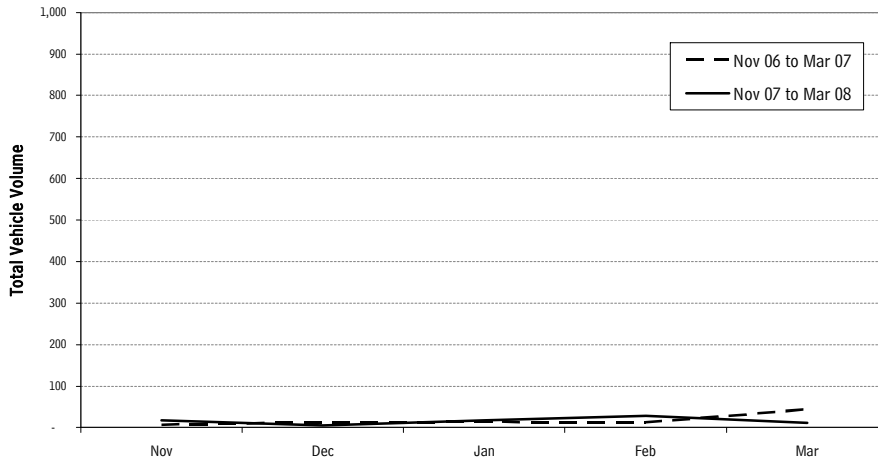


**Figure 51 Total Vehicle Volumes, Site 315 Southbound, 5 PM to 6 PM.**

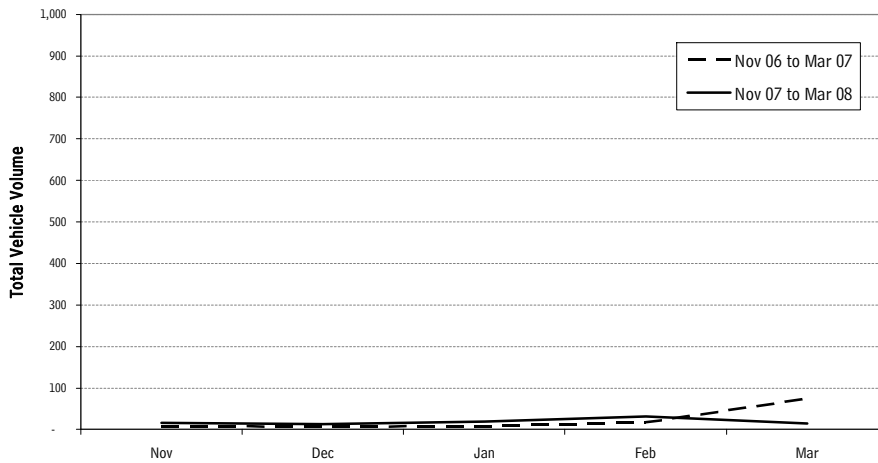


**Figure 52 Total Vehicle Volumes, Site 315 Southbound, 6 PM to 7 PM.**

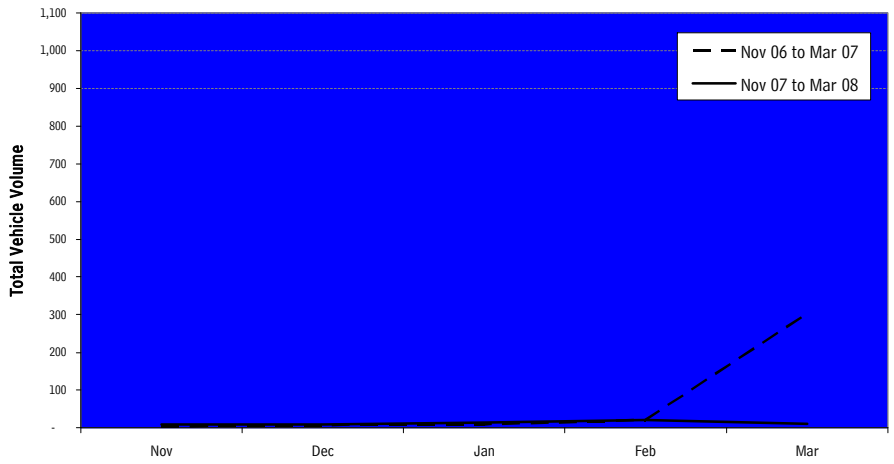
*Truck Volumes Southbound Direction, Afternoon Peak*



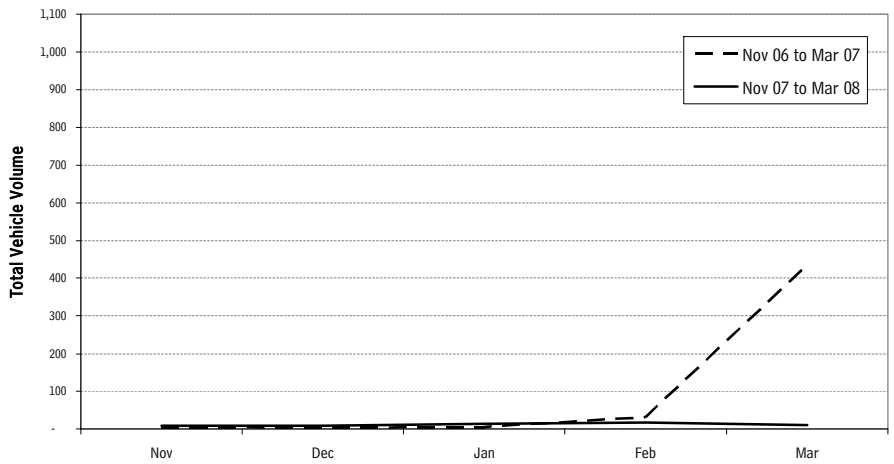
**Figure 53 Total Truck Volumes, Site 314 Southbound, 2 PM to 3 PM.**



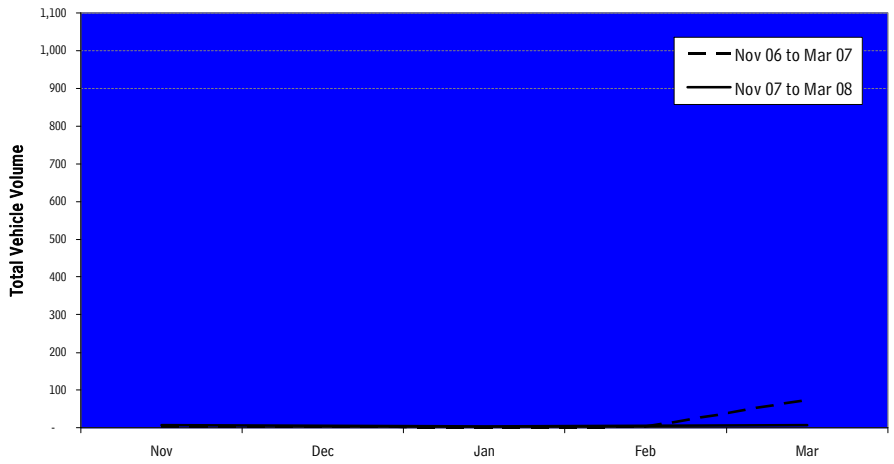
**Figure 54 Total Truck Volumes, Site 314 Southbound, 3 PM to 4 PM.**



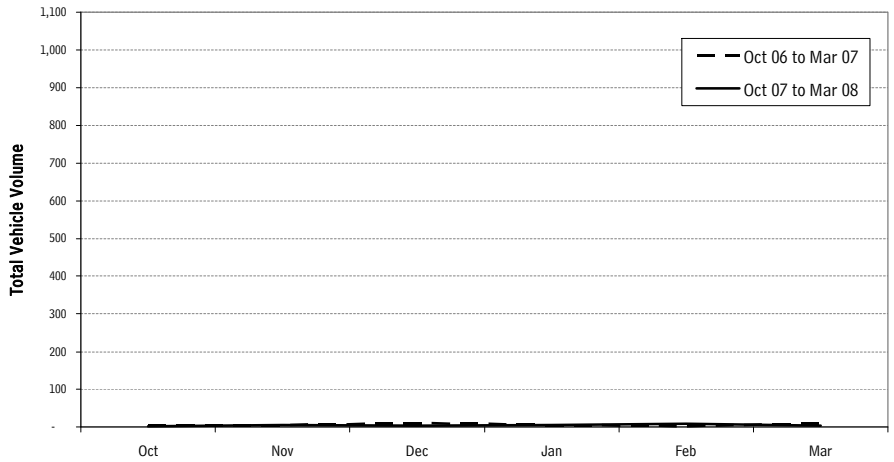
**Figure 55 Total Truck Volumes, Site 314 Southbound, 4 PM to 5 PM.**



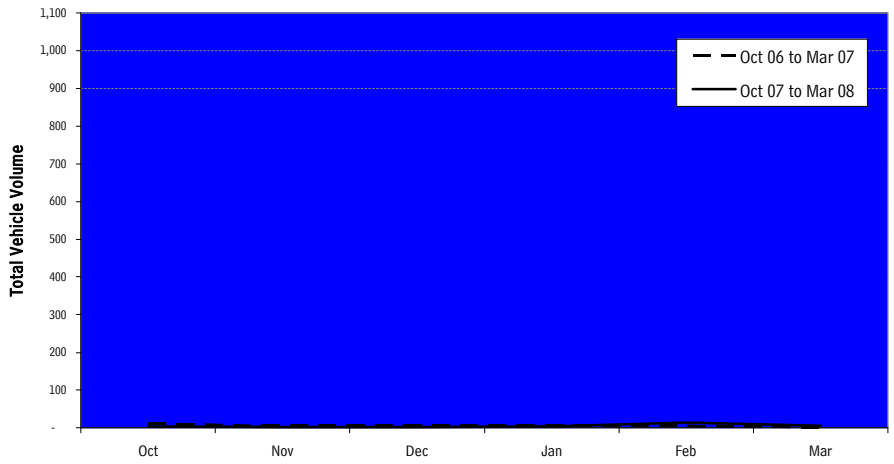
**Figure 56 Total Truck Volumes, Site 314 Southbound, 5 PM to 6 PM.**



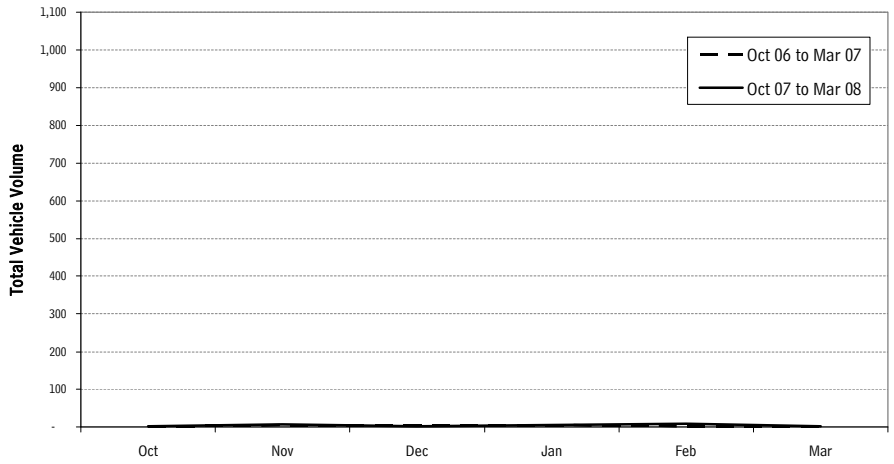
**Figure 57 Total Truck Volumes, Site 314 Southbound, 6 PM to 7 PM.**



**Figure 58 Total Truck Volumes, Site 315 Southbound, 2 PM to 3 PM.**

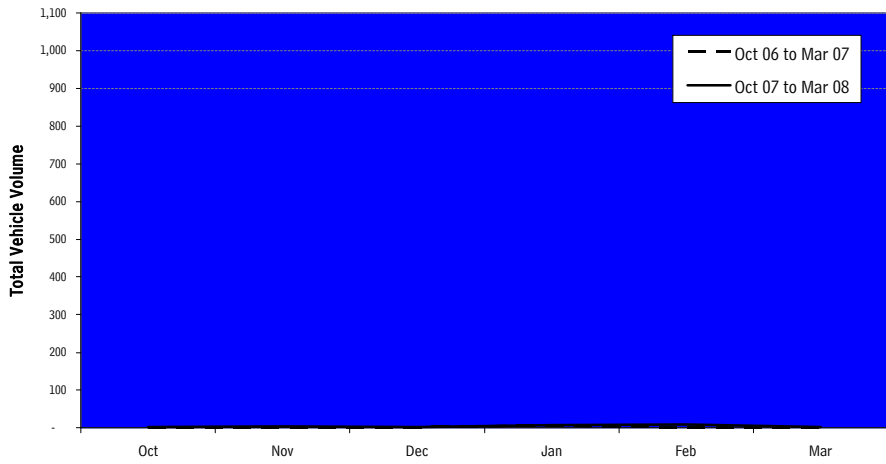


**Figure 59 Total Truck Volumes, Site 315 Southbound, 3 PM to 4 PM.**

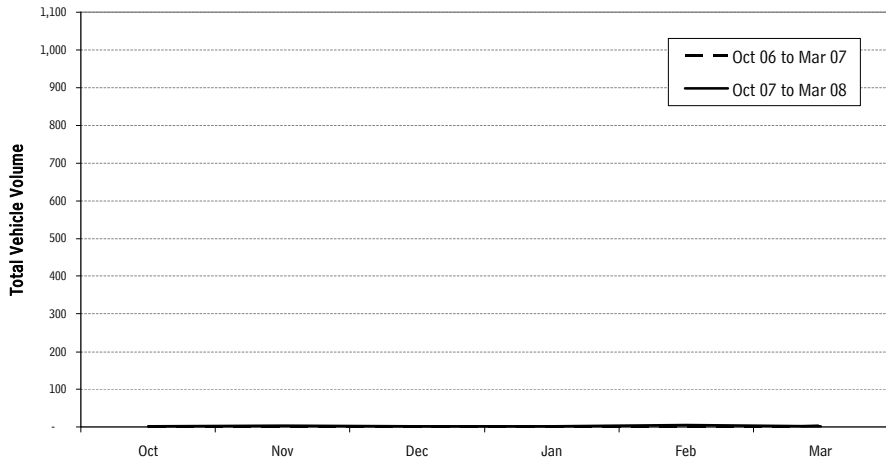


**Figure 60 Total Truck Volumes, Site 315 Southbound, 4 PM to 5 PM.**



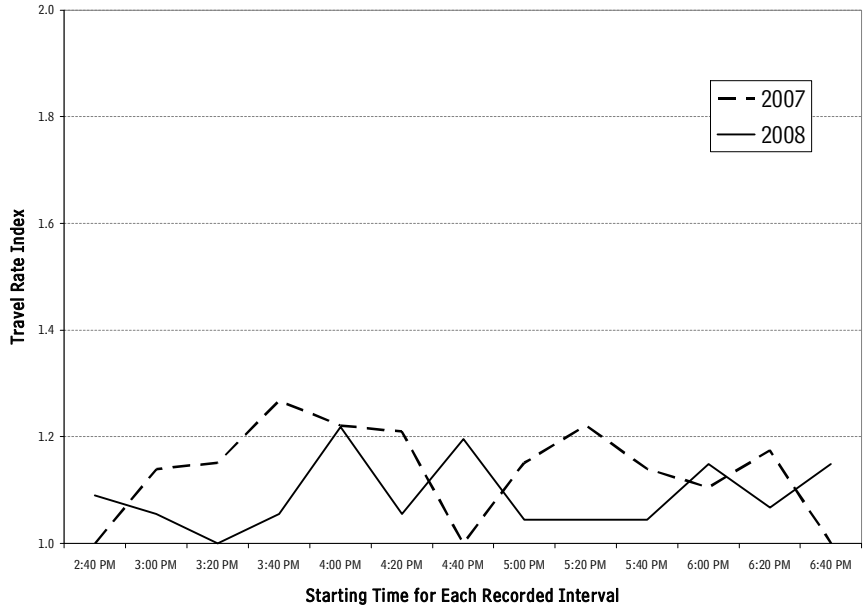


**Figure 61 Total Truck Volumes, Site 315 Southbound, 5 PM to 6 PM.**

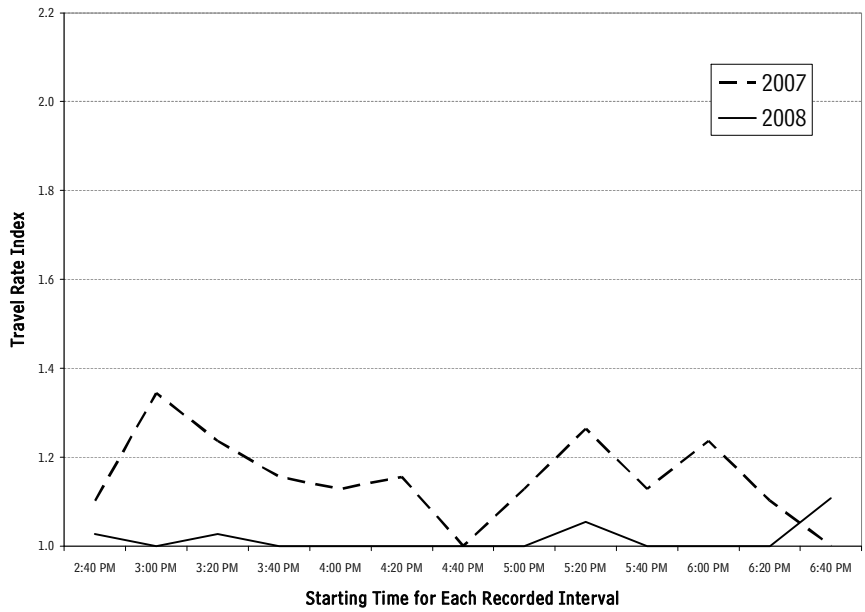


**Figure 62 Total Truck Volumes, Site 315 Southbound, 6 PM to 7 PM.**

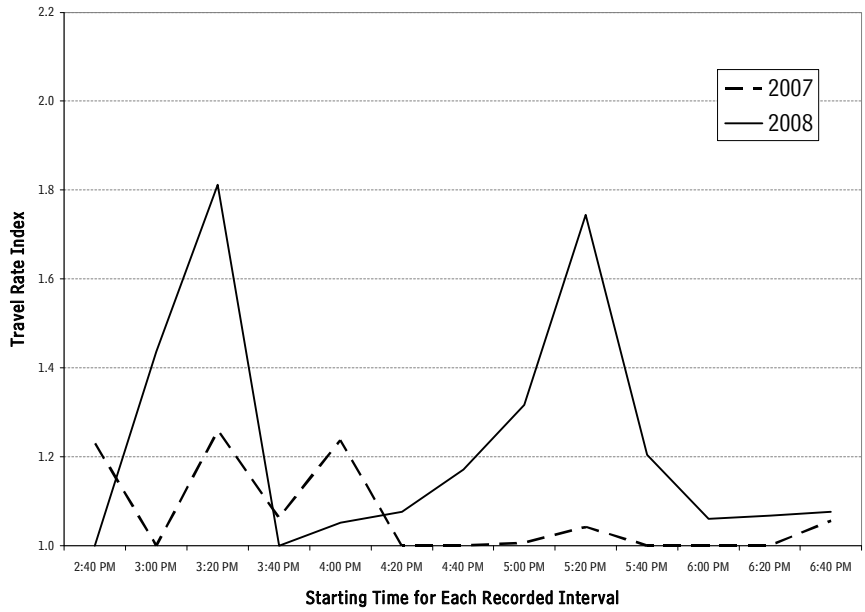
***Travel Time Runs, Afternoon Peak, Northbound Direction***



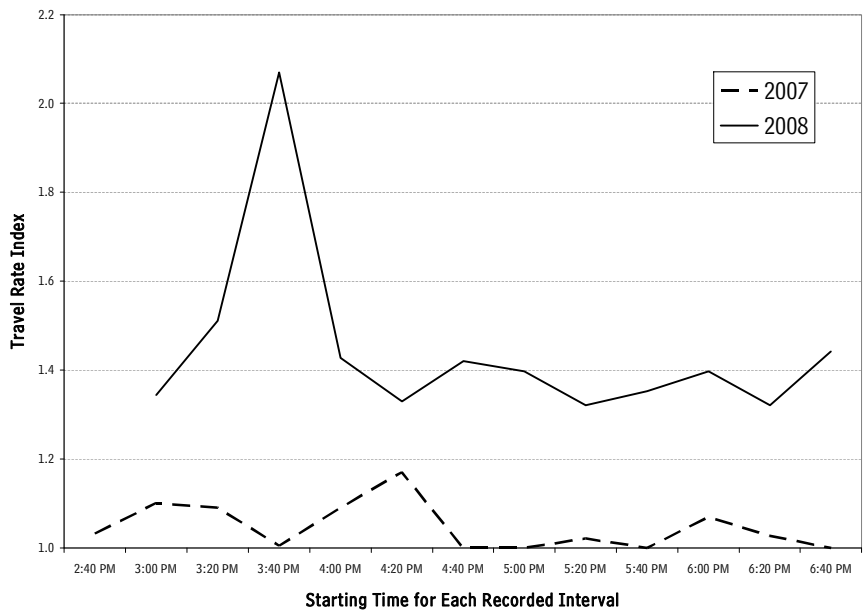
**Figure 63 Applewhite Rd (PM Peak), SL 1604 to Neal Rd, Northbound.**



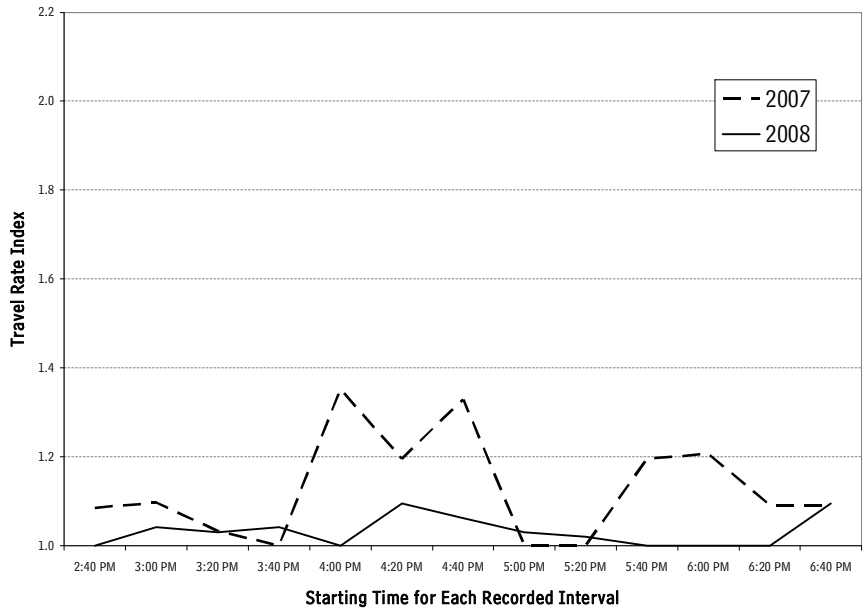
**Figure 64 Applewhite Rd (PM Peak), Neal Rd to Old Applewhite Rd, Northbound.**



**Figure 65 Applewhite Rd (PM Peak), Old Applewhite Rd to Lone Star Pass, Northbound.**

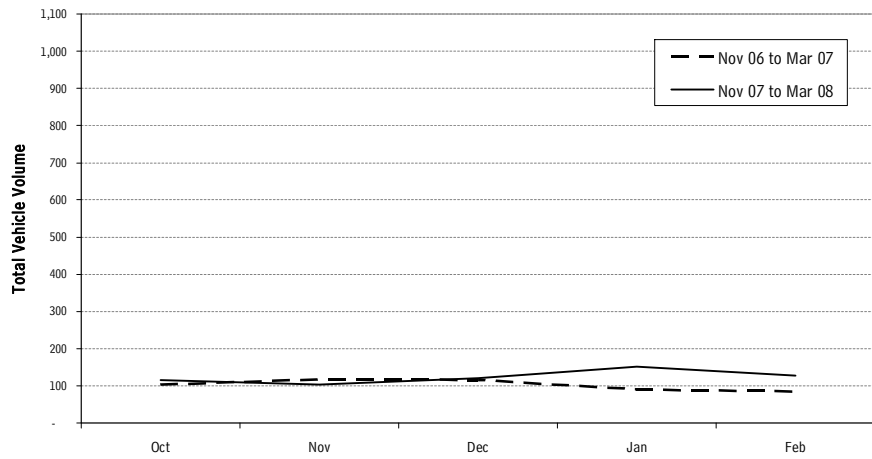


**Figure 66 Applewhite Rd (PM Peak), Lone Star Pass to Zarzamora St, Northbound.**

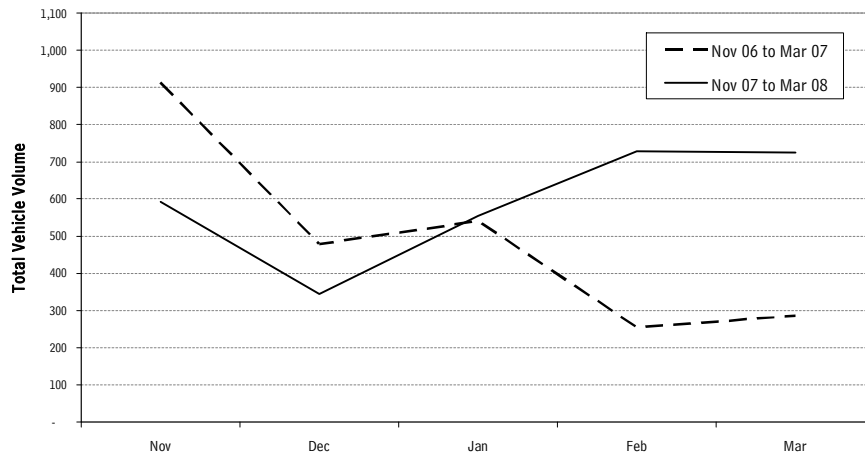


**Figure 67 Zarzamora St (PM Peak), Applewhite Rd to IH 410, Northbound.**

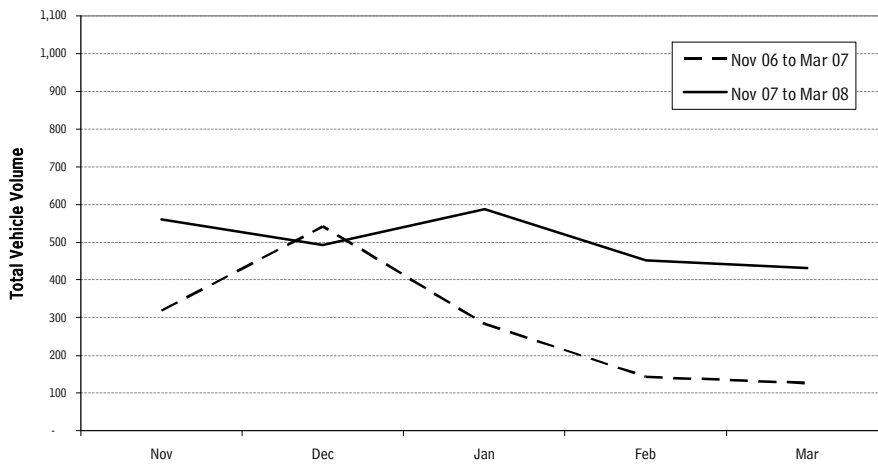
***Total Vehicle Volumes Northbound Direction, Afternoon Peak***



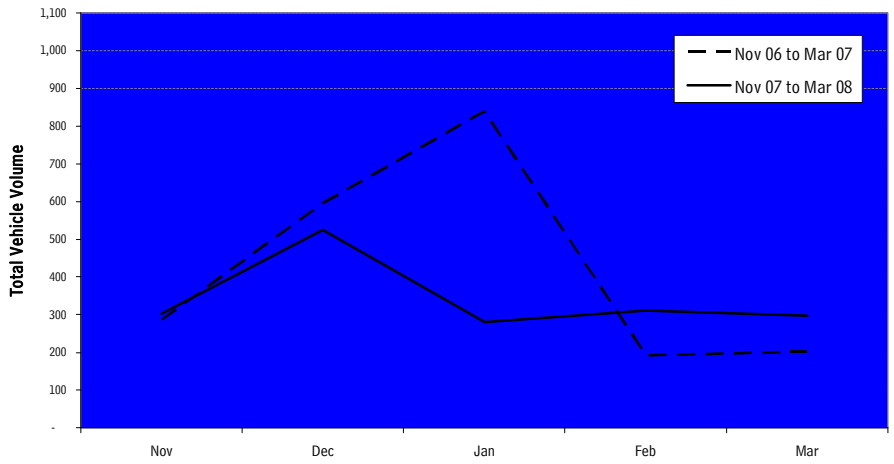
**Figure 68 Total Vehicle Volumes, Site 314 Northbound, 2 PM to 3 PM.**



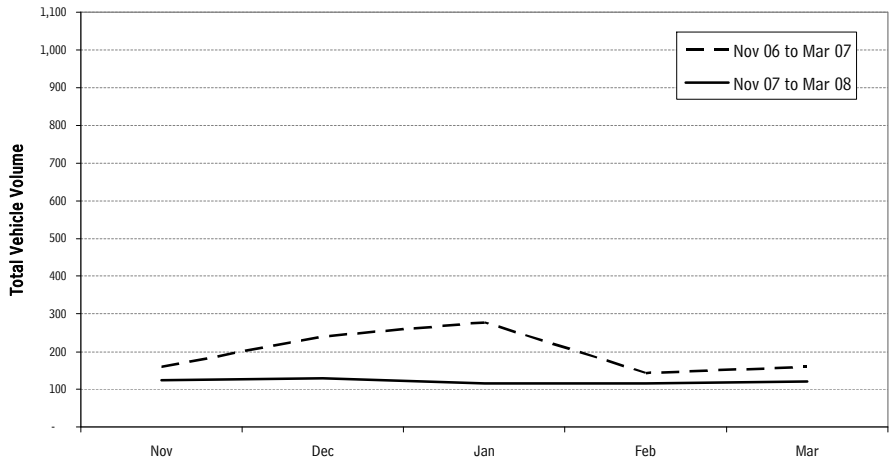
**Figure 69 Total Vehicle Volumes, Site 314 Northbound, 3 PM to 4 PM.**



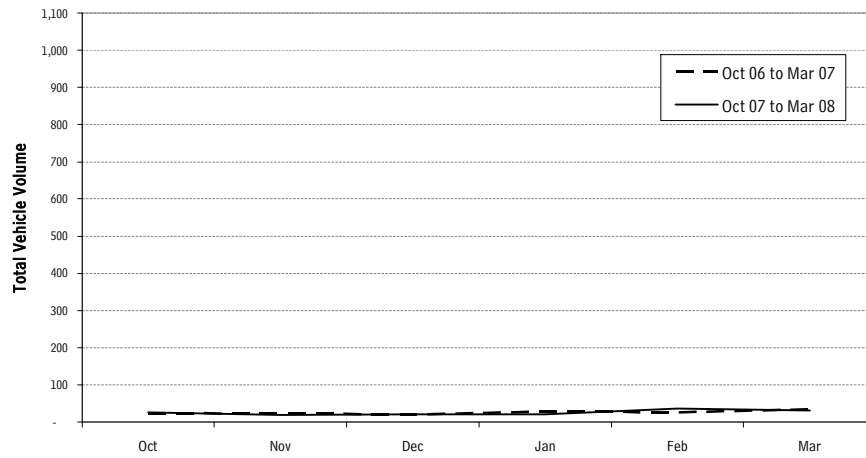
**Figure 70 Total Vehicle Volumes, Site 314 Northbound, 4 PM to 5 PM.**



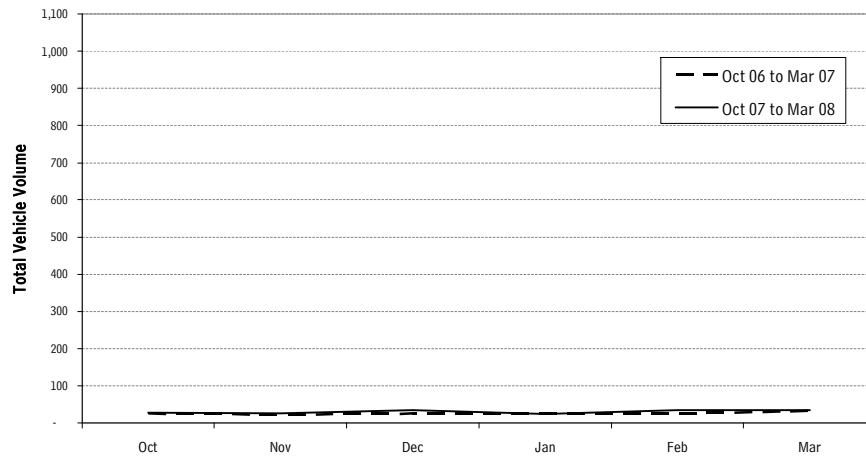
**Figure 71 Total Vehicle Volumes, Site 314 Northbound, 5 PM to 6 PM.**



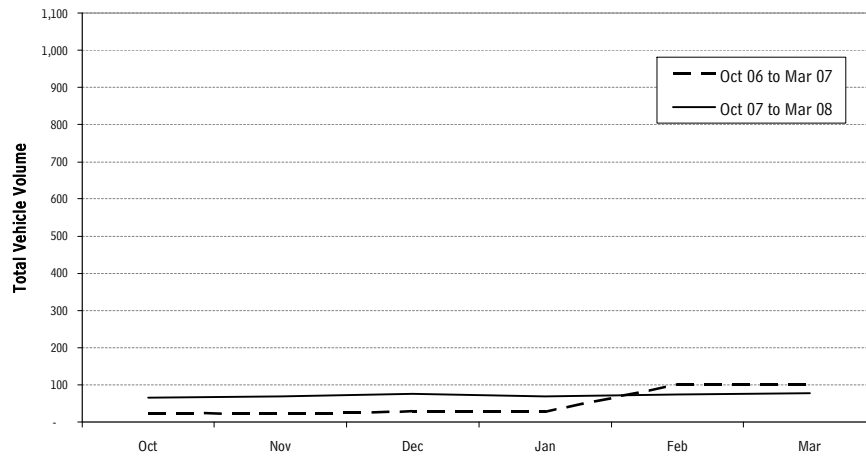
**Figure 72 Total Vehicle Volumes, Site 314 Northbound, 6 PM to 7 PM.**



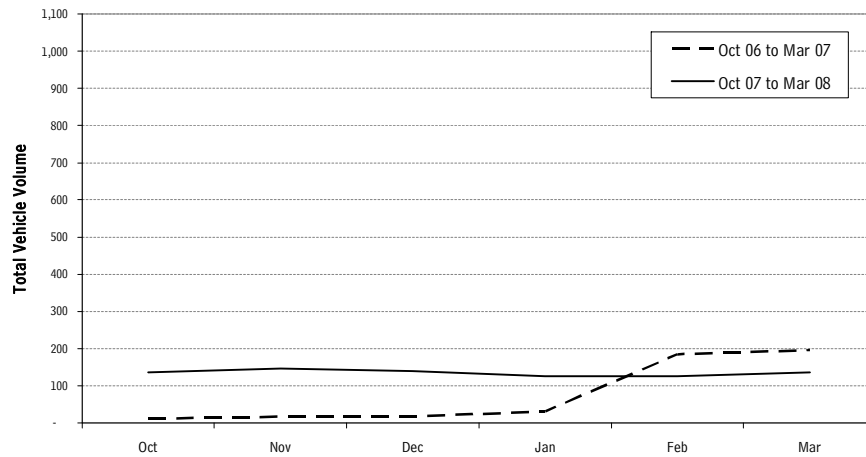
**Figure 73 Total Vehicle Volumes, Site 315 Northbound, 2 PM to 3 PM.**



**Figure 74 Total Vehicle Volumes, Site 315 Northbound, 3 PM to 4 PM.**

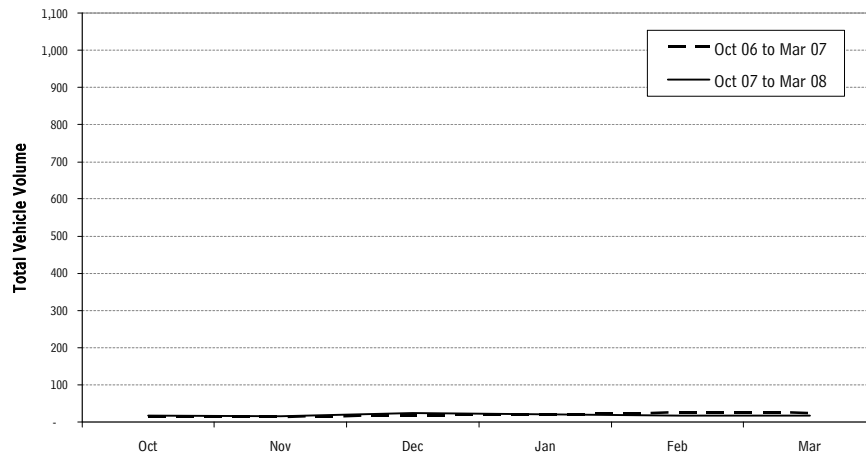


**Figure 75 Total Vehicle Volumes, Site 315 Northbound, 4 PM to 5 PM.**



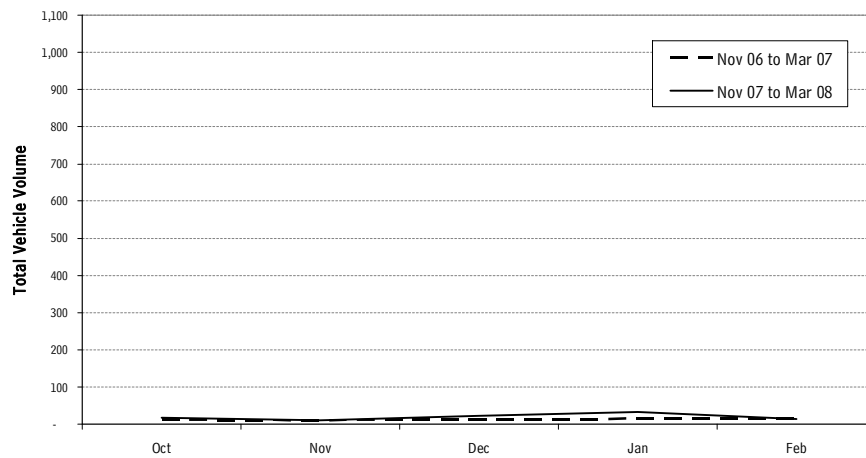
**Figure 76 Total Vehicle Volumes, Site 315 Northbound, 5 PM to 6 PM.**



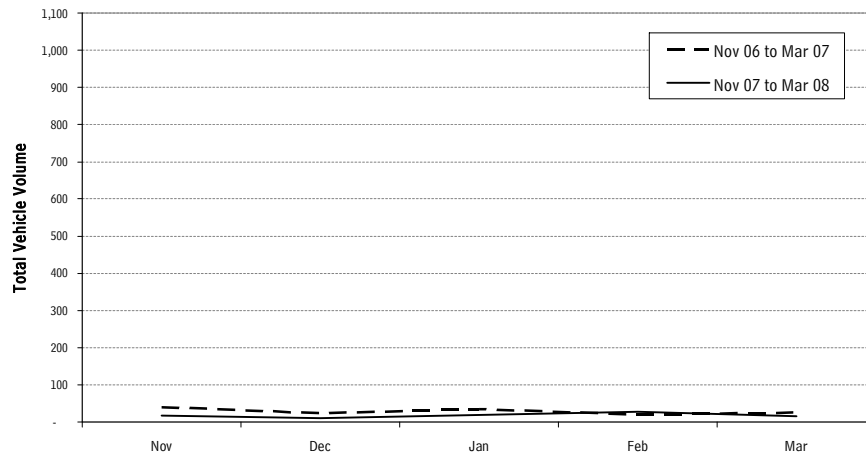


**Figure 77 Total Vehicle Volumes, Site 315 Northbound, 6 PM to 7 PM.**

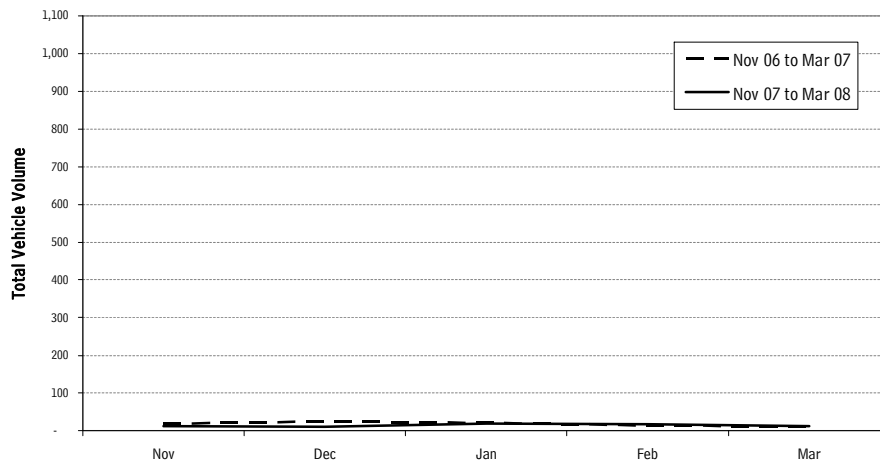
***Truck Volumes Northbound Direction, Afternoon Peak***



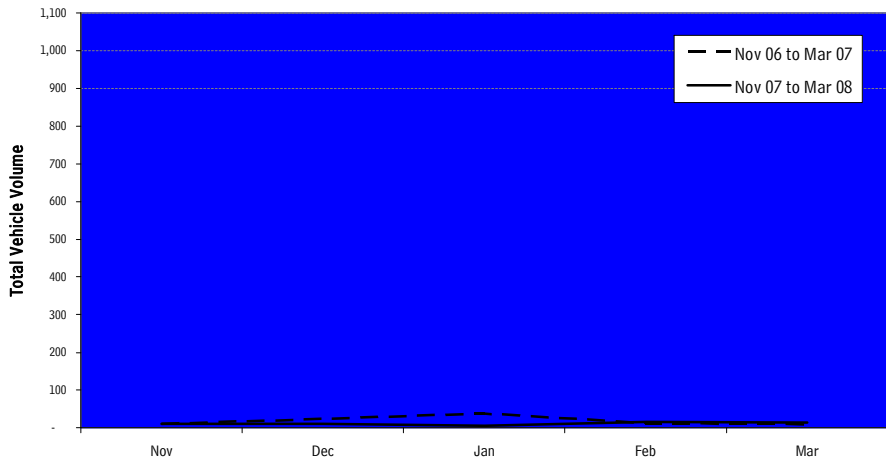
**Figure 78 Total Truck Volumes, Site 314 Northbound, 2 PM to 3 PM.**



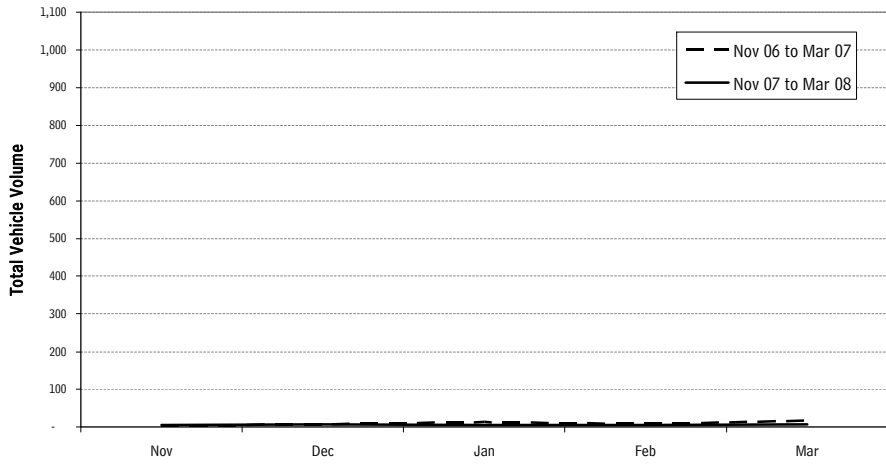
**Figure 79 Total Truck Volumes, Site 314 Northbound, 3 PM to 4 PM.**



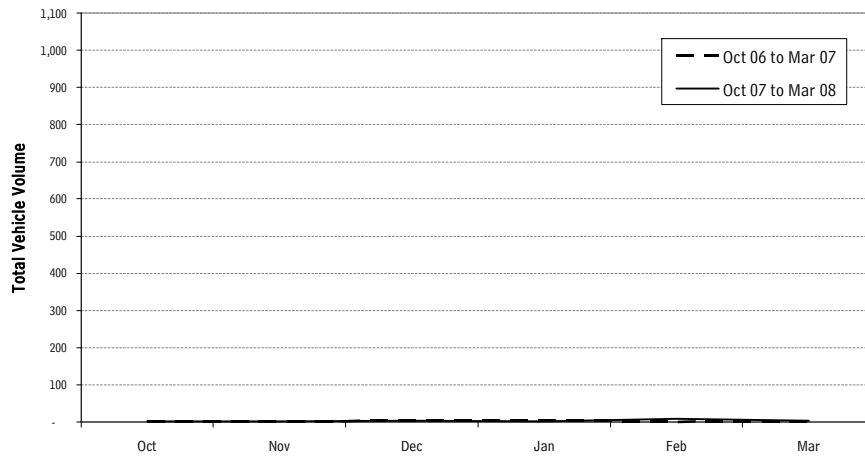
**Figure 80 Total Truck Volumes, Site 314 Northbound, 4 PM to 5 PM.**



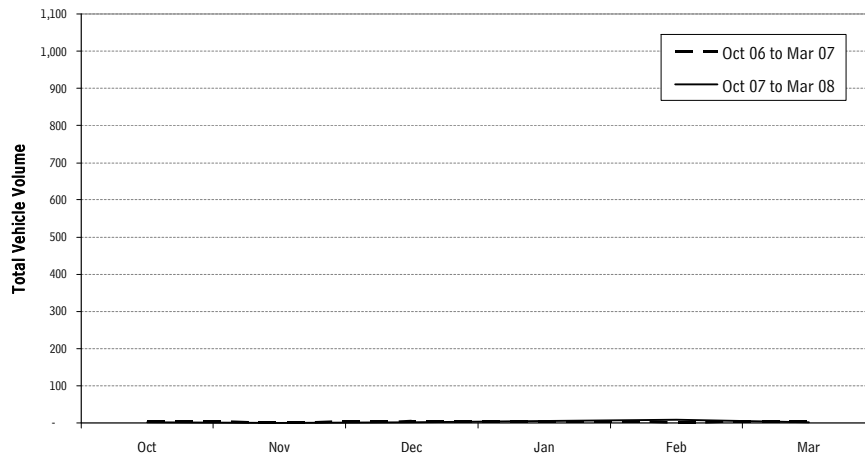
**Figure 81 Total Truck Volumes, Site 314 Northbound, 5 PM to 6 PM.**



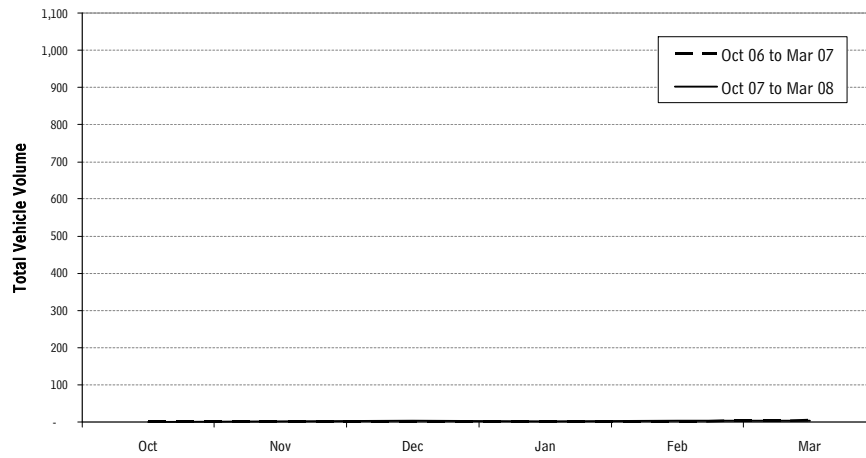
**Figure 82 Total Truck Volumes, Site 314 Northbound, 6 PM to 7 PM.**



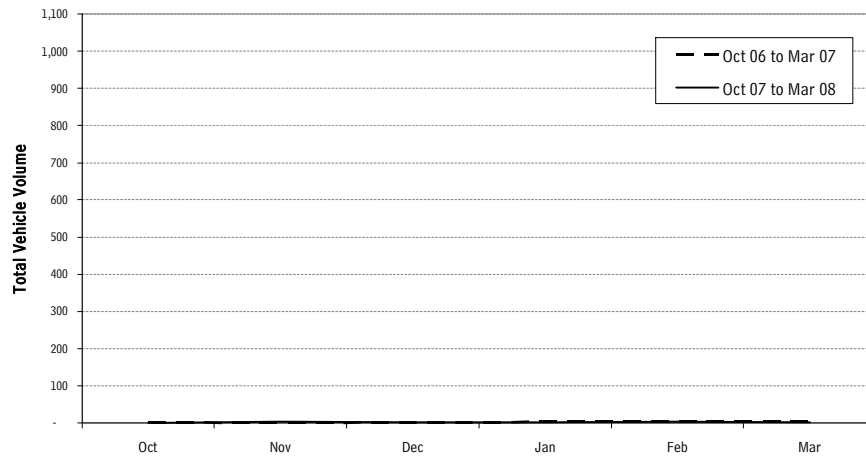
**Figure 83 Total Truck Volumes, Site 315 Northbound, 2 PM to 3 PM.**



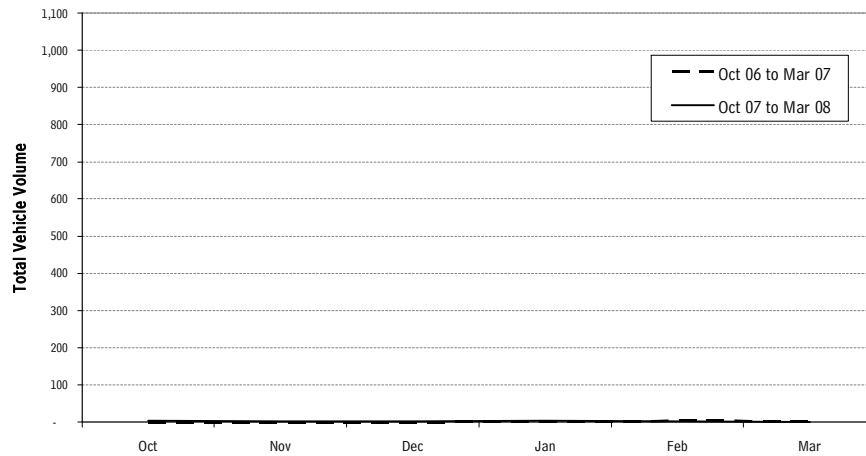
**Figure 84 Total Truck Volumes, Site 315 Northbound, 3 PM to 4 PM.**



**Figure 85 Total Truck Volumes, Site 315 Northbound, 4 PM to 5 PM.**



**Figure 86 Total Truck Volumes, Site 315 Northbound, 5 PM to 6 PM.**



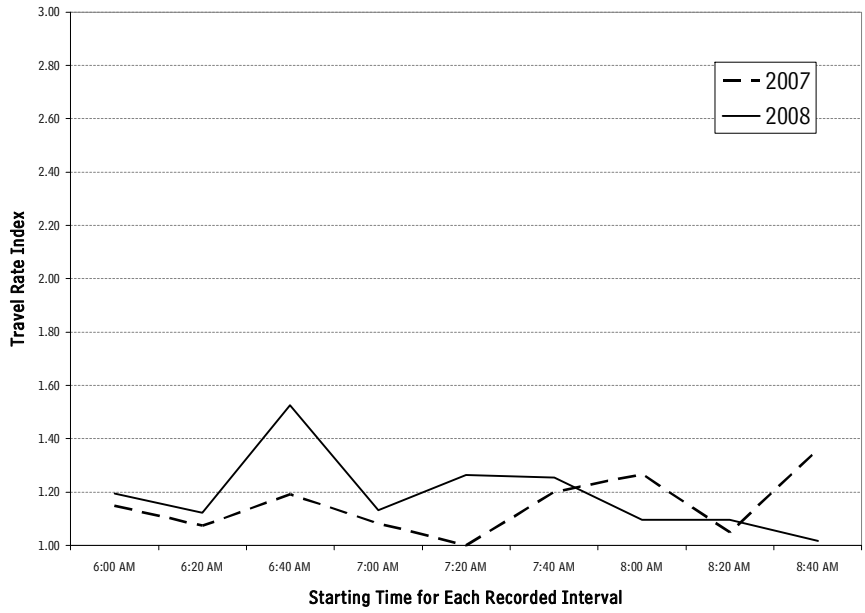
**Figure 87 Total Truck Volumes, Site 315 Northbound, 6 PM to 7 PM.**

**Corridor 2: Fisher Rd/Watson Rd/Lone Star Pass from IH 35 to Applewhite Rd**

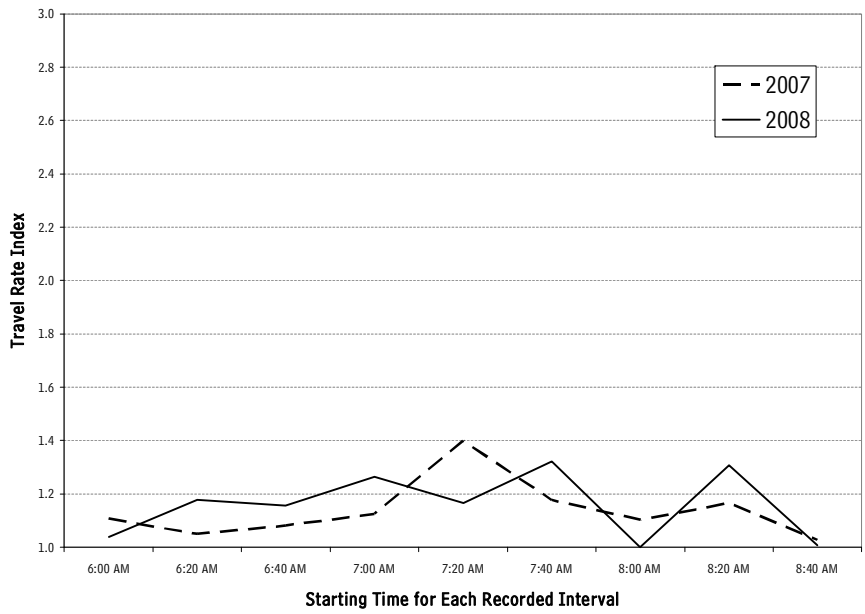
Corridor 2 is defined in linked segments as follows:

- (A) Fisher Rd from IH 35 to FM 2790
- (B) Watson Rd from FM 2790 to SH 16
- (C) Lone Star Pass from SH 16 to Applewhite Rd (Lone Star Pass leads into the middle gate of the Toyota plant)

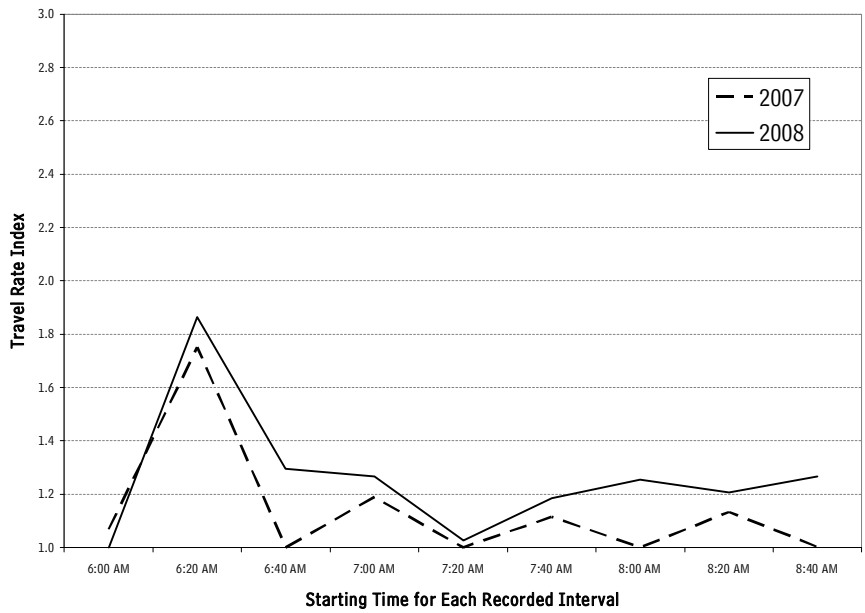
*Travel Time Runs, Morning Peak, Eastbound Direction*



**Figure 88 Fisher Rd (AM Peak), I 35 to FM 2790, Eastbound.**



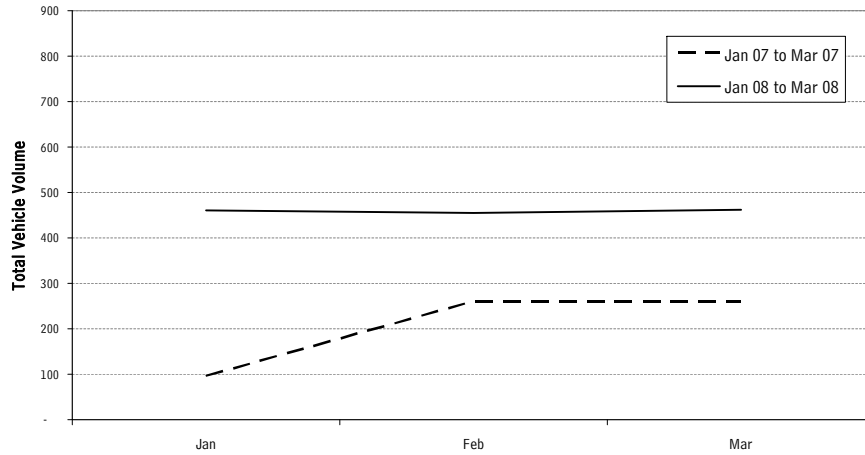
**Figure 89 Watson Rd (AM Peak), FM 2790 to SH 16, Eastbound.**



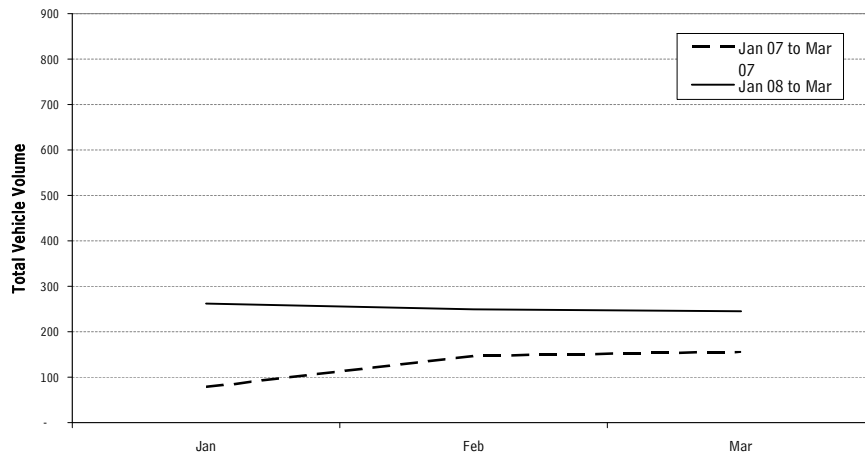
**Figure 90 Lone Star Pass (AM Peak), SH 16 to Applewhite Rd, Eastbound.**



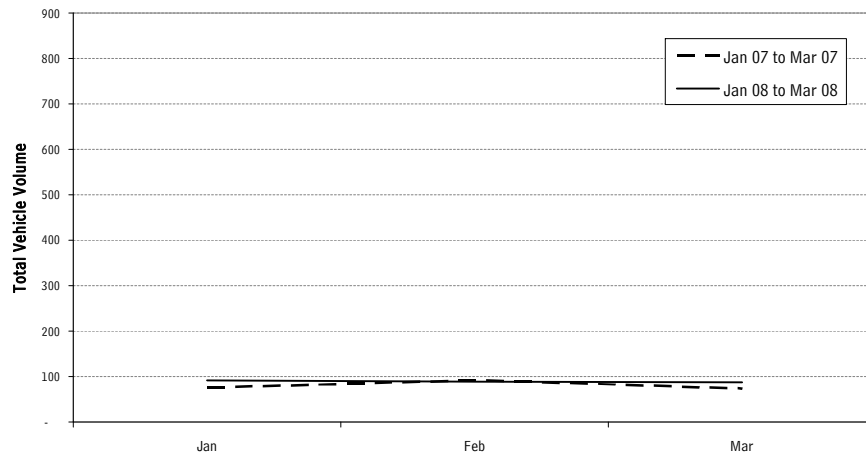
***Total Vehicle Volumes Eastbound Direction, Morning Peak***



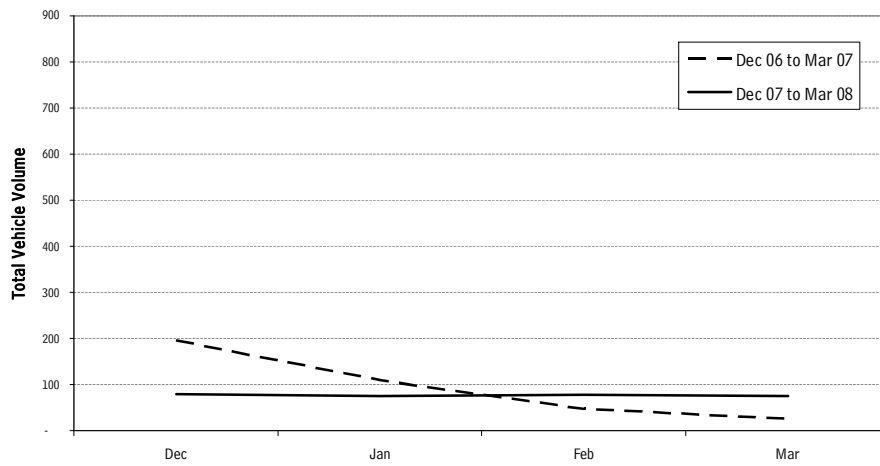
**Figure 91 Total Vehicle Volumes, Site 308 Eastbound, 6 AM to 7 AM.**



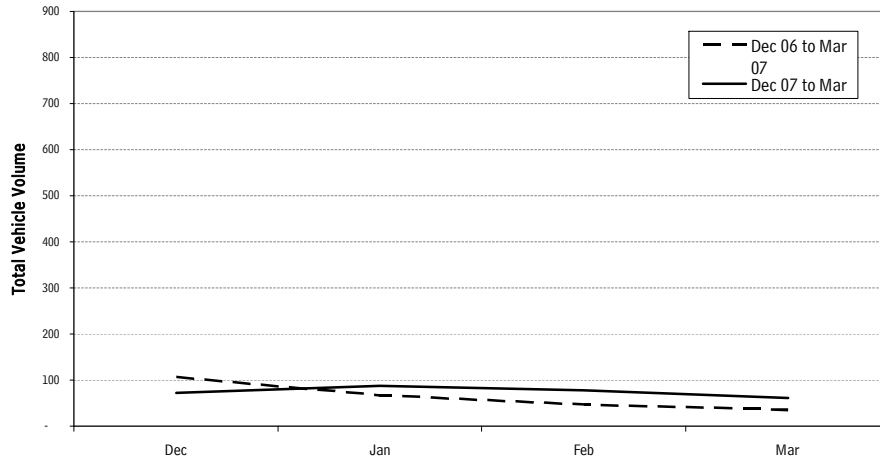
**Figure 92 Total Vehicle Volumes, Site 308 Eastbound, 7 AM to 8 AM.**



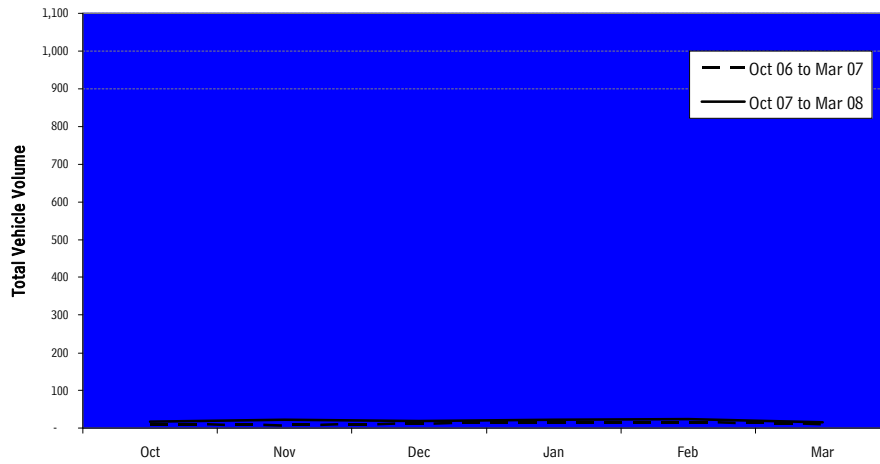
**Figure 93 Total Vehicle Volumes, Site 308 Eastbound, 8 AM to 9 AM.**



**Figure 94 Total Vehicle Volumes, Site 307 Eastbound, 6 AM to 7 AM.**

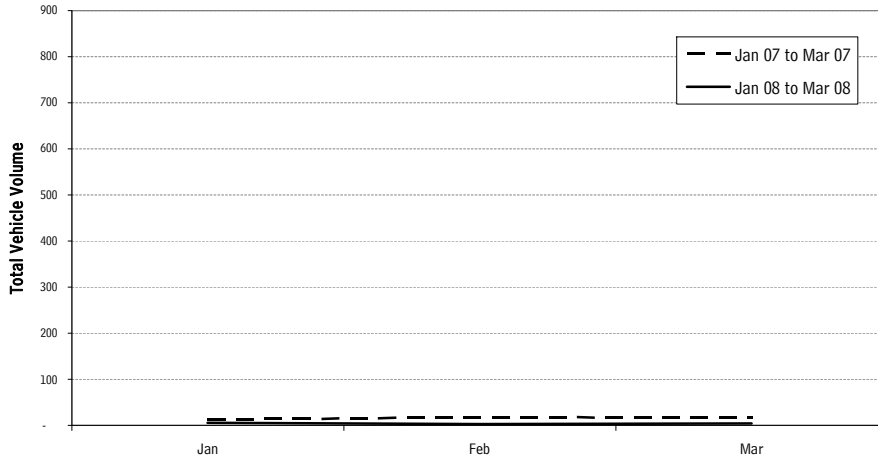


**Figure 95 Total Vehicle Volumes, Site 307 Eastbound, 7 AM to 8 AM.**

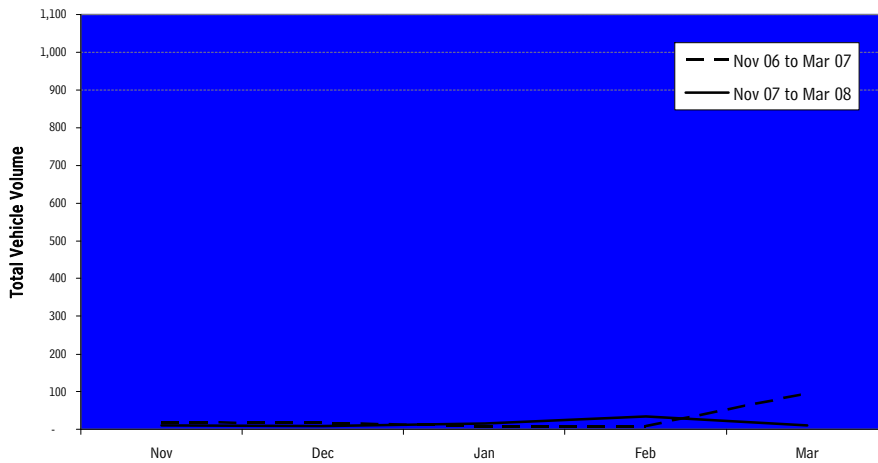


**Figure 96 Total Vehicle Volumes, Site 308 Eastbound, 8 AM to 9 AM.**

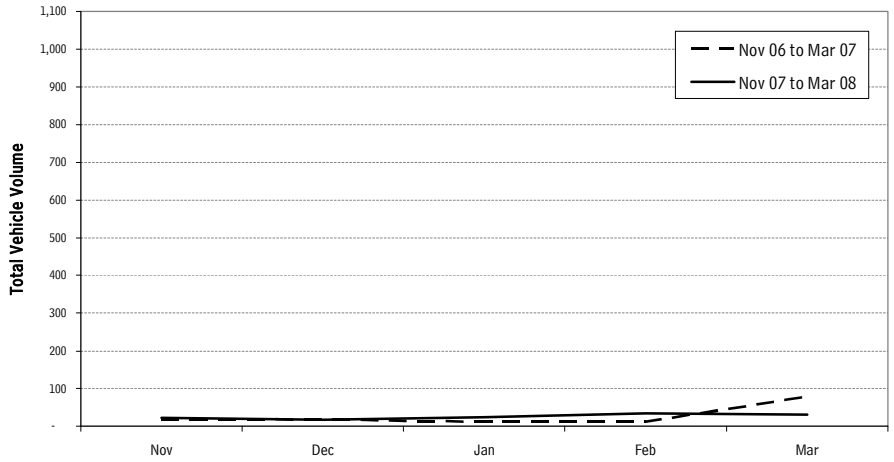
***Truck Volumes Eastbound Direction, Morning Peak***



**Figure 97 Total Truck Volumes, Site 308 Eastbound, 6 AM to 7 AM.**

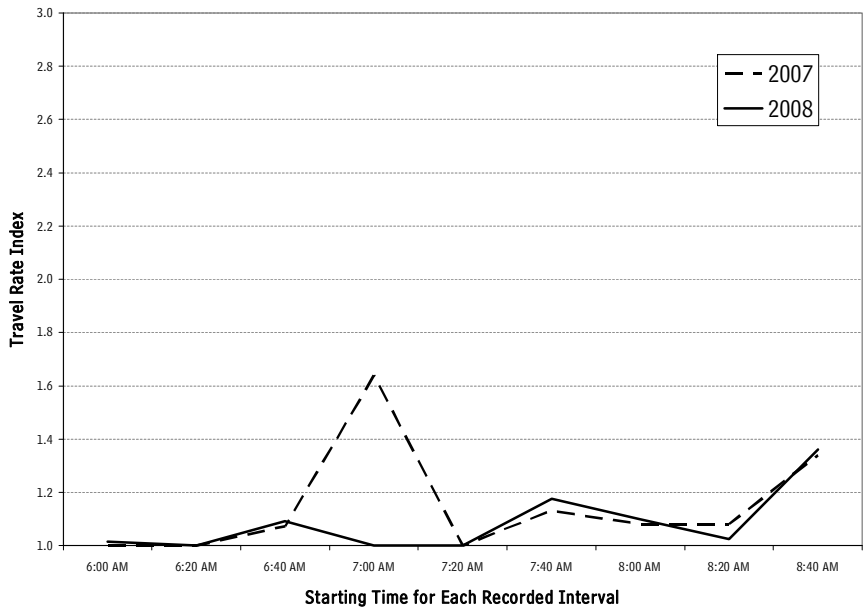


**Figure 98 Total Truck Volumes, Site 314 Southbound, 7 AM to 8 AM.**

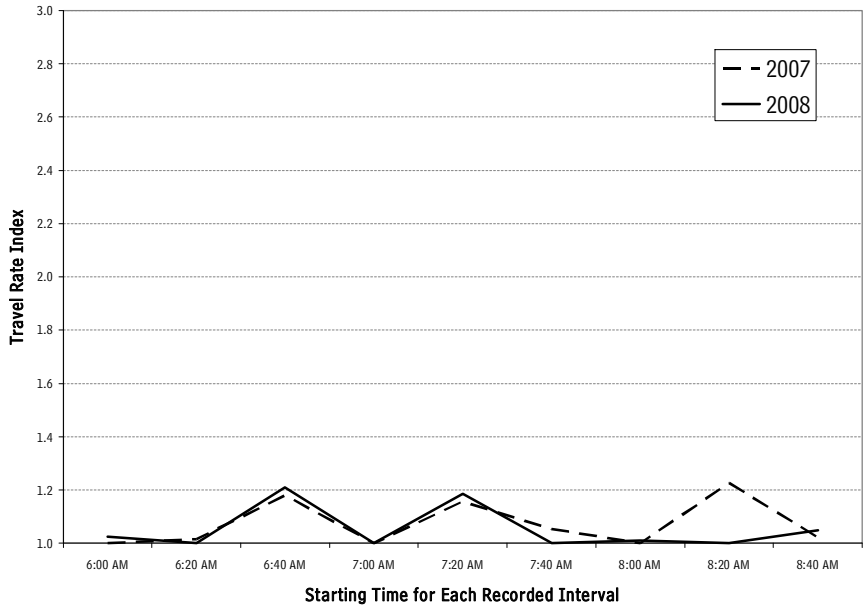


**Figure 99 Total Truck Volumes, Site 314 Southbound, 8 AM to 9 AM.**

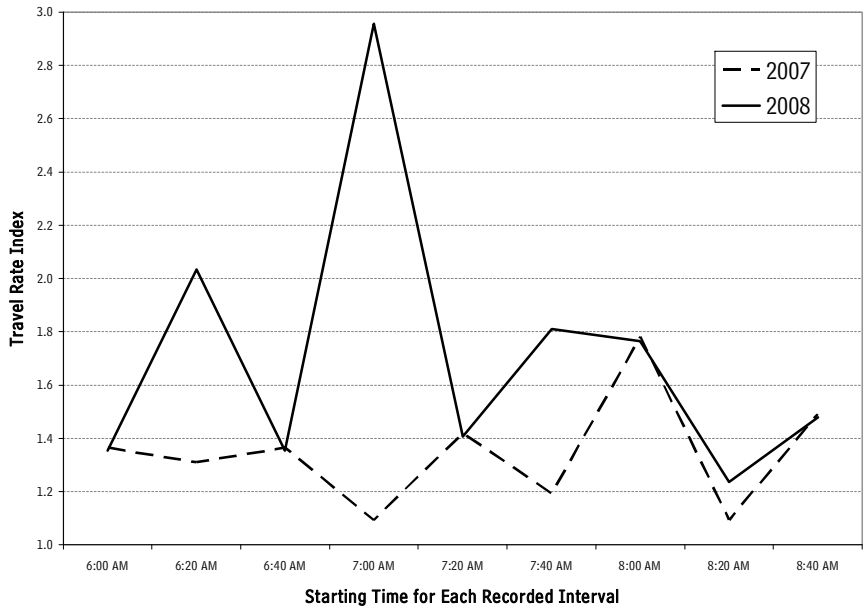
***Travel Time Runs, Morning Peak, Westbound Direction***



**Figure 100 Fisher/Watson/Lone Star Pass (AM Peak), SH 16 to Applewhite Rd, Westbound.**

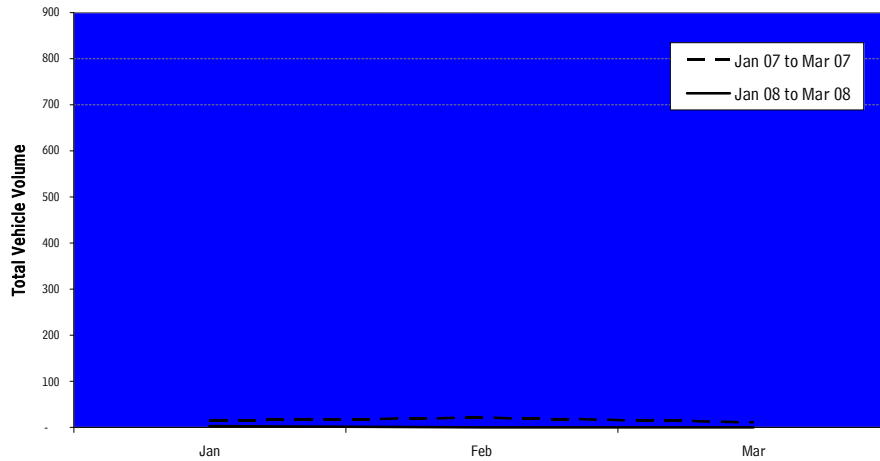


**Figure 101 Fisher/Watson/Lone Star Pass (AM Peak), SH 16 to FM 2790, Westbound.**

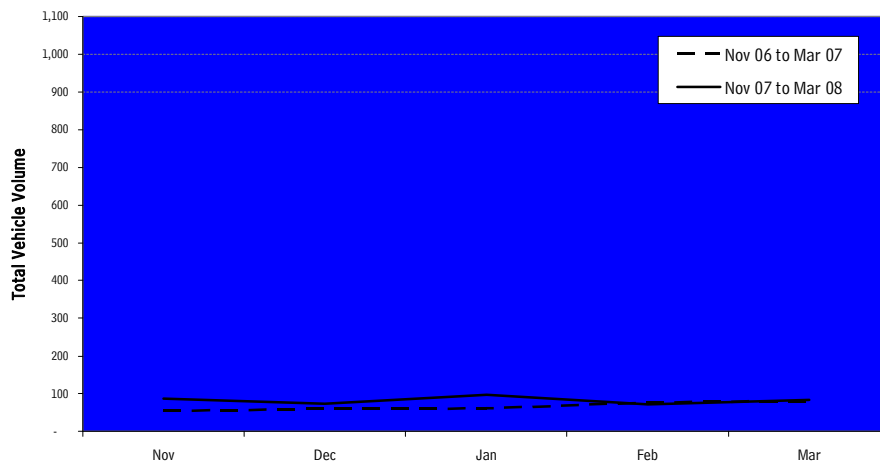


**Figure 102 Fisher/Watson/Lone Star Pass (AM Peak), FM 2790 to I 35, Westbound.**

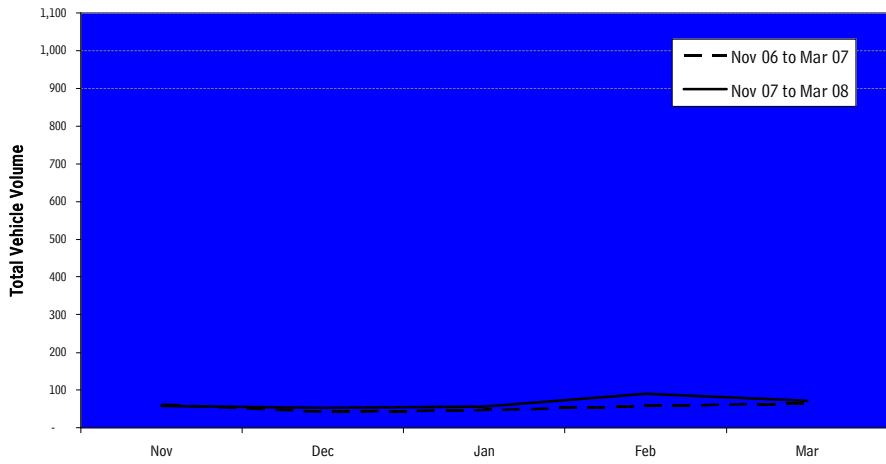
***Total Vehicle Volumes Westbound Direction, Morning Peak***



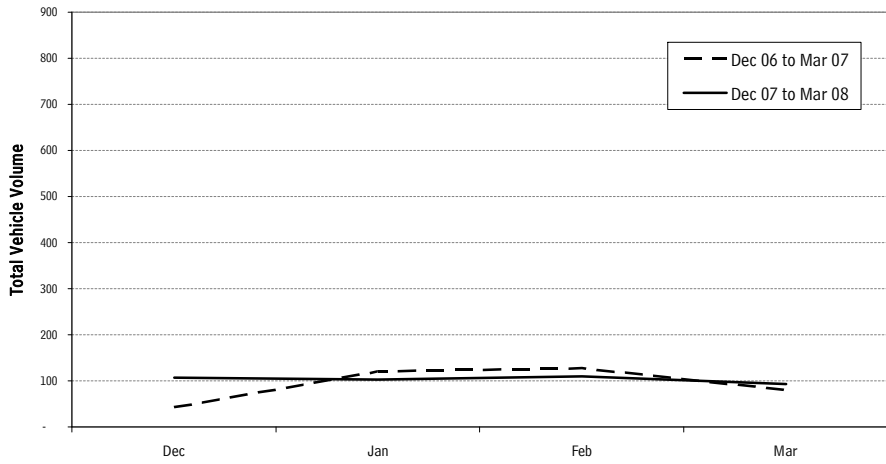
**Figure 103. Total Vehicle Volumes, Site 308 Westbound, 6 AM to 7 AM.**



**Figure 104 Total Vehicle Volumes, Site 314 Northbound, 7 AM to 8 AM.**

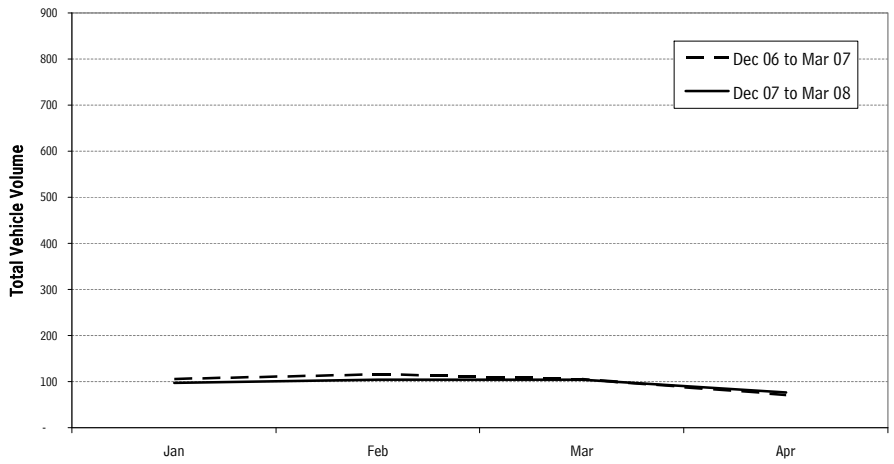


**Figure 105 Total Vehicle Volumes, Site 314 Northbound, 8 AM to 9 AM.**

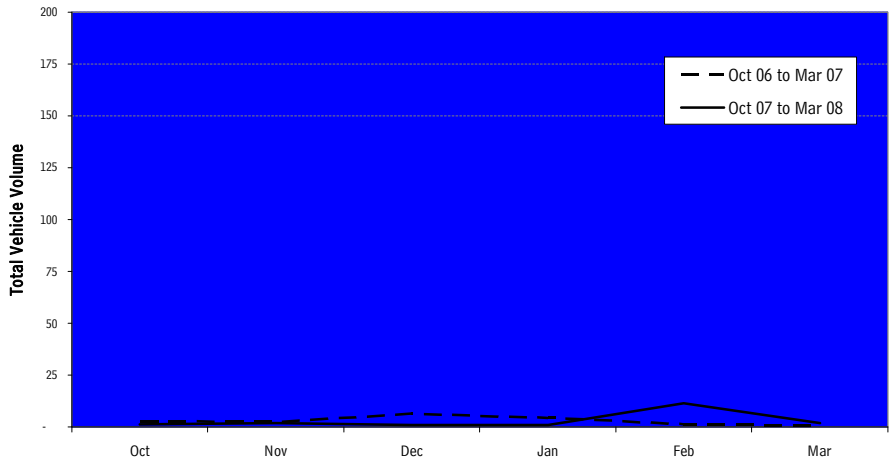


**Figure 106. Total Vehicle Volumes, Site 307 Westbound, 6 AM to 7 AM.**



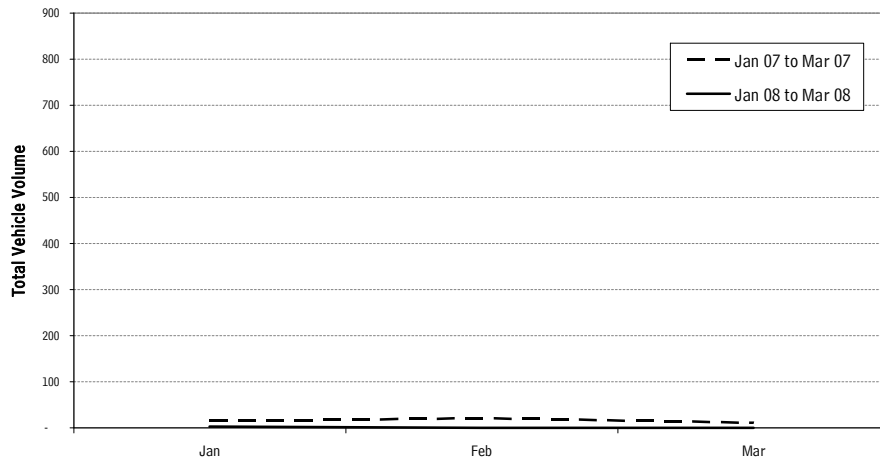


**Figure 107 Total Vehicle Volumes, Site 307 Westbound, 7 AM to 8 AM.**

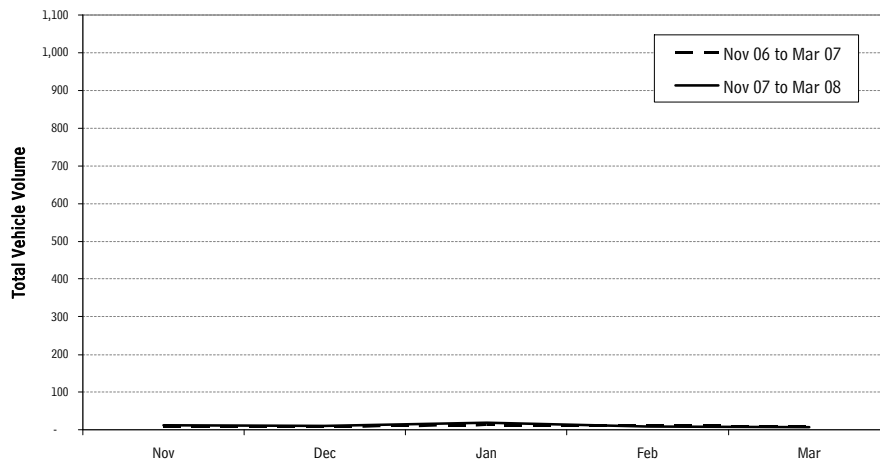


**Figure 108 Total Vehicle Volumes, Site 315 Northbound, 8 AM to 9 AM.**

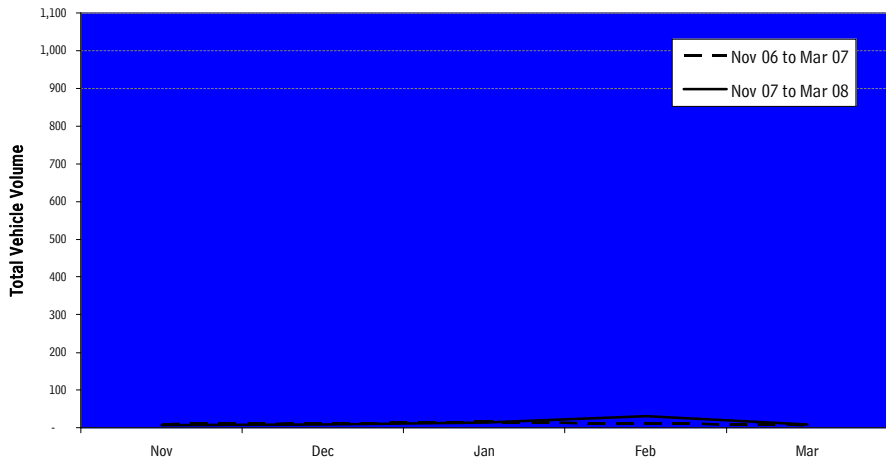
***Truck Volumes Westbound Direction, Morning Peak***



**Figure 109 Total Truck Volumes, Site 308 Westbound, 6 AM to 7 AM.**



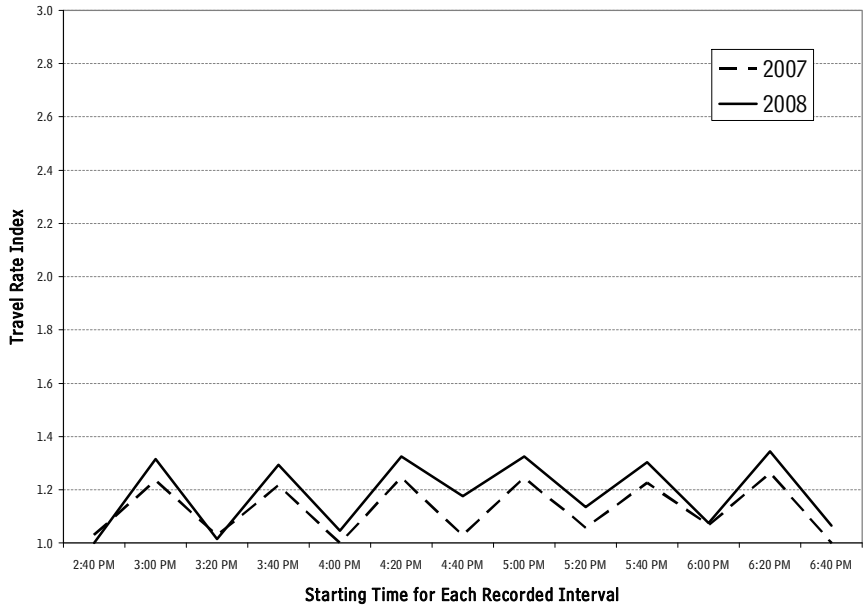
**Figure 110 Total Truck Volumes, Site 314 Northbound, 7 AM to 8 AM.**



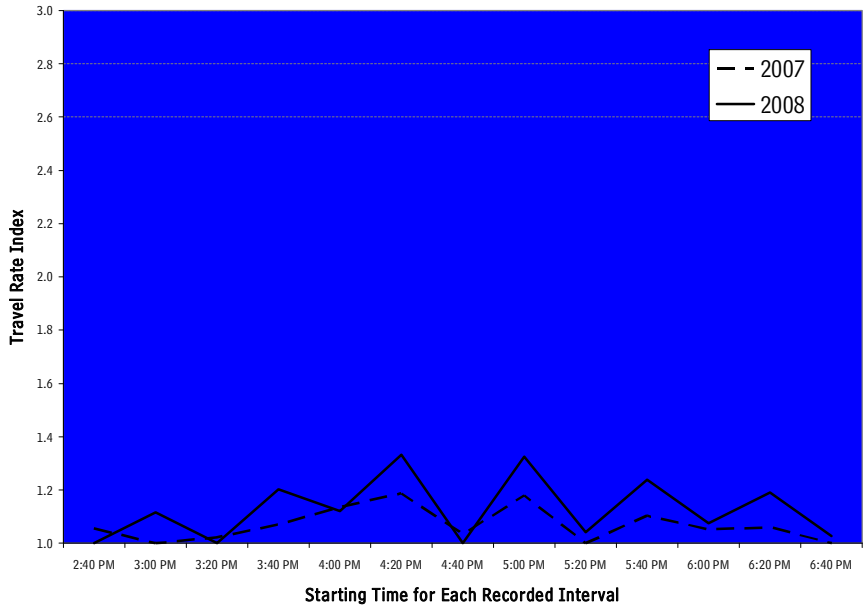
**Figure 111 Total Truck Volumes, Site 314 Northbound, 8 AM to 9 AM.**

*Travel Time Runs, Afternoon Peak, Eastbound Direction*

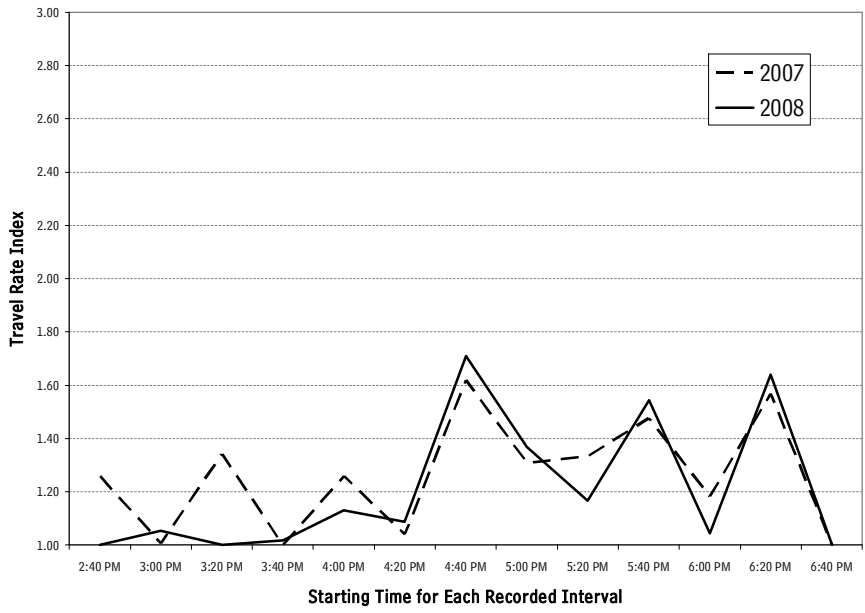
Figure 112 displays the indices observed for the afternoon peak in the southbound direction for segment A listed above. The solid line (2008) is above the dashed line (2007) in most time intervals observed. The graph of the solid line (2008) is visually higher indicating that it took longer to travel this corridor in the afternoon during May 2008 than in May 2007.



