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Mariposa Port of Entry Bottleneck Study

Nogales, Arizona • Nogales, Sonora

Facilitating efficient, secure and economical cross-border transportation movements

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October 2008

EXECUTIVE SUMMARY

The Arizona-Sonora border has become increasingly important to both states' economy due to increased trade between the regions following the 1994 passage of the North American Free Trade Agreement (NAFTA) and the establishment of *maquiladora* industries south of the border. Since the events of September 11, 2001 increased demands for border security have presented further challenges to the efficient flow of cross-border trade. Most of the exports and imports crossing the border are shipped by land transportation via truck or rail. These goods and the industries they support are crucial to the economic development of the border region.

The purpose of this study was to identify bottleneck areas to and from the Mariposa Port of Entry (POE) at Nogales that impact the efficient cross-border movement of goods and recommend low-cost, high-impact solutions. Nogales is the primary port accounting for more than three-quarters (77 percent) of all commercial traffic entering Arizona from Mexico and is one of the country's largest ports of entry for fruits and vegetables. For this project, a bottleneck is defined as "a condition that restricts the free movement of traffic, creating a point of congestion where demand exceeds capacity for a given length of time." This study employs traffic data collection and analysis to identify the location and nature of bottlenecks that restrict the free flow of people and goods into, and away from, the Mariposa POE. The focus areas include the roads immediately to the north and south of the Mariposa POE, respectively SR 189 (Mariposa Rd.) and the *Corredor Fiscal* (Fiscal Corridor), as shown below. The study also proposes improvements to alleviate congestion at the identified bottlenecks and provides estimates of associated costs.

This is the second in a planned series of cross-border bottleneck studies funded by the U.S.-Mexico Joint Work Committee (JWC) for Binational Planning and Programming. The first study, focusing on the San Diego-Tijuana Port of Entry Gateway (Otay Mesa/Mesa de Otay and San Ysidro/Puerta Mexico), was conducted by the California Department of Transportation and completed in 2004. That study developed a methodology that could be utilized at other international land ports of entry.

NORTH OF POE:

Findings and Short-Term Recommendations

Major bottlenecks were observed at several intersections/interchanges along the SR 189 corridor between the POE and the N. Grand Avenue/W. Mariposa Rd. intersection.

Bottleneck #1 W. Mariposa Rd./I-19 northbound (NB) On-Ramp Intersection

Recommendations:

(a) re-time signals

(b) add an additional lane to the existing left-turn lane

(c) widen on-ramp and extend merge point further downstream

Comments: Most delays occur at the left-turn lane. This spillback then affects the I-19 southbound (SB) ramp traffic as well and the upstream Frank Reed intersection.

Bottleneck #2 W. Mariposa Rd./N. Grand Ave. Intersection

Recommendations:

(a) coordinate the signal timing between the Baffert Drive/W. Mariposa Rd. and N. Grand Ave./W. Mariposa Rd. intersections

(b) extend the right-turn lane on N. Grand Ave. SB at the N. Grand Ave./W. Mariposa Rd. intersection.

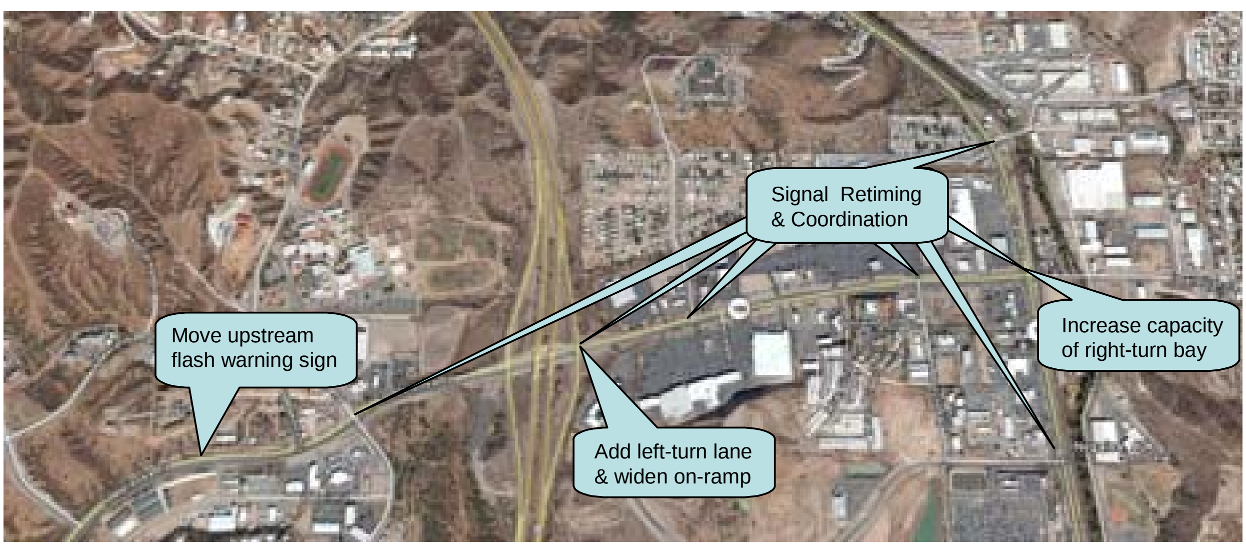
Comment: Afternoon truck traffic returning to Sonora from Arizona tends to create large right-turn volume at the intersection. At times, this causes spillbacks that impede N. Grand Avenue SB traffic.

Bottleneck #3 Frank Reed Rd./N. Mariposa Rd.

Recommendations:

(a) adjust signal timing at Frank Reed Rd. to permit more green time for N. Mariposa Rd. approaches during periods of decreased traffic from Frank Reed Rd. and N. Industrial Park Dr.

(b) move the flashing light further upstream away from the intersection for traffic coming from the POE. This would provide appropriate stopping sight distance when the signal is about to turn red.



Move upstream flash warning sign (Bottleneck #3); *add left-turn lane & widen on-ramp* (Bottleneck #1); *signal re-timing & coordination* (Bottlenecks #1, 2, 3 plus other intersections along SR-189 and near I-19) *increase capacity of right-turn bay* (Bottleneck #2)

Cost Estimate

The total construction, engineering and project management costs of implementing all the short-term, high impact recommendations for bottlenecks north of the Mariposa Port of Entry are estimated at approximately 1.5 million dollars.

Long-Term Recommendations

With anticipated increases in throughput at the Mariposa POE, two more extensive projects may be considered:

(a) direct connector from I-19 to the Mariposa POE separate from W. Mariposa Rd.

(b) frontage road east of I-19 between W. Mariposa Rd. and N. Apache Rd.

Comment: These two long-term projects will create a significant pattern shift in the traffic flow, thereby alleviating congestion at the existing bottlenecks.

SOUTH OF POE (FISCAL CORRIDOR):

Findings and Short-Term Recommendations

Bottleneck #4 Fiscal Corridor

Recommendation:

Place proper signage before the point where the road separates into private and commercial lanes. This would allow vehicles traveling at free flow speed (i.e., the speed when congestion is not present), to have sufficient advance warning to enable them to choose the correct lane.

Bottleneck #5 POE Entrance - Truckless Drivers

Truckless drivers *(cruzadores)*, who are Mexicans with border-crossing documentation, often wait in front of the Mariposa POE for northbound trucks to arrive at the border. At that time, they swap places with inbound drivers, and drive across the border. This situation causes traffic disturbances as drivers walk between lanes and force trucks to stop. This situation would be exacerbated if and when the POE inspection capability is expanded to accommodate a higher throughput.[1]

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[1] A feasibility study and an environmental impact study have already been carried out with a view to a major expansion of capacity at the Mariposa POE, but funding of construction has not yet occurred.

Recommendations:

(a) This situation should be resolved quickly since it contributes both to traffic congestion and hazardous conditions.

(b) If this practice needs to be accommodated, a location can be established further south, before the toll gate, to allow drivers to switch places safely.

Observations

Truck entrance to POE

High truck volumes were observed at the data collection point located before the Mariposa POE where northbound trucks enter shortly before the inspection station closes. This traffic might arrive from Mexican Customs in just enough time to reach the border before inspections cease for the day. Expanded hours of service, announced on Oct. 7, 2008, may ease this bottleneck.

Confederation of Agricultural Associations of the State of Sinaloa (CAADES) Facility

The CAADES facility located close to Mexican Customs had trucks stopping nearby for quality grading, agricultural inspections and other services before departing for the POE. In some cases drivers leave containers (both empty and full) on the sides of the road for other drivers to pick up. This situation causes a large bottleneck for trucks going into the CAADES facility and onto the Fiscal Corridor. Some improvements reportedly have been made since the data collection period.

ACKNOWLEDGEMENTS

We would like to express our gratitude to several individuals who provided invaluable assistance for this study:

Rudy Perez, Arizona-Mexico Liaison, Arizona Department of Transportation, for giving us the opportunity to conduct this important research

Jose Andres Sierra Hernandez, Director General, and Pablo de la Peña Sánchez**,** *Directo*r de *Graduados y Extensión, Instituto Tecnológico y de Estudios Superiores de Monterrey* (ITESM**),** *Campus Sonora Norte*, for facilitating the partnership between our universities

Terry Shannon, Jr., Chairman, Greater Nogales and Santa Cruz County Port Authority, for generously sharing his insights and time

Fernando Lam Koerdell, *Coordinador General de Proyectos Especiales, Secretaría de Infraestructura y Desarrollo Urbana*, Mexican State of Sonora, for arranging a stakeholders meeting in Hermosillo

Jesus Cruz, Chief, U.S. Customs and Border Protection, Nogales, Arizona, for graciously giving a tour of the Mariposa Port of Entry facilities

Sylvia Grijalva, US-Mexico Border Planning Coordinator, Federal Highway Administration, for her valuable comments throughout this process

Armando Goncalvez, Tucson Field Operations Office, U.S. Department of Homeland Security, for providing timely traffic data

Anthony Kleppe, Assistant Manager, General Services Administration, for providing information on the Mariposa Port of Entry redesign

Martha Rascon, SunFed and Greater Nogales and Santa Cruz County Port Authority, for providing access to the Fiscal Corridor Working Group and her knowledge about the Corridor

Arnold Maltz, Associate Professor of Supply Chain Management, Arizona State University, for sharing previous reports on the Port of Entry

Tom Martinez and Doug Kratina for providing valuable field assistance and instructions on the proper methods of placing pneumatic tube counters

Arizona Department of Transportation engineers Jerry James, P.E., Resident Engineer, James F. Gomes, Jr., Engineer In Training as well as to Transportation Engineering Specialist Manuel Bonorand, and University of Arizona intern Monica Soto, for their assistance in providing cost estimates and the Nogales site survey.

Brenda Bustillos and Eric Nava at the DynusT Laboratory at the Dept. of Civil Engineering and Engineering Mechanics, University of Arizona, for leading the organization and execution of the data collection in collaboration with *Instituto Tecnológico y de Estudios Superiores de Monterrey* (ITESM).

Dr. Mark Hickman, Department of Civil Engineering and Engineering Mechanics, Advanced Traffic and Logistics Algorithms and Systems (ATLAS) Research Center, University of Arizona for assisting with data collection using airborne cameras.

Mina Goldberg, for her many contributions to this report’s content and editing

Lourdes Gonzalez and Christopher Basaldu, for their assistance in the early stages of this project

All the members of the Technical Advisory Committee and Stakeholders Group for their invaluable advice and comments.

And most importantly, to the students from the University of Arizona and ITESM who collected the data that made this study possible.

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Description

The Mariposa POE, located in Nogales, Santa Cruz County, is Arizona's busiest border crossing. Located on the western side of Nogales approximately 1.5 miles from the central business district, the Mariposa POE sits atop a small mesa on 43 acres owned by the U.S. General Services Administration (GSA). Directly to the southeast is the City of Nogales, Sonora, Mexico. Mariposa POE is the largest port of entry for Mexican fresh fruits and vegetables and has a highly seasonal type of traffic that peaks in the winter months. Nogales, Sonora, has a significant cluster of *maquiladora* activity, which contributes to the bi-directional flow of truck traffic through the Mariposa POE (electronics, equipment, apparel, etc.). However, the significant traffic patterns of the agricultural industry, a sector affected by optimal planting and harvest times as well as by weather conditions, distinguish the Mariposa POE from other ports of entry.[2]

Although primarily a commercial port, the Mariposa POE also handles traffic from privately-owned vehicles (POVs) and pedestrian crossings.[3] Within the facility, federal inspectors conduct pre-screening, primary and secondary inspections for commercial and non-commercial vehicles, as well as bus and pedestrian inspections. In an annex belonging to the State of Arizona and operated jointly by state and federal authorities, vehicle safety inspections are conducted.

Access from Nogales, Arizona, is via State Route 189 (SR 189, also known as Mariposa Rd.), which has an interchange with I-19 approximately 3.1 miles north of the border crossing. Access from Nogales, Sonora, Mexico, is through a modern, eight-mile-long, six-lane highway, called the *Corredor Fiscal* (the "Fiscal Corridor"), that connects to Mexican Highway 15 at its south entrance. For POVs, there is also access from the Nogales, Sonora city center through a connector and interchange with the Fiscal Corridor a few meters south of the Mariposa POE.

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[2] McLaren, Dawn, 2007. "The Mariposa Port of Entry at Nogales, Arizona: Development of a Forecasting Model for Cargo Crossings," Arizona State University, L. William Seidman Research Institute.

[3] Two additional POEs are located in downtown Nogales. The DeConcini POE serves private vehicles, pedestrians and rail containers; and the Morley Gate is restricted to pedestrians. In 2003, the Mariposa POE accounted for only 14 percent of pedestrian crossings through all the Nogales POEs.

History

The Mariposa POE opened for commercial traffic in 1976 and expanded to handle POVs in 1983. Mirroring the growth of *maquiladora* assembly and manufacturing plants in Mexico and the impetus to cross-border trade provided by the North American Free Trade Agreement (NAFTA), the Mariposa POE has grown from a modest beginning to an important entry point from Mexico into the U.S. In particular, the significant level of agricultural imports is a distinctive feature of the Mariposa POE. Regional population growth, increased law enforcement activities and national security requirements have all further contributed to the demands on the Mariposa POE's capacities.

Originally designed to handle 400 trucks daily with an expected utility life of 25 to 30 years, the facility now handles up to 1,300 trucks a day during peak season.[4] Since NAFTA came into effect in 1994, the number of northbound commercial truck crossings per year has grown from 190,000 to over 280,000 in 2006. These crossings have also increased greatly in terms of value and weight. In 2007, the facility processed imports into the U.S. worth $8.4 billion with a weight of 6.26 billion pounds. Currently, the Mariposa POE processes 6.1 percent of the total value of imports from Mexico by truck.

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[4] U.S. Department of Transportation, Bureau of Transportation Statistics, Transborder Surface Freight Database (which also includes Border Crossing/Entry Data, based on data from U.S. Department of Homeland Security, Customs and Border Protection, OMR database). (The trade value figures for 1995 would total to 5582 instead of 5581. This slight differencer is due to rounding. There is a comparable slight difference in the 2007 value figures for the same reason.)
See also Doyle, Gary, "Environmental Fatal Flaw Screening and International Regulatory Issues," August 2001, p. 7. http://www.canamex.org/PDF/Environmental_and_International_Issues.pdf

Table 1-1 - Trade by Truck through Nogales, AZ [5]

Value in Millions of US Dollars by Truck through Nogales, Arizona			
	1995	**2007**	**% Change** 1995-2007
Total Trade Value by Truck	5,581	13,253	137.45
Exports Value by Truck	2,372	4,827	103.53
Imports Value by Truck	3,210	8,425	162.51
Weight in Millions of Pounds by Truck through Nogales, Arizona			
	1995	**2007**	**% Change** 1995-2007
Imports Weight by Truck	2,298	6,258	172.36

Despite various operational and structural changes, delays remain routine with long queues of trucks often waiting hours to enter the inspection facility. In the busy winter produce season, lines have stretched up to two miles with five-hour waits. These delays are costly, resulting in unpredictable deliveries, immobilized inventory, idle equipment, loss of income and profit, diminished tax revenues, and increased pollution. Prolonged waits are particularly severe for agricultural products that are highly perishable. Even when direct spoilage does not occur, the product has a shorter shelf life when it reaches its destination. For passengers in POVs, delays disrupt personal activities, particularly at holiday times.

Nature of Crossings

The Mariposa POE hours of operation for cargo are weekdays 8:00 a.m. to 7:00 p.m. and Saturdays to 6:00 p.m. Since 2005, limited hours on certain Sundays have been added from about mid-January to mid-April and sometimes during the grape harvesting season in July. These hours were expanded so that trucks with produce that arrive too late for Saturday processing do not have to remain idle until Monday morning. While the U.S. agencies at the

[5] Source: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, TransBorder Freight Data. In addition to trade through the Mariposa POE, there is trade by rail that crosses in downtown Nogales. Trade by rail through Nogales in 2007 amounted to $4.8 million with exports of $1.1 million and imports of $3.7 million.

Mariposa POE will process any cargo during open hours, Mexican customs authorities have at times limited their Sunday cargo processing to produce.[6]

Expanded seasonal hours of service were announced for the POE on Oct. 7, 2008: "Beginning January 1, 2009, the hours of service at the Mariposa Commercial Facility will expand by two hours per day with the closing time Monday through Friday extending to 9 p.m. and Saturday extending to 6 p.m. The port will open on Sunday as needed based on peak demand. This expansion of hours will extend through the produce season (approximately May 2009)."[7]

Produce Shipments

The Mariposa POE is the crossing point for 60 percent of all winter produce shipped from Mexico to the U.S., including tomatoes, cucumbers, melons, and peppers. Weather conditions in Mexico's produce-growing regions have a direct impact on the daily and seasonal flow of traffic. In recent years, billions of pounds of fresh fruit and vegetables pass through the facility annually for distribution in the U.S. and Canada. This traffic is highly seasonal; it increases during November through May, peaking from January through March. In recent years, the produce season has lengthened due to more greenhouse growing. Also, areas further from the border that did not previously export to the U.S. are starting to do so now. Depending upon where the demand is, this produce is often routed through the Mariposa POE.

In 2005, fresh fruits and vegetables through the Mariposa POE accounted for 4 billion pounds in weight and $2 billion in value out of a total of 5.5 billion pounds and $7.5 billion, leaving approximately 1.5 billion pounds and $5.5 billion for non-produce shipments. Non-produce category includes canned or processed fruits and vegetables. Compared to measurement by value, produce accounts for a disproportionately large share of northbound traffic when measured by weight or number of truck trips.

During peak months, the facility processes up to 30,000 trucks per month, or 1,200 to 1,300 trucks daily. The seasonality effect can be demonstrated through the monthly value of shipments. From June 2006 through May 2007, the monthly value of agricultural and non-agricultural northbound goods through the Mariposa POE ranged from a low of $453,000 (June 2006) to a high of $880,000 (March 2007), with the March figure reflecting the high agricultural

[6] http://www.cbp.gov/xp/cgov/toolbox/contacts/ports/az/2604.xml Mexican authorities have had variable Sunday practices, e.g., in 2007, during the limited high-season Sunday hours, all goods were accepted but, in 2008, during the limited high-season Sunday hours, only produce was considered eligible. What will be accepted in 2009 has not yet been announced.

[7] http://cbp.customs.gov/xp/cgov/newsroom/news_releases/10072008.xml

season. For that same period, the value of all types of southbound goods was fairly steady at $350,000 to $453,000 per month.

When Mexican packinghouses load a truck with produce, the growers submit information regarding the trailer's contents to the U.S. importer, and the U.S. and Mexican customhouse brokers. The brokers then prepare the documentation necessary for the product to cross the border, which is usually submitted to U.S. Customs and Border Protection (CBP) by the U.S. broker. However, much of the produce grading activity takes place in Mexico. The U.S. Department of Agriculture (USDA) has issued marketing orders for a number of produce items.[8] The Arizona Department of Agriculture, using USDA-approved inspectors, performs inspections in Mexico for quality, size, and freshness, as well as mandating proper labeling.[9] Inspections for pests, pesticide residues and contaminants are performed at the Mariposa POE. In 2003, responsibilities for USDA-mandated border inspection requirements and the coordination of food inspection agencies were transferred from USDA to CBP.

Industrial Shipments

Mexico's *maquiladora* system, established in 1965, enables plants to assemble or manufacture goods for export using duty-free imported inputs and includes other benefits. The passage of NAFTA boosted the use of this option. In 2005, Sonora was home to 205 *maquiladora* plants[10] with over 80,000 employees in a number of industries, with the heaviest concentration in electronic and automobile equipment. Other significant sectors include aerospace and medical devices.[11] These plants provide a regular stream of northbound trucks through the Mariposa POE as well as rail shipments through downtown Nogales. The *maquiladora* sector utilizes large amounts of materials and supplies. Some of these flow southbound from the U.S. for "just-in-time" manufacturing at the *maquiladora*s. As indicated above, the 2005 northbound truck shipments through the Mariposa POE for goods other than fresh produce amounted to approximately 1.5 billion pounds and $5.5 billion.

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[8] Marketing order are user-funded programs provide for product research and promotion, and often require quality grading.

[9] Arizona's Department of Agriculture has its own regulations, embodied in the Citrus, Fruit and Vegetable Standardization Program.

[10] Of these plants in the Mexican state of Sonora, 104 are located in the Nogales, Sonora, area as of 2007. Gabriella Rico, Arizona Daily Star, April 24, 2007, p. 1.

[11] U.S. Census Bureau, Foreign Trade Statistics. 2006b. *USA Trade Online*. http://www.usatradeonline.gov/

Privately-owned Vehicles

The Mariposa POE processed over 1.2 million POVs from mid-2005 to mid-2006.[12] Peak periods occur at holiday times (e.g., December – January) for shopping, family events and related activities. Spring Break, Memorial Day weekend and three-day weekends also see spikes in crossings by vacationers. However, crossing the border for shopping, business, tourism, health services, schooling or visiting family and friends, is a common practice year-round. POV and pedestrian processing hours are available seven days a week, 6:00 a.m. – 10:00 p.m., with late service offered at holiday times, as traffic dictates.[13]

Ingress and Egress Roads

Southbound (U.S. ⇨ Mexico)

From the U.S., the Mariposa POE is accessed via SR 189 (Mariposa Rd.). Beginning as an exit off Interstate 19 (I-19) approximately 3.1 miles north of the border, this two-lane road weaves through a commercial district on the outskirts of Nogales before ending at the Mariposa POE.[14]

Southbound commercial and passenger vehicles are checked by Mexican customs, immigration and other authorities, but do not experience the long queues and delays common for northbound commercial vehicles. Many southbound commercial vehicles are empty, and it is important for them to be able to cross back into Mexico promptly to pick up a new load.