**Figure 112 Fisher Rd (PM Peak), I 35 to FM 2790, Eastbound.**

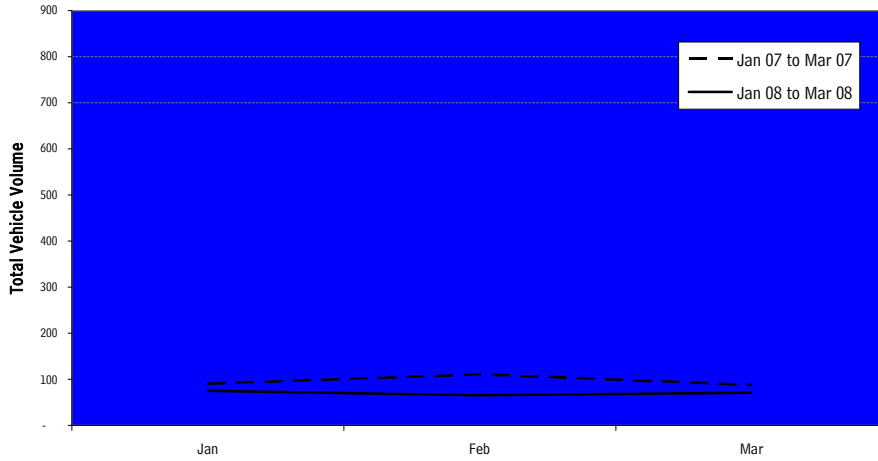


**Figure 113 Watson Rd (PM Peak), FM 2790 to SH 16, Eastbound.**

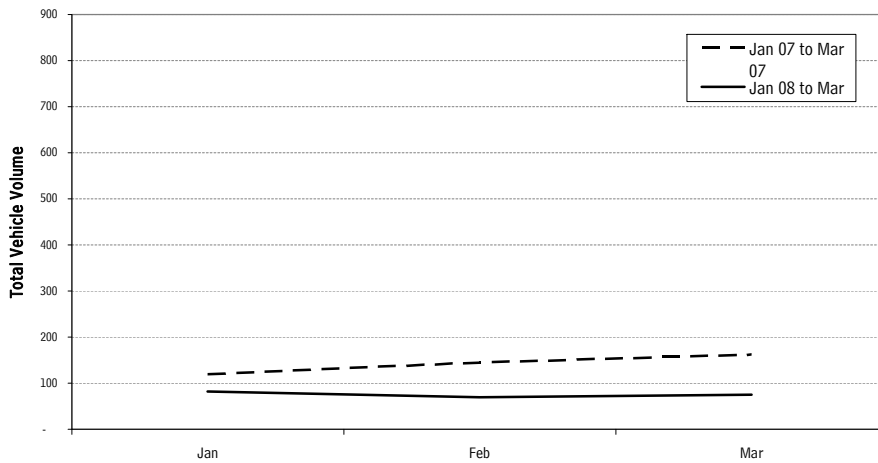


**Figure 114 Lone Star Pass (PM Peak), SH 16 to Applewhite Rd, Eastbound.**

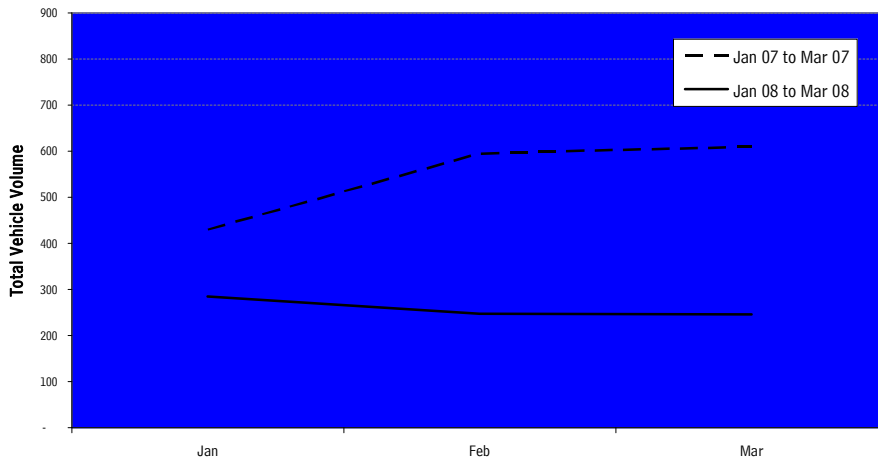
***Total Vehicle Volumes Eastbound Direction, Afternoon Peak***



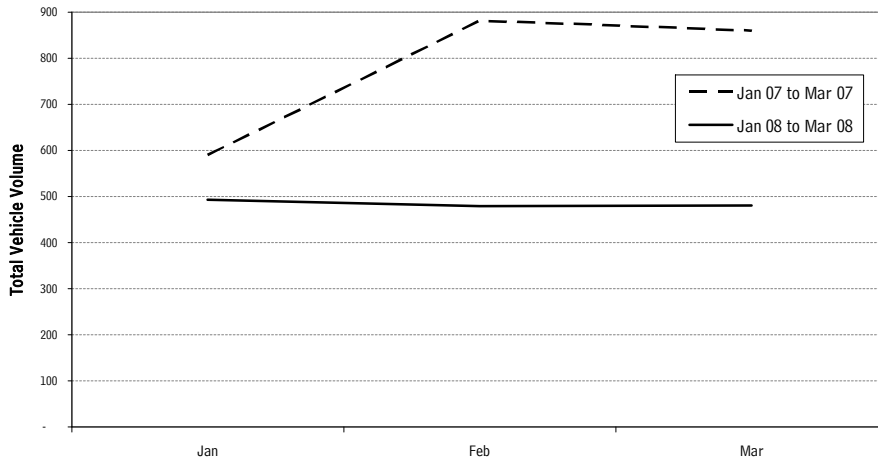
**Figure 115 Total Vehicle Volumes, Site 308 Eastbound, 2 PM to 3 PM.**



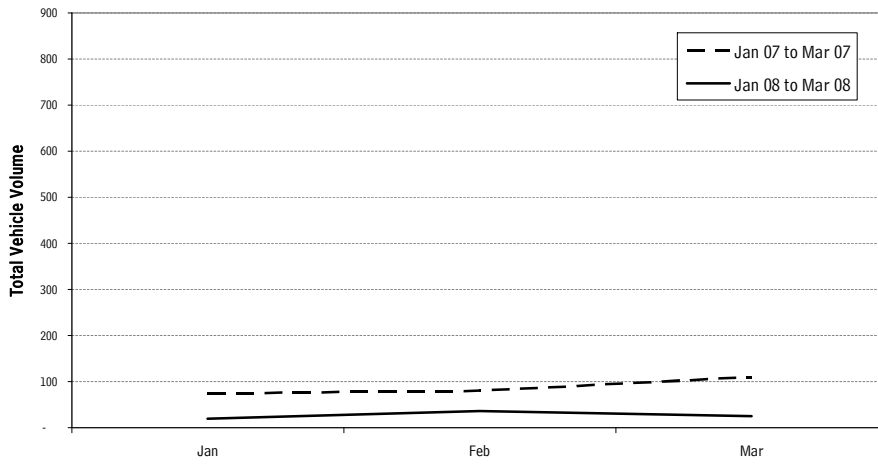
**Figure 116 Total Vehicle Volumes, Site 308 Eastbound, 3 PM to 4 PM.**



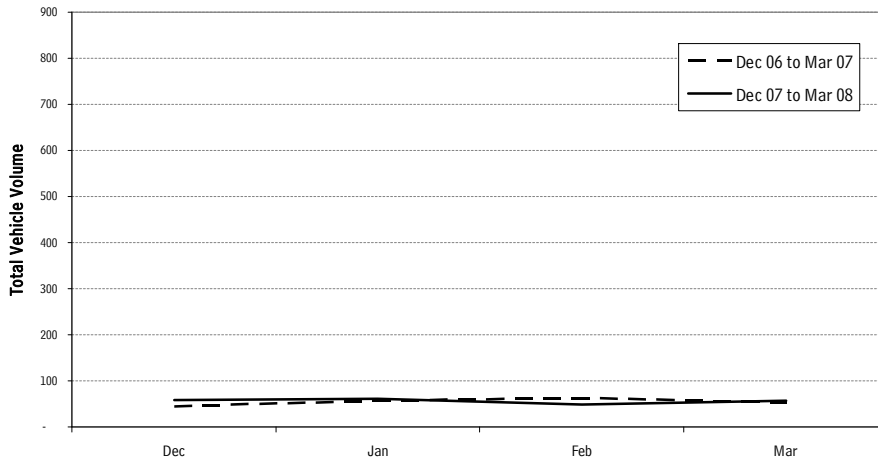
**Figure 117 Total Vehicle Volumes, Site 308 Eastbound, 4 PM to 5 PM.**



**Figure 118 Total Vehicle Volumes, Site 308 Eastbound, 5 PM to 6 PM.**

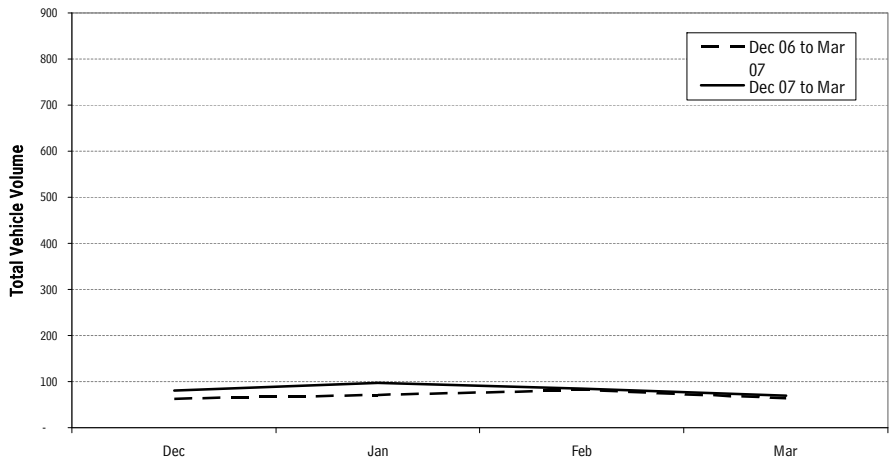


**Figure 119 Total Vehicle Volumes, Site 308 Eastbound, 6 PM to 7 PM.**

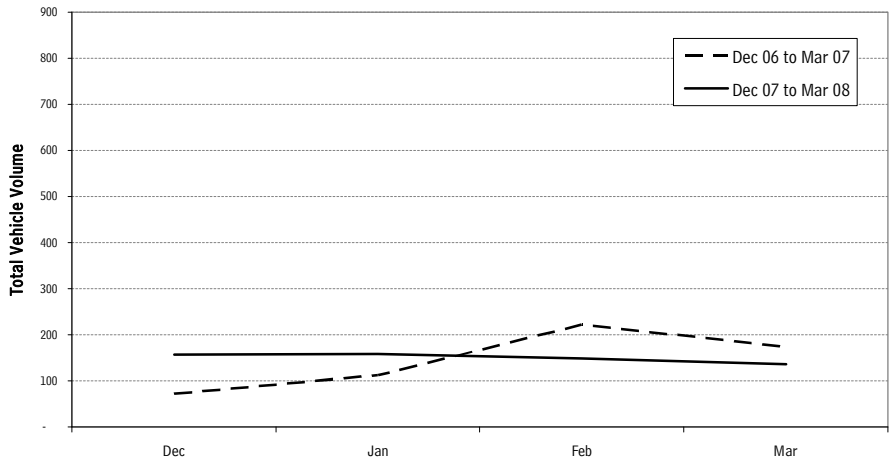


**Figure 120 Total Vehicle Volumes, Site 307 Eastbound, 2 PM to 3 PM.**

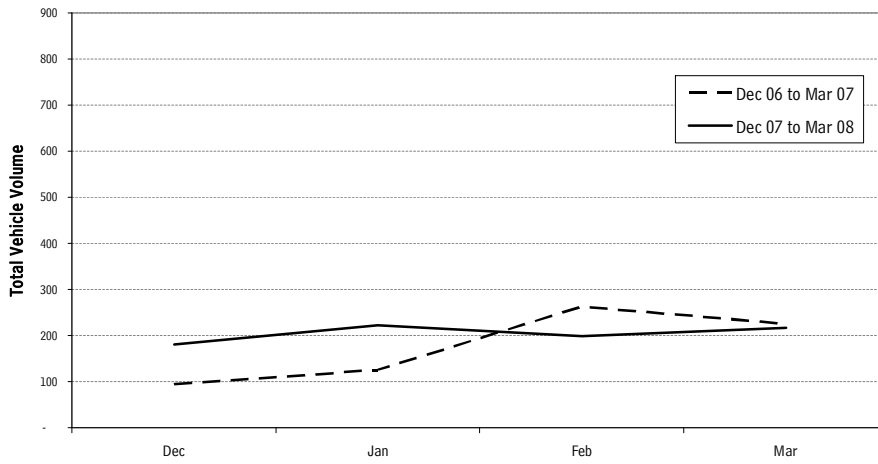




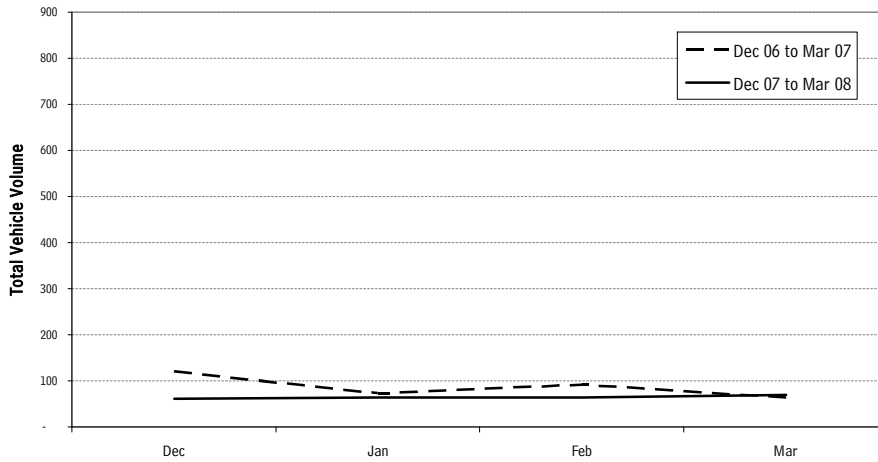
**Figure 121 Total Vehicle Volumes, Site 307 Eastbound, 3 PM to 4 PM.**



**Figure 122 Total Vehicle Volumes, Site 307 Eastbound, 4 PM to 5 PM.**

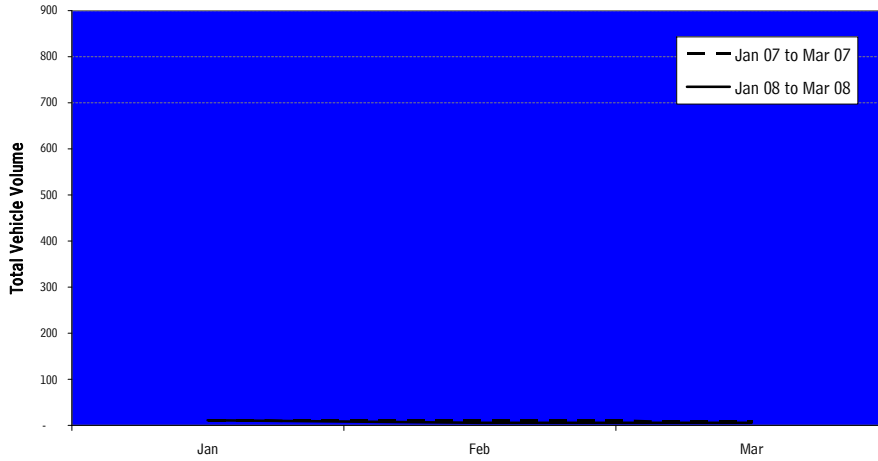


**Figure 123 Total Vehicle Volumes, Site 307 Eastbound, 5 PM to 6 PM.**

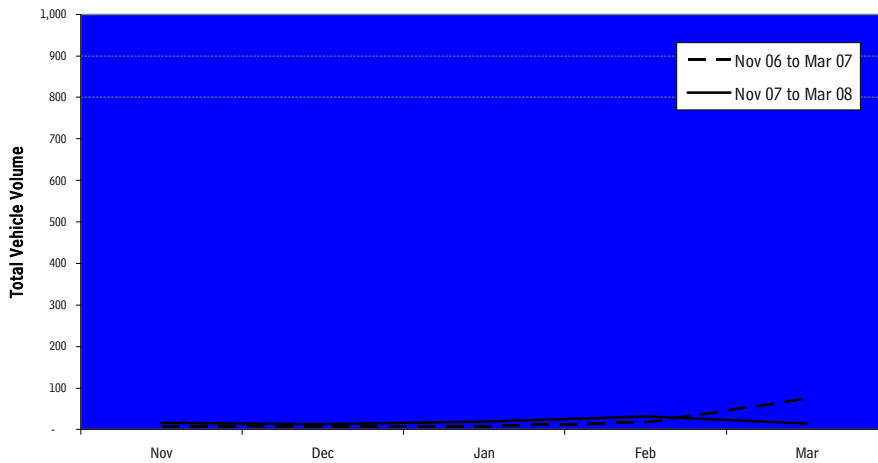


**Figure 124 Total Vehicle Volumes, Site 307 Eastbound, 6 PM to 7 PM.**

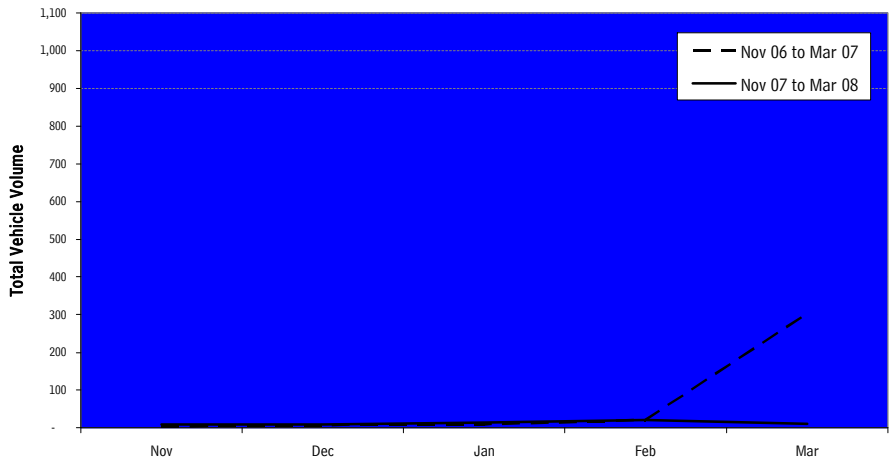
***Truck Volumes Eastbound Direction, Afternoon Peak***



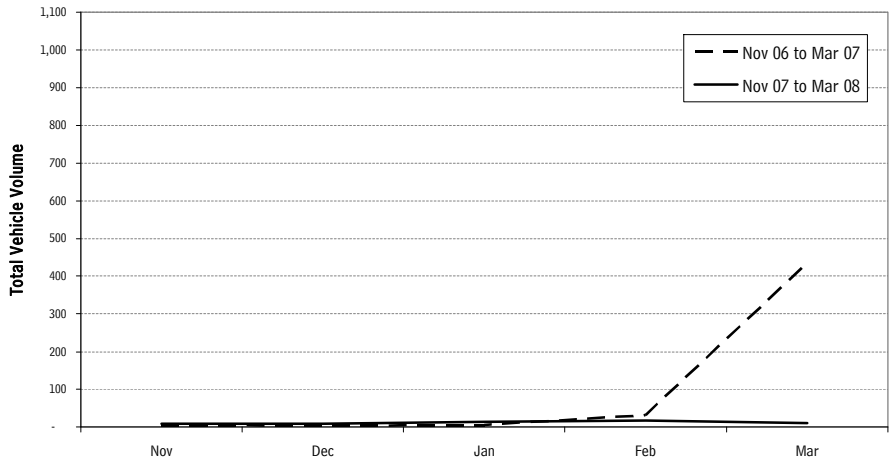
**Figure 125 Total Truck Volumes, Site 308 Eastbound, 2 PM to 3 PM.**



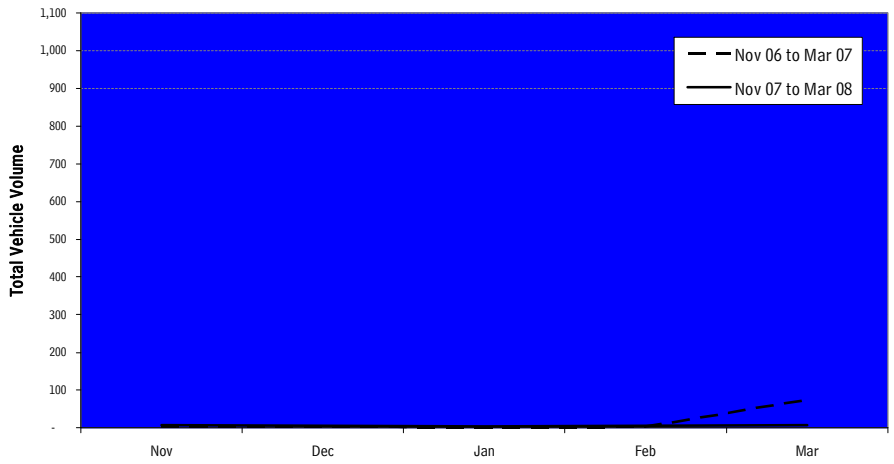
**Figure 126 Total Truck Volumes, Site 308 Eastbound, 3 PM to 4 PM.**



**Figure 127 Total Truck Volumes, Site 308 Eastbound, 4 PM to 5 PM.**

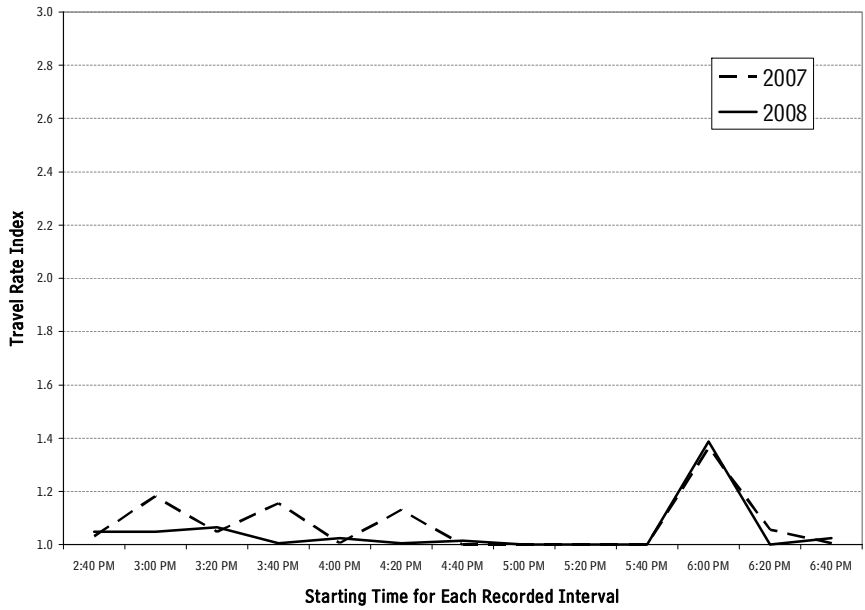


**Figure 128 Total Truck Volumes, Site 308 Eastbound, 5 PM to 6 PM.**

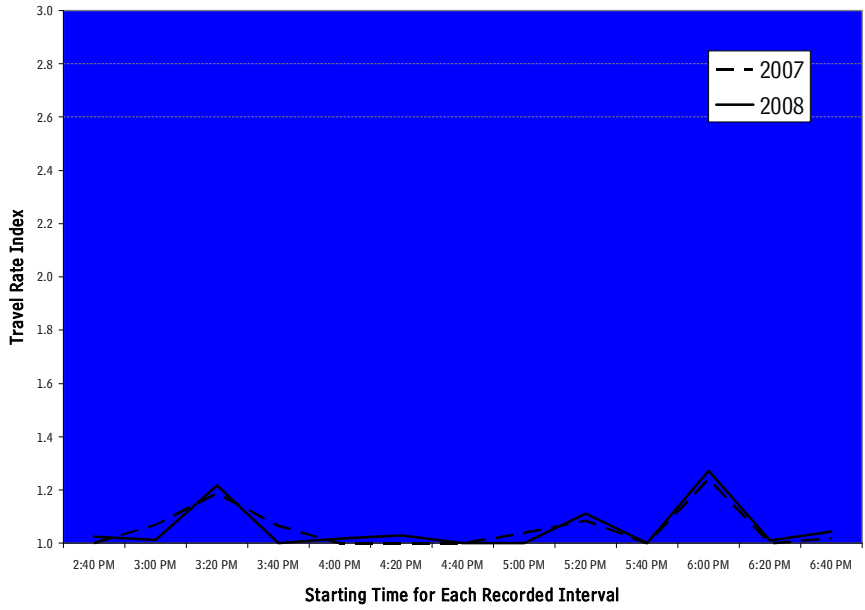


**Figure 129 Total Truck Volumes, Site 308 Eastbound, 6 PM to 7 PM.**

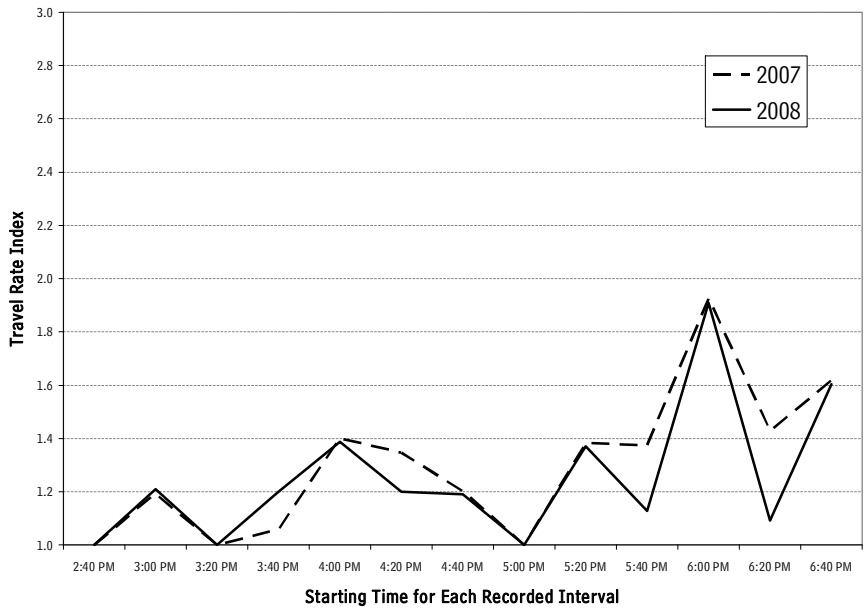
*Travel Time Runs, Afternoon Peak, Westbound Direction*



**Figure 130 Lone Star Pass (PM Peak), SH 16 to Applewhite Rd, Westbound.**

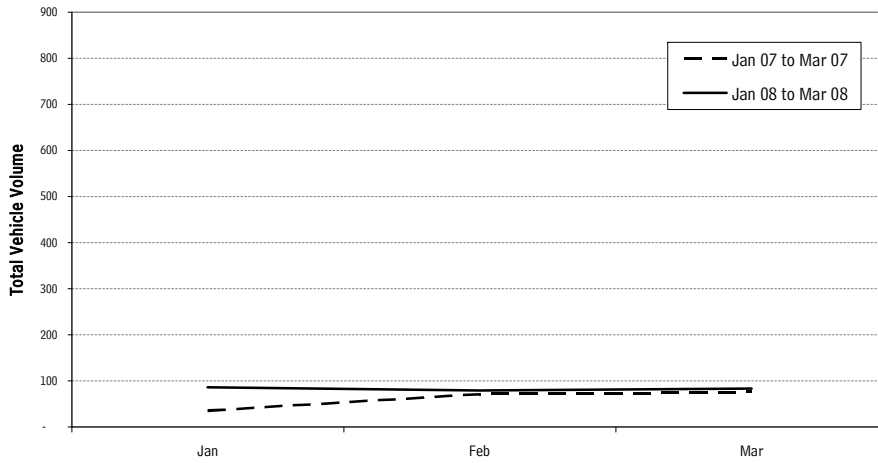


**Figure 131 Watson Rd (PM Peak), SH 16 to FM 2790, Westbound.**

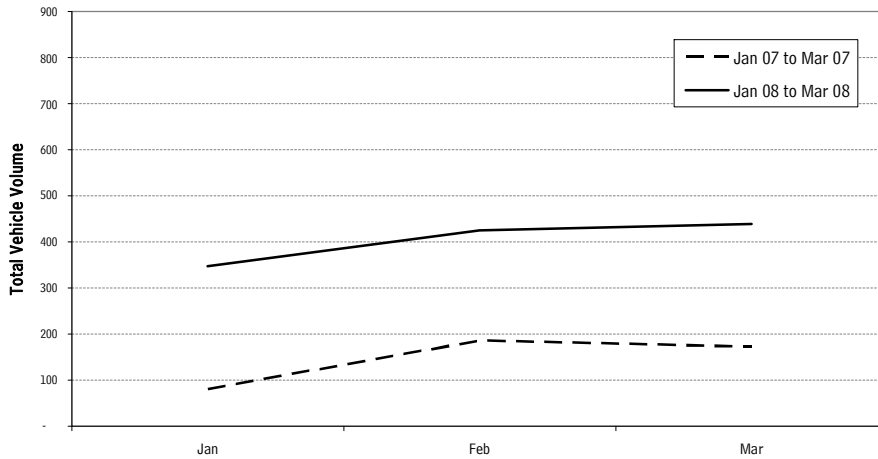


**Figure 132 Fisher Rd, FM 2790 to I 35, Westbound.**

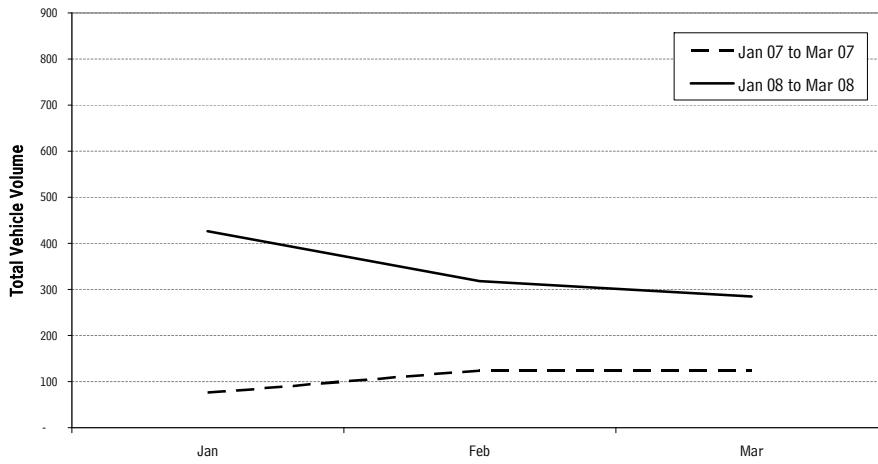
***Total Vehicle Volumes Westbound Direction, Afternoon Peak***



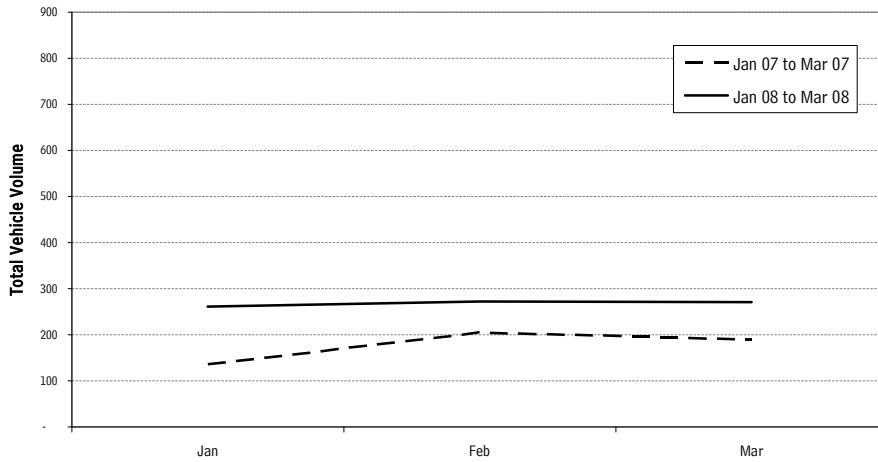
**Figure 133 Total Vehicle Volumes, Site 308 Westbound, 2 PM to 3 PM.**



**Figure 134 Total Vehicle Volumes, Site 308 Westbound, 3 PM to 4 PM.**

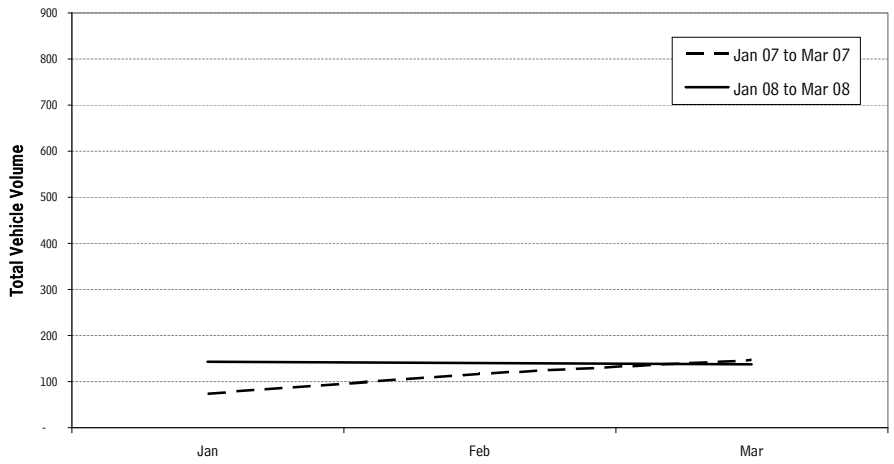


**Figure 135 Total Vehicle Volumes, Site 308 Westbound, 4 PM to 5 PM.**

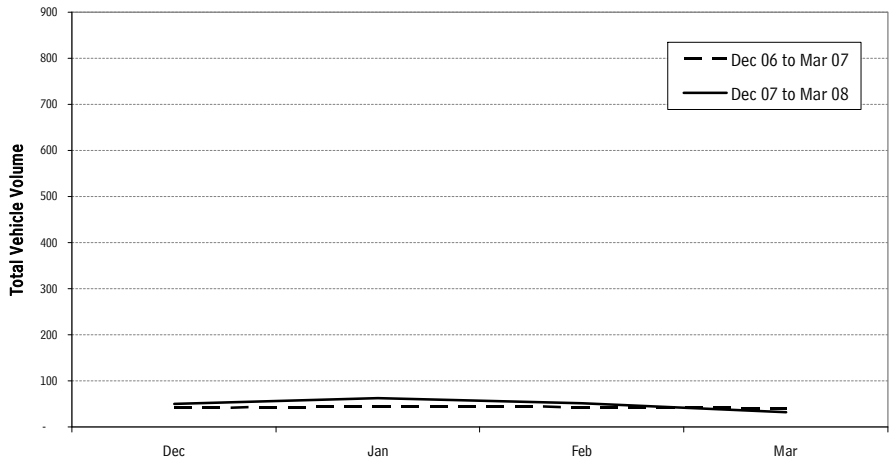


**Figure 136 Total Vehicle Volumes, Site 308 Westbound, 5 PM to 6 PM.**

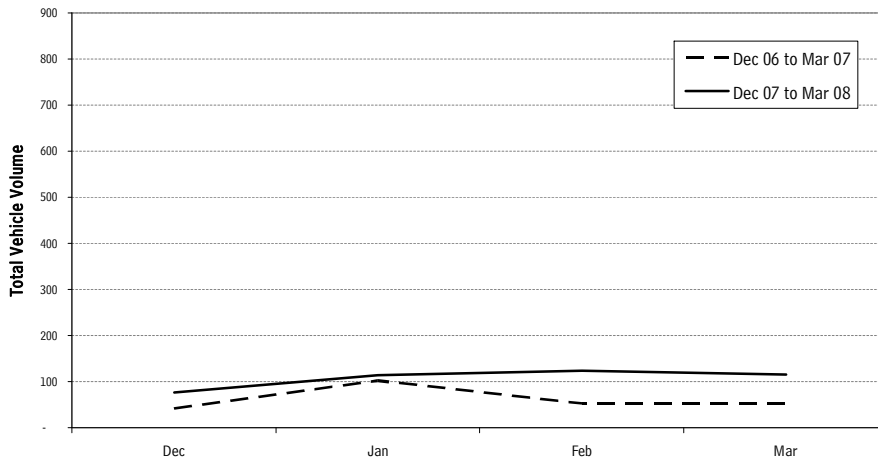




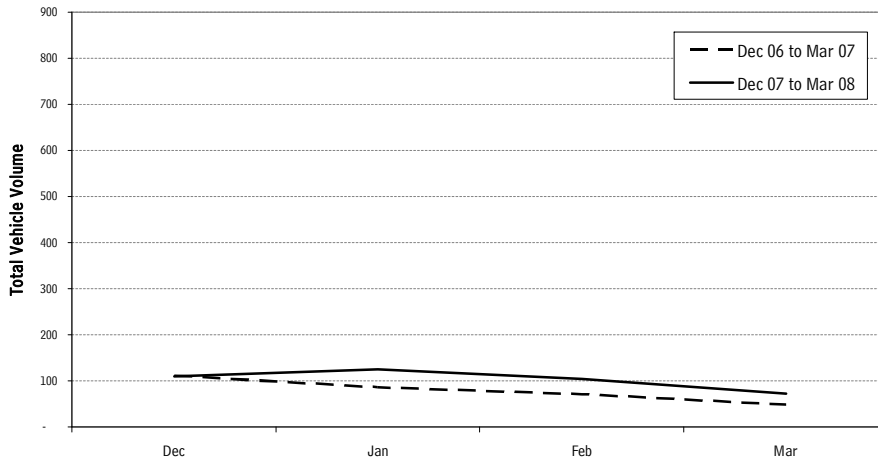
**Figure 137 Total Vehicle Volumes, Site 308 Westbound, 6 PM to 7 PM.**



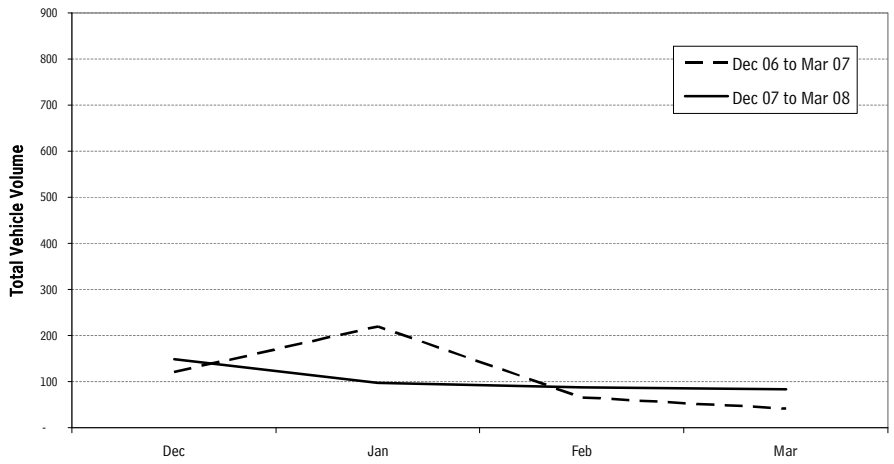
**Figure 138 Total Vehicle Volumes, Site 307 Westbound, 2 PM to 3 PM.**



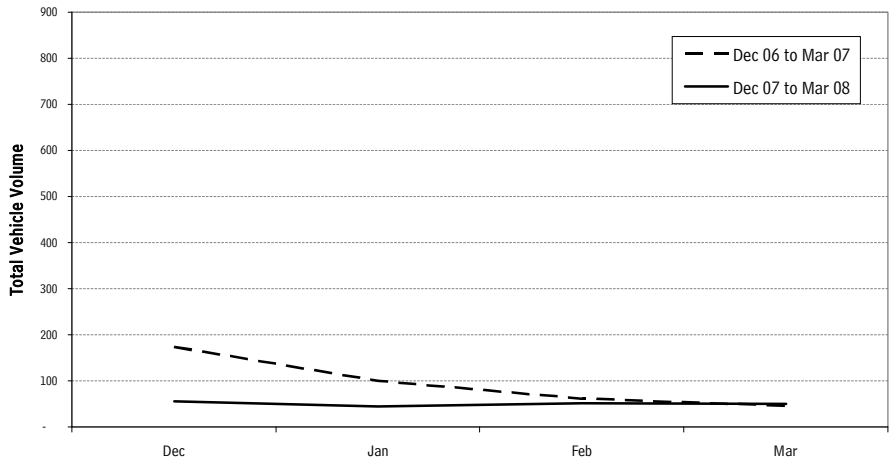
**Figure 139 Total Vehicle Volumes, Site 307 Westbound, 3 PM to 4 PM.**



**Figure 140 Total Vehicle Volumes, Site 307 Westbound, 4 PM to 5 PM.**

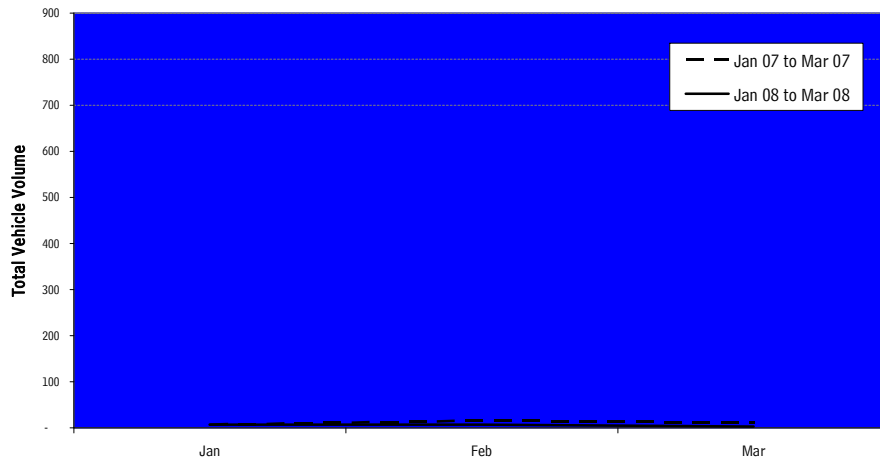


**Figure 141 Total Vehicle Volumes, Site 307 Westbound, 5 PM to 6 PM.**

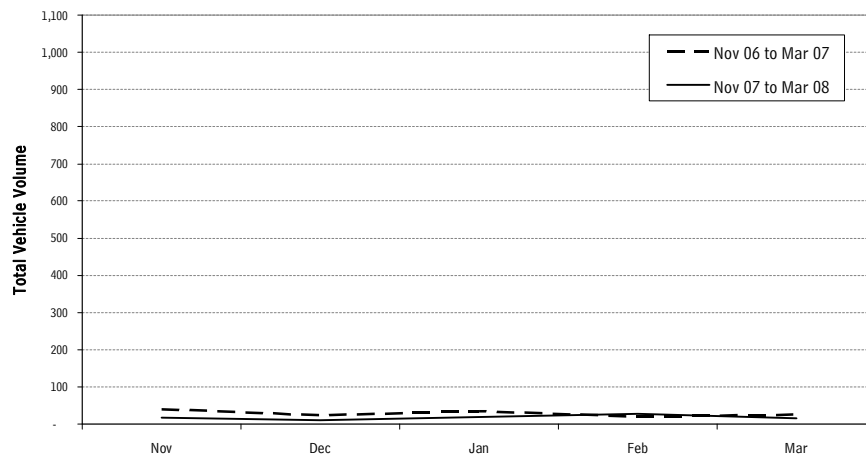


**Figure 142 Total Vehicle Volumes, Site 307 Westbound, 6 PM to 7 PM.**

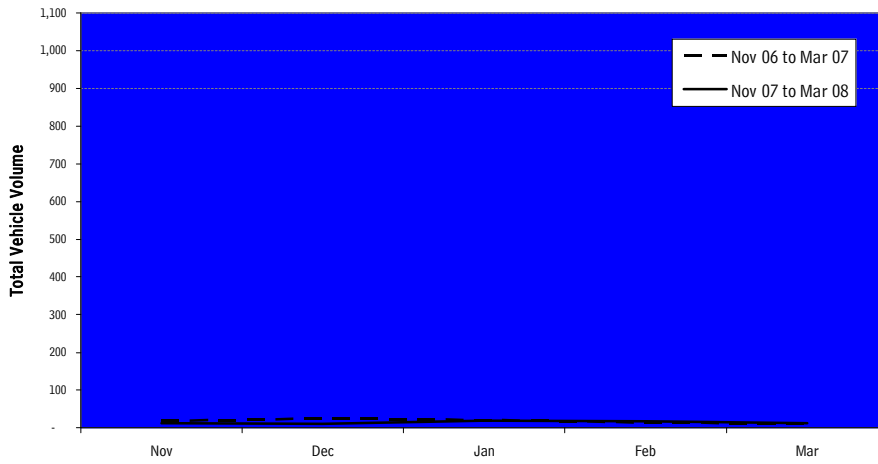
***Truck Volumes Westbound Direction, Afternoon Peak***



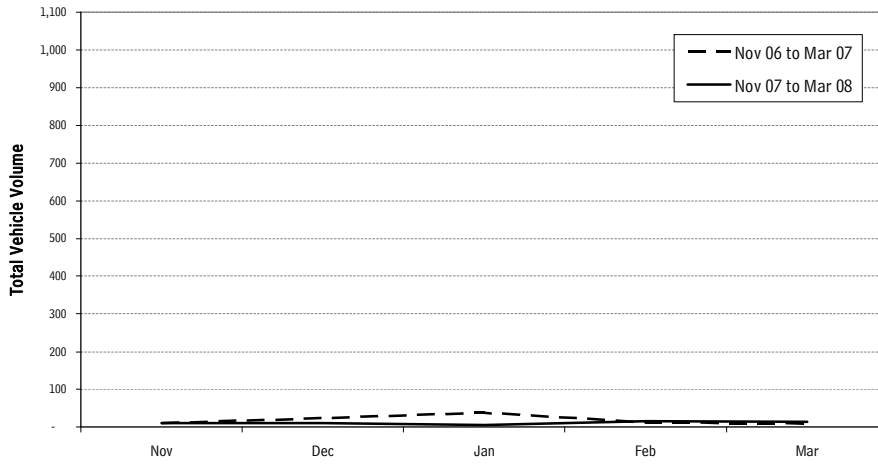
**Figure 143 Total Truck Volumes, site 308 Westbound, 2 PM to 3 PM.**



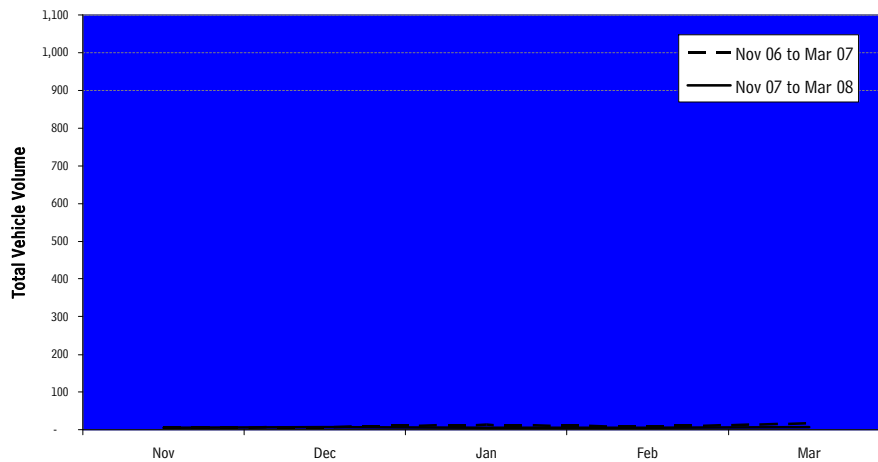
**Figure 144 Total Truck Volumes, Site 314 Northbound, 3 PM to 4 PM.**



**Figure 145 Total Truck Volumes, Site 314 Northbound, 4 PM to 5 PM.**



**Figure 146 Total Truck Volumes, Site 314 Northbound, 5 PM to 6 PM.**



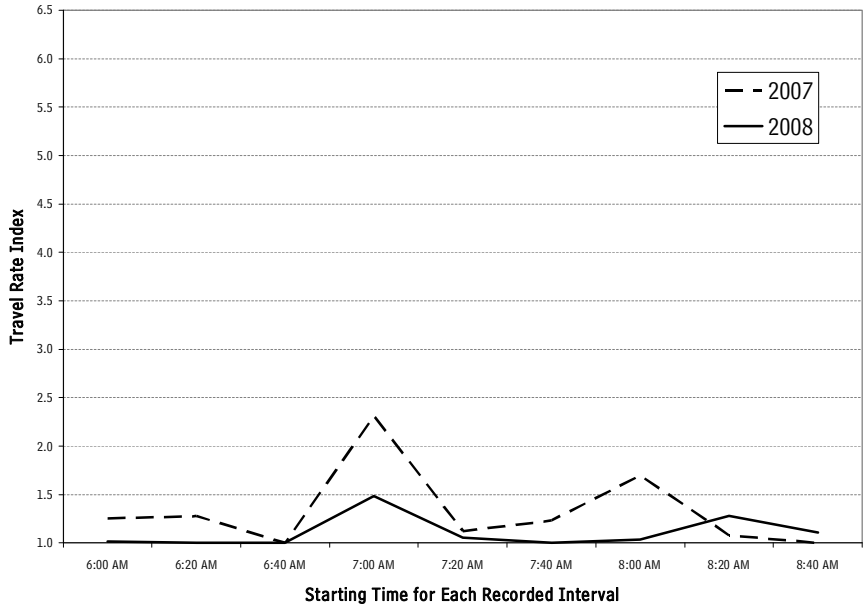
**Figure 147 Total Truck Volumes, Site 314 Northbound, 6 PM to 7 PM.**

### **Corridor 3: SH 16 from SL 1604 to IH 35**

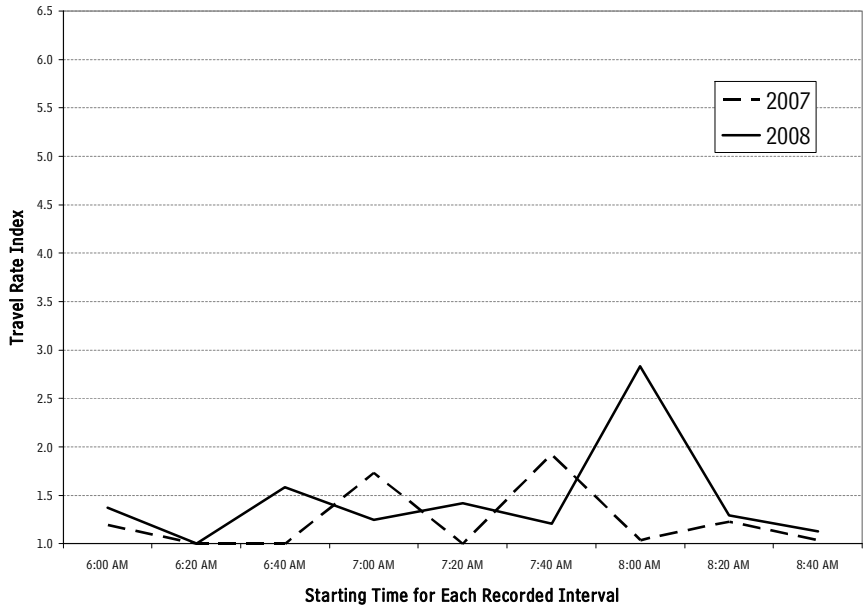
Corridor 3 is defined in linked segments as follows:

- (A) SH 16 from IH 35 to Hunter Ave
- (B) SH 16 from Hunter Ave to Gillette Blvd
- (C) SH 16 from Gillette Blvd to W Villaret Blvd
- (D) SH 16 from W Villaret Blvd to IH 410
- (E) SH 16 from IH 410 to Kingsride Blvd/Appleswhite Rd
- (F) SH 16 from Kingsride Blvd/Appleswhite Rd to S Zarzamora St
- (G) SH 16 from S Zarzamora St to Lone Star Pass/Watson Rd
- (H) SH 16 from Lone Star Pass/Watson Rd to Noyes Rd
- (I) SH 16 from Noyes Rd to SL 1604

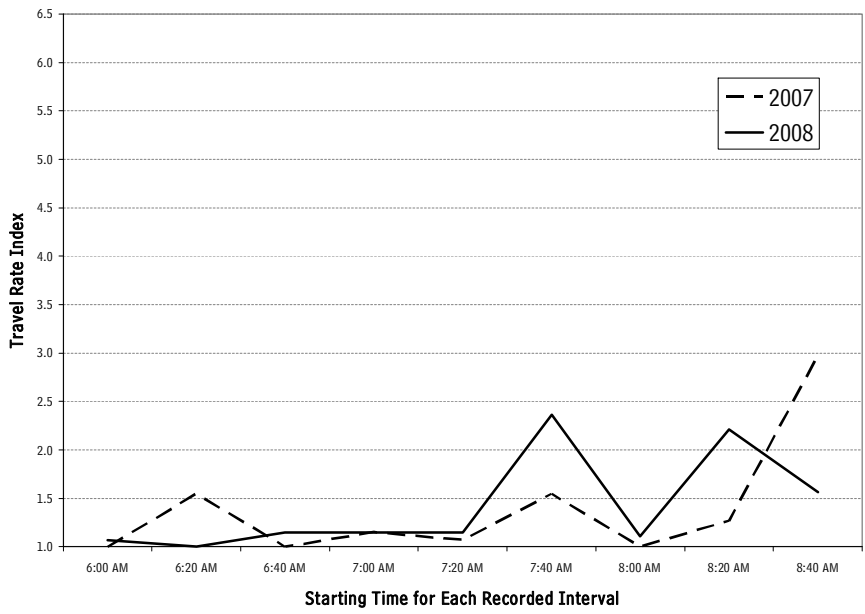
***Travel Time Runs, Morning Peak, Southbound Direction***



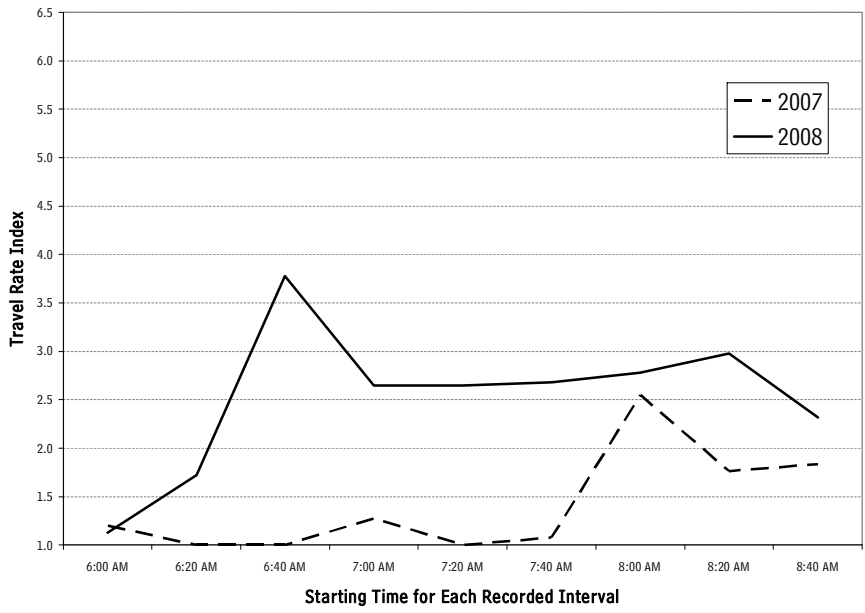
**Figure 148 SH 16 (AM Peak), IH 35 to Hunter Ave, Southbound.**



**Figure 149 SH 16 (AM Peak), Hunter Ave to Gillette Blvd, Southbound.**

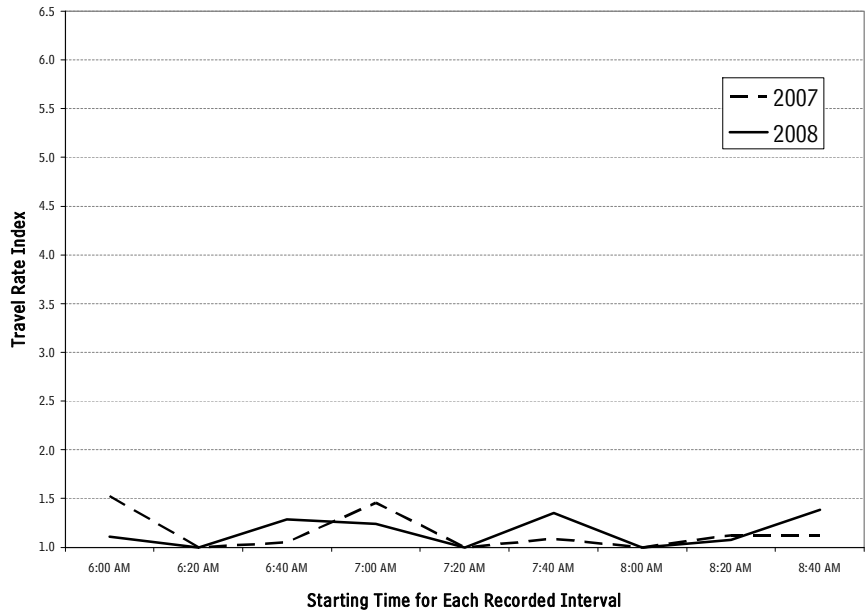


**Figure 150 SH 16 (AM Peak), Gillette Blvd to W Villaret Blvd, Southbound.**

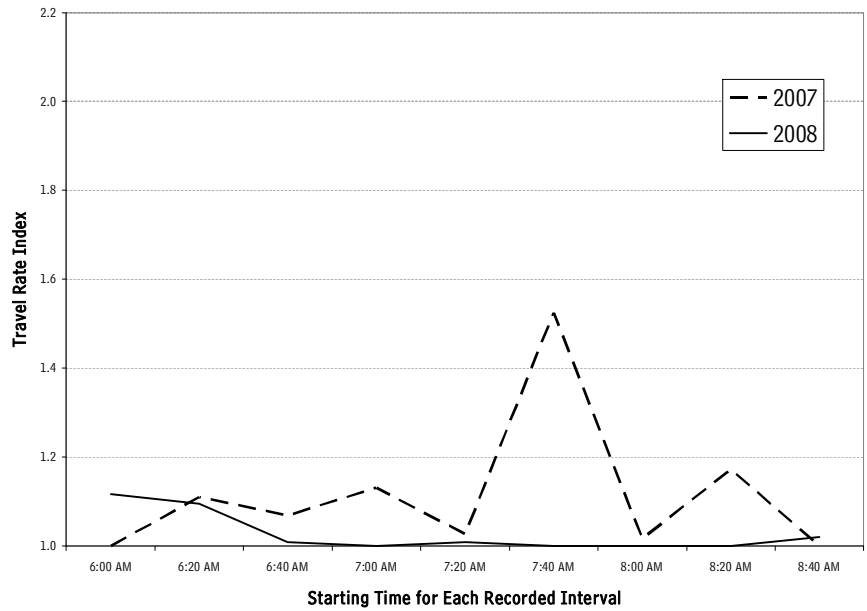


**Figure 151 SH 16 (AM Peak), W Villaret Blvd to IH 410, Southbound.**

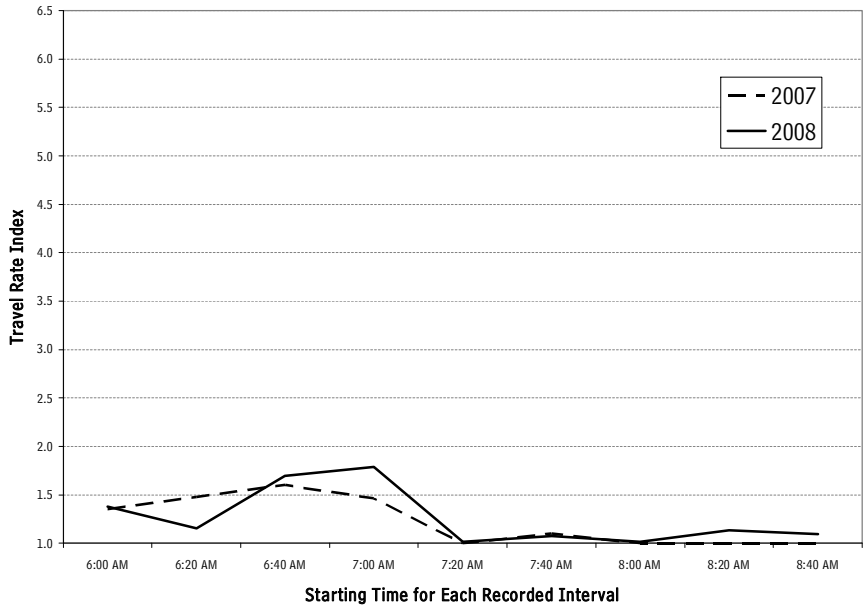




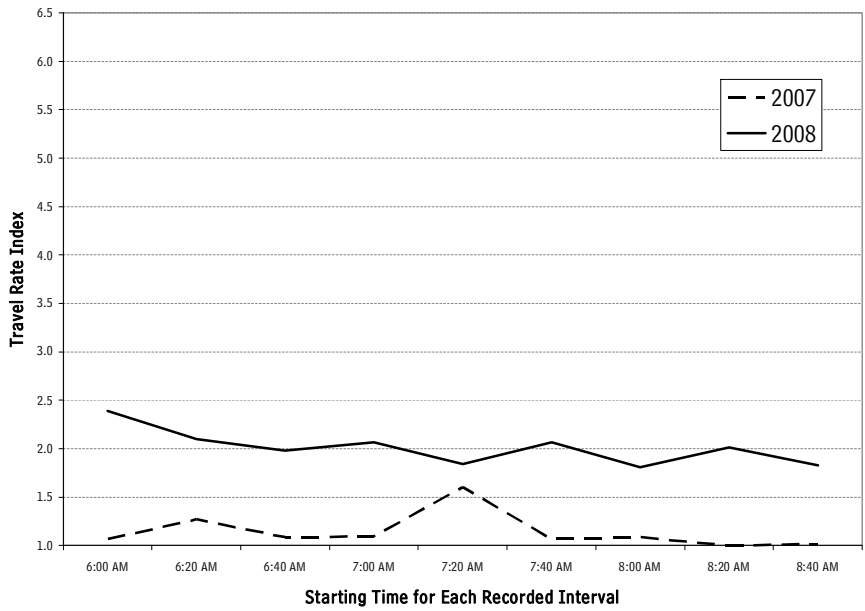
**Figure 152 IH 410 to Kingsride Blvd/Appplewhite Rd, Southbound.**



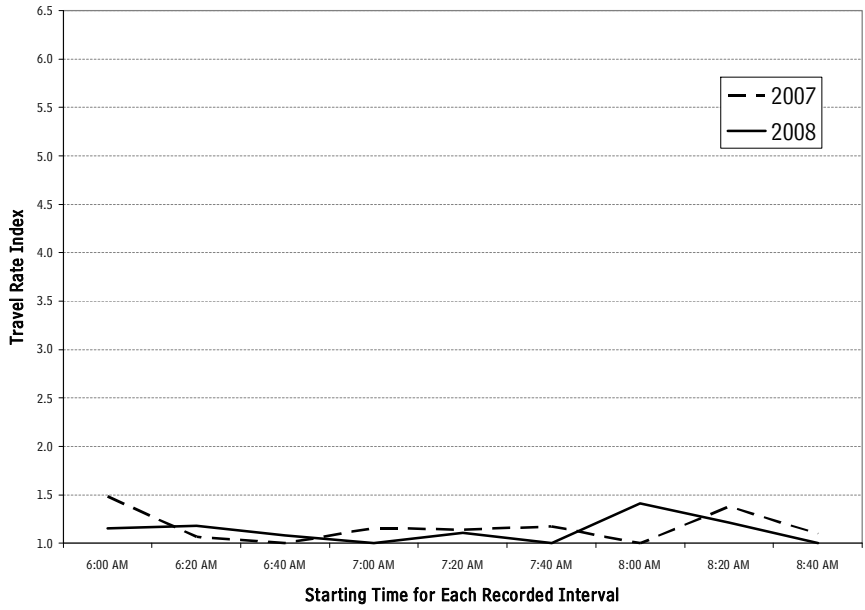
**Figure 153 SH 16 (AM Peak), Kingsride Blvd/Appplewhite Rd to S Zarzamora St, Southbound.**



**Figure 154 SH 16 (AM Peak), S Zarzamora St to Lone Star Pass/Watson Rd, Southbound.**

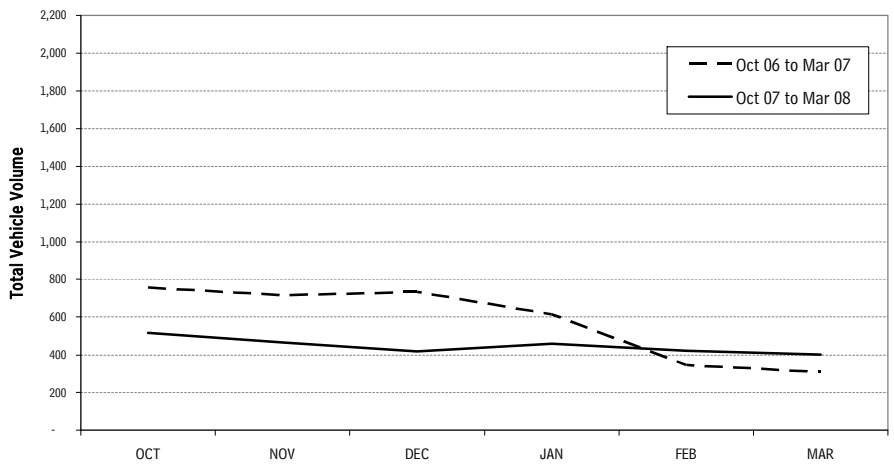


**Figure 155 SH 16 (AM Peak), Lone Star Pass/Watson Rd to Noyes Rd, Southbound.**

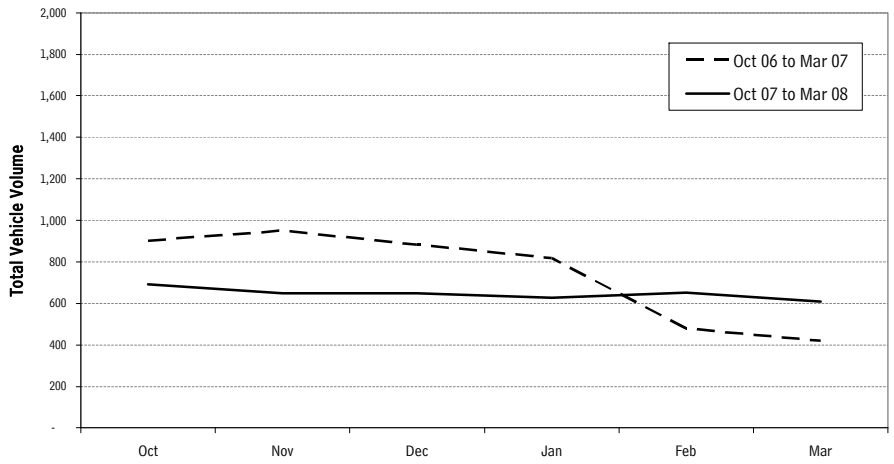


**Figure 156 SH 16 (AM Peak), Noyes Rd to SL 1604, Southbound.**

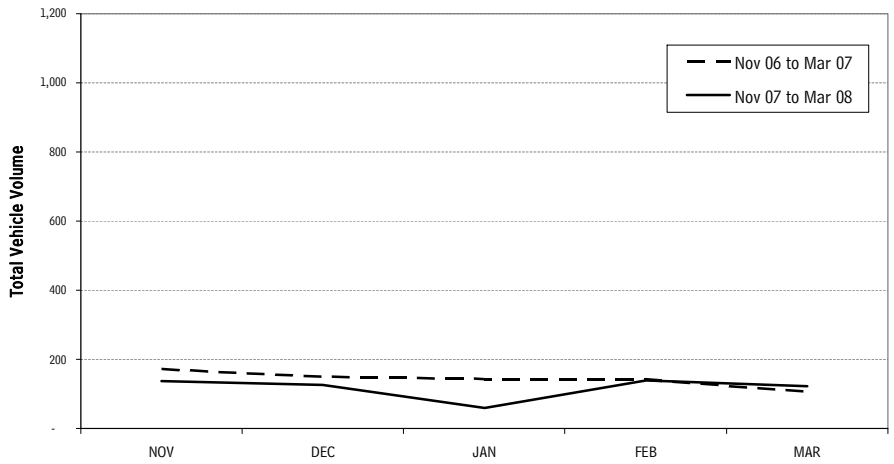
***Total Vehicle Volumes Southbound Direction, Morning Peak***



**Figure 157 Total Vehicle Volumes, Site 309 Southbound, 6 AM to 7 AM.**

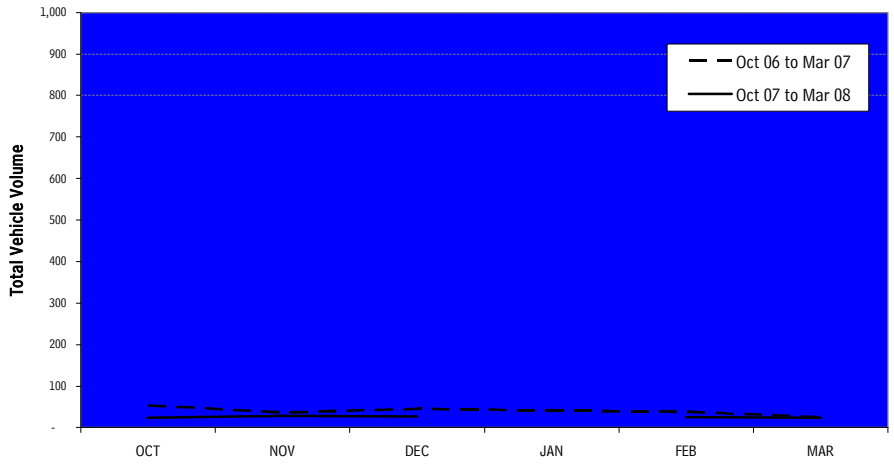


**Figure 158 Total Vehicle Volumes, Site 311 Southbound, 6 AM to 7 AM.**

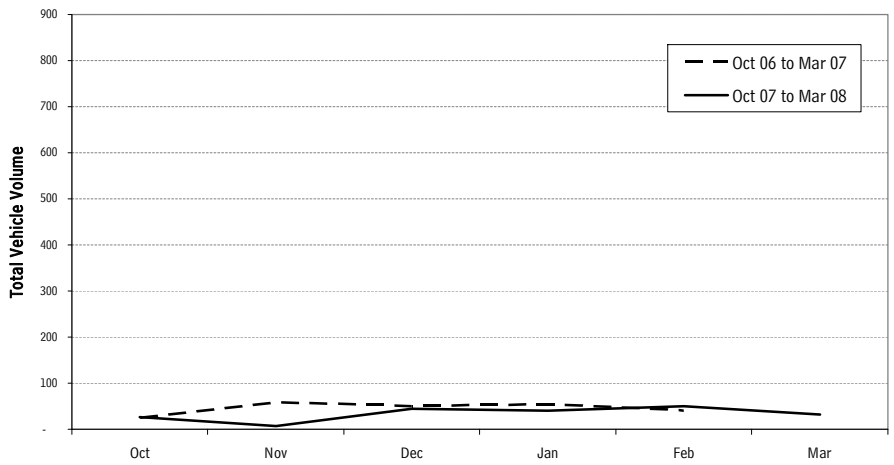


**Figure 159 Total Vehicle Volumes, Site 328 Southbound, 6 AM to 7 AM.**

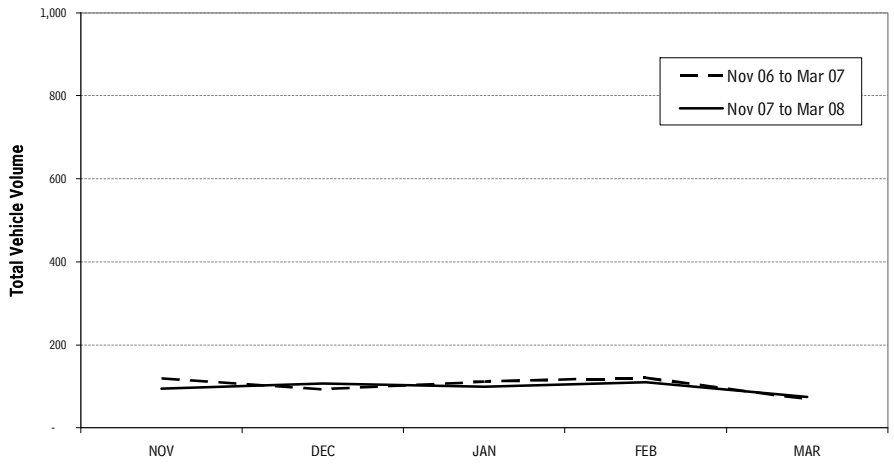
***Truck Volumes Southbound Direction, Morning Peak***