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[12] RTI International. June 2007. "The Economic Benefits of Expanding the Border-Crossing for Commercial Vehicles at the Mariposa Crossing in Nogales," Prepared for Gary Becker, U.S. Department of Homeland Security, Private Sector Office. Of these 1.2 million POVs, 72,000 were referred for secondary inspection. http://www.azmc.org/story/?ID=144

[13] http://www.cbp.gov/xp/cgov/toolbox/contacts/ports/az/2604.xml. In addition, in September 2008, CBP was installing radio frequency identification (RFID) devices at the Mariposa POE to be used in conjunction with travel documents required under the Western Hemisphere Travel Initiative (WHTI). WHTI requires all travelers to and from Canada, Mexico, the Caribbean and Bermuda who have historically been exempt from passport requirements, to present a passport or other approved document that establishes the bearer's identity and citizenship in order to enter or re-enter the United States. http://www.cbp.gov/xp/cgov/newsroom/news_releases/archives/2008_news_releases/sep_2008/09042008_3.xml

[14] http://www.canamex.org/PDF/Environmental_and_International_Issues.pdf

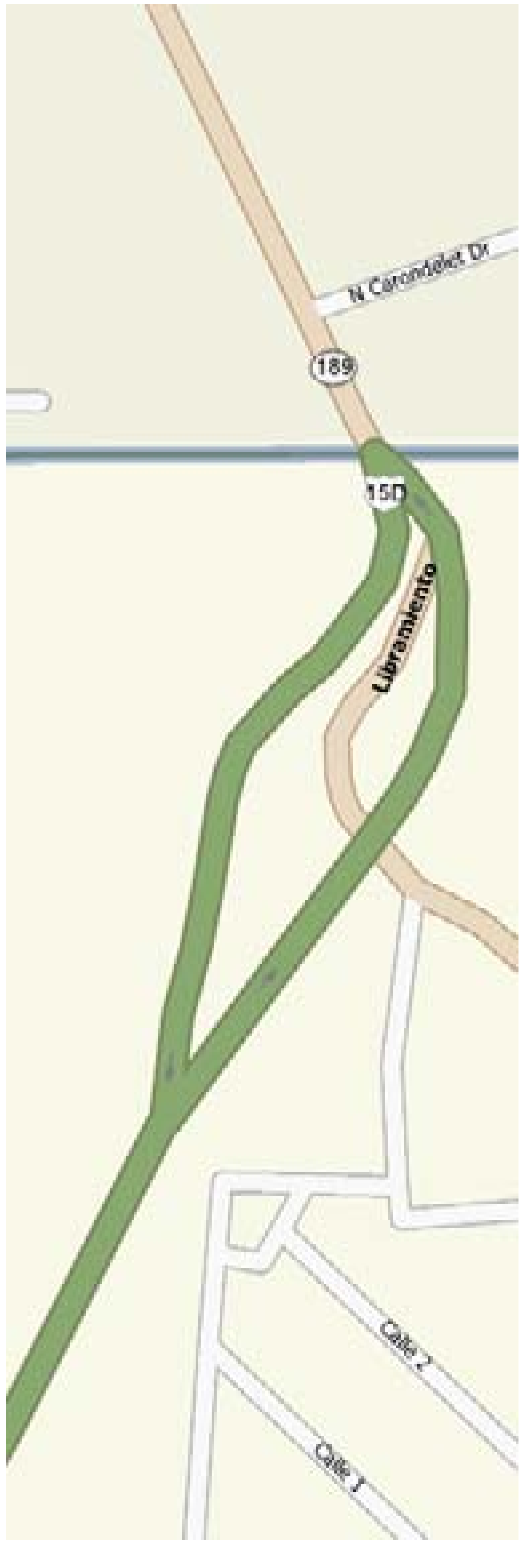

Figure 1-1 - Cross-Border Roads at Mariposa POE

Northbound (Mexico ⇨` U.S.)

1. Lanes (queues) before crossing the physical border.
2. Pre-screening lanes and inspection stations.
3. Primary inspection stations (SuperBooths).
4. Different quantities of docks at each side of the main compound, where the detailed inspection takes place.
5. X-Ray stations.
6. Inspection lanes in the ADOT yard.
7. Parking spaces at the ADOT yard.

Figure 1-2 - Mariposa POE Compound [15]

For access from Mexico, the Fiscal Corridor, opened in 1999, is owned and operated by a private concessionaire and is fenced-in to restrict access. The road was built to ease congestion and expedite the flow of cross-border traffic towards the Mariposa POE. Previous to that, trucks traveled on local roads through the City of Nogales, Sonora. A half mile after exiting Highway 15, northbound vehicles arrive at the 20-acre Mexican customs station where truckers file their export paperwork, separate from the facilities for declaring imported merchandise. The Fiscal Corridor and customs station is monitored by long-range cameras.[16] Immediately to the south of this facility is the CAADES Station, which provides export and inspection services for its members.[17] At the CAADES facility, agricultural grading inspections are completed by third-party inspectors contracted and certified through the Arizona Department of Agriculture.

[15] J. René Villalobos, Arnold Maltz, Omar Ahumada, Gerardo Treviño, Octavio Sánchez, and Hugo C. García, Logistics Capacity Study of the Guaymas-Tucson Corridor, Arizona State University Departments of Industrial Engineering and Department of Supply Chain (a report to ADOT), 2006., p. 38.
http://tpd.azdot.gov/planning/Files/guaymas/FinalReport_%20English.pdf

[16] http://www.nusd.k12.az.us/schools/nhs/gthomson.class/articles/truckers.gowest.html

[17] *La Confederación de Asociaciones Agrícolas del Estado de Sinaloa* (Confederation of Agricultural Associations of the State of Sinaloa - CAADES) was formed in 1932 to unite agricultural producers in the Sinaloa region. It consists of 10 agricultural associations representing some 25,000 farmers, whose food production is responsible for 30% of the State of Sinaloa's gross domestic product. http://www.caades.org.mx/publico/principal/index.asp and http://www.agriworldexchange.com/images/Press_Release_CAADES.pdf

After clearing customs, vehicles entering the Fiscal Corridor pay a toll.[18] This is a sealed road with barricades on either side to limit unauthorized incursions on the right-of-way, the highway has no intermediate off-ramps and terminates at the entrance to the Mariposa POE. For trucks leaving *maquiladora* plants located close to the border, the Fiscal Corridor is less direct than the previous route, as they must drive south to access the toll road.

During peak season, long delays are common on the Fiscal Corridor as traffic approaches the Mariposa POE. On February 14, 2007, truckers staged a spontaneous blockage of commercial traffic to express their discontent with the newly initiated eManifest system, along with frustrations with the overburdened infrastructure.[19] The blockade, at the northern end of the Fiscal Corridor, was dismantled after four days, at which time all lanes became northbound to clear the congestion. Shortly thereafter, new lanes were added by using the shoulders of the road.[20]

Another blockade took place during the 2008 high season, April 19-20 at the southern part of the Fiscal Corridor. Truckers protested delays caused by a new policy that required all trucks to be scanned by the single gamma ray machine available at the Mexican Customs facility. The main purpose of this scan was to intercept drugs or weapons. In response to the protest, Mexican Customs officials agreed to use random screening instead of requiring a 100% screening.[21]

Road network (number and direction of lanes)

Fiscal Corridor

As it approaches the border, the Fiscal Corridor divides into four northbound lanes for different types of traffic: approved FAST Lane commercial vehicles (one lane), non-approved commercial vehicles (two lanes), and POVs (one lane). The two right-hand lanes of the

[18] The various toll charges in pesos as of September 2008 are:

	Local	Not Local
Cars and Motorcycles	27.00 pesos	37.00 pesos
3 Axles	53.00	75.00
4 to 5 Axles	133.00	133.00
6 to 9 Axles	152.00	152.00
Over 9 Axles	171.00	171.00

This charge is the same for both northbound and southbound trips. A truck coming to Nogales, Arizona, will pay twice, once entering and once again leaving the Corridor.

[19] The eManifest allows truckers to electronically file their cargos with CBP prior to crossing the border.

[20] Written Testimony of Maria Luisa O'Connell, President of the the Border Trade Alliance, before the House Homeland Security Subcommittee on Border, Maritime and Global Counterterrorism, July 26, 2007.

[21] *El Imparcial*, April 22-24, 2007, Nogales section, published in Hermosillo, Mexico.

northbound Fiscal Corridor are for the commercial vehicles not enrolled in FAST, the next lane is for commercial vehicles using FAST, and the left-hand lane is for POVs.

Northbound Privately-owned Vehicles

Northbound POVs from the City of Nogales area access the Fiscal Corridor from a local connector road, called the *Donaldo Colosio Periférico*, which leads to a two-lane on-ramp at the northern end of the Fiscal Corridor. They then merge with the POV lane on the Fiscal Corridor.[22] After crossing the border, POVs move forward to the east side of the main building, situated 700 feet from the border; the building has four POV primary inspection booths. A follow-on area is available for any needed POV secondary inspection and is adjacent to a small x-ray enclosure.

Commercial traffic

It is mandatory at all land border crossings, including the Mariposa POE, for a truck's cargo manifest to be reported electronically to Customs and Border Protection (CBP) before the truck's arrival at the port of entry. Cargo data are usually entered by brokers. The eManifest, which is integrated with the CBP computer system used to track cargo, known as the Automated Commercial Environment (ACE),[23] includes information on the cargo, truck cab and trailer, and the driver in addition to the product, importer, and exporter information.[24]

Northbound commercial traffic, moving into the Mariposa POE compound passes between radiation detectors. Trucks then proceed to the pre-primary Drug Screening Area, a shelter located outside the compound, where dogs sniff the queue for drugs. The shelter includes platforms and catwalks that permit inspectors to inspect an entire truck. ADOT installed weigh-in-motion scales at the immediate approach to the Drug Screening facility in order to pre-weigh all incoming commercial vehicles.

Commercial vehicles entering the U.S. first pass through the pre-screening area, located 500 feet from the border. From there, four lanes lead to primary inspection, which consists of four SuperBooths, each staffed with three people to deal with the requirements of several agencies in one location (Customs, Food and Drug Administration [FDA], etc.) in the one location plus an oversize lane. Finally, there are spaces available for secondary inspections, which range from a brief assessment to the unloading of all cargo for 100% inspection.

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[22] The *Periférico* passes under the Fiscal Corridor and so approaches from the left of the northbound Fiscal Corridor.
[23] http://www.cbp.gov/linkhandler/cgov/toolbox/about/modernization/ace_welcome/ace101.ctt/ace101.pdf and http://cbp.gov/xp/cgov/toolbox/about/modernization/whats_new/survey_cbp_officers.xml
[24] In addition to the potential in general for greater efficiency and effectiveness, this pre-notification rule is useful in alerting officials when a shipment of hazardous materials is en route.

The SuperBooths, where eManifests and any paperwork are reviewed, are located separate from, and to the east of, the POV primary inspection booths. After pre-screening and primary inspection, commercial vehicles may be either released or sent for a more thorough secondary screening and/or x-ray inspection. Secondary inspections for trucks are performed at a commercial inspection building surrounded by a pinwheel-shaped configuration of docks. (The number of docks, however, do not correspond to the inspection capacity, i.e., the number of trucks that can be accommodated at one time, as some docks are blocked by special-purpose portable buildings and, thus, unavailable for secondary inspections.) Secondary inspection may include hazardous materials and weapons inspection as well as other checks, such as for narcotics and agricultural pests. Vehicles requiring an x-ray inspection go to x-ray stations, located on the northern edge of the compound.

ADOT Station

On an adjacent site, state and federal vehicle inspections and driver checks for safety, highway user fee compliance, etc., are conducted. The Mariposa State Motor Carrier Safety Inspection Station is a two-story, two-bay building, operated jointly by federal and state authorities.[25] There are two approaching lanes from the POE compound as well as lanes that lead out of the station directly to SR 189 (Mariposa Rd.) without returning through the POE. On the north side of the station is a facility used as a place for out-of-service commercial vehicles as well as for other vehicles that have drivers who have been disqualified for safety or other motor carrier infractions.

1.2 Recent and proposed improvements

Over the past decade, the Mariposa POE underwent various improvements to accommodate increasing traffic volume.[26] The “SuperBooth” concept was implemented for primary inspection with officials of different agencies sharing the same processing space, and a bypass was constructed for commercial vehicles cleared in the primary inspection phase. Truck x-ray capacity was added in 1999, reducing the need to unload suspicious cargo. A mobile gamma x-ray unit was also installed that is of particular benefit for examining tanker vehicles. Another improvement was the Commercial Vehicle Port Intelligent Transportation System, known as EPIC (i.e., Expedited Processing at International Crossings).[27]

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[25] It houses inspection teams from the Arizona Department of Public Safety (Highway Patrol), ADOT’s Motor Vehicle Division (MVD) and the Federal Motor Carrier Safety Administration (FMCSA).

[26] http://www.ers.usda.gov/publications/agoutlook/sep2000/ao274h.pdf and http://kyl.senate.gov/record.cfm?id=270780

[27] For more about EPIC, see Section 2.1 of this report.

In 1999, on the Mexican side, leading to the Mariposa POE from the south, the four-lane, fenced, restricted-access, toll road, known as the Fiscal Corridor, was built. This road diverted cross-border traffic toward the Mariposa POE and away from the DeConcini POE, located in downtown Nogales, Arizona.

In 2000, land was acquired for building the ADOT commercial motor vehicle inspection station. In 2003, a fourth SuperBooth was added. In early 2004, the new motor carrier inspection station, on the U.S. side, gave state and federal inspectors one building to work from while inspecting trucks and their drivers. A lane was added routing commercial vehicles to the new station. The Mariposa State Motor Carrier Safety Inspection Station has itself undergone some upgrades since it was built.

In December 2004, the Nogales and Santa Cruz County Port Authority was established to represent the Nogales and Santa Cruz region. Present members include Santa Cruz County, City of Nogales, Nogales Chamber of Commerce, Fresh Produce Association of the Americas, Nogales U.S. Customs Brokers Association, Nogales Alliance, which consists of Port of the Future, Nogales Community Development Corporation, and Santa Cruz Tourism Council. The Port Authority organizes regular meetings to keep the public informed about various issues, including the Mariposa POE and its future development. It has sought, *inter alia*, to have studies commissioned to recommend road improvements to the Mariposa POE from the north. In 2008, the Arizona Department of Transportation (ADOT) selected the firm of Wilbur Smith Associates to study the possibility of a divided access connector road directly between the Mariposa POE and I-19. This connector would facilitate the exit from the Mariposa POE, by enabling many vehicles to avoid the commercial area they now traverse and to prevent delays that now occur at the interchange as vehicles enter I-19. This study is expected to be completed in 2009.

One operational improvement instituted in 2005 added limited Sunday hours during the peak agricultural period from mid-January to mid-April.

In the spring of 2006, the computer system used to track cargo was phased out in favor of a new system that consolidates several databases into one. The new system allows officials to obtain history about drivers, shipments and companies through one source. Nogales was one of the first POEs to implement the new system called Automated Commercial Environment (ACE).[28]

In mid 2006, two Free and Secure Trade (FAST) lanes were added for use by carriers who have been pre-qualified as trusted. FAST lanes allow expedited travel for pre-screened, low risk trucks bringing products into the U.S. The cost of implementing the FAST lanes at the

[28] http://www.cbp.gov/linkhandler/cgov/toolbox/about/modernization/ace_welcome/ace101.ctt/ace101.pdf

Mariposa POE was approximately $4.3 million on the U.S. side plus costs incurred by Mexico of about $1 million for connecting lanes on the Sonoran side. On the U.S. side, additional commercial vehicle lanes were constructed to the east of the already existing lanes and allowed flexibility to shift trucks among the four lanes according to demand. In 2007, two lanes were added to the Fiscal Corridor on the Mexican side by making use of the shoulders on both sides of the highway. The result was six narrow lanes, two southbound and four northbound.[29] In these new lanes, passing is difficult, but nevertheless frequent.

Figure 1-3 - Mariposa POE before construction of FAST lanes and new ADOT inspection station[30]

1. Border 2. Document distribution 3. USDOT inspection 4. Weigh-in-Motion 5. Drug and weapons screening 6. Primary/superbooths 7. Personal vehicle entries 7a. Primary entry 7b. Secondary entry 8. Flow into secondary inspection 9. Secondary inspections 9a U.S. Department of Agriculture 9b Intensive inspections 9c. Brokers 10. X-ray, VACIS 11. Primary exit 12. Secondary exit

The FAST lanes are based on the Customs-Trade Partnership Against Terrorism (C-TPAT), a public-private partnership for commercial carriers that includes background checks and other requirements. CBP's FAST program enables certified commercial vehicles to cross the border using faster-moving lanes and experiencing fewer inspections. In exchange for shorter wait times and less scrutiny at the border, the companies must meet minimum security

[29] Truckers had blocked the area where the Fiscal Corridor approaches the border to protest glitches related to new U.S. computerization, but also noted that they could not access benefits from the U.S. FAST lanes unless there were connecting "fast" lanes on the Mexican side.
[30] Cyberport Study. (2003). P. 143.

guidelines outlined by CBP.[31] FAST clearance can be used only if an approved driver carries eligible goods for an approved carrier, importer and shipper.

In January 2007, it became mandatory for a truck's cargo manifest to be reported electronically to CBP before the truck arrives at land border crossings. The Mariposa POE was one of the earliest border crossings where this operational improvement was implemented.[32]

After a feasibility study completed in May 2005, $13.69 million was appropriated in the Fiscal Year 2007 (FY 2007) federal budget for the design phase of a complete state-of-the-art reconfiguration and modernization of the Mariposa POE. This work is virtually complete. An environmental assessment has already been carried out and the draft circulated for public comment.[33] It was anticipated by officials and the affected communities that substantial additional funding (approximately $170 million) would be requested in the General Services Administration's Federal Building Fund appropriation for FY 2009 in order to go forward with construction. The expected target date for completing construction was to be 2011, with construction being done in phases so that the Mariposa POE could remain in operation. However, the President's budget request for FY 2009 omitted any funds for this construction, putting any further action on hold.[34] On the Mexican side, design work has begun on increases in capacity needed there to complement the increased capacity that is planned for the U.S. side.

1.3 Review of existing studies including CyberPort Study and Mariposa POE Feasibility Study

The Mariposa Port of Entry (POE) has been studied a number of times in recent years, both as a main subject and as part of regional or statewide analysis. Nearly all of these previous studies commented on congestion at the border and the variability[35] of traffic at the Mariposa

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[31] http://cbp.customs.gov/linkhandler/cgov/import/commercial_enforcement/ctpat/fast/us_mexico/mexico_fast.ctt/mexico_fast.doc
http://cbp.customs.gov/xp/cgov/import/commercial_enforcement/ctpat/fast/us_mexico/mexico_manuf/foreign_manuf.xml
http://cbp.customs.gov/xp/cgov/import/commercial_enforcement/ctpat/fast/us_mexico/mexico_manuf/manuf_seal_requirements.xml

[32] Code of Federal Regulations, Title 19, Part 123.92 (19 CFR 123.92). This regulation requires that advance electronic cargo information, in the form of an eManifest, be provided to CBP one hour (for FAST lanes, thirty minutes) prior to the arrival of the conveyance at the U.S. port of arrival.

[33] Federal Register, Vol. 72, No. 192, October 4, 2007, p. 56763

[34] Budget of the United States Government, Fiscal Year 2009—Appendix, General Services Administration. http://www.whitehouse.gov/omb/budget/fy2009/pdf/appendix/gsa.pdf The FY 2009 Budget is expected to be considered in Congress in January 2009. In order not to lose a year, some have recommended that, if necessary, instead of the usual practice of appropriating the full amount for a major project (in this instance over $170 million), a first installment of $20 million for the groundwork be made available in FY 2009. Further construction would then depend upon future year appropriations.

[35] By season, time of day and day of the week.

POE. Some highlight the significance of bi-directional flows through the Mariposa POE to the development of the CANAMEX Trade Corridor.[36]

Earlier reports on the Mariposa POE include the *Arizona Port Efficiency Study* (1997) and the *Arizona Trade Corridor Study* (1999). The *Arizona Port Efficiency Study* recommended bilingual signs, installation of elevated SuperBooths, cross-training of inspectors on requirements of other border agencies, and other steps to promote efficiency within the POE compound.[37] On a border-wide level, a U.S. General Accounting Office (GAO) study, the *U.S.-Mexico Border: Better planning needed to handle growing commercial traffic* (2000), mentioned Nogales and commented, with respect to POEs in general, on difficulties resulting from multiple checks by various federal and state agencies as well as the lack of land for POE expansion.

Intelligent Transportation Systems at International Borders (2001)[38], prepared by the U.S. Federal Highway Administration and U.S. Transit Administration, covered the larger POEs at the northern and southern U.S. borders. With respect to Nogales, the report noted the importance of fresh produce shipped in the winter months and the value in Nogales of *maquiladora* trade. The report commented on the cooperation between U.S. and Mexican officials, reviewed existing technologies and recommended further consideration of technologies for vehicle identification, status and operating condition. Another overall study, *Truck Transportation Through Border Ports of Entry: Analysis of Coordination Systems* (2002)[39], urged greater coordination at POEs among the numerous stakeholders, such as federal agencies, shippers, carriers, brokers, etc.

Other studies looked at Arizona and the Mexican State of Sonora as a region. Some recommended investment in the Port of Guaymas in Sonora to supply the Mexican market and to serve as an alternative to congested port facilities on the U.S. west coast.[40] This prospect, still under serious consideration, faces several obstacles, including shallow draft and a low level of outbound cargo as indicated in *Arizona's Global Gateway: Addressing the Priorities of Our*

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[36] http://www.canamex.org/publications.asp . CANAMEX was designated by the U.S. Congress in 1995 as a High Priority Corridor and is still being developed. The designation was under the National Highway Systems Designation Act. This U.S. north-south corridor starts from Nogales, Arizona, and goes through Las Vegas, Nevada, to Salt Lake City, Utah, to Idaho Falls, Idaho, to Montana, to the Canadian border. At the north and south ends of the CANAMEX Corridor, Canadian and Mexican roads lead, respectively, into Alberta and toward Mexico's western ports.

[37] Conducted by TransCore in cooperation with Science Applications International Corporation (SAIC) and the National Law Center for Inter-American Free Trade. 1997. http://www.borderplanning.fhwa.dot.gov/TTIstudy/TTIAppA.htm

[38] http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/11490.pdf

[39] Mark I.Ojah Juan Carlos Villa, William R. Stockton, P.E., David M. Luskin, and Rob Harrison, Texas Transportation Institute, The Texas A&M University System, 2002. http://www.borderplanning.fhwa.dot.gov/TTIstudy/FOA_english.htm#fig2

[40] The port of Guaymas could perhaps also be useful for shipments from points of origin on the west coast of South America as a route to the U.S. mid-west rather than through the Panama Canal to the U.S. east coast.

Border Communities (2003), sponsored by the Arizona Mexico Commission.[41] A more recent study, *Logistics Capacity Study of the Guaymas-Tucson Corridor* (2006)[42] pointed out the need for cranes on the dock or on the arriving ship, and concluded that minor improvements could allow container service to start at Guaymas.

The Nogales *CyberPort Project: Comprehensive Report* (2003) explored options for further improving the efficiency and increasing the throughput by means of changes in processes and increased use of technology.[43] The CyberPort Report recommended operational principles, structural features, roadway improvements and possible off-site activities as part of an overall re-design. The study noted that trade-flow volumes through the Mariposa POE are more highly subject to variation with respect to time of day, day of the week and season of the year than any other border POEs. Other sources indicate that Wednesdays and Thursdays during the peak crop season tend to be the busiest. Recommendations included a flexible staffing that allowed for allocation of human resources to accommodate changes in demand throughout the day, week, and season. Pre-payment and pre-issuance arrangements for fees and permits were also proposed.

Federal funding related to the CyberPort concept financed the construction of two Free and Secure Trade (FAST) lanes at the Mariposa POE and a feasibility study for the facility's total re-design. These are brick-and-mortar projects that would incorporate a number of technological improvements consistent with the CyberPort concept.

The CyberPort Report also recommended that the Mariposa POE be designated as a national pilot test site for implementation of new technologies and procedures. While not formally designated, the Mariposa POE has served as a test bed for new methods to measure vehicle emissions and scenarios to inform officials who find that a vehicle registered positive for radiation. In 2005, the U.S. Environmental Protection Agency funded a test of air pollution emissions from trucks along the U.S.-Mexico border near Nogales, Arizona, this effort was supported by the Mexican and Arizonan environmental agencies. Testing was performed using drive-by ultraviolet/infrared, onboard, and tailpipe devices. It was found that diesel emissions from the increasing number of trucks at the border crossing can present a significant public

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[41] Deeper water exists nearby, but would require substantial investment to develop.

[42] J.René Vilalobos, Amold Maltz, Omar Ahumada, Gerardo Treviño, Octavio Sánchez, and Hugo C. García, Arizona State University Department of Industrial Engineering and Department of Supply Chain (a report to ADOT). http://tpd.azdot.gov/planning/Files/guaymas/FinalReport_%20English.pdf

[43] "Expanding Trade throught Safe and Secure Borders" (hereinafter "CyberPort Study"). 2003. Commissioned by the Governor's CANAMEX Task Force sponsored by the Arizona Department of Transportation and conducted by the University of Arizona Office of Economic Development.
http://tpd.azdot.gov/reports/pdf/UAE3003cyberrtexecrep.pdf and
http://www.bip.arizona.edu/pubs_pdf/Cyber_Full.pdf

health risk to residents on both sides of the border. The report, issued in 2006, recommended looking into new and emerging technologies and fuels.[44]

In 2005, the U.S. General Services Administration (GSA) conducted a feasibility study of the Mariposa POE to examine the requirements, costs and benefits of a number of expansion options.[45] Based on traffic projections through 2020, the study put forward several alternatives, including the preferred one that proposed a transformed Mariposa POE with increased capacity and that the POE be designed so as to allow some further expansion if the forecasts for 2020 prove too conservative. The study proposal includes an increase of POV processing slots from four to six for primary inspection and from eight to 16 for secondary inspections. Commercial primary inspection booths would increase to six with an expansion capacity to eight, and pedestrians' primary processing would go from one to three physical positions. Funds were appropriated for the design phase but, as noted above (Section 1.2), funding for construction has not been made available so far.

The Economic Benefits of Expanding the Border-Crossing for Commercial Vehicles at the Mariposa Crossing in Nogales (2007) analyzed the cost of freight traffic delays to directly affected industries (logistics providers, shippers and their customers, etc.) as well as the indirect cost to the related local, regional and national economies and additional environmental costs associated with air pollution with respect to repairing damage and providing for prevention.[46] This study calculated direct, indirect and induced benefits of reducing delays and added that faster throughput of trade could, over time, also mean more investment in the region and a further increase in trade.

1.4 Stakeholder Meetings

A series of sessions was held with Mariposa POE stakeholders to elicit their perspectives on POE bottlenecks and congestion. These meetings served to elicit anecdotal information about the facility and its operations, to determine what the stakeholders considered as the boundaries for this study and to discuss related changes and challenges that have occurred over recent years. There were five stakeholders sessions: (1) an initial meeting in Tucson, with Arizona and Sonoran stakeholders to launch the project, (2) a second one to present the initial findings, (3) a

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[44] http://www.epa.gov/ocem/gneb/gneb9threport/English-GNEB-9th-Report.pdf. E.g., advanced engines in newer trucks can make use of Ultra Low Sulfur Diesel (ULSD) and produce significantly lower emissions.

[45] "Feasibility Study: Mariposa US Port of Entry, Nogales, Arizona." May 2005. Prepared for Arizona Department of Transportation and U.S. General Services Administration. Prepared by Kimley-Horn and Associates and BPLW Architects Engineers, Inc.

[46] RTI International. June 2007. Prepared for Gary Becker, U.S. Department of Homeland Security, Private Sector Office. *Op. cit.*

meeting in Nogales, Arizona, under the auspices of the Nogales and Santa Cruz Port Authority, 4) a meeting in Hermosillo, Sonora, with regional stakeholders, as well as a meeting with ITESM for a preview of the project's workscope and 5) a meeting in Nogales, Sonora, with the Fiscal Corridor Working Group. Participants have included brokers and individuals from a number of stakeholder entities, including the following:

Arizona Department of Transportation (ADOT), Special Border Projects Administrator
Arizona-Mexico Commission
Arizona State University
CANAMEX Corridor Coalition
City of Nogales, Sonora, Mexico
Fresh Produce Association of the Americas
Greater Nogales and Santa Cruz County Port Authority
Maquiladora Association of Sonora
Mexican Customs at Nogales (*Aduanas Nogales)*
Mexico's Department of Communications and Transport *(Secretaría de Comunicaciones y Transportes)*
Nogales Community Development Corp., Nogales, Arizona
Nogales U.S. Customs Brokers Association
SouthEastern Arizona Governments Organization (SEAGO)
State of Sonora: Department of Infrastructure and Urban Development *(Secretaría de Infraestructura y Desarrollo Urbana),* Roadway Board *(Junta de Caminos del Gobierno del Estado de Sonora);* State of Sonora's Tourism Promotion Commission *(Comisión de Fomento al Turismo)* and foreign commerce coordinator
The Sonora Arizona Commission *(Comisión Sonora-Arizona)*
Santa Cruz County
Transportes Pitic, S.A. de C.V.
U.S. federal agencies: Department of Homeland Security (DHS) and Customs and Border Protection (CBP), Federal Highway Administration (FHWA), General Services Administration (GSA)

1.5 Study Objectives

The study had three major objectives. The first objective was to collect traffic data that could be analyzed the data to identify the location and nature of bottlenecks that impede the efficient cross-border movements of people and goods into the Mariposa POE. The focus areas for data collection include the roads immediately to the north and south of the Mariposa POE, respectively SR 189 (Mariposa Rd.) and its major intersections, and the Fiscal Corridor. The second objective was also to offer recommendations to alleviate congestion and provide estimated costs. The final objective was to analyze the benefits of each recommendation based on traffic analyses.

2 SYSTEM DEFINITION AND STUDY BOUNDARIES

2.1 Descriptions of Mariposa POE System

The study area for the Mariposa POE in the Nogales, Arizona, traffic network is defined by the following boundaries:

- North: I-19 and Frank Reed Rd. intersection
- East: Grand Ave.
- West: Mariposa Rd.
- South: U.S.A. and Mexico border

The major roadways in the area are I-19 (known also as the Tucson-Nogales Highway), Grand Ave., Country Club Drive, N. Old Tucson Rd., Valle Verde, Frank Reed Rd., Baffert Drive, Mariposa Rd., White Park, Bankard, Doe, SR 82, Western Ave., Morley Ave., Walnut St., Crawford St., and Park St., with several points with significant intersections along Mariposa Rd. The study area contains approximately twenty traffic signal controls, mostly concentrated along Mariposa Rd. and Grand Ave. The area also houses numerous warehouses and container facilities, as well as federal and state import and export inspection facilities. Refer to Figure 2-1 for a graphical representation of the Nogales, Arizona, study area.

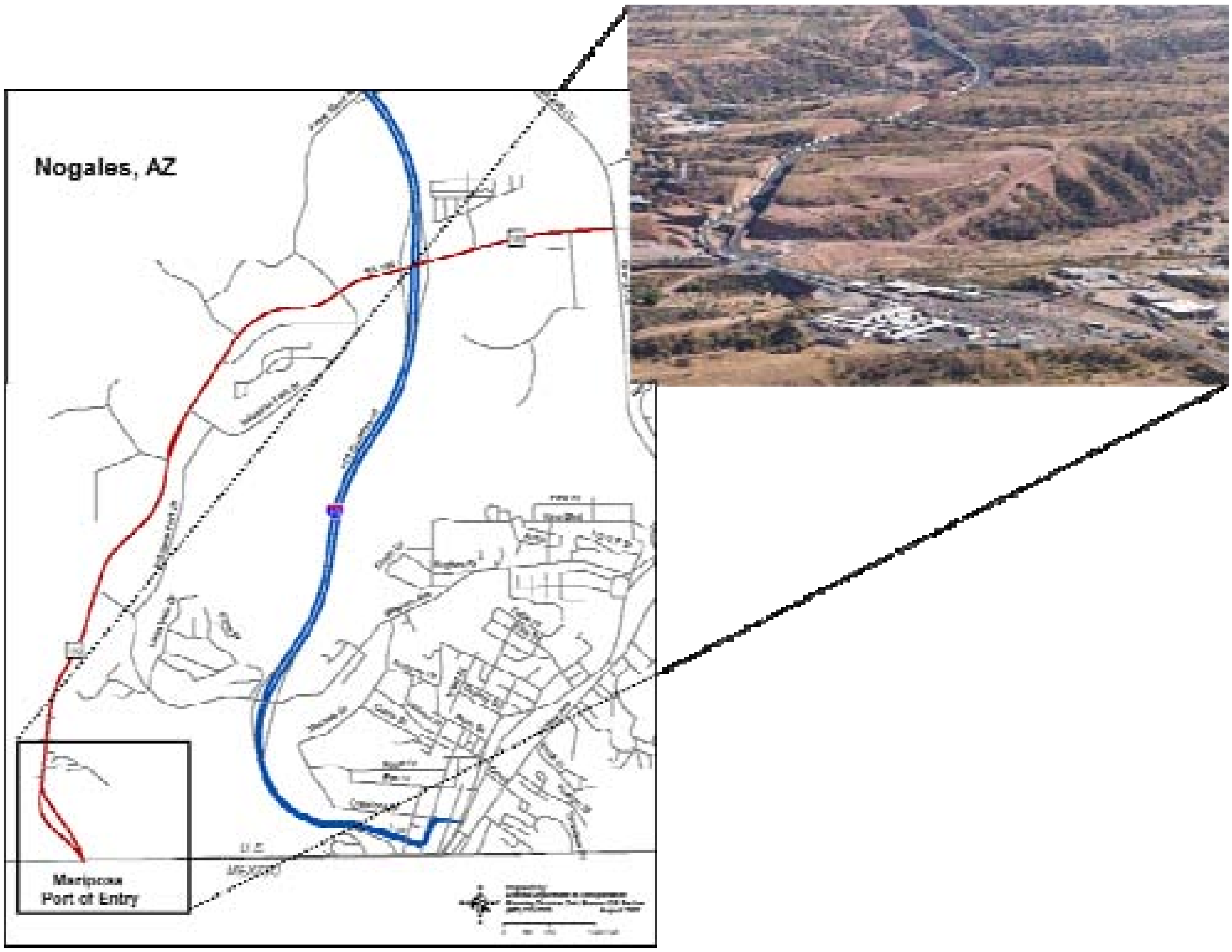


Figure 2-1 - Nogales, Arizona (U.S.), Traffic Network and Mariposa POE (Courtesy of ADOT)

The Nogales, Sonora, Mexico, study area is defined by the following boundaries:

- North: U.S. and Mexico border (POE)
- East: Plutarco Elias Calles Ave. and Prof. Alvaro Obregon Ave.
- West: Fiscal Corridor
- South: Fiscal Corridor and Prof. Alvaro Obregon Ave. intersection

It is important to note that the Southern end of the Fiscal Corridor accommodates a toll and scale station that processes traffic proceeding Northbound on this Corridor. Refer to Figure 2-2 for a graphical representation of the study area.

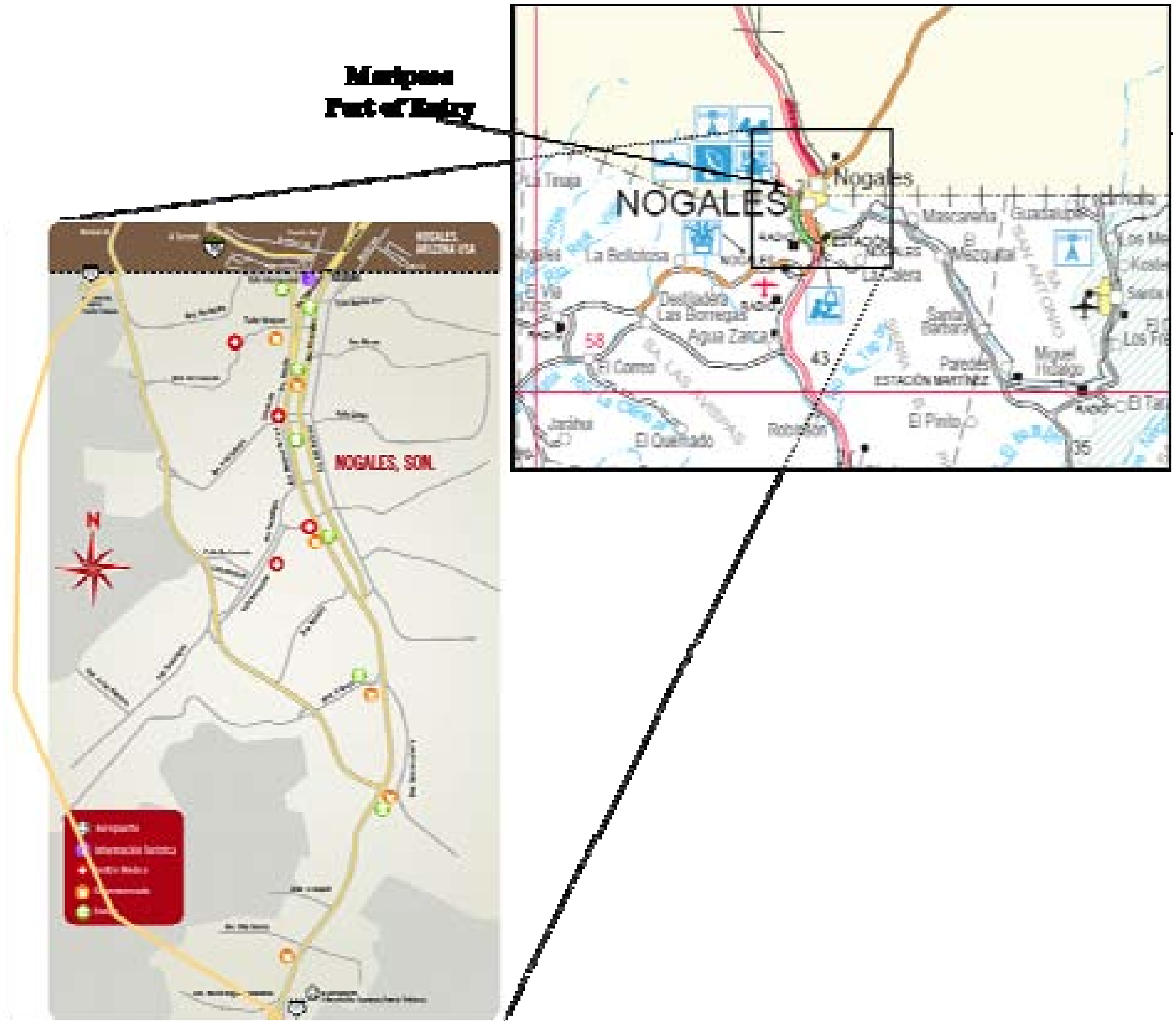


Figure 2-2 - Nogales, Sonora (Mexico), Traffic Network and Mariposa POE

2.2 Study Scope

The scope of the Mariposa POE Bottleneck study encompasses the following nine tasks.

- TASK 1 - CONTEXT AND BACKGROUND

The result of this task is a narrative report which is included in Sections 1.1, 1.2 and 1.3 of this report.

- TASK 2 - STAKEHOLDER MEETINGS

Several stakeholders meetings were conducted to gain perspectives on Mariposa POE bottlenecks and congestion. Information on the stakeholder meetings is provided in Section 1.4 and is reflected in the acknowledgements.

- TASK 3 - SYSTEMS DEFINITION AND STUDY BOUNDARIES

The description of the study area is provided in the last subsection. The research team defined the north and south end points. In addition, the team described the major features of the traffic network within the study area, including the number and direction of lanes and the ingress/egress facilities to major highways as well as traffic signals and traffic management characteristics.

- TASK 4 - POE DATA COLLECTION

The data appendices contain the products resulting from completing this task. In the appendices are data on the travel demand, travel speed on main roads, the traffic volumes, delays at main intersections and travel times collected manually around POE in the U.S. and Mexico within the study area. Summaries of the data are given in Sections 4.1 and 4.2 of this report.

- TASK 5 - SYSTEM CAPACITY ANALYSIS

From the data collected, the research team determined border crossing times as well as travel times, queues, and delays in order to ascertain the traffic capacities in the road network and in the truck processing (document screening and inspection of trucks) capacities at the POE. Results of this task are given in Section 5.1 of this report.

- TASK 6 - IDENTIFICATION OF BOTTLENECKS

For the performance of this task, tables and maps were created showing road infrastructure bottlenecks and traffic operation bottlenecks. The infrastructure examined included factors such as the number of lanes, line dividers, traffic points of conflict, and geometric design deficiencies. The traffic operations category included factors such as signaling devices to direct traffic to designated lanes, traffic signals at intersections, and changeable message signs providing crossers with updates. Results are included in Sections 6.1 and 6.2 of this report.

- TASK 7 – RECOMMEND IMPROVEMENTS

The results associated with this task are reported in Section 6 on improvements recommended on road infrastructure and traffic operations. The report includes cost estimates for implementing the suggested improvements.

- TASK 8 - PRELIMINARY REPORT

The product associated with this task was the draft of this report that consolidated and summarized the results from all previous tasks into one comprehensive document that was submitted to ADOT for review.

- TASK 9 - FINAL REPORT

The product for this task is this final report which is being submitted to ADOT, in PDF format, and incorporates the comments provided through the ADOT review.

3 STUDY METHODOLOGY

3.1 Study Framework

The overall study framework, as shown in Figure 3-1, started with the collection of background information, through both literature review and stakeholder meetings. As described in the preceding sections, the stakeholder meetings generated useful information that allowed the study team to identify the appropriate data collection season, dates, times, and locations. It was decided that information on both volume and speed would need to be collected to provide a comprehensive description of the congestion patterns and locations.

Using the collected field data, the study team analyzed the temporal and spatial traffic patterns to identify any existing problems of congestion and bottlenecks. Through analysis of possible mitigation strategies, the team would then recommend approaches to improve these bottlenecks.

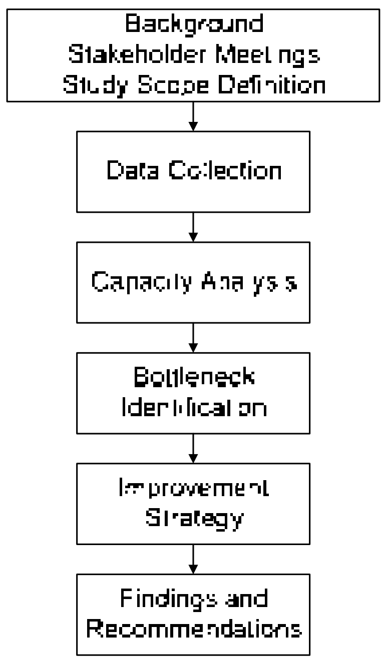


Figure 3-1 - Research Framework

3.2 Data Collection

The data collection team consisted of groups of students from the University of Arizona and the *Instituto Tecnológico de Estudios Superiores de Monterrey* (ITESM) at Hermosillo. The data collection dates were determined in consultation with the Technical Advisory Committee (TAC) members and stakeholders. Data collection locations were determined along the major corridors, such as the intersections along Mariposa Rd., I-19, and Grand Ave. Data collection in Mexico took place on the same dates, using locations at key points along Highway 15 and the Fiscal Corridor.

In the Nogales, Arizona, area, both manual intersection counters and tube counters were used at the selected locations. Intersection counters capture the vehicle turning volumes by vehicle classes. Tube counters capture not only the traffic counts, but also the operating speeds. In Nogales, Sonora, students were positioned at selected locations and manual vehicle counts were collected by vehicle classes.

In addition, six camcorders were deployed; four at three locations in Nogales, Arizona, and two in Nogales, Sonora. These camcorders were used to capture images of the commercial vehicle license plates. The collected license plate data from each camcorder location was then compared to the license plate data from other locations to find matches. The matches allowed estimation of travel times on selected routes.

The study team coordinated with other ATLAS researchers working on another project where data was being collected from an airborne platform. A helicopter carrying cameras pointed vertically downward hovered over selected intersections in the study area on the same dates, collecting videos and images of traffic during the same times that our team was collecting ground-based data.

Further details relating to the data collection using the above-mentioned technologies will be discussed in Chapter 4.

3.3 Bottleneck Identification

A bottleneck is defined as a location where significant delay is observed. This can be caused by various roadway/traffic flow conditions – flow conflicts, roadway configurations, or traffic controls. In this task, collected traffic data, in conjunction with observations on the roadway configurations and traffic controls, were used to identify and quantify bottlenecks. The license plate data were used to estimate the travel time over several segments along the study corridor, including the Mariposa POE. Further information is given in Chapter 5.

3.4 Congestion Mitigation Strategies

Congestion mitigation strategies were postulated based on findings from the capacity analysis and bottleneck identification tasks. These strategies can be categorized into (1) roadway configuration improvements, (2) traffic control improvement, and (3) demand-supply integration. Roadway configuration improvement strategies include changes of roadway geometry in order to improve the traffic flow at various locations. Traffic control improvement strategies focus on adjusting the traffic signals to improve capacity and reduce delays due to traffic controls. Demand-supply integration strategies investigate integrated treatments that create opportunities for further improvement that goes beyond roadway configuration and signal control strategies.

This study also attempts to provide a general picture of how a re-designed Mariposa POE may increase the inspection discharge flow rate and how this may create traffic congestion in the study area. Such hypothetical scenarios consider several possible flow rate scenarios as per the *Mariposa POE Program Development Study Final Report*, prepared for the General Service Administration (2007). The estimated traffic through the Mariposa POE from the years 2003 to 2025, as shown in Table 3-1, increases from 238,340 to 338,468 commercial vehicles per year, representing a 43% increase.

Table 3-1 Existing and Predicted Traffic Through Mariposa POE (Louis Berger Group and Performa, 2007)

INSL_CAL (MARIPOSA)	FY2003_Total	FY2025_Total	% change		2025 SRA data
POV	1,417,456	1,633,421	15.2%		1,399,133
Buses	4,207	10,079	139.6%		6,991
Commercial Vehicles	238,340	338,468	42.0%		309,864
Pedestrians	80,258	233,466	190.9%		398,513

4 MARIPOSA POE DATA COLLECTION PROCESS

4.1 Planning for Data Collection

4.1.1 Nogales, Arizona, U.S.

Several preparatory steps were conducted prior to the actual data collection. ADOT lent thirty safety vests to the research team to use during data collection. Four pneumatic tube counters and eight hand-held intersection counters were rented for the Nogales, Arizona data collection. Ten traffic counters were purchased for the Nogales, Sonora data collection. In addition, six camcorders were purchased/borrowed in order to capture (via video) license plate information on passing traffic.