**Figure 160 Total Truck Volumes, Site 309 Southbound, 6 AM to 7 AM.**

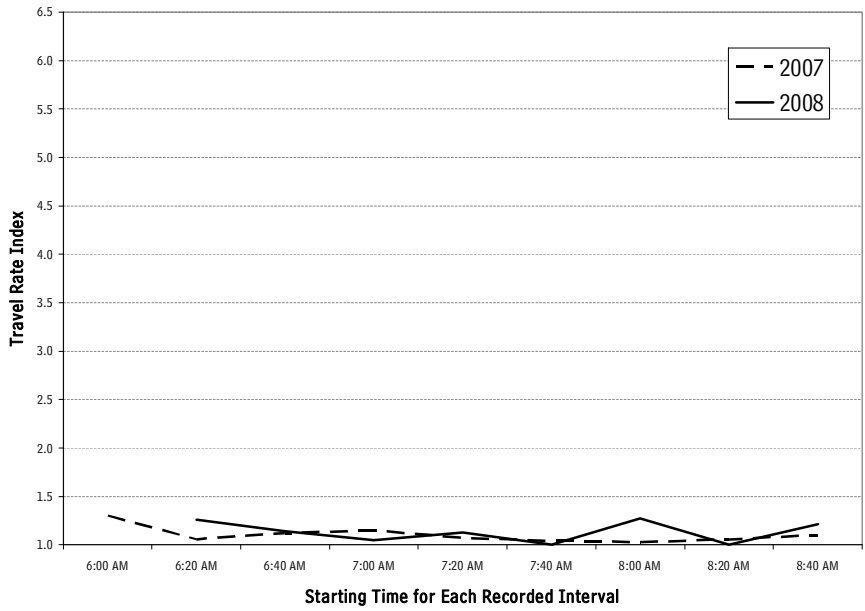


**Figure 161 Total Truck Volumes, Site 311 Southbound, 6 AM to 7 AM.**

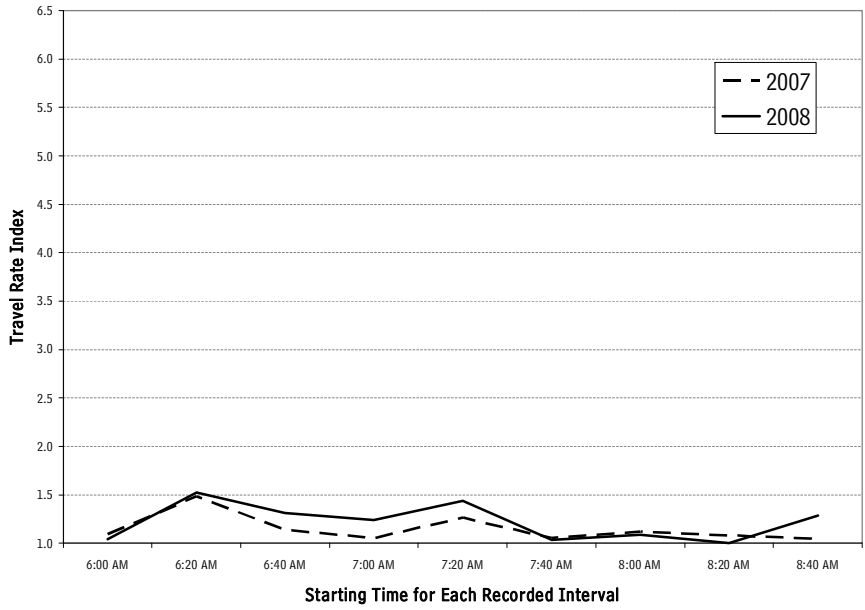


**Figure 162 Total Truck Volumes, Site 328 Southbound, 6 AM to 7 AM.**

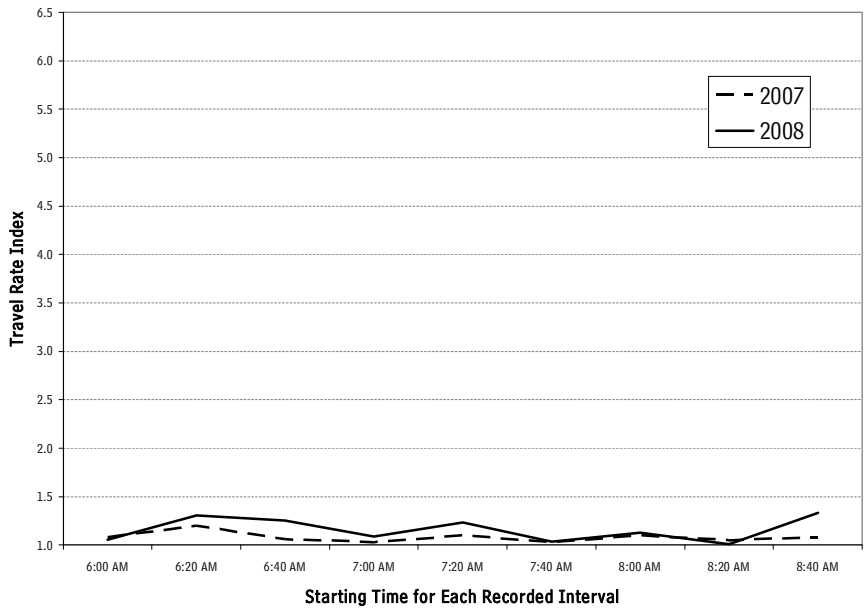
***Travel Time Runs, Morning Peak, Northbound Direction***



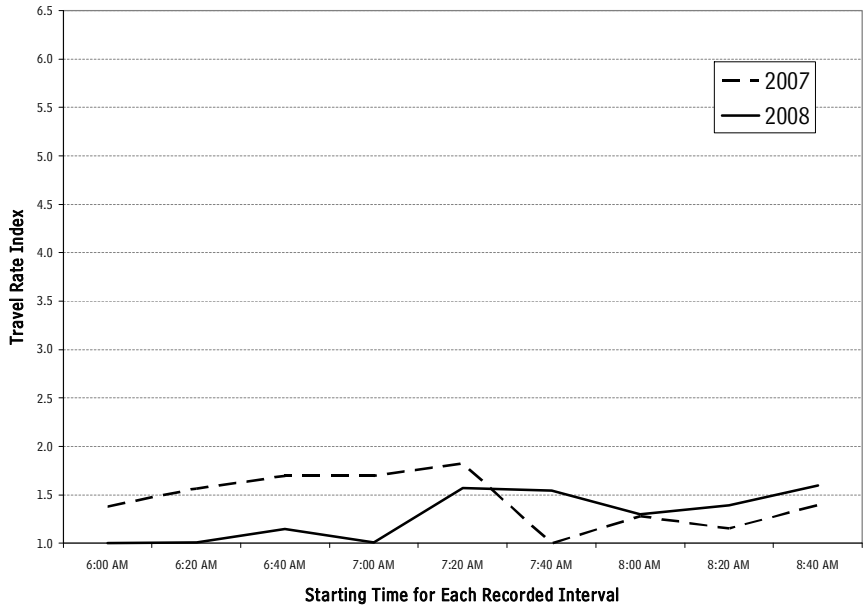
**Figure 163. SH 16 (AM Peak), Noyes Rd to SL 1604, Northbound.**



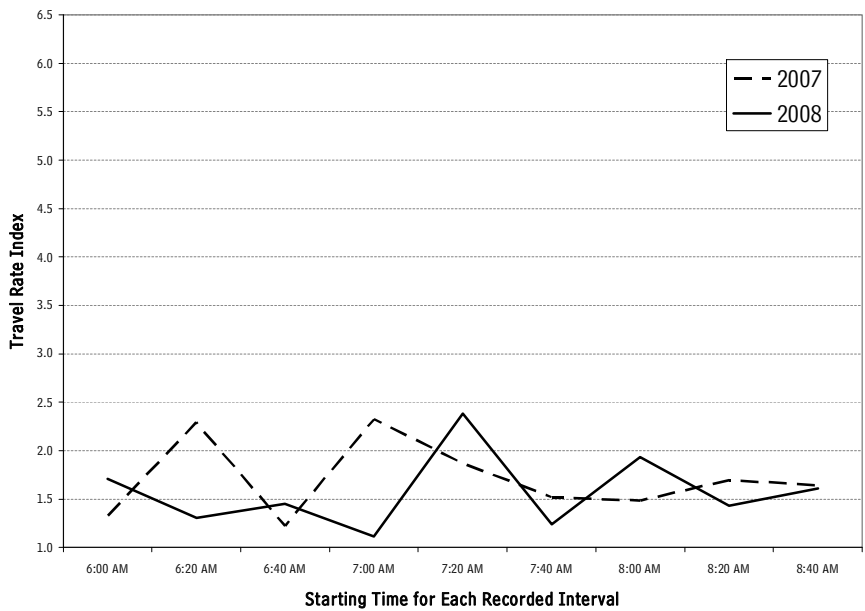
**Figure 164. SH 16 (AM Peak), Lone Star Pass/Watson Rd to Noyes Rd, Northbound.**



**Figure 165. SH 16 (AM Peak), S Zarzamora St to Lone Star Pass/Watson Rd, Northbound.**

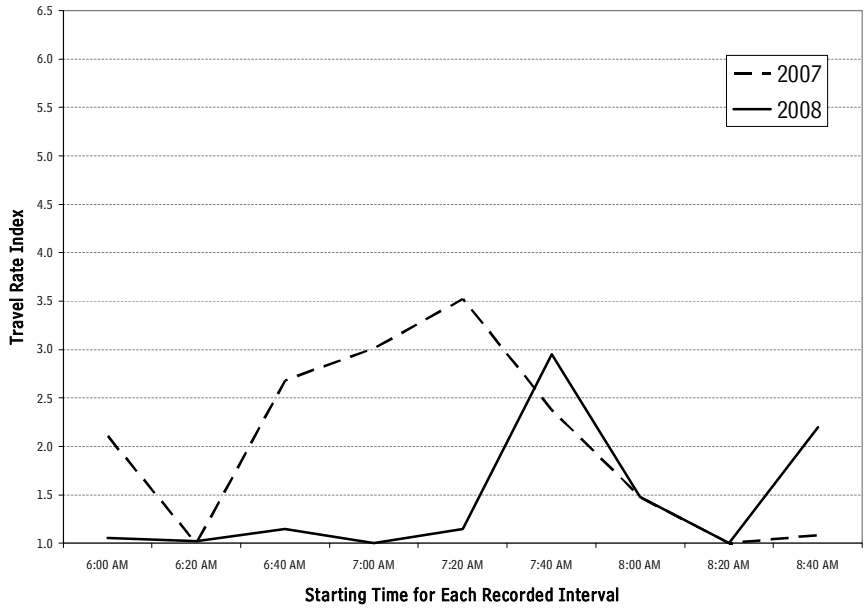


**Figure 166. SH 16 (AM Peak), Kingsride Blvd/Appplewhite Rd to S Zarzamora St, Northbound.**

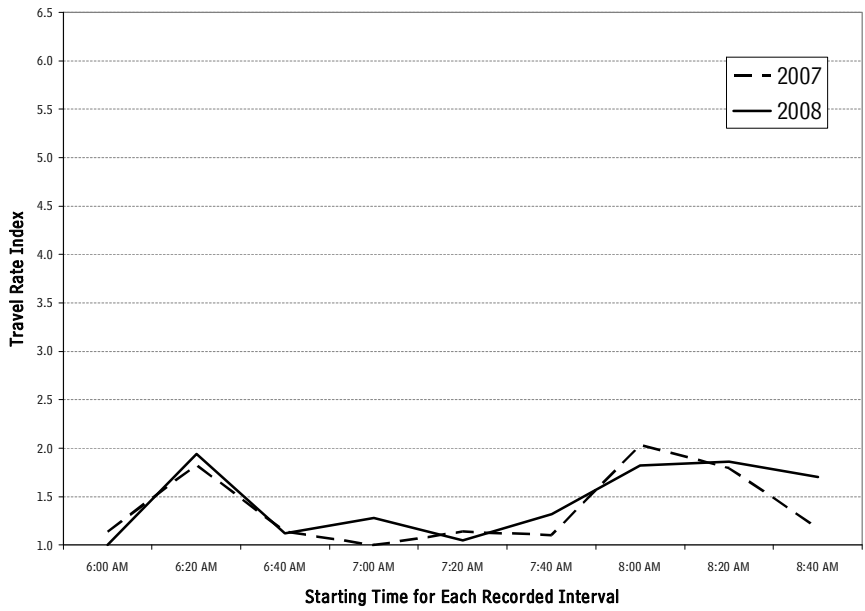


**Figure 167. SH 16 (AM Peak), IH 410 to Kingsride Blvd/Appplewhite Rd, Northbound.**

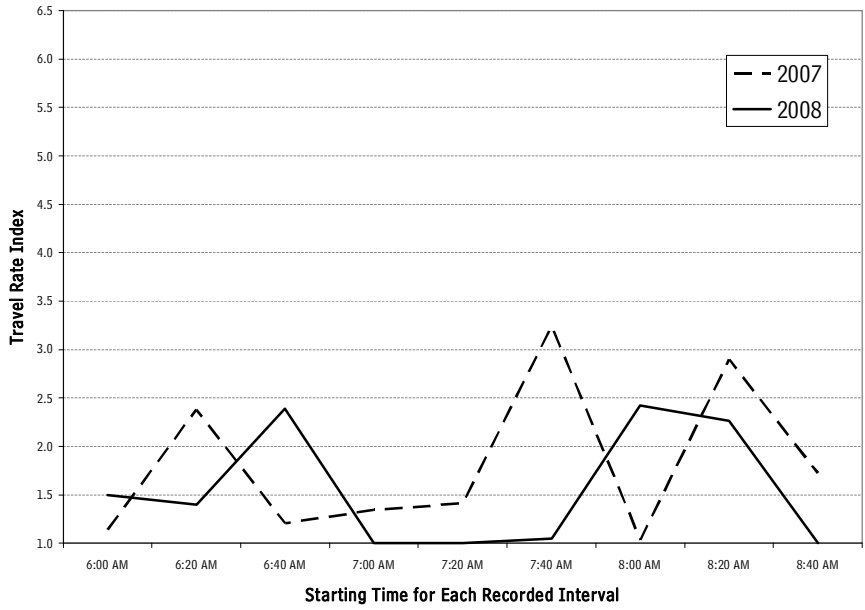




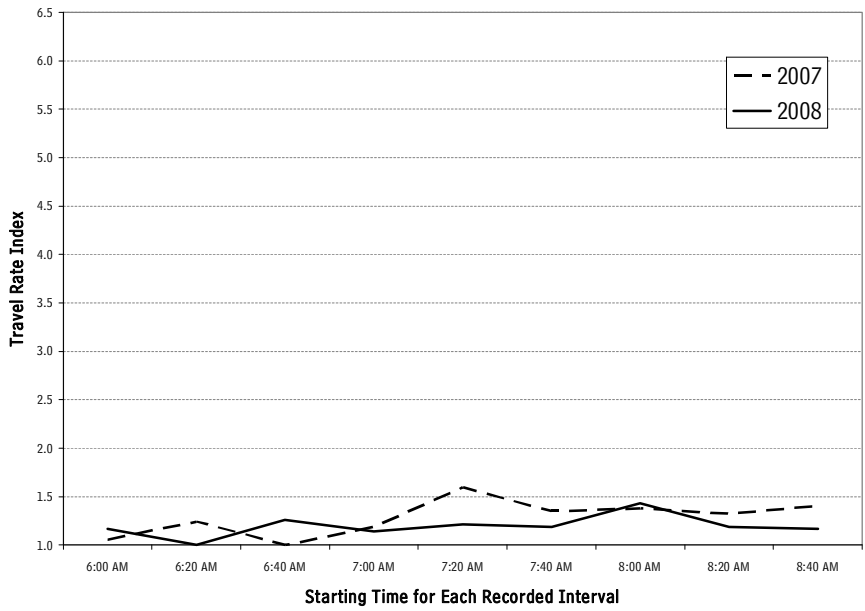
**Figure 168 SH 16 (AM Peak), W Villaret Blvd to IH 410, Northbound.**



**Figure 169 SH 16 (AM Peak), Gillette Blvd to W Villaret Blvd, Northbound.**

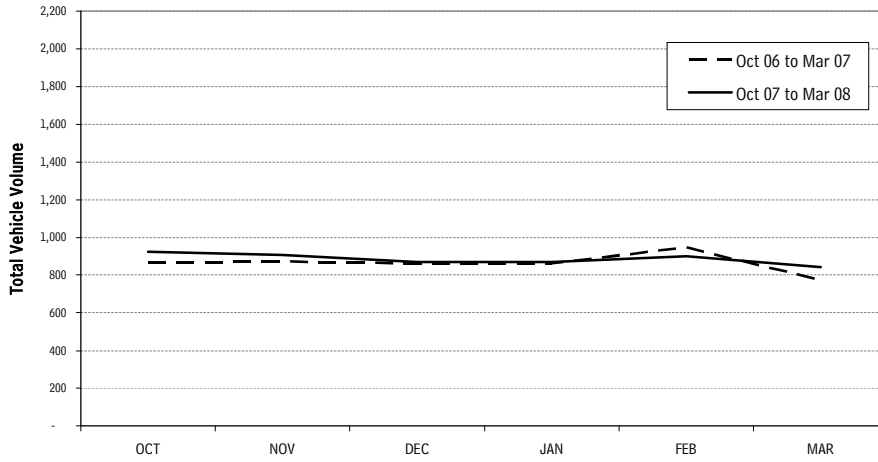


**Figure 170 SH 16 (AM Peak), Hunter Ave to Gillette Blvd, Northbound.**

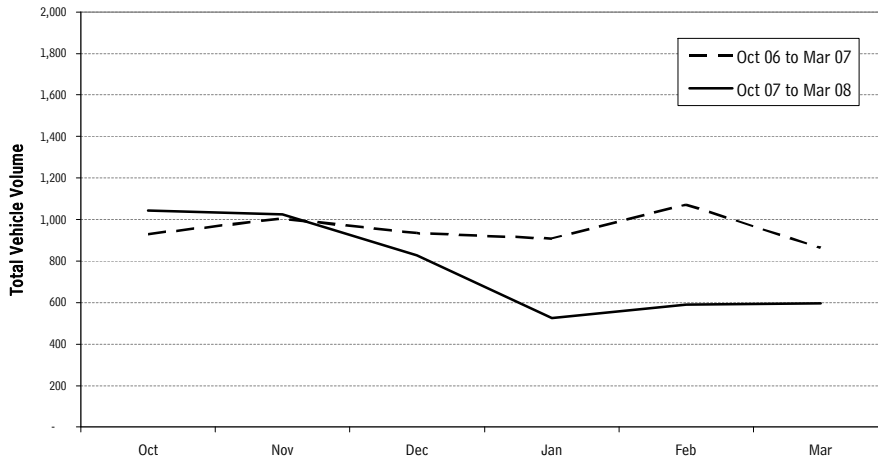


**Figure 171 SH 16 (AM Peak), IH 35 to Hunter Ave, Northbound.**

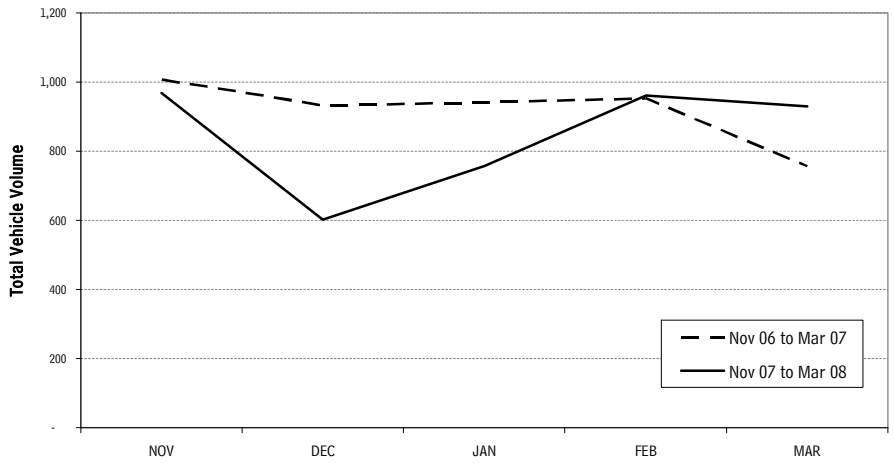
**Total Vehicle Volumes Northbound Direction, Morning Peak**



**Figure 172 Total Vehicle Volumes, Site 309 Northbound, 6 AM to 7 AM.**

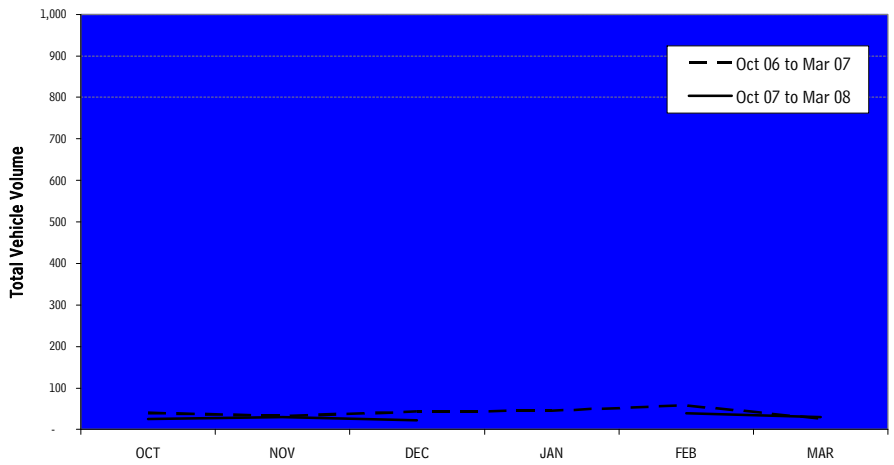


**Figure 173 Total Vehicle Volumes, Site 311 Northbound, 6 AM to 7 AM.**

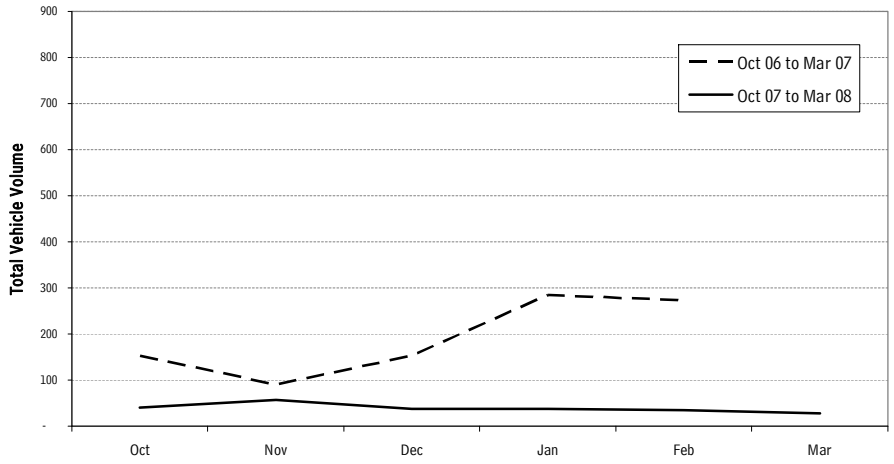


**Figure 174 Total Vehicle Volumes, Site 328 Northbound, 6 AM to 7 AM.**

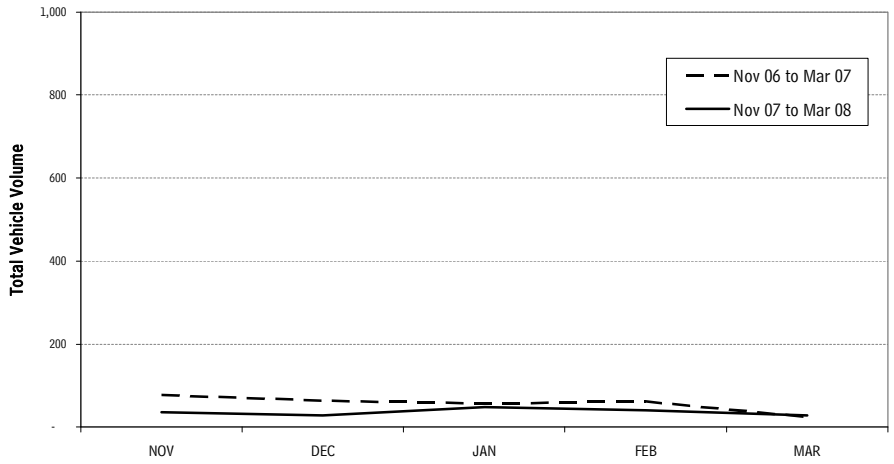
***Truck Volumes Northbound Direction, Morning Peak***



**Figure 175 Total Truck Volumes, Site 309 Northbound, 6 AM to 7 AM.**

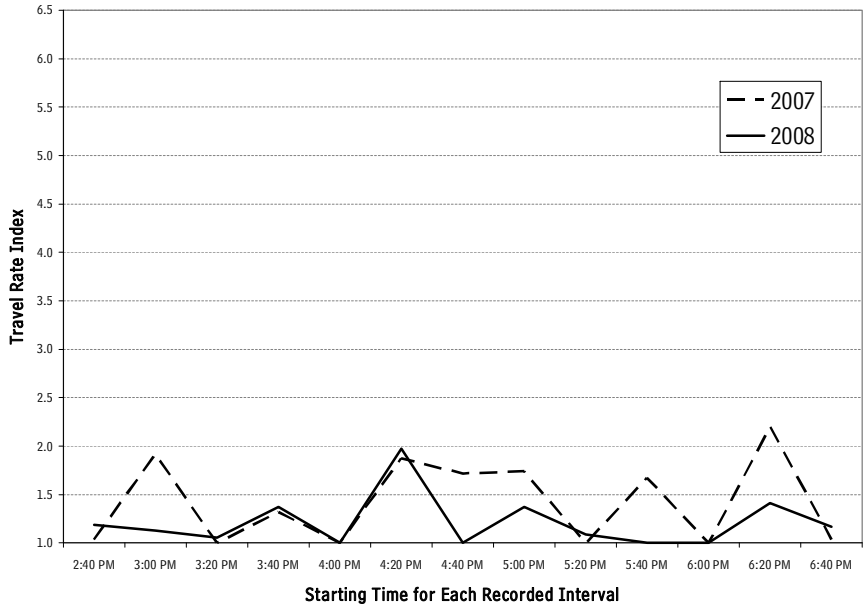


**Figure 176 Total Truck Volumes, Site 311 Northbound, 6 AM to 7 AM.**

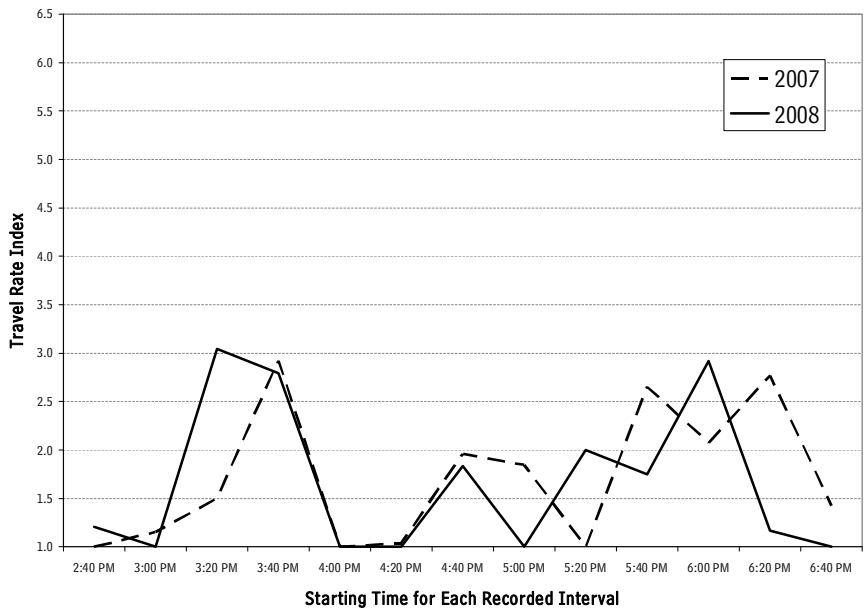


**Figure 177 Total Truck Volumes, Site 328 Northbound, 6 AM to 7 AM.**

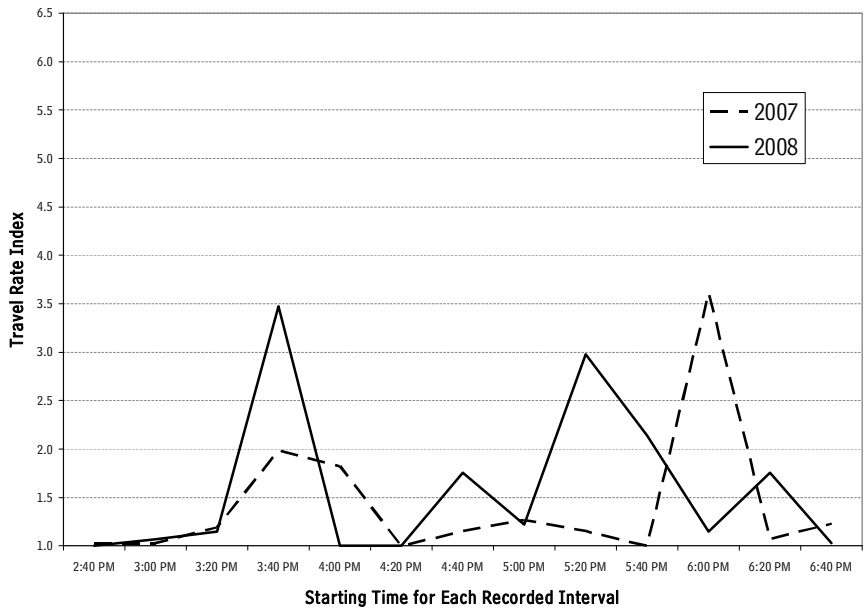
*Travel Time Runs, Afternoon Peak, Southbound Direction*



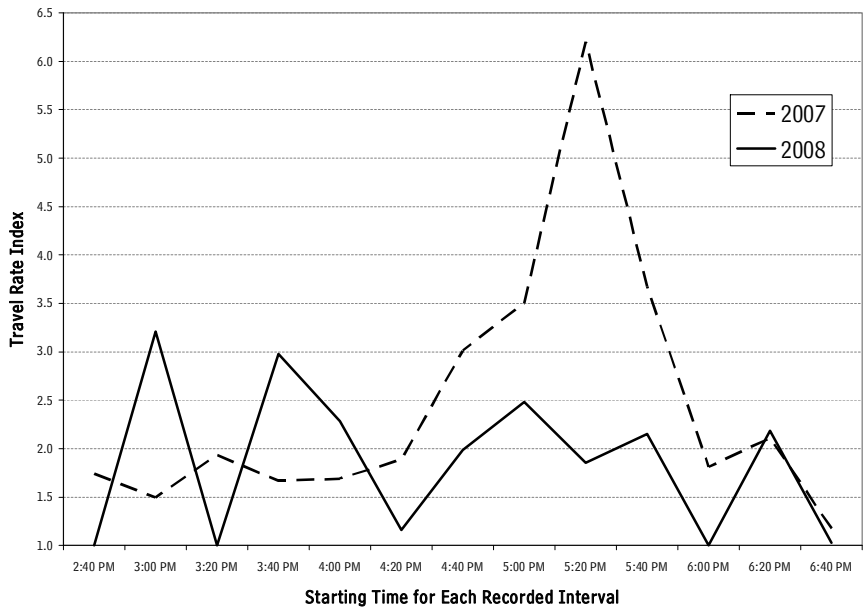
**Figure 178 SH 16 (PM Peak), IH 35 to Hunter Ave, Southbound.**



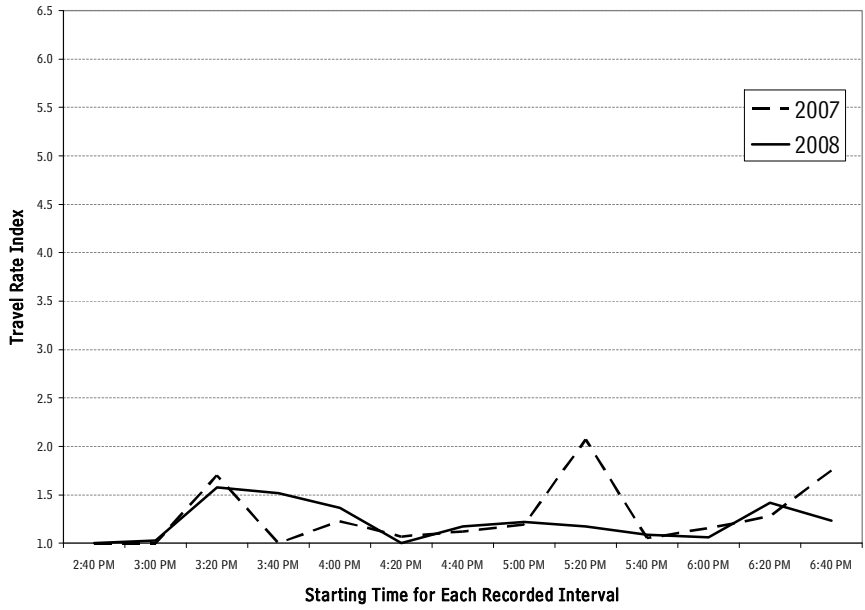
**Figure 179 SH 16 (PM Peak), Hunter Ave to Gillette Blvd, Southbound.**



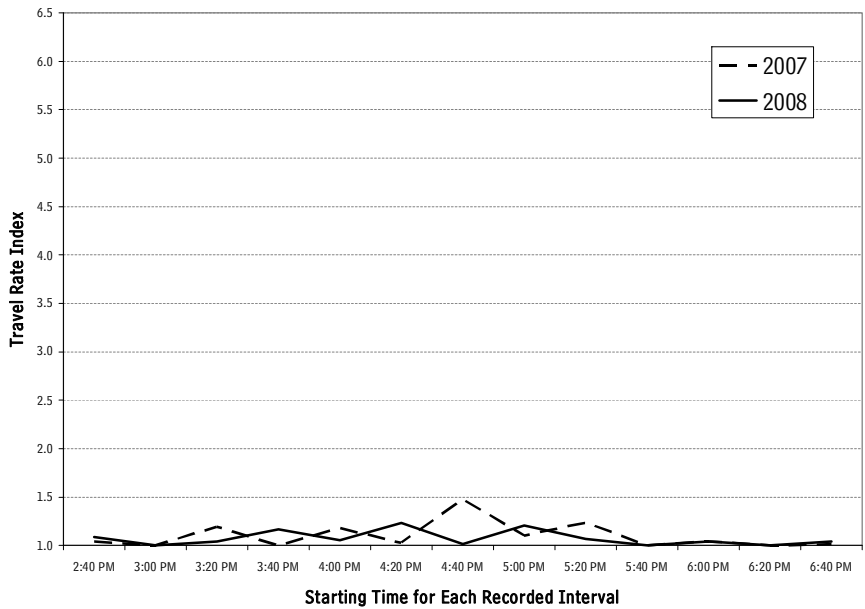
**Figure 180 SH 16 (PM Peak), Gillette Blvd to W Villaret Blvd, Southbound.**



**Figure 181 SH 16 (PM Peak), W Villaret Blvd to IH 410, Southbound.**

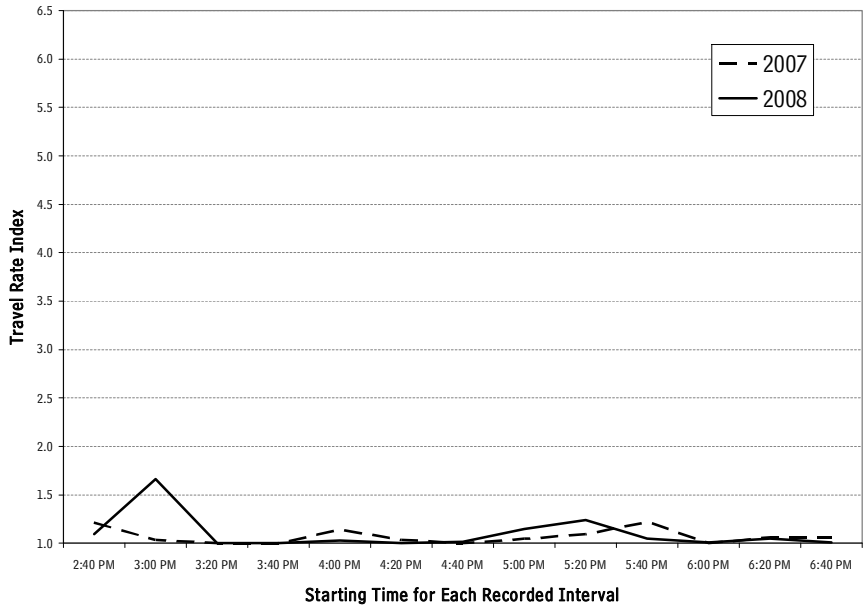


**Figure 182 SH 16 (PM Peak), IH 410 to Kingsride Blvd/Appplewhite Rd, Southbound.**

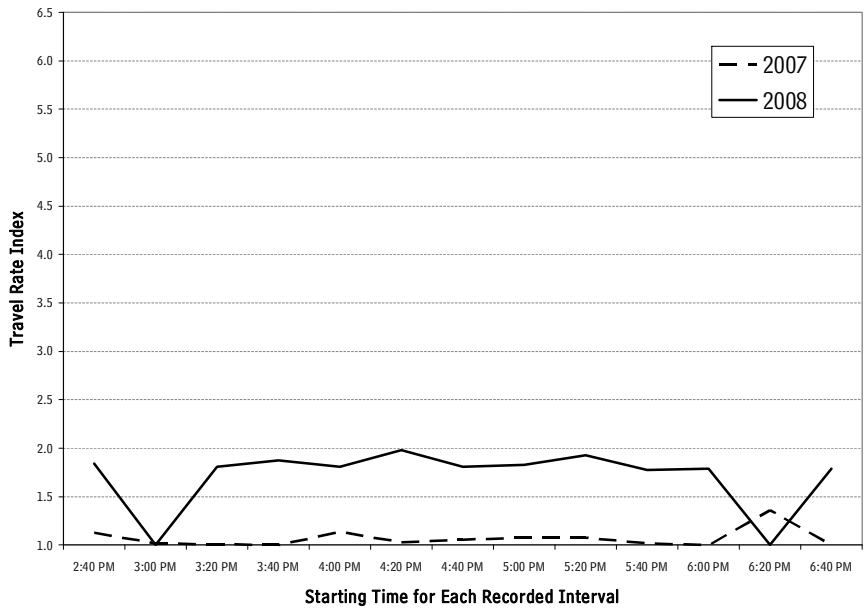


**Figure 183 SH 16 (PM Peak), Kingsride Blvd/Appplewhite Rd to S Zarzamora St, Southbound.**

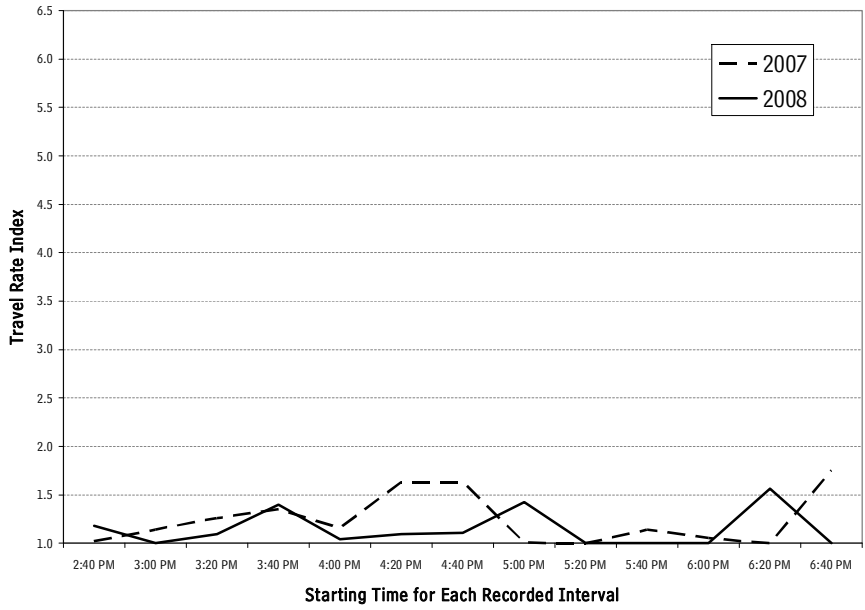




**Figure 184 SH 16 (PM Peak), S Zarzamora St to Lone Star Pass/Watson Rd, Southbound.**

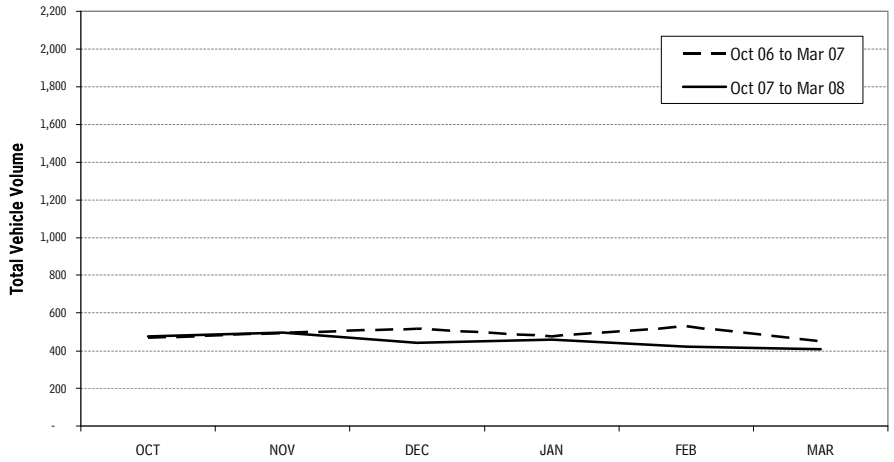


**Figure 185 SH 16 (PM Peak), Lone Star Pass/Watson Rd to Noyes Rd, Southbound.**

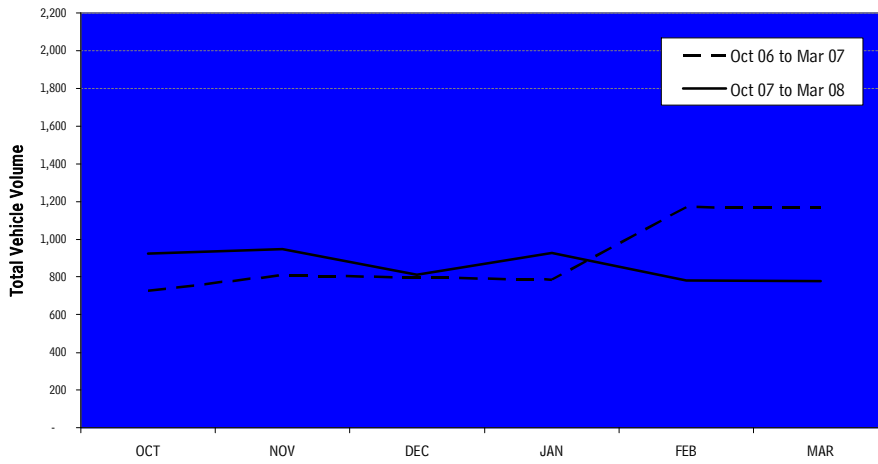


**Figure 186 SH 16 (PM Peak), Noyes Rd to SL 1604, Southbound.**

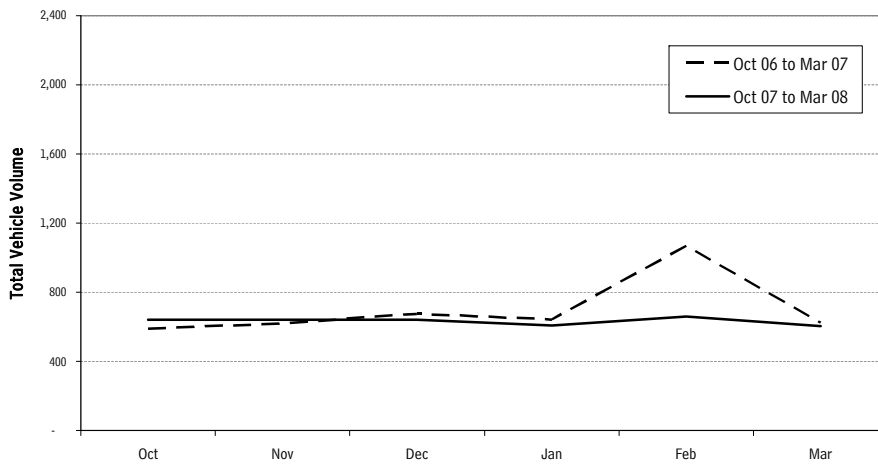
***Total Vehicle Volumes Southbound Direction, Afternoon Peak***



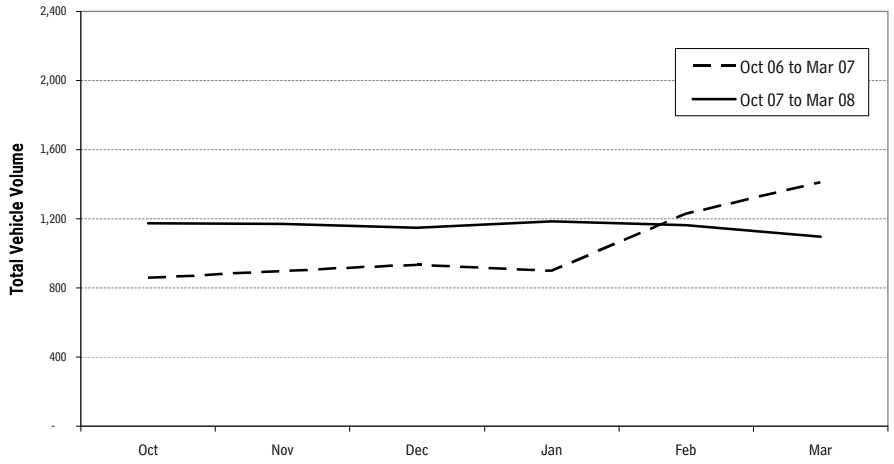
**Figure 187 Total Vehicle Volumes, Site 309 Southbound, 2 PM to 3 PM.**



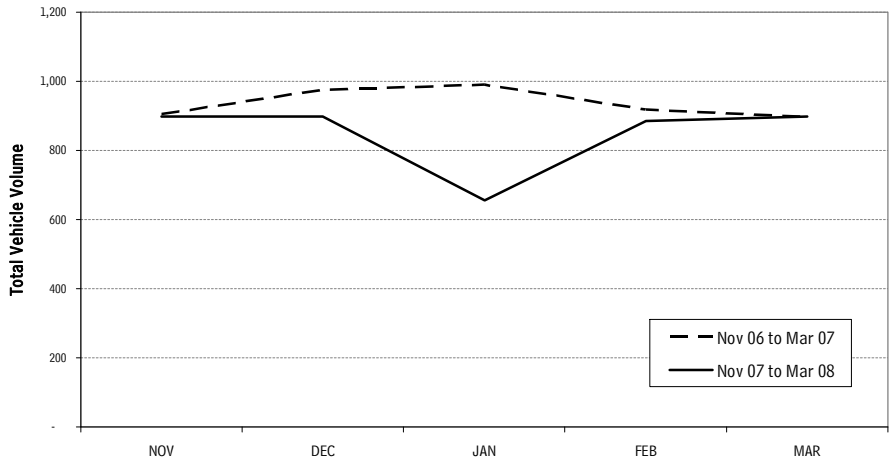
**Figure 188 Total Vehicle Volumes, Site 309 Southbound, 4 PM to 5 PM.**



**Figure 189 Total Vehicle Volumes, Site 311 Southbound, 2 PM to 3 PM.**



**Figure 190 Total Vehicle Volumes, Site 311 Southbound, 2 PM to 3 PM.**

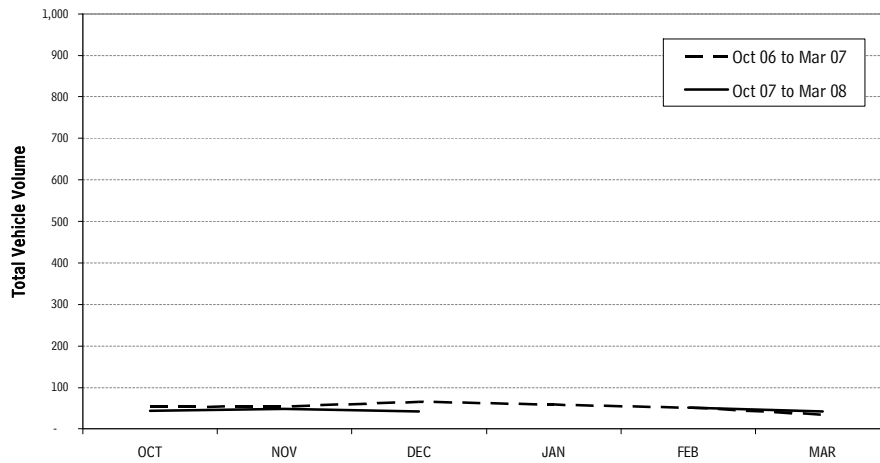


**Figure 191 Total Vehicle Volumes, Site 328 Southbound, 2 PM to 3 PM.**

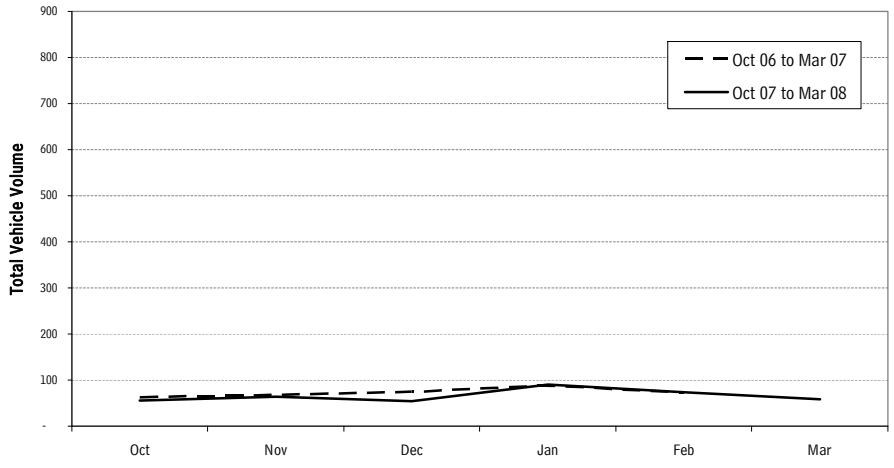
**Table 1 Peak Hours with 2007 Vehicle Volumes**

	Vehicles per Hour
2 PM to 3 PM	400
3 PM to 4 PM	600
4 PM to 5 PM	800
5 PM to 6 PM	900 - 1000
6 PM to 7 PM	800

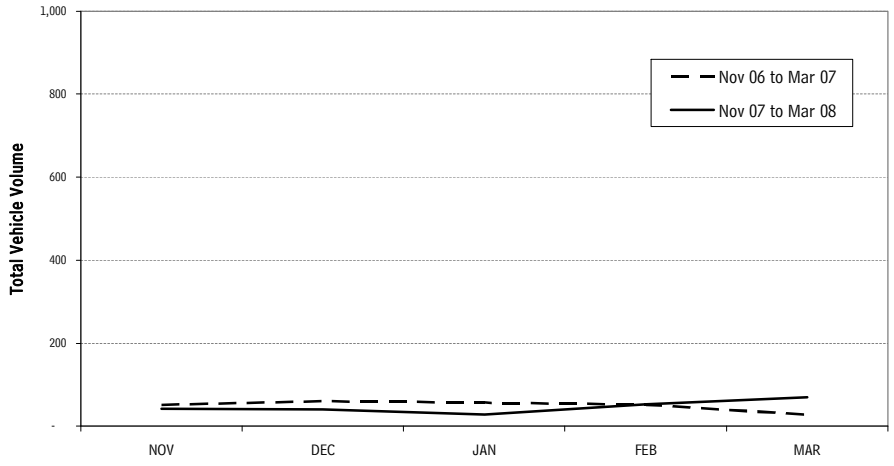
***Truck Volumes Southbound Direction, Afternoon Peak***



**Figure 192 Total Truck Volumes, Site 309 Southbound, 2 PM to 3 PM.**

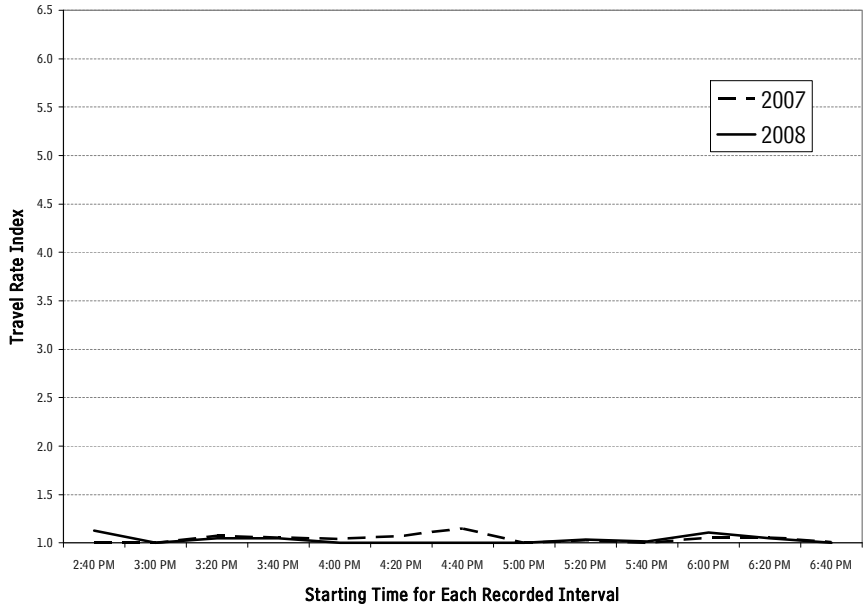


**Figure 193 Total Truck Volumes, Site 311 Southbound, 2 PM to 3 PM.**

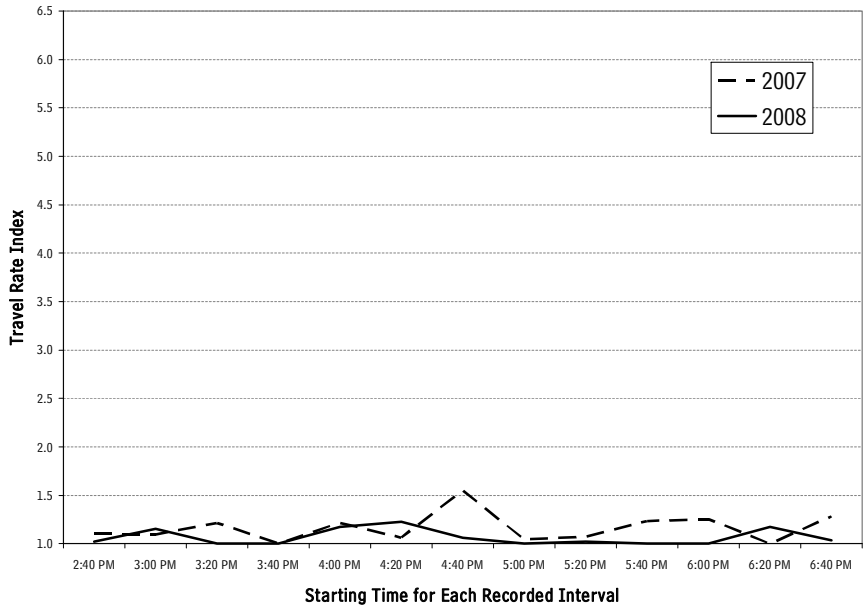


**Figure 194 Total Truck Volumes, Site 328 Southbound, 2 PM to 3 PM.**

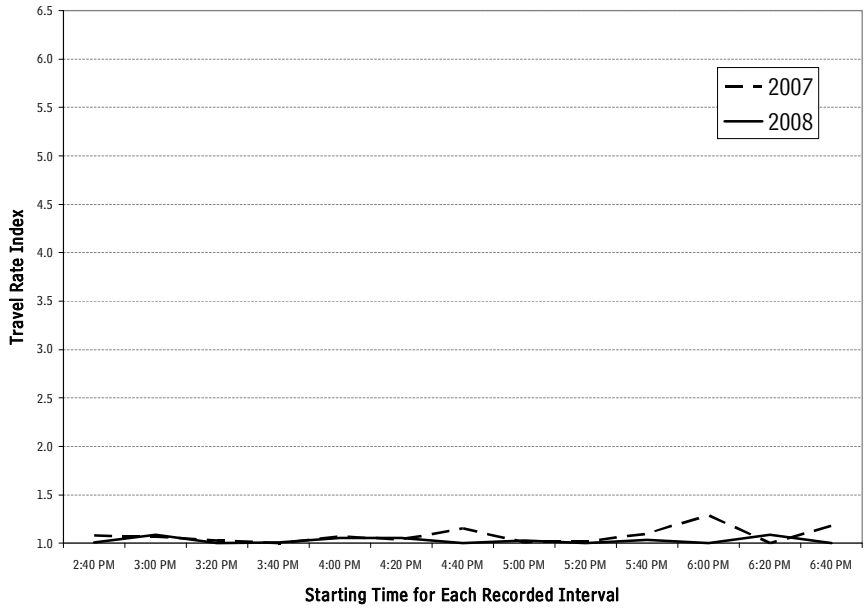
*Travel Time Runs, Afternoon Peak, Northbound Direction*



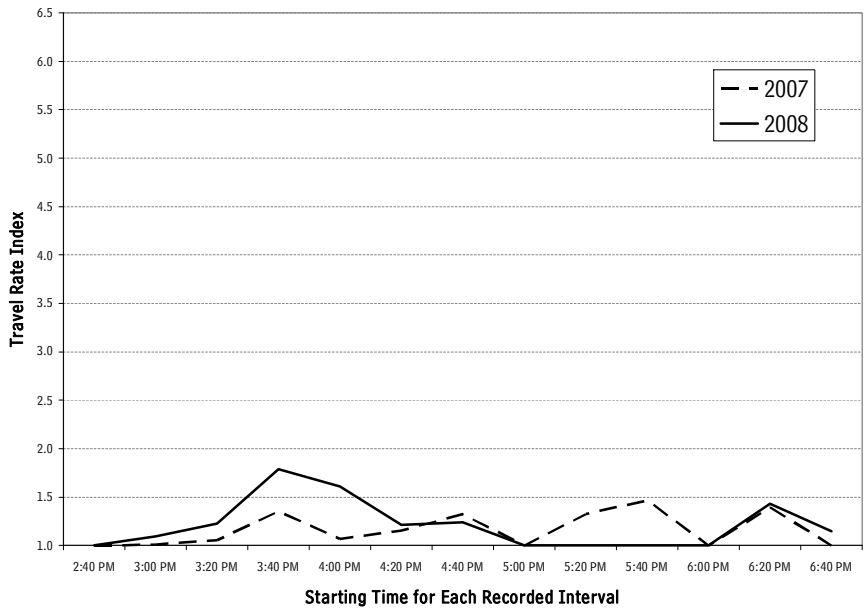
**Figure 195 SH 16 (PM Peak), Noyes Rd to SL 1604, Northbound.**



**Figure 196 SH 16 (PM Peak), Lone Star Pass/Watson Rd to Noyes Rd, Northbound.**

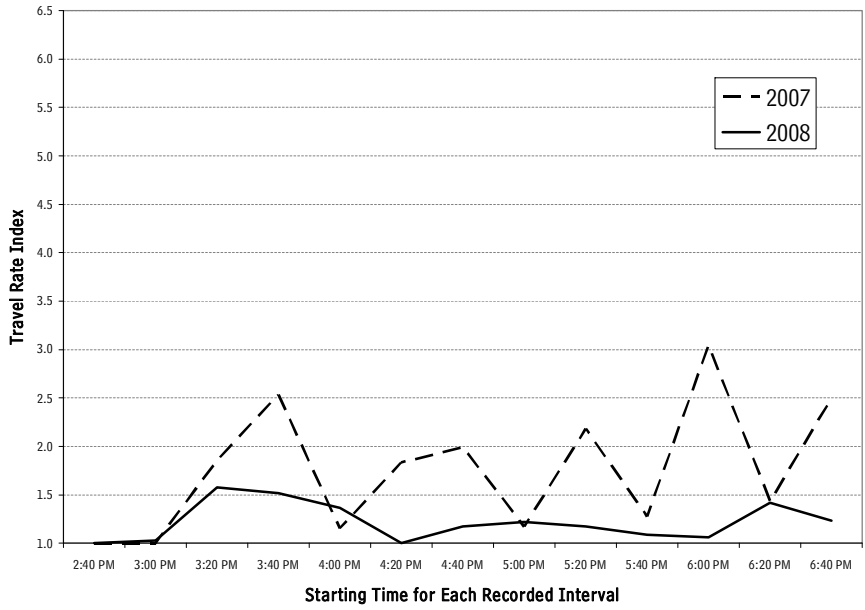


**Figure 197 SH 16 (PM Peak), S Zarzamora St to Lone Star Pass/Watson Rd, Northbound.**

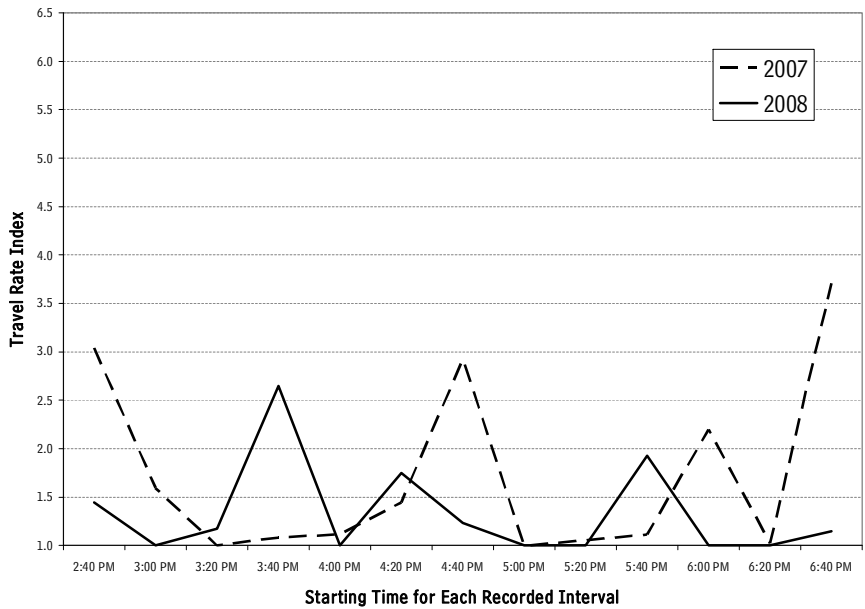


**Figure 198 SH 16 (PM Peak), Kingsride Blvd/Appplewhite Rd to S Zarzamora St, Northbound.**

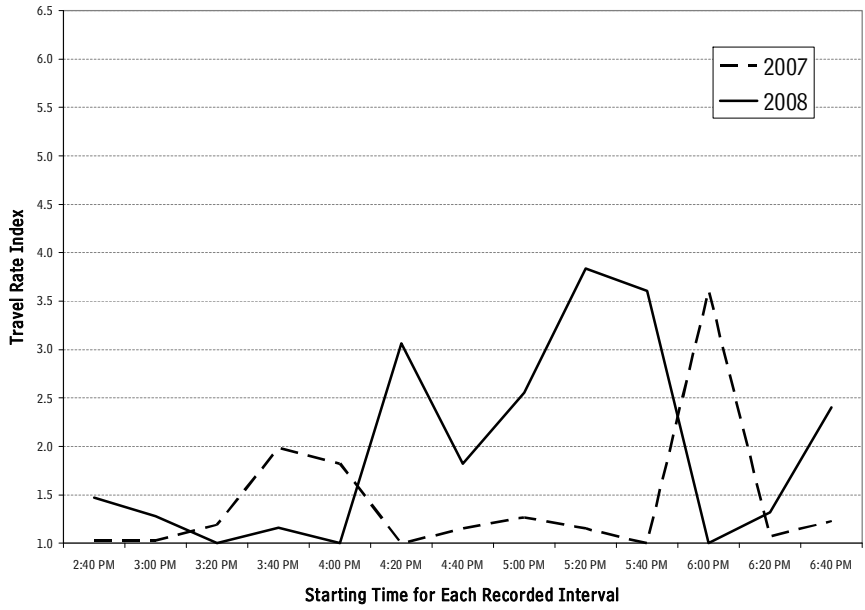




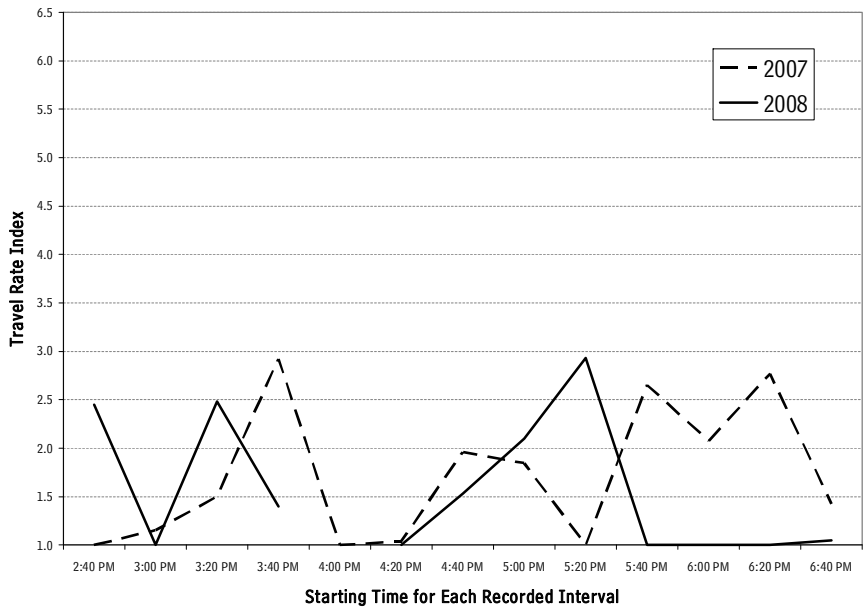
**Figure 199 SH 16 (PM Peak), IH 410 to Kingsride Blvd/Appleswhite Rd, Northbound.**



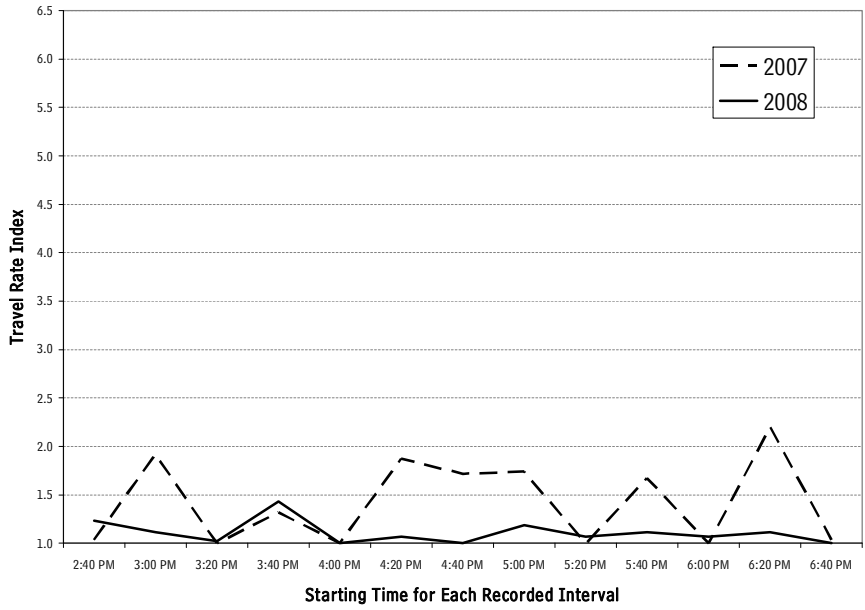
**Figure 200 SH 16 (PM Peak), W Villaret Blvd to IH 410, Northbound.**



**Figure 201 SH 16 (PM Peak), Gillette Blvd to W Villaret Blvd, Northbound.**

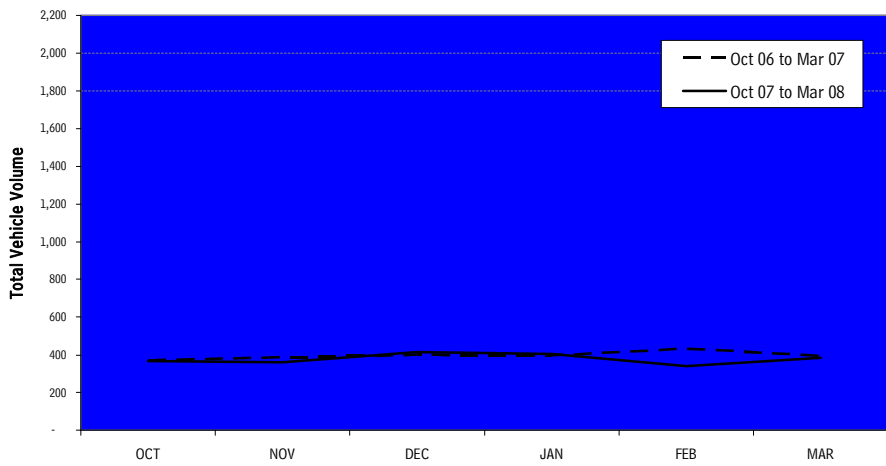


**Figure 202 SH 16 (PM Peak), Hunter Ave to Gillette Blvd, Northbound.**

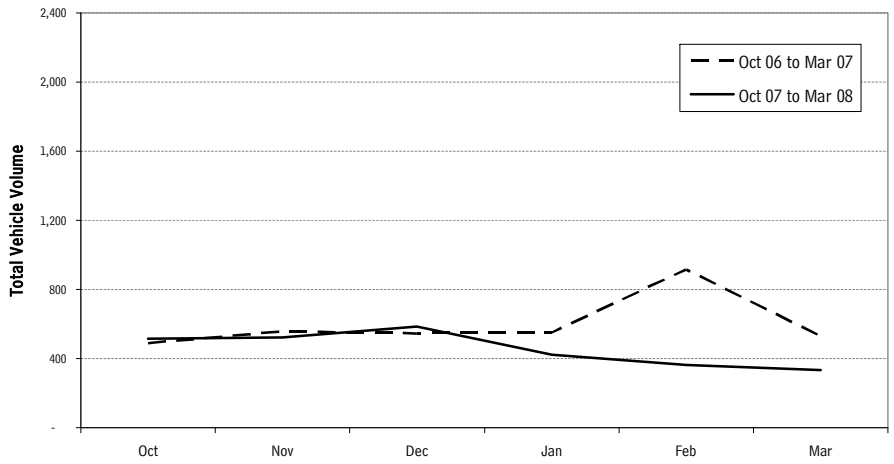


**Figure 203 SH 16 (PM Peak), IH 35 to Hunter Ave, Northbound.**

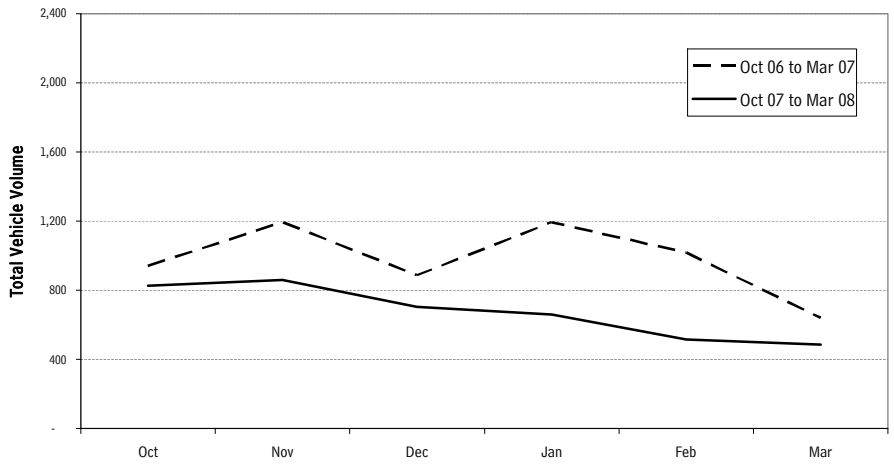
*Total Vehicle Volumes Northbound Direction, Afternoon Peak*



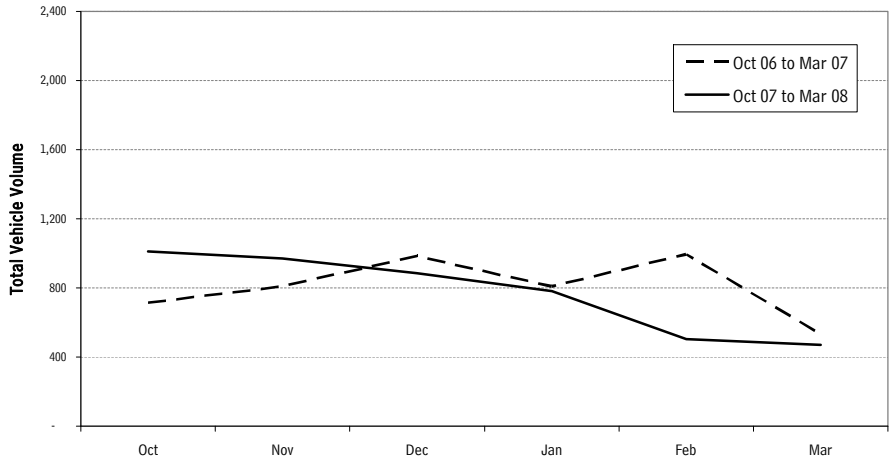
**Figure 204 Total Vehicle Volumes, Site 309 Northbound, 2 PM to 3 PM.**



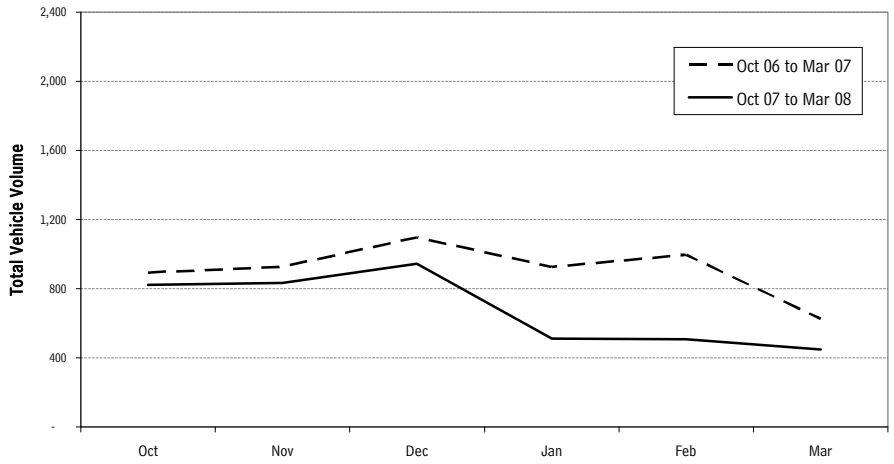
**Figure 205 Total Vehicle Volumes, Site 311 Northbound, 2 PM to 3 PM.**



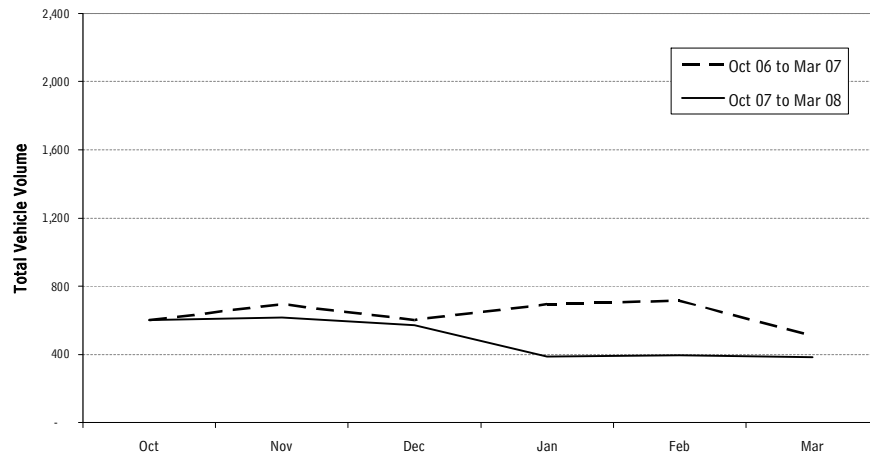
**Figure 206 Total Vehicle Volumes, Site 311 Northbound, 3 PM to 4 PM.**



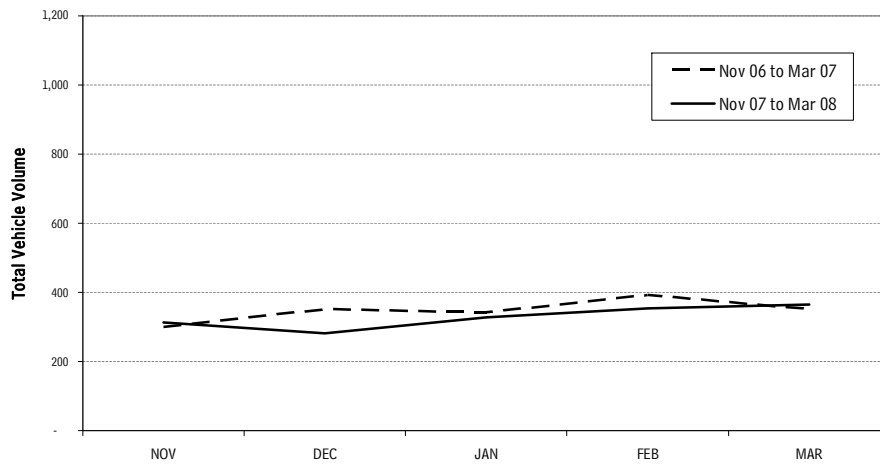
**Figure 207 Total Vehicle Volumes, Site 311 Northbound, 4 PM to 5 PM.**



**Figure 208 Total Vehicle Volumes, Site 311 Northbound, 5 PM to 6 PM.**

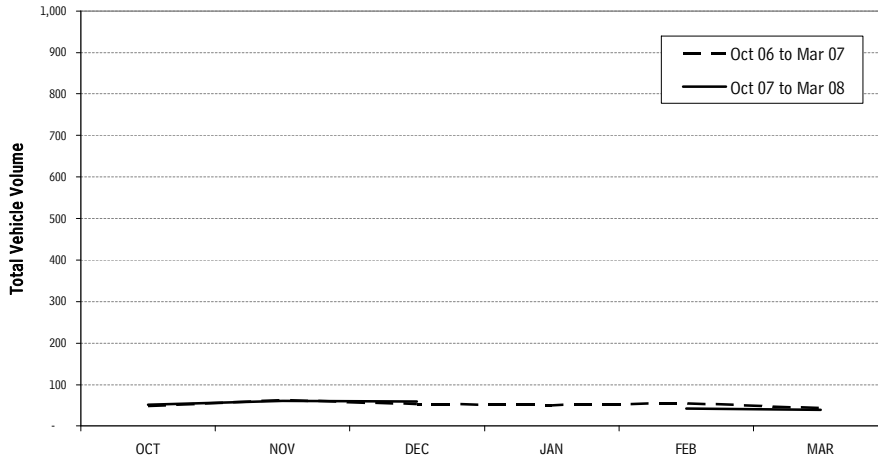


**Figure 209 Total Vehicle Volumes, Site 311 Northbound, 6 PM to 7 PM.**

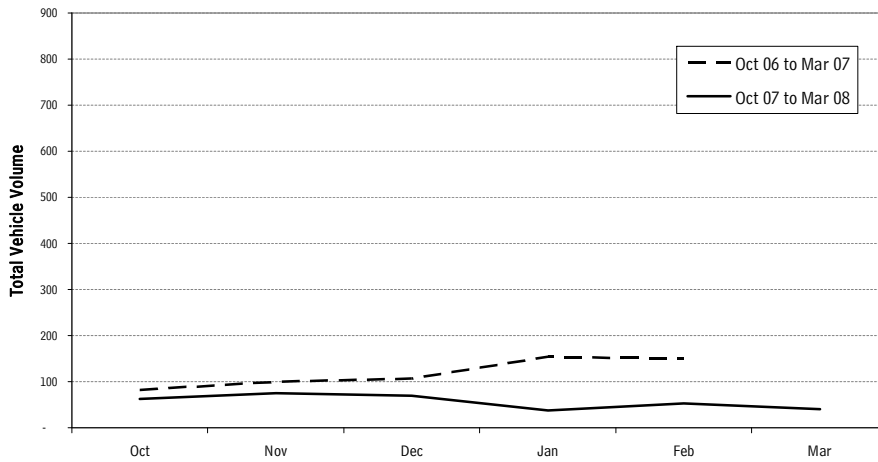


**Figure 210 Total Vehicle Volumes, Site 328 Northbound, 2 PM to 3 PM.**

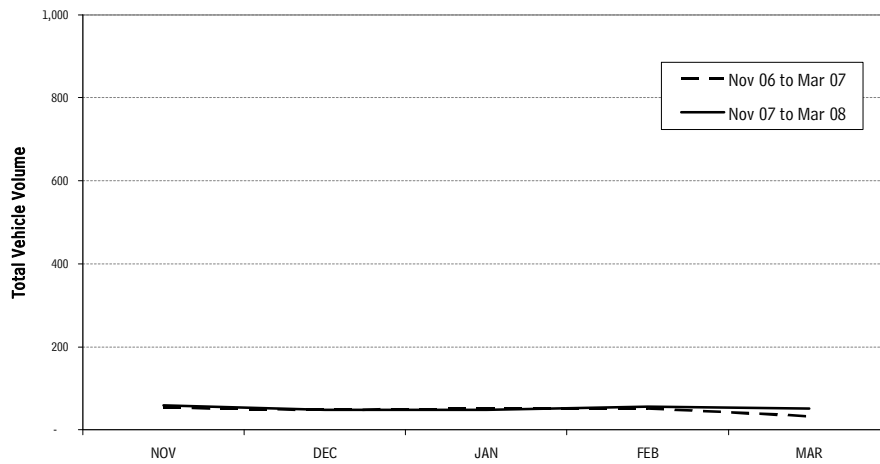
***Truck Volumes Northbound Direction, Afternoon Peak***



**Figure 211 Total Truck Volumes, Site 309 Northbound, 2 PM to 3 PM.**



**Figure 212 Total Truck Volumes, Site 311 Northbound, 2 PM to 3 PM.**



**Figure 213 Total Truck Volumes, Site 328 Northbound, 2 PM to 3 PM.**

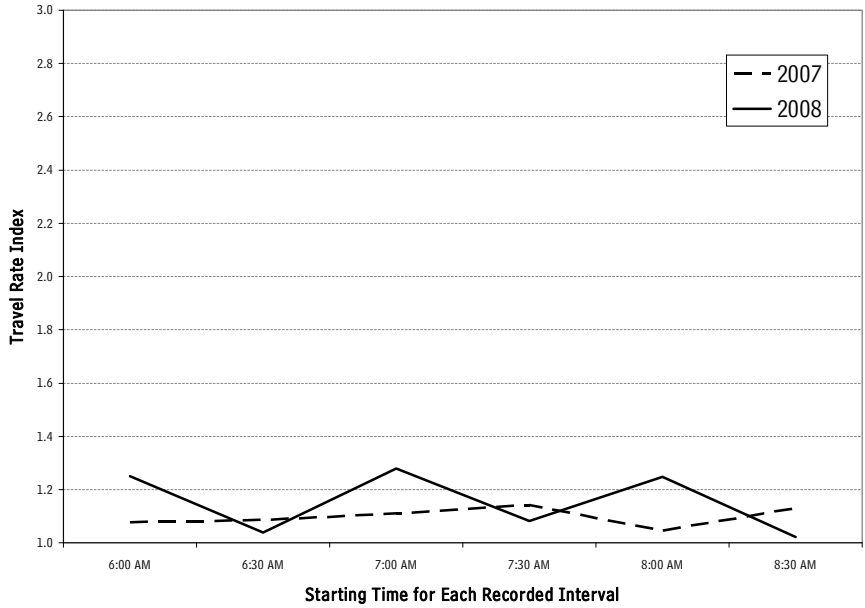
**Corridor 4: SL 1604 from IH 35 to IH 37**

Corridor 4 is defined in linked segments as follows:

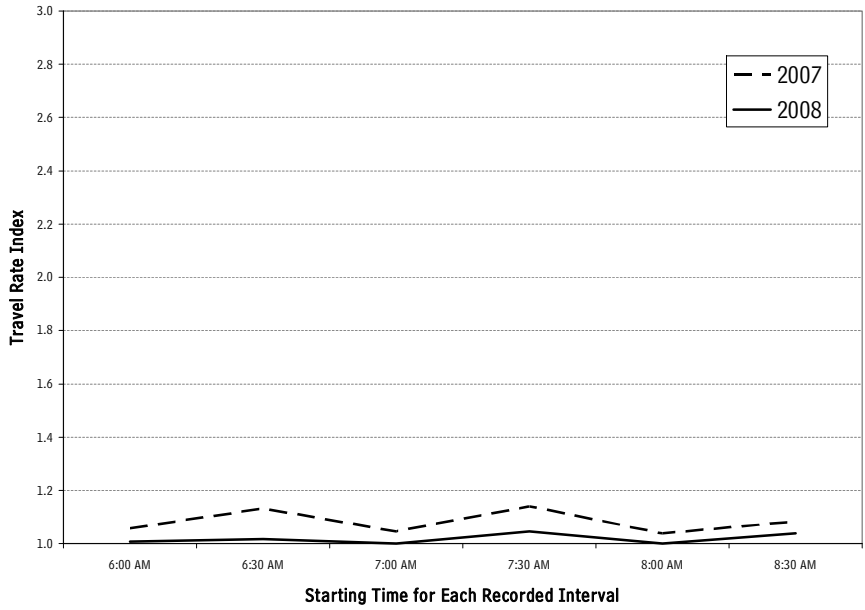
- (A) SL 1604 from IH 35 to FM 2790
- (B) SL 1604 from FM 2790 to Senior Rd
- (C) SL 1604 from Senior Rd to SH 16
- (D) SL 1604 from SH 16 to Applewhite Rd
- (E) SL 1604 from Applewhite Rd to SH 281
- (F) SL 1604 from SH 281 to IH 37