Intersections and roads of interest for the data collection were identified in Arizona and Sonora. For each location, a decision was then made on the types of data collection method to be utilized, such as intersection or traffic tally counters, pneumatic tube counters or camcorder recordings. Figure 4-1 shows data collection locations for intersection counters, pneumatic tube counters, and camcorders on the traffic network for Nogales, Arizona.

For data processing purposes, each intersection counter, pneumatic tube counter and camcorder was given an individual label based on location (L) and the two day data period (D), such as AIntLD, ATbLD and AcamLD. For example, data collection on day 1 for intersection 5 in Nogales, Arizona, was labeled as AInt51. In this example, "A" indicates the Arizona side of the border, "Int" is the intersection counter type of data collector, "5" is the location and "1" is day one of data collection. Similarly, pneumatic tube counter 1 was labeled ATb51 and camcorder 1 as ACam11 for day 1 data collection. Refer to Figure 4-1 for labels of the other counter and camcorder locations in Nogales, Arizona.

Data collection 'crew' schedules for the fifteen-member Arizona team were drafted and finalized for each of the locations prior to data collection. Data was collected on February 27th and 28th for approximately ten continuous hours on each day.

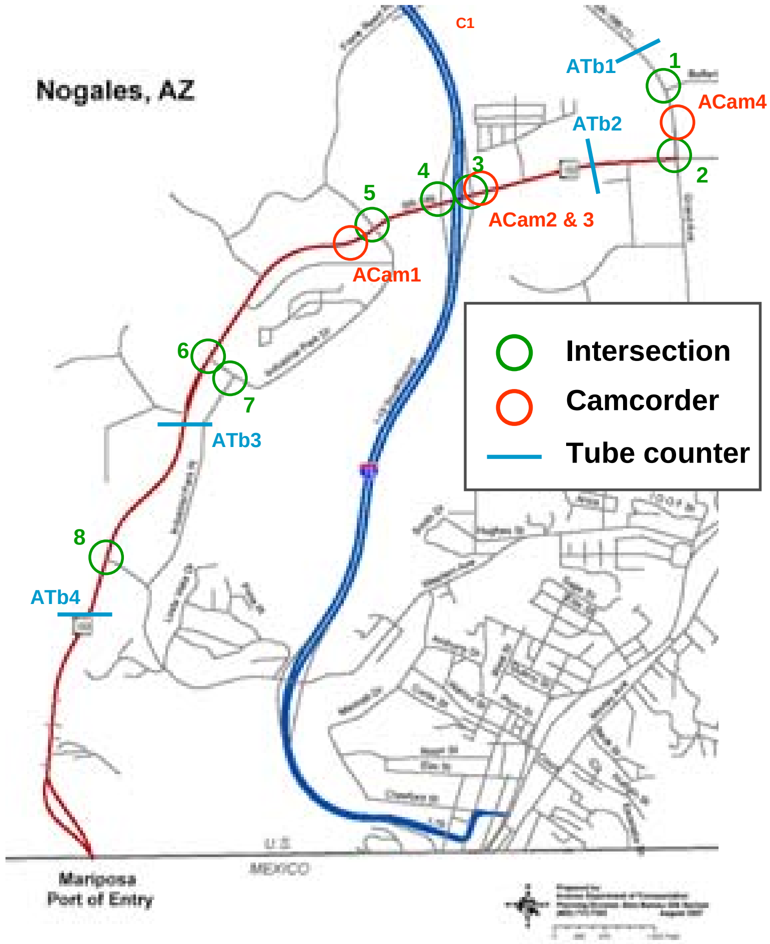


Figure 4-1 - Nogales, Arizona, Data Collection Locations

4.1.2 Nogales, Sonora, Mexico

The planning process in Mexico started in the month of September 2007 when the University of Arizona team visited ITESM Sonora Norte for a meeting with ITESM students.

The sixteen ITESM students who participated were selected based upon their academic performance and interests. The faculty supervisor of the team was Industrial Engineering Professor Gertie Agraz, who selected the team and coordinated its activities before, during and after data collection.

In January 2008, the research team met with Gertie Agraz in Nogales and identified data collection points in Nogales, Sonora. Subsequently, Dr. Elyse Golob of the University of Arizona (UA) team and Gertie Agraz met with customs authorities in Sonora to let them know that data collection would take place on February 27th and 28th.

The data collection points in Mexico were determined with the purpose of obtaining necessary information on the flow of trucks from Mexico going north, regardless of their destination in U.S. or Canada. The data collection points in Nogales, Sonora, are shown in Figure 4-2:

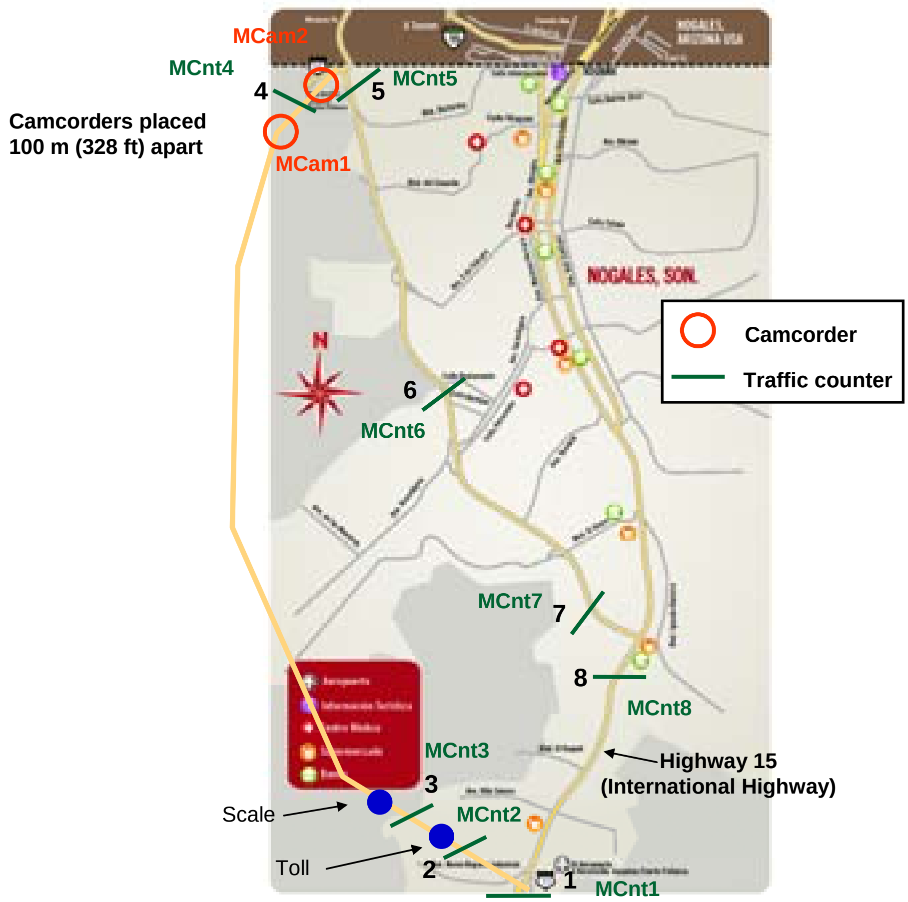


Figure 4-2 - Nogales, Sonora, Data Collection Locations

On February 26, Professor Chiu of the UA team conducted a training session for the ITESM team at the Hotel Fiesta Inn in Nogales, Sonora. All the details on the data collection process were explained to the ITESM team. Pairs of students were assigned to each data collection point identified.

As seen in the previous figure, one data collection point (no. 1) is located at Highway 15 before the fork in the road, where one road leads to Nogales, Sonora, and the other to the Mariposa POE. Three data collection points (nos. 2, 3 and 4) were located on the Fiscal Corridor.

Two camcorders were located at point 4, just before the border, separated by 100 meters, to record the license plates numbers of the trucks that were going north and about to cross the border at the Mariposa POE.

Points 5 through 8 were located inside the City of Nogales, Sonora, to collect data on trucks and cars going through the city.

4.2 Traffic Data Collection

4.2.1 Nogales, Arizona, U.S.

Data collection in Nogales, Arizona, utilized eight hand held intersection counters, four pneumatic tube counters, and four camcorders. It is important to note that camcorder directions may change according to the specific day; further information is provided later in this section. Figure 4-1 - Nogales, Arizona, Data Collection Locations depicts data collection locations for intersection counters, pneumatic tube counters, and camcorders in the traffic network in Nogales, Arizona. In the figure, a green circle identifies an intersection counter location, a red circle identifies a camcorder location, and a blue line identifies a pneumatic tube.

During data collection, the team observed the following situations:

1. Most observed 18-wheelers were hauling a container; rarely were 18-wheelers seen without a container.
2. There were greater volumes of 18-wheeler traffic on Wednesday, February 27th in comparison to volumes on Thursday, February 28th.
3. Many 18-wheelers were observed entering/exiting area warehouse areas.

As indicated above, for data processing purposes, each intersection counter, pneumatic tube counter and camcorder was given an individual label based on location (L) and the two day data period (D). In addition to identifying locations for intersection counters, the research team assigned a location and direction within the intersection where each student participant was to face in order to collect data. For further clarification, Figure 4-3 through Figure 4-10 show aerial and schematic views of the eight intersections where data was collected. The views illustrate the specific location for each counter together with the direction in which traffic data was collected.

It is important to note that pneumatic tube counts and camcorder recordings were used only for northbound traffic.

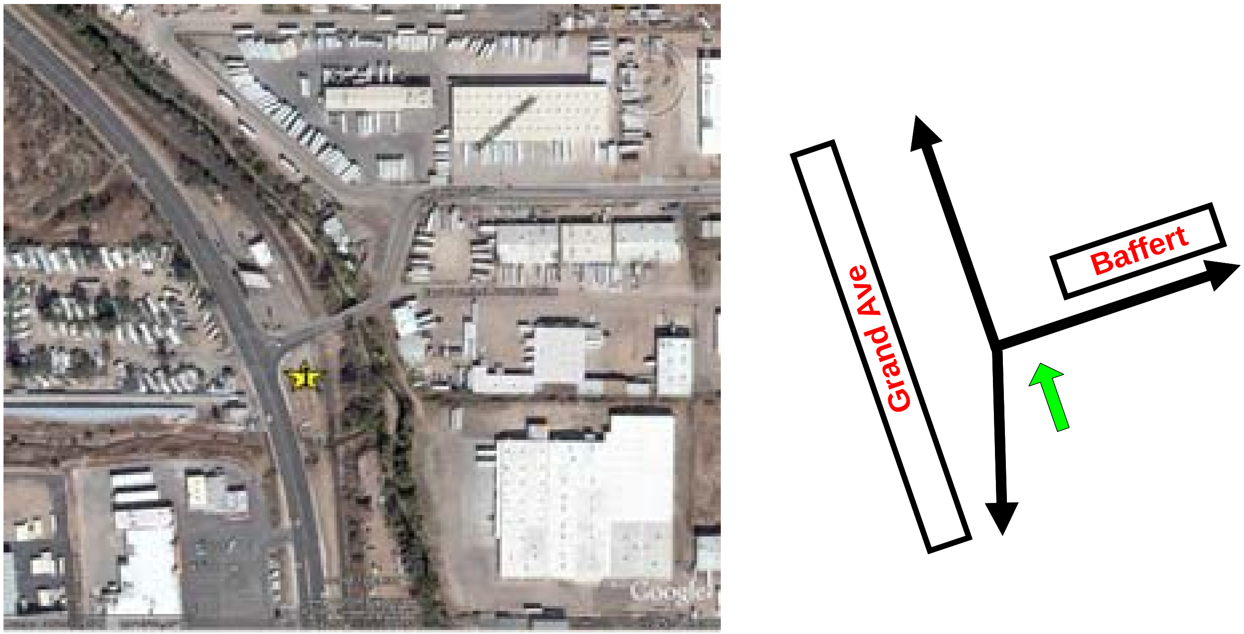


Figure 4-3 - Aerial View: Location and Direction for Intersection 1 Data Collection

Figure 4-4 - Aerial View: Location and Direction for Intersection 2 Data Collection

Figure 4-5 - Aerial View: Location and Direction for Intersection 3 Data Collection

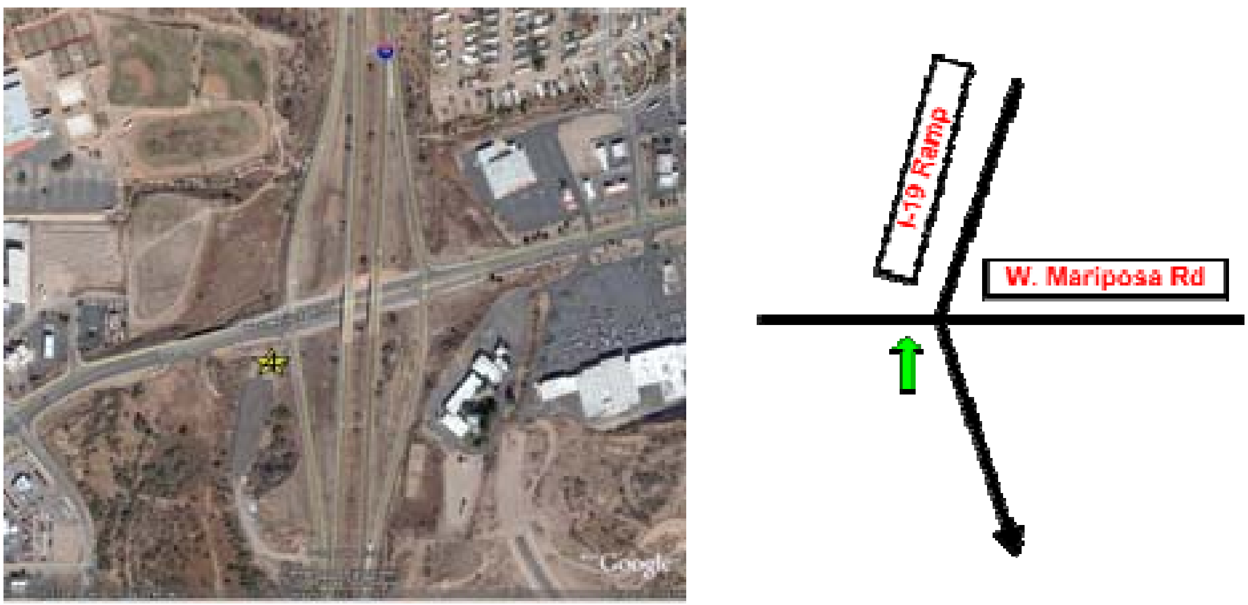


Figure 4-6 - Aerial View: Location and Direction for Intersection 4 Data Collection

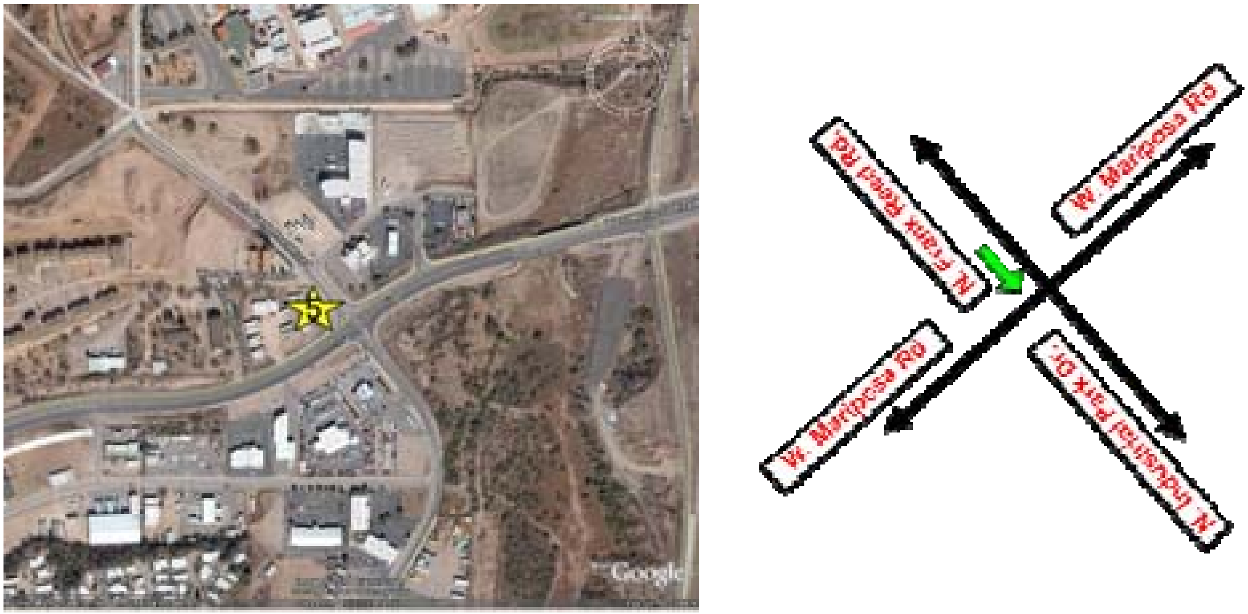


Figure 4-7 - Aerial View: Location and Direction for Intersection 5 Data Collection

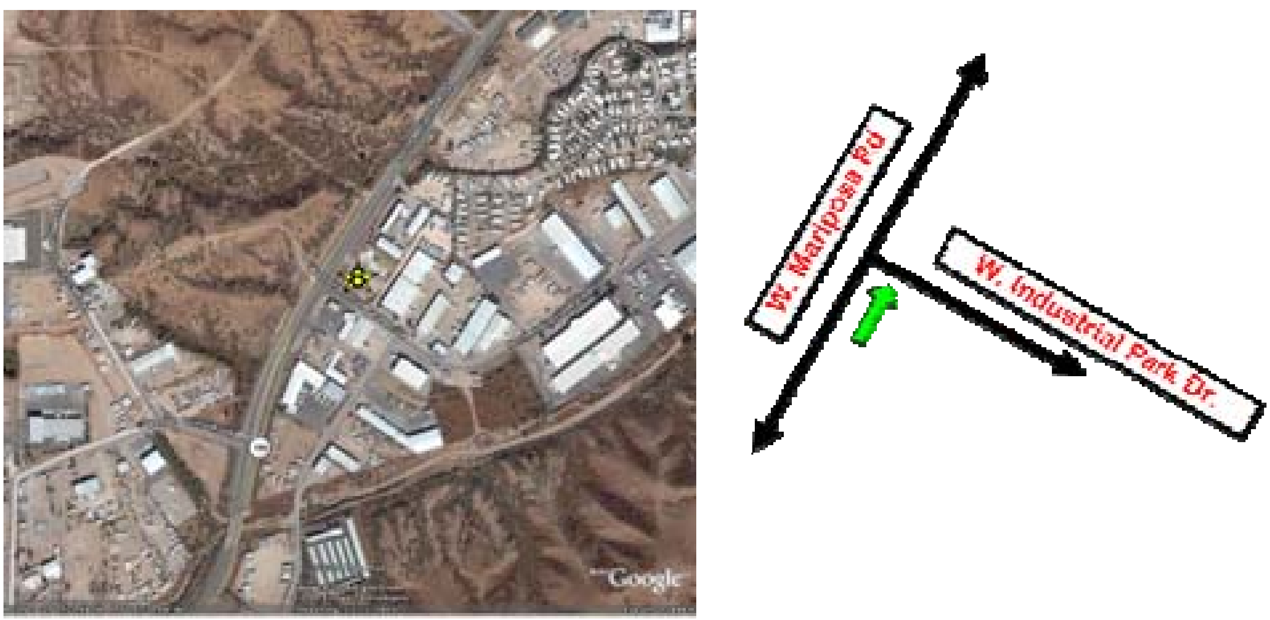


Figure 4-8 - Aerial View: Location and Direction for Intersection 6 Data Collection

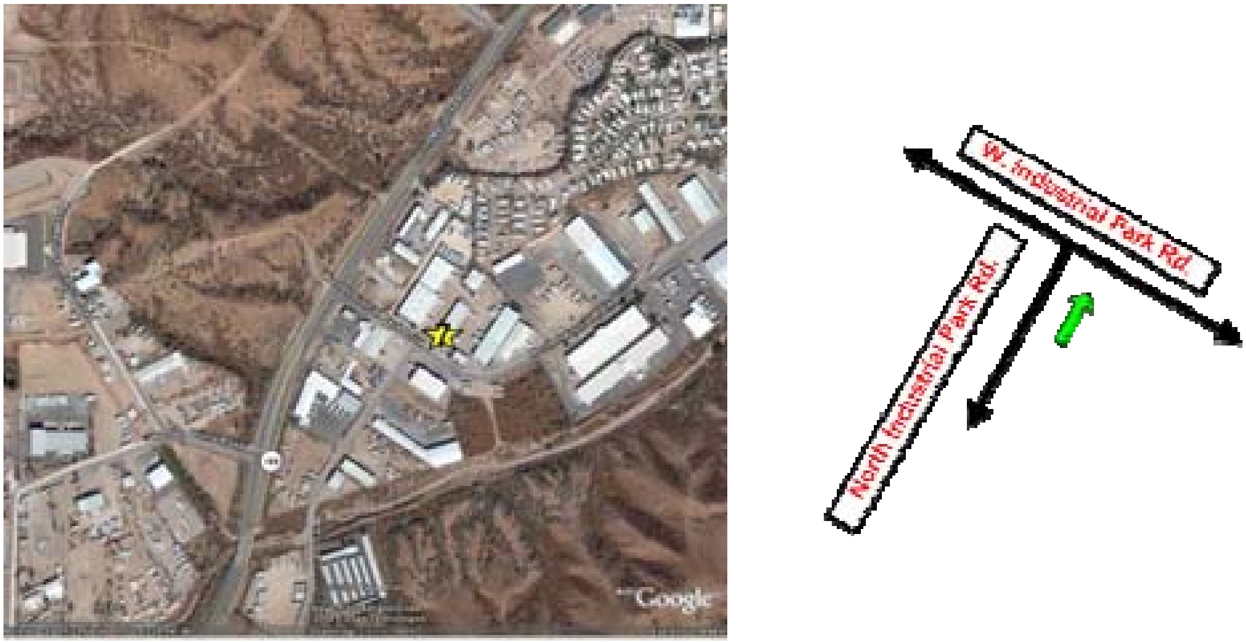


Figure 4-9 - Aerial View: Location and Direction for Intersection 7 Data Collection

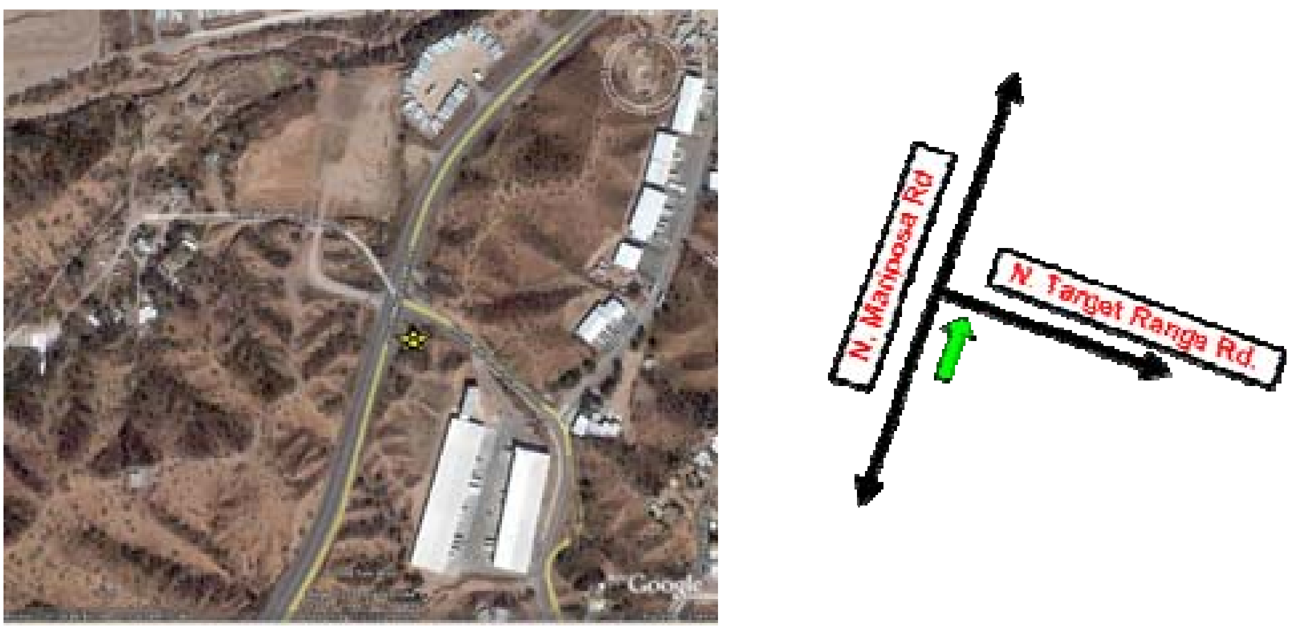


Figure 4-10 - Aerial View: Location and Direction for Intersection 8 Data Collection

4.2.2 Nogales, Sonora, Mexico

The team had some initial difficulties in location of the data collection points, which had been defined ealier on a map. At the actual site, the points along the Fiscal Corridor were hard to establish due to safety concerns regarding students placement. The issues were resolved with supervision from the team leader, Professor Agraz.