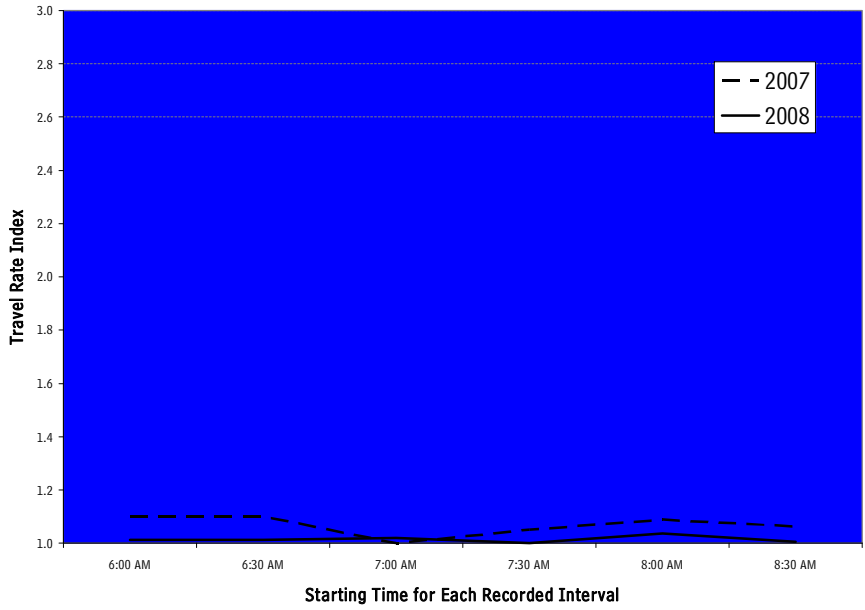
*Travel Time Runs, Morning Peak, Eastbound Direction*



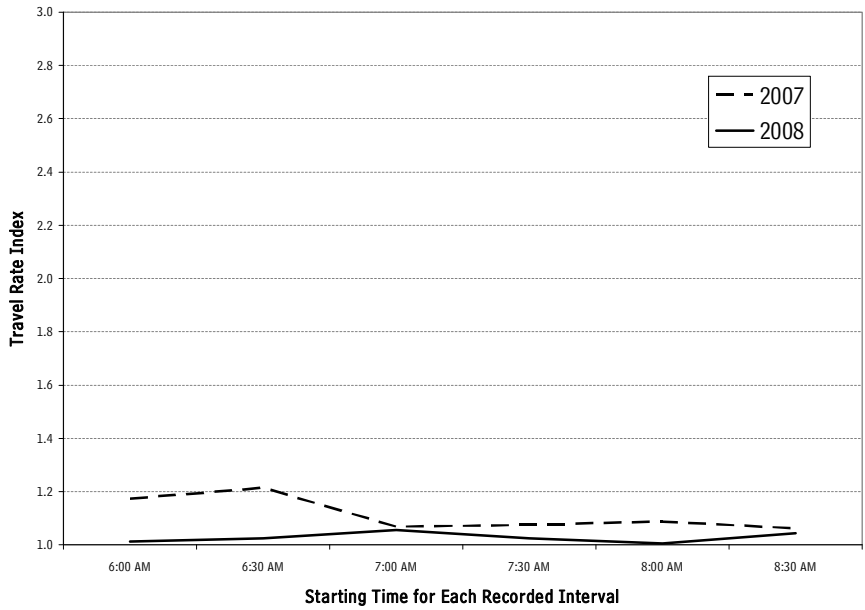
**Figure 214 SL 1604 (AM Peak), IH 35 to FM 2790, Eastbound.**



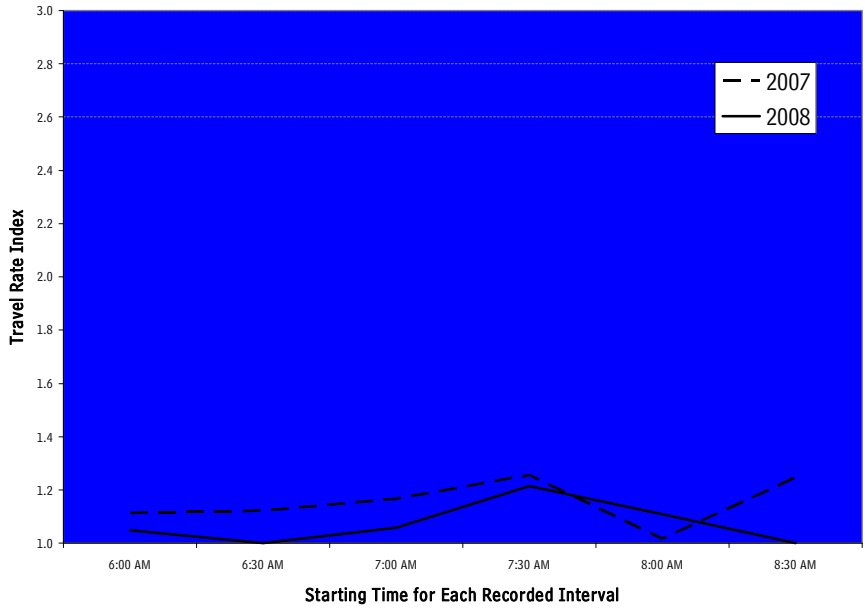
**Figure 215 SL 1604 (AM Peak), FM 2790 to Senior Rd, Eastbound.**



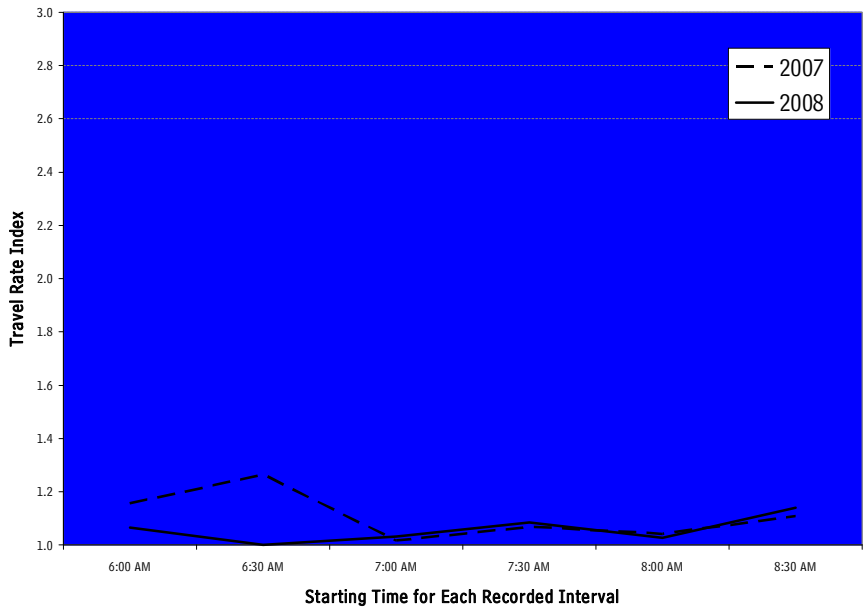
**Figure 216 SL 1604 (AM Peak), Senior Rd to SH 16, Eastbound.**



**Figure 217 SL 1604 (AM Peak), SH 16 to Applewhite Rd, Eastbound.**

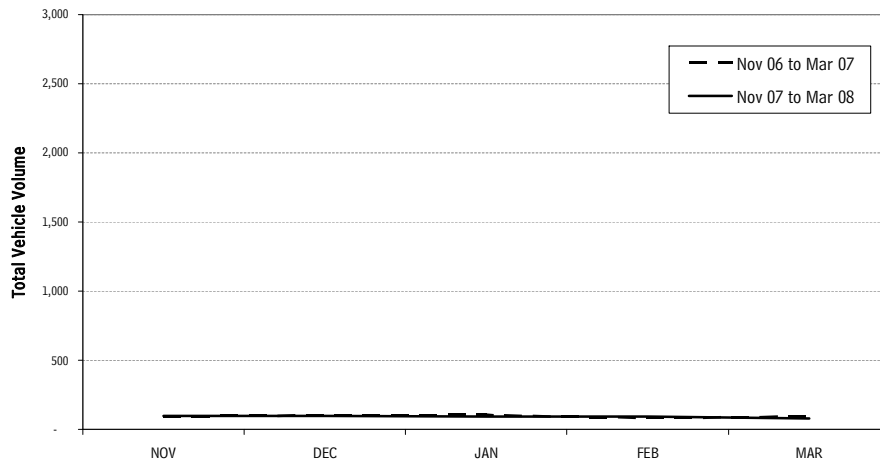


**Figure 218 SL 1604 (AM Peak), Applewhite Rd to SH 281, Eastbound.**

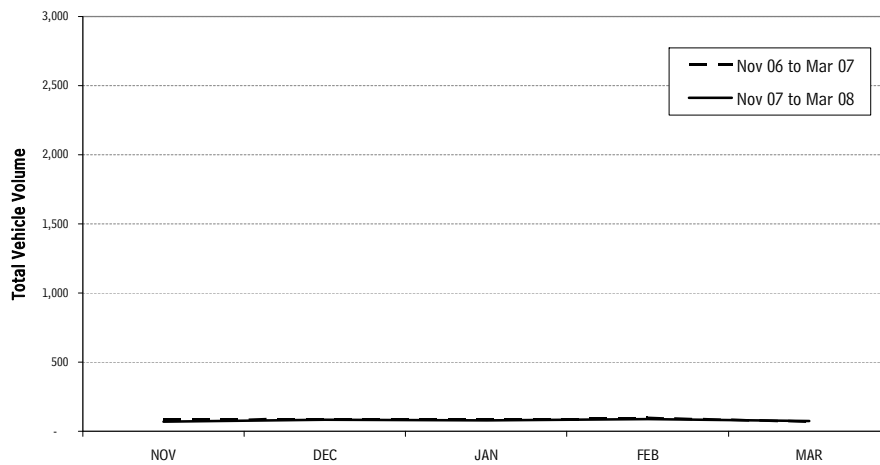


**Figure 219 SL 1604 (AM Peak), SH 281 to IH 37, Eastbound.**

***Total Vehicle Volumes Eastbound Direction, Morning Peak***

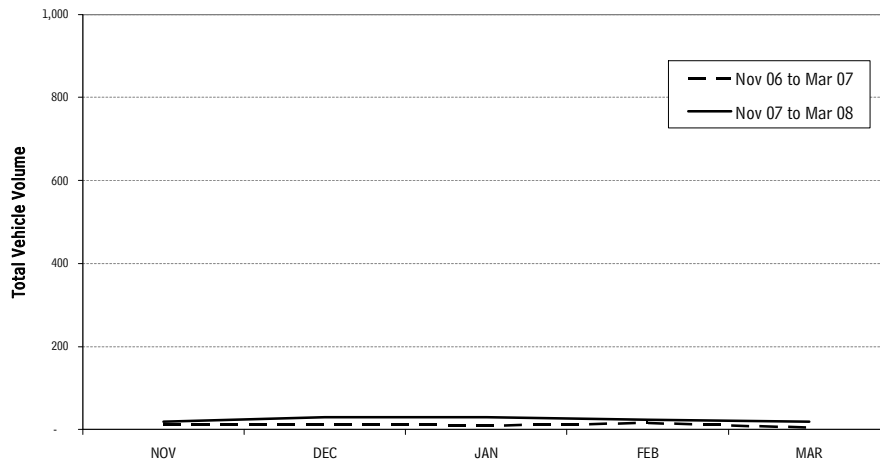


**Figure 220 Total Vehicle Volumes, Site 317 Eastbound, 6 AM to 7 AM.**

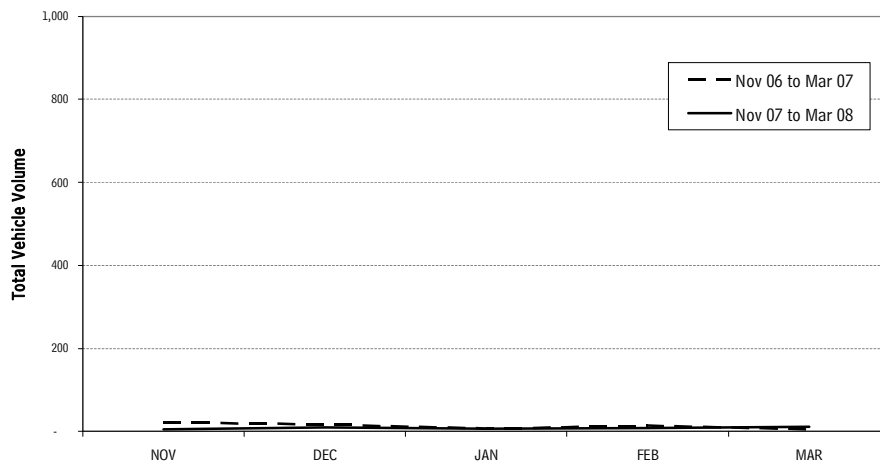


**Figure 221 Total Vehicle Volumes, Site 318 Eastbound, 6 AM to 7 AM.**

***Truck Volumes Eastbound Direction, Morning Peak***

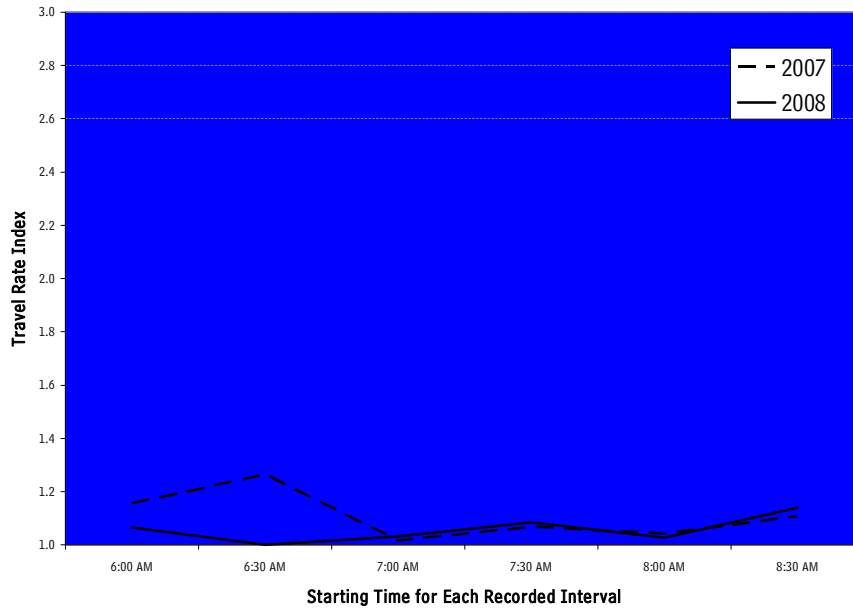


**Figure 222 Total Truck Volumes, Site 317 Eastbound, 6 AM to 7 AM.**

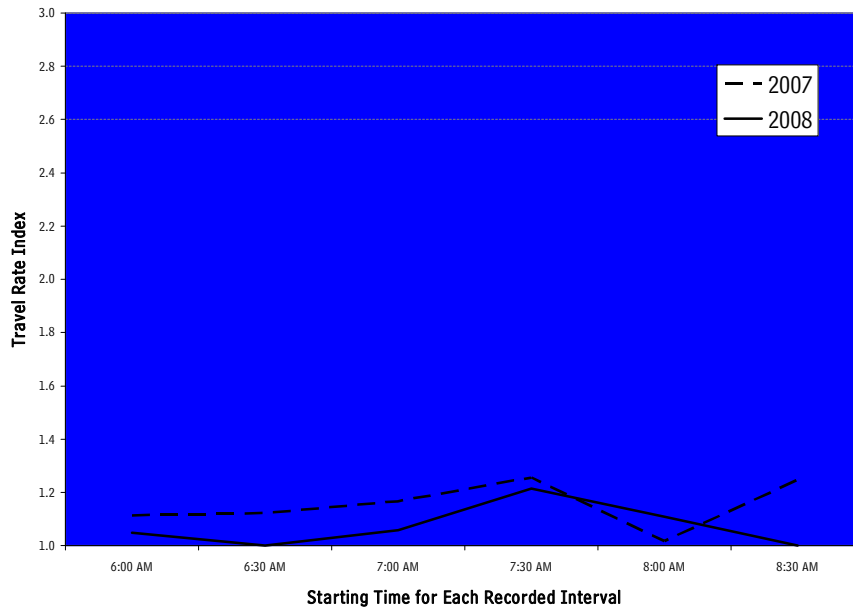


**Figure 223 Total Truck Volumes, Site 318 Eastbound, 6 AM to 7 AM.**

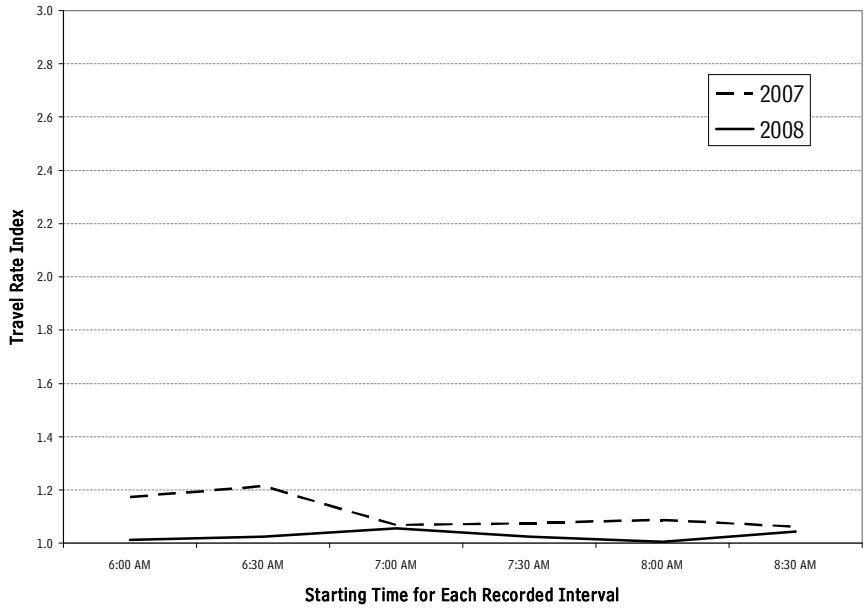
*Travel Time Runs, Morning Peak, Westbound Direction*



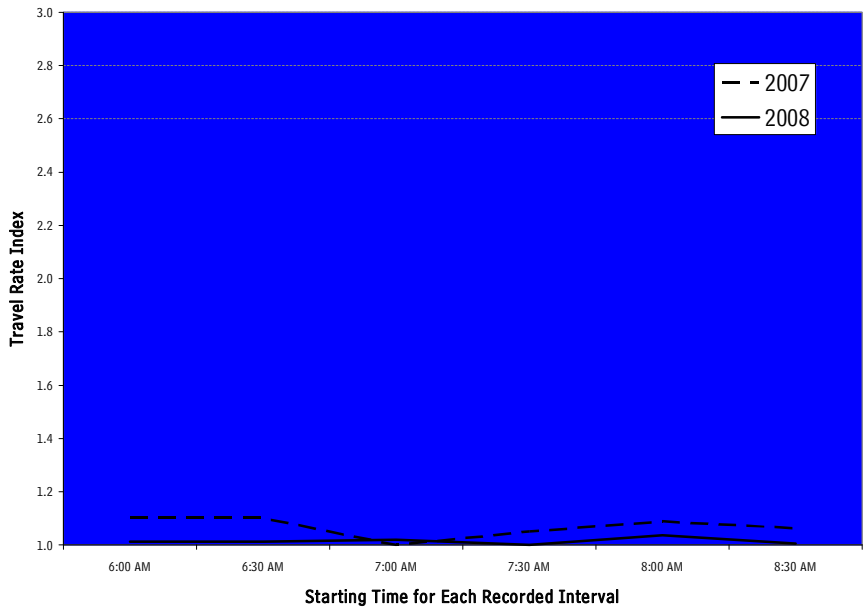
**Figure 224. SL 1604 (AM Peak), SH 281 to IH 37, Eastbound.**



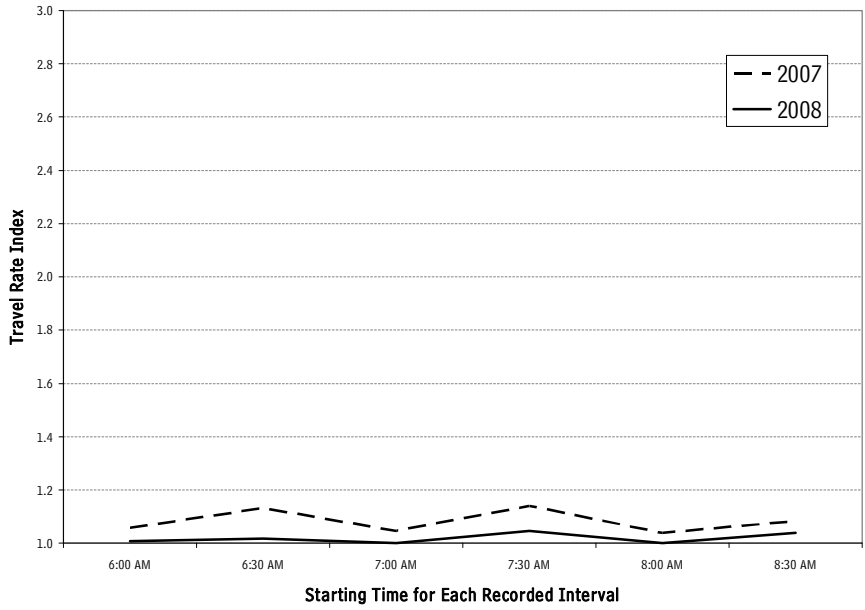
**Figure 225. SL 1604 (AM Peak), Applewhite Rd to SH 281, Eastbound.**



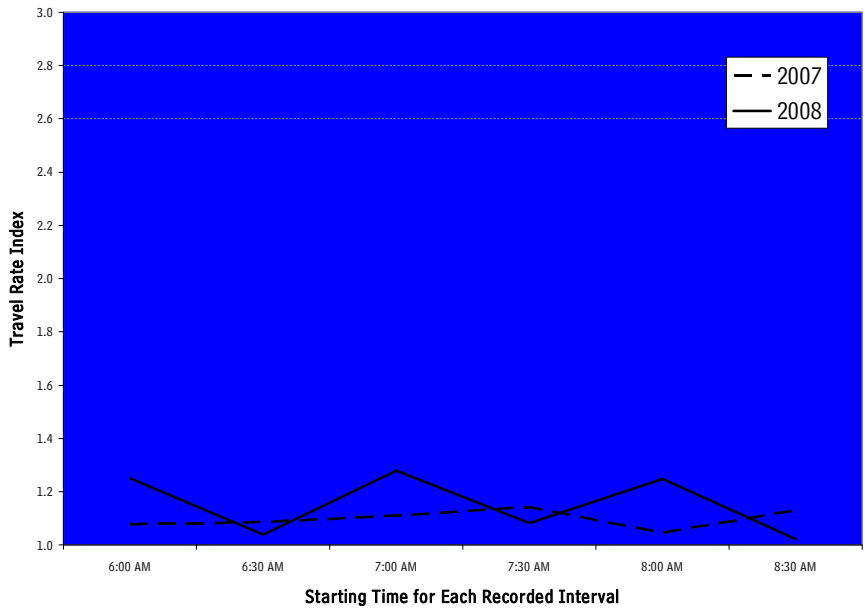
**Figure 226 SL 1604 (AM Peak), SH 16 to Applewhite Rd, Eastbound.**



**Figure 227 SL 1604 (AM Peak), Senior Rd to SH 16, Eastbound.**



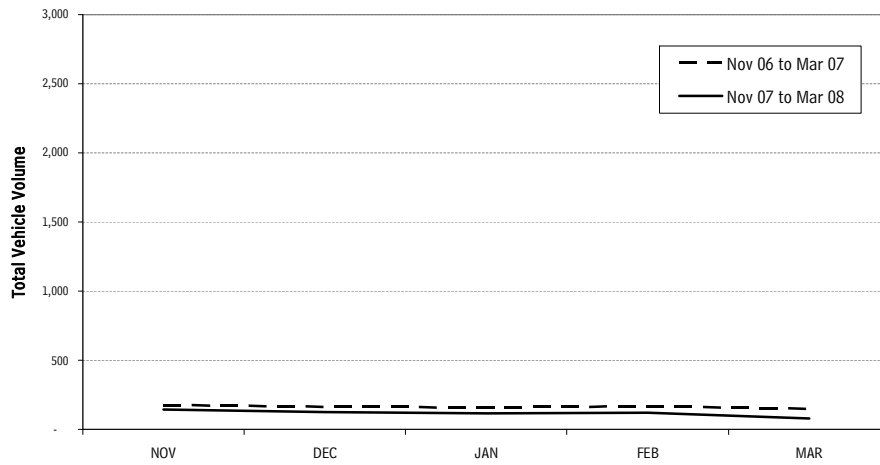
**Figure 228 SL 1604 (AM Peak), FM 2790 to Senior Rd, Eastbound.**



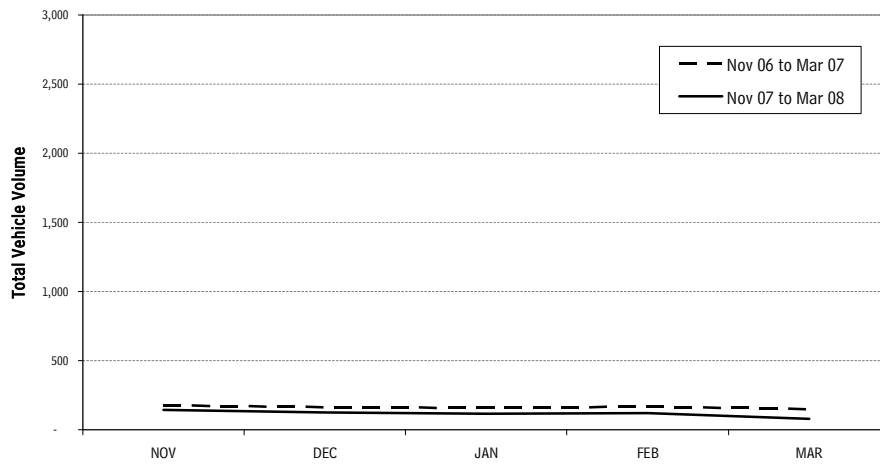
**Figure 229 SL 1604 (AM Peak), IH 35 to FM 2790, Eastbound.**



***Total Vehicle Volumes Westbound Direction, Morning Peak***

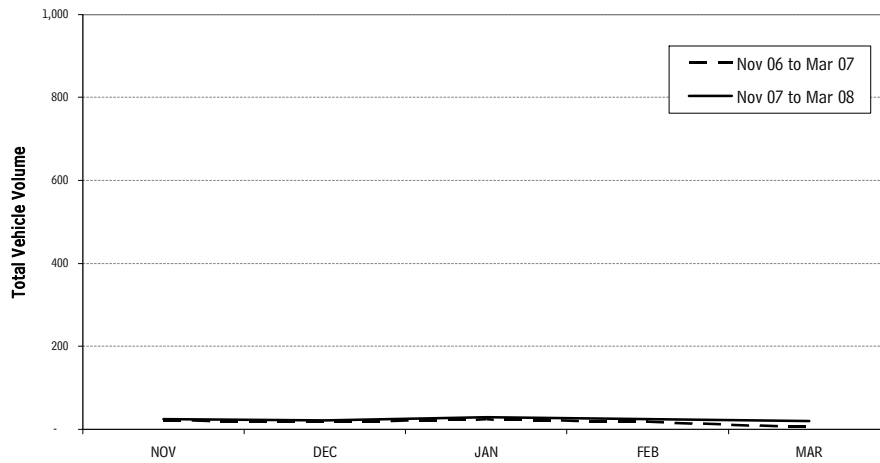


**Figure 230 Total Vehicle Volumes, Site 317 Westbound, 6 AM to 7 AM.**

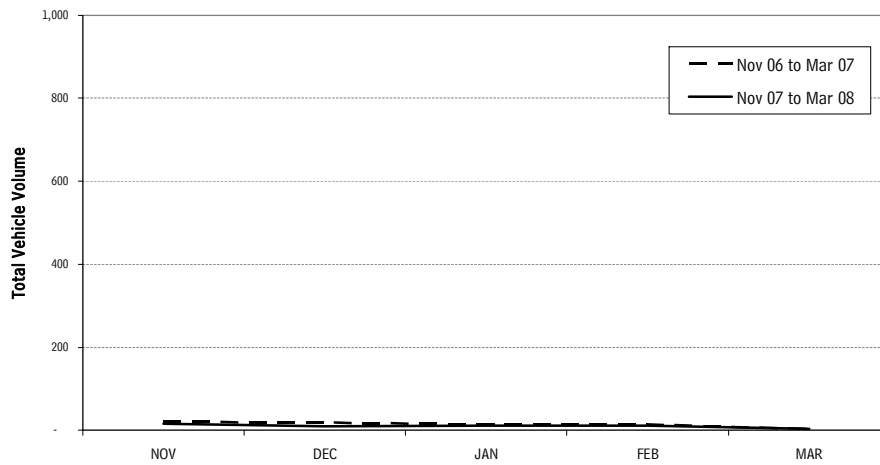


**Figure 231 Total Vehicle Volumes, Site 318 Westbound, 6 AM to 7 AM.**

***Truck Volumes Westbound Direction, Morning Peak***

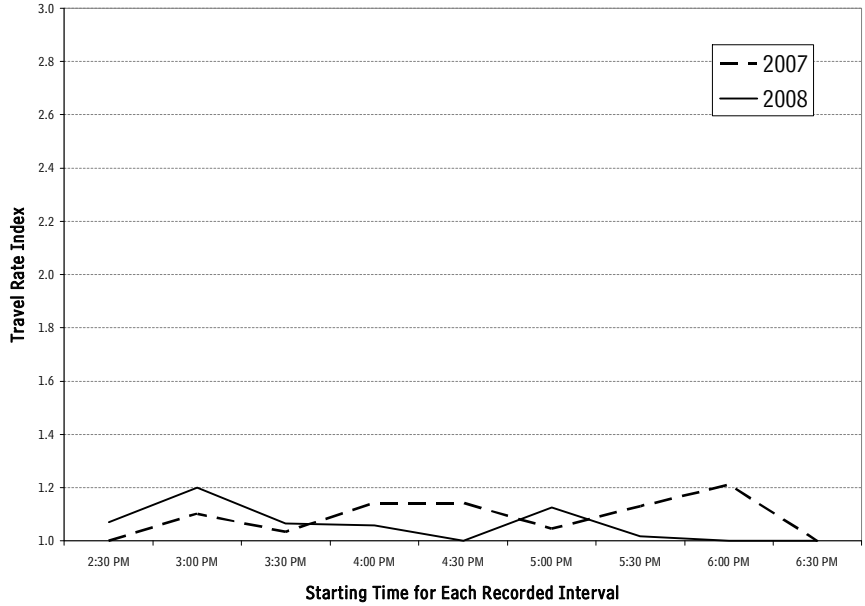


**Figure 232 Total Truck Volumes, Site 317 Westbound, 6 AM to 7 AM.**

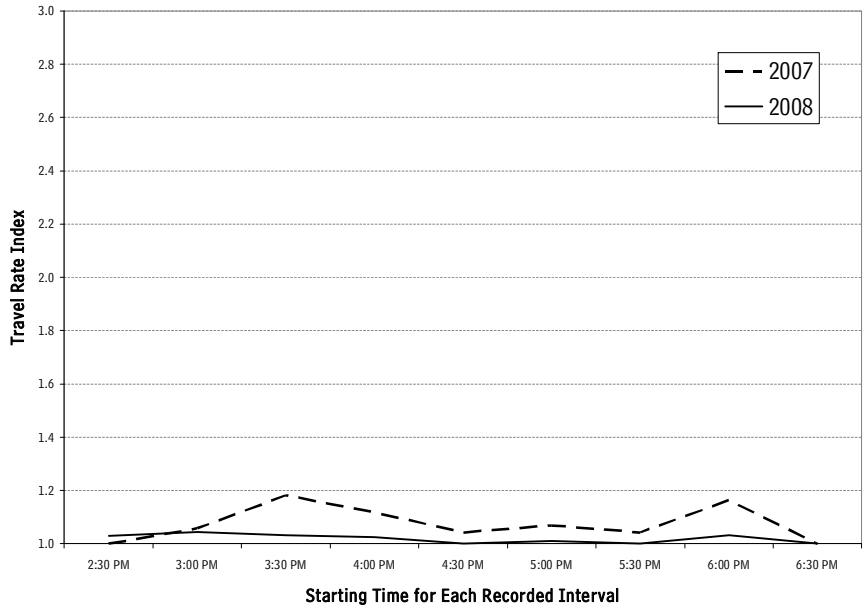


**Figure 233 Total Truck Volumes, Site 318 Westbound, 6 AM to 7 AM.**

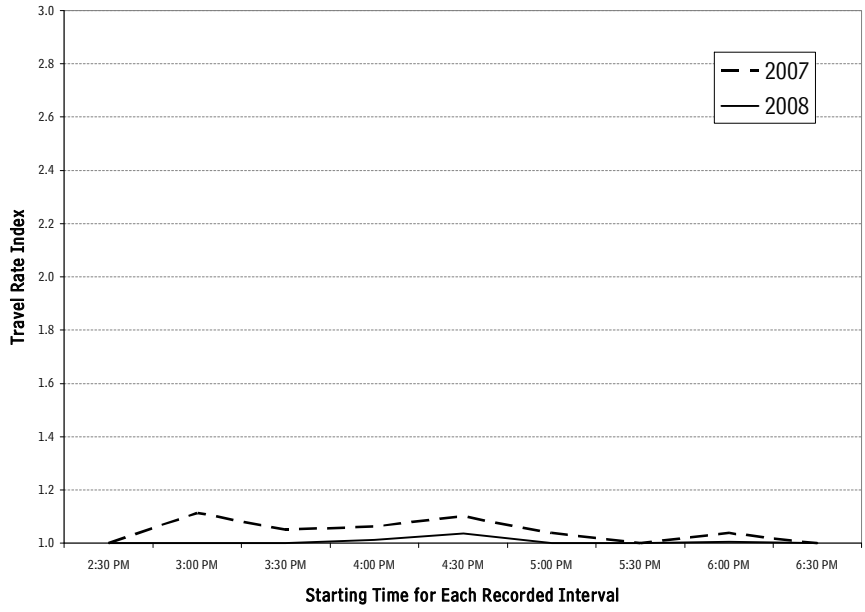
*Travel Time Runs, Afternoon Peak, Eastbound Direction*



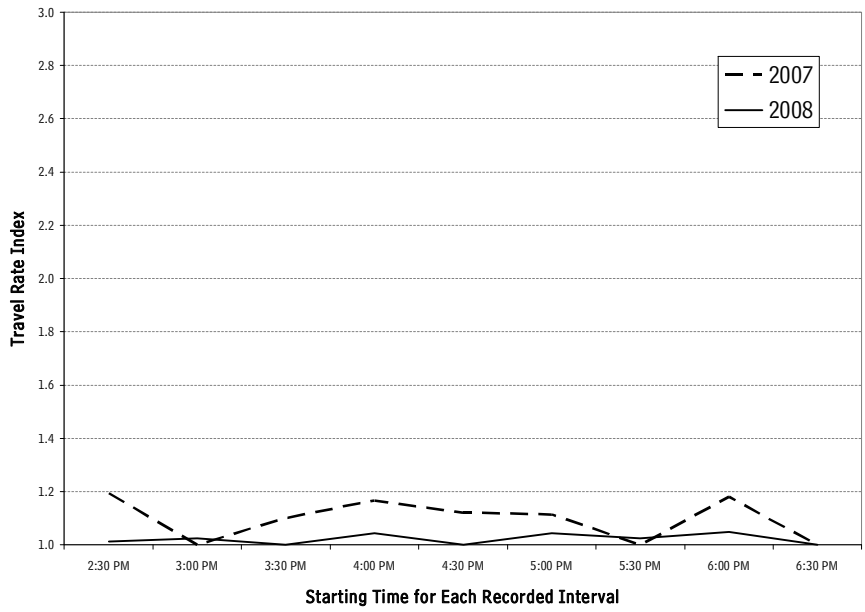
**Figure 234 SL 1604 (PM Peak), IH 35 to FM 2790, Eastbound.**



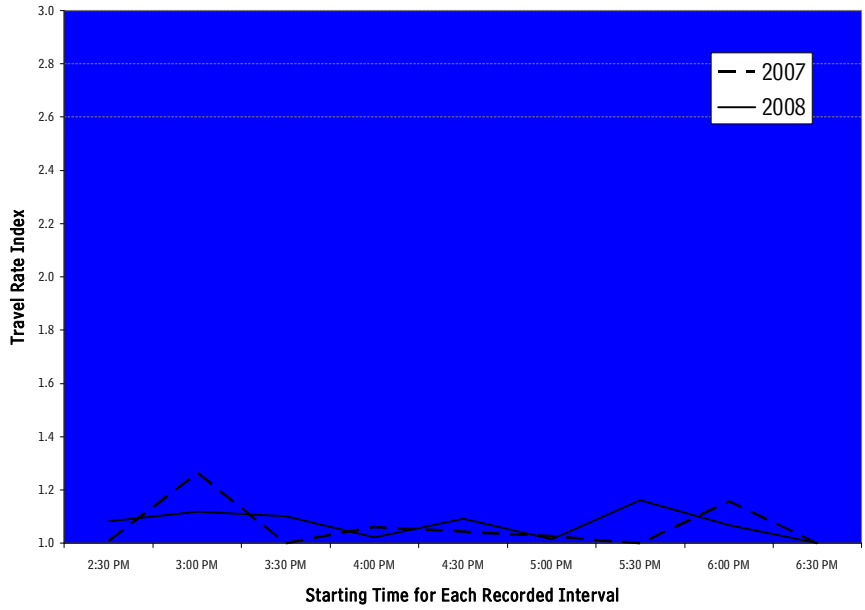
**Figure 235 SL 1604 (PM Peak), FM 2790 to Senior Rd, Eastbound.**



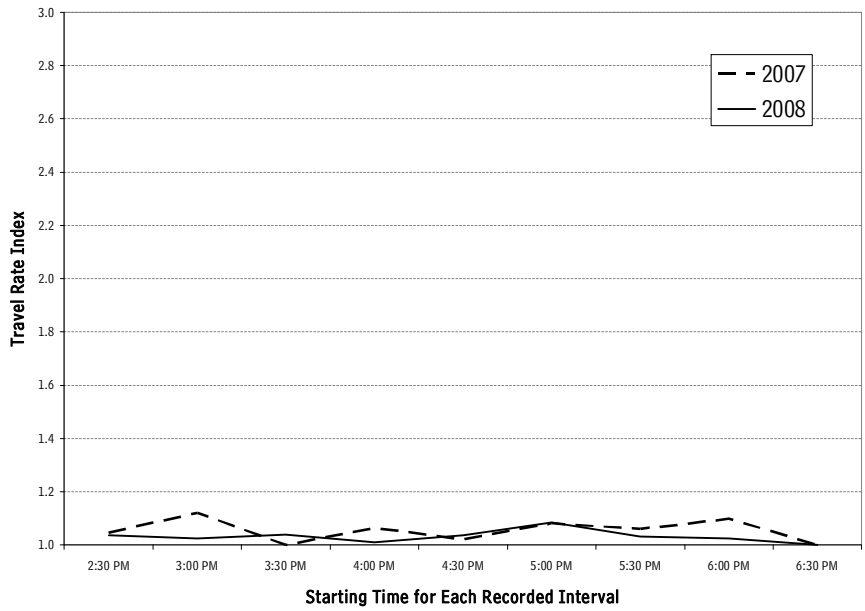
**Figure 236 SL 1604 (PM Peak), Senior Rd to SH 16, Eastbound.**



**Figure 237 SL 1604 (PM Peak), SH 16 to Applewhite Rd, Eastbound.**

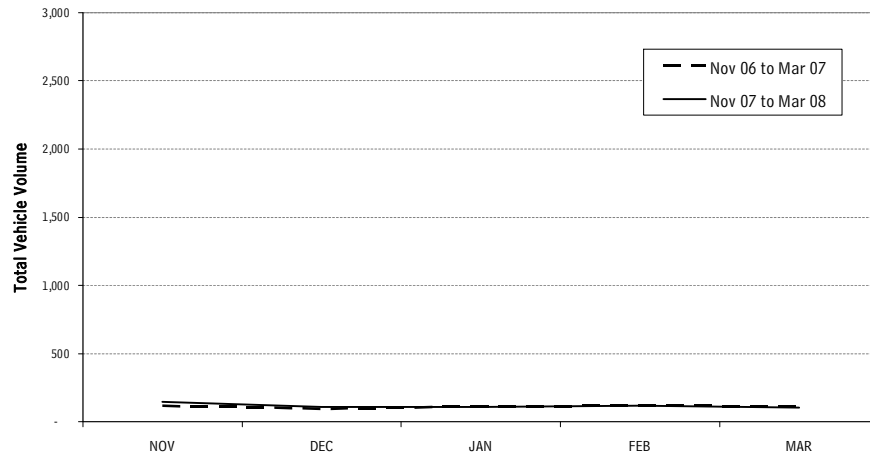


**Figure 238 SL 1604 (PM Peak), Applewhite Rd to SH 281, Eastbound.**

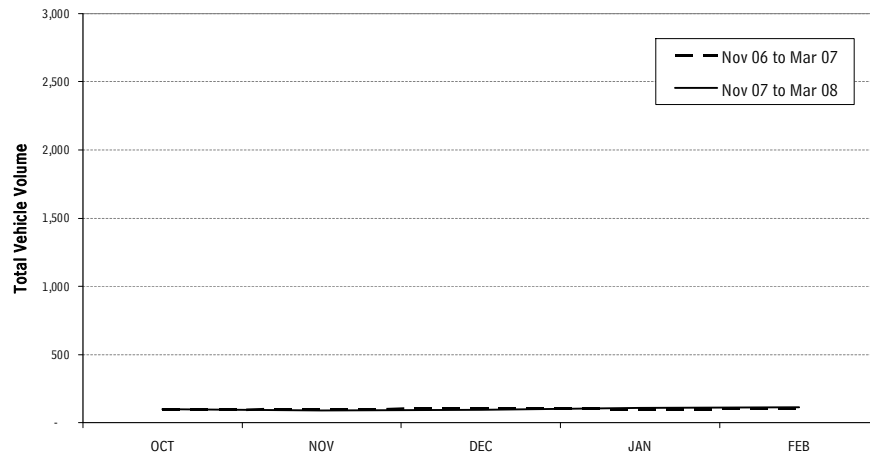


**Figure 239 SL 1604 (PM Peak), SH 281 to IH 37, Eastbound.**

**Total Vehicle Volumes Eastbound Direction, Afternoon Peak**

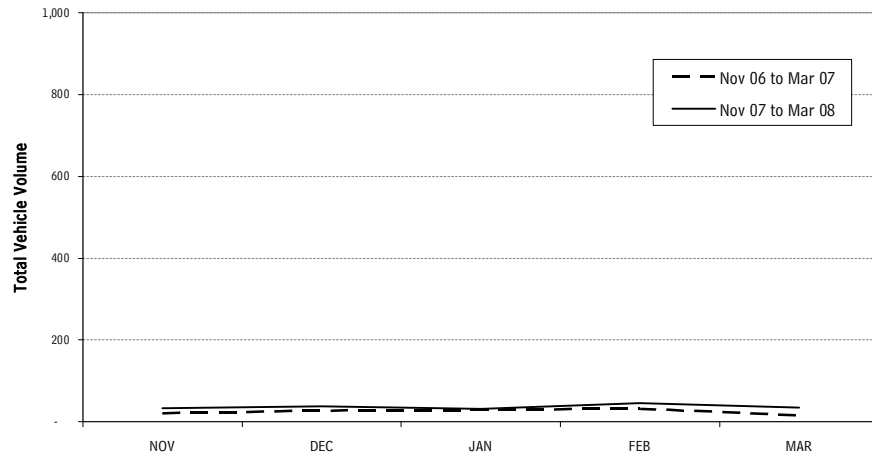


**Figure 240 Total Vehicle Volumes, Site 317 Eastbound, 2 PM to 3 PM.**

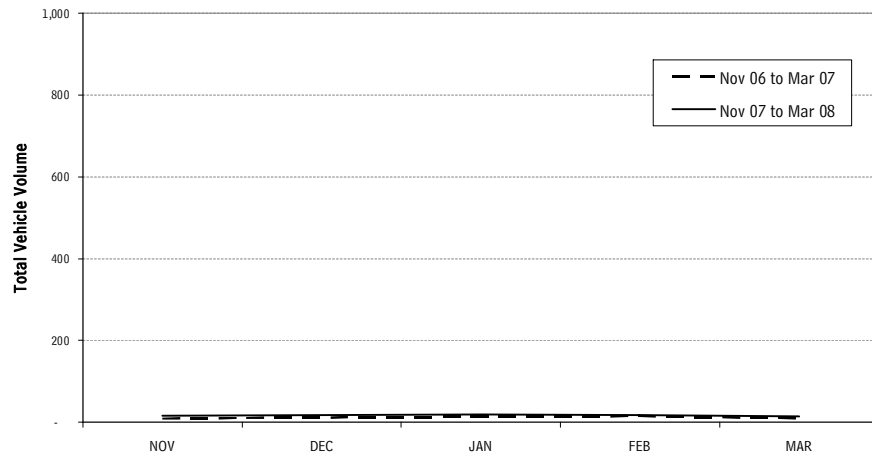


**Figure 241 Total Vehicle Volumes, Site 318 Eastbound, 2 PM to 3 PM.**

***Truck Volumes Eastbound Direction, Afternoon Peak***

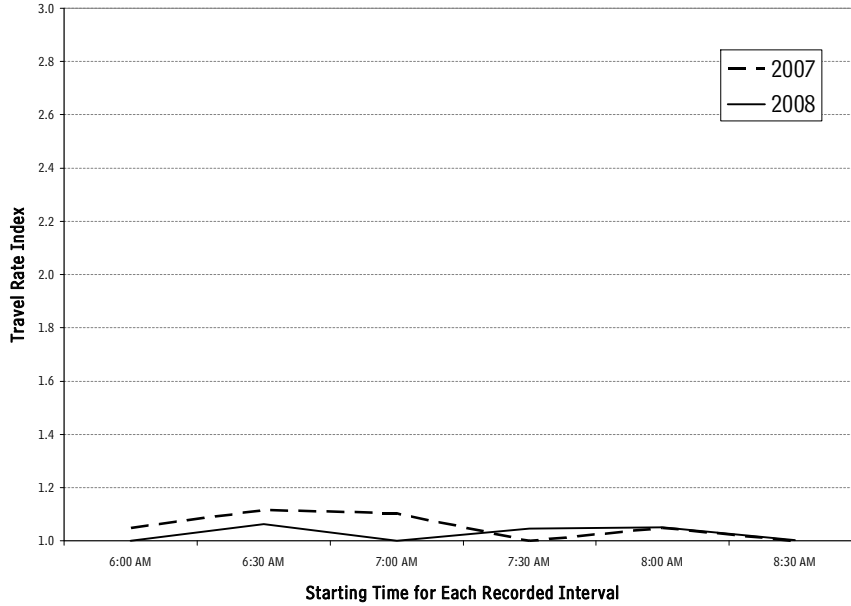


**Figure 242 Total Truck Volumes, Site 317 Eastbound, 2 PM to 3 PM.**

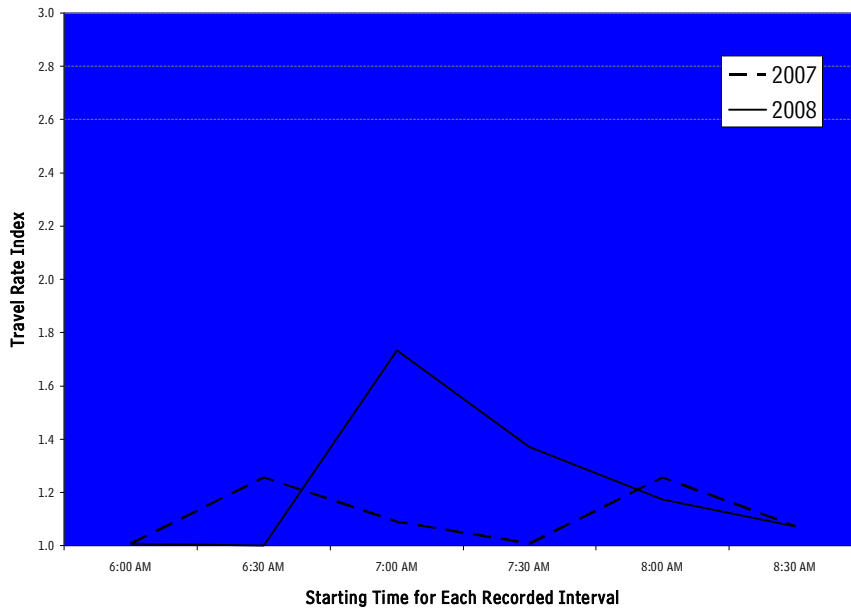


**Figure 243 Total Truck Volumes, Site 318 Eastbound, 2 PM to 3 PM.**

***Travel Time Runs, Afternoon Peak, Westbound Direction***

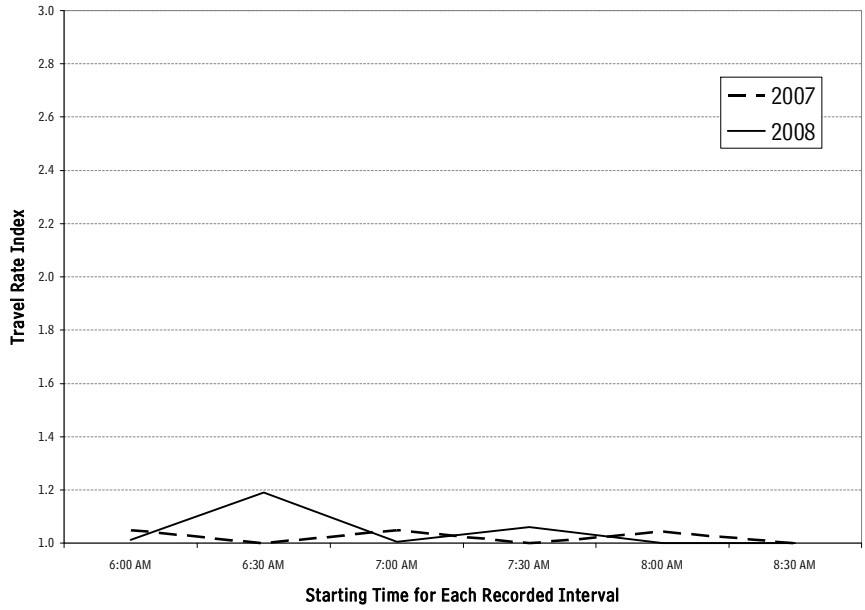


**Figure 244 SL 1604 (PM Peak), SH 281 to IH 37, Westbound.**

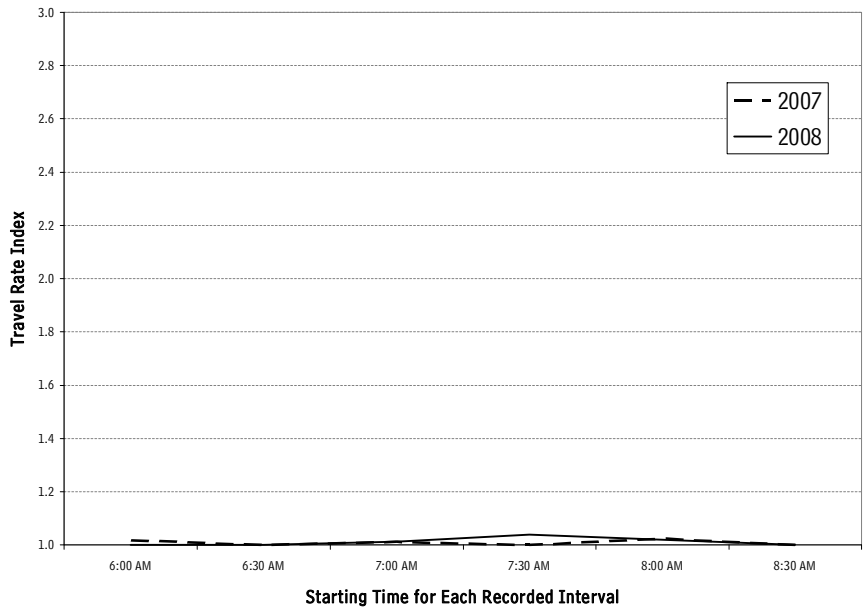


**Figure 245 SL 1604 (PM Peak), Applewhite Rd to SH 281, Westbound.**

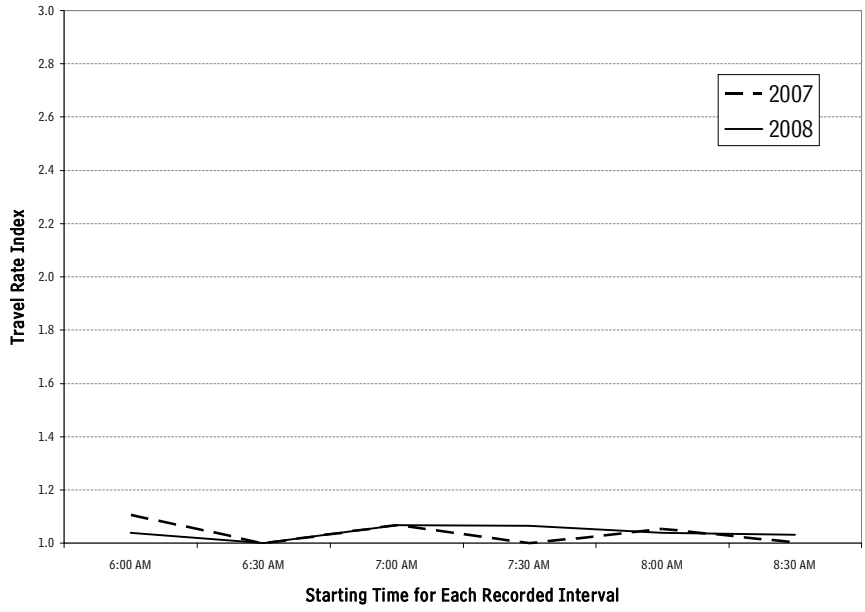




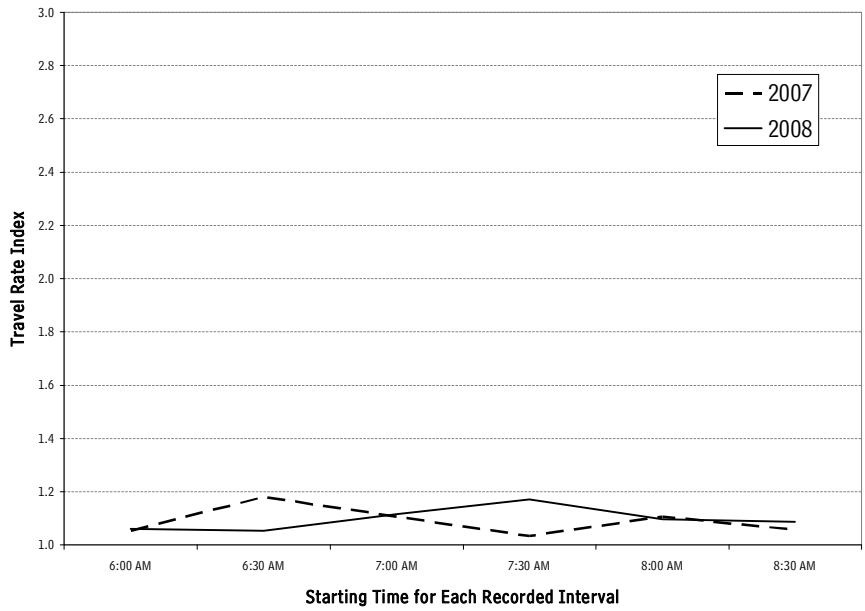
**Figure 246 SL 1604 (PM Peak), SH 16 to Applewhite Rd, Westbound.**



**Figure 247 SL 1604 (PM Peak), Senior Rd to SH 16, Westbound.**

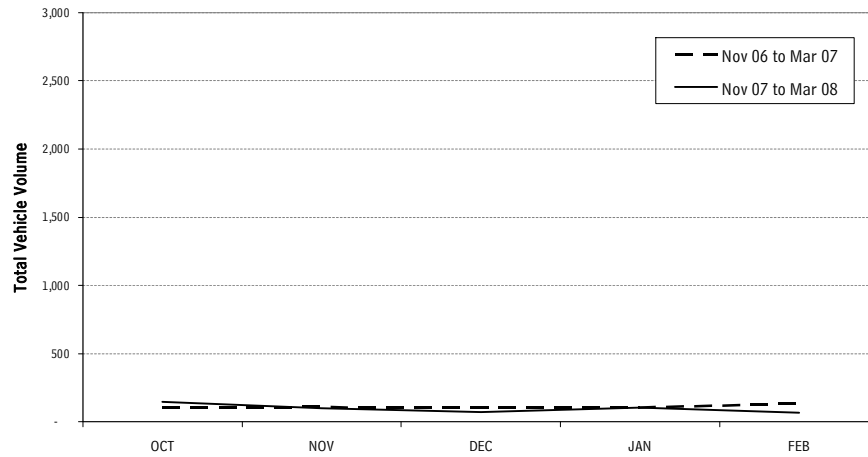


**Figure 248 SL 1604 (PM Peak), FM 2790 to Senior Rd, Westbound.**

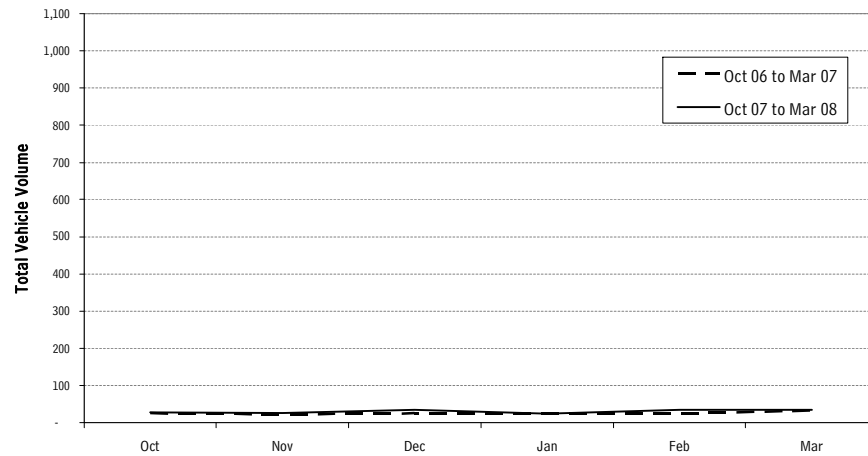


**Figure 249 SL 1604 (PM Peak), IH 35 to FM 2790, Westbound.**

**Total Vehicle Volumes Westbound Direction, Afternoon Peak**

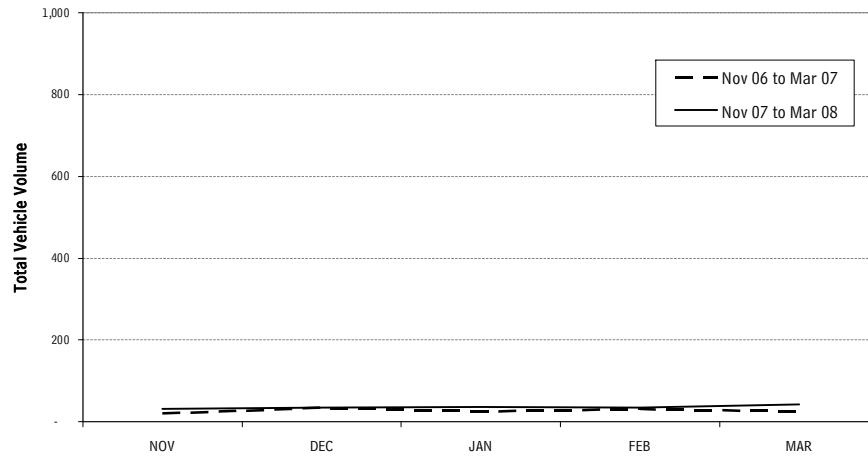


**Figure 250 Total Vehicle Volumes, Site 317 Westbound, 2 PM to 3 PM.**

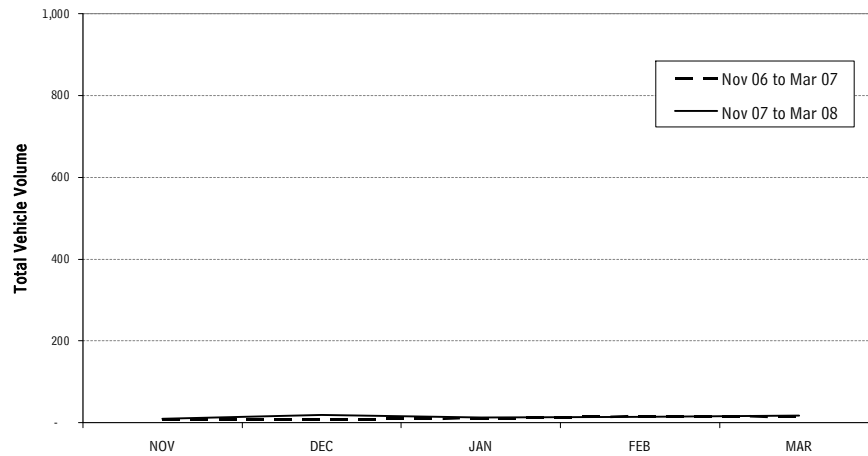


**Figure 251 Total Vehicle Volumes, Site 318 Westbound, 3 PM to 4 PM.**

***Truck Volumes Westbound Direction, Afternoon Peak***



**Figure 252 Total Truck Volumes, Site 317 Westbound, 2 PM to 3 PM.**



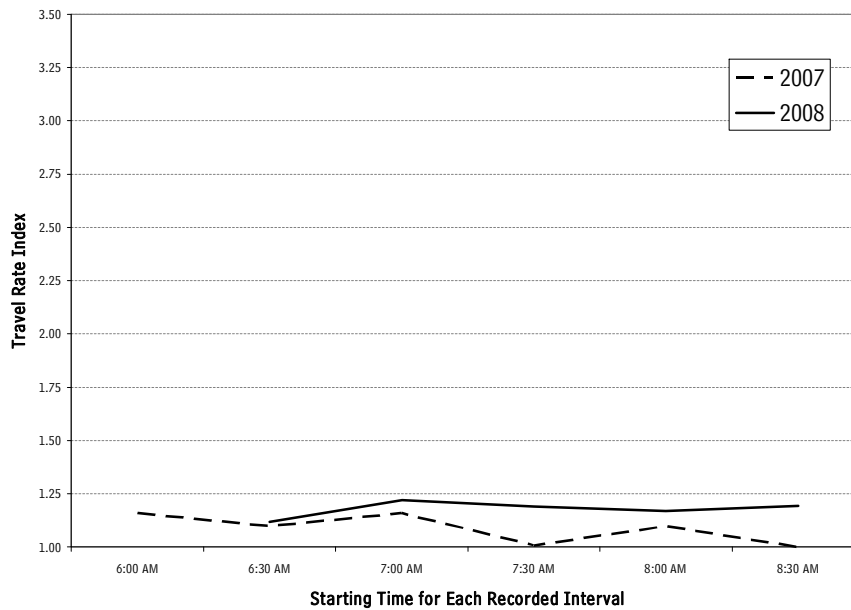
**Figure 253 Total Truck Volumes, Site 318 Westbound, 2 PM to 3 PM.**

## Corridor 5: IH 410 from FM 2536 to IH 37

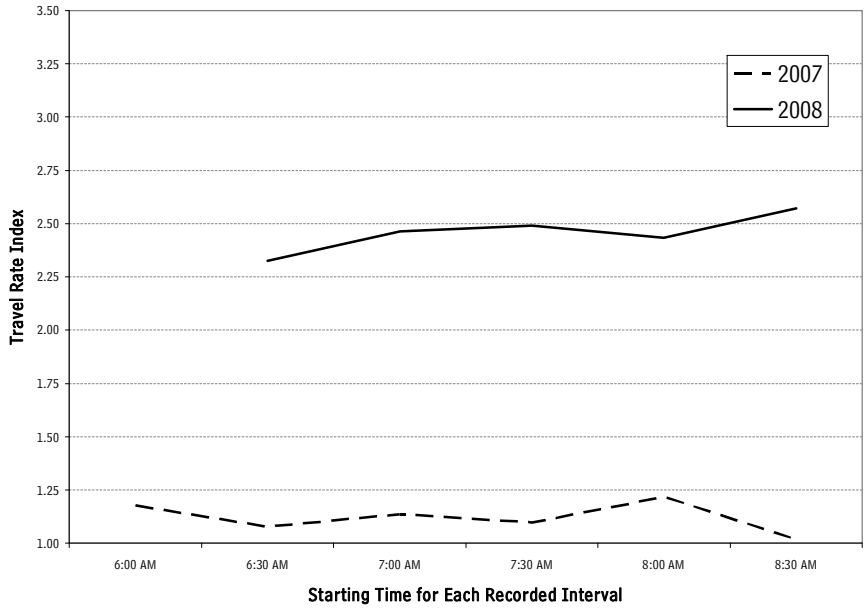
Corridor 5 is defined in linked segments as follows:

- (A) IH 410 from FM 2536 to IH 35
- (B) IH 410 from IH 35 to Somerset Rd
- (C) IH 410 from Somerset Rd to SH 16
- (D) IH 410 from SH 16 to Zarzamora St
- (E) IH 410 from Zarzamora St to Moursund Rd
- (F) IH 410 from Moursund Blvd to IH 37

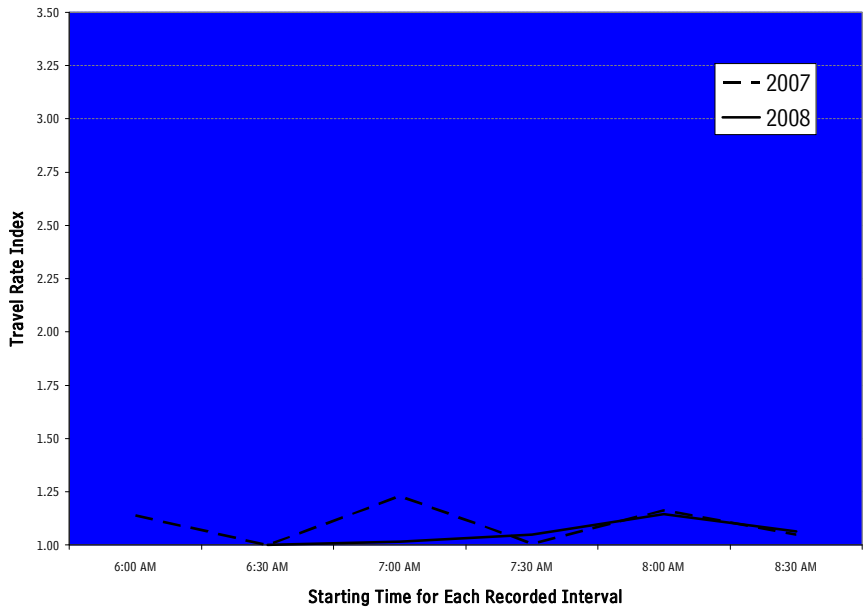
### *Travel Time Runs, Morning Peak, Eastbound Direction*



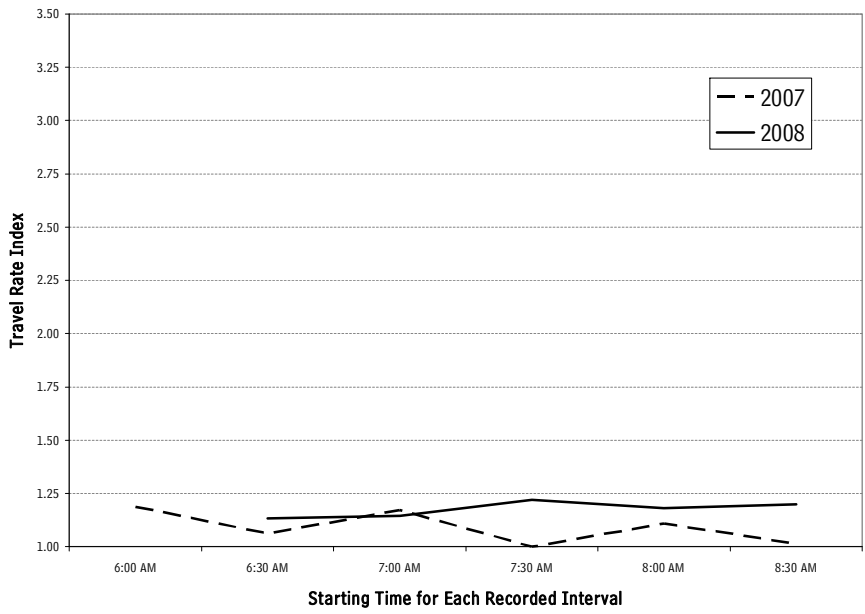
**Figure 254 IH 410 (AM Peak), FM 2536 to IH 35, Eastbound.**



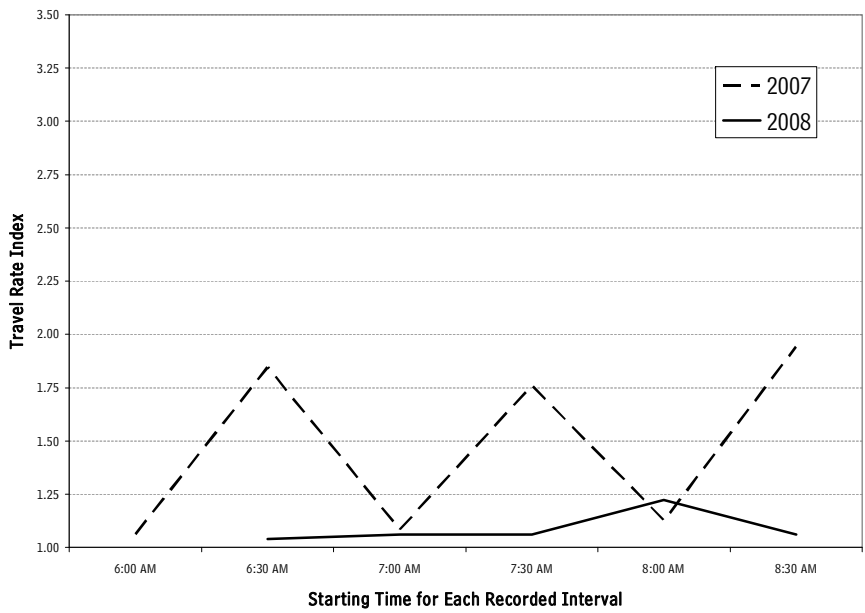
**Figure 255 IH 410 (AM Peak), IH 35 to Somerset Rd, Eastbound.**



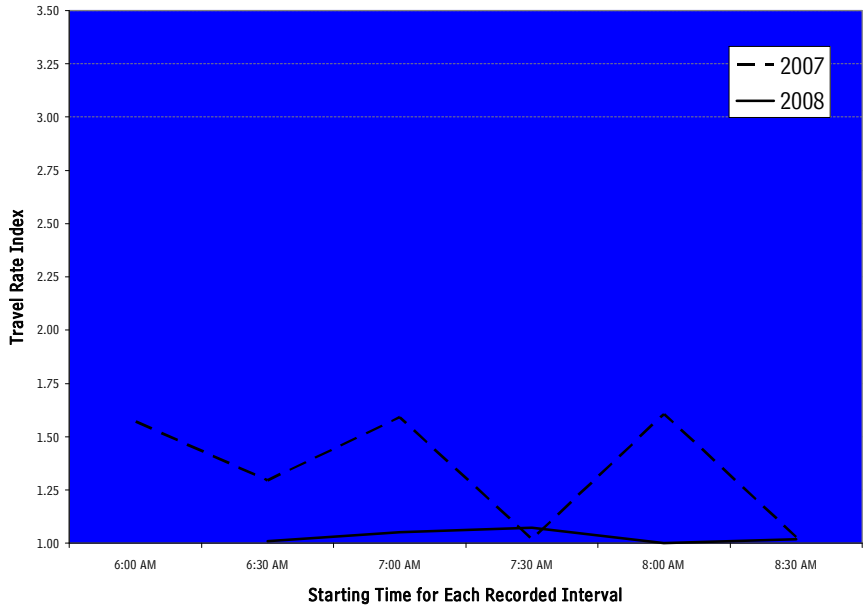
**Figure 256 IH 410 (AM Peak), Somerset Rd to SH 16, Eastbound.**



**Figure 257 IH 410 (AM Peak), SH 16 to Zarzamora St, Eastbound.**

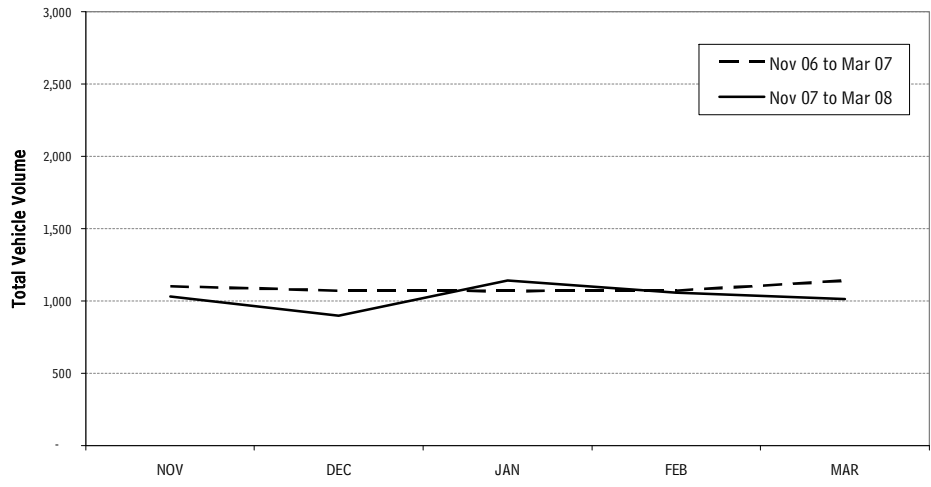


**Figure 258 IH 410 (AM Peak), Zarzamora St to Moursund Blvd, Eastbound.**



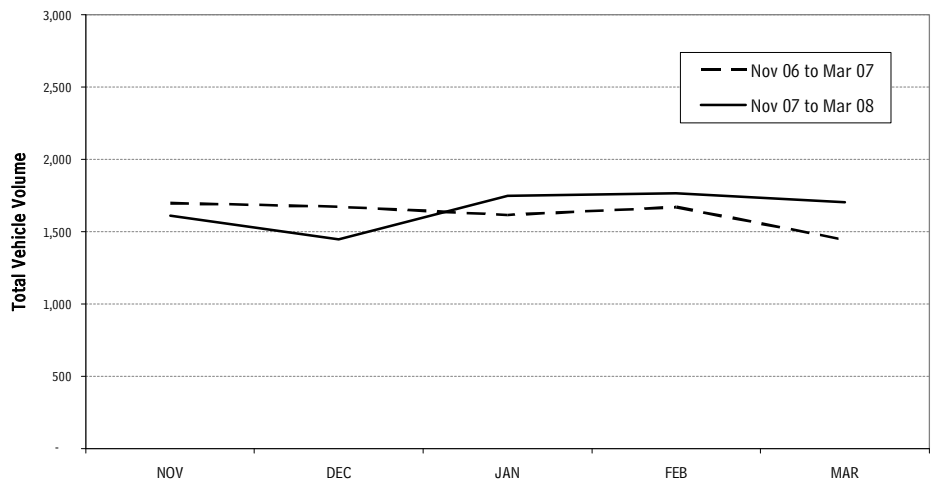
**Figure 259 IH 410 (AM Peak), Moursund Blvd to IH 37, Eastbound.**

*Total Vehicle Volumes Eastbound Direction, Morning Peak*

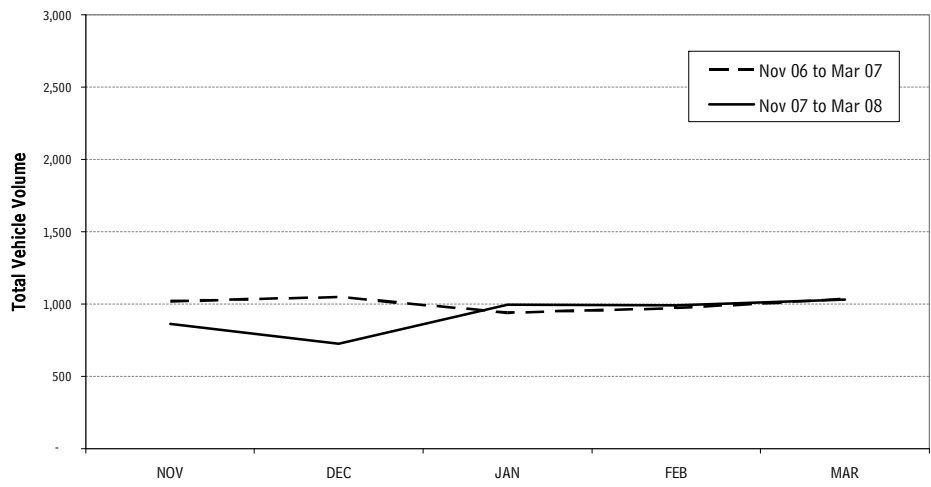


**Figure 260 Total Vehicle Volumes, Site 312 Eastbound, 6 AM to 7 AM.**



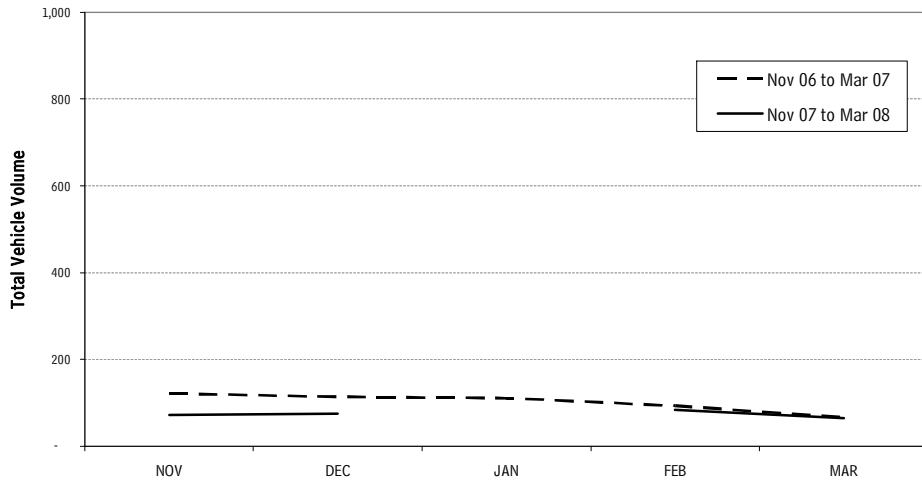


**Figure 261 Total Vehicle Volumes, Site 312 Eastbound, 7 AM to 8 AM.**

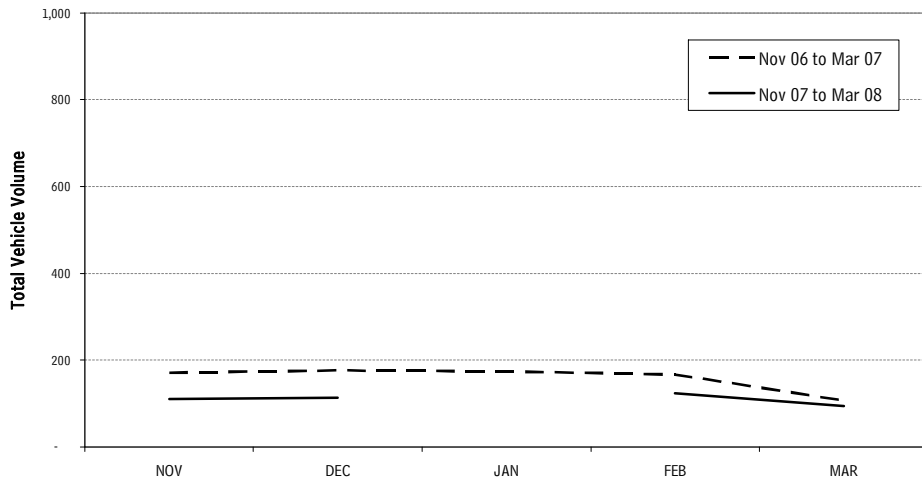


**Figure 262 Total Vehicle Volumes, Site 312 Eastbound, 8 AM to 9 AM.**

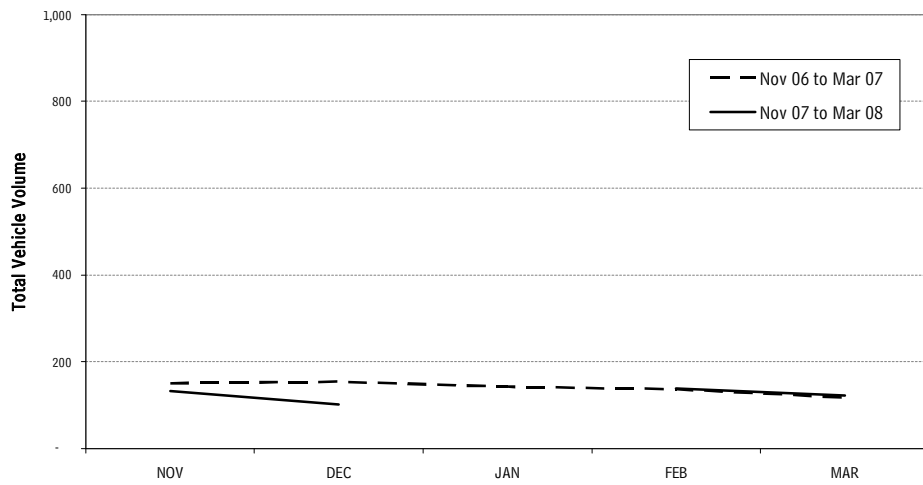
**Total Truck Volumes Eastbound Direction, Morning Peak**



**Figure 263 Total Truck Volumes, Site 312 Eastbound, 6 AM to 7 AM.**

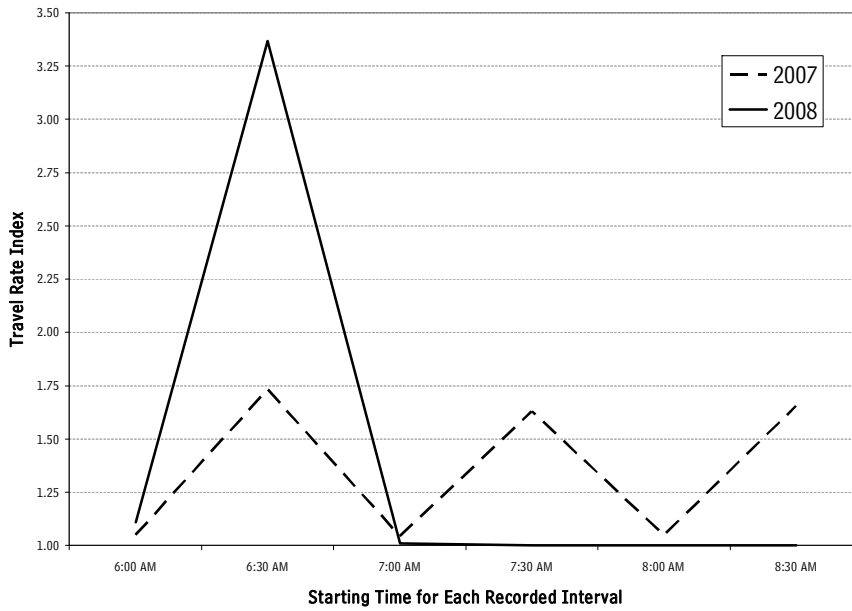


**Figure 264 Total Truck Volumes, Site 312 Eastbound, 7 AM to 8 AM.**

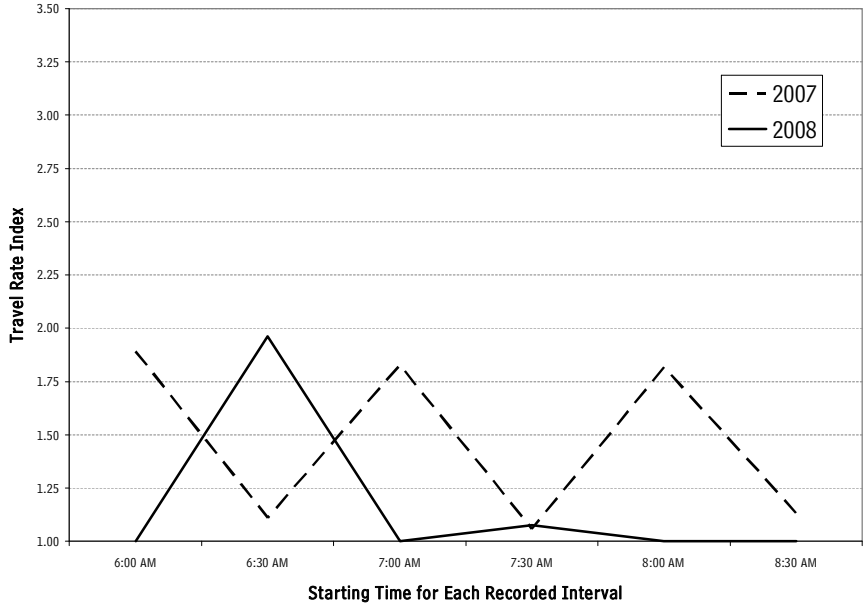


**Figure 265 Total Vehicle Volumes, Site 312 Eastbound, 8 AM to 9 AM.**

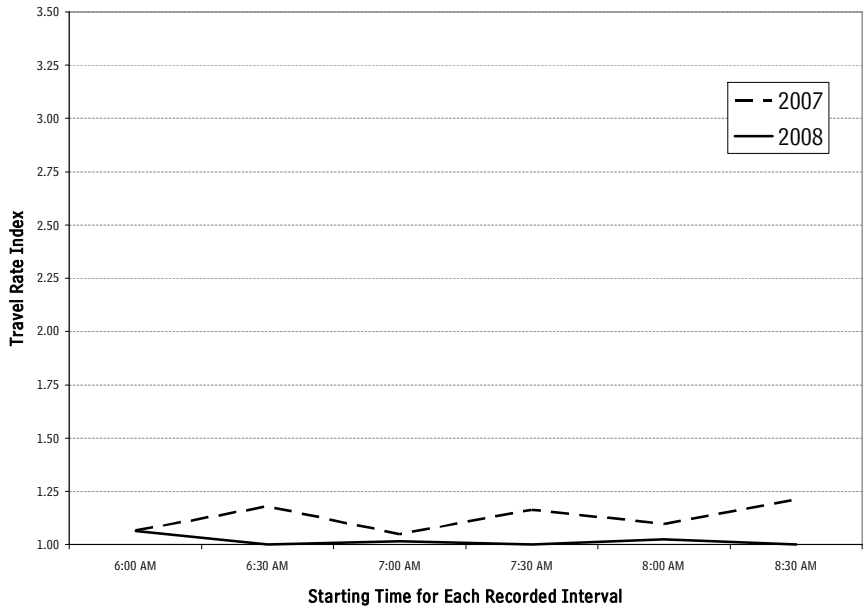
***Travel Time Runs, Morning Peak, Westbound Direction***



**Figure 266 IH 410 (AM Peak), Moursund Blvd to IH 37, Westbound.**

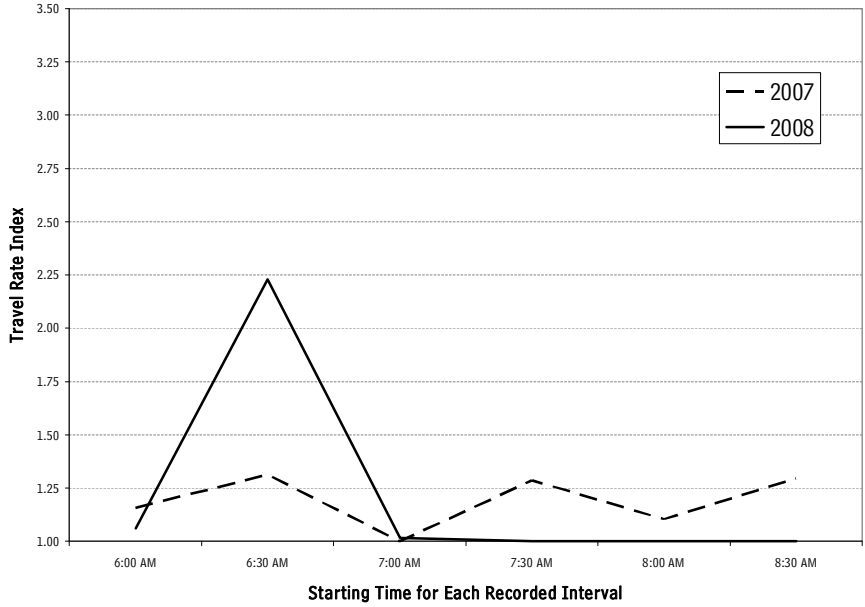


**Figure 267 IH 410 (AM Peak), Zarzamora St to Moursund Blvd, Westbound.**

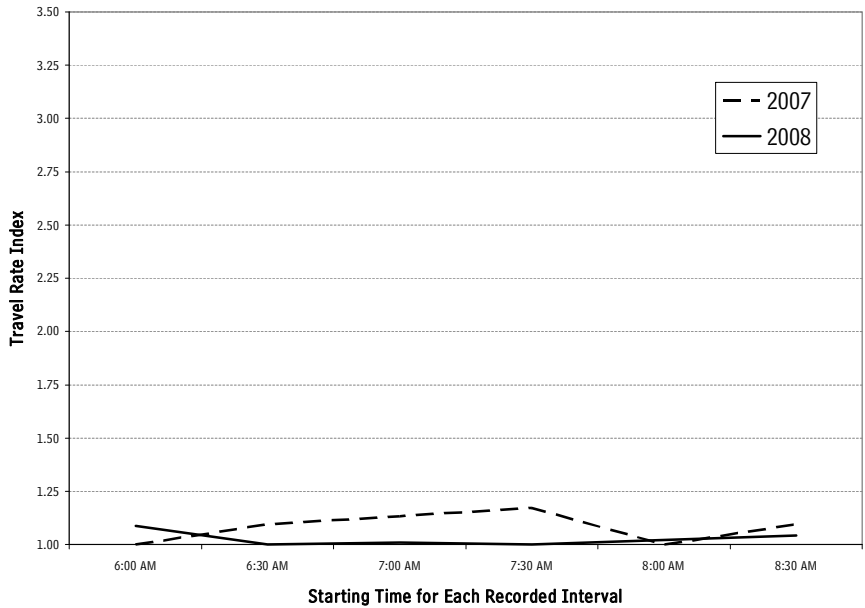


**Figure 268 IH 410 (AM Peak), SH 16 to Zarzamora St, Westbound.**

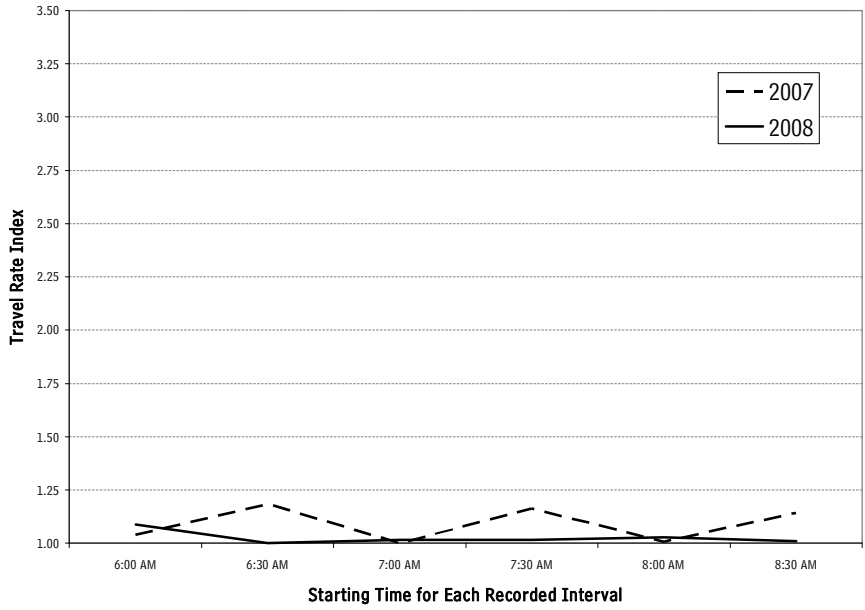
The one exception is the time interval from 6:30 am to 7:00 am. In this time interval, the 2008 data indicated that it took over twice as long to travel this segment than normal free flow conditions. This is seen in the previous segments.