The team alerted authorities in the Fiscal Corridor about the data collection process and received excellent cooperation, particularly from Officer Víctor Verduzco.

Two camcorders were set at data collection location 4, close to the border, so license plate information from 18-wheelers could be recorded in order to evaluate the travel time and speed between two points of the route.

During data collection, the team observed the following situations:

1. Some vehicles other than trucks enter the truck lane by mistake and have to be redirected at the end of the lane, before crossing. This error causes delays due to stops and U-turns to enable these vehicles to exit the truck lane. No route is provided to enable these vehicles to enter the car lane. Thus cars must return using the same truck lane to go in the opposite (wrong) direction. This situation was observed in particular for data collection location 5 on the Mexico side.
2. At data collection location 4, some drivers referred to as "*cruzadores*" are present. *Cruzadores* are qualified to drive trucks across the border. They wait for trucks to arrive at a point before the border-crossing in order to proceed to take the truck into the U.S. Often, *cruzadores* wait for trucks but, other times, a truck waits for the *cruzador*. The latter situation can cause a bottleneck just upstream of the POE.
3. Many trucks arrive early at the entry to the Fiscal Corridor (before 8:00 AM); however, the Gamma Inspection gate is not opened until 9:00 AM. Before that time trucks wait in line to cross the gate. At this inspection point, trucks are randomly selected.
4. Often during the day, trucks going into Gamma Inspection block all lanes causing a queue before the Fiscal Corridor's toll. The process does not last long, but traffic entering the Fiscal Corridor is blocked at that time. This condition was observed between 11:00 AM and noon and at 6:00 PM when southbound traffic crosses the Fiscal Corridor's toll gate.
5. Many trucks stop/park near the CAADES facility located before the Fiscal Corridor's toll gate. Also, many leave the CAADES facility around 6:00 PM in order to arrive at

the border before inspection closes. At that time, increases in truck flows are observed.

6. Some companies have their own pre-check of documentation in a provisional facility located within the Fiscal Corridor, but before the toll gate. One such company-operated site is located at data collection location 2. Trucks from that company stop for pre-check and then proceed to the toll gate and then enter the Fiscal Corridor.
7. At data collection points located in the city, mostly small cars and small trucks were observed. The 18-wheelers, those that were observed at points in the city, did not usually have a container.
8. Most vehicles going to the border through data collection location 5 were cars and 18-wheelers. There were times when some of these vehicles decided not to cross the border and. Thus, proceeded to go back to the city. These vehicles caused delays as they maneuvered to turn back into lanes going in the opposite (wrong) direction.

4.3 Summary

A vast amount of traffic data was collected during the two-day collection. As described in the next Section, the data were used to analyze the bottlenecks of the study area. Detailed data tables and statistics are presented in the Appendices contained in Section 6 through Section 9 below.

5 BOTTLENECK IDENTIFICATION

5.1 Bottlenecks in Nogales, Arizona

5.1.1 Analysis of tube counter data

The performance of roadways in the study area was assessed using the data collected by various counters, including pneumatic road tubes and intersection counters. The main performance measure considered in this study is the Level of Service (LOS). According to the Highway Capacity Manual (HCM), differences in LOS are defined based on differences in density ranges as shown in Table 5-1 Density Ranges for Level of Service.

Table 5-1 Density Ranges for Level of Service

Level of Service	Density Range (pc/mi/ln)
A	0-11
B	>11-18
C	>18-26
D	>26-35
E	>35-45
F	>45*

***** Source: HCM, 2000, p. 23-3.

TRAXPRO software[47] was used to download time-mean speeds and vehicle counts data from the counters, based upon which the space mean speed and passenger car equivalents (PCE) were derived using the equation below.

$$v_t = v_s + \frac{\sigma^2}{v_s}$$

where, v_t = time mean speed

v_s = space mean speed

σ^2 = standard deviation of spot speed

All the vehicle counts were converted to PCE by applying the PCE factor of 1.5 to trucks. To this extent, the density can be calculated using the obtained flow rate and space-mean speed using the equation below.

[47] The JAMAR automatic traffic recorders saved raw data from tube counters, and we downloaded all raw data by TRAXPro software program. We also generated basic traffic flow data (Basic Data, Per Vehicle Data) by TRAXPro software. Those are JAMAR Technologies Company's products.

$$D = \frac{Q}{S}$$

where, Q = Flow rate (vehicle / hour / lane)

S = Space mean speed (mile / hour)

D = Density (vehicle / mile / lane)

All LOS results are displayed in the tables as can be seen in Table 5-2 - **Level of Service at ATb1 (day1)** through

Table **5-9 – Level of Service at ATb4 (day2)**, corresponding to the locations shown in Figure 5-1.

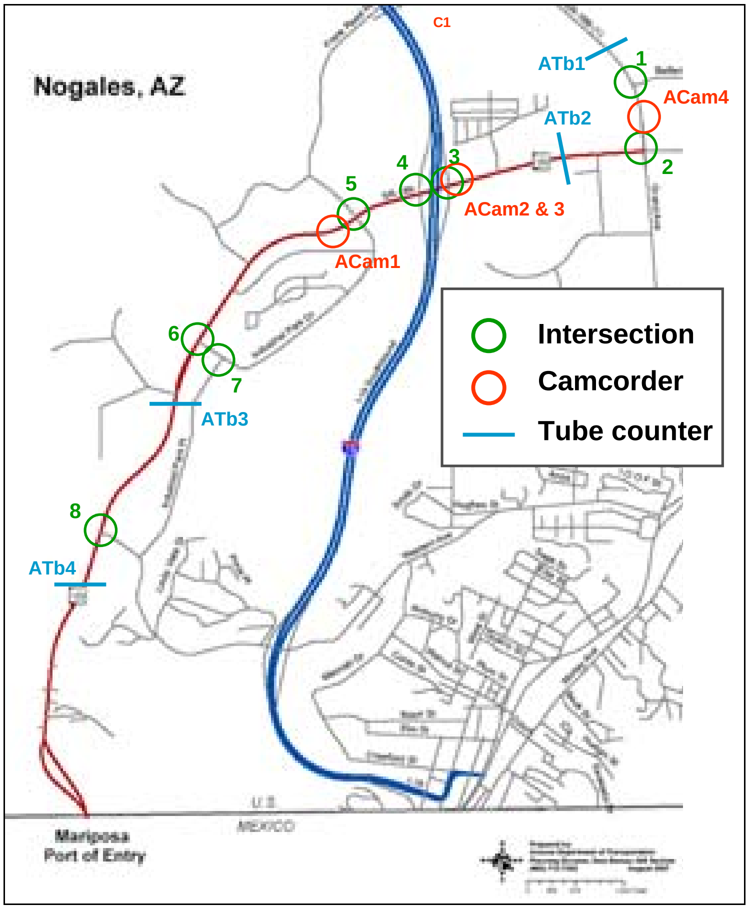


Figure 5-1 - Nogales, Arizona, Data Collection Locations

Most of the locations exhibited reasonable LOS at either LOS = A or LOS = B during the data collection period. However, it needs to be noted that most tube counters were laid at the mid-block of the arterial segments, while delays tend to occur mostly at the downstream intersections. Further analysis was conducted to analyze delays at the intersections where the intersection counts were collected; this analysis is presented in the next subsection.

Table 5-2 - Level of Service at ATb1 (day1)

Hour	PCE (pc/hr/ln)	Time mean speed (mi/h)	Space mean speed(mi/h)	Density (pc/mi/ln)	Level of Service
11	315.75	39.85	38.58	8.18	A
12	362	38.79	37.57	9.64	A
13	329.25	39.70	38.43	8.57	A
14	379	39.38	38.16	9.93	A
15	410	38.71	37.55	10.92	A
16	474	38.48	37.55	12.62	B
17	425.5	38.05	37.06	11.48	B
18	411.5	39.18	38.11	10.80	A
19	493.25	38.16	37.26	13.24	B
20	398.5	38.58	37.61	10.60	A
21	343.75	38.33	37.28	9.22	A

Table 5-3 – Level of Service at ATb1 (day2)

Hour	PCE (pc/hr/ln)	Time mean speed(mi/h)	Space mean speed(mi/h)	Density (pc/mi/ln)	Level of Service
11	328	38.49	37.24	8.80	A
12	369	36.94	35.56	10.36	A
13	338	37.52	36.36	9.30	A
14	406	35.88	34.57	11.75	B
15	437	35.97	34.41	12.69	B
16	463	34.78	33.01	14.01	B

Table 5-4 – Level of Service at ATb2 (day1)

Hour	PCE (pc/hr/ln)	Time mean speed(mi/h)	Space mean speed(mi/h)	Density (pc/mi/ln)	Level of Service
11	395	34.90	33.34	11.84	B
12	469	33.24	31.69	14.78	B
13	428	32.90	31.51	13.58	B
14	510	32.10	30.83	16.55	B
15	470	31.37	29.61	15.87	B
16	499	32.06	30.63	16.29	B
17	477	31.33	29.54	16.16	B
18	464	33.72	32.56	14.25	B
19	501	33.92	32.88	15.24	B
20	418	33.86	32.85	12.72	B
21	358	33.98	32.77	10.92	A

Table 5-5 – Level of Service at ATb2 (day2)

Hour	PCE (pc/hr/ln)	Time mean speed(mi/h)	Space mean speed(mi/h)	Density (pc/mi/ln)	Level of Service
11	366	34.35	32.82	11.15	B
12	388	34.77	33.47	11.58	B
13	395	33.33	31.81	12.43	B
14	498	32.00	30.39	16.37	B
15	484	32.28	31.00	15.62	B
16	510	31.74	30.20	16.90	B
17	510	32.20	30.52	16.72	B
18	484	33.89	32.53	14.87	B
19	530	34.74	33.55	15.78	B
20	455	33.37	32.05	14.20	B
21	363	33.15	31.83	11.40	B
22	266	34.72	33.32	7.99	A

Table 5-6 – Level of Service at ATb3 (day1)

Hour	PCE (pc/hr/ln)	Time mean speed(mi/h)	Space mean speed(mi/h)	Density (pc/mi/ln)	Level of Service
12	257	62.64	61.26	4.19	A
13	254	63.52	62.34	4.07	A
14	269	64.90	63.51	4.23	A
15	282	64.76	63.45	4.44	A
16	288	64.44	63.17	4.56	A
17	278	65.36	64.30	4.32	A
18	285	66.18	64.96	4.39	A
19	273	65.98	64.68	4.21	A
20	209	65.78	64.42	3.24	A
21	192	65.04	63.89	3.00	A

5-7 – Level of Service at ATb3 (day2)

Hour	PCE (pc/hr/ln)	Time mean speed(mi/h)	Space mean speed(mi/h)	Density (pc/mi/ln)	Level of Service
11	260	65.66	64.32	4.03	A
12	242	66.19	64.76	3.74	A
13	261	66.30	64.92	4.02	A
14	274	67.37	66.31	4.13	A
15	313	67.32	65.97	4.74	A
16	265	68.99	67.50	3.92	A
17	330	68.52	66.93	4.92	A
18	293	70.49	69.04	4.25	A
19	287	70.44	69.22	4.14	A
20	266	67.78	66.39	4.01	A
21	211	68.08	66.75	3.16	A
22	161	69.62	67.85	2.37	A

Table 5-8 – Level of Service at ATb4 (day1)

Hour	PCE (pc/hr/ln)	Time mean speed(mi/h)	Space mean speed(mi/h)	Density (pc/mi/ln)	Level of Service
9	243	52.41	51.47	4.73	A
10	254	53.56	52.38	4.85	A
11	264	53.06	51.84	5.08	A
12	257	53.23	52.17	4.93	A
13	298	52.32	51.13	5.83	A
14	293	52.18	51.15	5.73	A
15	308	51.73	50.52	6.10	A
16	293	52.86	51.54	5.68	A
17	297	52.88	51.71	5.75	A
18	261	52.01	50.90	5.12	A
19	201	51.66	50.42	3.99	A

Table 5-9 – Level of Service at ATb4 (day2)

Hour	PCE (pc/hr/ln)	Time mean speed(mi/h)	Space mean speed(mi/h)	Density (pc/mi/ln)	Level of Service
8	197	54.17	53.19	3.70	A
9	234	53.27	52.14	4.49	A
10	283	52.00	50.70	5.58	B
11	272	53.10	51.99	5.23	A
12	306	52.97	51.86	5.90	B
13	291	53.38	52.34	5.55	B
14	288	53.43	52.24	5.52	B
15	308	53.30	51.93	5.94	B
16	306	53.41	52.26	5.86	B
17	294	52.73	51.58	5.70	B
18	303	51.33	50.11	6.04	B
19	201	51.73	50.45	3.98	A
20	120	53.20	51.91	2.30	A

5.1.2 Intersection Delay Analysis

Delay at an intersection was defined as the additional time vehicles spend to traverse an intersection during the data collection period, compared with the time needed, if the vehicle traverses at light traffic conditions. The delay for each inbound approach of an intersection is calculated by the "cumulative curve" method as described in detail in the Appendix contained in Chapter 8.

The calculated total delay and average delay on Day 1 are shown in Figure 5-2. The average delay was obtained by taking the total delay divided by the total number of vehicles, giving the average delay per vehicle. As shown in Figure 5-2, traveling from AInt5 (Mariposa

Rd. and Frank Reed Rd. intersection) and arriving at AInt4 (I-19 ramp at Mariposa Rd. intersection), the average delay is 2.00 minutes. The average delay at AInt3 (Mariposa Rd. and I-19 northbound ramp intersection), coming from AInt4 (I-19 ramp at Mariposa Rd. intersection) meant an increase of 3.08 minutes. Note that the total delay is the highest at the I-19 northbound ramp, indicating the largest traffic volume is at that location, combining the traffic from Mariposa Westbound and I-19 Southbound to merge to Mariposa eastbound.

The results, however, show that the location that exhibits the most severe delay is the Mariposa and Grand Ave. intersection coming from I-19. While the total delay may not be as high as that at I-19, the average delay is the highest at 4.63 minutes. Overall the excessive delays at the intersections indicate that the average LOS measures are well below LOS F.

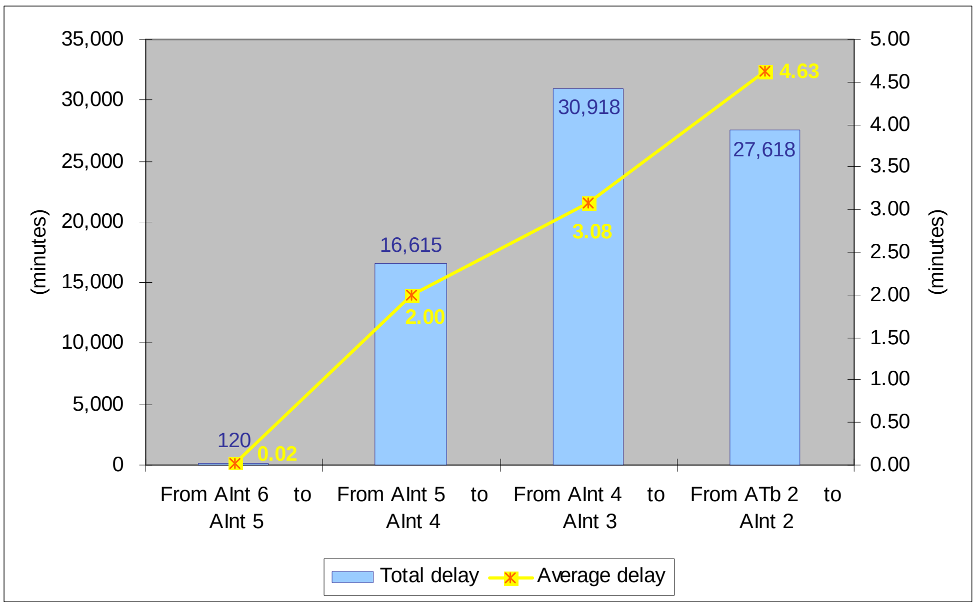


Figure 5-2 – Total delay and average delay (day1)

Further analyses were conducted to understand how delays occur at different times of the day. Figure 5-3 through Figure 5-10 show the time-varying delay for each intersection in the study area. Overall, the frequency and the length of delay for the first day were bigger than for the second day. As shown in Figure 5-3 and Figure 5-4, there was little delay observed at the Mariposa and Frank Reed intersection (Intersection 5) from upstream Intersection 6.

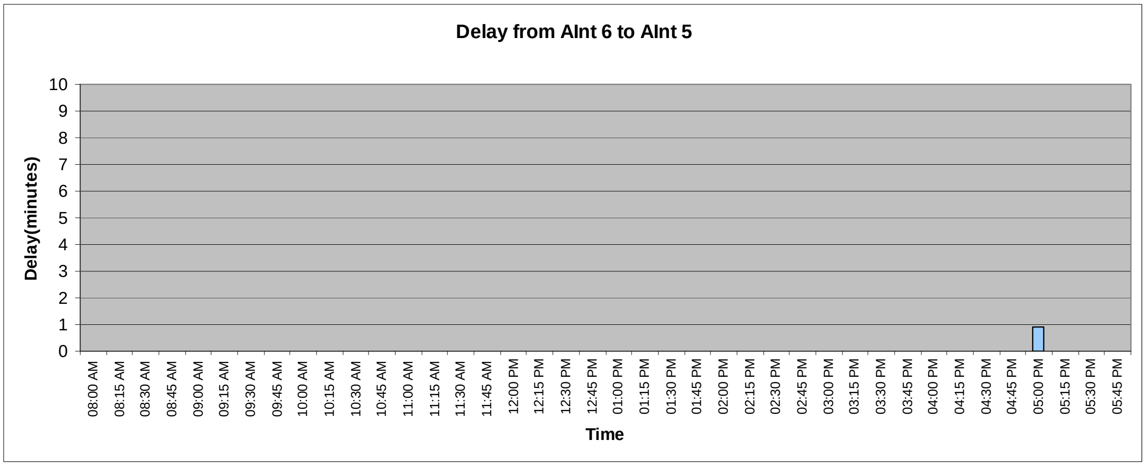


Figure 5-3 –Delay at AInt 5 (Frank Reed) from AInt 6 (Industrial Park) (day1)

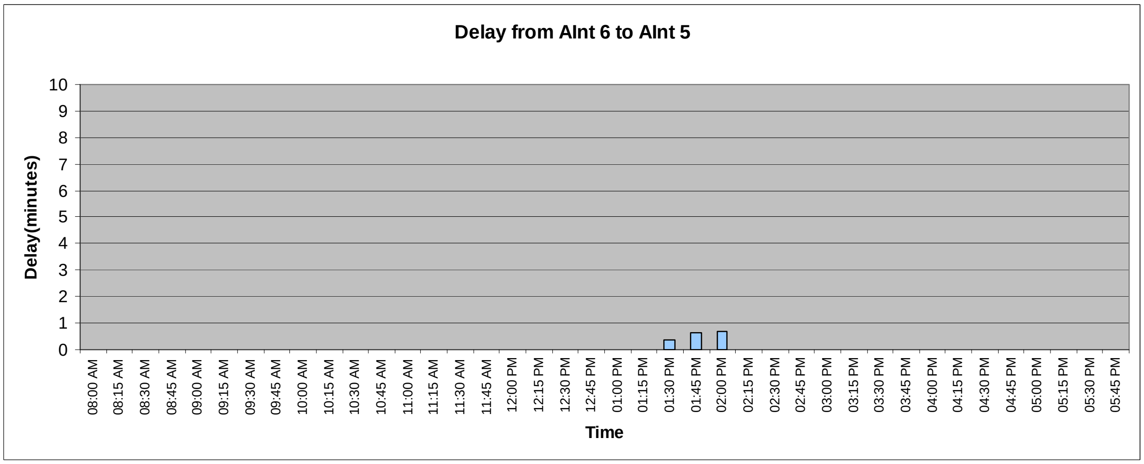


Figure 5-4 –Delay at AInt5 (Frank Reed) from AInt6 (Industrial Park Dr.) (day2)

However, at the I-19 southbound (SB) ramp, significant delays were observed on both days, albeit with different temporal patterns. On Day 1, the delays started at 11:15 AM and reached the peak at 1:30 PM (Figure 5-5). On Day 2, the delays started at around 8:30 AM and continued until around 11:00 AM. After that, sporadic delays occurred throughout the afternoon until 4:30 PM (see Figure 5-6).