**Figure 269 IH 410 (AM Peak), Somerset Rd to SH 16, Westbound.**

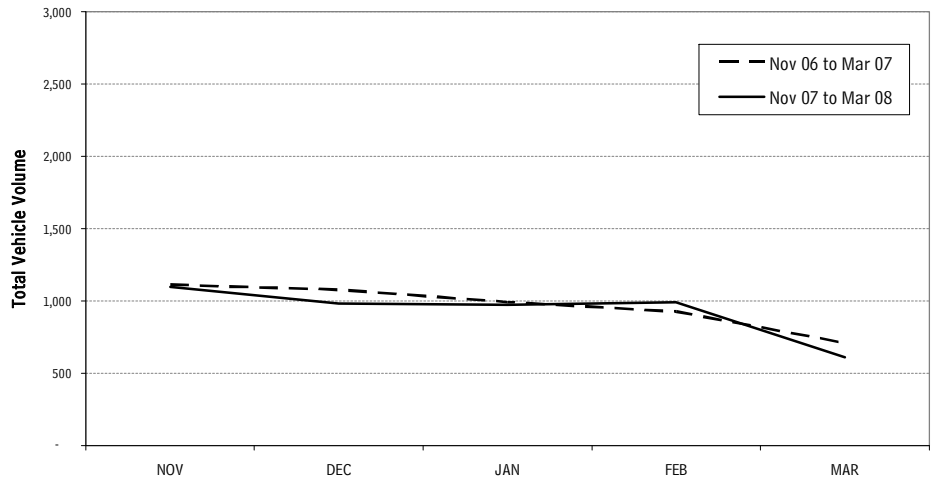


**Figure 270 IH 410 (AM Peak), IH 35 to Somerset Rd, Westbound.**

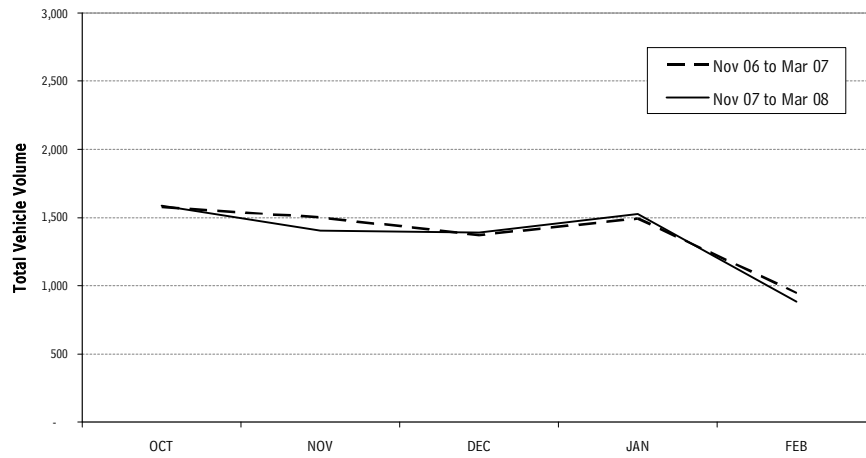


**Figure 271 IH 410 (AM Peak), FM 2536 to IH 35, Westbound.**

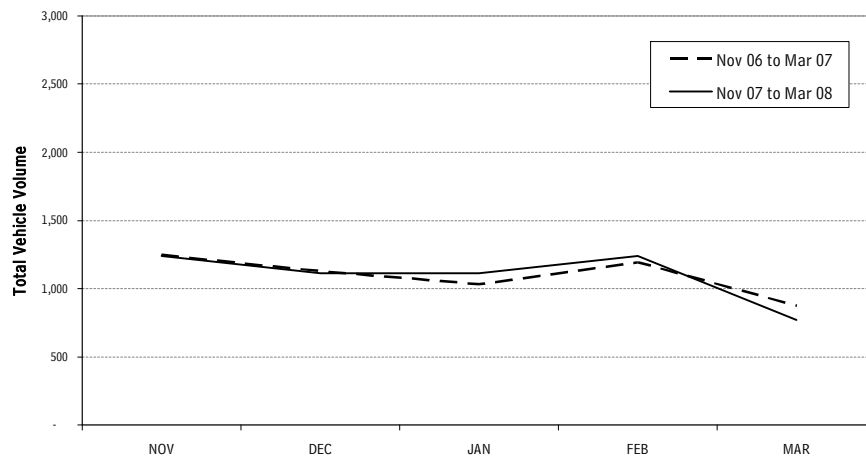
***Total Vehicle Volumes Westbound Direction, Morning Peak***



**Figure 272 Total Vehicle Volumes, Site 312 Westbound, 6 AM to 7 AM.**

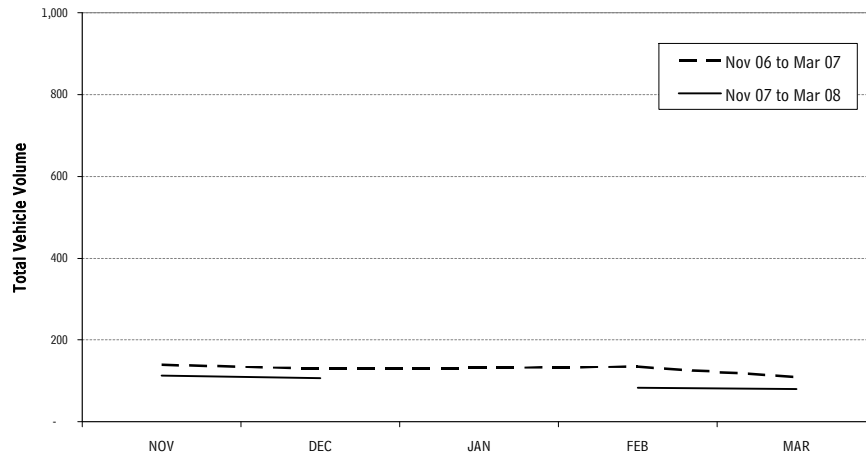


**Figure 273 Total Vehicle Volumes, Site 312 Westbound, 7 AM to 8 AM.**

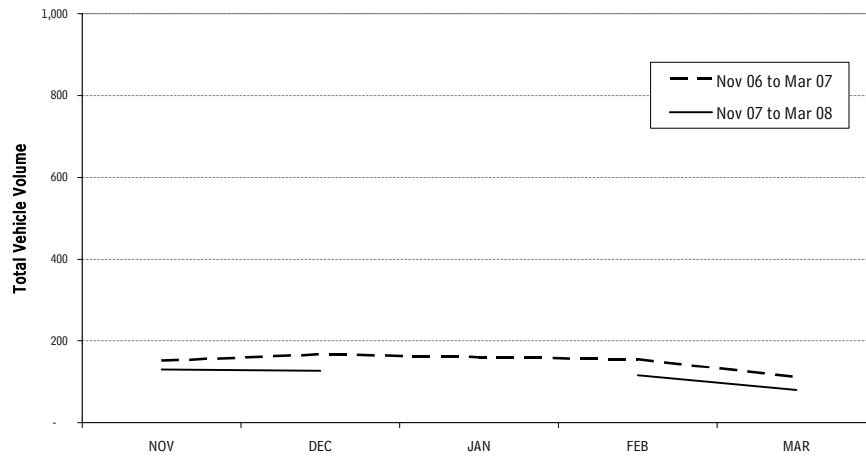


**Figure 274 Total Vehicle Volumes, Site 312 Westbound, 8 AM to 9 AM.**

**Total Truck Volumes Westbound Direction, Morning Peak**

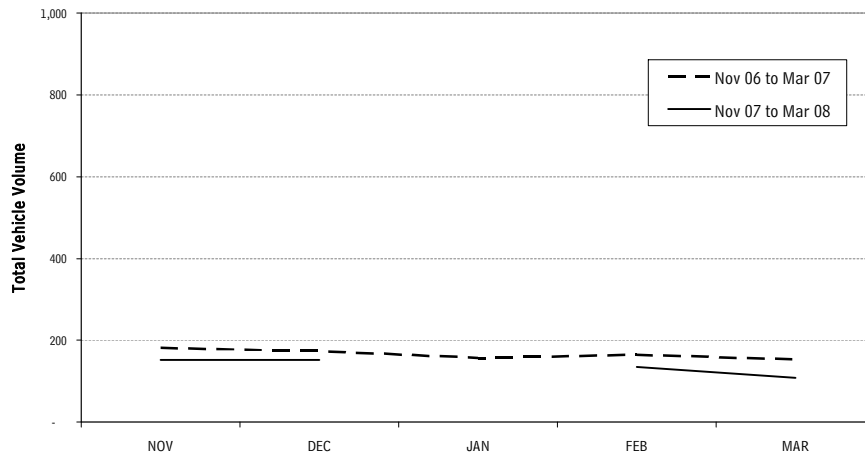


**Figure 275 Total Vehicle Volumes, Site 312 Westbound, 6 AM to 7 AM.**



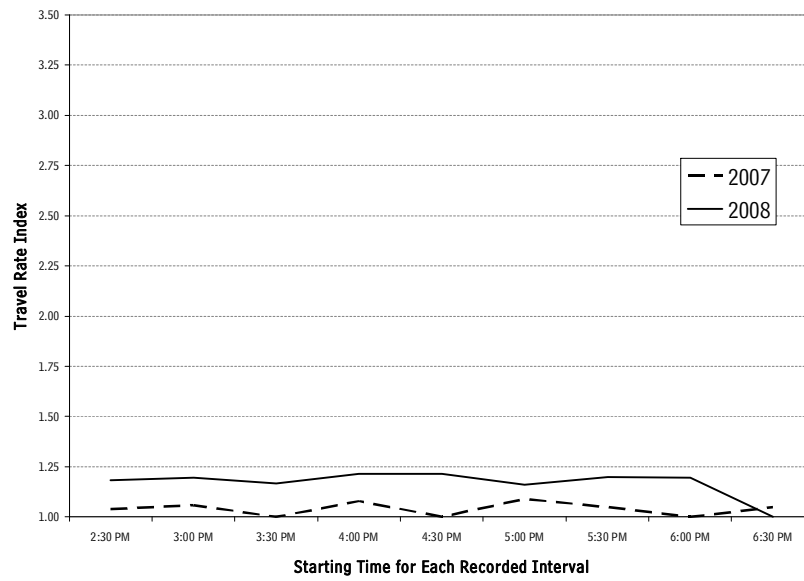
**Figure 276 Total Vehicle Volumes, Site 312 Westbound, 7 AM to 8 AM.**



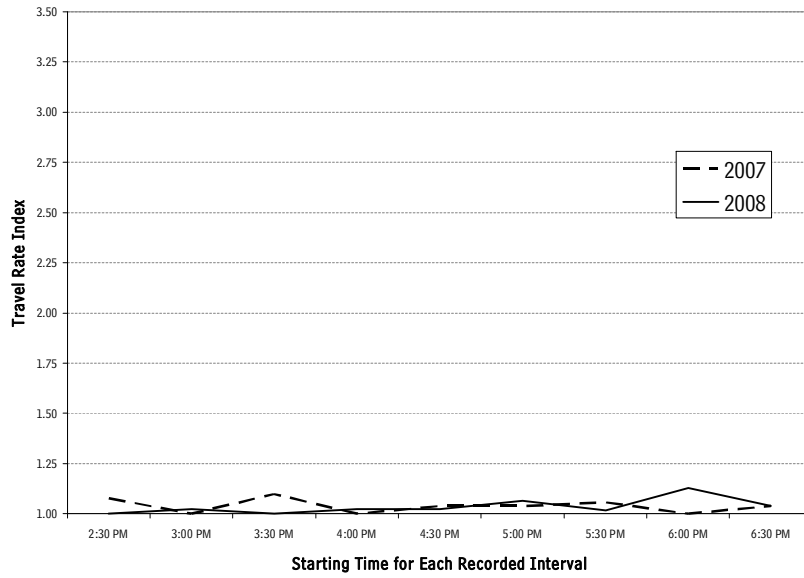


**Figure 277 Total Vehicle Volumes, Site 312 Westbound, 8 AM to 9 AM.**

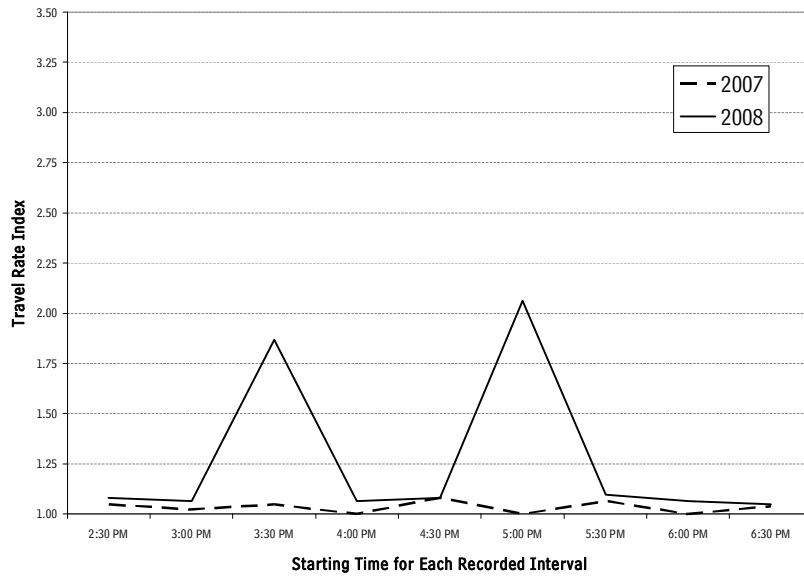
***Travel Time Runs, Afternoon Peak, Eastbound Direction***



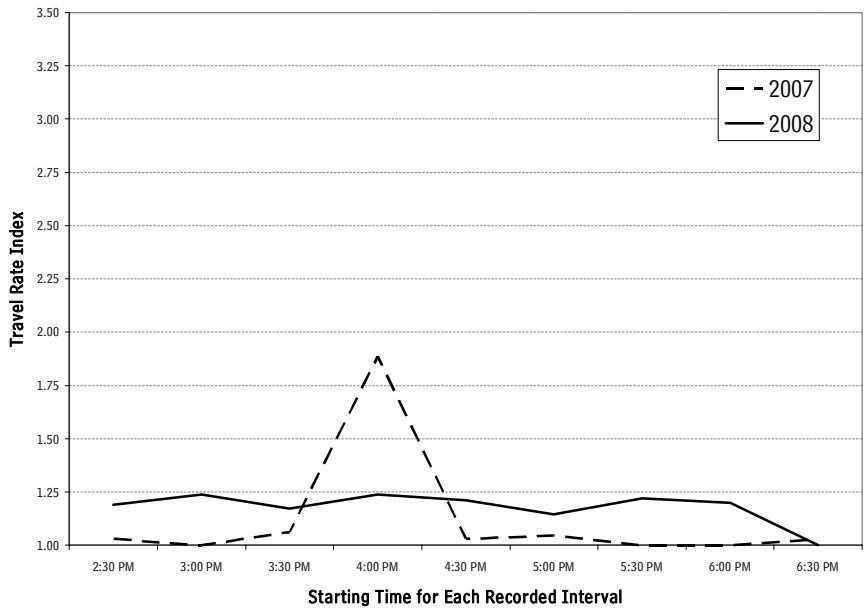
**Figure 278 IH 410 (PM Peak), FM 2536 to IH 35, Eastbound.**



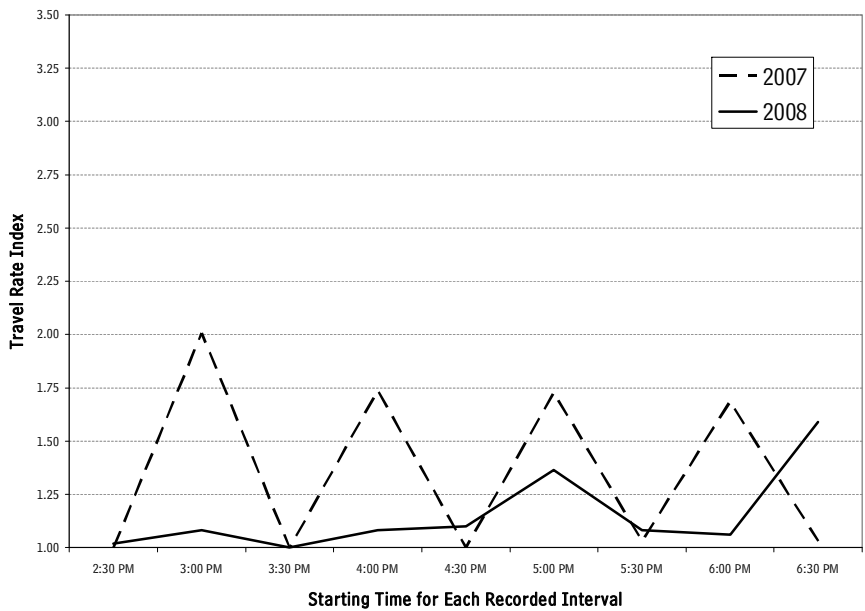
**Figure 279 IH 410 (PM Peak), IH 35 to Somerset Rd, Eastbound.**



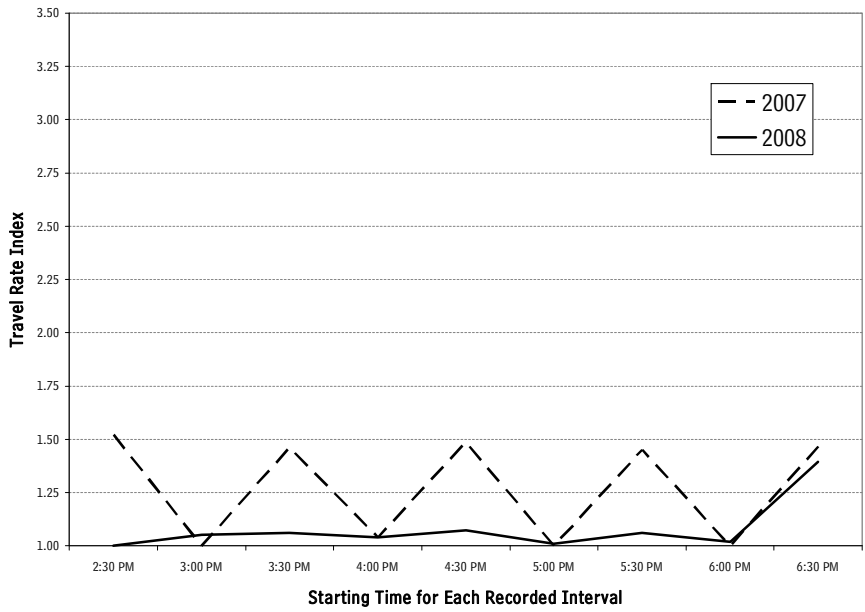
**Figure 280 IH 410 (PM Peak), Somerset Rd to SH 16, Eastbound.**



**Figure 281 IH 410 (PM Peak), SH 16 to Zarzamora St, Eastbound.**

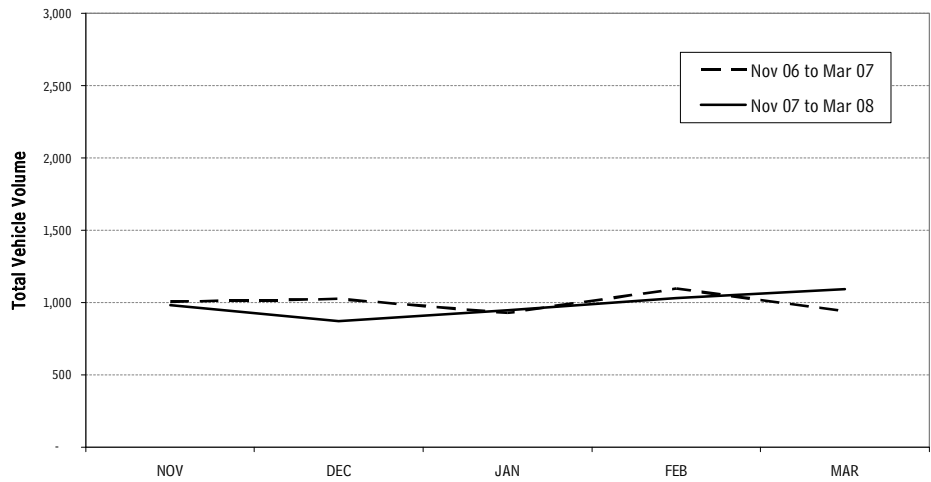


**Figure 282 IH 410 (PM Peak), Zarzamora St to Moursund Blvd, Eastbound.**

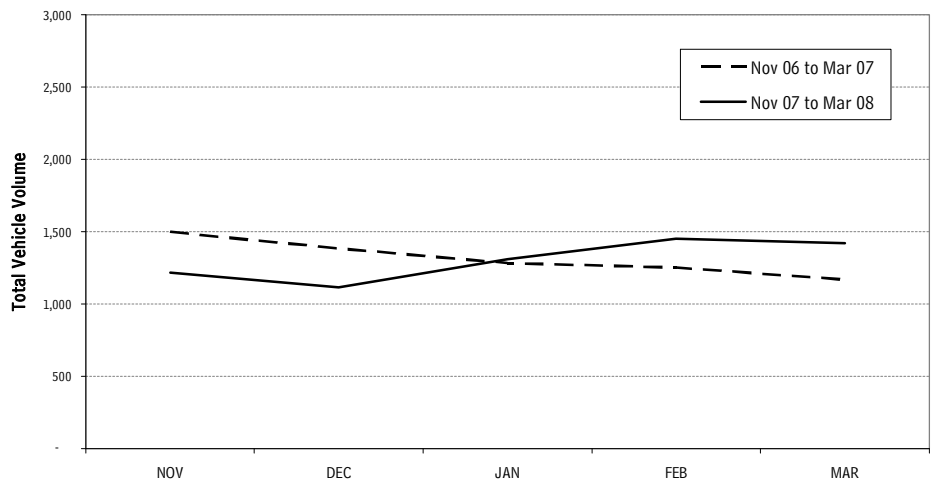


**Figure 283 IH 410 (PM Peak), Moursund Blvd to IH 37, Eastbound.**

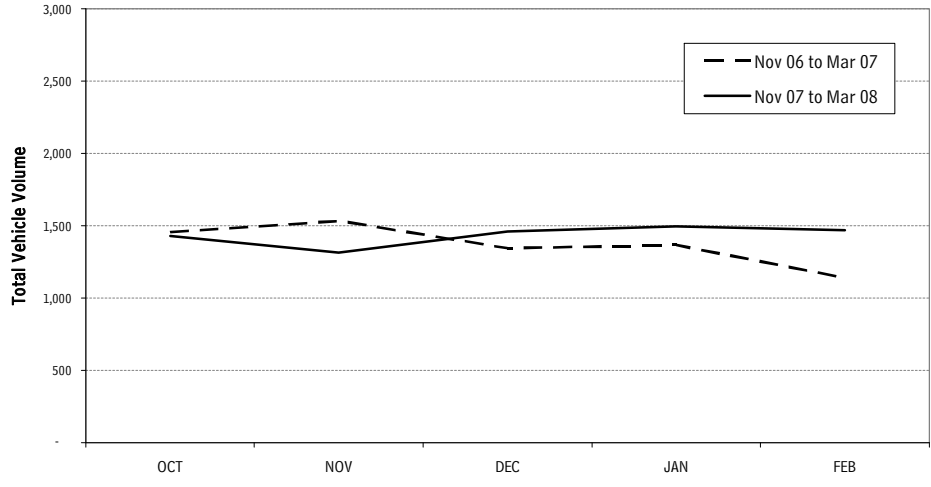
***Total Vehicle Volumes Eastbound Direction, Afternoon Peak***



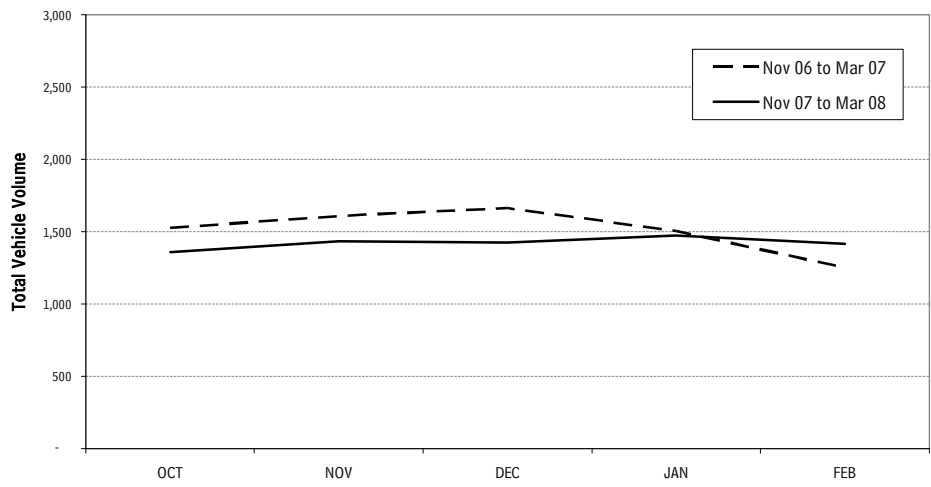
**Figure 284 Total Vehicle Volumes, Site 312 Eastbound, 2 PM to 3 PM.**



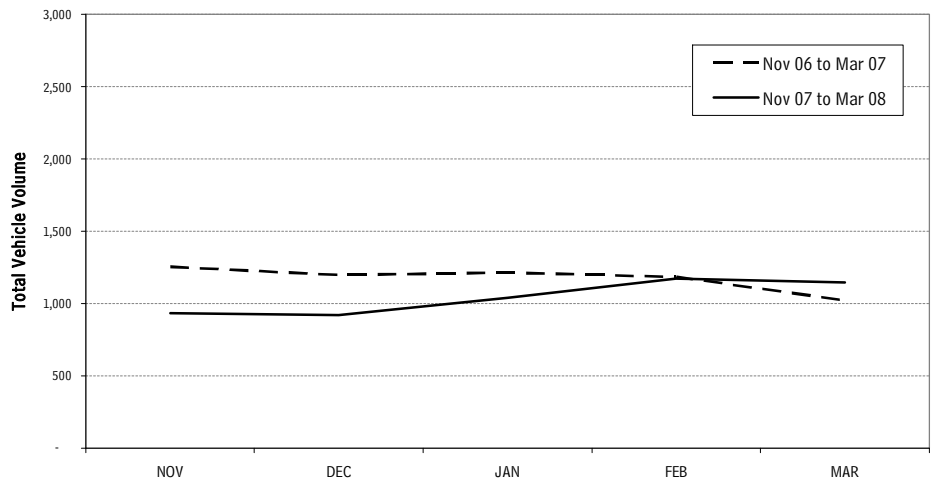
**Figure 285 Total Vehicle Volumes, Site 312 Eastbound, 3 PM to 4 PM.**



**Figure 286 Total Vehicle Volumes, Site 312 Eastbound, 4 PM to 5 PM.**

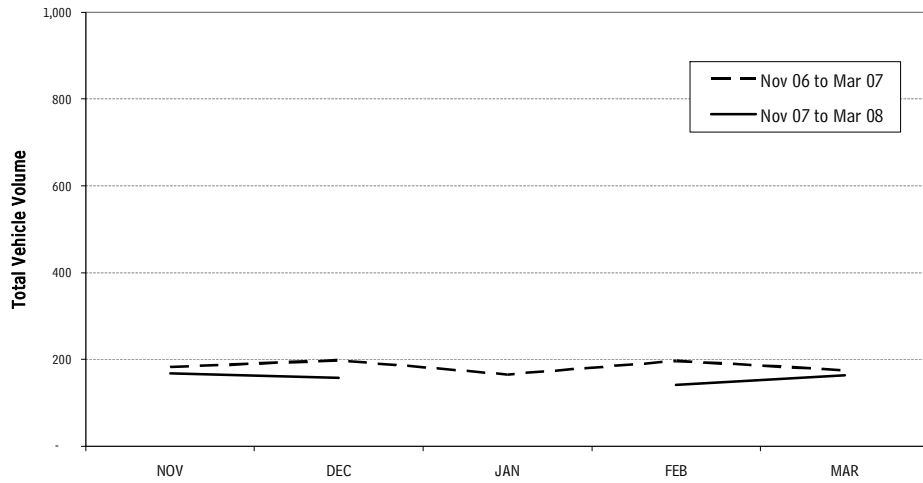


**Figure 287 Total Vehicle Volumes, Site 312 Eastbound, 5 PM to 6 PM.**

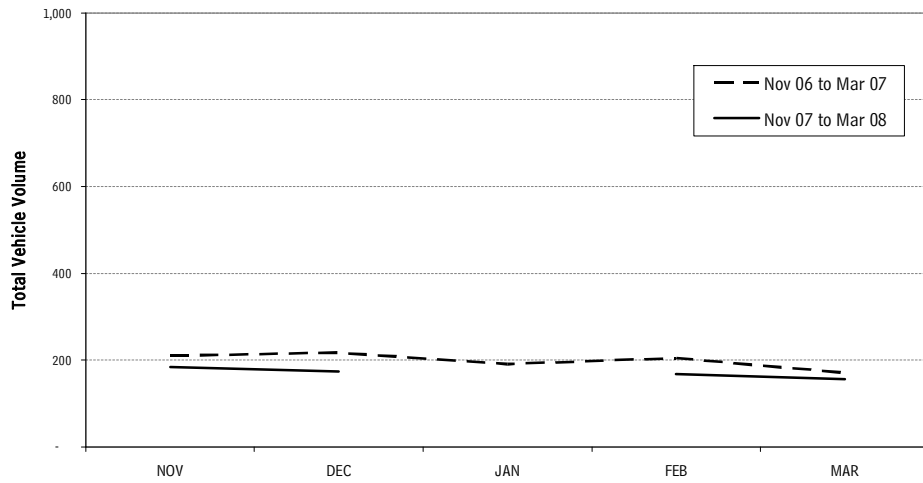


**Figure 288 Total Vehicle Volumes, Site 312 Eastbound, 6 PM to 7 PM.**

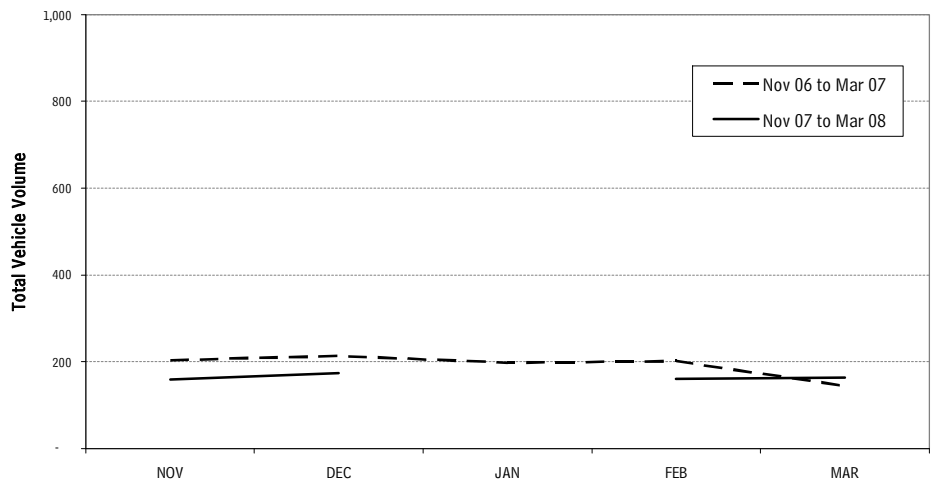
**Total Truck Volumes Eastbound Direction, Afternoon Peak**



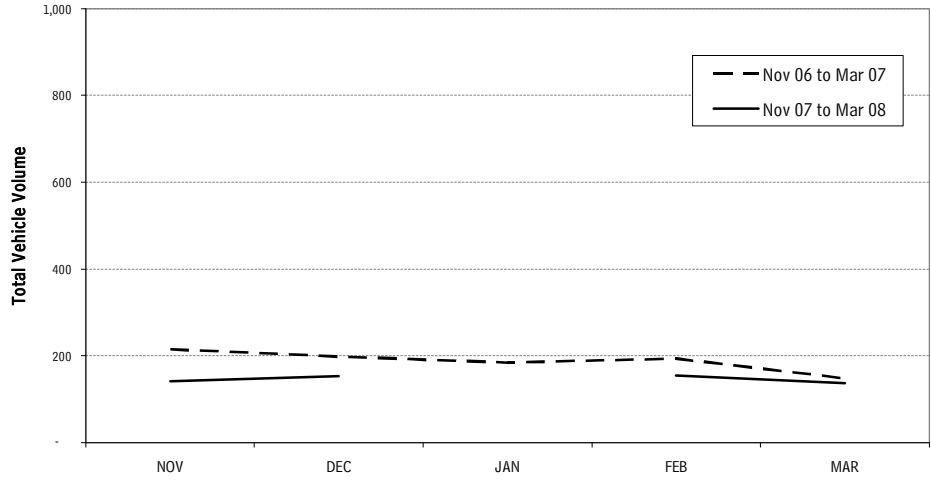
**Figure 289 Total Vehicle Volumes, Site 312 Eastbound, 2 PM to 3 PM.**



**Figure 290 Total Vehicle Volumes, Site 312 Eastbound, 3 PM to 4 PM.**

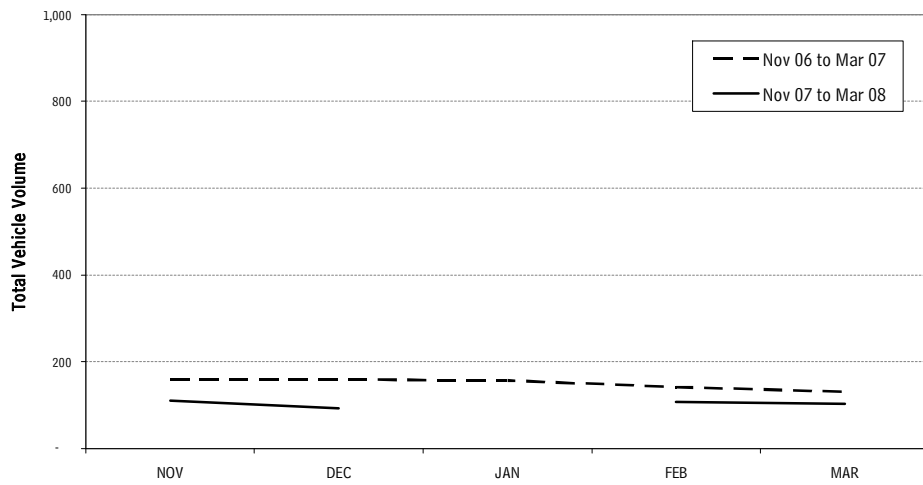


**Figure 291 Total Vehicle Volumes, Site 312 Eastbound, 4 PM to 5 PM.**



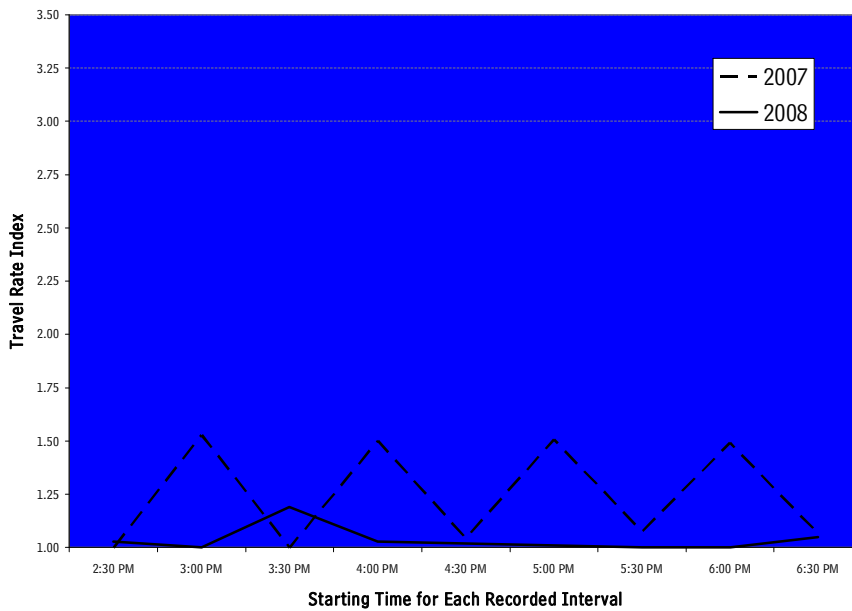
**Figure 292 Total Vehicle Volumes, Site 312 Eastbound, 5 PM to 6 PM.**



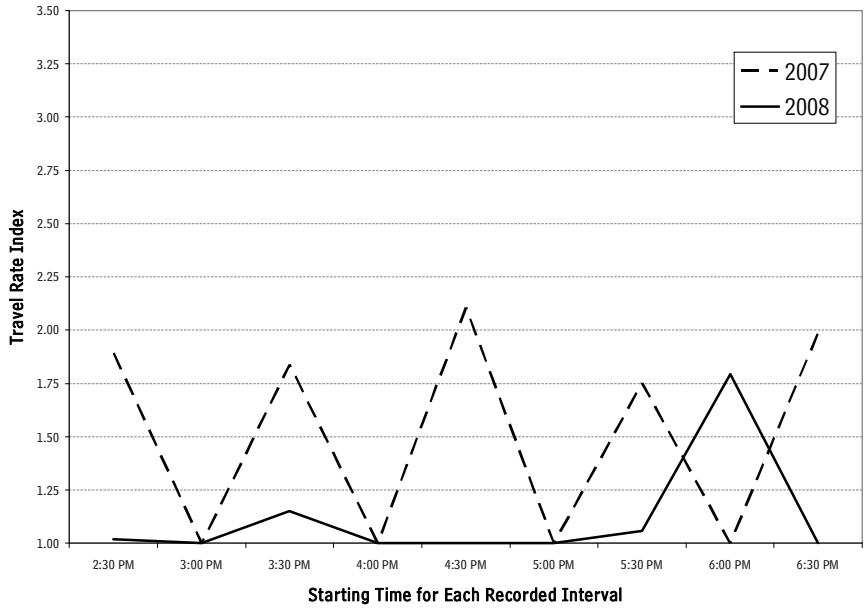


**Figure 293 Total Vehicle Volumes, Site 312 Eastbound, 5 PM to 6 PM.**

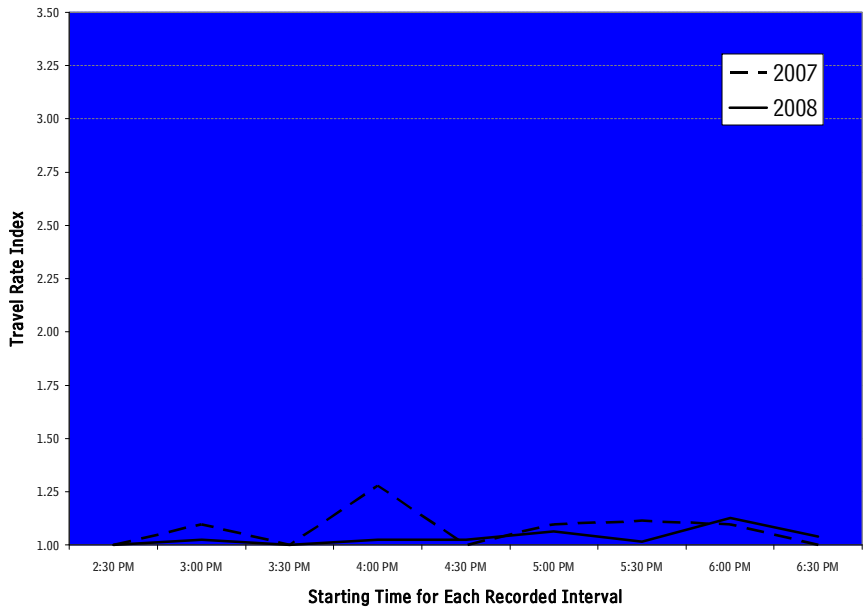
*Travel Time Runs, Afternoon Peak, Westbound Direction*



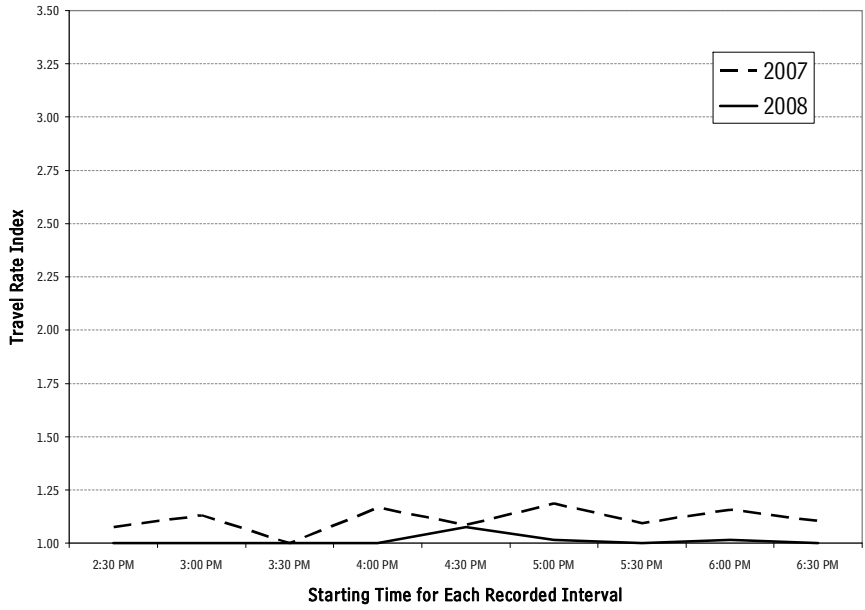
**Figure 294 IH 410 (PM Peak), Moursund Blvd to IH 37, Westbound.**



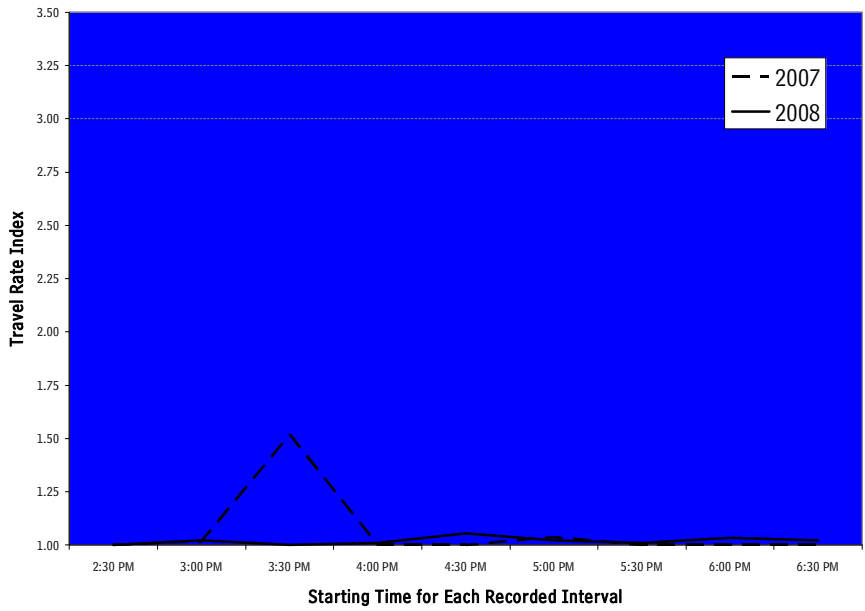
**Figure 295 IH 410 (PM Peak), Zarzamora St to Moursund Blvd, Westbound.**



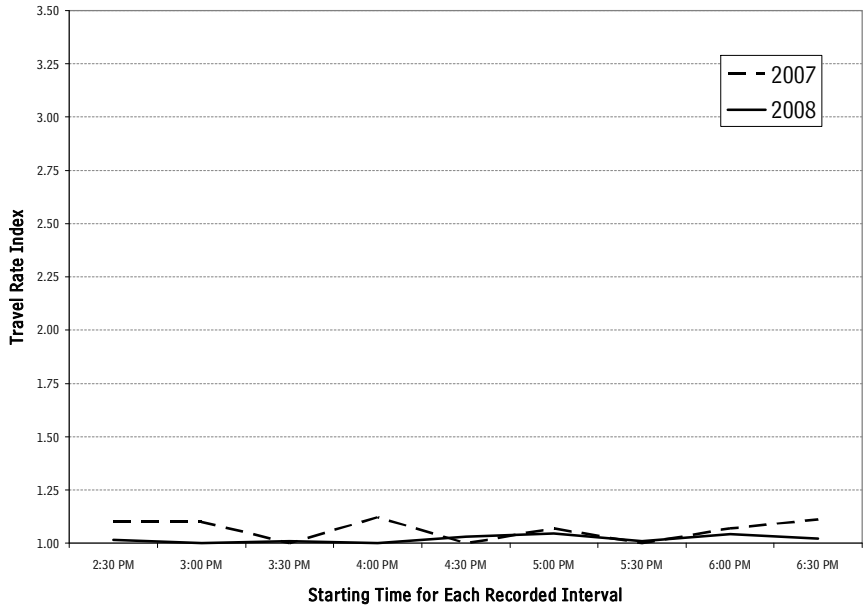
**Figure 296 IH 410 (PM Peak), SH 16 to Zarzamora St, Westbound.**



**Figure 297 IH 410 (PM Peak), Somerset Rd to SH 16, Westbound.**

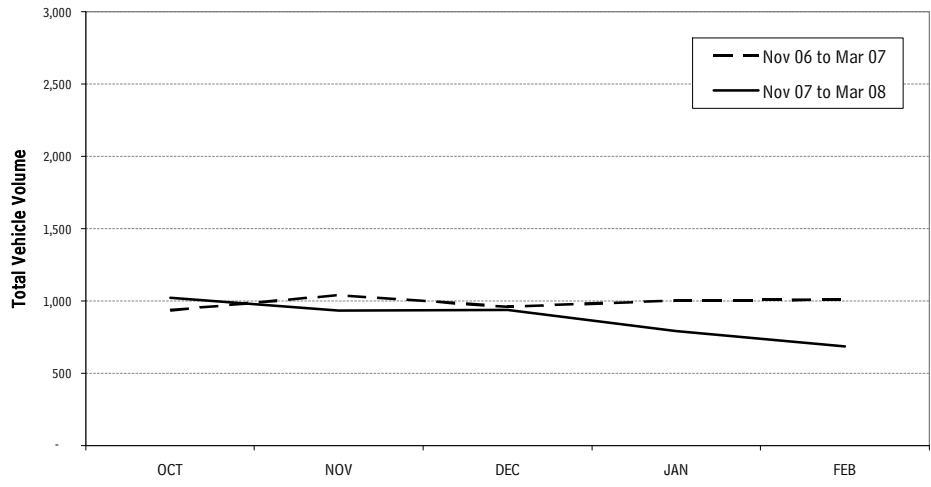


**Figure 298 IH 410 (PM Peak), IH 35 to Somerset Rd, Westbound.**

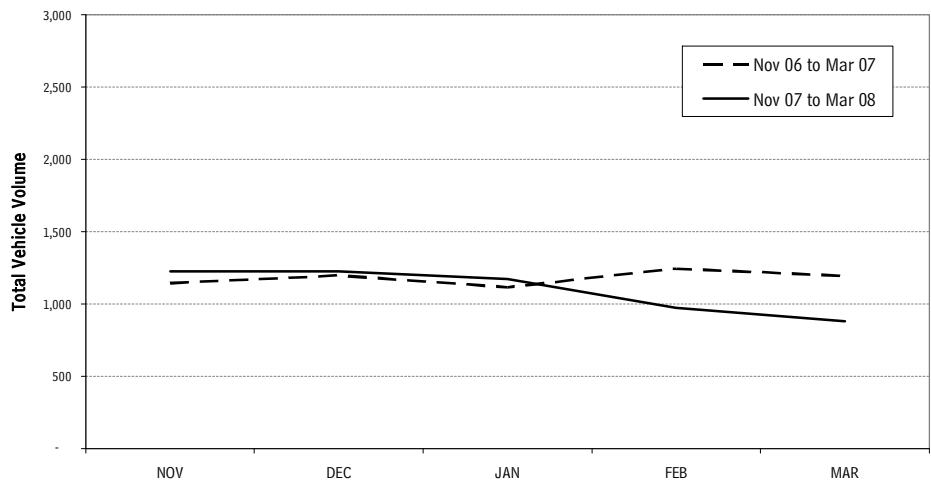


**Figure 299 IH 410 (PM Peak), FM 2536 to IH 35, Westbound.**

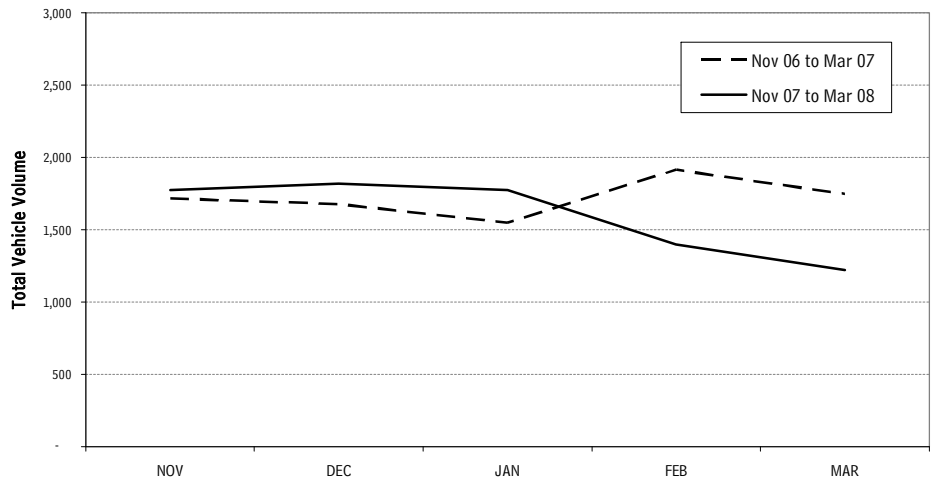
***Total Vehicle Volumes Westbound Direction, Afternoon Peak***



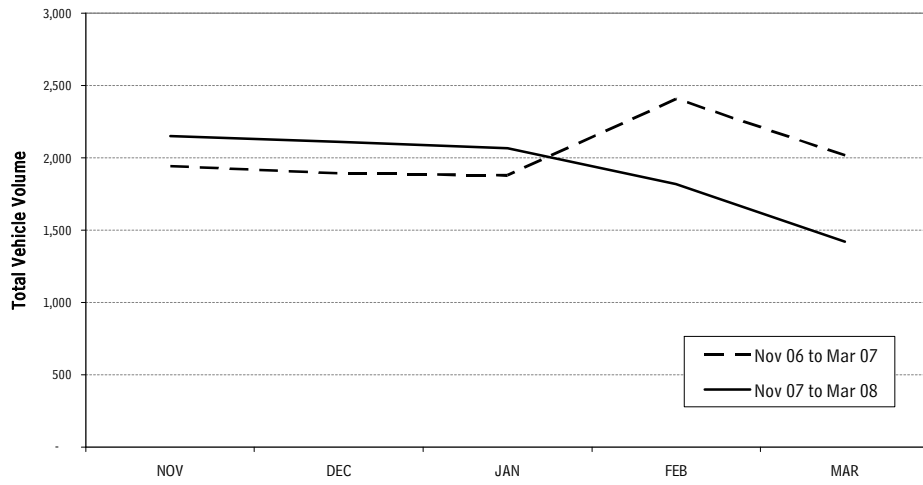
**Figure 300 Total Vehicle Volumes, Site 312 Westbound, 2 PM to 3 PM.**



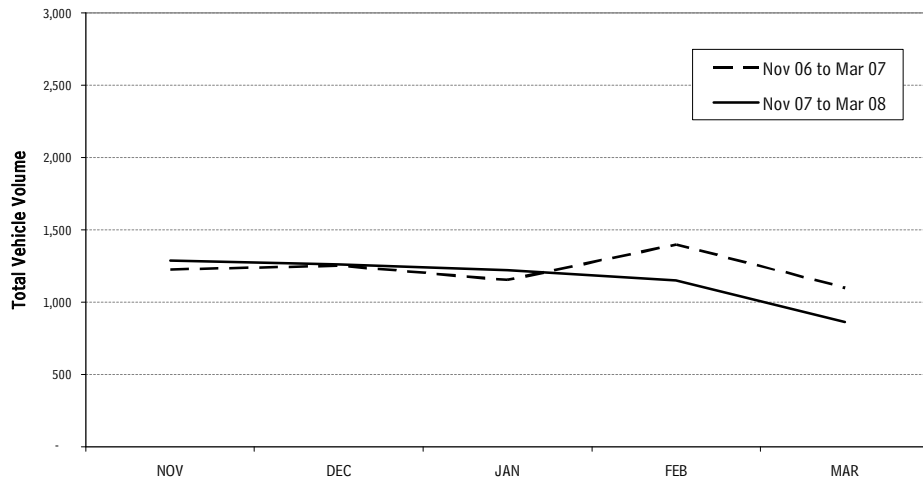
**Figure 301 Total Vehicle Volumes, Site 312 Westbound, 3 PM to 4 PM.**



**Figure 302 Total Vehicle Volumes, Site 312 Westbound, 4 PM to 5 PM.**

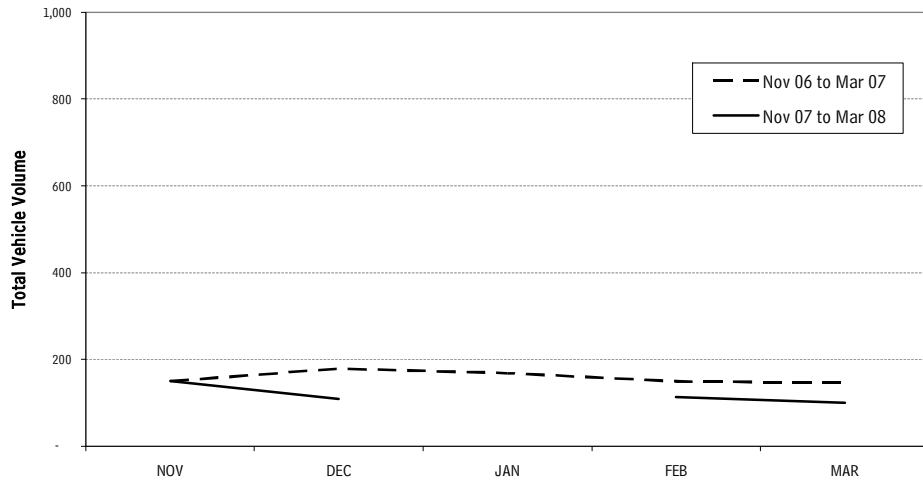


**Figure 303 Total Vehicle Volumes, Site 312 Westbound, 5 PM to 6 PM.**

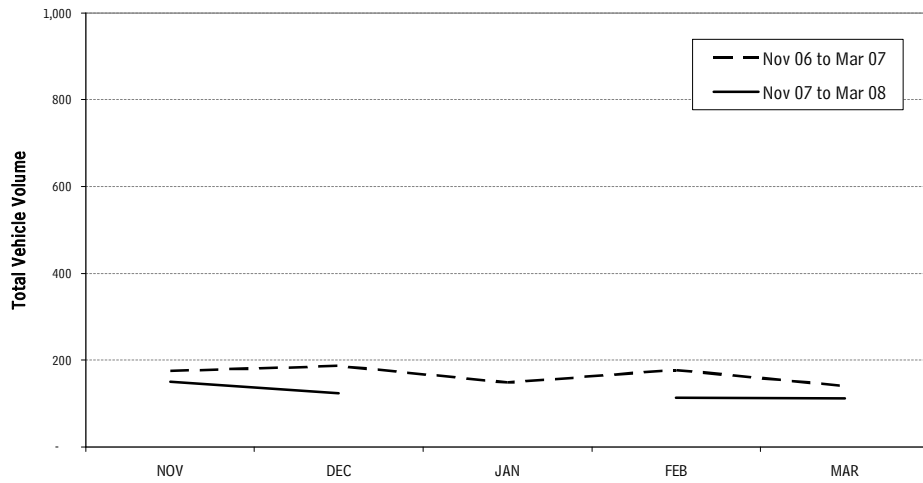


**Figure 304 Total Vehicle Volumes, Site 312 Westbound, 6 PM to 7 PM.**

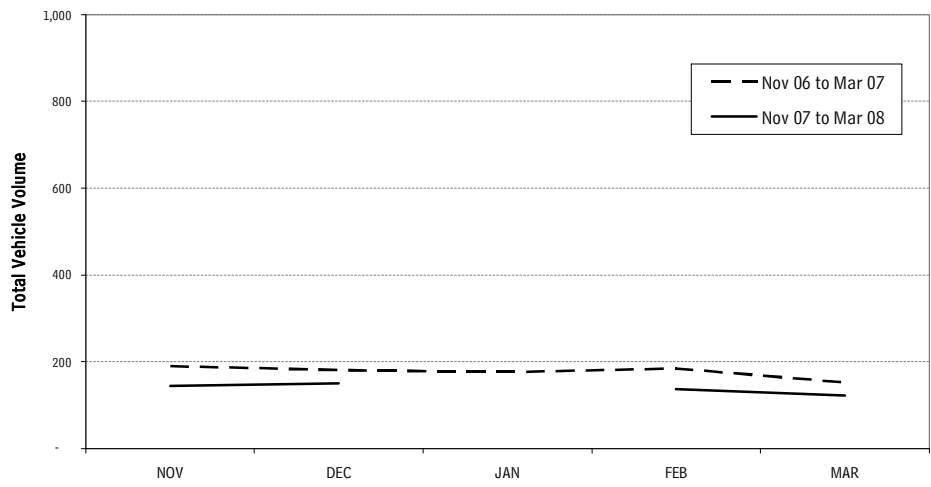
**Total Truck Volumes Westbound Direction, Afternoon Peak**



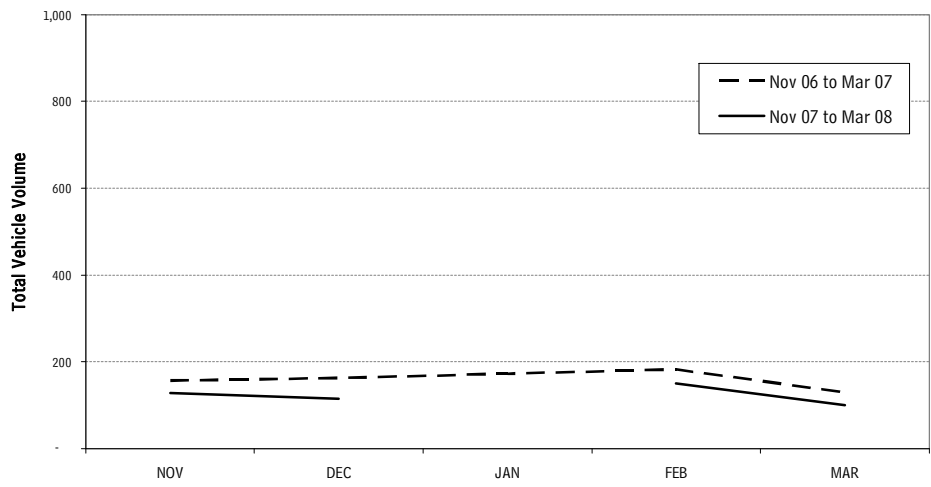
**Figure 305 Total Vehicle Volumes, Site 312 Westbound, 2 PM to 3 PM.**



**Figure 306 Total Vehicle Volumes, Site 312 Westbound, 3 PM to 4 PM.**

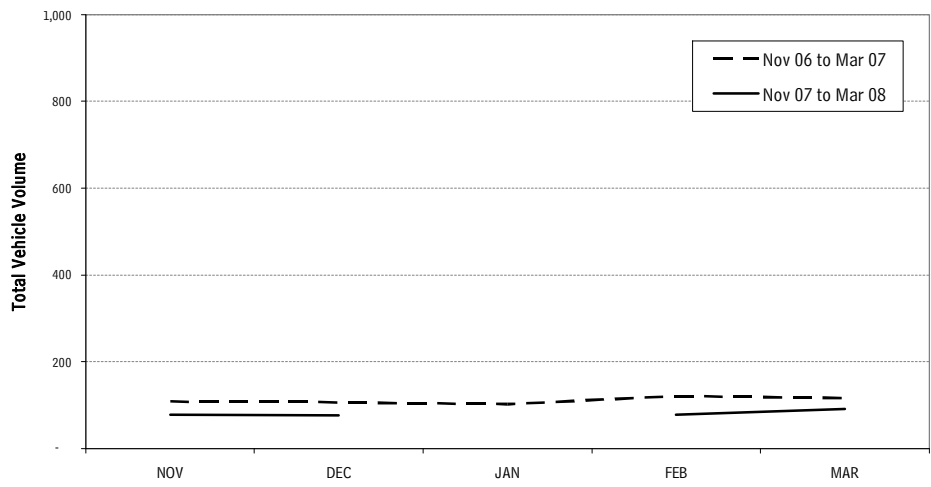


**Figure 307 Total Vehicle Volumes, Site 312 Westbound, 4 PM to 5 PM.**



**Figure 308 Total Vehicle Volumes, Site 312 Westbound, 5 PM to 6 PM.**





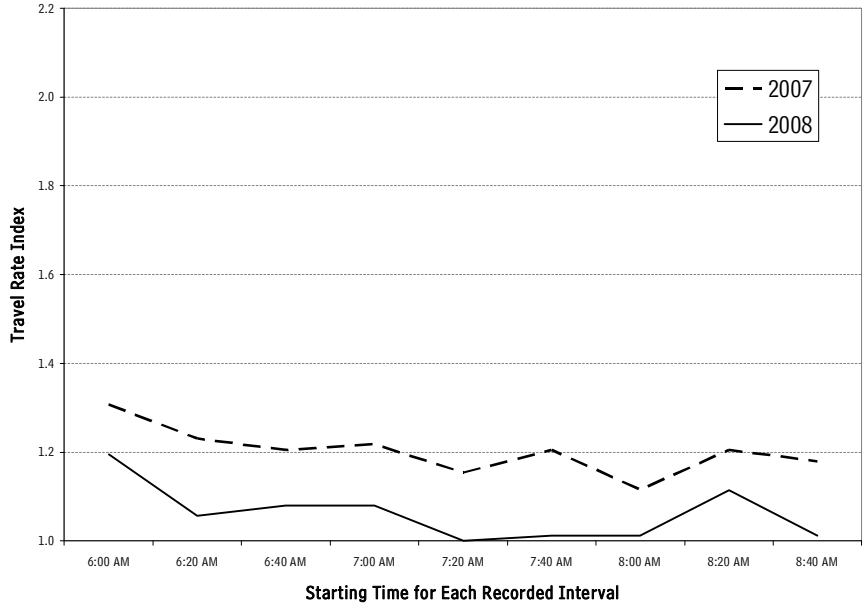
**Figure 309 Total Vehicle Volumes, Site 312 Westbound, 6 PM to 7 PM.**

**Corridor 6: US 281 from IH 410 to SL 1604**

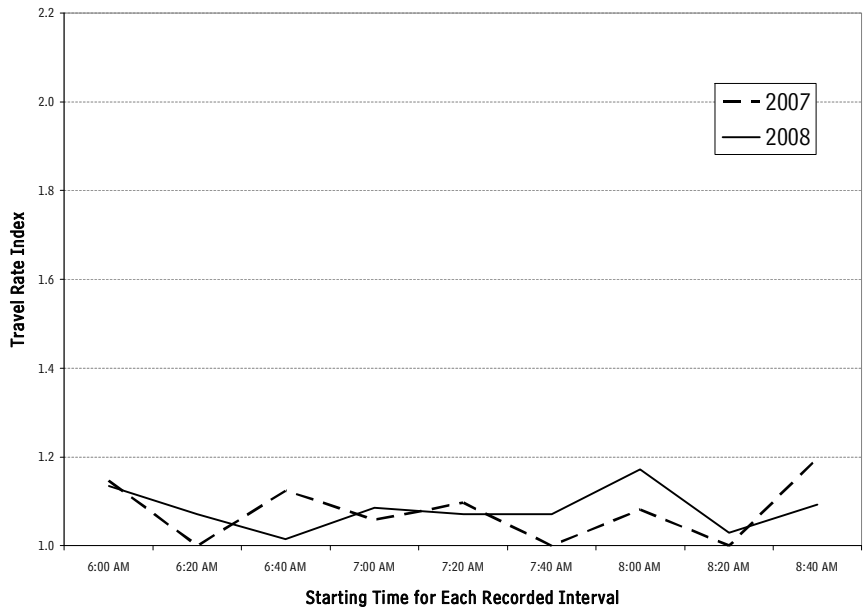
Corridor 6 is defined in linked segments as follows:

- (A) US 281 from IH 410 to FM 1937
- (B) US 281 from FM 1937 to FM 2537
- (C) US 281 from FM 2537 to SL 1604

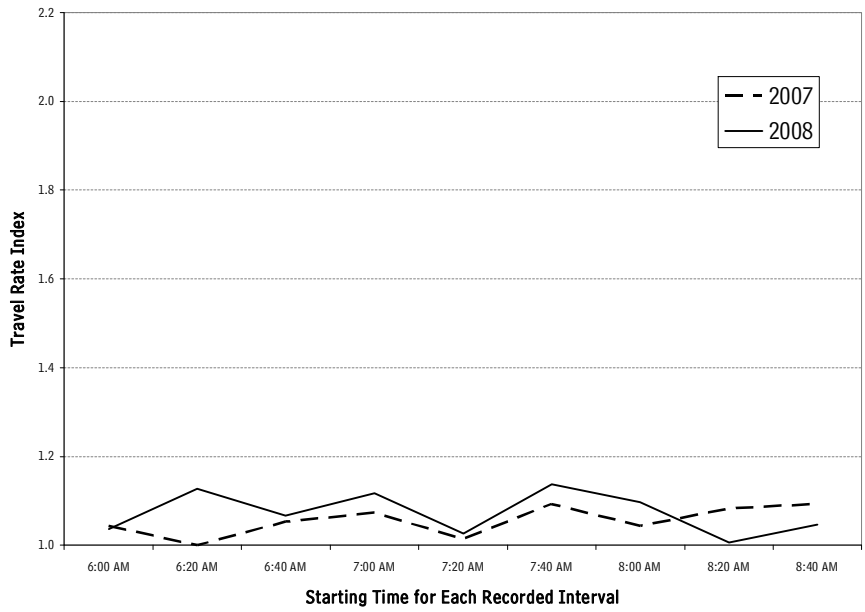
*Travel Time Runs, Morning Peak, Southbound Direction*



**Figure 310 US 281 (AM Peak), IH 410 to FM 1937, Southbound.**

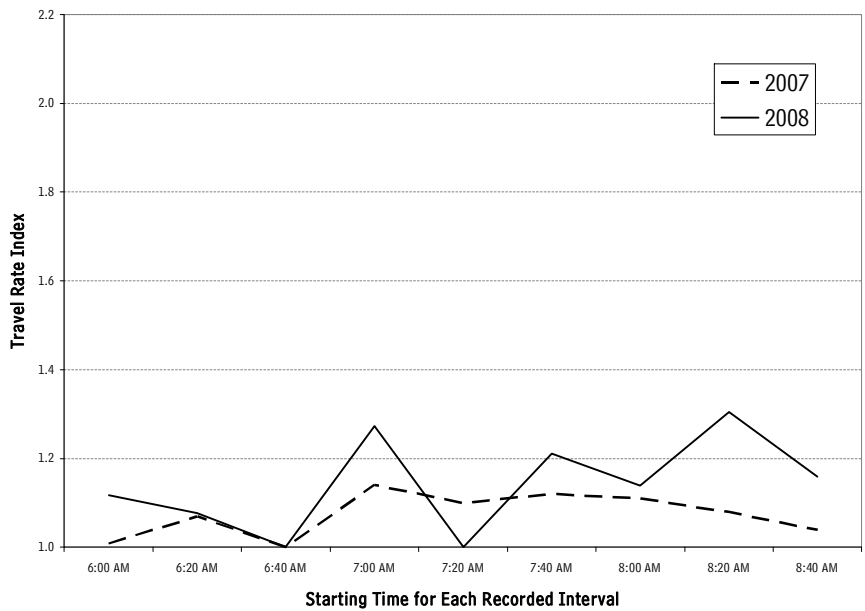


**Figure 311 US 281 (AM Peak), FM 1937 to FM 2537, Southbound.**

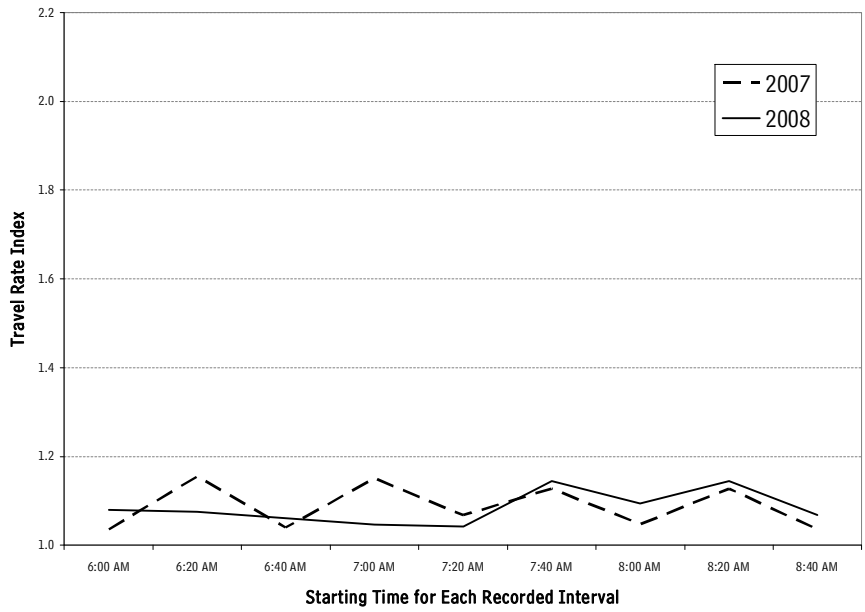


**Figure 312 US 281 (AM Peak), FM 2537 to SL 1604, Southbound.**

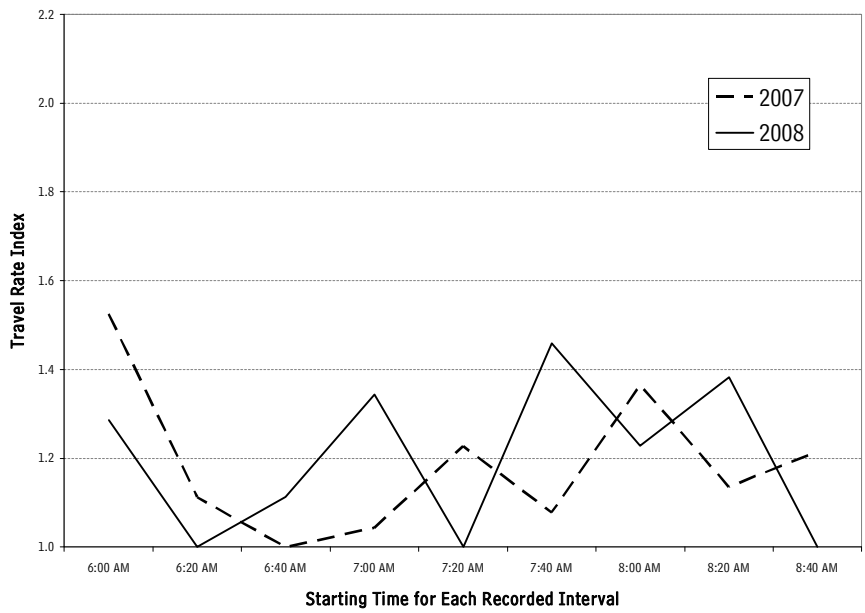
*Travel Time Runs, Morning Peak, Northbound Direction*



**Figure 313 US 281 (AM Peak), FM 2537 to SL 1604, Northbound.**

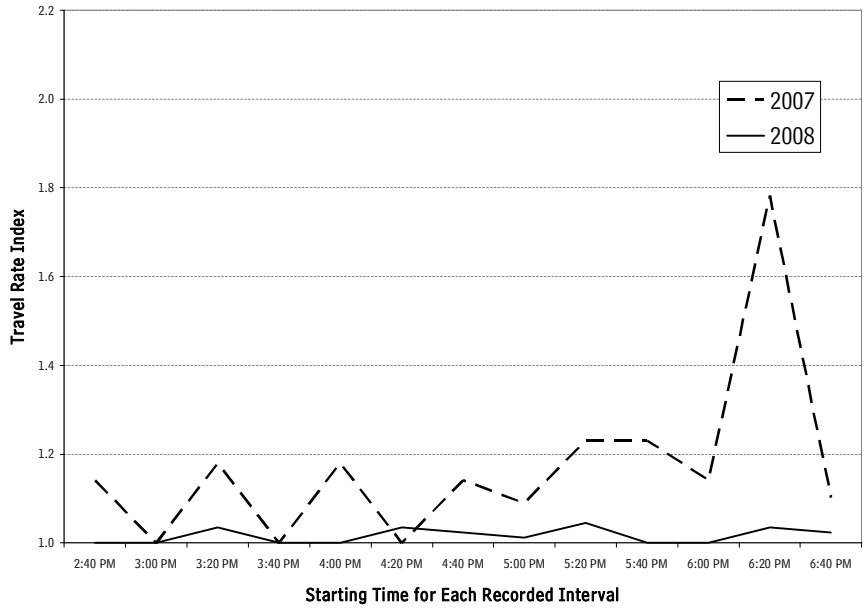


**Figure 314 US 281 (AM Peak), FM 1937 to FM 2537, Northbound.**

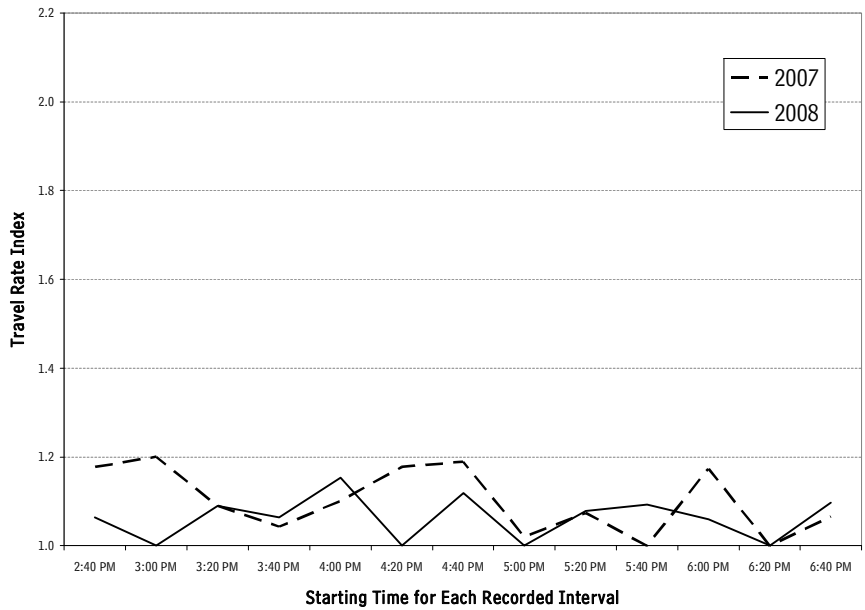


**Figure 315 US 281 (AM Peak), IH 410 to FM 1937, Northbound.**

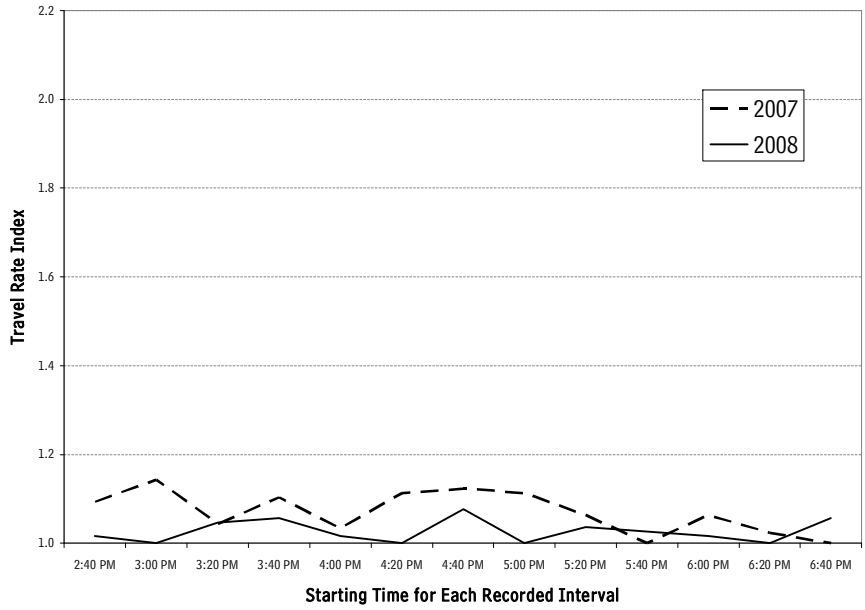
***Travel Time Runs, Afternoon Peak, Southbound Direction***