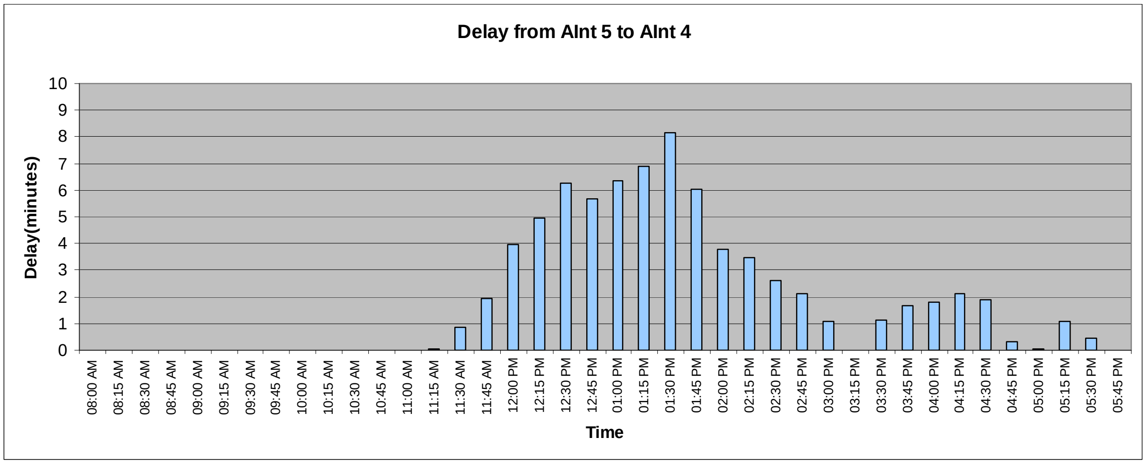


Figure 5-5 – Delay at AInt4 (I-19 SB Ramp) from AInt5 (Frank Reed) (day1)

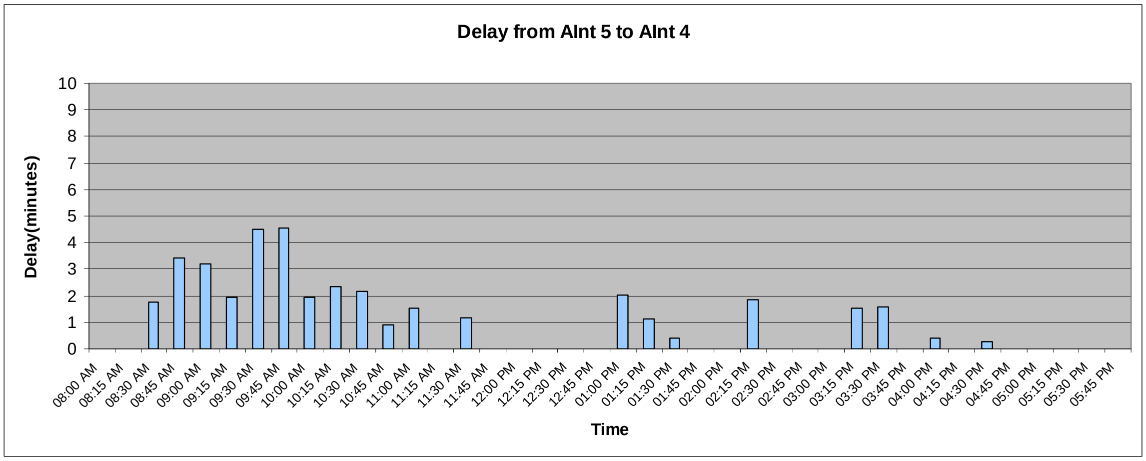


Figure 5-6 – Delay at AInt4 (I-19 SB Ramp) from AInt5 (Frank Reed) (day2)

Examining Figure 5-7 and Figure 5-8, one sees that the intersection of I-19 SB and Mariposa Rd. appears to be heavily congested. On Day 1, the delays started at 8:30 AM, subsided slightly during lunch time and then quickly peaked and were sustained throughout the afternoon until 5:15 PM; see Figure 5-7. The results shown in Figure 5-8 indicate that the delay was much less on Day 2.

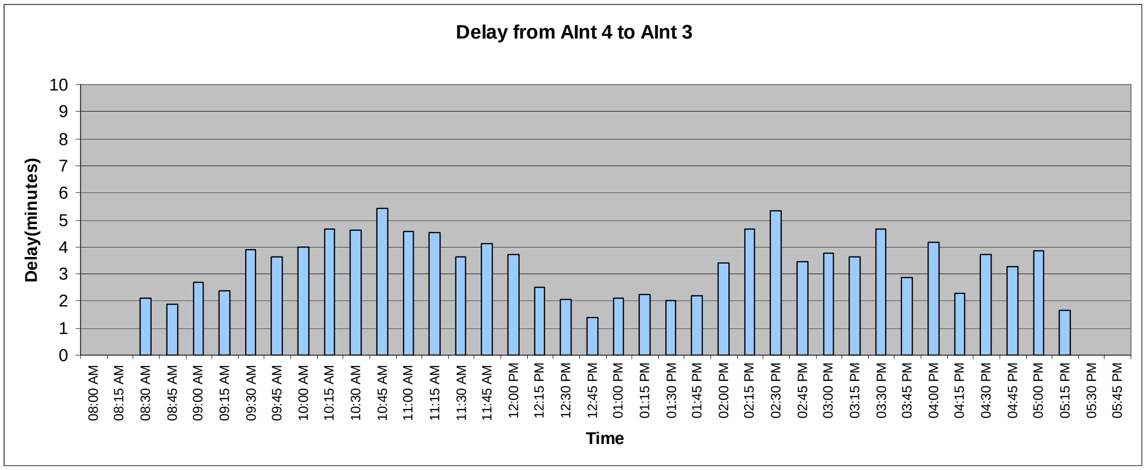


Figure 5-7 – Delay at AInt3 (I-19 NB Ramp) from AInt 4 (I-19 SB Ramp) (day1)

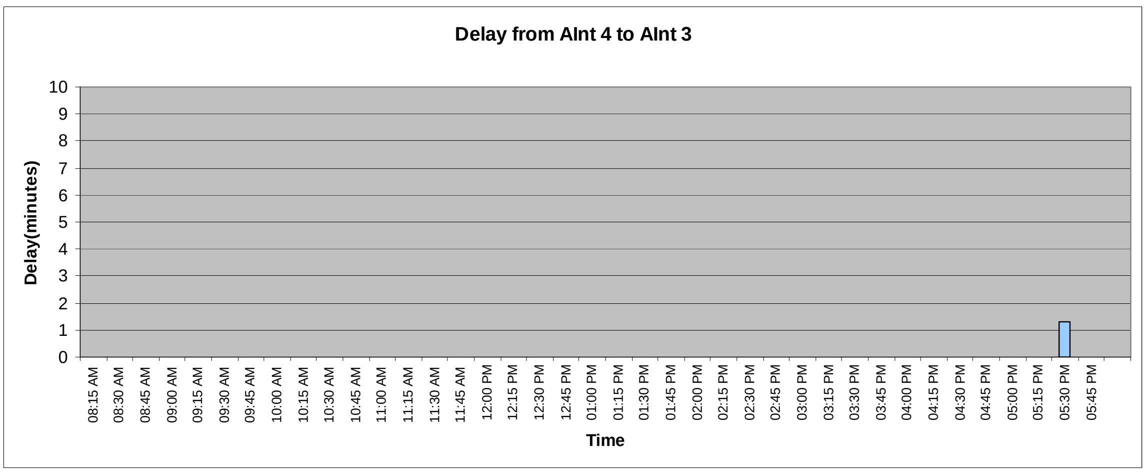


Figure 5-8 – Delay at AInt3 (I-19 NB Ramp) from AInt 4 (I-19 SB Ramp) (day2)

The Mariposa and Grand Ave. intersection was observed as having the highest delay. Day 1 data shows that the congestion starts at around 11:00 AM and sustained a peak from 1:00 PM to 2:00 PM. Although the delay began to subside after 2:00 PM, another wave of congestion occurred from 4:00 PM to 5:15 PM, indicating that this intersection is heavily used by commuting traffic. The same peak did not appear during the morning peak hours, indicating that the PM delay resulted from interactions between commuting traffic and the truck traffic returning from warehouses to the POE. The traffic counts also indicate a high truck volume in the PM period at this location.

As discussed previously, Day 2 overall exhibited much lower traffic compared with Day 1. Reflecting that decrease in traffic, consistently less delay was also observed in the Day 2 data as shown in Figure 5-10.

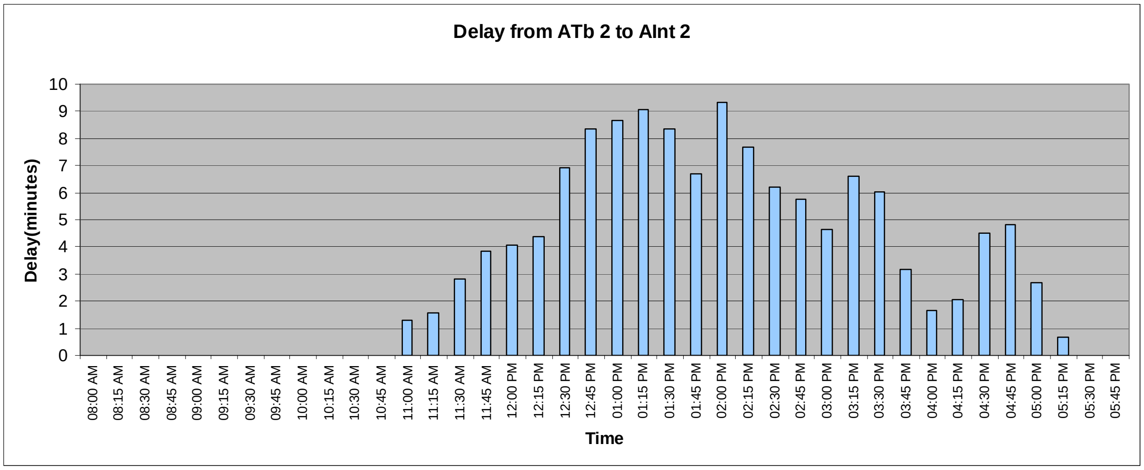


Figure 5-9 – Delay at AInt 2 (Grand Ave.) from ATb 2 (Mariposa Rd.) (day1)

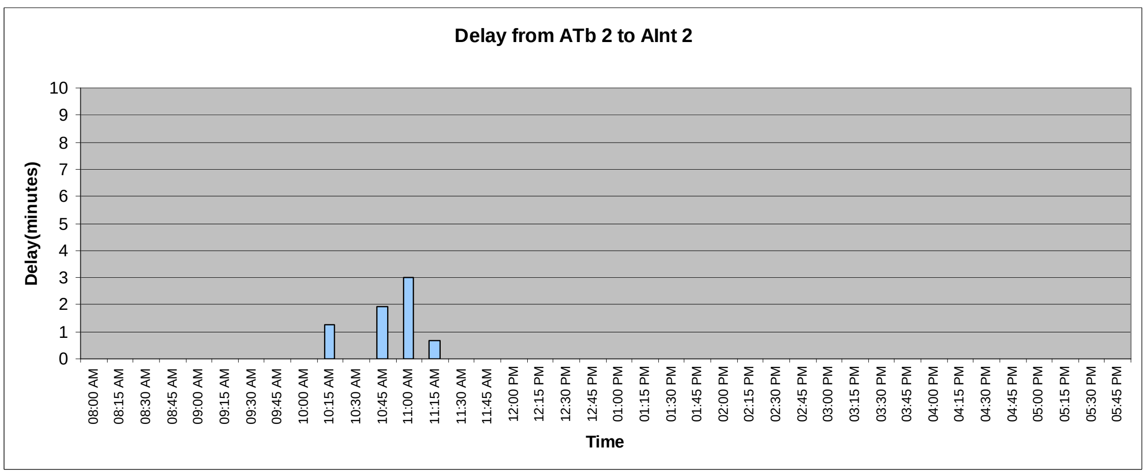


Figure 5-10 – Delay at AInt 2 (Grand Ave.) from ATb 2 (Mariposa Rd.) (day1)

In summary, although Day 2 data collection did not capture the consistent high traffic flow of Day 1, the traffic on Day 1 can be used as the benchmark to understand the severity of traffic congestion throughout the system for any given high-volume date.

5.1.3 Travel time analysis from license plate data

A major task in the data collection was to use license plate data to understand point-to-point travel times for various locations in Nogales, Arizona, as well as for the POE crossing. Four camcorders were deployed at three locations in Nogales, Arizona, and two in the Fiscal

Corridor in Nogales, Sonora. The video tapes were digitized and the license plates and time stamps were read and recorded one-by-one from the images by team members and placed in files. A computer program was developed to read these data and match license plates from all locations. Once a license plate was matched in a pair of images, the travel time between the two locations was calculated by subtracting the time stamp of the downstream image from the upstream image.

5.1.3.1 Travel time analysis

As shown in Figure 5-11 and Figure 5-12, four cameras were deployed on the U.S. side and two were deployed in the Fiscal Corridor on the Mexico side. The two Mexico-side cameras were 100 meters apart. The datasets that were collected for each day are given in Table 5-10.

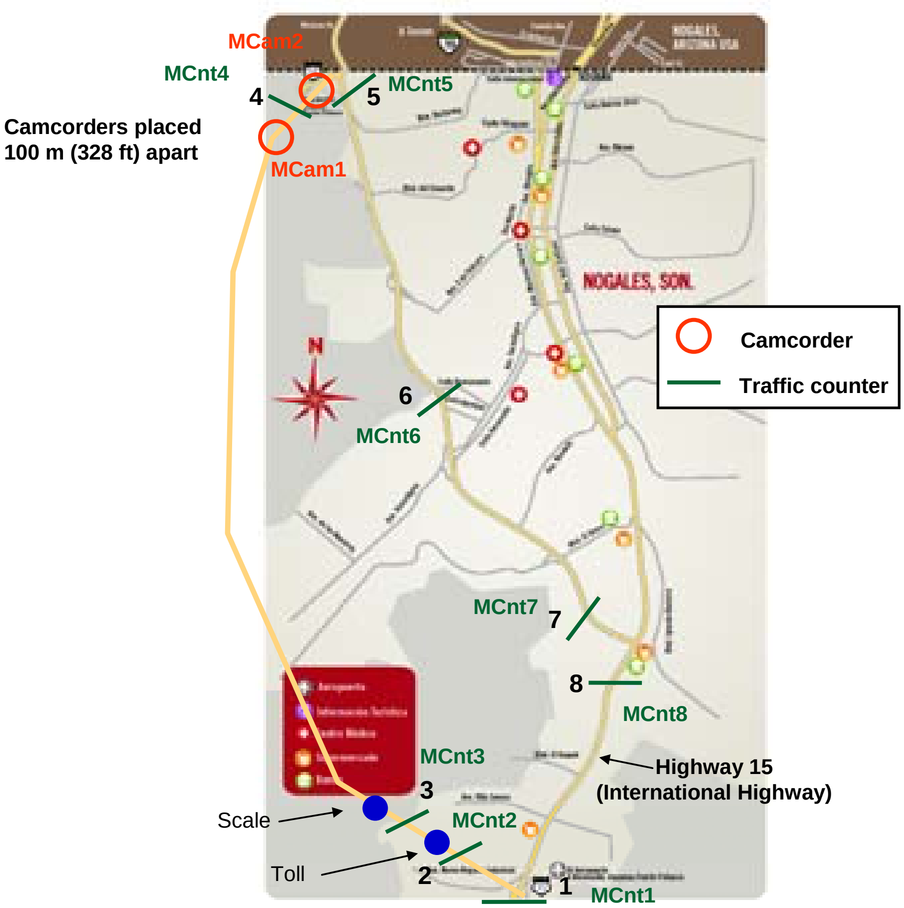


Figure 5-11 - Nogales, Sonora, Data Collection Locations

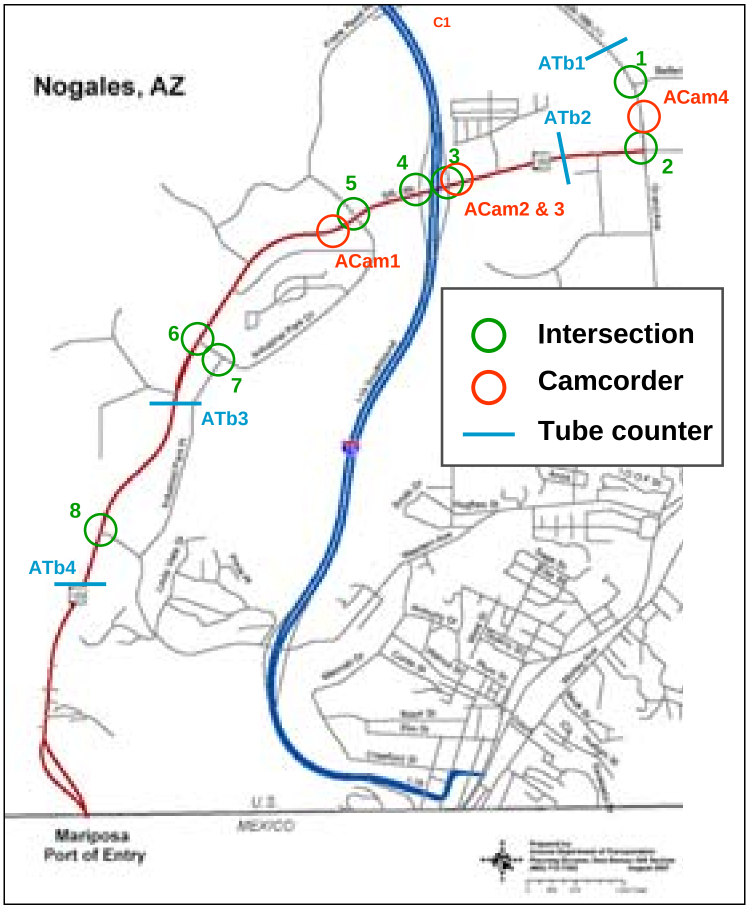


Figure 5-12 - Nogales, Arizona, Data Collection Locations

Table 5-10 Camcorder collection points matching sets

The first day	The second day
MCam1 – MCam2	MCam1 – MCam2
MCam1 – ACam2	MCam1 – ACam1
MCam1-ACam4	MCam2 – ACam1
MCam2 – ACam2	ACam1 – ACam2
MCam2 – ACam4	ACam1 – ACam3

Several camera pairs were selected to calculate the following travel times:

- The travel times just before entering the Mariposa POE from Mexico were calculated using MCam1 – MCam2 datasets for both days.

- The crossing time through the Mariposa POE was calculated by the MCam2 – ACam1 datasets for the second day.[48]
- Travel time on Mariposa Rd. after the Mariposa POE was computed by the ACam1–ACam2 datasets and the ACam1– ACam3 datasets.

With respect to camera license plate matching, certain factors need to be taken into account when interpreting the results. These include:

- Some trucks that park temporarily between MCam1 and MCam2 to wait for qualified drivers can affect travel times and traffic conditions in the Fiscal Corridor.
- Because only a subset of vehicles could be filmed and matched, the results are sample statistics.
- Some trucks may make more than one trip per day and the license plate numbers may be partially captured on each of the trips. This leads to data that indicates excessively high travel times for the matched vehicles. These data were considered outliers and were filtered out from the analysis.

5.1.3.2 Travel time in the Fiscal Corridor south of the Mariposa Port of Entry

The travel time northbound between MCam1 and MCam2 varied over time. Since the distance between the two cameras was fixed at 100 meters, the travel time gives an indication of how slowly the traffic is moving in the queue. Because these vehicles are already in queues, the travel times also give an indication of how fast the POE discharges vehicles. Also note that the end of the queue extended further back into Mexico beyond the position of the first camera (MCam1), so the travel time measures do not indicate how long the queue is or how much time the trucks spend in queue.

For the first day, the minimum travel time was 0.05 minutes, and the maximum travel time was 29.82 minutes. Travel time generally increased from morning to around noon and decreased afterwards. The Day 2 results show travel times less than 12 minutes throughout the day, except the last data point at 43.15 minutes. Generally speaking, travel times on Day 1 were slightly higher than those on Day 2, indicating a higher arrival rate for truck traffic or a slower inspection rate on Day 1. Examining the Day 1 and Day 2 data, it was observed that Day 1 showed distinctly higher northbound traffic volumes on Mariposa Road; this indicates that the longer travel times on Day 1 resulted primarily from higher arrival rates for trucks. Figure 5-13 and

[48] The MCam2-ACam1 dataset was selected among six dataset that included the POE (see Table 5-11). With respect to the first day, the four candidate datasets were not suitable for estimating POE crossing time. The main reason was that ACam1 results from Day 1 were not legible and no license plate data were made available.

Figure 5-14 show the matched travel time data points at different times of the day for Day 1 and Day 2.

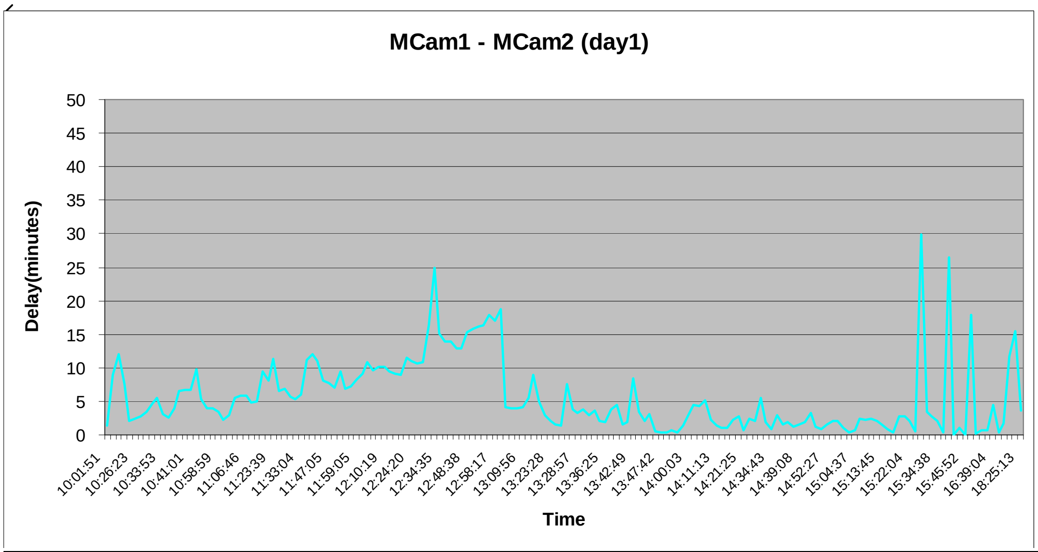


Figure 5-13 – Travel time from MCam 1 to MCam 2 (day1)

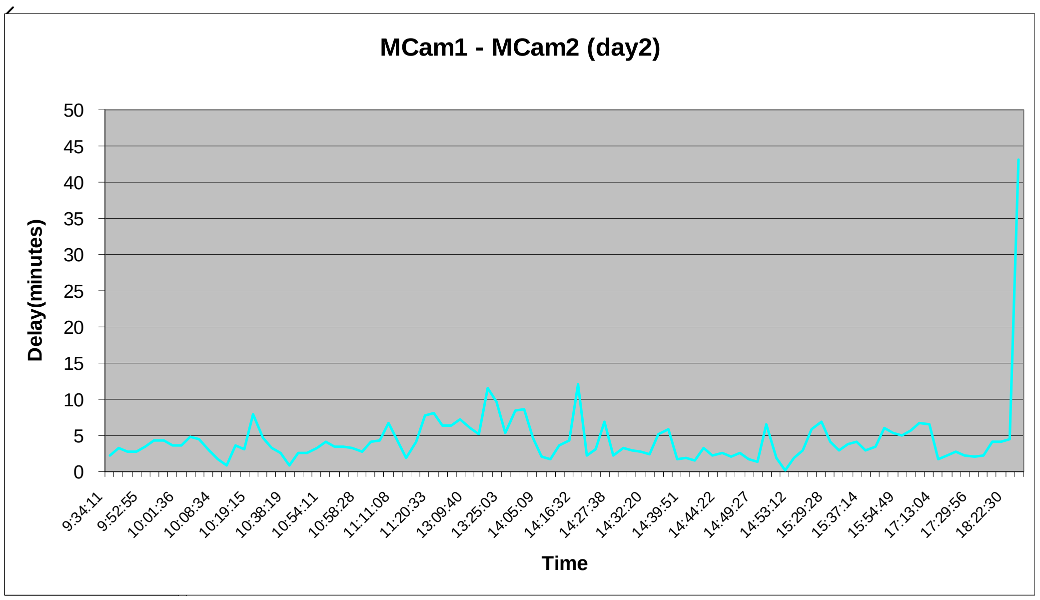


Figure 5-14 – Travel time from MCam 1 to MCam 2 (day2)

Figure 5-15 and Figure 5-16 show the same data but now averaged by the time of day. For example, on Day 1, the average travel time at 10 AM in the morning was 4.94 minutes.