**Figure 316 US 281 (PM Peak), IH 410 to FM 1937, Southbound.**

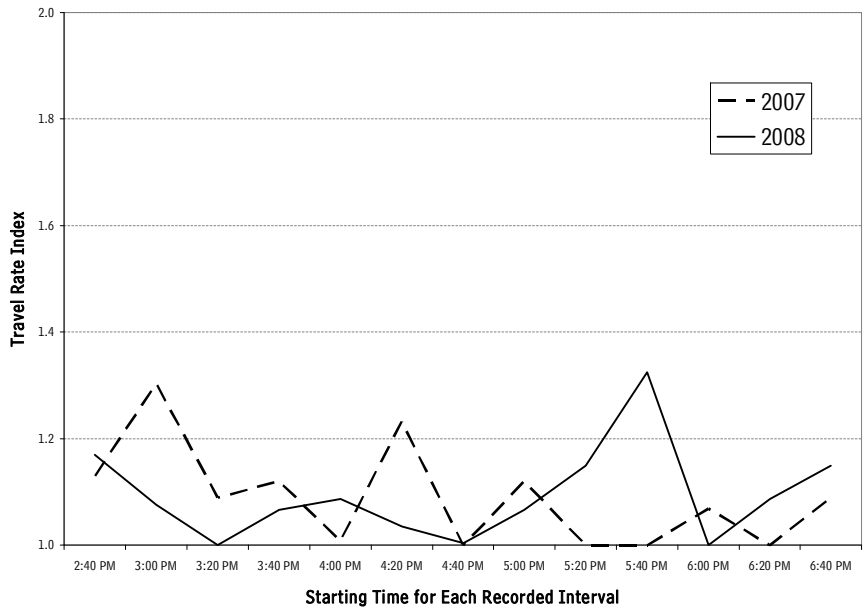


**Figure 317 US 281 (PM Peak), FM 1937 to FM 2537, Southbound.**

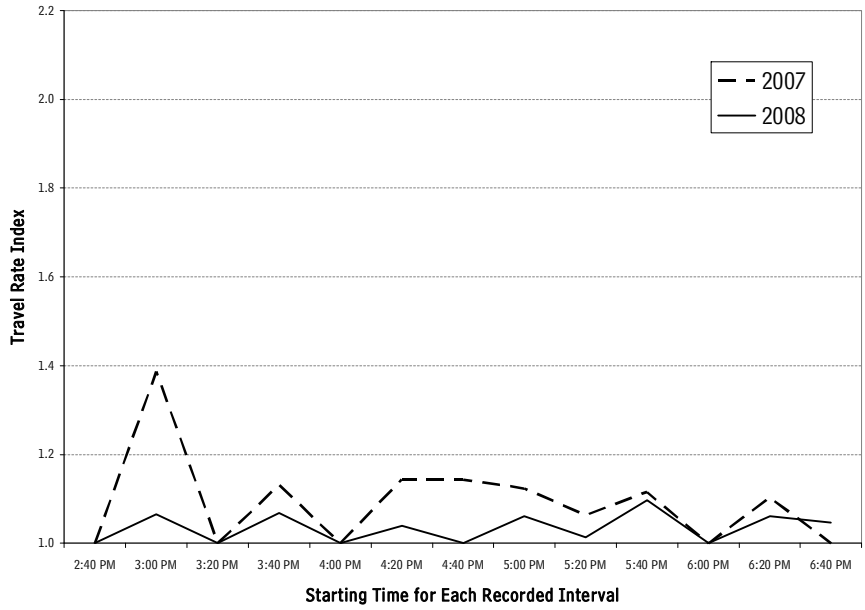


**Figure 318 US 281 (PM Peak), FM 2537 to SL 1604, Southbound.**

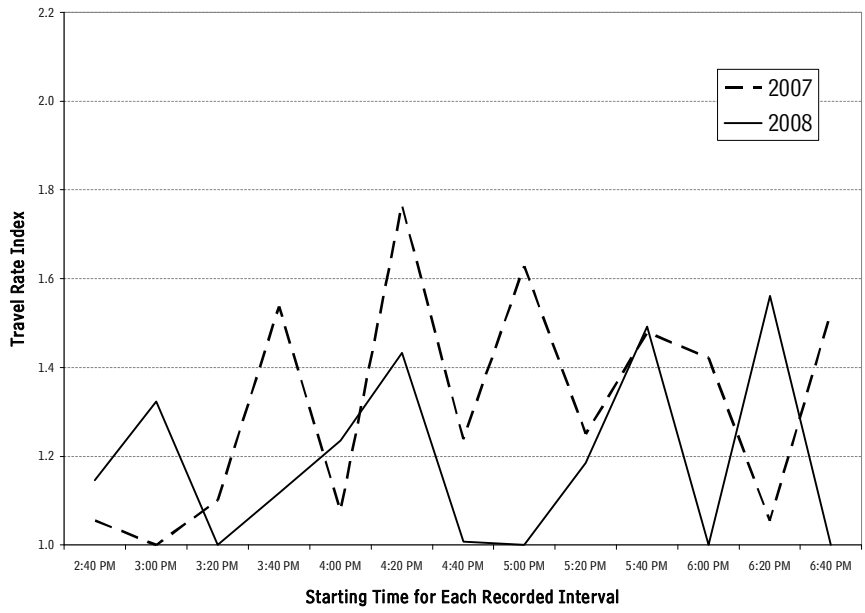
*Travel Time Runs, Afternoon Peak, Northbound Direction*



**Figure 319 US 281 (PM Peak), FM 2537 to SL 1604, Northbound.**



**Figure 320 US 281 (PM Peak), FM 1937 to FM 2537, Northbound.**



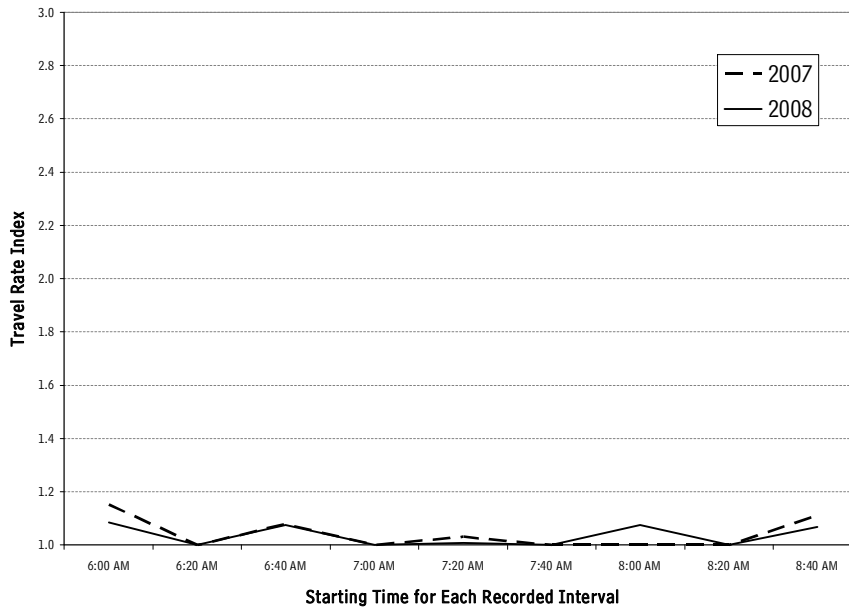
**Figure 321 US 281 (PM Peak), IH 410 to FM 1937, Northbound.**

## Corridor 7: FM 2790 from SL 1604 to IH 410

Corridor 7 is defined in linked segments as follows:

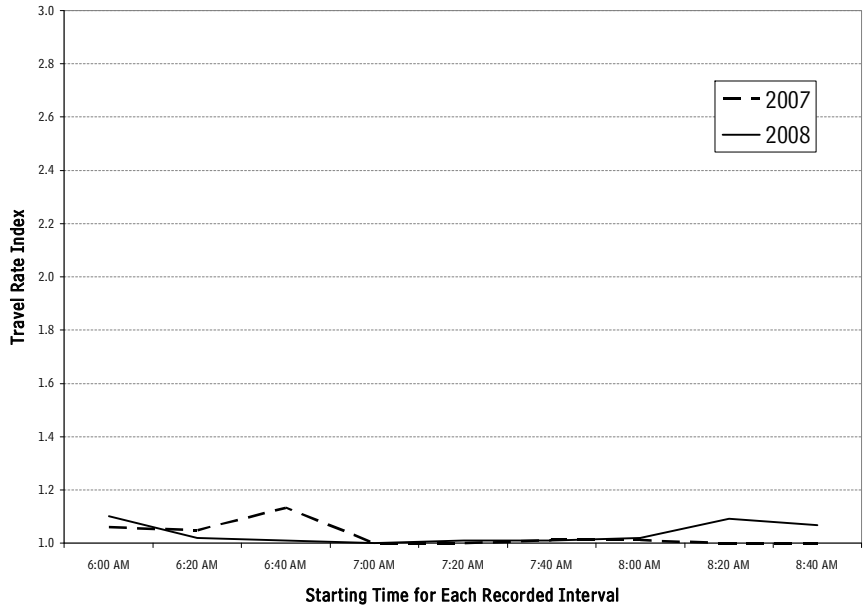
- (D) FM 2790 from IH 410 to Watson Rd/Fisher Rd
- (E) FM 2790 from Watson Rd/Fisher Rd to Old Somerset Rd
- (F) FM 2790 from Old Somerset Rd to Senior Rd
- (G) FM 2790 from Senior Rd to S Evans Rd
- (H) FM 2790 from S Evans Rd to Frank Hoffman Rd
- (I) FM 2790 from Frank Hoffman Rd to Rockport Rd
- (J) FM 2790 from Rockport Rd to SL 1604

### *Travel Time Runs, Morning Peak, Southbound Direction*

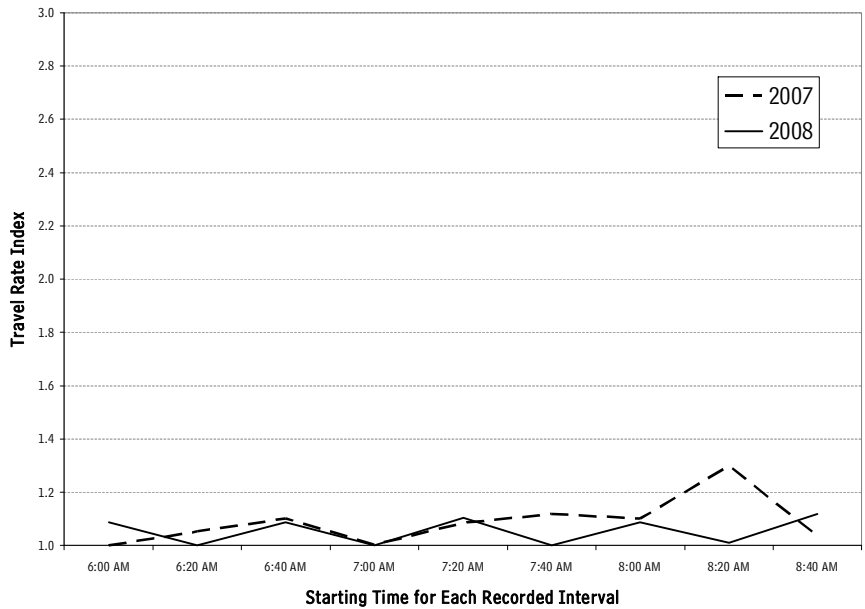


**Figure 322 FM 2790 (AM Peak), IH 410 to Watson Rd/Fisher Rd, Southbound.**

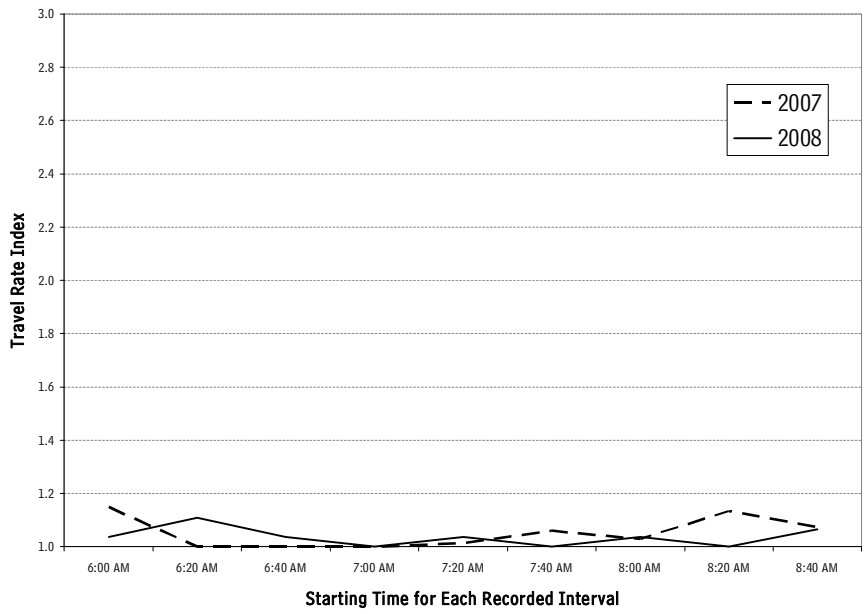




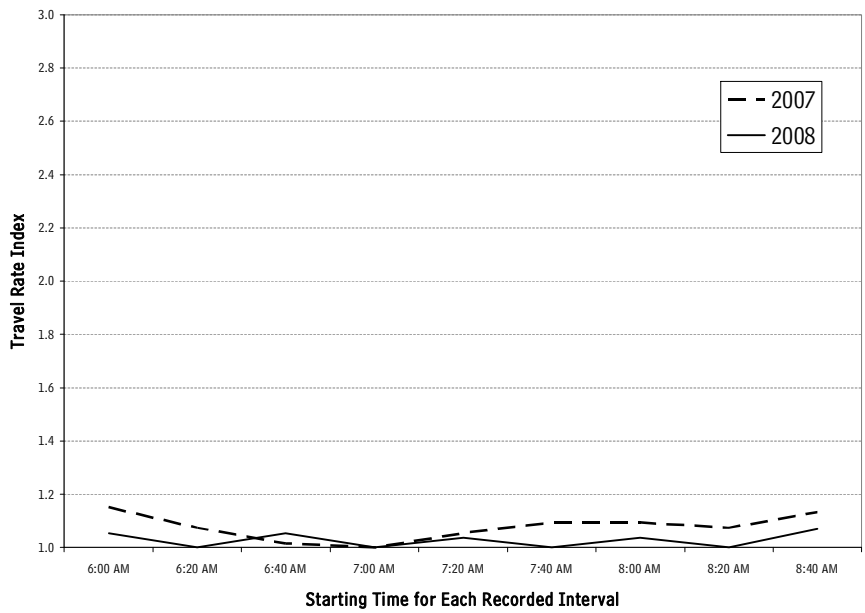
**Figure 323 FM 2790 (AM Peak), Watson Rd/Fisher Rd to Old Somerset Rd, Southbound.**



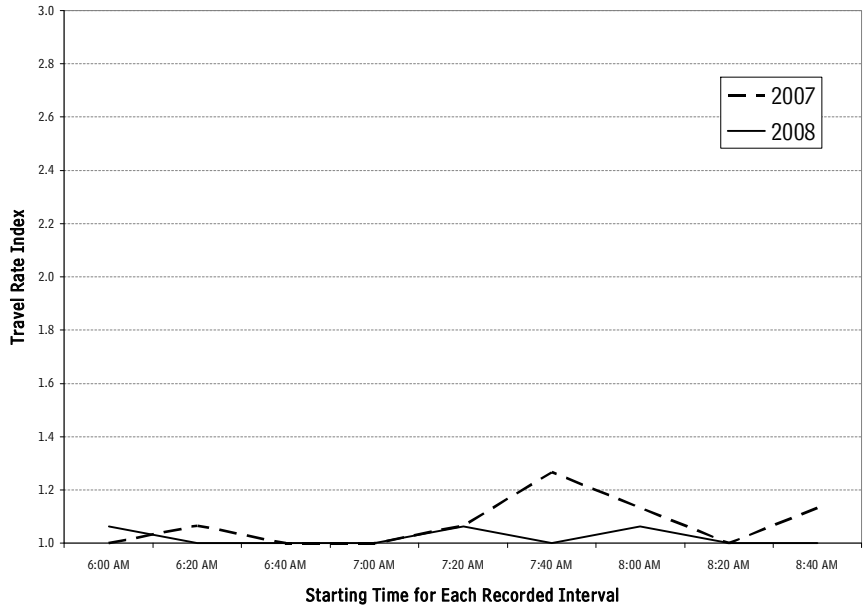
**Figure 324 FM 2790 (AM Peak), Old Somerset Rd to Senior Rd, Southbound.**



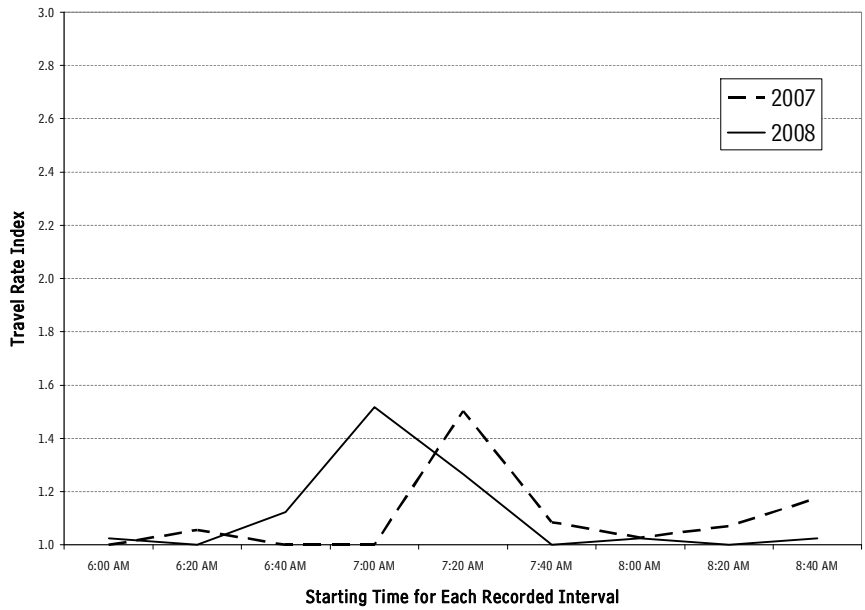
**Figure 325 FM 2790 (AM Peak), Senior Rd to S Evans Rd, Southbound.**



**Figure 326 FM 2790 (AM Peak), S Evans Rd to Frank Hoffman Rd, Southbound.**

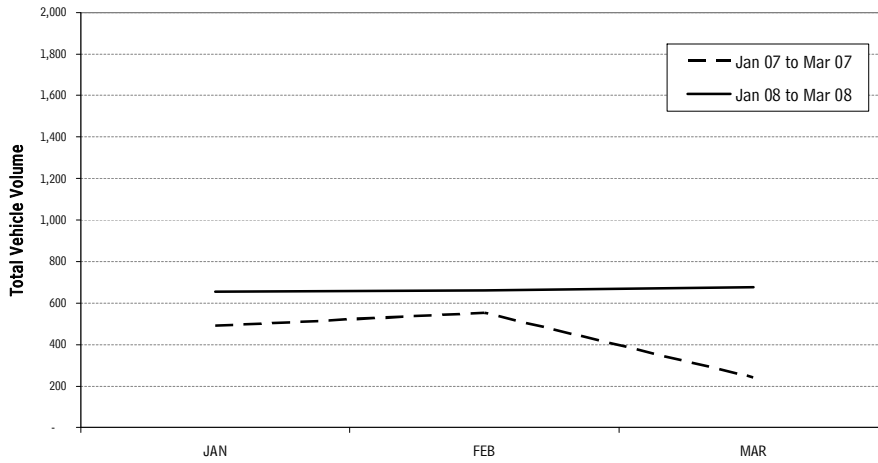


**Figure 327 FM 2790 (AM Peak), Frank Hoffman Rd to Rockport Rd, Southbound.**

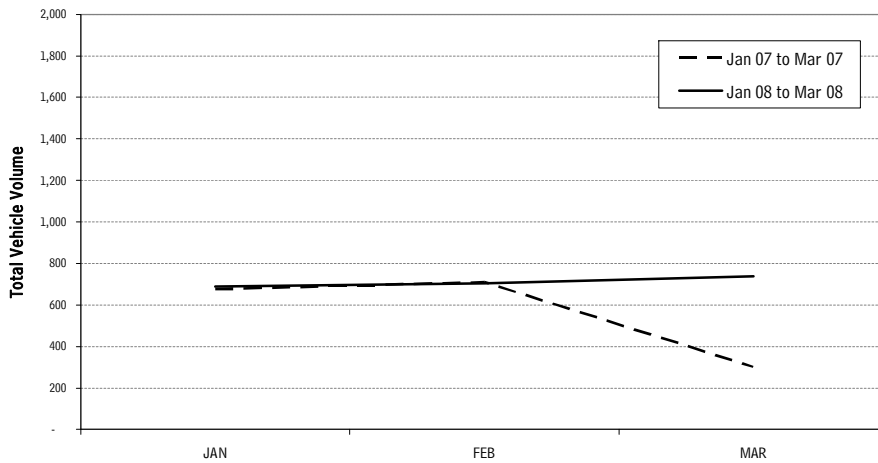


**Figure 328 FM 2790 (AM Peak), Rockport Rd to SL 1604, Southbound.**

**Total Vehicle Volumes Southbound Direction, Morning Peak**

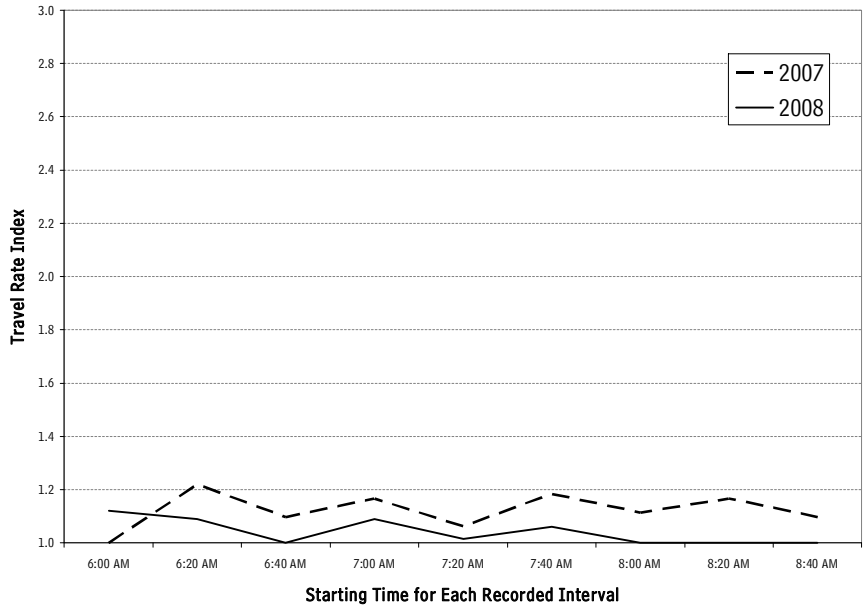


**Figure 329 Total Vehicle Volumes, Site 304 Southbound, 6 AM to 7 AM.**

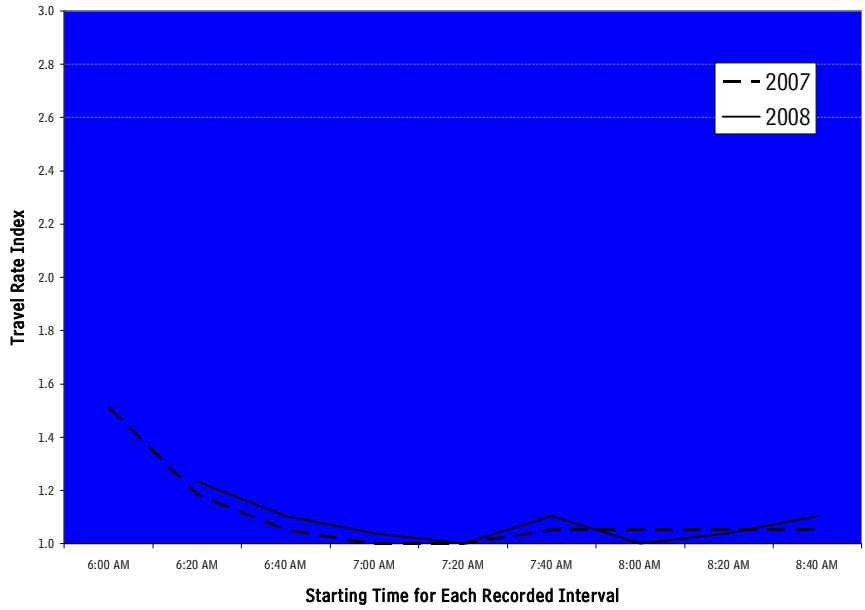


**Figure 330 Total Vehicle Volumes, Site 304 Southbound, 7 AM to 8 AM.**

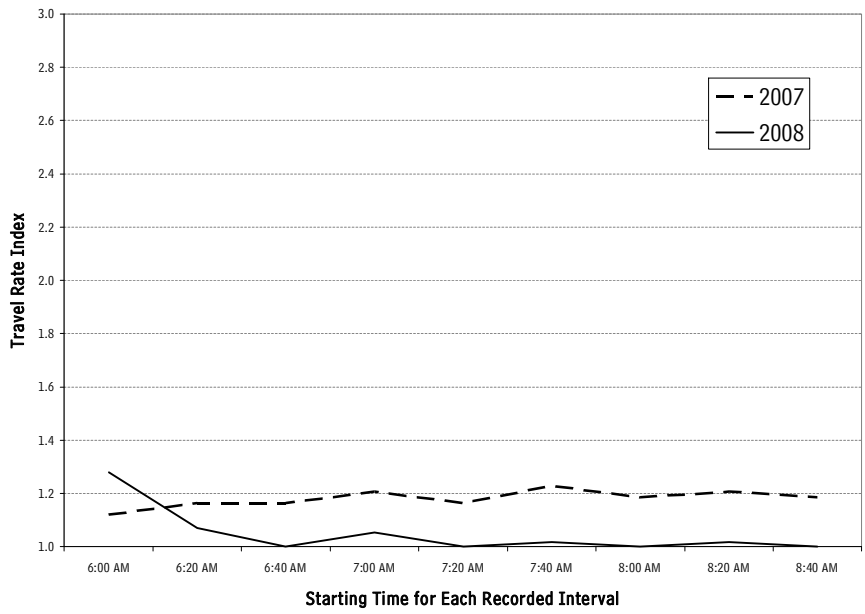
***Travel Time Runs, Morning Peak, Northbound Direction***



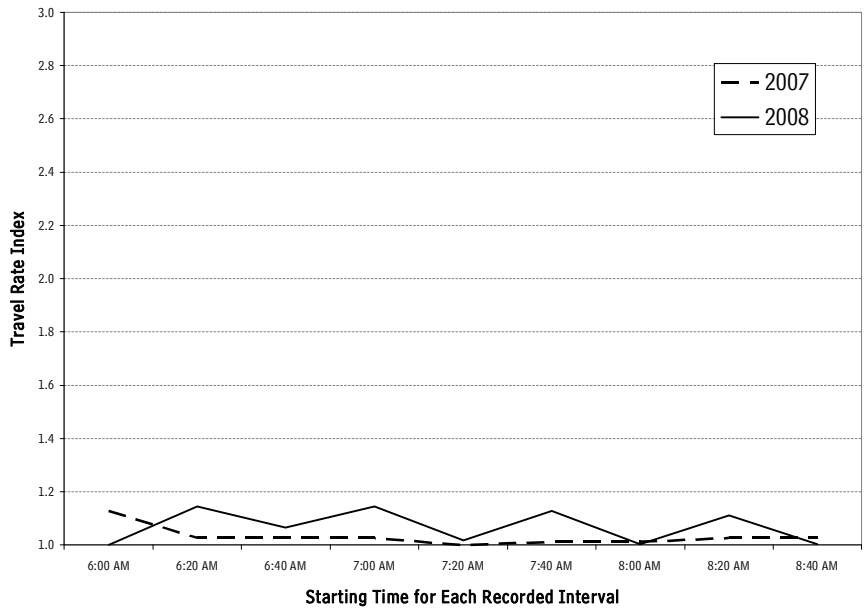
**Figure 331 FM 2790 (AM Peak), Rockport Rd to SL 1604, Northbound.**



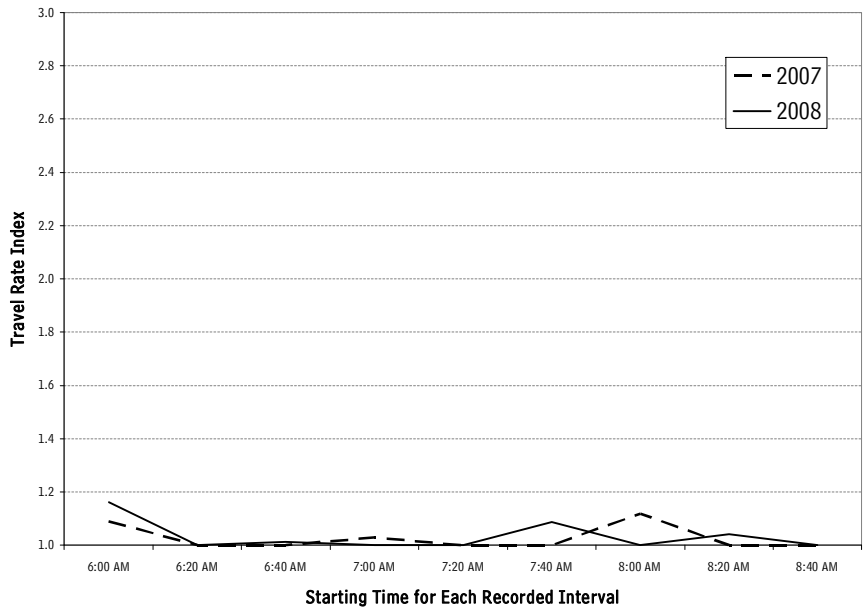
**Figure 332 FM 2790 (AM Peak), Frank Hoffman Rd to Rockport Rd, Northbound.**



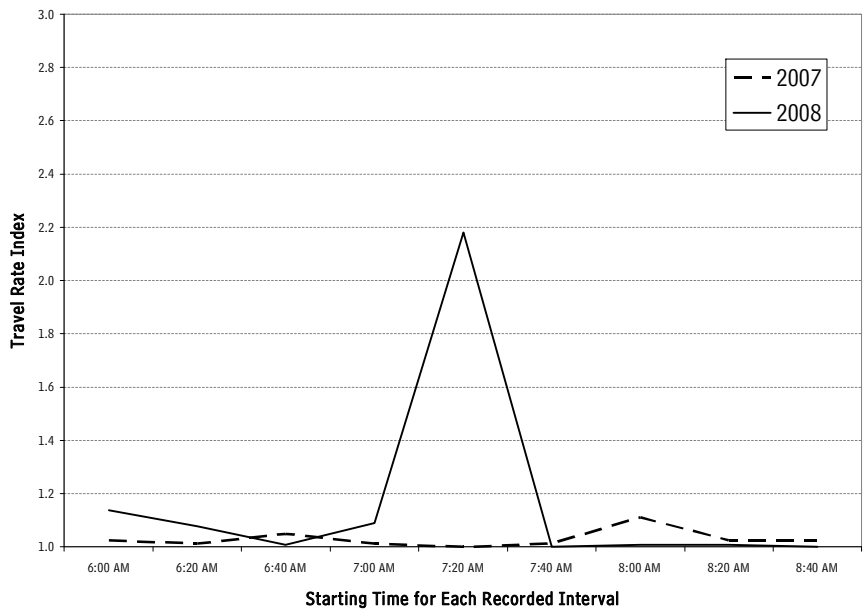
**Figure 333 FM 2790 (AM Peak), S Evans Rd to Frank Hoffman Rd, Northbound.**



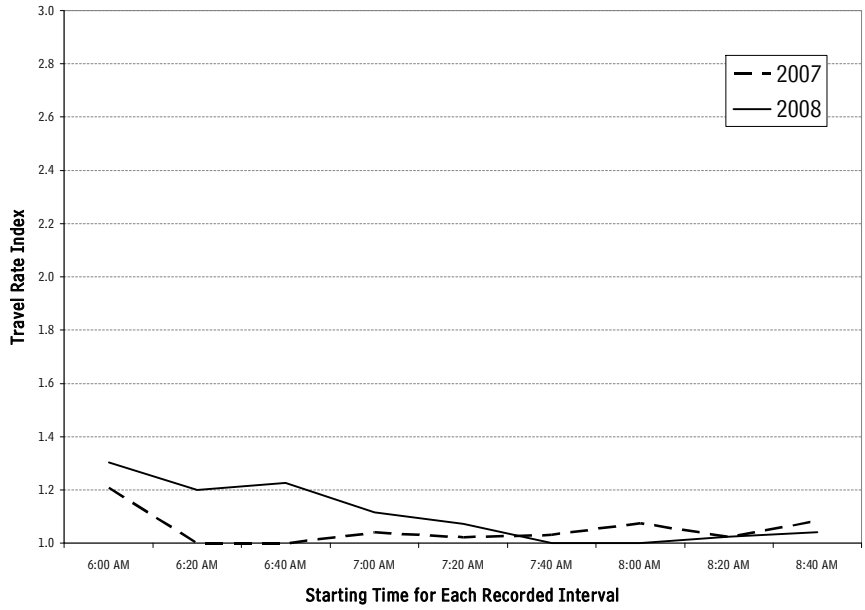
**Figure 334 FM 2790 (AM Peak), Senior Rd to S Evans Rd, Northbound.**



**Figure 335 FM 2790 (AM Peak), Old Somerset Rd to Senior Rd, Northbound.**

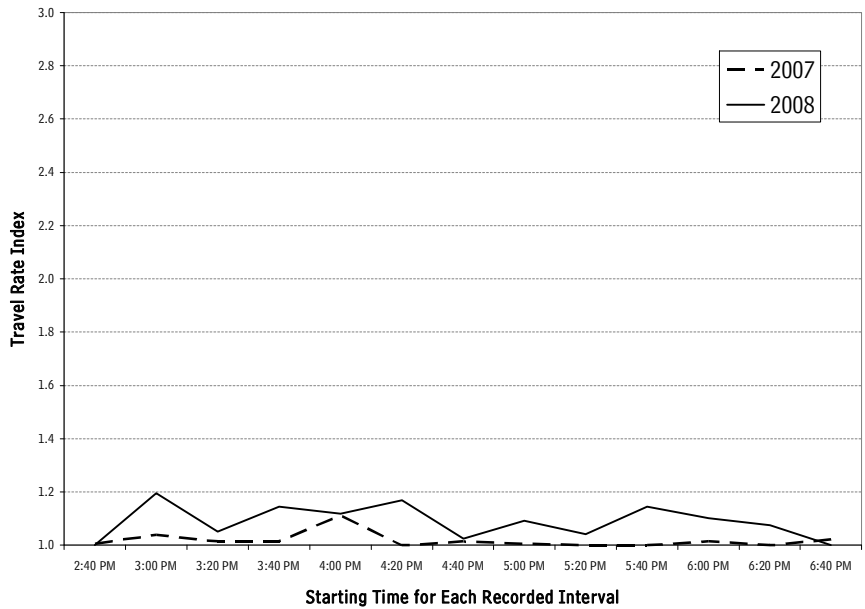


**Figure 336 FM 2790 (AM Peak), Watson Rd/Fisher Rd to Old Somerset Rd, Northbound.**



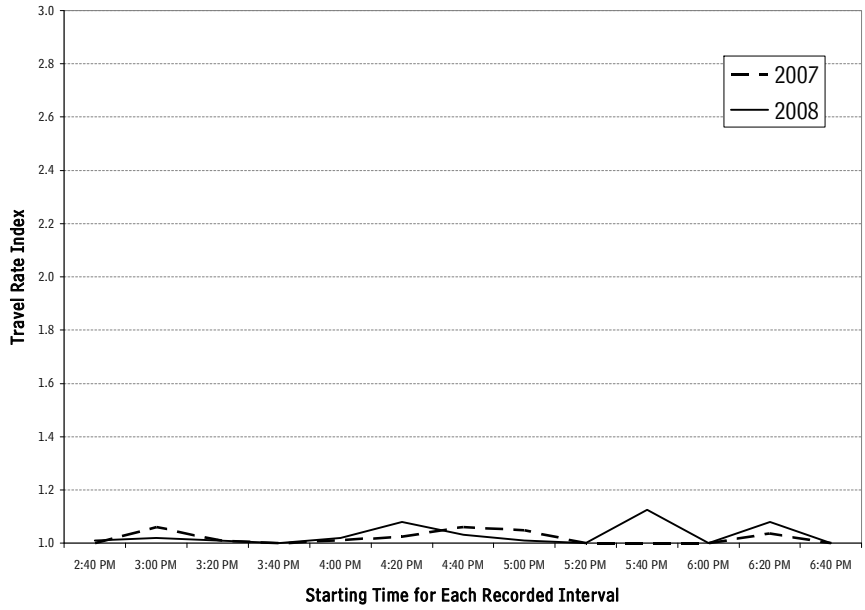
**Figure 337 FM 2790 (AM Peak), IH 410 to Watson Rd/Fisher Rd, Northbound.**

*Travel Time Runs, Afternoon Peak, Southbound Direction*

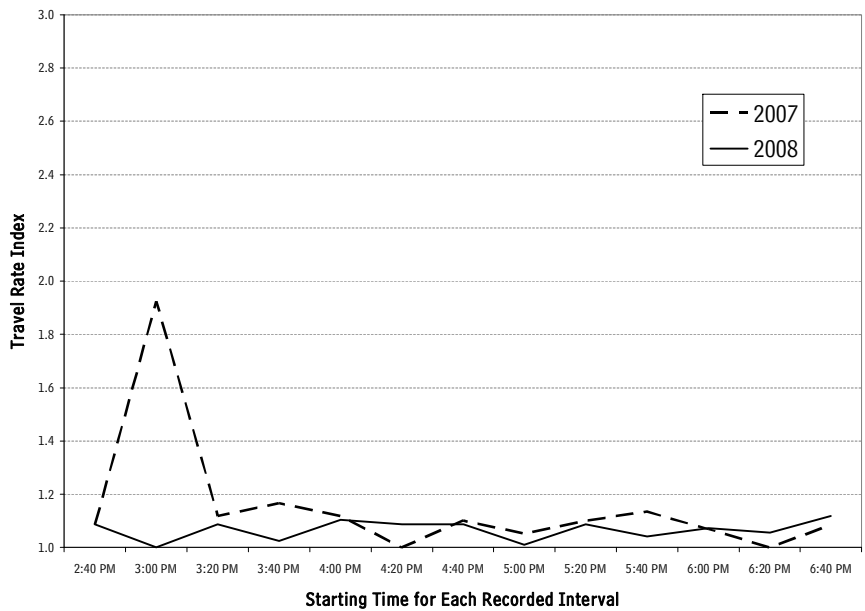


**Figure 338 FM 2790 (PM Peak), IH 410 to Watson Rd/Fisher Rd, Southbound.**

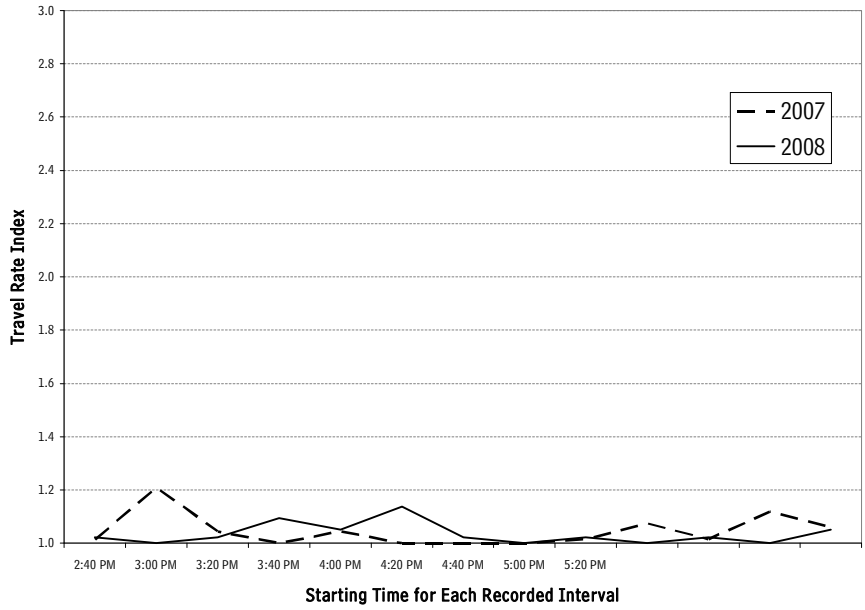




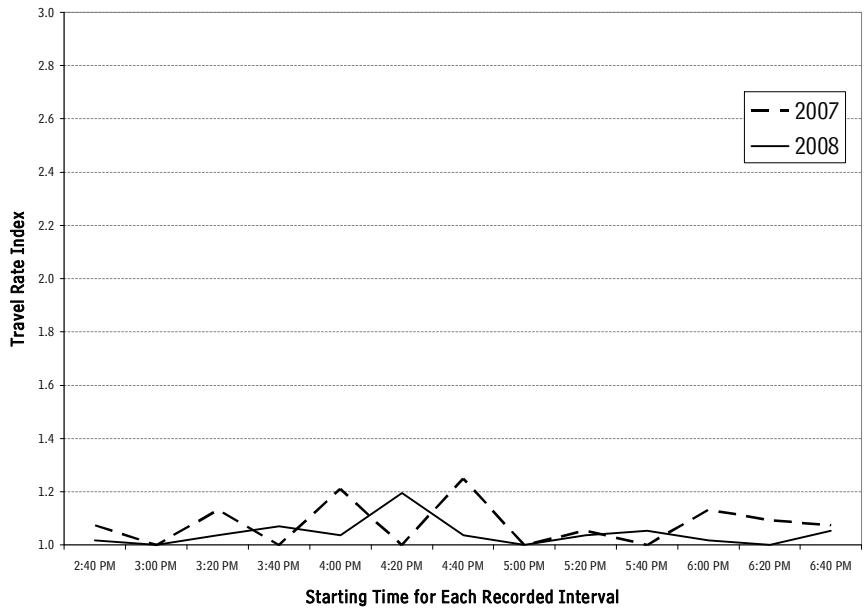
**Figure 339 FM 2790 (PM Peak), Watson Rd/Fisher Rd to Old Somerset Rd, Southbound.**



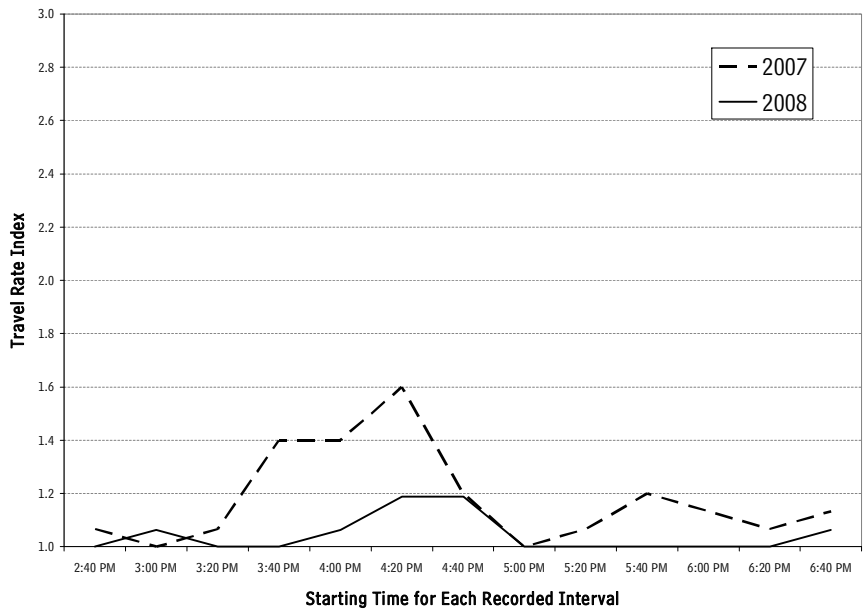
**Figure 340 FM 2790 (PM Peak), Old Somerset Rd to Senior Rd, Southbound.**



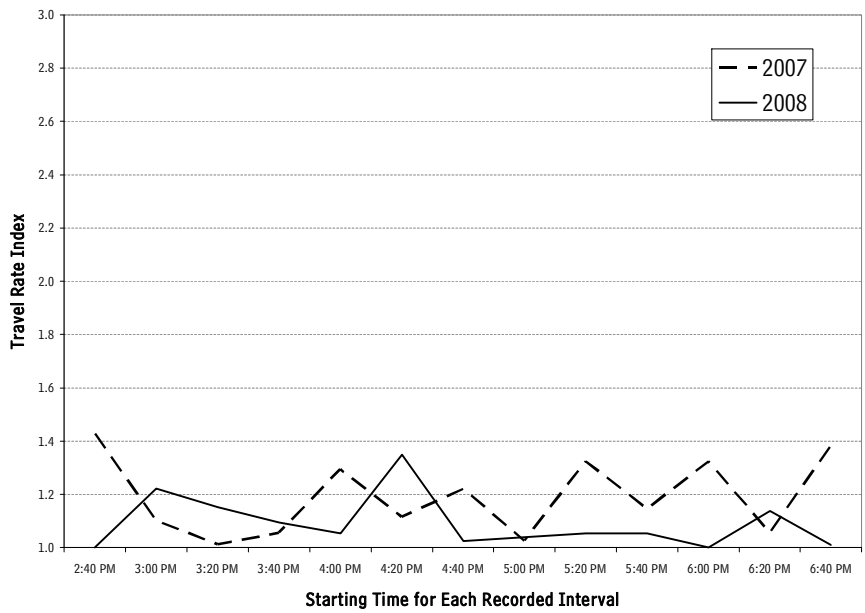
**Figure 341 FM 2790 (PM Peak), Senior Rd to S Evans Rd, Southbound.**



**Figure 342 FM 2790 (PM Peak), S Evans Rd to Frank Hoffman Rd, Southbound.**

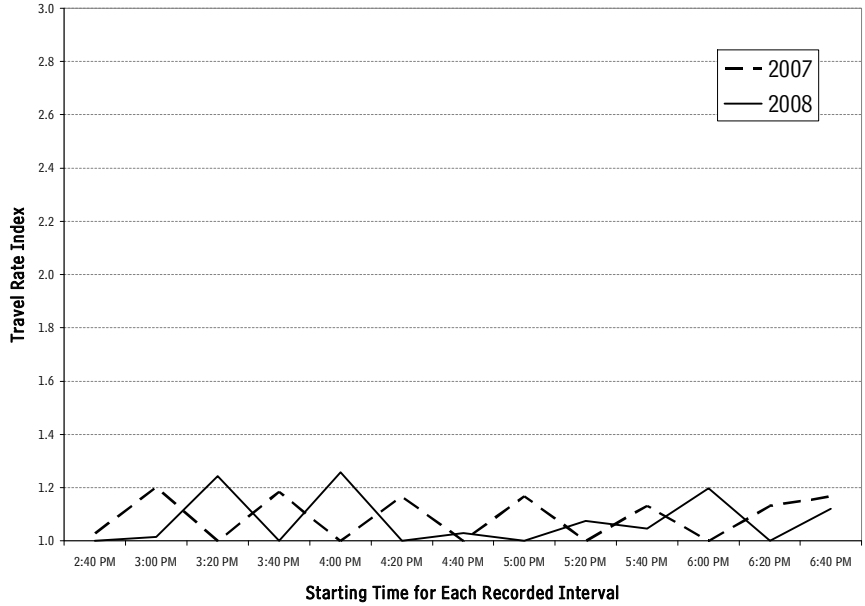


**Figure 343 FM 2790 (PM Peak), Frank Hoffman Rd to Rockport Rd, Southbound.**

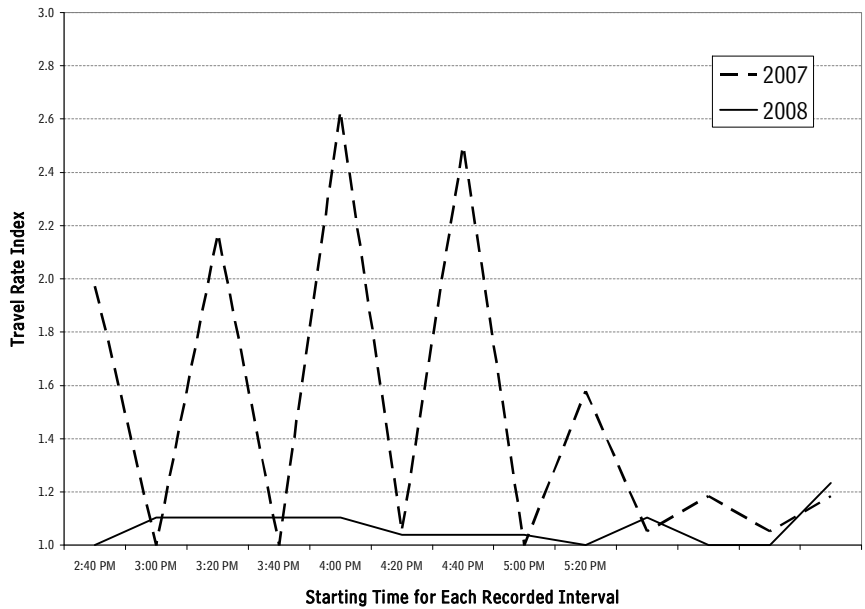


**Figure 344 FM 2790 (PM Peak), Rockport Rd to SL 1604, Southbound.**

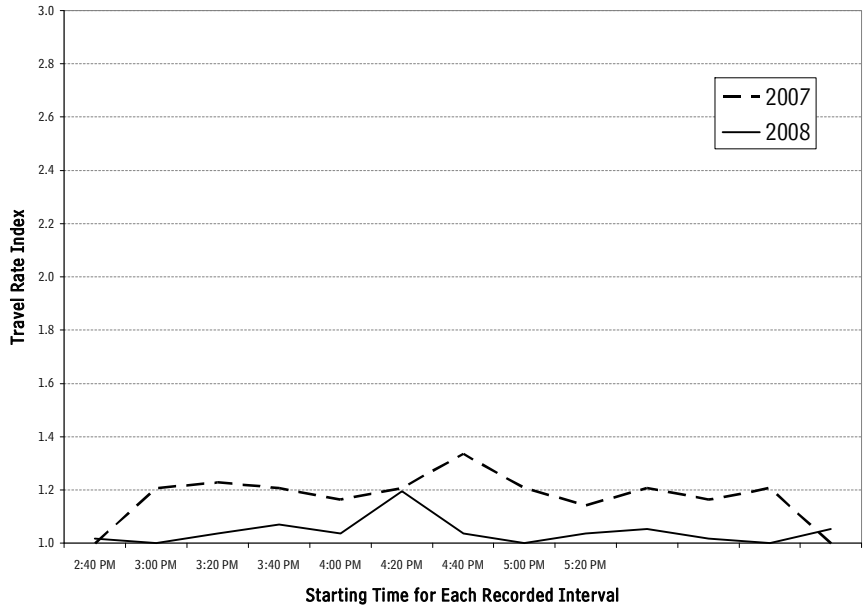
*Travel Time Runs, Afternoon Peak, Northbound Direction*



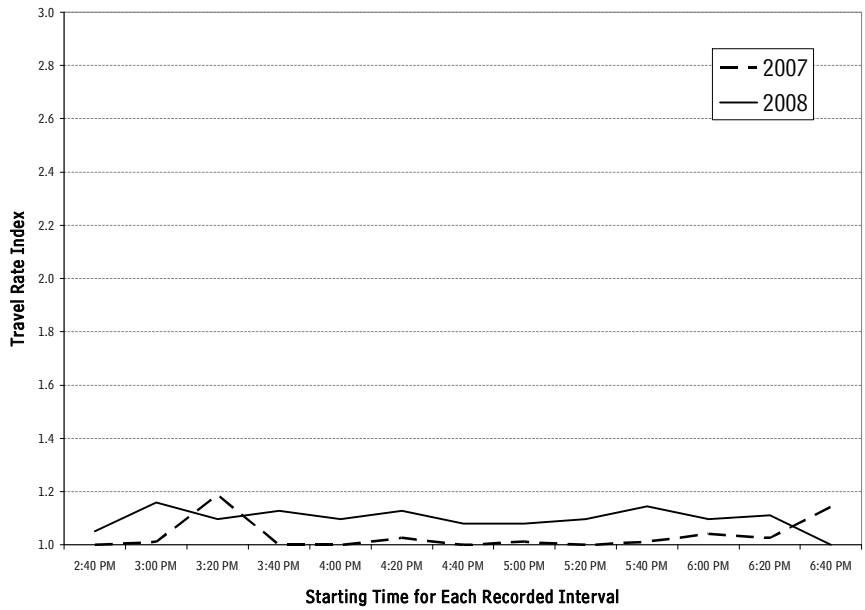
**Figure 345 FM 2790 (PM Peak), Rockport Rd to SL 1604, Northbound.**



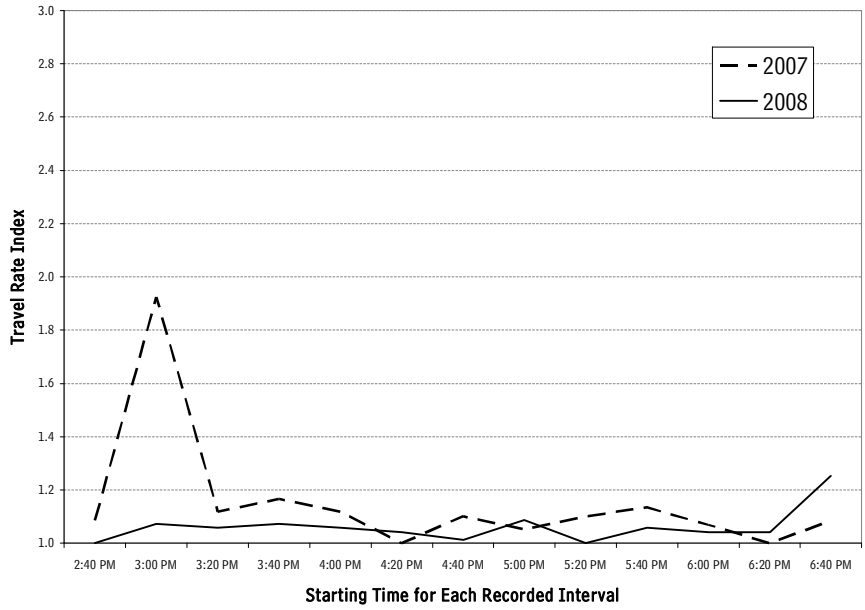
**Figure 346 FM 2790 (PM Peak), Frank Hoffman Rd to Rockport Rd, Northbound.**



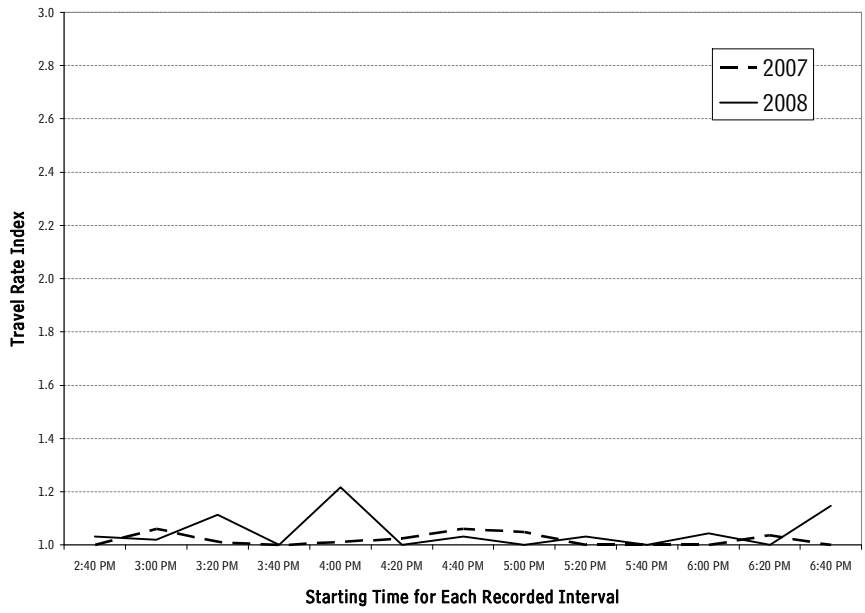
**Figure 347 FM 2790 (PM Peak), S Evans Rd to Frank Hoffman Rd, Northbound.**



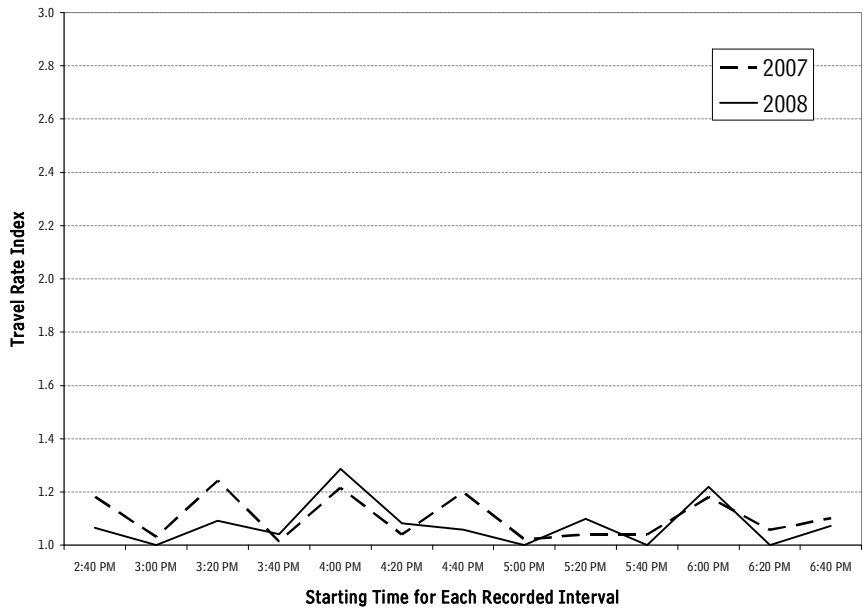
**Figure 348 FM 2790 (PM Peak), Senior Rd to S Evans Rd, Northbound.**



**Figure 349 FM 2790 (PM Peak), Old Somerset Rd to Senior Rd, Northbound.**



**Figure 350 FM 2790 (PM Peak), Watson Rd/Fisher Rd to Old Somerset Rd, Northbound.**



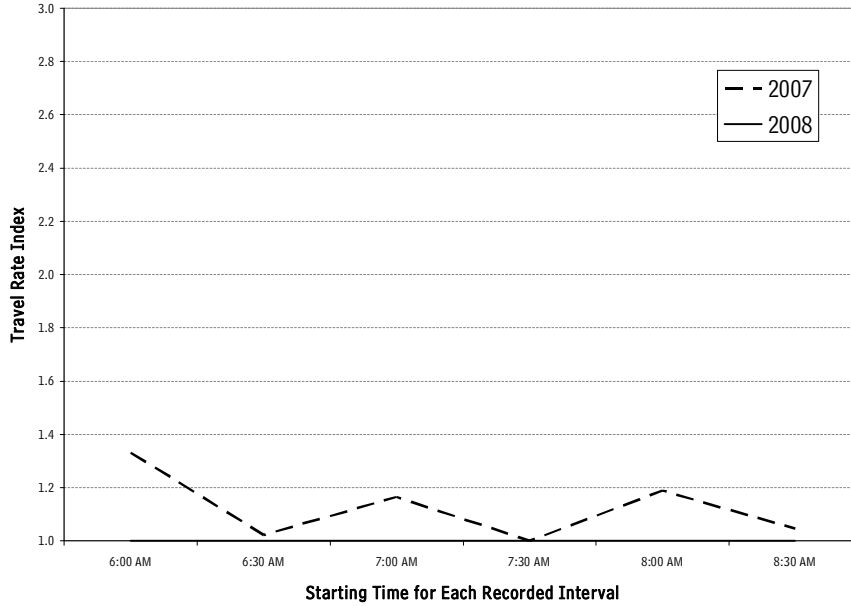
**Figure 351 FM 2790 (PM Peak), IH 410 to Watson Rd/Fisher Rd, Northbound.**

**Corridor 8: IH 35 from FM 2790 to SP 422**

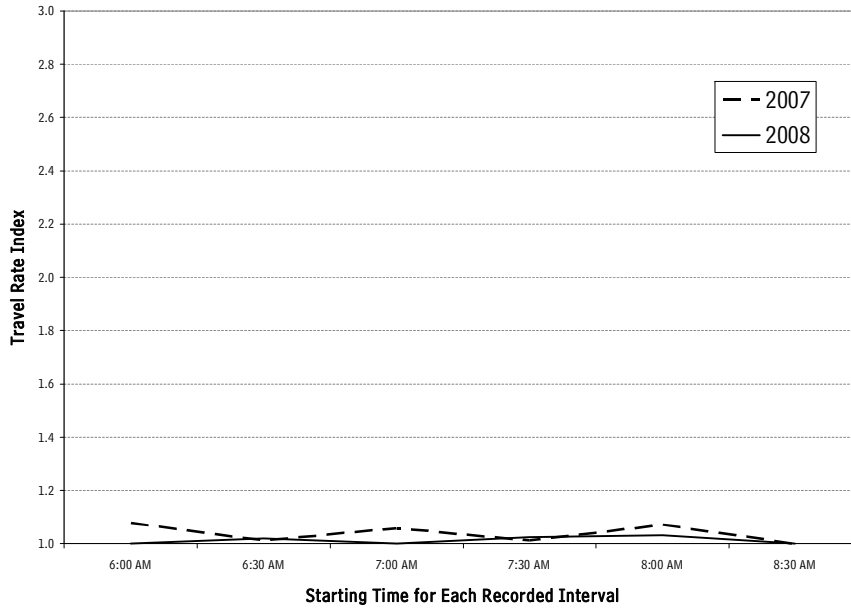
Corridor 8 is defined in linked segments as follows:

- (A) IH 35 from SP 422 to Somerset Rd
- (B) IH 35 from Somerset Rd to IH 410
- (C) IH 35 from IH 410 to Fisher Rd
- (D) IH 35 from Fisher Rd to SL 1604
- (E) IH 35 from SL 1604 to Kinney Rd
- (F) IH 35 from Kinney Rd to Shepherd Rd
- (G) IH 35 from Shepherd Rd to Lucky Rd
- (H) IH 35 from Lucky Rd to US 81
- (I) IH 35 from US 81 to FM 2790

*Travel Time Runs, Morning Peak, Southbound Direction*

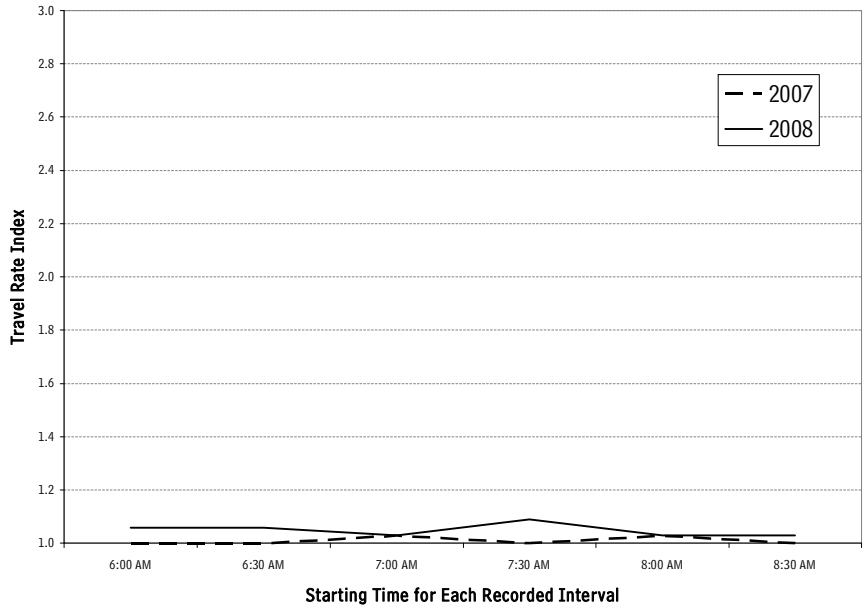


**Figure 352 IH 35 (AM Peak), SP 422 to Somerset Rd, Southbound.**

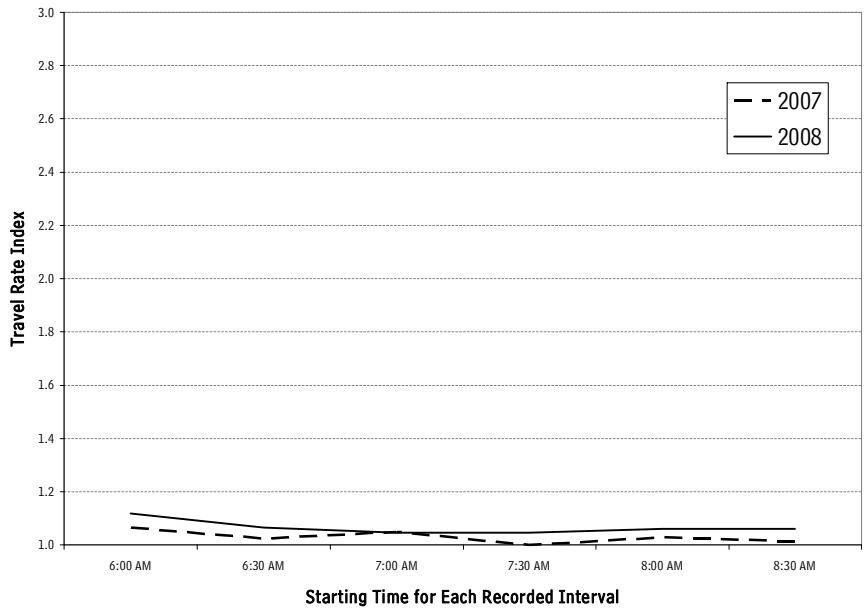


**Figure 353 IH 35 (AM Peak), Somerset Rd to IH 410, Southbound.**

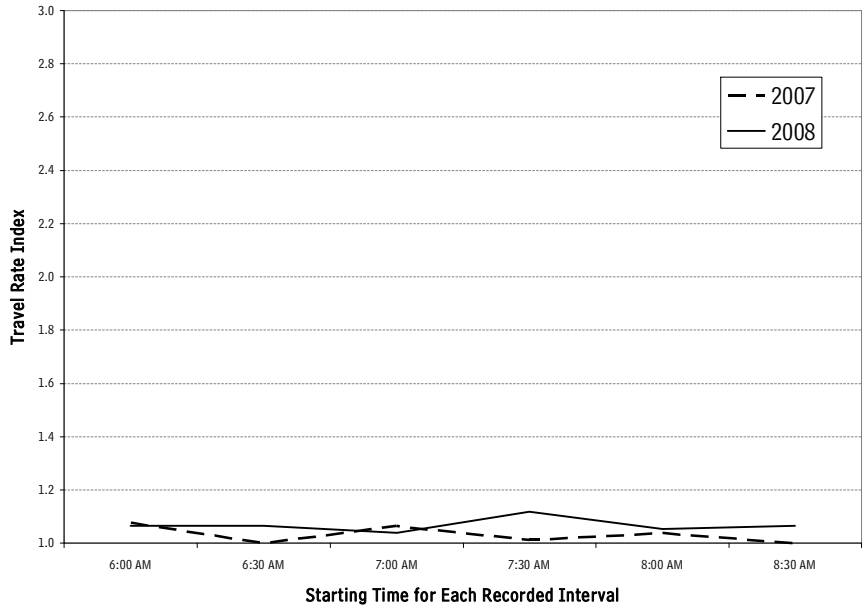




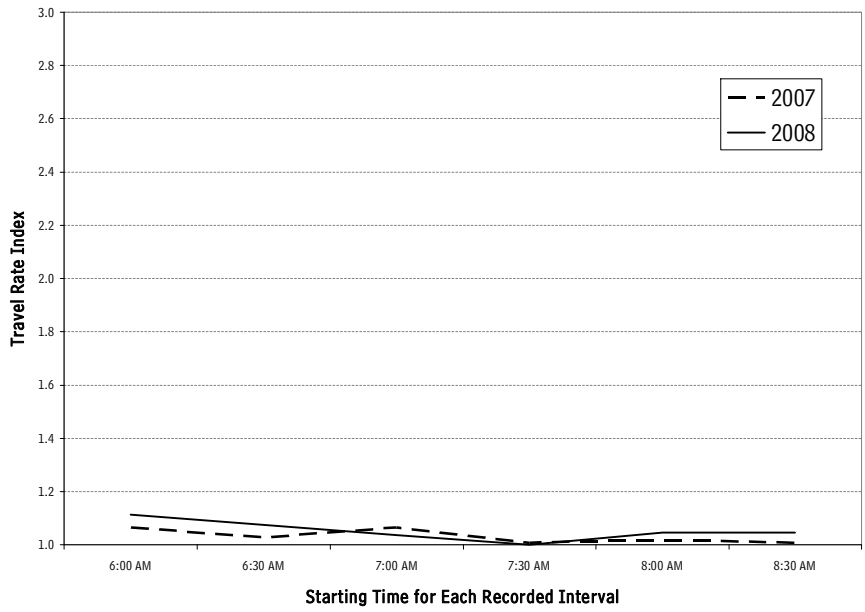
**Figure 354 IH 35 (AM Peak), IH 410 to Fisher Rd, Southbound.**



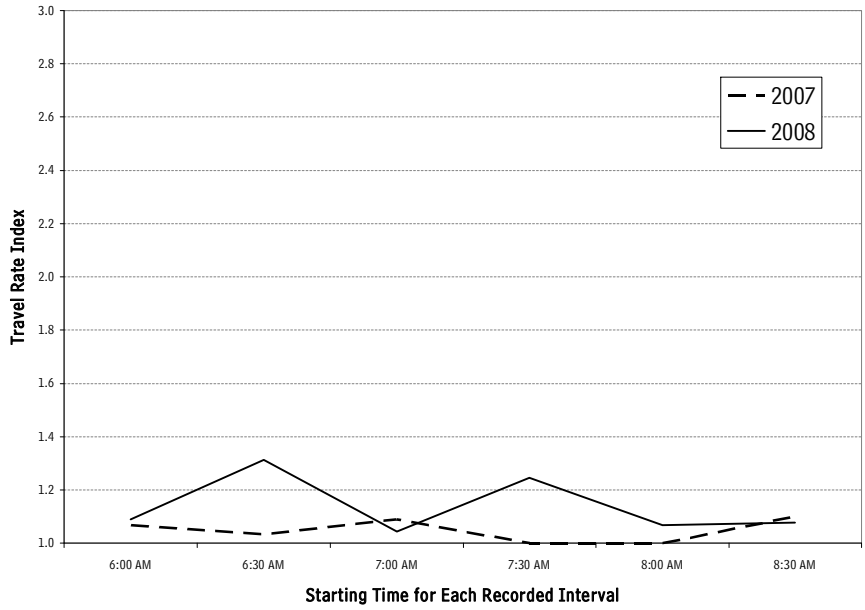
**Figure 355 IH 35 (AM Peak), Fisher Rd to SL 1604, Southbound.**



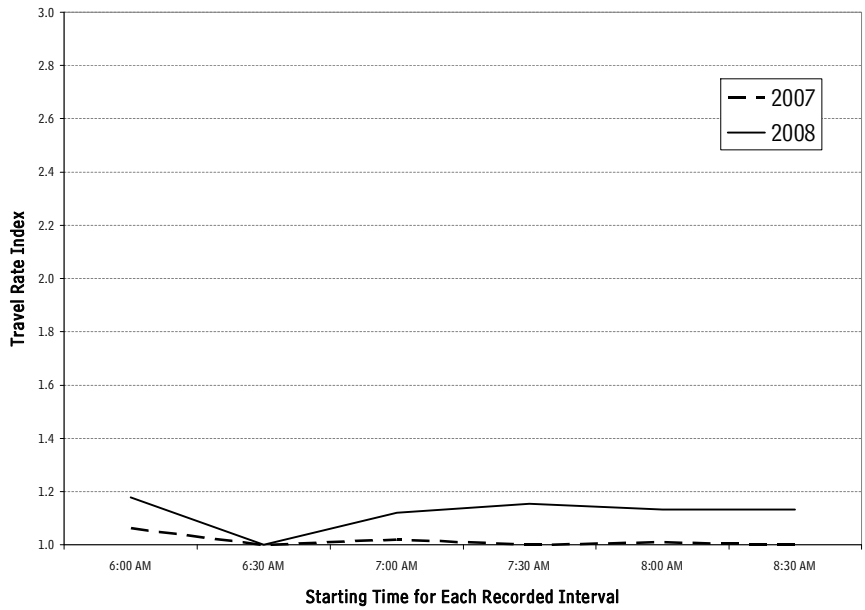
**Figure 356 IH 35 (AM Peak), SL 1604 to Kinney Rd, Southbound.**



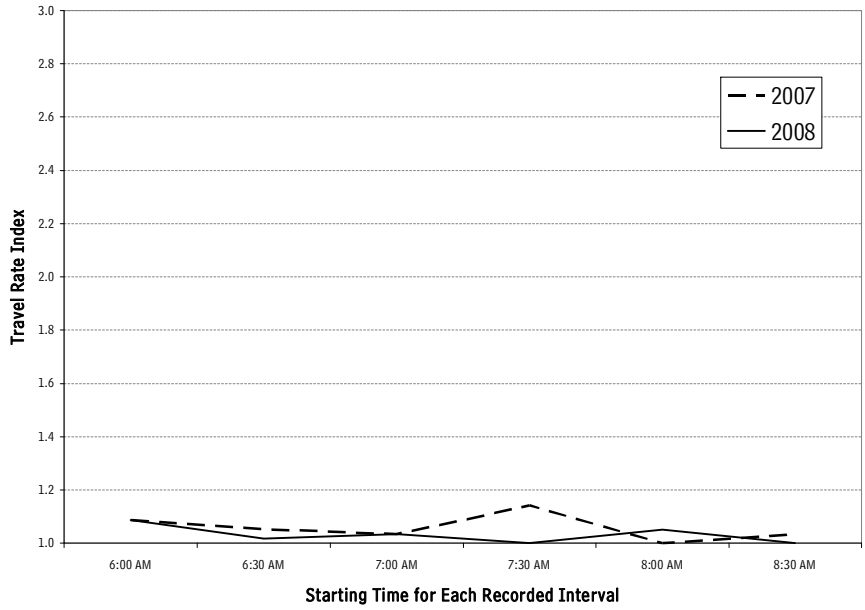
**Figure 357 IH 35 (AM Peak), Kinney Rd to Shepherd Rd, Southbound.**



**Figure 358 IH 35 (AM Peak), Shepherd Rd to Lucky Rd, Southbound.**

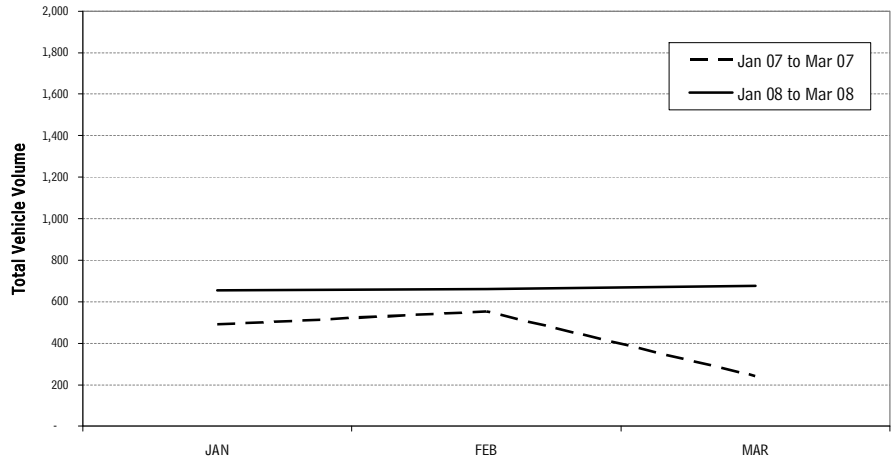


**Figure 359 IH 35 (AM Peak), Lucky Rd to US 81, Southbound.**

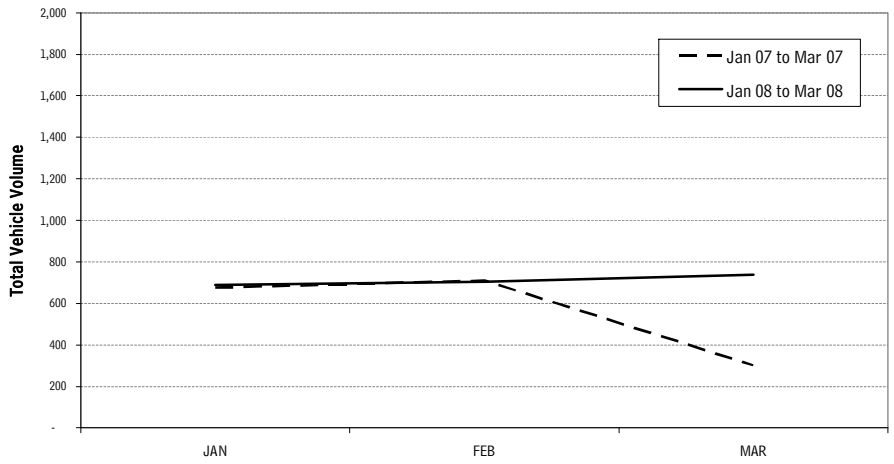


**Figure 360 IH 35 (AM Peak), US 81 to FM 2790, Southbound.**

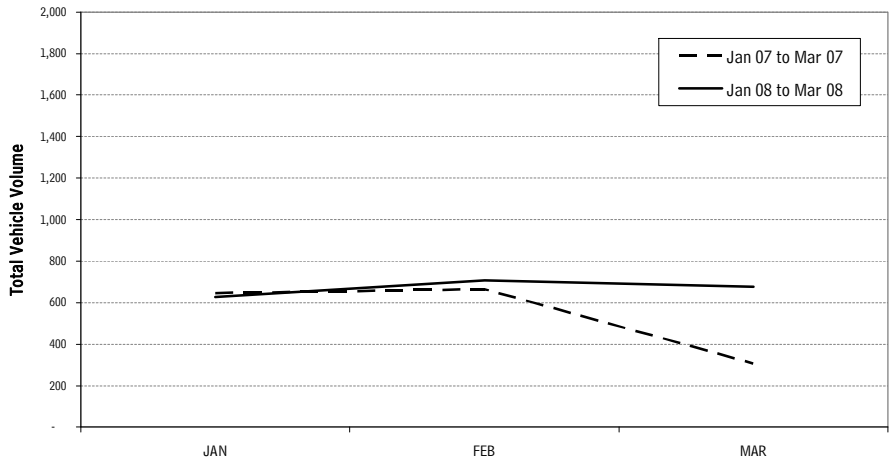
***Total Vehicle Volumes Southbound Direction, Morning Peak***



**Figure 361 Total Vehicle Volumes, Site 304 Southbound, 6 AM to 7 AM.**

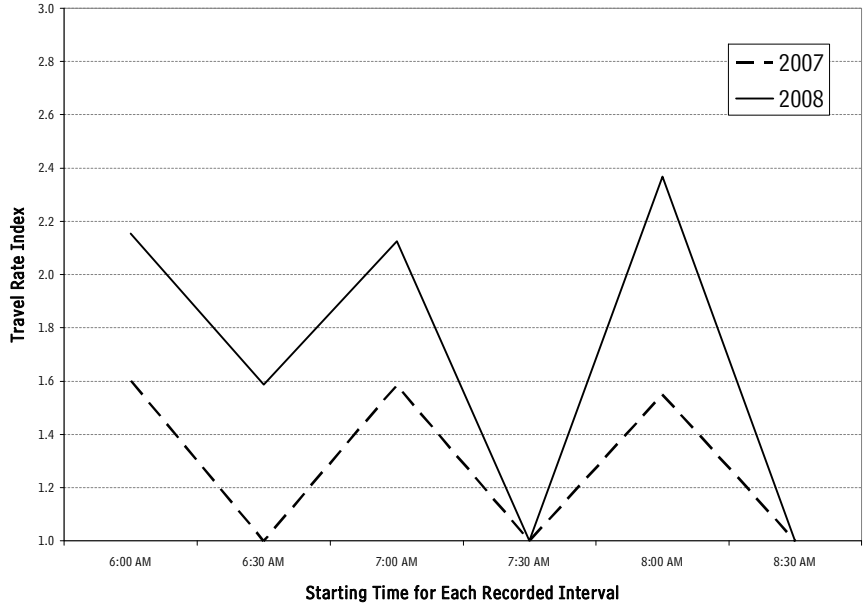


**Figure 362 Total Vehicle Volumes, Site 304 Southbound, 7 AM to 8 AM.**

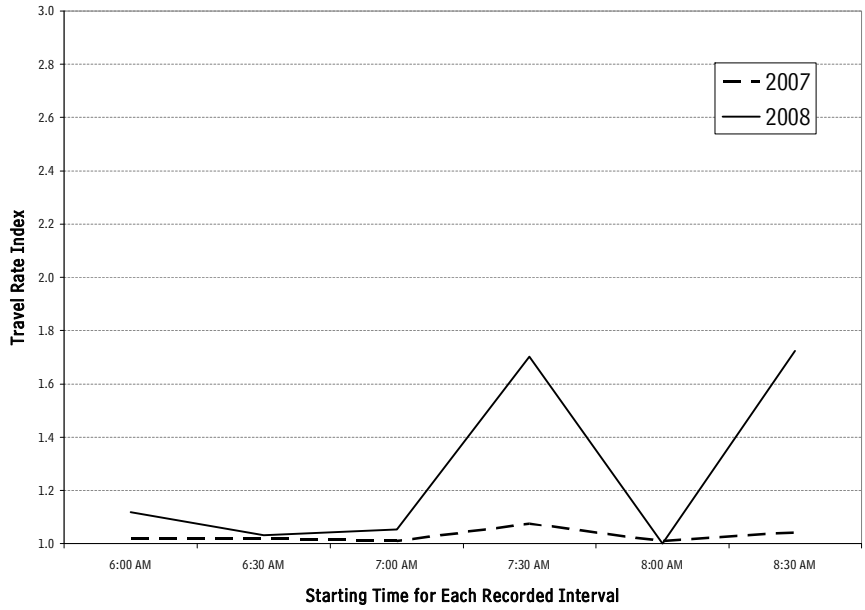


**Figure 363 Total Vehicle Volumes, Site 304 Southbound, 8 AM to 9 AM.**

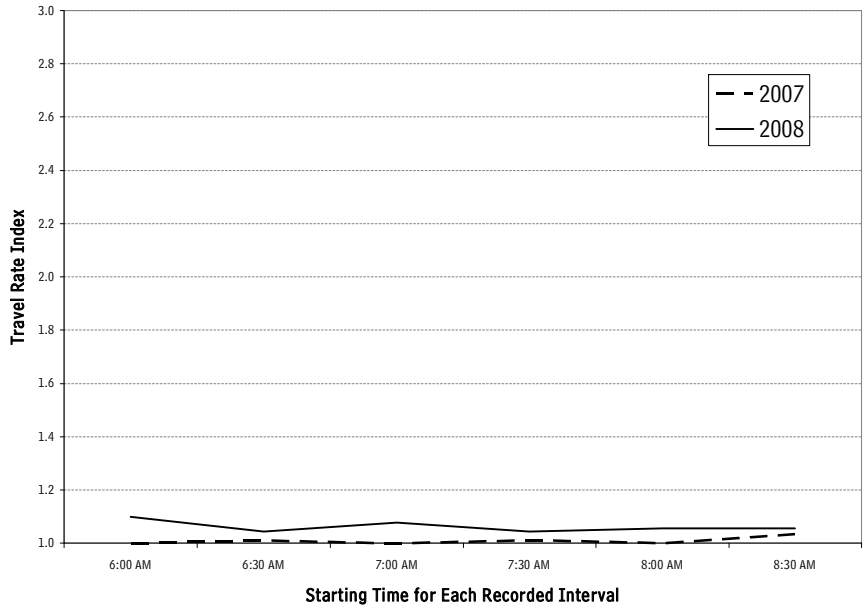
***Travel Time Runs, Morning Peak, Northbound Direction***



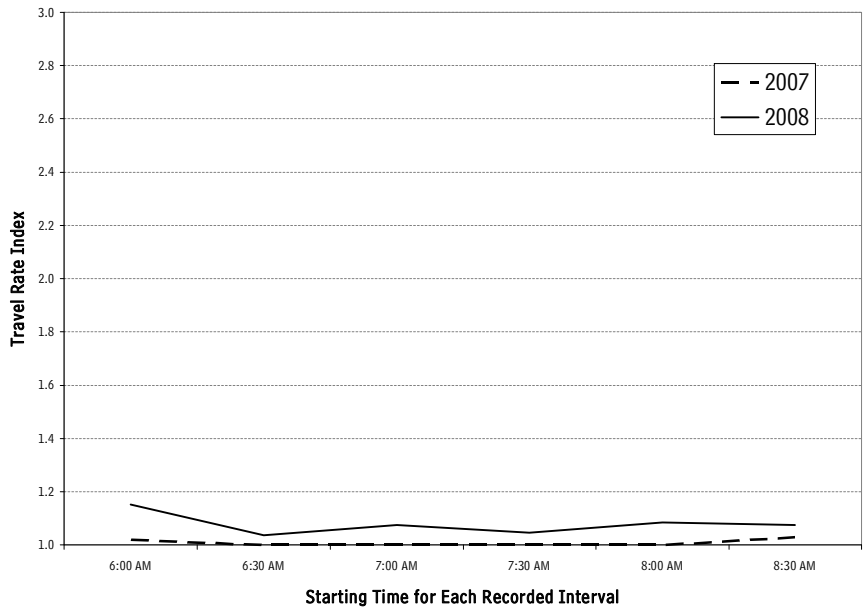
**Figure 364 IH 35 (AM Peak), US 81 to FM 2790, Northbound.**



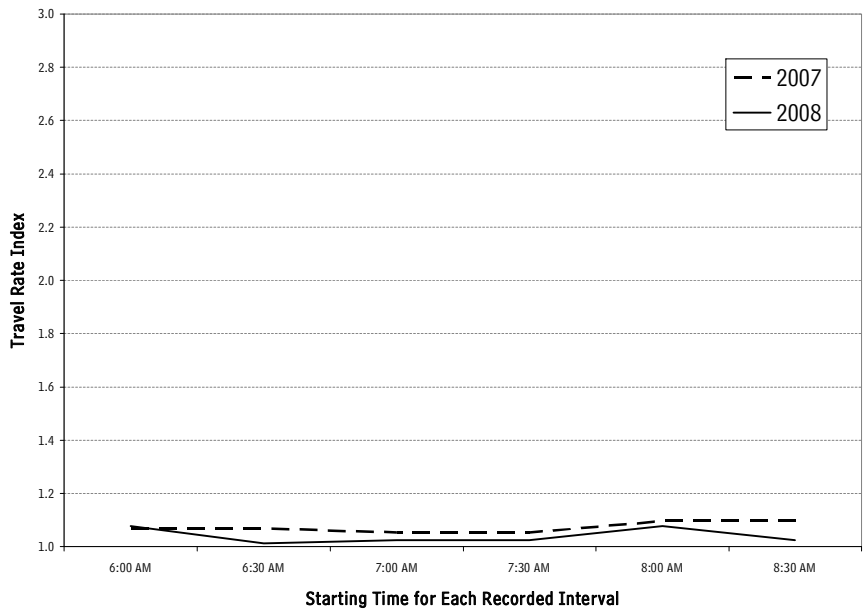
**Figure 365 IH 35 (AM Peak), Lucky Rd to US 81, Northbound.**



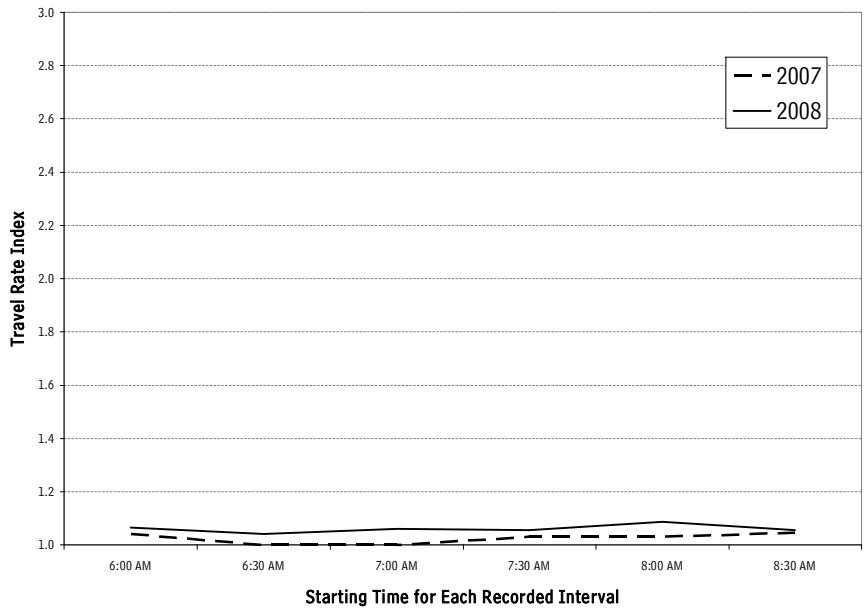
**Figure 366 IH 35 (AM Peak), Shepherd Rd to Lucky Rd, Northbound.**



**Figure 367 IH 35 (AM Peak), Kinney Rd to Shepherd Rd, Northbound.**

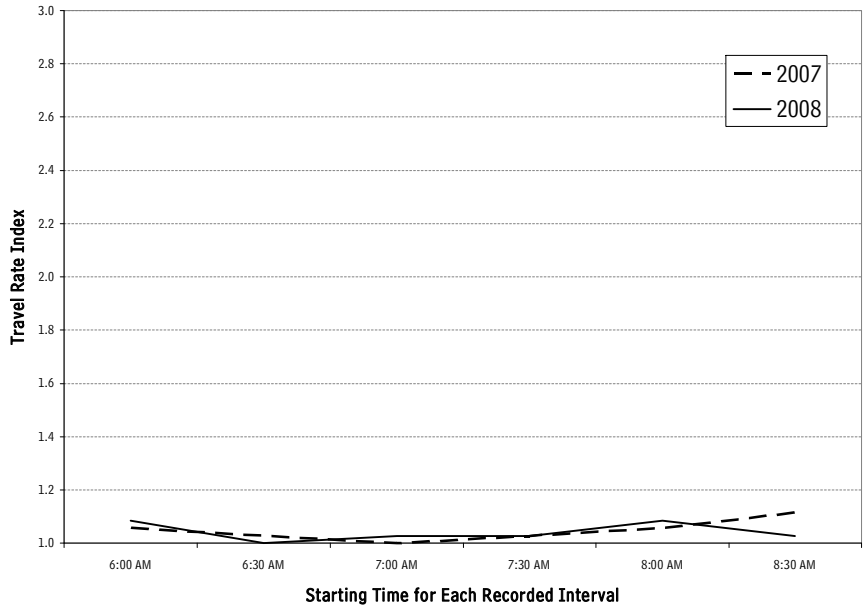


**Figure 368 IH 35 (AM Peak), SL 1604 to Kinney Rd, Northbound.**

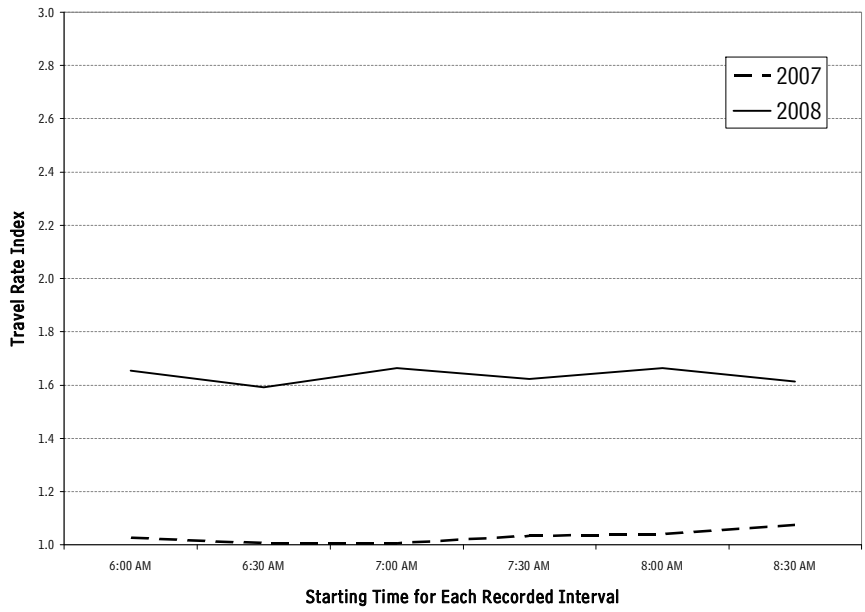


**Figure 369 IH 35 (AM Peak), Fisher Rd to SL 1604, Northbound.**

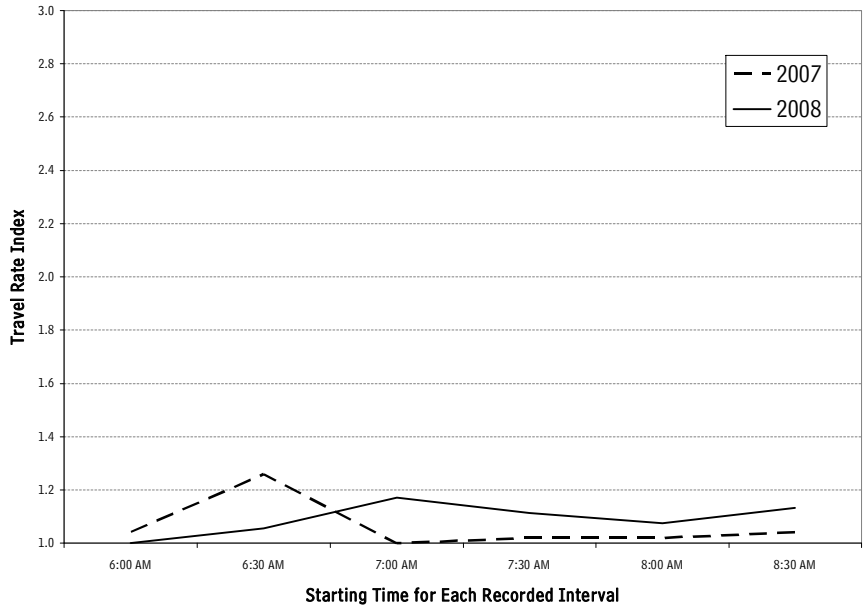




**Figure 370 IH 35 (AM Peak), IH 410 to Fisher Rd, Northbound.**

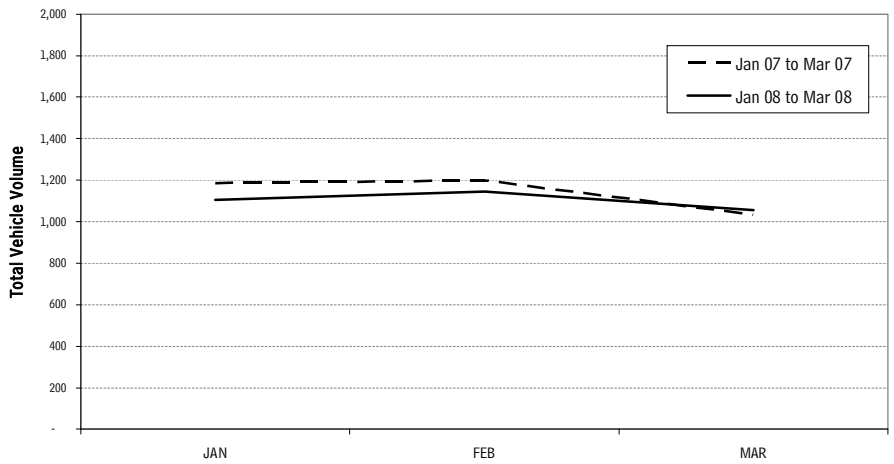


**Figure 371 IH 35 (AM Peak), Somerset Rd to IH 410, Northbound.**

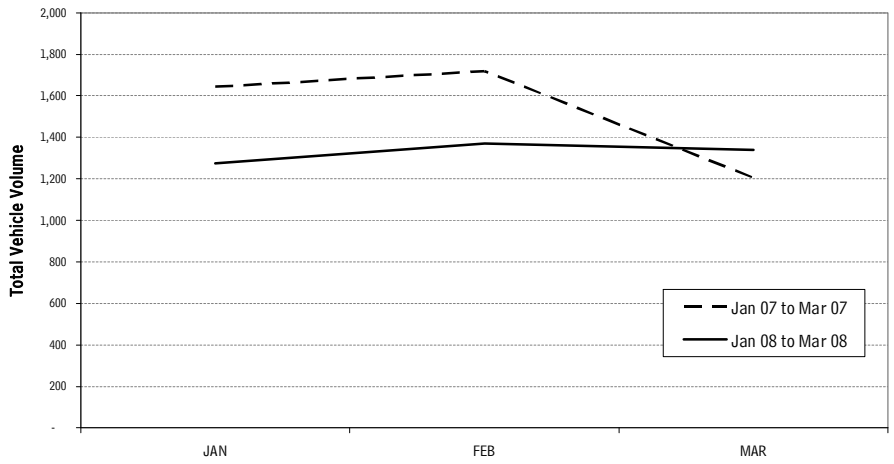


**Figure 372 IH 35 (AM Peak), SP 422 to Somerset Rd, Northbound.**

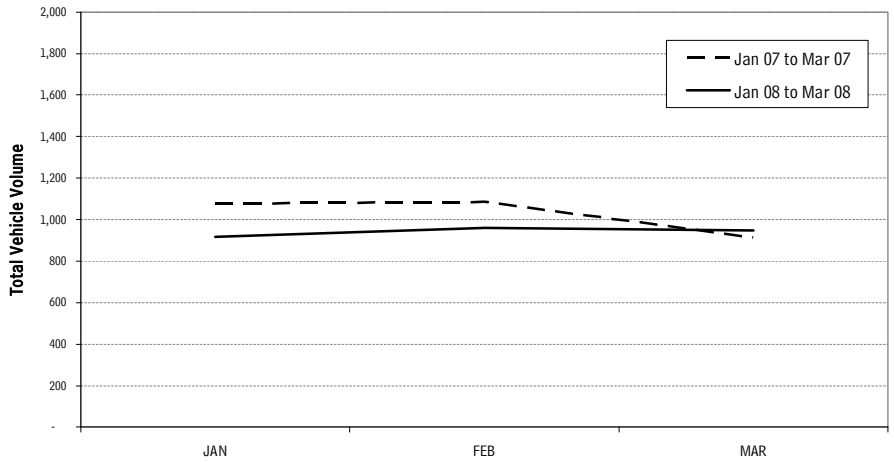
***Total Vehicle Volumes Northbound Direction, Morning Peak***



**Figure 373 Total Vehicle Volumes, Site 304 Northbound, 6 AM to 7 AM.**

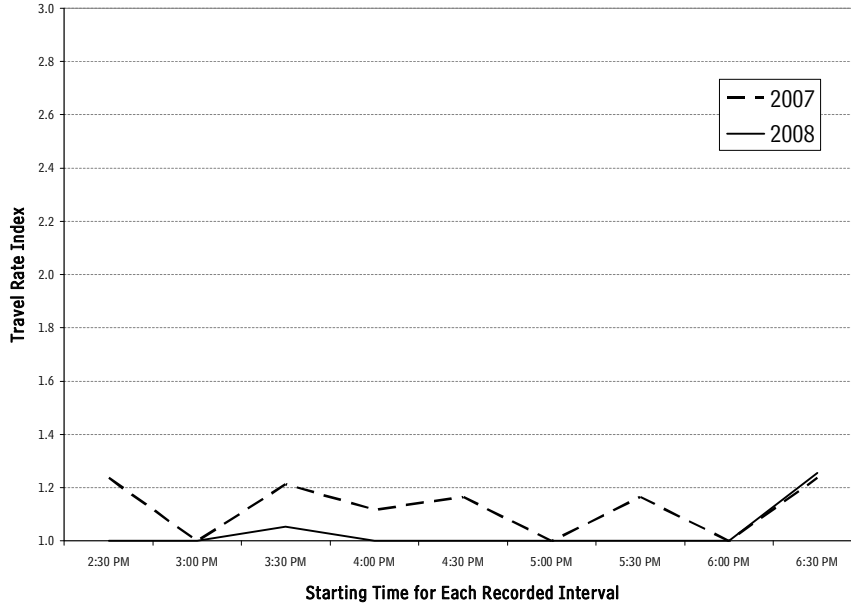


**Figure 374 Total Vehicle Volumes, Site 304 Northbound, 7 AM to 8 AM.**

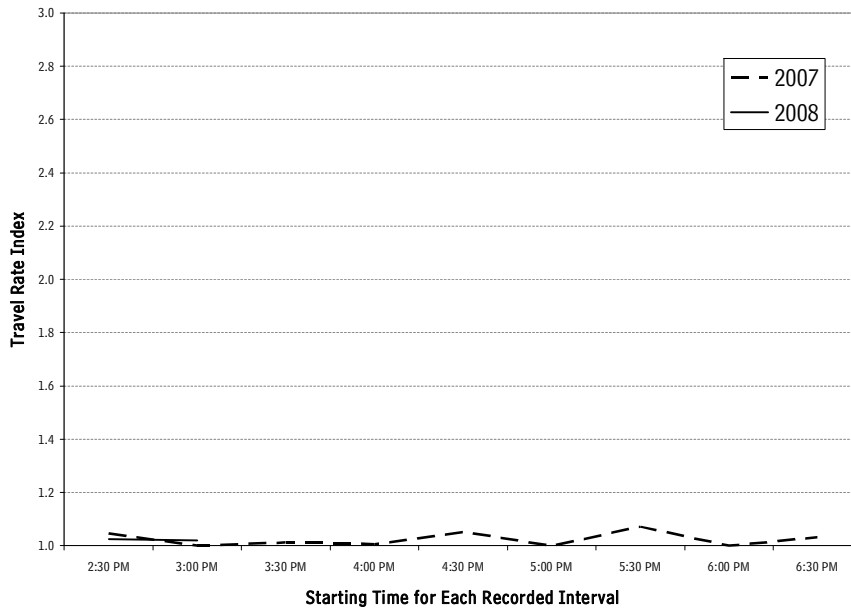


**Figure 375 Total Vehicle Volumes, Site 304 Northbound, 8 AM to 9 AM.**

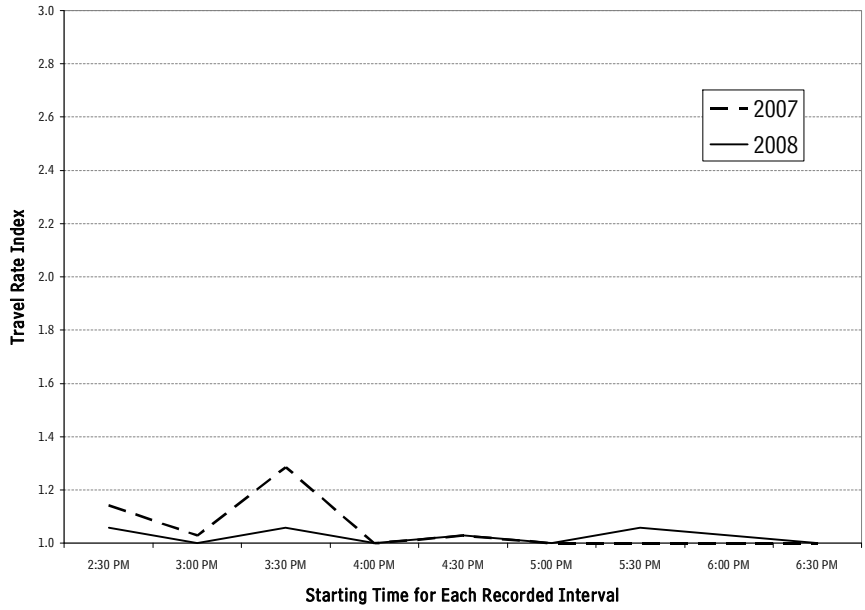
***Travel Time Runs, Afternoon Peak, Southbound Direction***



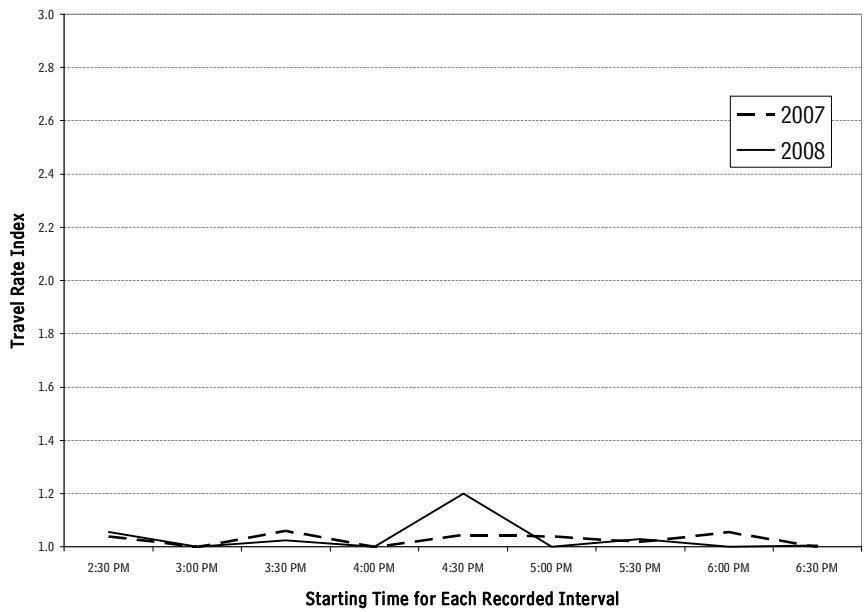
**Figure 376 IH 35 (PM Peak), SP 422 to Somerset Rd, Southbound.**



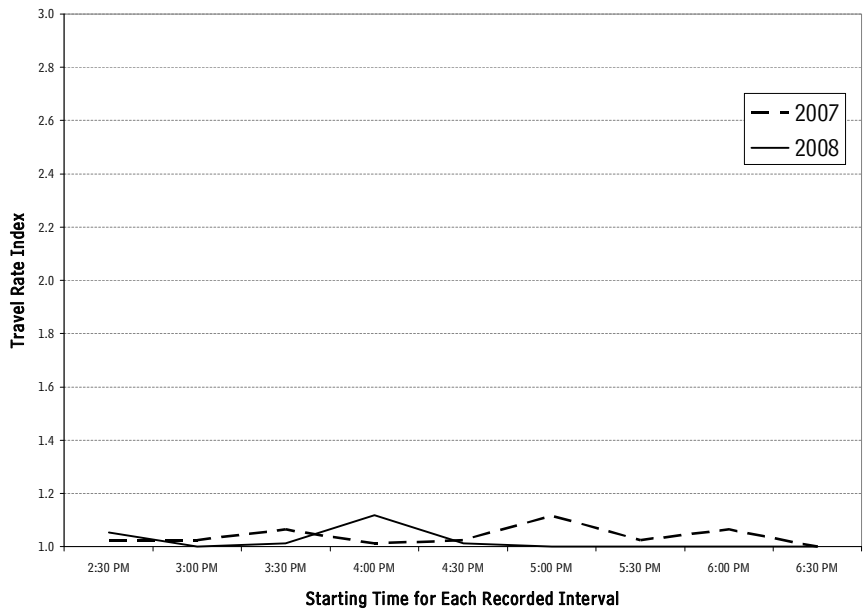
**Figure 377 IH 35 (PM Peak), Somerset Rd to IH 410, Southbound.**



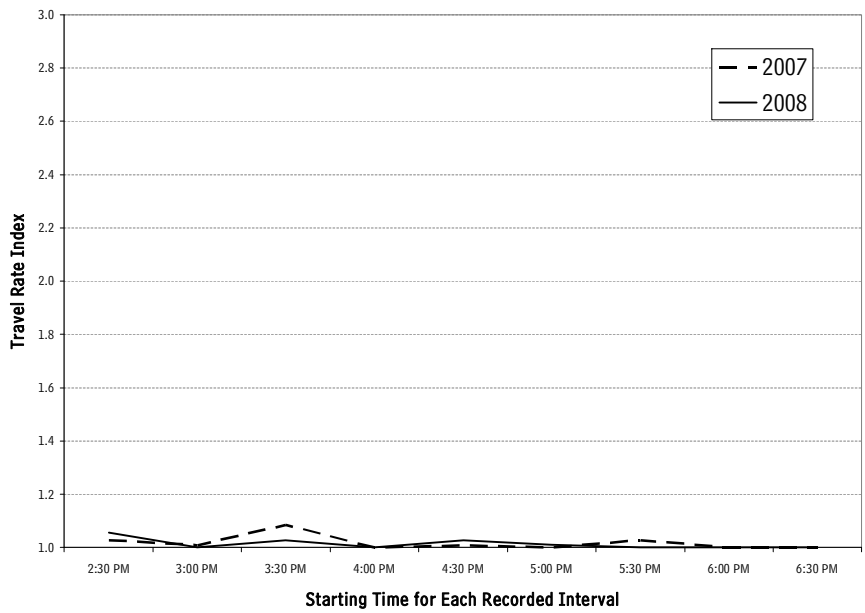
**Figure 378 IH 35 (PM Peak), IH 410 to Fisher Rd, Southbound.**



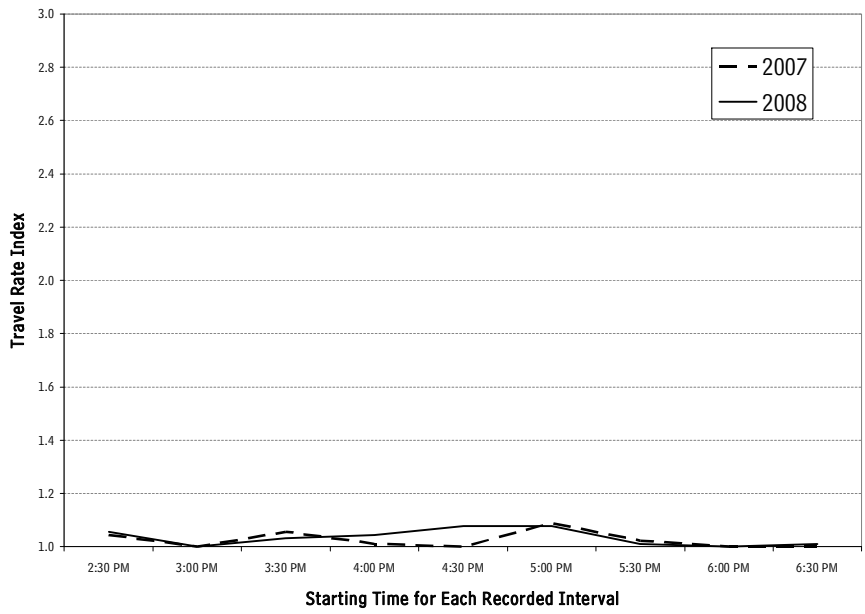
**Figure 379 IH 35 (PM Peak), Fisher Rd to SL 1604, Southbound.**



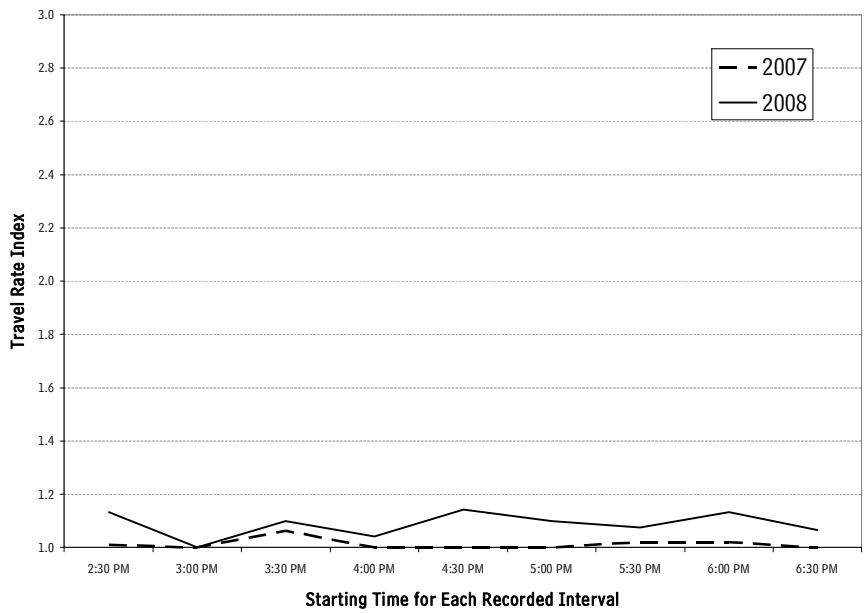
**Figure 380 IH 35 (PM Peak), SL 1604 to Kinney Rd, Southbound.**



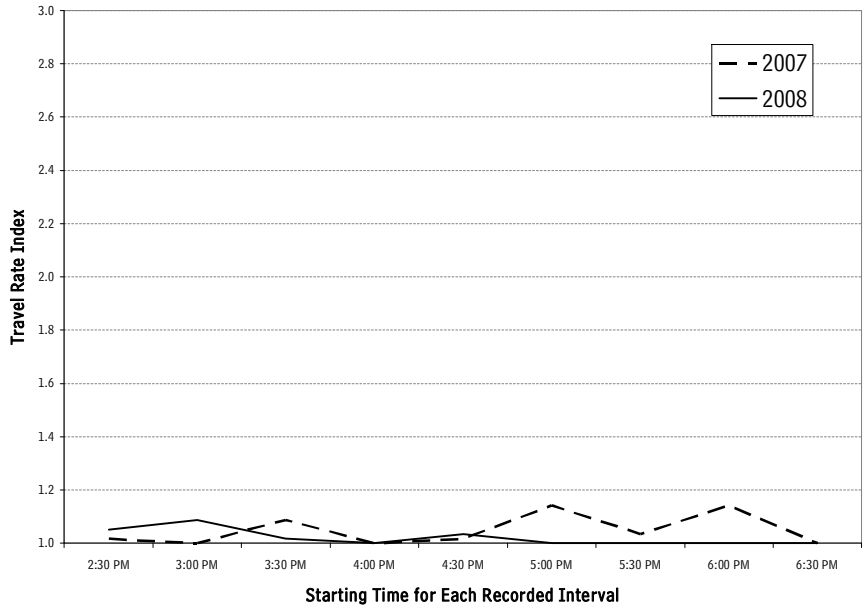
**Figure 381 IH 35 (PM Peak), Kinney Rd to Shepherd Rd, Southbound.**



**Figure 382 IH 35 (PM Peak), Shepherd Rd to Lucky Rd, Southbound.**

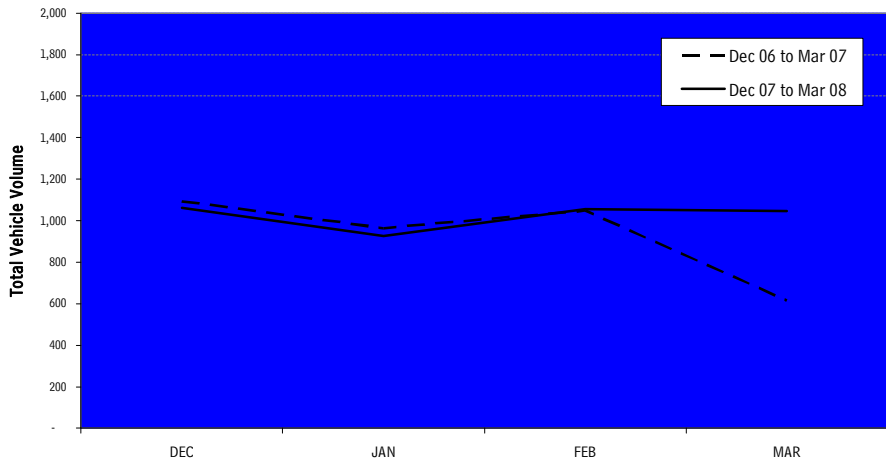


**Figure 383 IH 35 (PM Peak), Lucky Rd to US 81, Southbound.**



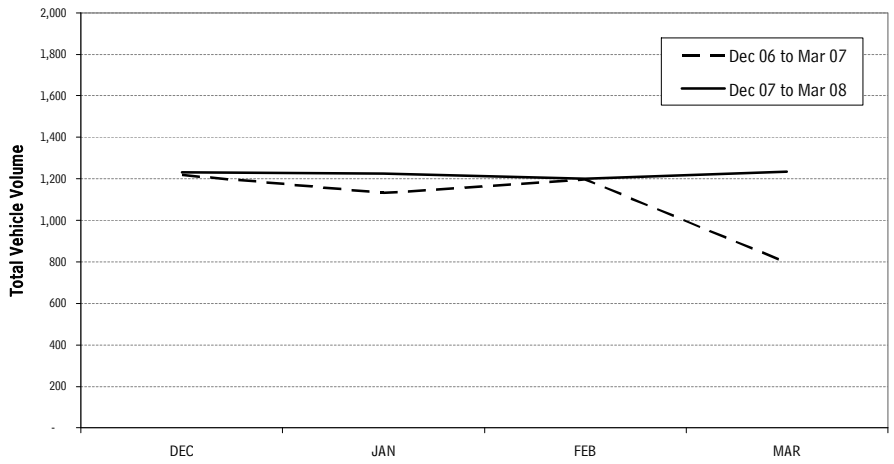
**Figure 384 IH 35 (PM Peak), US 81 to FM 2790, Southbound.**

***Total Vehicle Volumes Southbound Direction, Afternoon Peak***

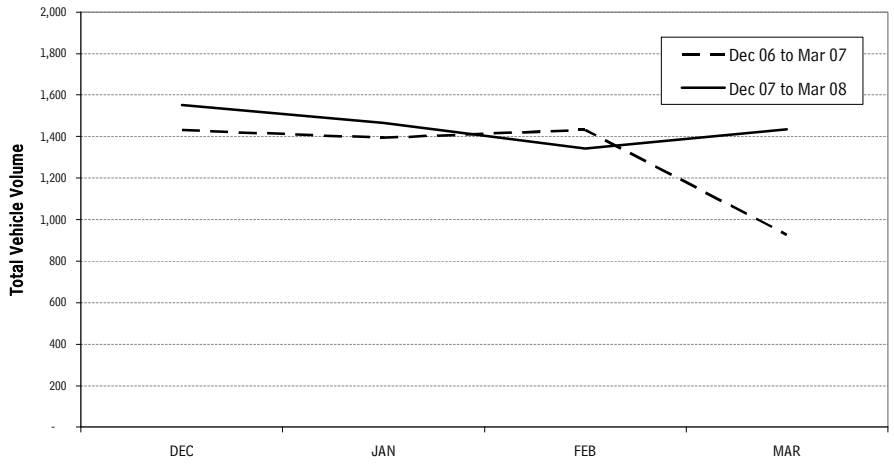


**Figure 385 Total Vehicle Volumes, Site 304 Southbound, 2 PM to 3 PM**

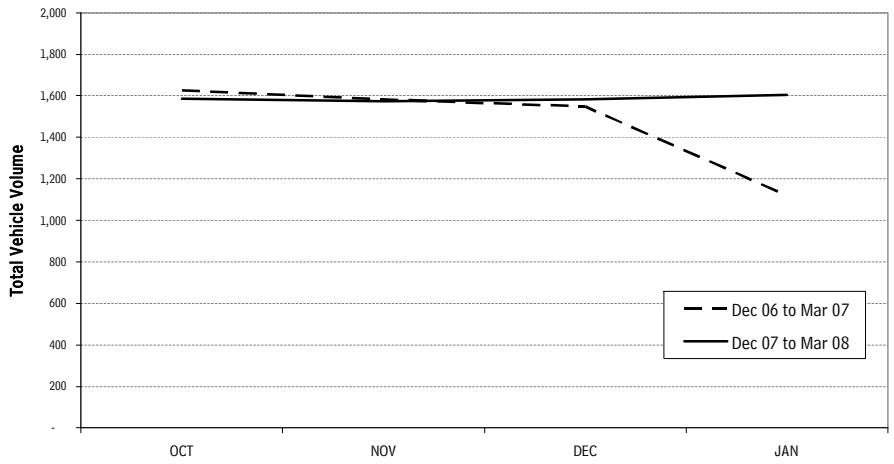




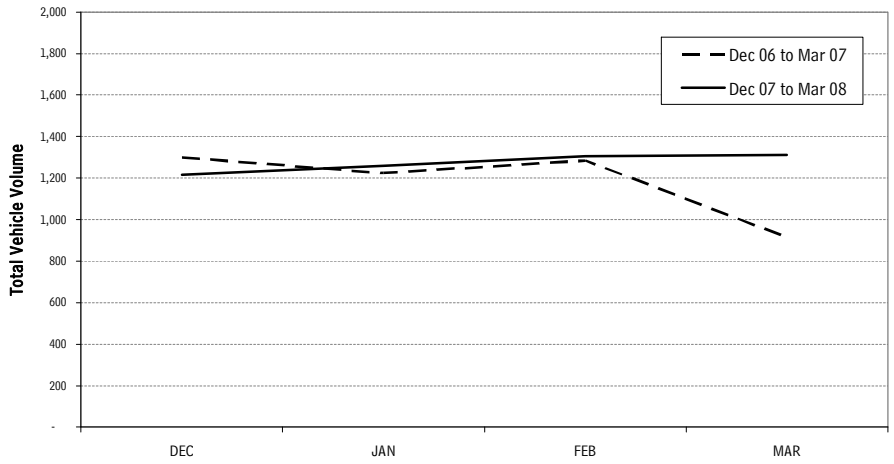
**Figure 386 Total Vehicle Volumes, Site 304 Southbound, 3 PM to 4 PM**



**Figure 387 Total Vehicle Volumes, Site 304 Southbound, 4 PM to 5 PM**

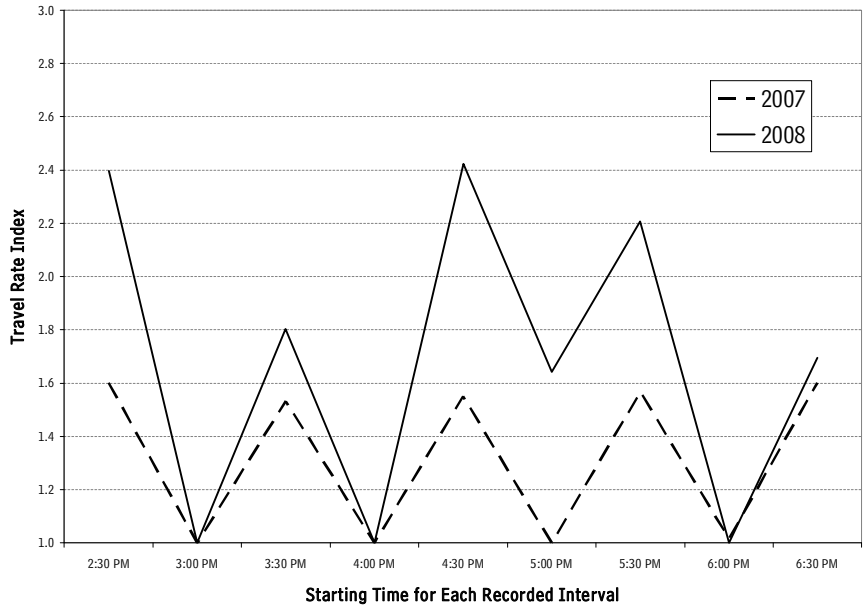


**Figure 388 Total Vehicle Volumes, Site 304 Southbound, 5 PM to 6 PM**

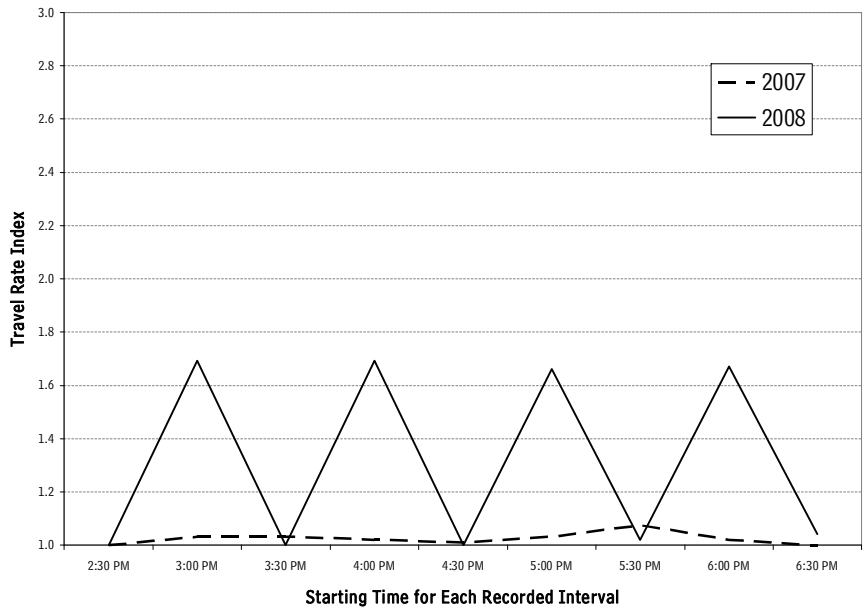


**Figure 389 Total Vehicle Volumes, Site 304 Southbound, 6 PM to 7 PM**

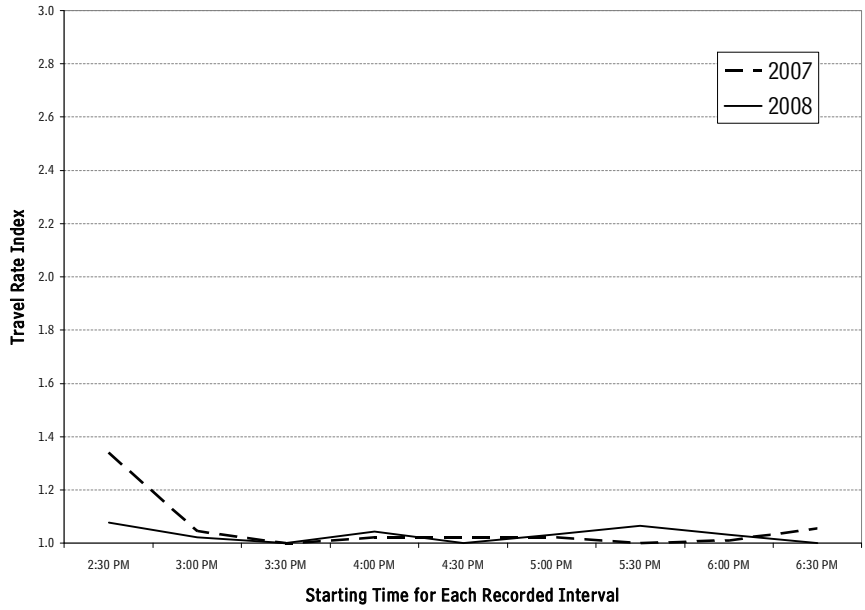
***Travel Time Runs, Afternoon Peak, Northbound Direction***



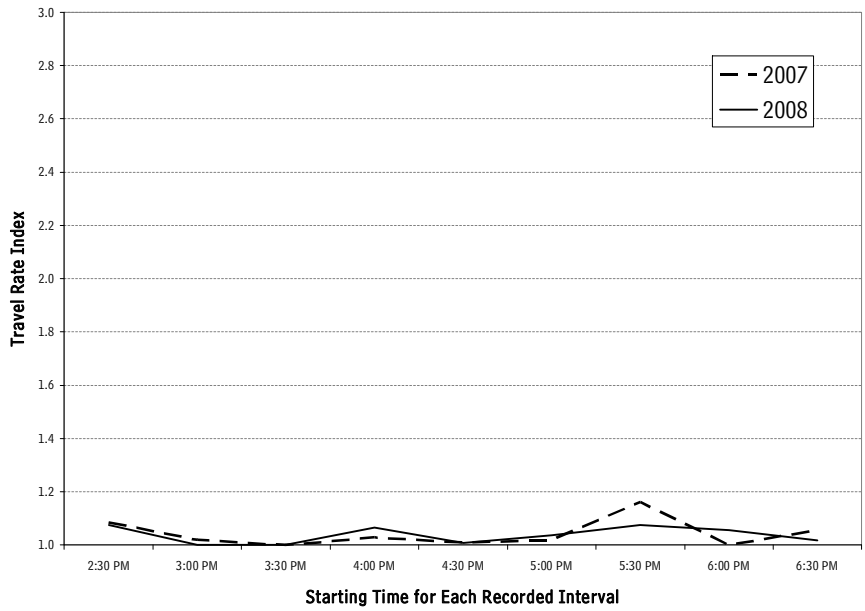
**Figure 390 IH 35 (PM Peak), US 81 to FM 2790, Northbound.**



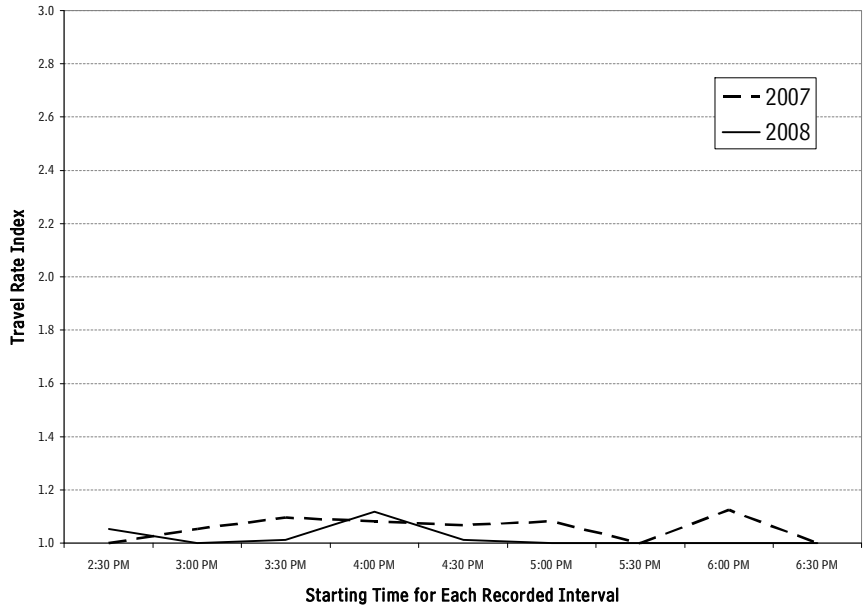
**Figure 391 IH 35 (PM Peak), Lucky Rd to US 81, Northbound.**



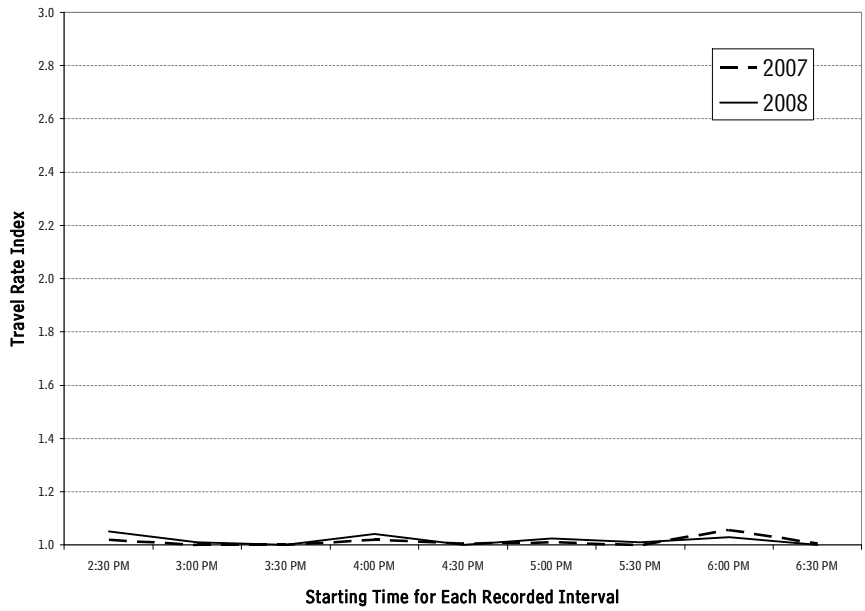
**Figure 392 IH 35 (PM Peak), Kinney Rd to Shepherd Rd, Northbound.**



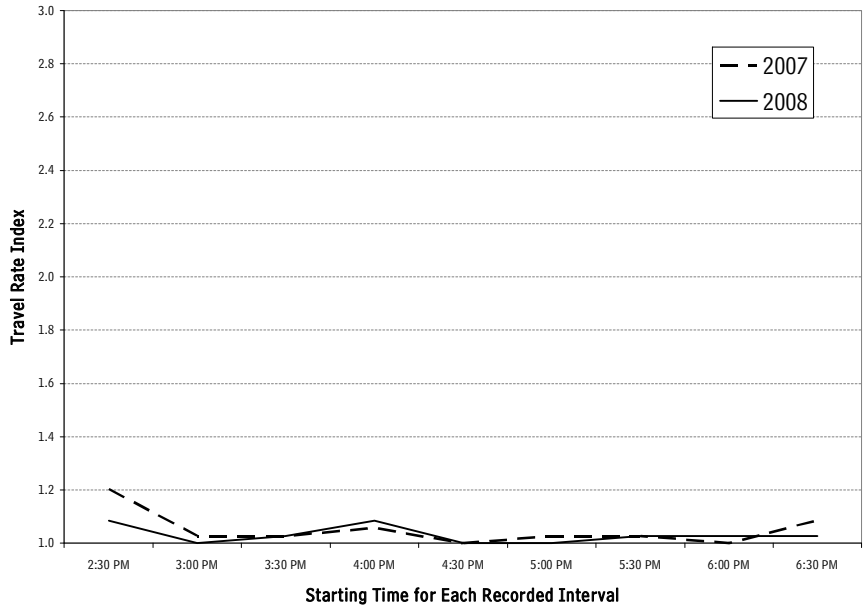
**Figure 393 IH 35 (PM Peak), Kinney Rd to Shepherd Rd, Northbound.**



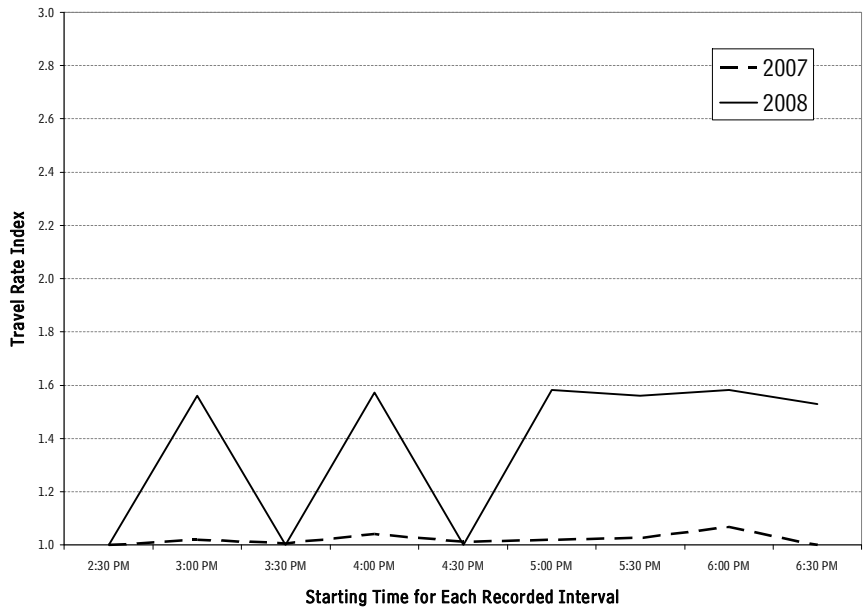
**Figure 394 IH 35 (PM Peak), SL 1604 to Kinney Rd, Northbound.**



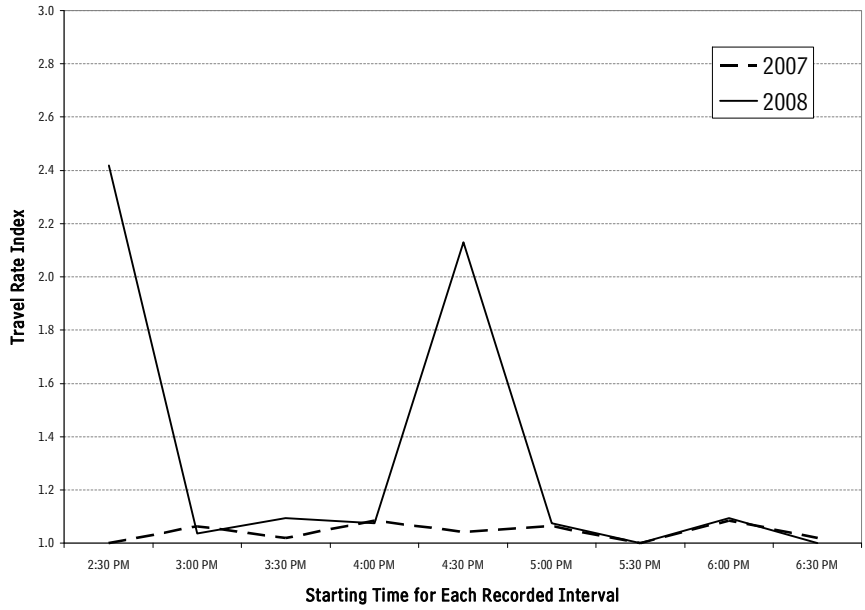
**Figure 395 IH 35 (PM Peak), Fisher Rd to SL 1604, Northbound.**



**Figure 396 IH 35 (PM Peak), IH 410 to Fisher Rd, Northbound.**

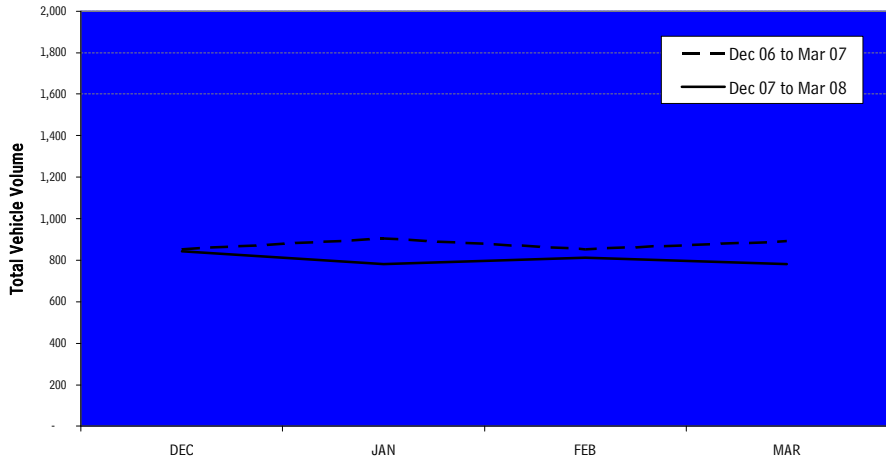


**Figure 397 IH 35 (PM Peak), Somerset Rd to IH 410, Northbound.**

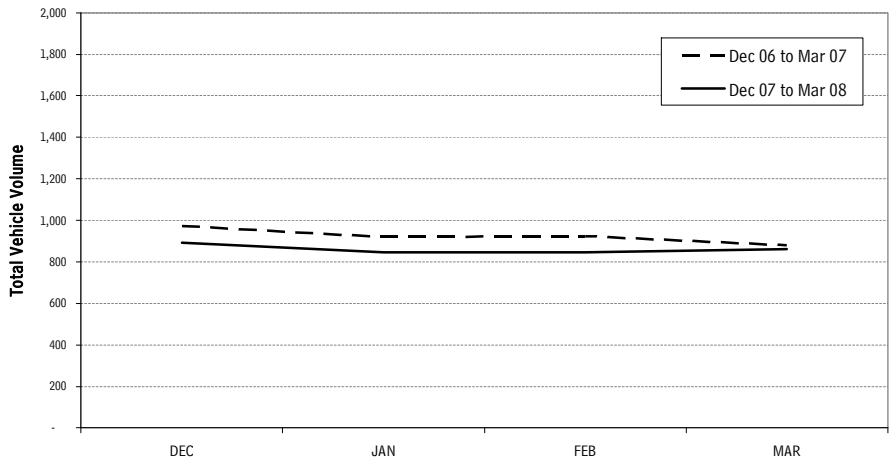


**Figure 398 IH 35 (PM Peak), SP 422 to Somerset Rd, Northbound.**

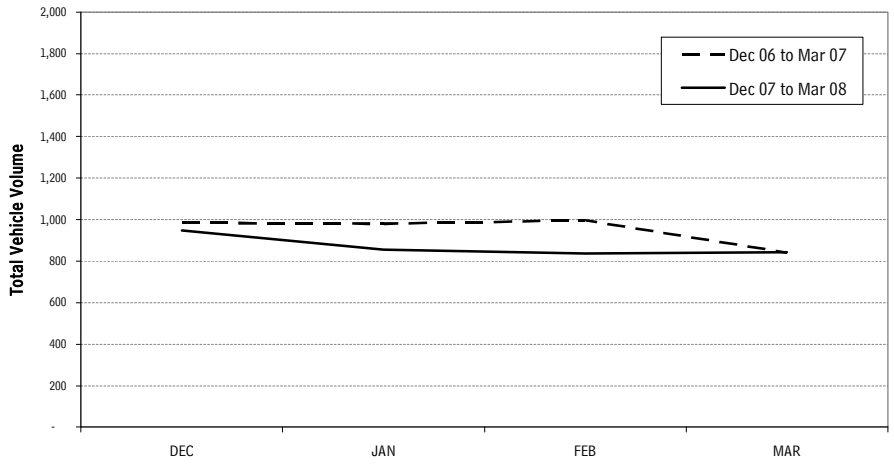
*Total Vehicle Volumes Northbound Direction, Afternoon Peak*



**Figure 399 Total Vehicle Volumes, Site 304 Northbound, 2 PM to 3 PM**

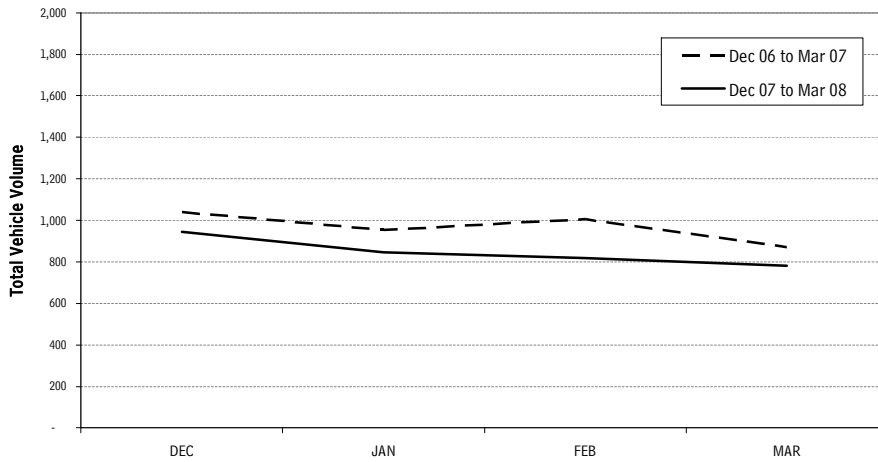


**Figure 400 Total Vehicle Volumes, Site 304 Northbound, 3 PM to 4 PM**

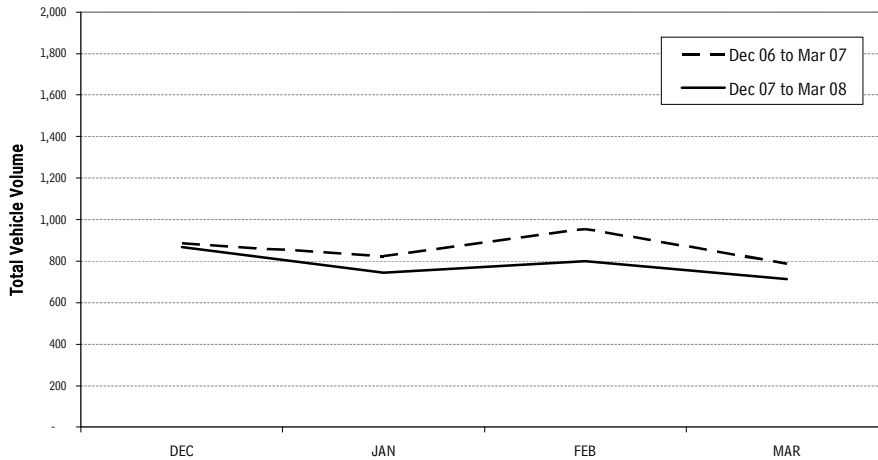


**Figure 401 Total Vehicle Volumes, Site 304 Northbound, 4 PM to 5 PM**





**Figure 402 Total Vehicle Volumes, Site 304 Northbound, 5 PM to 6 PM**



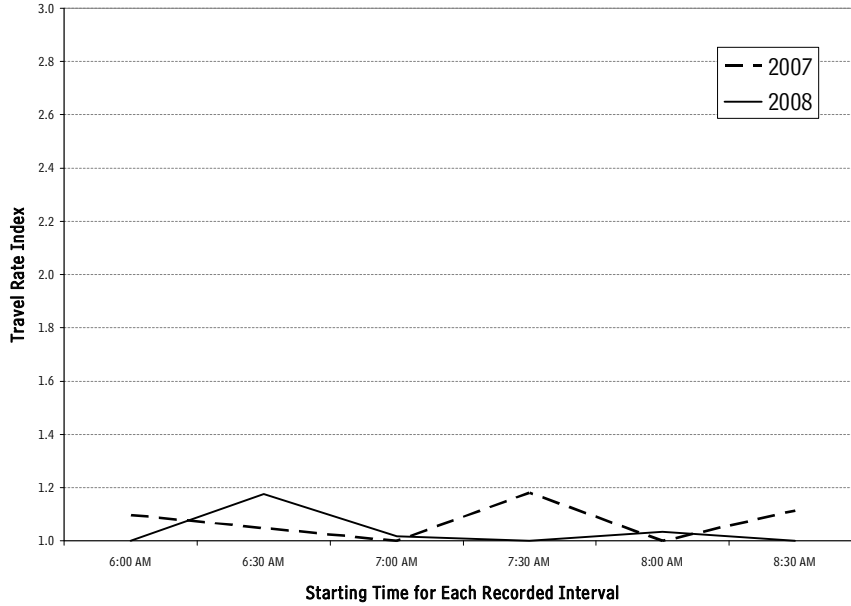
**Figure 403 Total Vehicle Volumes, Site 304 Northbound, 6 PM to 7 PM**

**Corridor 9: IH 37 from IH 410 to SL 1604**

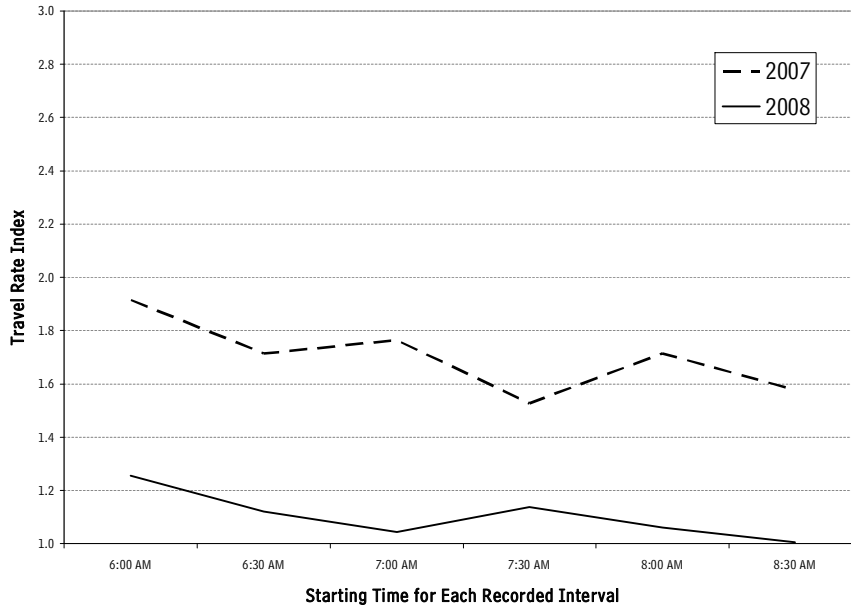
Corridor 9 is defined in linked segments as follows:

- (A) IH 37 from IH 410 to SH 122
- (B) IH 37 from SH 122 to Southon Rd
- (C) IH 37 from Southon Rd to SL 1604

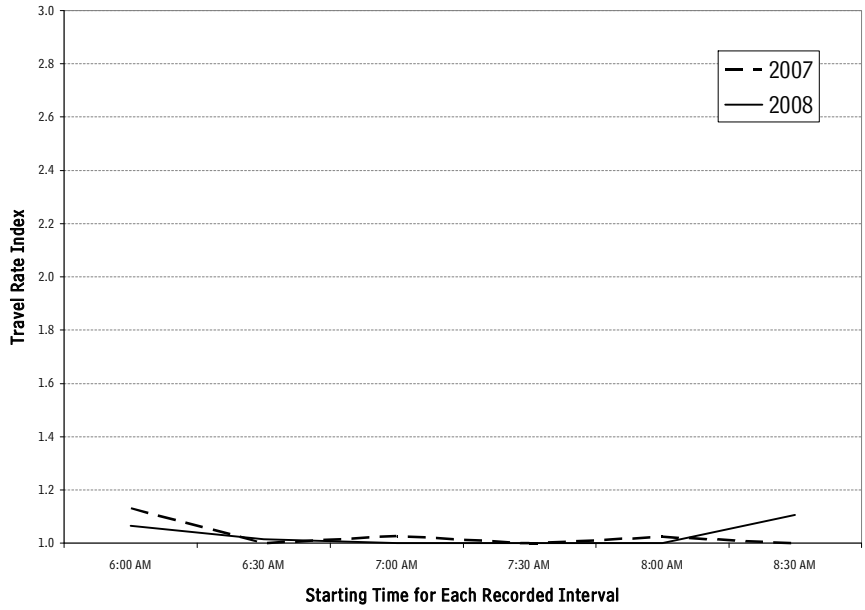
***Travel Time Runs, Morning Peak, Southbound Direction***



**Figure 404 IH 37 (AM Peak), IH 410 to SH 122, Southbound.**

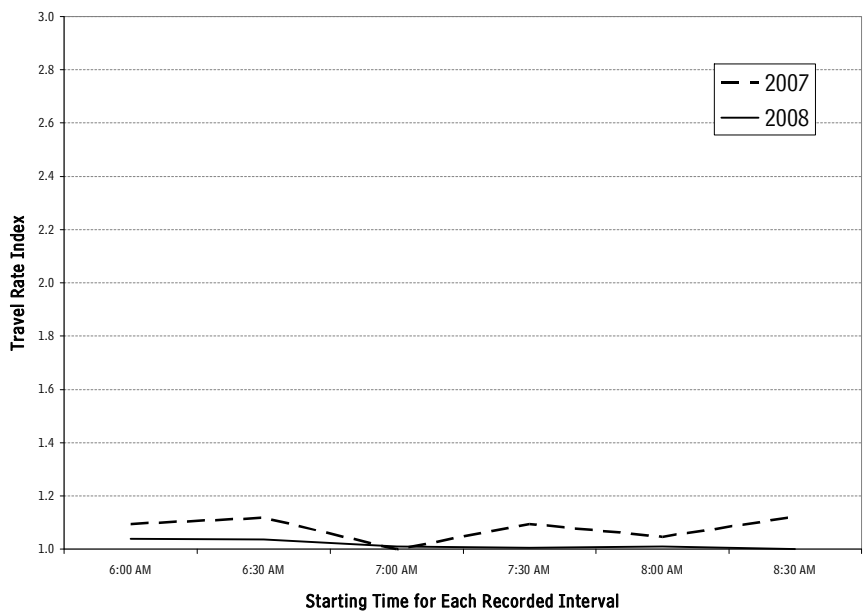


**Figure 405 IH 37 (AM Peak), SH 122 to Southon Rd, Southbound.**

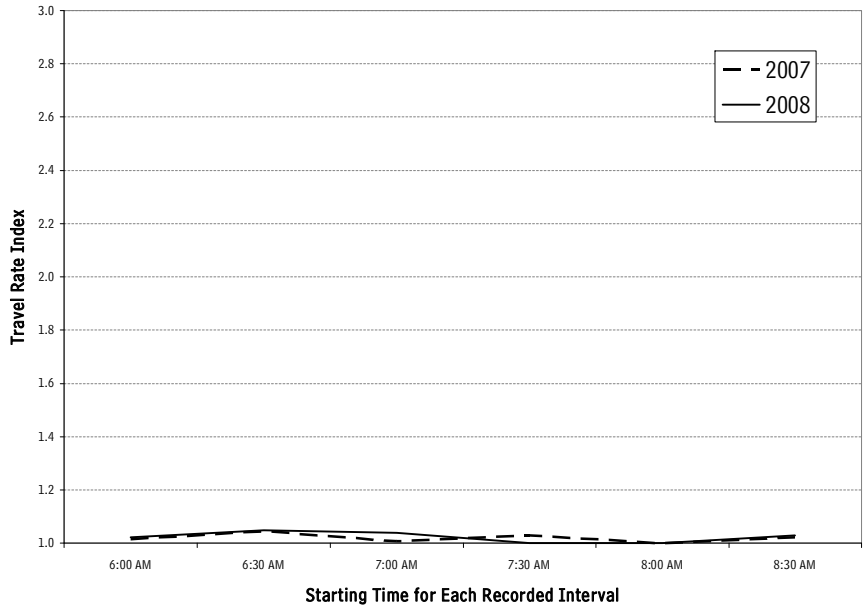


**Figure 406 IH 37 (AM Peak), Southon Rd to SL 1604, Southbound.**

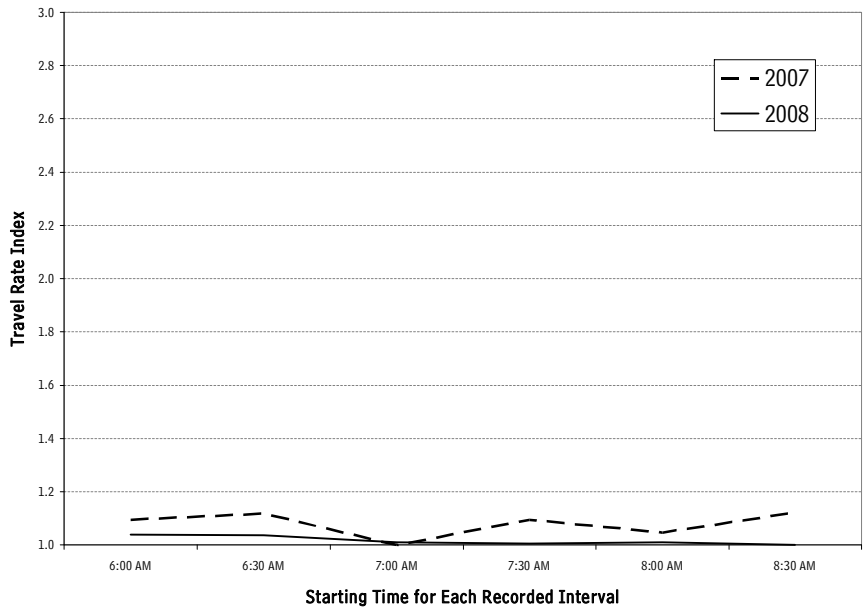
*Travel Time Runs, Morning Peak, Northbound Direction*



**Figure 407 IH 37 (AM Peak), Southon Rd to SL 1604, Northbound.**

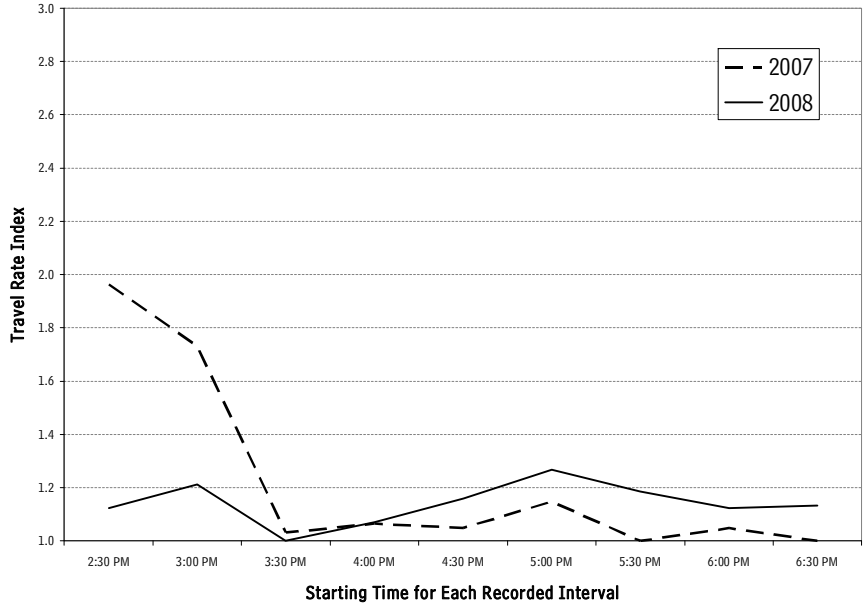


**Figure 408 IH 37 (AM Peak), SH 122 to Southon Rd, Northbound.**

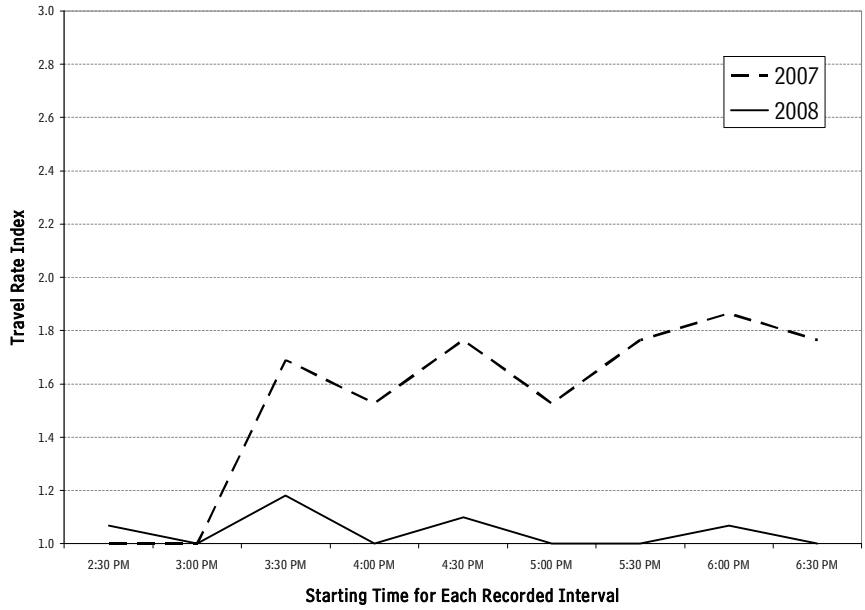


**Figure 409 IH 37 (AM Peak), Southon Rd to SL 1604, Northbound.**

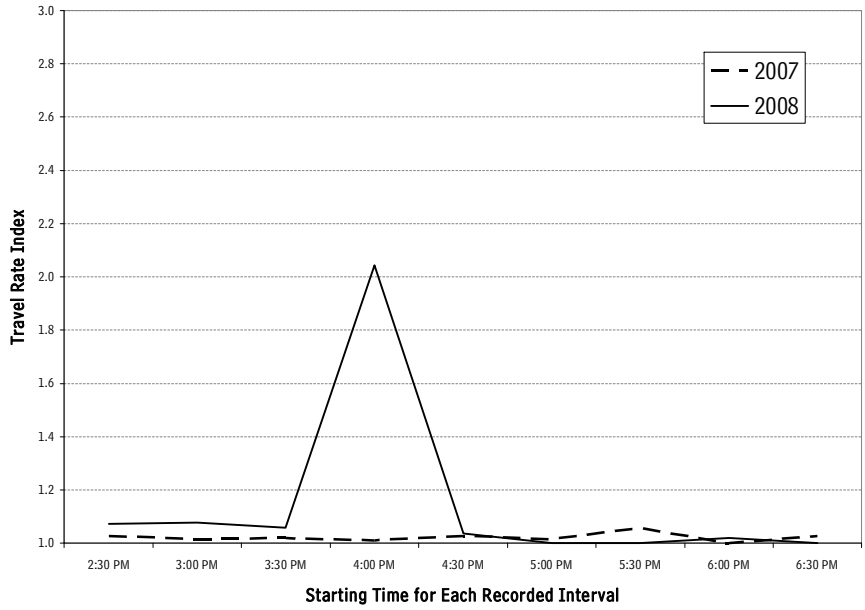
***Travel Time Runs, Afternoon Peak, Southbound Direction***



**Figure 410 IH 37 (PM Peak), IH 410 to SH 122, Southbound.**

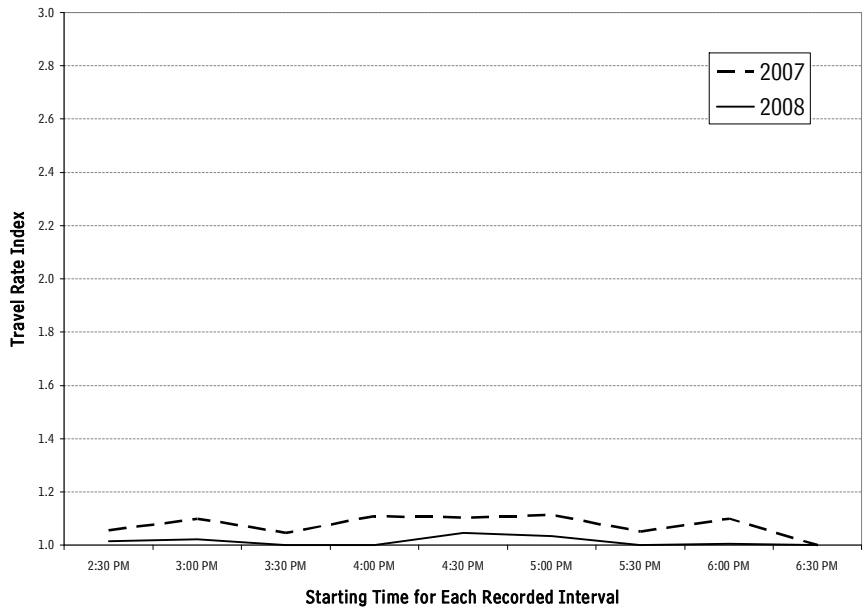


**Figure 411 IH 37 (PM Peak), SH 122 to Southon Rd, Southbound.**

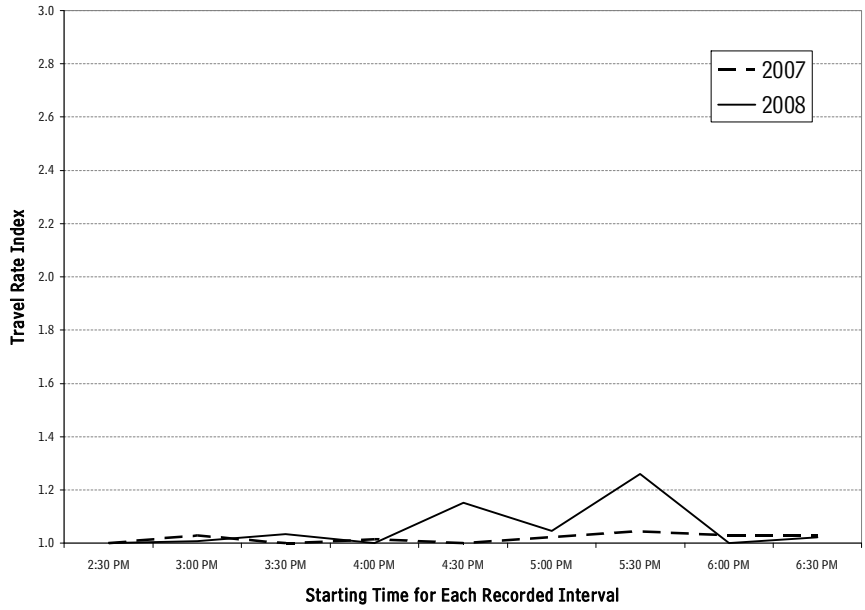


**Figure 412 IH 37 (PM Peak), Southon Rd to SL 1604, Southbound.**

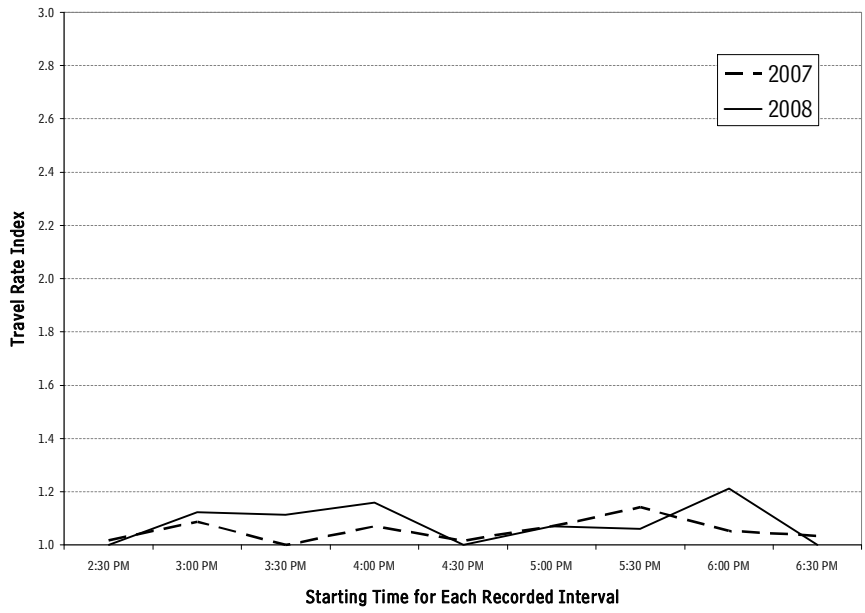
*Travel Time Runs, Afternoon Peak, Northbound Direction*



**Figure 413 IH 37 (PM Peak), Southon Rd to SL 1604, Northbound.**



**Figure 414 IH 37 (PM Peak), SH 122 to Southon Rd, Northbound.**



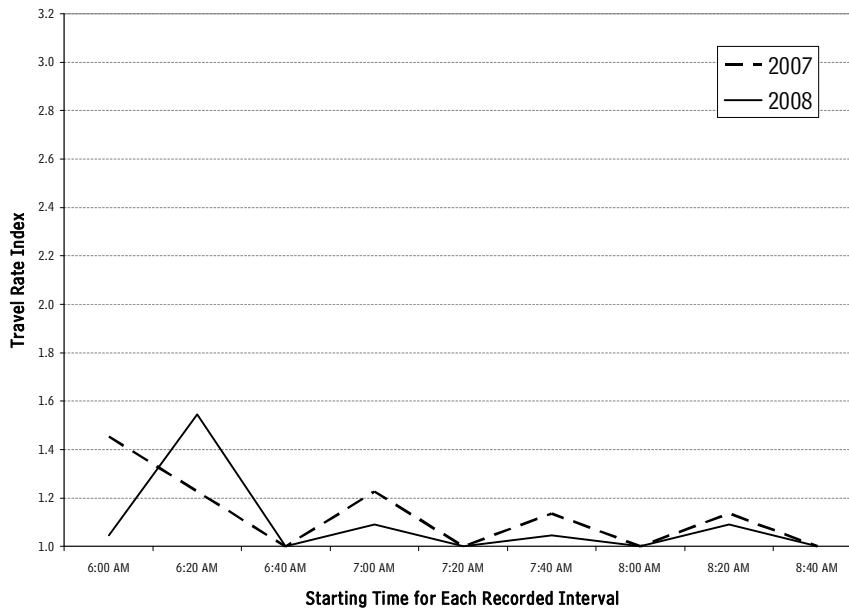
**Figure 415 IH 37 (PM Peak), IH 410 to SH 122, Northbound.**