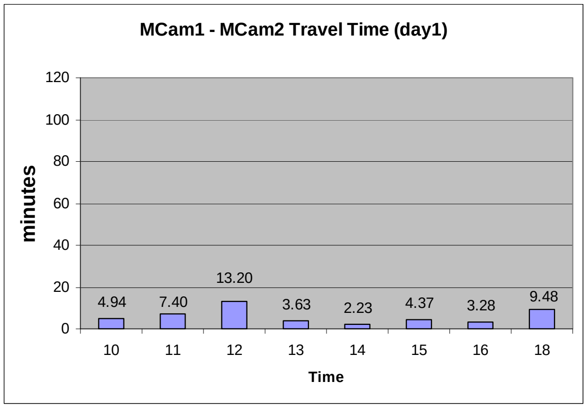


Figure 5-15 – Average travel time by hour of day (day1)

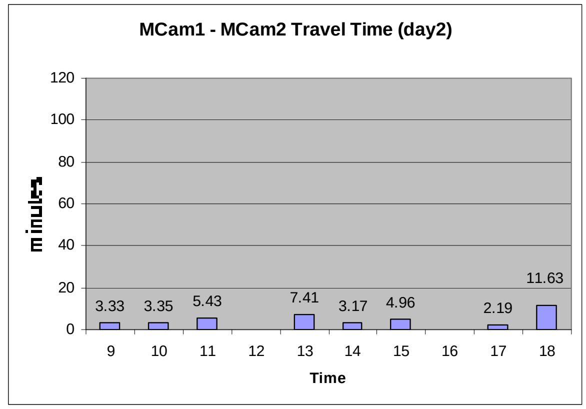


Figure 5-16 – Average travel time by hour of day (day2)

Figure 5-17 and Figure 5-18 show the frequency of observed travel times falling into different travel time intervals. The results show that the majority of the vehicles have travel times within 5 minutes, followed by travel times of 5-10 minutes for the next largest group. Specifically, 60 percent of vehicles spend less than 5 minutes and about 19 percent of vehicles spend more than 10 minutes to pass these points. For the second day, 73 percent of vehicles spent less than 5 minutes and 3 percent spent more than 10 minutes.

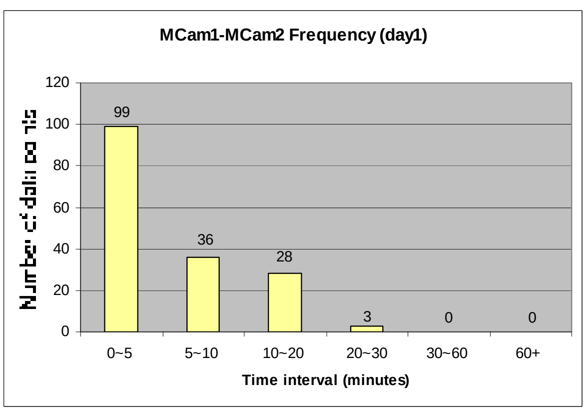


Figure 5-17 – Travel time distribution (day1)

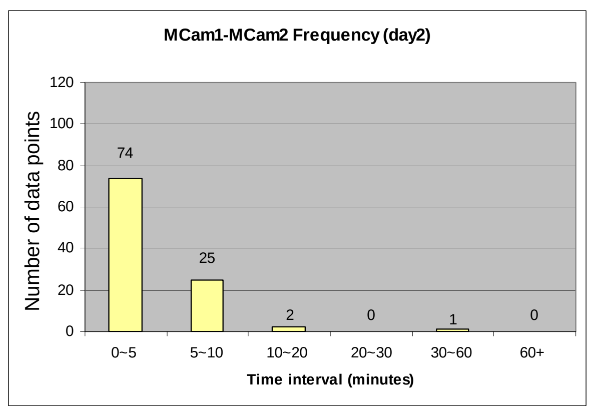


Figure 5-18 – Travel time distribution (day2)

5.1.3.3 POE Crossing Time

The following dataset pairs were available for estimating POE crossing time. The second day MCam2 – ACam1 dataset, however, was the one used to estimate POE crossing time due to two main considerations: (1) there were parked trucks between MCam1 and MCam 2; using the upstream MCam1 dataset would include those parked trucks, and could create misleading information about POE crossing time. (2) On Day 1, the ACam1 video results were found to be not legible and no license plate data could be successfully extracted.

Table 5-11 – Matching sets including POE inspection time

The first day	The second day
• MCam1 – ACam2 • MCam1 – ACam4 • MCam2 – ACam2 • MCam2 – ACam4	• MCam1 – ACam1 • MCam2 – ACam1

The distance between MCam2 and ACam1 was 2.65 miles. The posted speed limit was 45 miles per hour. The free-flow travel time was 3.53 minutes. Subtracting the free-flow travel time from actual travel time permits calculation of the inspection time at the POE and the State Motor Carrier Safety Station. Figure 5-19 shows the inspection times by time of the day and Figure 5-20 shows the hourly average for the same data. One can see a general increase in inspection times during the morning, then a decrease with fluctuating trends in the afternoon. Inspection times increased gradually to above 100 minutes by noon. In the afternoon, the inspection time decreased with a few "spikes," indicating some trucks were retained considerably at the secondary inspections and/or the safety inspection. The inspection time increased again from 4:00 PM to 5:00 PM. The results depicted by Figure 5-20 indicate the same trend.

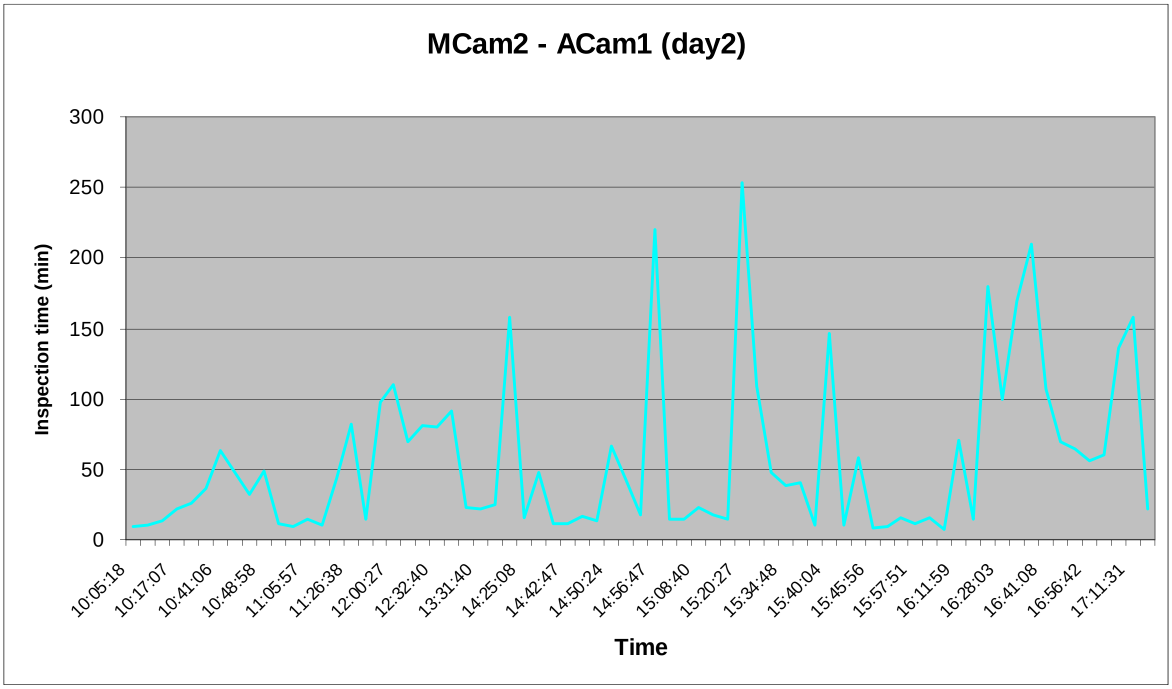


Figure 5-19 – POE inspection time by hour of day

From the inspection distribution shown in Figure 5-21, one can see a clear "bi-modal" distribution, in which the inspection time intervals having highest percentage of vehicles are 10-20 minutes (28% of the total) and 60+ minutes (35% of the total), accounting for a total of 45 out of 71 sample size (63% of the total). The rest (37%) are relatively evenly distributed to other time intervals.

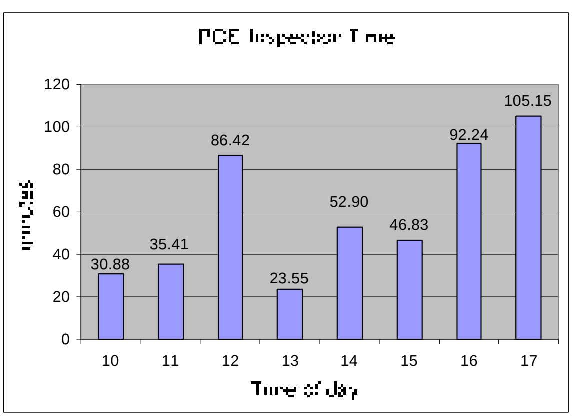


Figure 5-20 – Averaged POE inspection time by hour of day

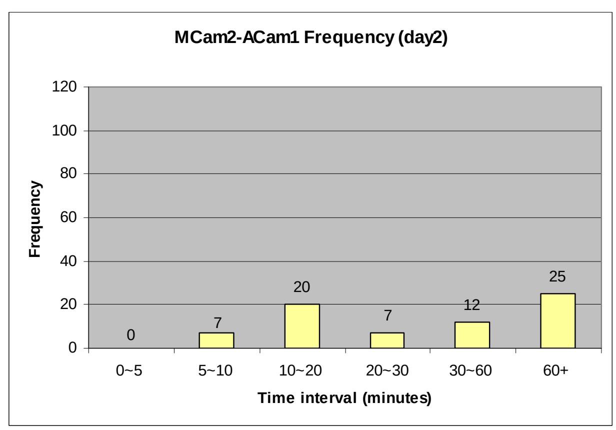


Figure 5-21 – POE inspection time distribution

5.2 Bottlenecks in Nogales, Sonora, Mexico

On the Mexico side, the roadway configuration of the Fiscal Corridor consists of three lanes for normal truck traffic and one additional lane for FAST traffic as seen in Figure 5-22. Trucks have to take the outside-lanes when traveling through the Fiscal Corridor in order to enter the inspection stations.

Normal passenger-car traffic takes the inside-lanes, whether they are coming from the Fiscal Corridor highway or from the City of Nogales, Sonora. But this traffic does not interfere with truck traffic, unless cars take the lane to the right of the POV lane by mistake.

Figure 5-22 Traffic lanes taken by vehicles before the Port of Entry

It is recommended to place proper signage before the road separates in the Fiscal Corridor, so that passenger vehicles do not mistakenly take the truck lane. Because vehicles usually travel at a high speed in the Corridor, the lack of appropriate signage could easily cause confusion in lane selection. The percentage of cars taking the lane to the right of the passenger-vehicle lane by mistake was observed at 4%. Seemingly a small percentage, it nevertheless interferes with northbound truck traffic before the trucks reached the inspection site at the Mariposa POE.

High truck volumes were observed at the data collection point No.4 (before trucks enter the Mariposa POE) between 6:30 PM and 7:00 PM, just before the closing of the inspection site at the POE as shown in Figure 5-23. This situation was especially evident on February 27th (Wednesday). The same situation was seen on data collection point No. 3 between 6:00 PM and 6:15 PM, but interestingly it was not evident at data collection point No. 2. It may be concluded that this traffic might be coming from Mexican Customs to get to the border just in time to cross before the POE closes. At this point, it is difficult to speculate why they get to the border at these times of the day, but this provides an indication of where the traffic surge arises and why increased delay is observed at some times of the day.

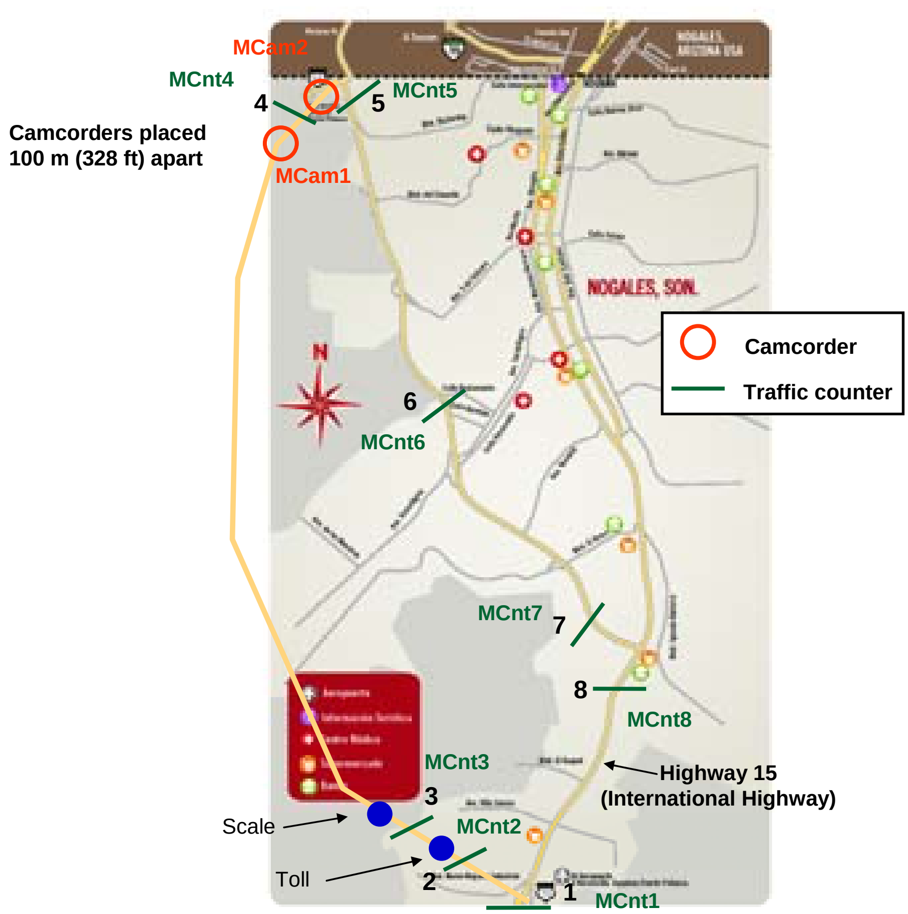


Figure 5-23 - Nogales, Sonora Data Collection Locations

As mentioned in the preceding sections, truckless drivers (*cruzadores*), who are Mexicans with border-crossing documentation, wait before the Mariposa POE for trucks to arrive at the border. *Cruzadores* then change places with the drivers who bring the trucks to the border and then drive the trucks from that point onwards across the border. This practice causes disturbances to the traffic flow when many trucks change drivers. These disturbances are caused mainly by drivers walking between the lanes and making trucks stop. Some trucks stopped also to wait for *cruzadores*.

The documentation for *cruzadores* includes a visa issued by the U.S. Department of State in one of various formats; an international commercial drivers license issued by Mexcio's *Secretaria de Comunicaciones y Transportes* (SCT), and a local compound security badge (in Spanish, *el gafete)* issued by U.S. CBP. As described on page 35, every cargo container that crosses into the U.S. must be in the ACE system at least one hour before the cargo arrives at the POE, and every time the driver's data needs to be typed into the ACE portal system since there is a completely new screen for every crossing. Thus, when the original driver comes to where the *cruzadores* are, the original driver seeks a specific *cruzador* whose data has already been entered into ACE for that shipment. At times, however, the container is sent forward from CAADES or elsewhere without knowing who will be available to cross it. The shipper or driver must then locate a *cruzador* once the truck is already on its way or in line to cross the border. If a *cruzador* is not located quickly, the truck does not move and blocks others in line.

If this situation cannot be resolved soon, one may consider establishing a location before the Fiscal Corridor toll gate so drivers can switch places without risking their safety and causing traffic congestion.

Also, as mentioned above, the Gamma Inspection site at the Mexican Customs station might be another cause of delayed traffic to the border. However, the Gamma Inspection is probably not affecting the bottleneck at the POE because that inspection occurs before the Fiscal Corridor tollgate.

A similar argument applies to the CAADES facility that is located close to Mexican Customs. Trucks stop there for grading and other services before they get to the POE. In some cases, drivers leave containers (both empty and full) on the sides of the road to wait for other drivers to pick them up. This situation causes a large bottleneck for trucks going into the facility. However, this bottleneck does not directly affect traffic at the POE, although it does generate traffic disturbance at the CAADES location.

The CAADES facility situation was not analyzed in detail for the following reasons:

1. Data collection points in the Fiscal Corridor were far from the entrance to the CAADES facility so it was difficult for the team to observe what happened when trucks entered.
2. Trucks going into the CAADES facility did not block the entrance to the Fiscal Corridor, at least, not during the data collection days.

3. The delays caused by trucks going into the CAADES facility were not considered to add to bottleneck problems at the POE.

The Mexico team suggested that the CAADES facility situation can be the subject of further investigation. This can be planned and executed upon request by the Mexican customs authorities and customs agencies working in Mexico.

6 RECOMMENDED IMPROVEMENTS

6.1 Local and short-term improvements

The previous Section identified bottleneck locations at which excessive delays occur. This Section presents proposed improvements and short-term recommendations for each of these locations. Furthermore, it offers recommendations and considerations for long-term improvements. It is noteworthy that ADOT engineers provided the research team with significant man-hours and expertise in estimating costs for the recommended projects. This information, based upon state cost estimate guidelines, improved the accuracy of the cost estimations.

W. Mariposa Rd and I-19 northbound (NB) Ramp Intersection

The delays and queue at this intersection were particularly evident in the Day 1 traffic data. Most of the delays affected traffic heading eastbound on W. Mariposa Rd and making a left turn at the I-19 intersection to head north on I-19. The existing one-lane left-turn lane is approximately 480 ft in length. When the queue spills back to the upstream link, it increases the probability that the queue will block, or interfere with, I-19 southbound traffic, turning into W. Mariposa Rd. eastbound.

Improvement opportunities include (1) re-timing the signal or specifying a time-of-day timing plan for this diamond interchange, and (2) adding one additional left-turn lane to the existing left-turn lane. Both strategies are aimed at increasing the left-turn capacity at this intersection.

(1) Signal re-timing or time-of-day timing plan

The re-timing effort is the most effective if it is coordinated with the re-timing efforts at the intersections that are described later in this Section. Due to seasonal variation and within-day traffic fluctuations, it is suggested that a time-of-day timing plan be configured for this interchange to accommodate the surge of left-turn traffic at 11:00 a.m. to 2:00 p.m. during high-season. Such a plan would not severely impact the traffic movement in the opposite directions, such as commuting traffic that occurs at different time periods.

The anticipated cost of re-timing at this intersection would involve primarily ADOT engineer hours if this task is handled in-house. A complete discussion of the estimated cost for signal re-timing along the W. Mariposa Rd. corridor is provided on page 87.

(2) Left-turn lane addition

In analyzing the feasibility of adding one left-turn lane to the existing one, the main consideration is whether lateral space is available so that once the lane is added, all the eastbound traffic lanes can be shifted southward without severely affecting the horizontal alignment and the traffic movement. According to the photos shown in Figure 6-1 - Available space underneath I-19 bridge next to the abutment, looking eastbound (Courtesy: James Gomes, Jerry James, ADOT)and Figure 6-2 - Available space at right-side shoulder on W Mariposa Rd., looking eastbound (Courtesy: James Gomes, Jerry James, ADOT) and field measurements by UA engineers and ADOT engineers, additional shoulder space along W. Mariposa Rd. and underneath the I-19 bridge appear to be available for one additional lane. However, Figure 6-1 also shows that the sidewalk on the south side of W. Mariposa Rd. east of the I-19 bridge needs to taper over toward the right to maintain reasonable space and alignment for the traffic lane.

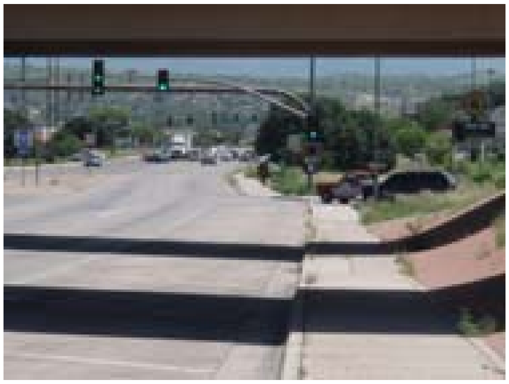


Figure 6-1 - Available space underneath I-19 bridge next to the abutment, looking eastbound (Courtesy: James Gomes, Jerry James, ADOT)

Figure 6-2 - Available space at right-side shoulder on W Mariposa Rd., looking eastbound (Courtesy: James Gomes, Jerry James, ADOT)

This would require construction to remove existing sidewalks, curbs, gutters, and guardrails, adding filling, roadway excavation, repaving (PCCP pavement, i.e., Portland Cement Concrete Pavement), new striping for the traffic lanes, and re-installation of signs and posts. Furthermore, the I-19 NB on-ramp has two lanes that merge on the incline. This ramp needs to be widened and lengthened in order to accommodate an increase in flow; this would result in the two lanes merging farther downstream. The merge point would then occur not on the incline of the ramp, but at the crest of the incline. Further design review consideration would be needed regarding the location of the existing overhead sign structure on NB SR 189 just before I-19. The cantilever sign structure as seen in Figure 6-3 - Cantilever sign structure at the study site (Courtesy: James Gomes, Jerry James, ADOT) and Figure 6-4 - View of the intersection (Courtesy: James Gomes, Jerry James, ADOT), may need to be lengthened and the foundation moved. Alternatively, it may be able to remain and be protected by a concrete barrier.

Figure 6-3 - Cantilever sign structure at the study site (Courtesy: James Gomes, Jerry James, ADOT)

Figure 6-4 - View of the intersection (Courtesy: James Gomes, Jerry James, ADOT)

The preliminary estimated cost for this effort is $729,532, plus construction engineering and project management costs, as listed in Table 6-1.