## Control Corridor 1: SH 16 from SL 1604 to Reyes Canyon

Control corridor 1 is defined in linked segments as follows:

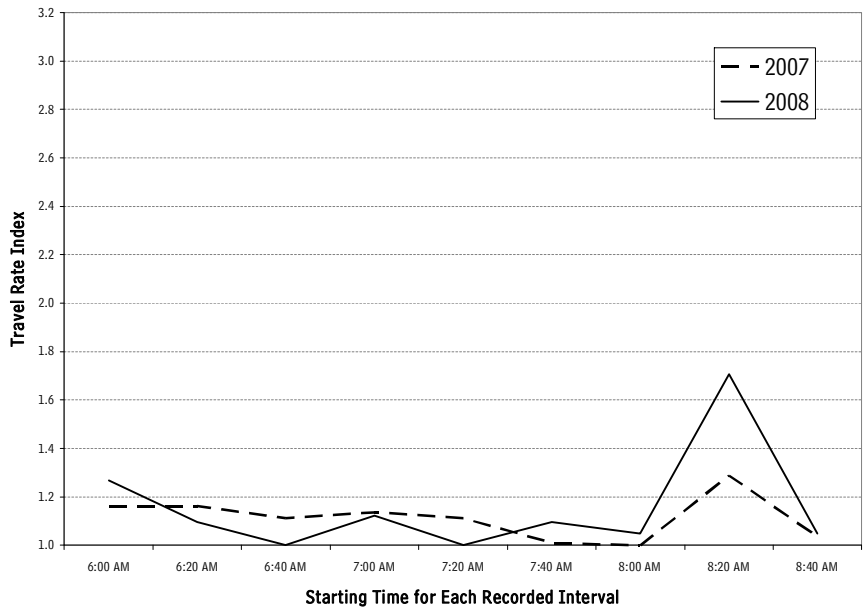
- (A) SH 16 from Whip O Will Way to Reyes Canyon
- (B) SH 16 from Scenic Loop Rd to Whip O Will Way
- (C) SH 16 from FM 1560 to Scenic Loop Rd
- (D) SH 16 from Hausman Rd to FM 1560
- (E) SH 16 from SL 1604 to Hausman Rd

### *Travel Time Runs, Morning Peak, Southbound Direction*

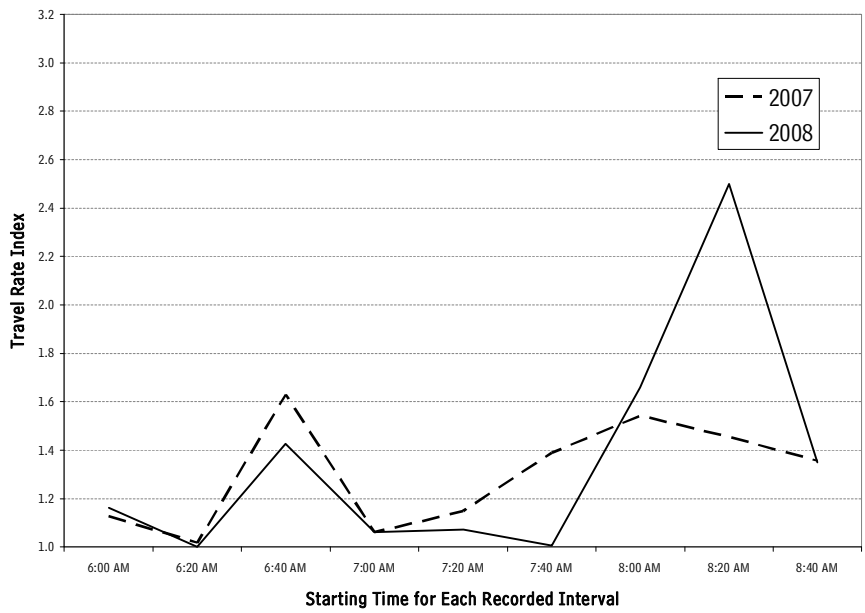


**Figure 416 SH 16 (AM Peak), Whip O Will Way to Reyes Canyon, Southbound.**

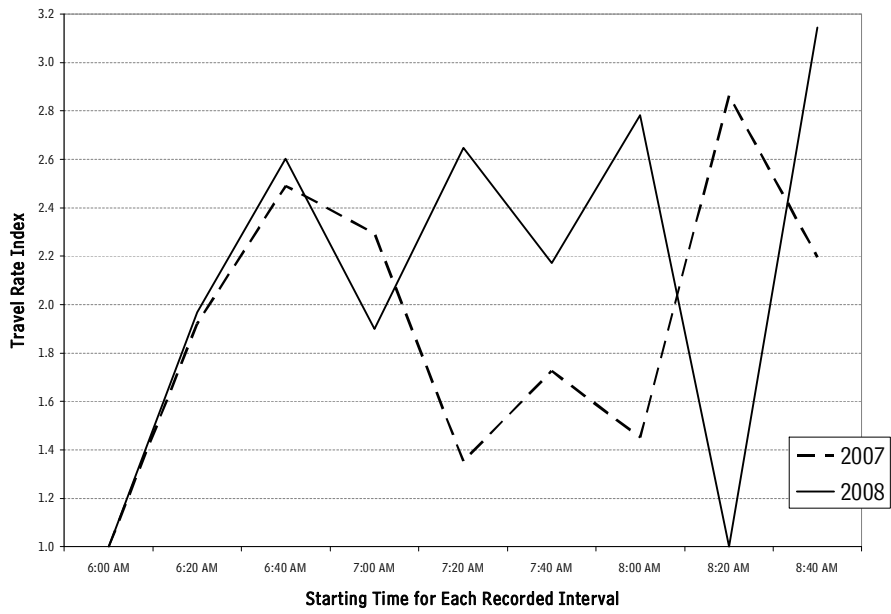




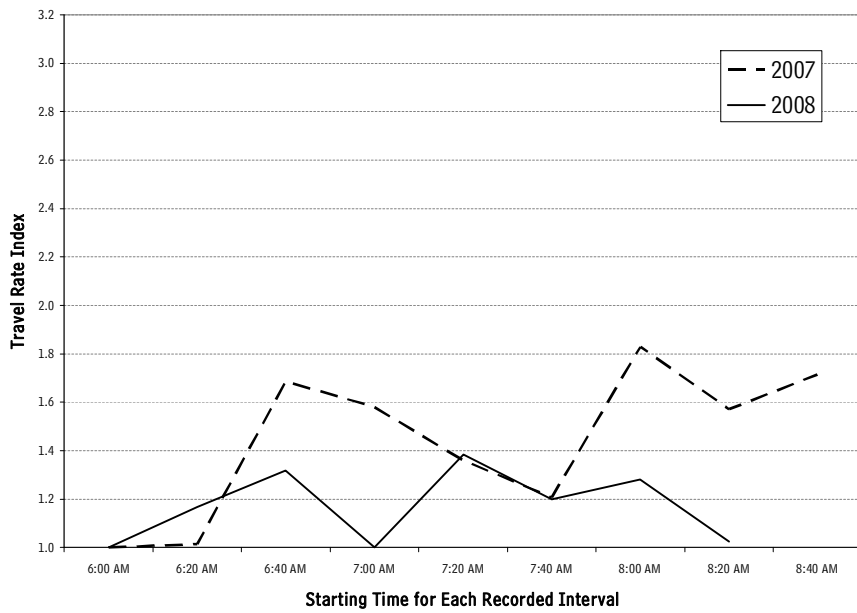
**Figure 417 SH 16 (AM Peak), Scenic Loop Rd to Whip O Will Way, Southbound.**



**Figure 418 SH 16 (AM Peak), FM 1560 to Scenic Loop Rd, Southbound.**

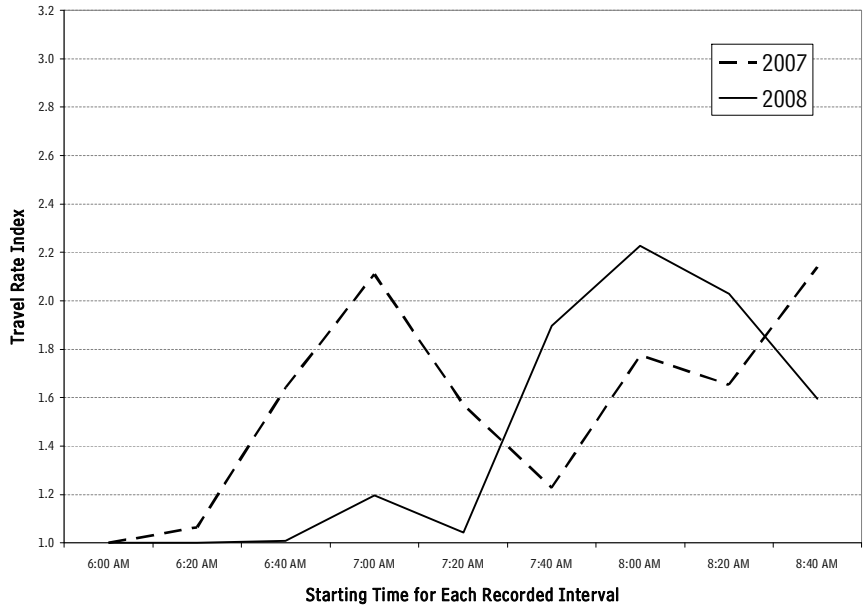


**Figure 419 SH 16 (AM Peak), Hausman Rd to FM 1560, Southbound.**

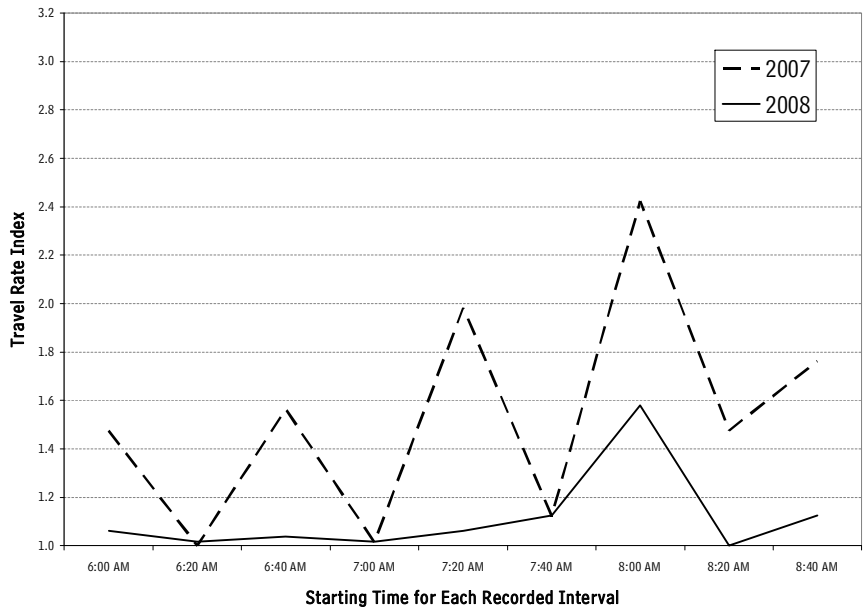


**Figure 420 SH 16 (AM Peak), SL 1604 to Hausman Rd, Southbound.**

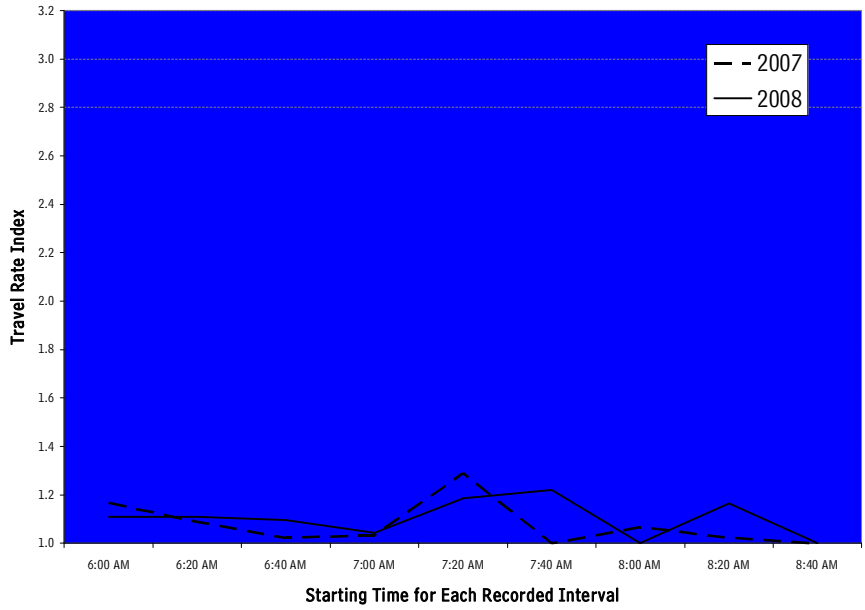
***Travel Time Runs, Morning Peak, Northbound Direction***



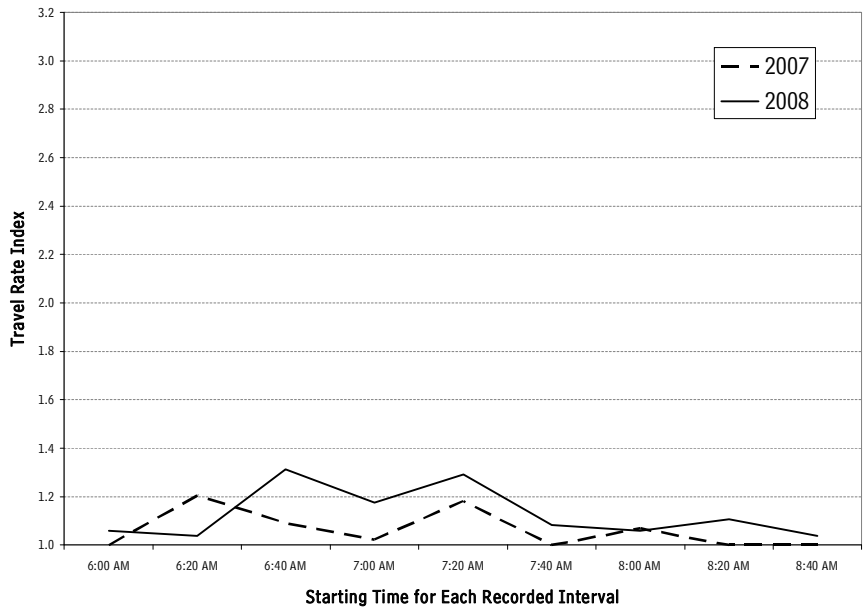
**Figure 421 SH 16 (AM Peak), SL 1604 to Hausman Rd, Northbound.**



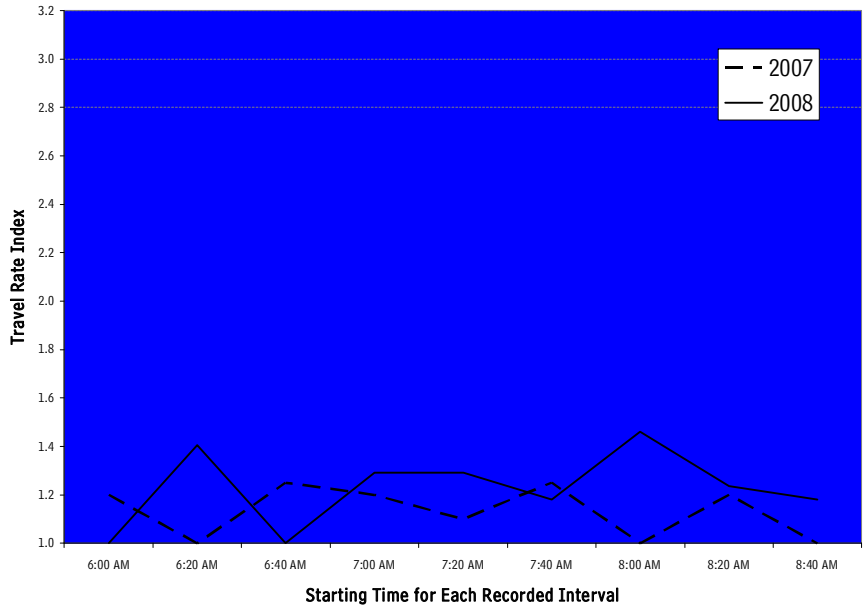
**Figure 422 SH 16 (AM Peak), Hausman Rd to FM 1560, Northbound.**



**Figure 423 SH 16 (AM Peak), FM 1560 to Scenic Loop Rd, Northbound.**

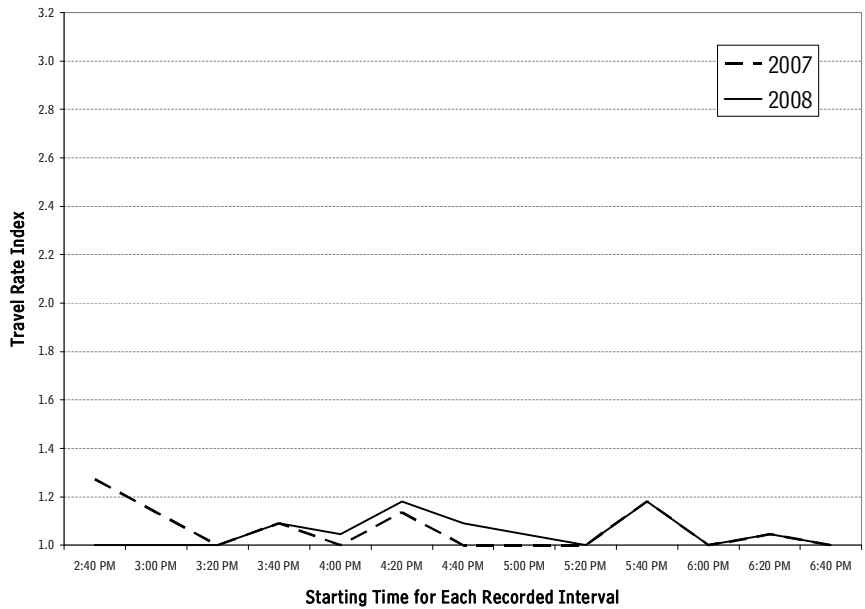


**Figure 424 SH 16 (AM Peak), Scenic Loop Rd to Whip O Will Way, Northbound.**

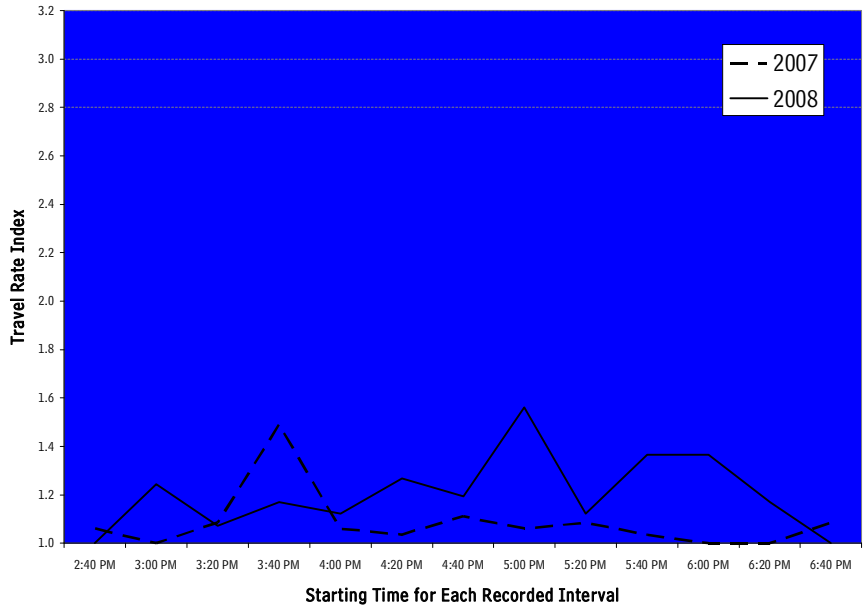


**Figure 425 SH 16 (AM Peak), Whip O Will Way to Reyes Canyon, Northbound.**

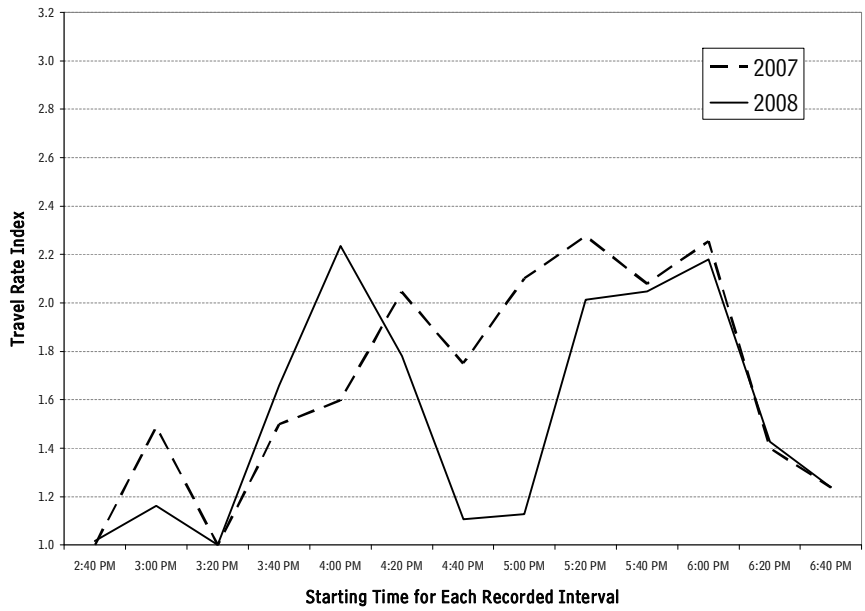
*Travel Time Runs, Afternoon Peak, Southbound Direction*



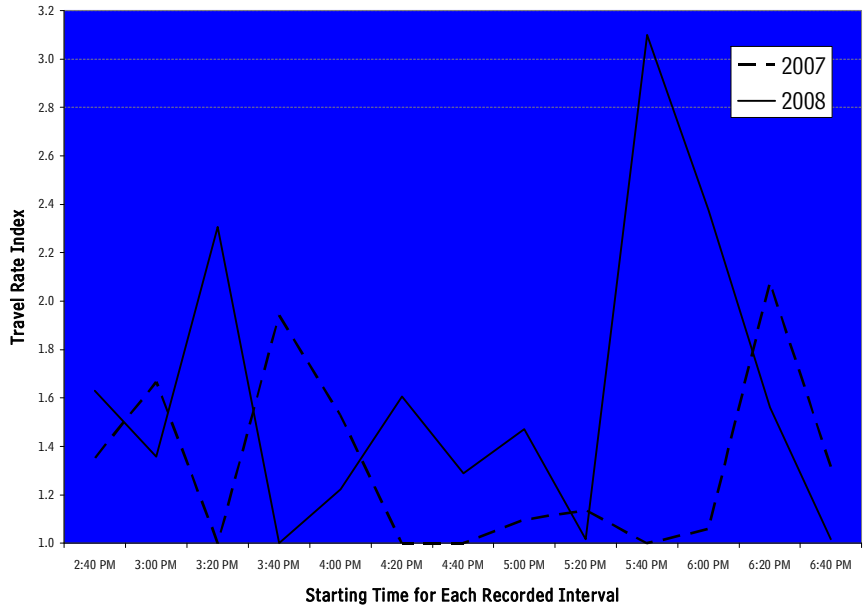
**Figure 426 SH 16 (PM Peak). Whip O Will Way to Reyes Canyon, Southbound.**



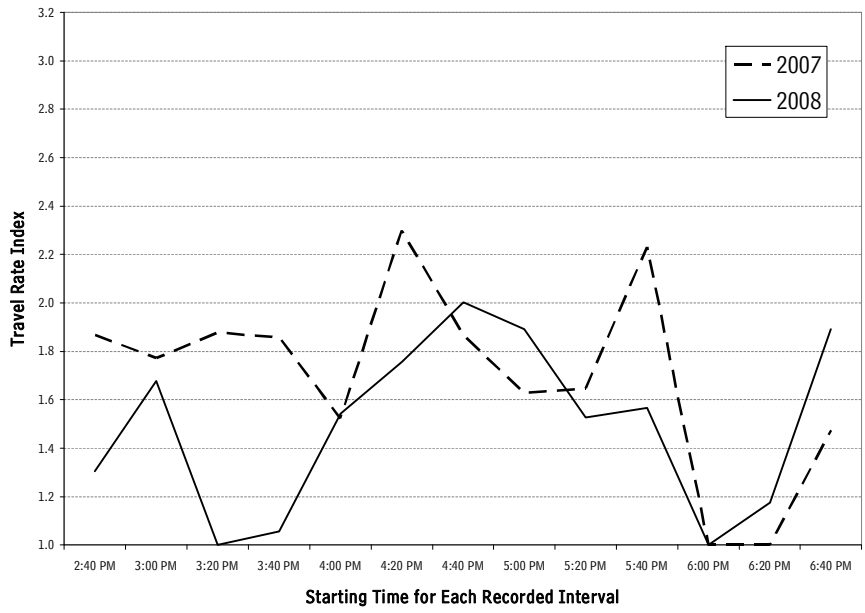
**Figure 427 SH 16 (PM Peak), Scenic Loop Rd to Whip O Will Way, Southbound.**



**Figure 428 SH 16 (PM Peak), FM 1560 to Scenic Loop Rd, Southbound.**

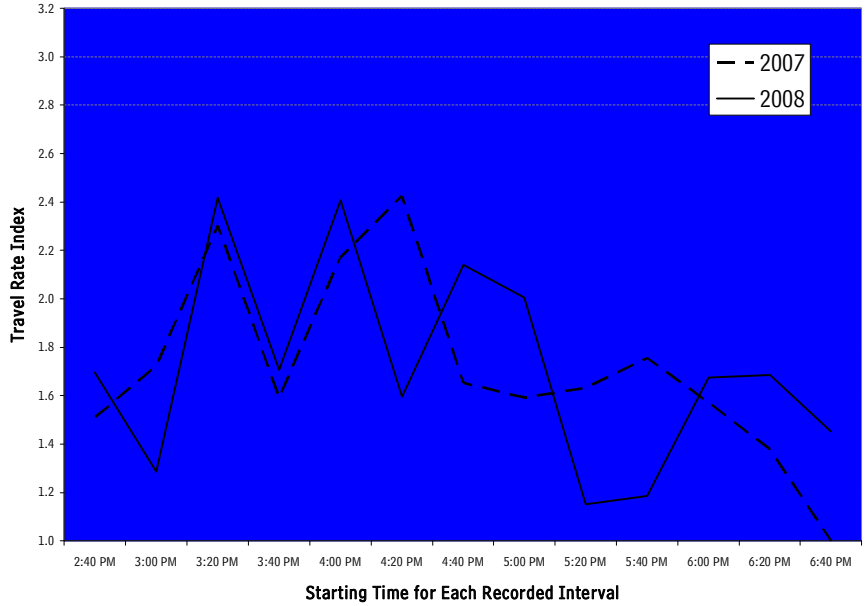


**Figure 429 SH 16 (PM Peak), Hausman Rd to FM 1560, Southbound.**

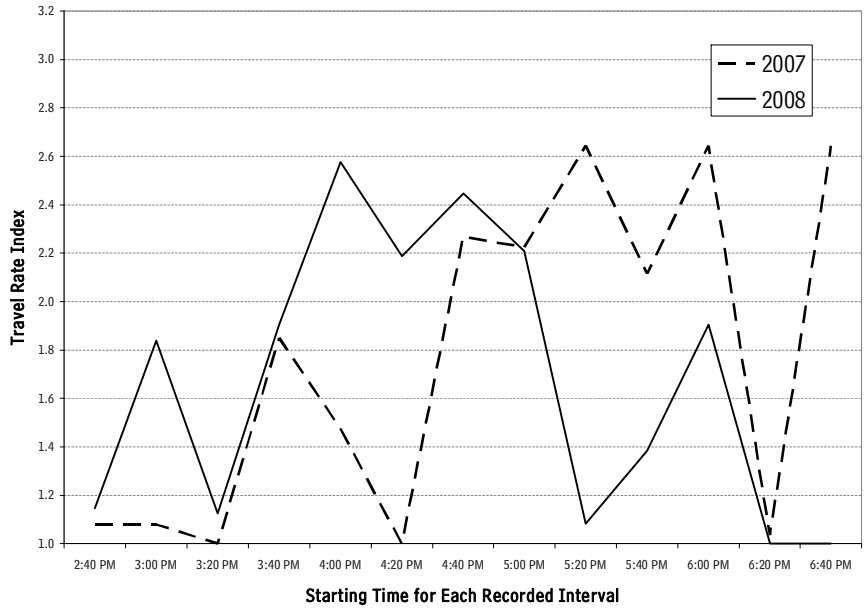


**Figure 430 SH 16 (PM Peak), SL 1604 to Hausman Rd, Southbound.**

***Travel Time Runs, Afternoon Peak, Northbound Direction***

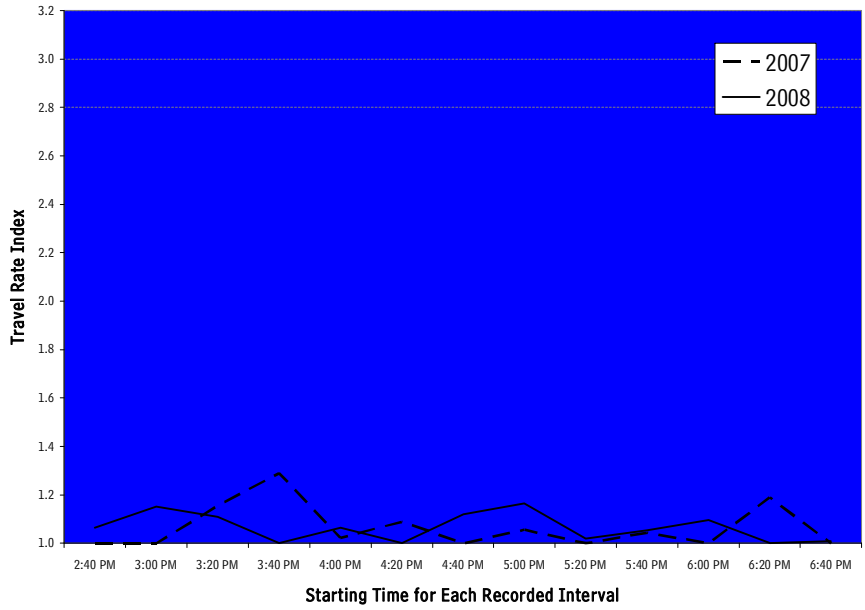


**Figure 431 SH 16 (PM Peak), SL 1604 to Hausman Rd, Northbound.**

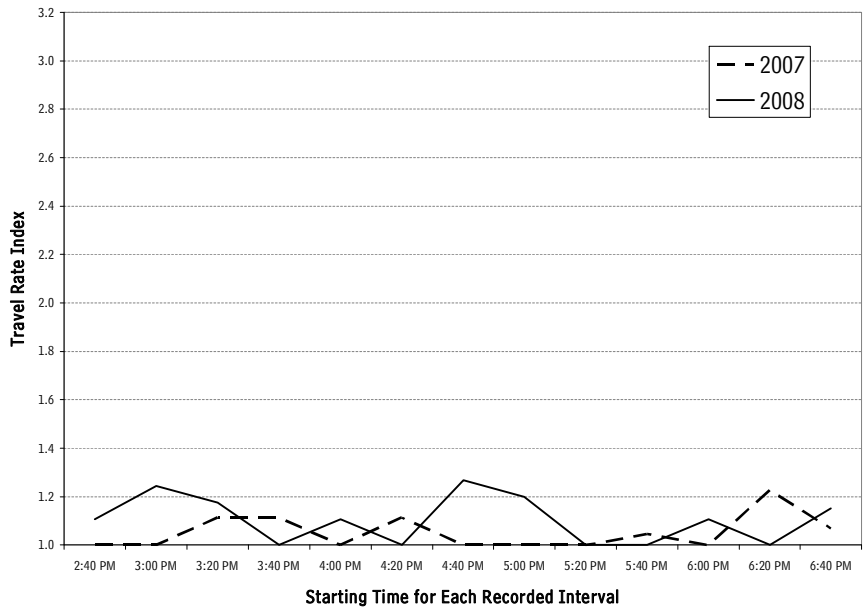


**Figure 432 SH 16 (PM Peak), Hausman Rd to FM 1560, Northbound.**

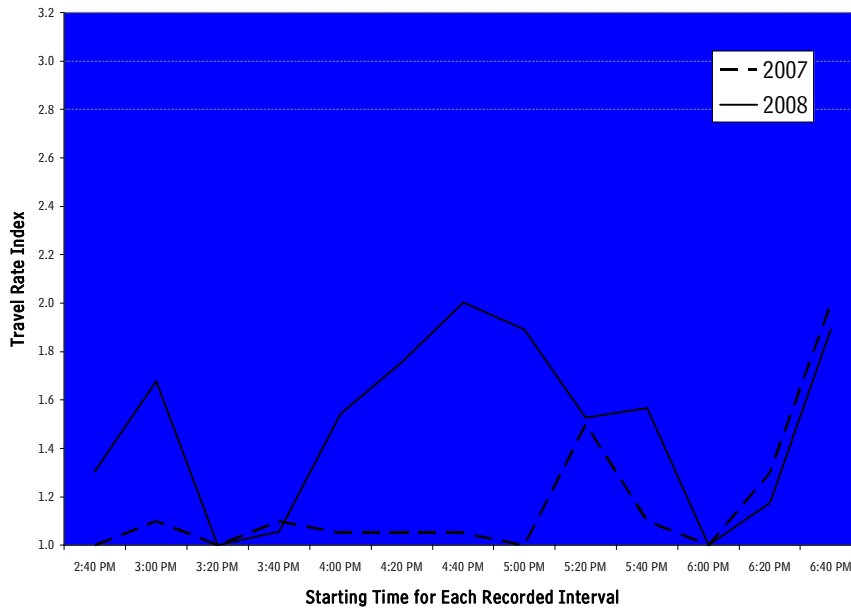




**Figure 433 SH 16 (PM Peak), FM 1560 to Scenic Loop Rd, Northbound.**



**Figure 434 SH 16 (PM Peak), Scenic Loop Rd to Whip O Will Way, Northbound.**



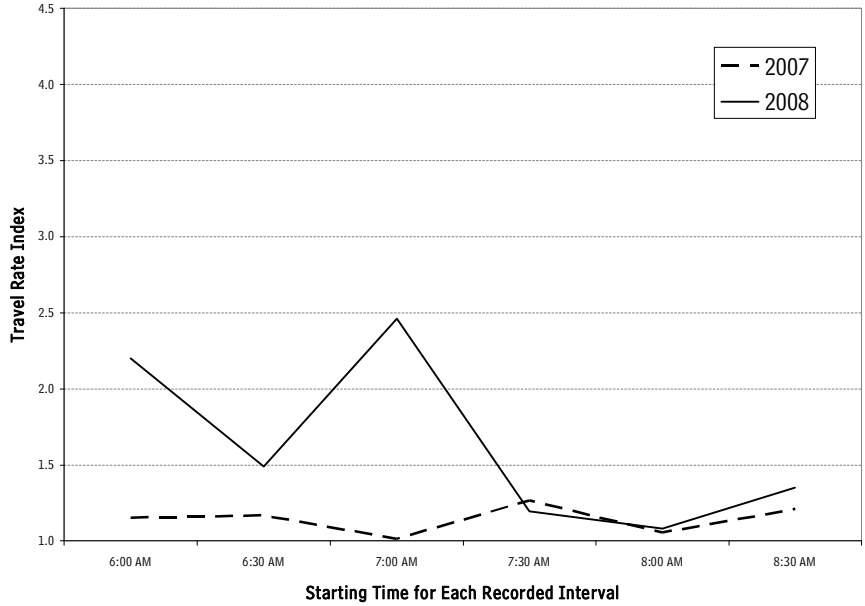
**Figure 435 SH 16 (PM Peak), Whip O Will Way to Reyes Canyon, Northbound.**

**Control Corridor 2: SL 1604 from SH 151 to US 90**

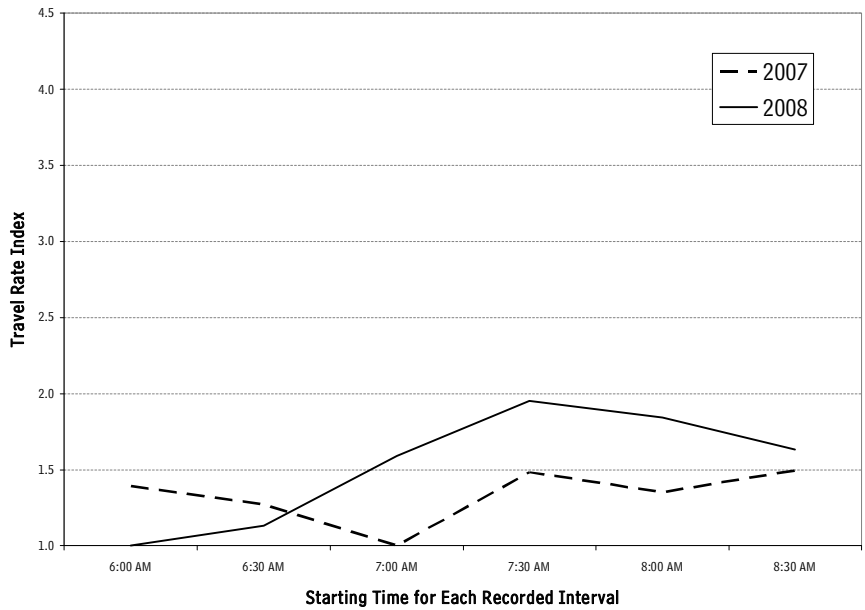
Control corridor 2 is defined in linked segments as follows:

- (A) SL 1604 from SH 151 to Wiseman Rd
- (B) SL 1604 from Wiseman Rd to Military Dr W
- (C) SL 1604 from Military Dr W to SH 1957
- (D) SL 1604 from SH 1957 to Marbach Rd
- (E) SL 1604 from Marbach Rd to US 90

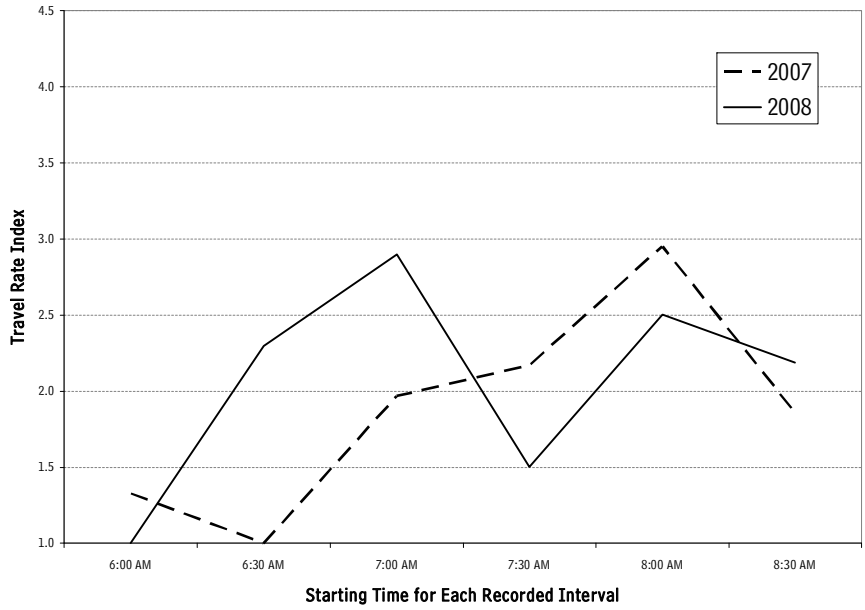
***Travel Time Runs, Morning Peak, Southbound Direction***



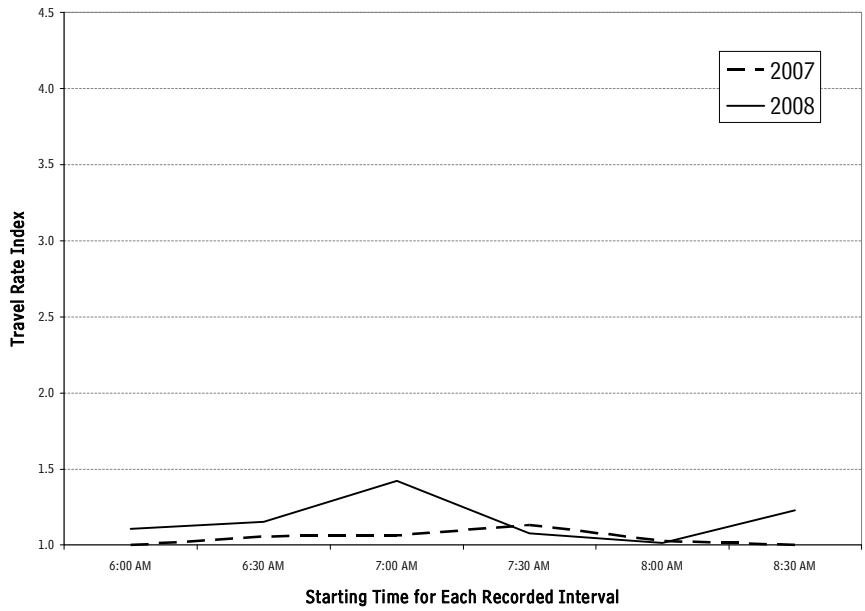
**Figure 436 SL 1604 (AM Peak), SH 151 to Wiseman Rd, Southbound.**



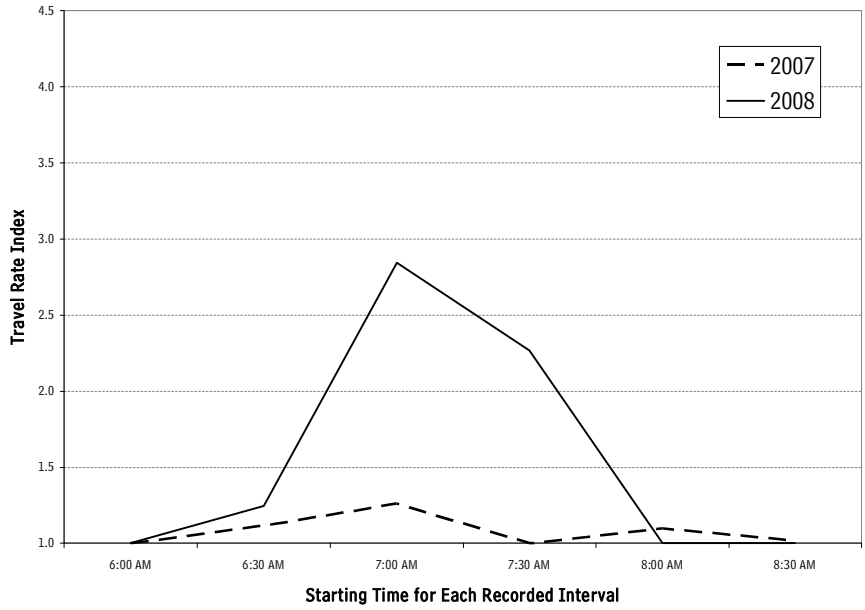
**Figure 437 SL 1604 (AM Peak), Wiseman Rd to Military Dr W, Southbound.**



**Figure 438 SL 1604 (AM Peak), Military Dr W to SH 1957, Southbound.**

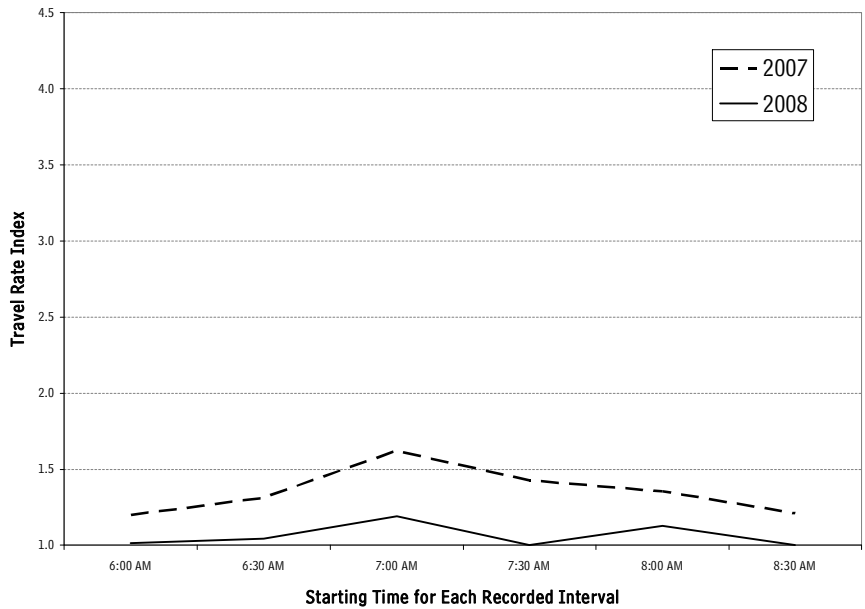


**Figure 439 SL 1604 (AM Peak), SH 1957 to Marbach Rd, Southbound.**

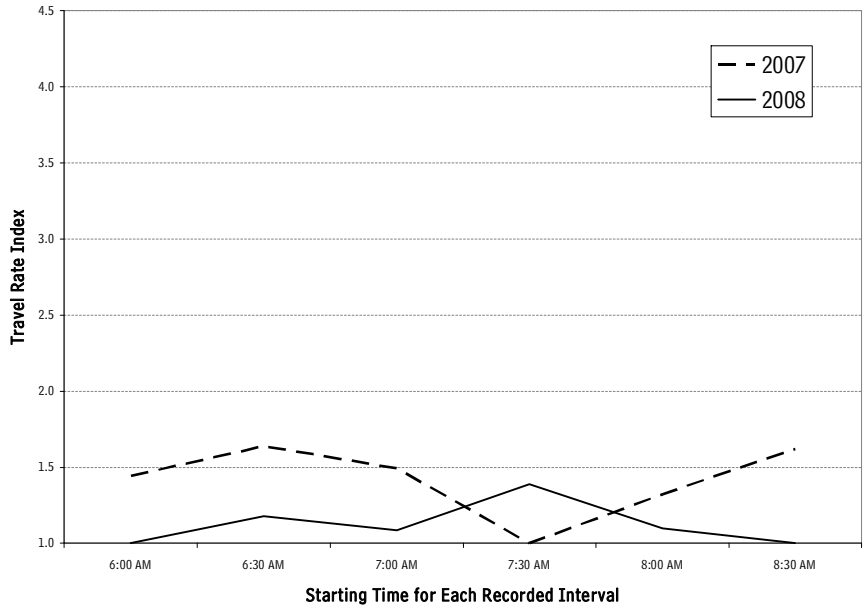


**Figure 440 SL 1604 (AM Peak), Marbach Rd to US 90, Southbound.**

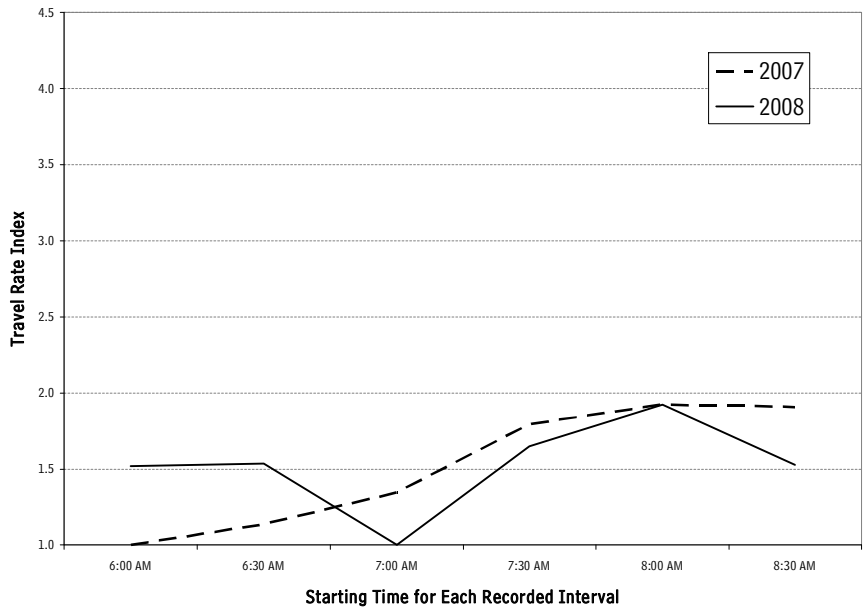
*Travel Time Runs, Morning Peak, Northbound Direction*



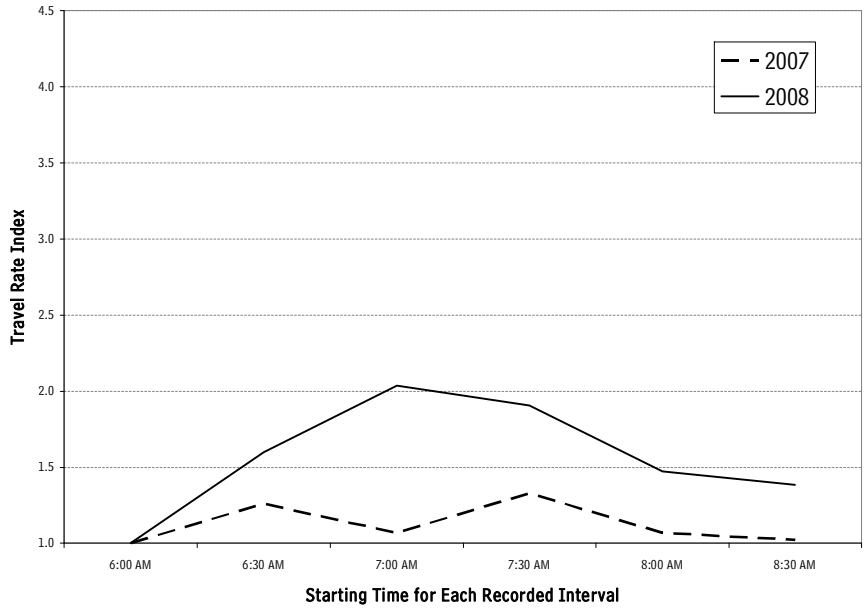
**Figure 441 SL 1604 (AM Peak), Marbach Rd to US 90, Northbound.**



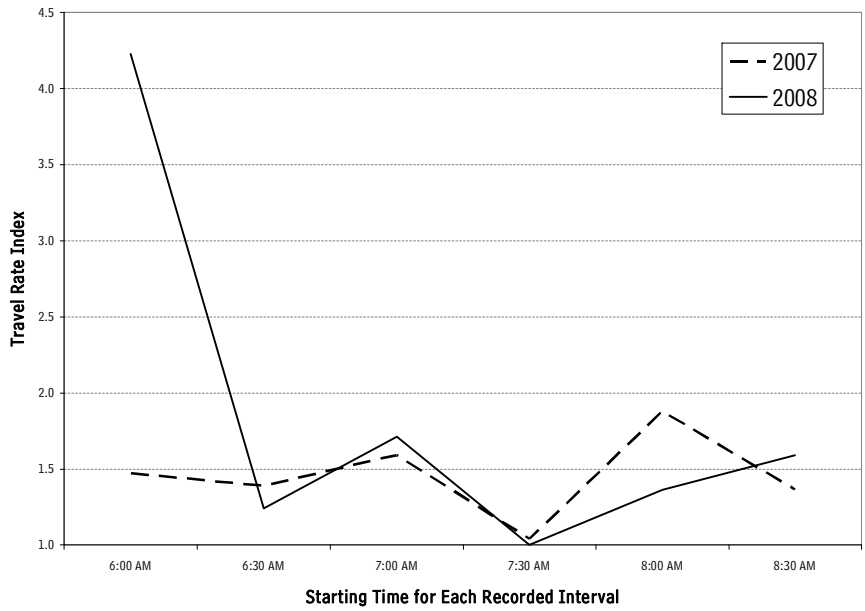
**Figure 442 SL 1604 (AM Peak), SH 1957 to Marbach Rd, Northbound.**



**Figure 443 SL 1604 (AM Peak), Military Dr W to SH 1957, Northbound.**

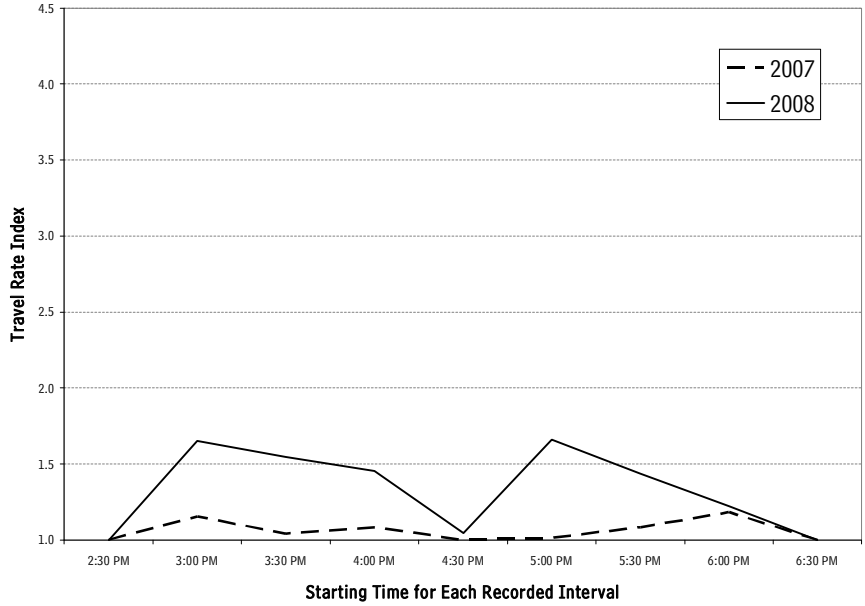


**Figure 444 SL 1604 (AM Peak), Wiseman Rd to Military Dr W, Northbound.**

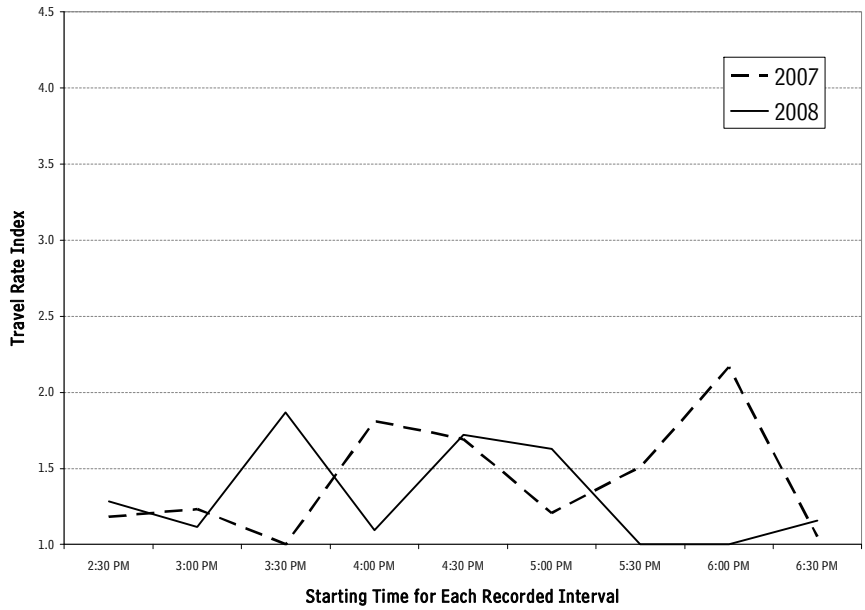


**Figure 445 SL 1604 (AM Peak), SH 151 to Wiseman Rd, Northbound.**

*Travel Time Runs, Afternoon Peak, Southbound Direction*

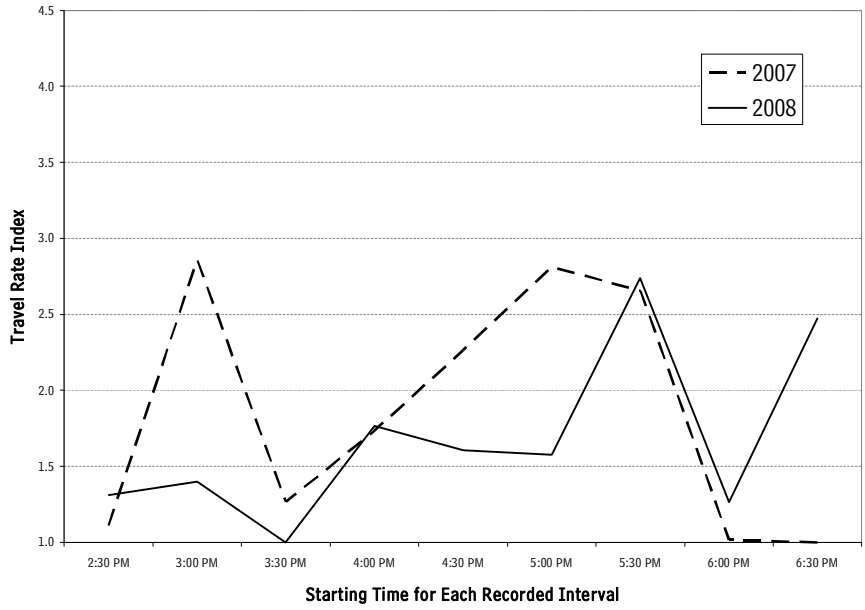


**Figure 446 SL 1604 (PM Peak), SH 151 to Wiseman Rd, Southbound.**

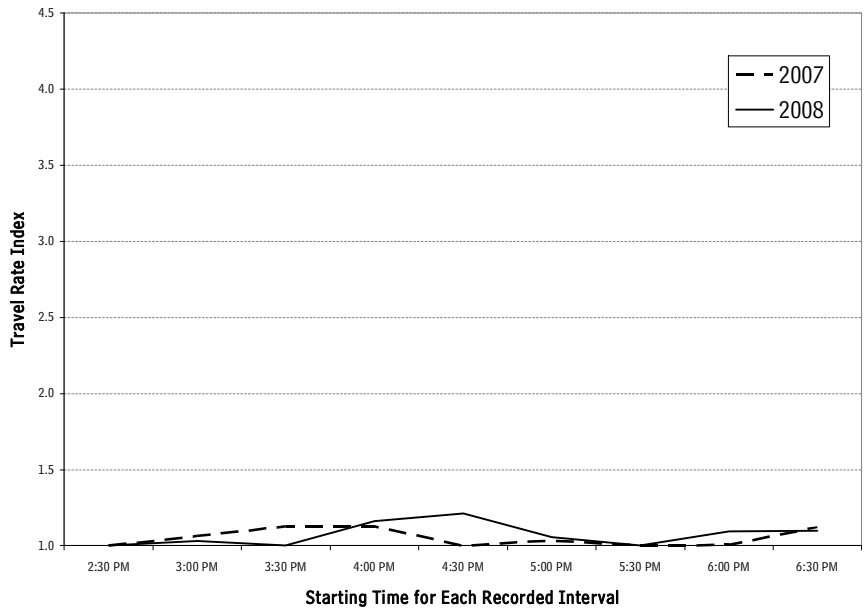


**Figure 447 SL 1604 (PM Peak), Wiseman Rd to Military Dr W, Southbound.**

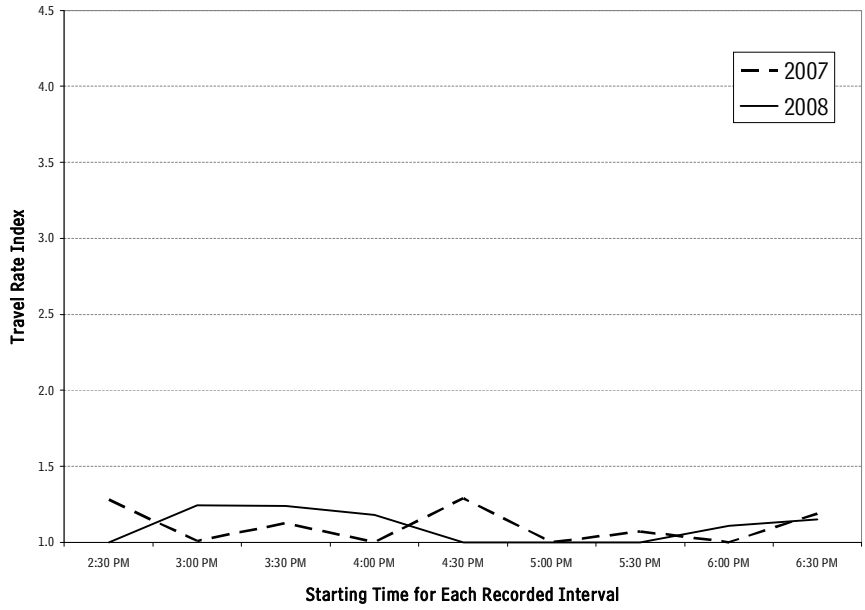




**Figure 448 SL 1604 (PM Peak), Military Dr W to SH 1957, Southbound.**

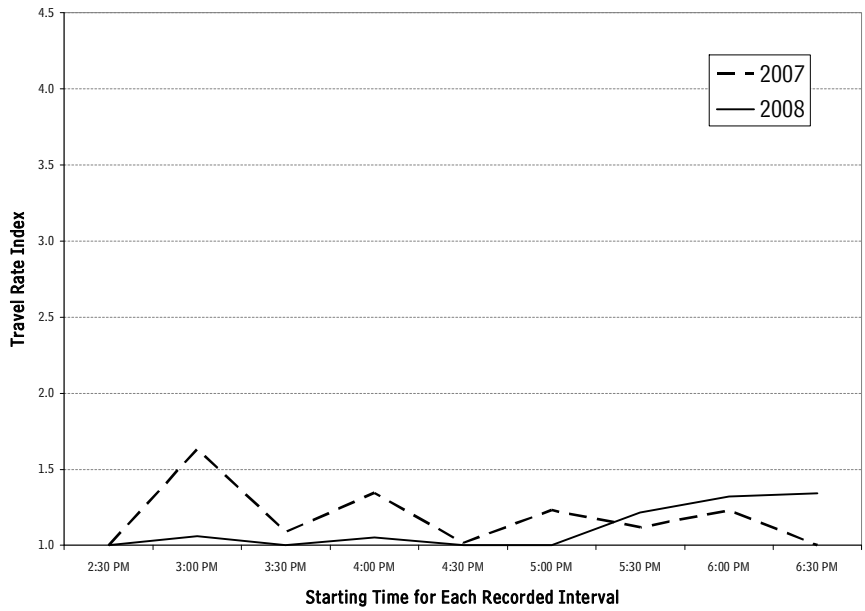


**Figure 449 SL 1604 (PM Peak), SH 1957 to Marbach Rd, Southbound.**

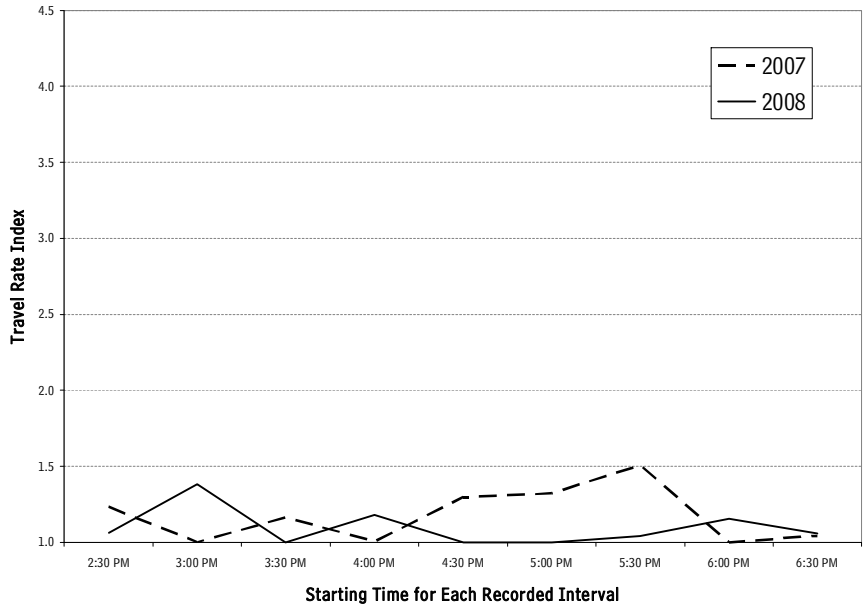


**Figure 450 SL 1604 (PM Peak), Marbach Rd to US 90, Southbound.**

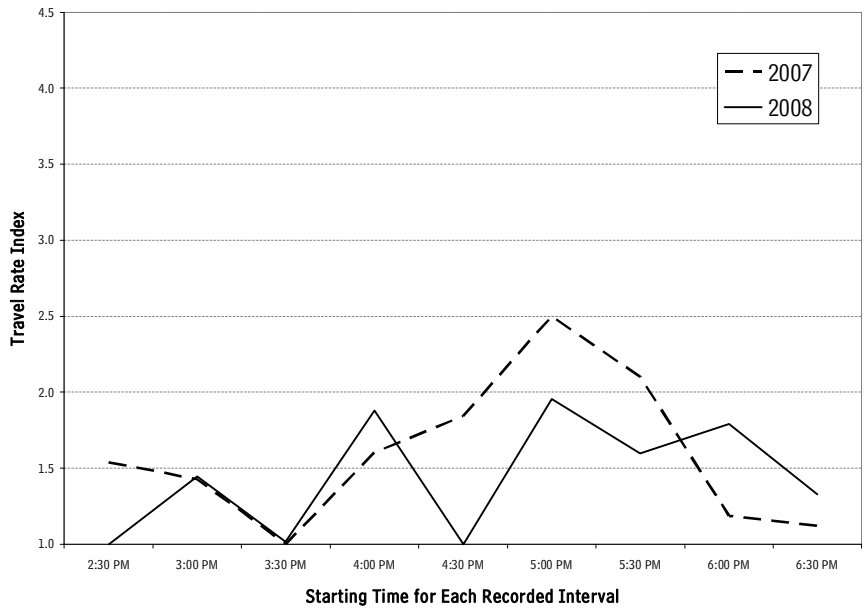
*Travel Time Runs, Afternoon Peak, Northbound Direction*



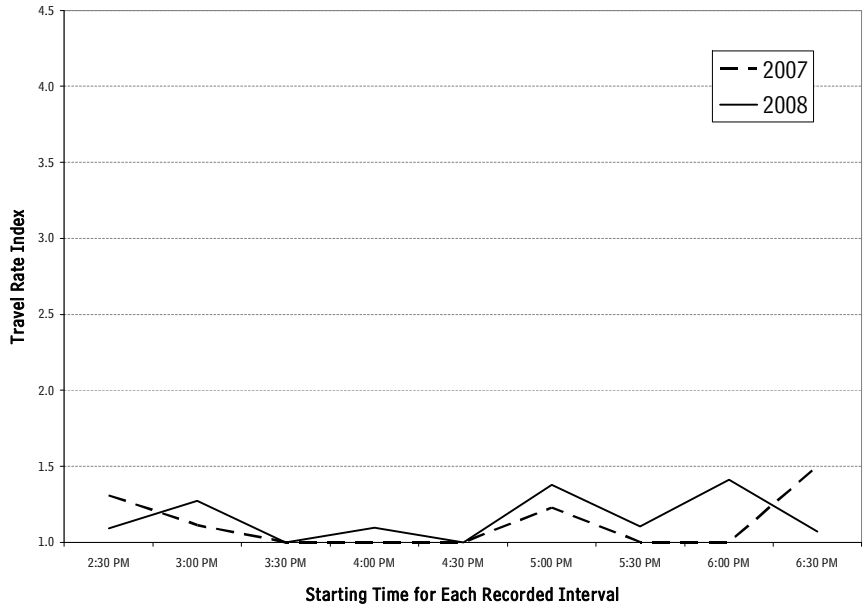
**Figure 451 SL 1604 (PM Peak), Marbach Rd to US 90, Northbound.**



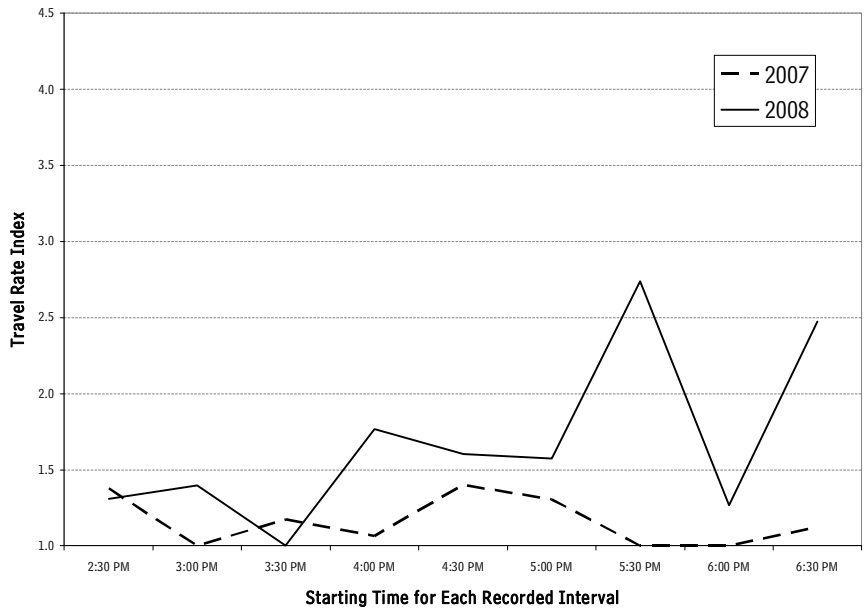
**Figure 452 SL 1604 (PM Peak), SH 1957 to Marbach Rd, Northbound.**



**Figure 453 SL 1604 (PM Peak), Military Dr W to SH 1957, Northbound.**



**Figure 454 SL 1604 (PM Peak), Wiseman Rd to Military Dr W, Northbound.**



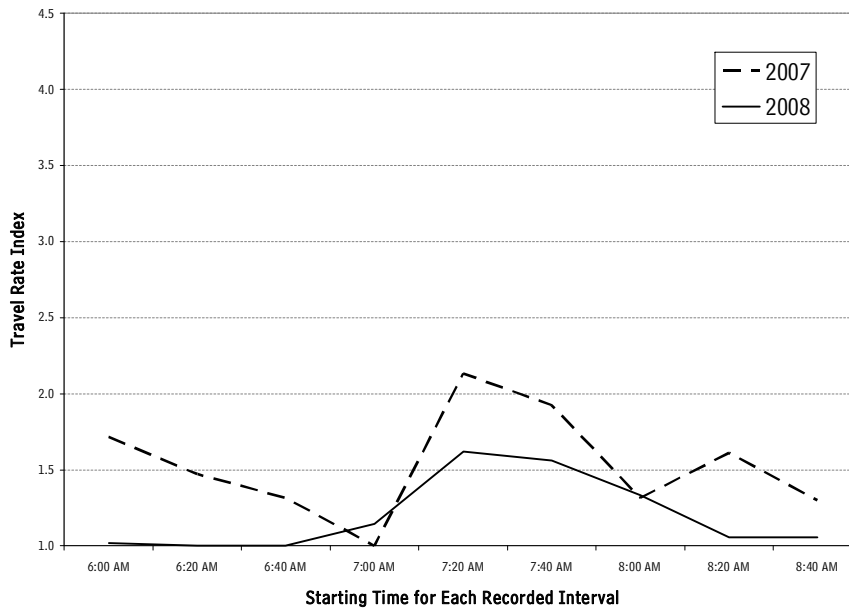
**Figure 455 SL 1604 (PM Peak), SH 151 to Wiseman Rd, Northbound.**

### Control Corridor 3: IH 10 from SL 1604 to Boerne Stage Rd

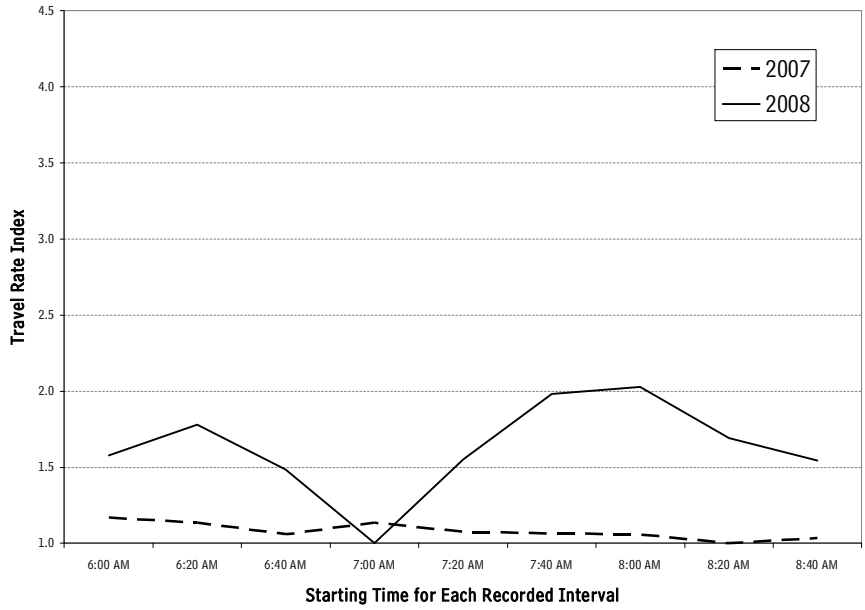
Control Corridor 3 is defined in linked segments as follows:

- (A) IH 10 from Camp Bullis Rd to Boerne Stage Rd
- (B) IH 10 from SL 1604 to Camp Bullis Rd

#### *Travel Time Runs, Morning Peak, Southbound Direction*

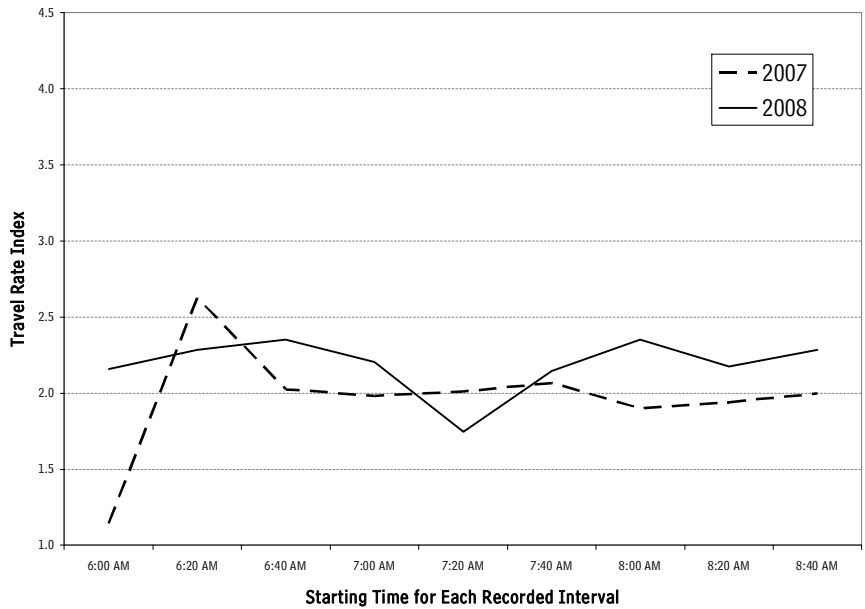


**Figure 456 IH 10 (AM Peak), Boerne Stage Rd to Camp Bullis Rd, Southbound.**

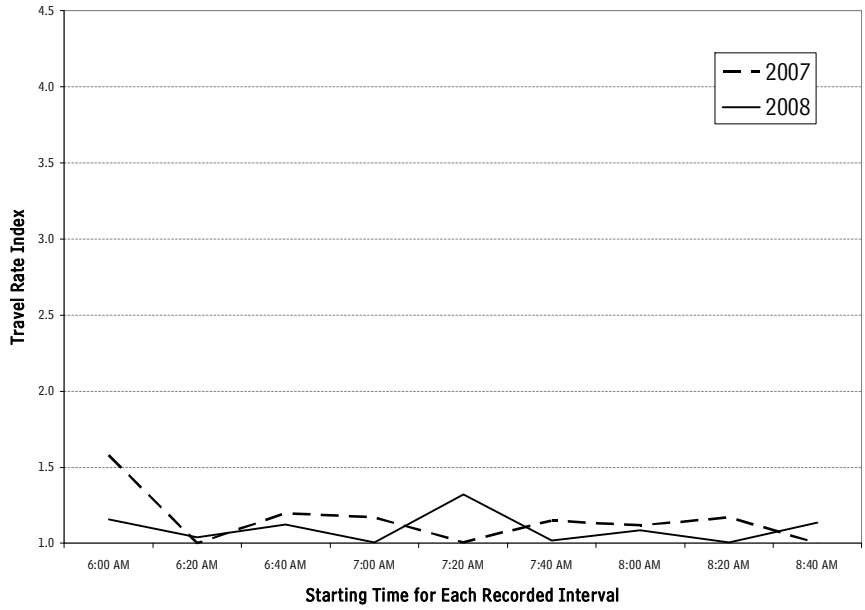


**Figure 457 IH 10 (AM Peak), Camp Bullis Rd to SL 1604, Southbound.**

*Travel Time Runs, Morning Peak, Northbound Direction*

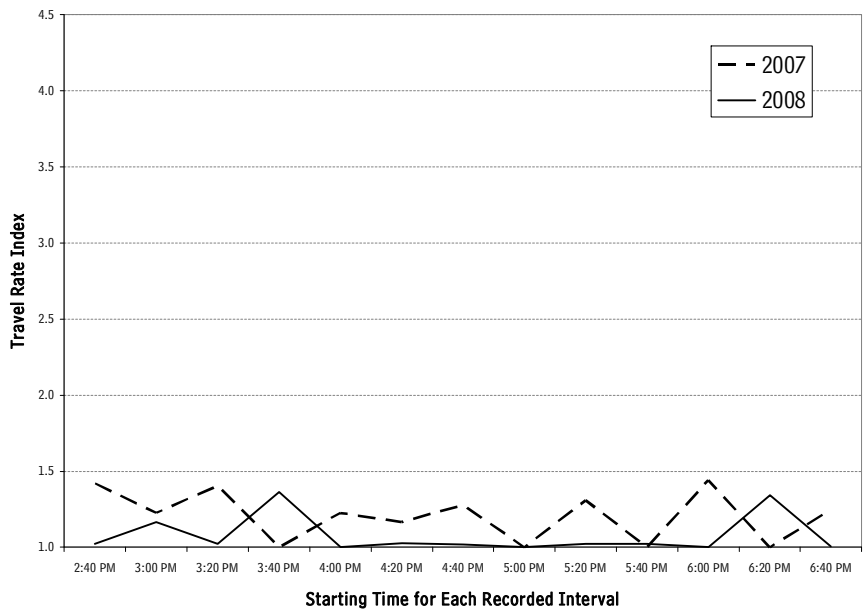


**Figure 458 IH 10 (AM Peak), Camp Bullis Rd to SL 1604, Northbound.**

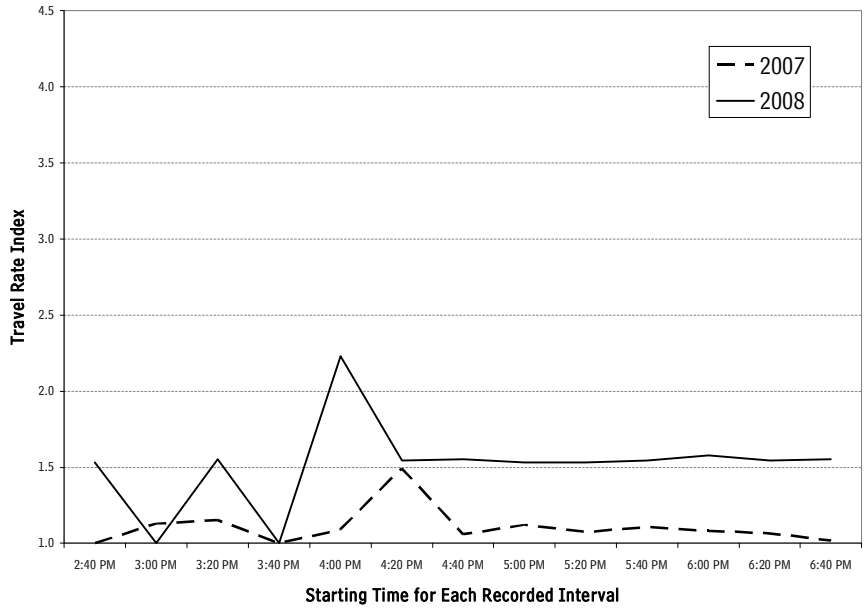


**Figure 459 IH 10 (AM Peak), Boerne Stage Rd to Camp Bullis Rd, Northbound.**

*Travel Time Runs, Afternoon Peak, Southbound Direction*

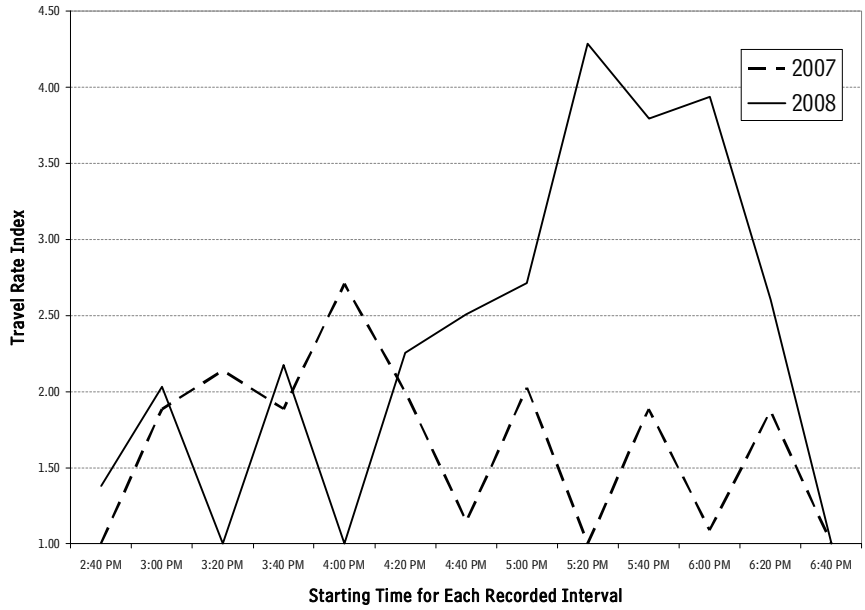


**Figure 460 IH 10 (PM Peak), Boerne Stage Rd to Camp Bullis Rd, Southbound.**



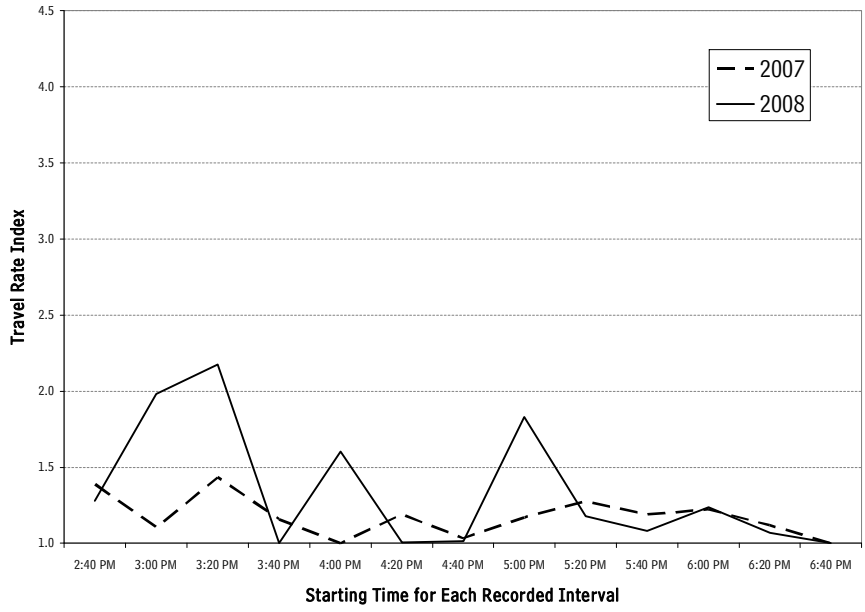
**Figure 461 IH 10 (PM Peak), Camp Bullis Rd to SL 1604, Southbound.**

*Travel Time Runs, Afternoon Peak, Northbound Direction*



**Figure 462 IH 10 (PM Peak), Camp Bullis Rd to SL 1604, Northbound.**





**Figure 463 IH 10 (PM Peak), Boerne Stage Rd to Camp Bullis Rd, Northbound.**