Table 6-1 - Cost estimation for addition of second left-turn lane at Mariposa and I-19

Description	unit	quantity	unit price	Total cost
Removal of concrete sidewalks, driveways, and slabs	Sq.ft.	2080	$7.00	$14,560.00
Removal of concrete curb and gutter	L.ft.	520	$32.00	$16,640.00
Remove and salvage guardrail	L.ft.	800	$5.00	$4,000.00
Roadway excavation	Cu.yd.	2000	$18.00	$36,000.00
Guardrail, w-beam, single face	L.ft.	500	$18.00	$9,000.00
Guardrail, end terminal assembly	Each			$2,000.00
Asphaltic concrete (misc. structure)	Ton	220	$125.00	$27,500.00
Portland cement concrete pavement (12")	Sq.yd.	3150	$90.00	$283,500.00
Obliterate pavement marking (stripe)	L.ft.	~1000	$1.25	$12,500.00
Borrow	Cu.yd.	2000	$20.00	$40,000.00
Pavement marking(white sprayed thermoplastic .060")	L.ft.	~1250	$1.75	$2,187.50
Permanent pavement marking (painted symbol)(arrow)	Each	1	$80.00	$80.00
Permanent pavement marking(painted legend)(only)	Each	1	$100.00	$100.00
Concrete curb and gutter(install)	L.ft.	520	$45.00	$23,400.00
Concrete sidewalk (C-05.20) (install)	Sq.ft.	2080	$8.00	$16,640.00
Pole (traffic signal/lights)	Each	2	$50,000.00	$100,000.00
Mile post marker (relocate)	Each	1	$350.00	$350.00
Permanent pavement marking (painted)(white)	L.ft.	~1250	$1.50	$1,875.00
Cantilever sign structure	Each	1	$10,000.00	$10,000.00
Relocate signs/posts/foundation	Each	3	$400.00	$1,200.00
Maintenance and protection of traffic	L.sum		$50,000.00	$50,000.00
Mobilization	L.sum		$50,000.00	$50,000.00
Construction survey and layout	L.sum		$10,000.00	$10,000.00
Contractor quality control	L.sum		$10,000.00	$10,000.00
Concrete catch basin (C-15.92)	Each	1	$3,000.00	$3,000
Concrete barrier	L.ft.	25	$200.00	$5,000
Total Construction Cost			**$729,532.50**	
Construction Engineering Costs (Typically 15%)			**$109,429.88**	
Design and Project Management Costs (Vary considerably)			**$145,906.50**	

W. Mariposa Rd. and N. Grand Ave.to Baffert Dr. Intersections

The collected data and field observations indicate that NB traffic waiting at the intersection of Grand Ave. and Baffert Drive may spill back to the W. Mariposa Rd. and N. Grand Ave. intersection during rush hours. This worsens congestion at the intersection during hours with high truck volumes. In the afternoon, a significant number of N Grand Ave. southbound (SB) trucks turn right at the intersection, as they make their way back to the POE. The existing right-turn bay is not sufficient to accommodate the surge of right-turn traffic and, at times, the spillback also blocks the N. Grand Ave. main lane traffic, delaying both through traffic and right-turn traffic.

Improvement opportunities include (1) re-adjusting and coordinating the signal timing for the two intersections – N. Grand Ave.and Baffert Dr. and N. Grand Ave.and W. Mariposa Rd. to facilitate smooth and continuous traffic movements for traffic traversing these two intersections, and (2) extending the right-turn lane to accommodate more right-turn traffic and reduce the spillback during afternoon rush hours.

(1) Signal coordination

Signal coordination would allow traffic coming from W Mariposa Rd, making a left-turn NB through the Baffert Dr. to continue moving without being stopped while on the roadway segment between the two intersections. This would permit higher throughput in this high-volume corridor during the late morning and early afternoon rush hours.

The estimated cost for signal coordination includes costs for traffic counts, data analysis using Synchro, field work and new GPS clocks for clock synchronization. It is noted that the most costly item is the installation of new conduits. This cost can be reduced if wireless technology is applied; however, the cost for wireless technology is not considered in this estimate. The estimate includes the installation of new conduit and pull boxes. The total estimated cost is $150,750.

Table 6-2 Cost estimation for signal coordination for Baffert Dr/N Grand Ave.and W Mariposa Rd./N Grand Ave

Description	unit	quantity	unit price	Total cost
Traffic Counts	Hrs.	80	$50.00	$4,000.00
Office Work - Includes Traffic Count Analysis, Synchro	Hrs.	40	$50.00	$2,000.00
Field Work - Setting Timing, Cabinet Work, Field Adjustments	Hrs.	120	$50.00	$6,000.00
Materials - New GPS Clocks, Cabinets (Installed)	Ea.	6	$2,500.00	$15,000.00
Materials - New Conduit (Installed)	L.Ft	7500	$15.00	$112,500.00
Materials - Pull Boxes (Installed)	Ea.	15	$750.00	$11,250.00
Total construction cost				**$150,750.00**

(2) Right-turn bay extension

This estimate includes lengthening the right turn lane from SB N Grand Ave. to WB W Mariposa Rd. (SR 189). There are several utilities that run along the shoulder that could conflict with this type of work. The sidewalk would have to be removed and relocated along with a fiber optic line and its pedestals and drainage features. It might be possible to build without moving the large utility pole that lies in the path of the new sidewalk construction. Further design considerations would have to be made to determine if the pole would need to be relocated.

Figure 6-5 - N Grand Ave.looking SB at the W Mariposa Intersection (Courtesy: James Gomes, Jerry James, ADOT)

Figure 6-6 - Close-up view of the intersection (Courtesy: James Gomes, Jerry James, ADOT)

The preliminary estimated cost for this effort is $148,700 plus the costs for construction engineering and project management, per the estimated figures listed in Table 6-3.

Table 6-3 - Cost estimation for addition of right turn lane at Grand Ave. and Mariposa Lengthen 150'

description	unit	quantity	unit price	Total cost
Removal of concrete sidewalks, driveways, and	Sq.ft.	480	$5.00	$2,400.00
Removal of concrete curb and gutter	L.ft.	150	$50.00	$7,500.00
Asphaltic concrete (misc. structure)	Ton	110	$125.00	$13,750.00
Obliterate pavement marking (stripe)	L.ft.	120	$14.00	$1,680.00
Pavement marking (white sprayed	L.ft.	120	$3.00	$360.00
Permanent pavement marking (painted	Each	1	$80.00	$80.00
Permanent pavement marking (painted	Each	1	$100.00	$100.00
Concrete curb and gutter (install)	L.ft.	150	$55.00	$8,250.00
Concrete sidewalk (C-05.20) (install)	Sq.ft.	480	$8.00	$3,840.00
Permanent pavement marking (white)	L.ft.	120	$1.50	$180.00
Utility pole	L.sum	1	$50,000.00	$50,000.00
Fiber optic transceiver	Each	2	$700.00	$1,400.00
Metal handrail	L.ft.	270	$48.00	$12,960.00
Relocate signs / posts / foundation	Each	3	$400.00	$1,200.00
Maintenance and protection of traffic	L.sum		$20,000.00	$20,000.00
Mobilization	L.sum		$15,000.00	$15,000.00
Construction survey and layout	L.sum		$5,000.00	$5,000.00
Contractor quality control	L.sum		$5,000.00	$5,000.00
Total construction cost				**$148,700.**
Construction Engineering Costs (Typically 15%)				**$22,305.0**
Design and Project Management Costs				**$111,525.**

N. Mariposa Rd. and Frank Reed Rd. Intersection

It was found that traffic arriving at this intersection from N. Mariposa Rd. is relatively steady and at a higher level than that from Frank Reed Rd. At the times when school starts and ends, the traffic in and out of Frank Reed Rd. may surge and fluctuate. It is suggested that a review of the signal timing plans and setup of the time-of-day timing plan be conducted. The goal of the re-timing would be to provide a longer green split for N. Mariposa Rd., and vehicle actuation on Frank Reed Rd. outside of school rush hours. This would allow less stopping at the intersection by the N. Mariposa Rd. traffic during those periods when there is little or no traffic on Frank Reed Rd.

Another suggestion for safety improvement is to review the location on N. Mariposa Rd. prior to arriving at the intersection of the existing flashing yellow light. The goal is to ensure that sufficient stopping sight distance is provided with respect to the intersection but also with respect to the end of the queue if a queue exists. After discussion with ADOT engineers, the cost associated with this recommendation may be on the order of thousands, which is considered rather minimal.

W. Mariposa Rd. between I-19 and N. Grand Ave

Due to intensive commercial activities along W. Mariposa Rd. between I-19 and N. Grand Ave, jaywalking has been observed along W Mariposa Rd. Moving sidewalks inward and separating the sidewalk with guardrails or landscaping may discourage jaywalking and improve safety along this corridor.

The recommendations are summarized in Figure 6-7 - Summary of Recommendations and Figure 6-8 - Summary of Recommendations (cont'd).

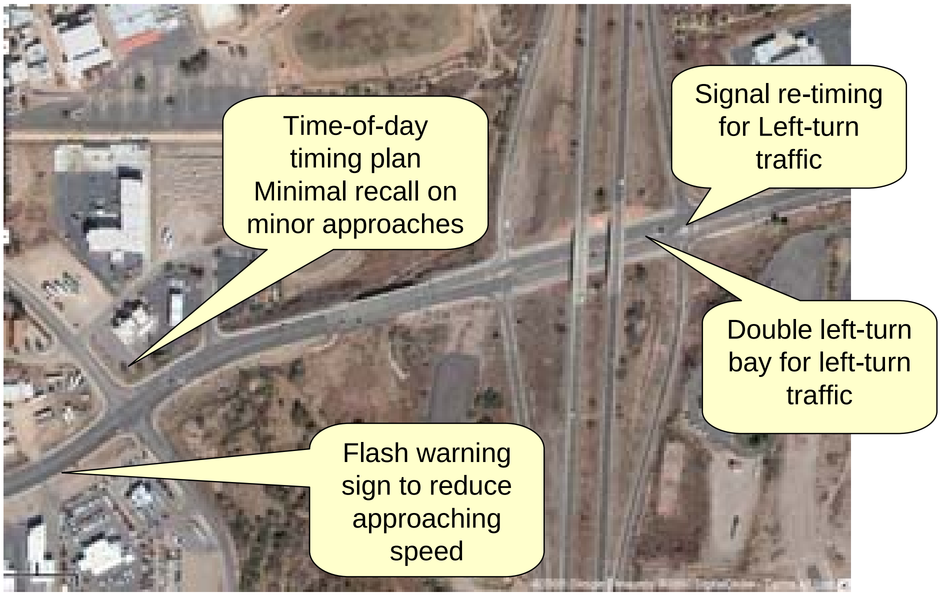


Figure 6-7 - Summary of Recommendations

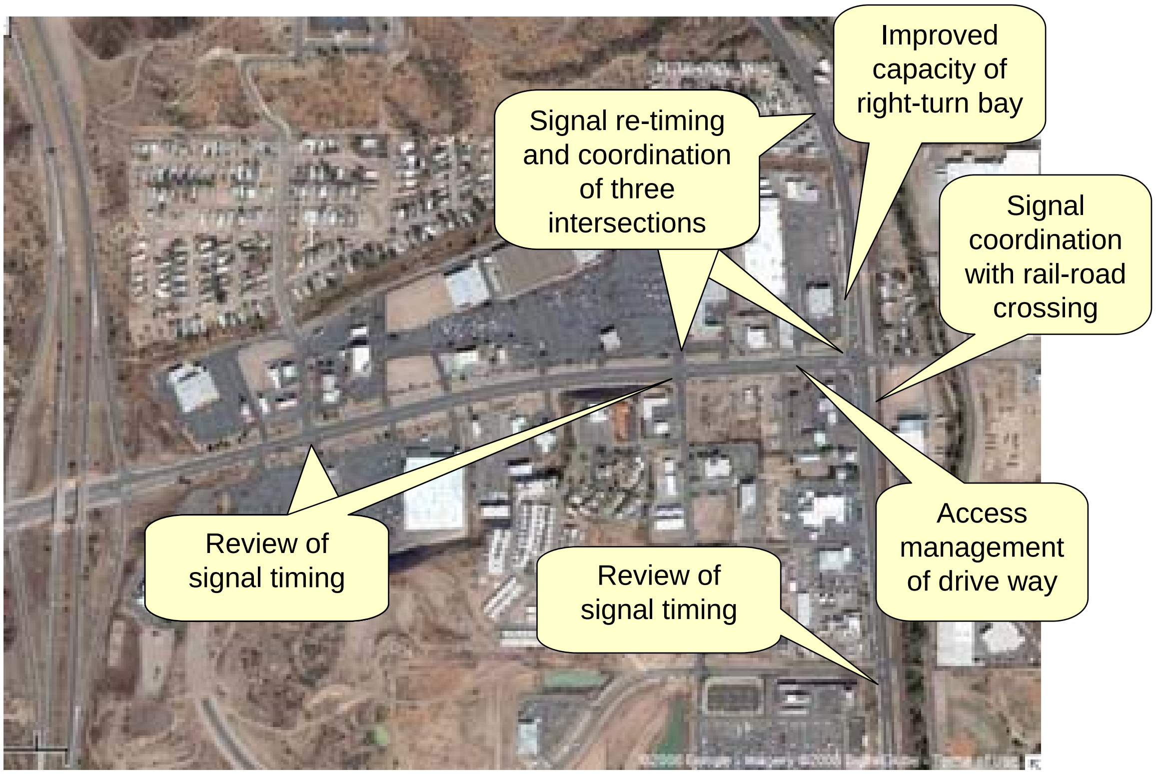


Figure 6-8 - Summary of Recommendations (cont'd)

6.2 Long-term improvements

The short-term improvement recommendations discussed in the preceding section were proposed to alleviate the significant congestion observed at several bottlenecks along the SR 189 corridor between the Mariposa POE and Baffert Dr./N. Grand Ave. Costs for these projects are considered moderate but with substantial benefit. However, the additional roadway capacity provided by these projects may soon be offset by increased POE crossing volumes resulting from expanded POE capacity or increased POE crossing demand in the foreseeable future. Accordingly, a longer-term vision and solution may need to be considered. One recognized strategy, other than increasing roadway capacity, is to modify the transportation network connectivity so that the traffic pattern is shifted from existing bottlenecks to other roadways that may be able to accommodate the diverted traffic.

Two concepts, if implemented, have the potential to make a fundamental shift in the commercial traffic flow patterns in this region. These are:

<u>(1) Direct connector between the Mariposa POE and I-19</u>

Providing a direct access route to I-19 from the POE could significantly reduce the northbound traffic on SR 189 between the POE and I-19, because traffic heading toward I-19 N would be diverted to the connector, significantly reducing the left-turn traffic at the I-19 N ramp. Traffic heading toward Baffert Dr./N. Grand Ave. will also take the connector and exit I-19 at W. Mariposa Rd. making make a right-turn onto W. Mariposa and, therefore, bypassing the Frank Reed and I-19 intersection. The positive impact upon the Frank Reed Rd. and I-19 intersection is clear. The I-19 connector concept is illustrated in Figure 6-9 - I-19 access (frontage) road.

Figure 6-9 - I-19 access (frontage) road

(2) Frontage road between W. Mariposa Rd. and N. Apache Rd.

Another concept that would facilitate the shift of traffic flow is to add a frontage road between W. Mariposa Rd. and N. Apache Rd. Currently, no connectivity exists between I-19 and N Apache Rd. Traffic bound for warehouses along N. Grand Ave. or the mobile home park (as shown in Figure 6-10 - I-19 Frontage Road between W Mariposa Rd. and N Apache Rd.) must traverse the W. Mariposa/N. Grand Ave. intersection, contributing to high traffic volume at that intersection. This frontage road would allow part of such traffic to divert away from the W. Mariposa Rd/N. Grand Ave. intersection. A local access road into the mobile home park would permit a quick access for park residents so that traffic in and out of the park would not be concentrated on N. Grand Ave. Moreover, the I-19 connector and the frontage road concepts may provide benefits that work in synergy, as the former reduces traffic on SR 189 between the POE and I-19, and the latter reduces traffic at the W. Mariposa/N. Grand intersection. Nonetheless, it should be noted that the frontage road would increase the left-turn traffic at the W. Mariposa/I-19 interchange, so this recommendation should be studied in conjunction with the double left-turn lane concept to avoid the bottleneck.

Because both concepts require major funding for design and construction as well as federal approval, their costs are not considered part of this study and are not included in this report. The Arizona Department of Transportation is currently conducting the Mariposa/I-19 Connector Route Study. This study will determine the feasibility of a connector route from the Mariposa POE to I-19. The concept of a frontage road between W. Mariposa Rd. and N. Apache Rd. will be studied further in the Unified Nogales/Santa Cruz County Transportation Plan 2010.

Figure 6-10 - I-19 Frontage Road between W Mariposa Rd. and N Apache Rd.

APPENDICES

7 TRAFFIC DATA DESCRIPTIVE STATISTICS

7.1 **Nogales, Arizona. U.S.**

7.1.1 Pneumatic Tube Count Datasets

- Location 1

The location of tube counter 1 (ATb1) was on Grand Avenue. Traffic data was collected from 10:15 AM to 10:00 PM for the first day, and from 10:15 AM to 11:00 PM for the second day. However, the tube counter was ripped off by traffic at approximately 5:00 PM on Day Two, due to a queue buildup from a work-zone situated less than a quarter of a mile downstream of the location.

A total of 8221 vehicles were recorded: 84.24 percent autos, 10.70 percent light trucks, and 5.06 percent 18-wheelers for the first day. On the second day, a total of 4,714 vehicles was recorded: 78.66 percent autos, 11.99 percent light trucks, and 9.36 percent 18-wheelers. The average mean speed was 38.97 miles per hour (mph) for the first day and 36.81 for the second day. The posted speed limit was 45 mph.

In Figure 7-1 and Figure 7-2, the variation of mean speed and traffic volume was not high. The mean speed was approximately the same for the complete time intervals for the two days. For the first day, the traffic volumes smoothly increased from 11:00 AM to 12:00 PM, and then slightly decreased until 1:00 PM. After that, volume gradually increased until 4:00 PM. It slightly decreased until 6:00 PM, and then the maximum traffic volume occurred at approximately 7:00 PM. From then on, traffic volumes decreased.

On the second day, the pattern was similar to that on the first day but with a reduced traffic volume. In terms of the mean speed, a slight fluctuation was observed for the light trucks and the 18-wheelers; refer to Figure 7-3 and Figure 7-4. According to Figure 7-5 and Figure 7-6, traffic volumes for light trucks and 18-wheelers were stable by hour of data collection, whereas the traffic volumes for automobiles had high variation over the course of the day. The traffic pattern at location ATb11 was affected mainly by the automobiles.

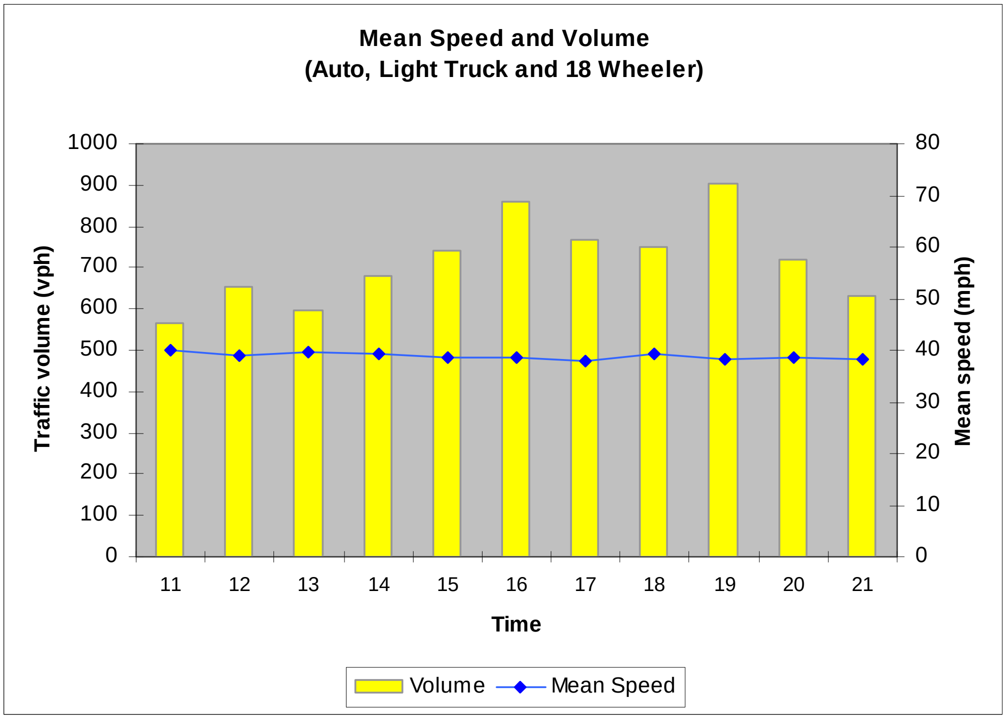


Figure 7-1 - Speed Volume Data (ATb11)

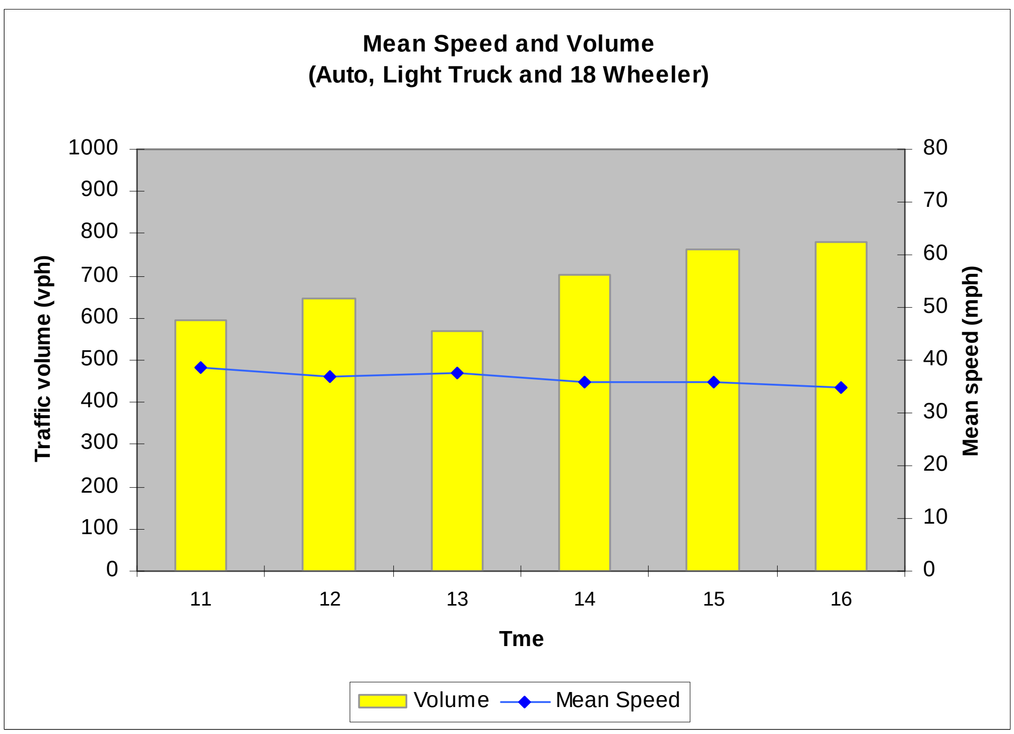


Figure 7-2 - Speed Volume Data (ATb12)

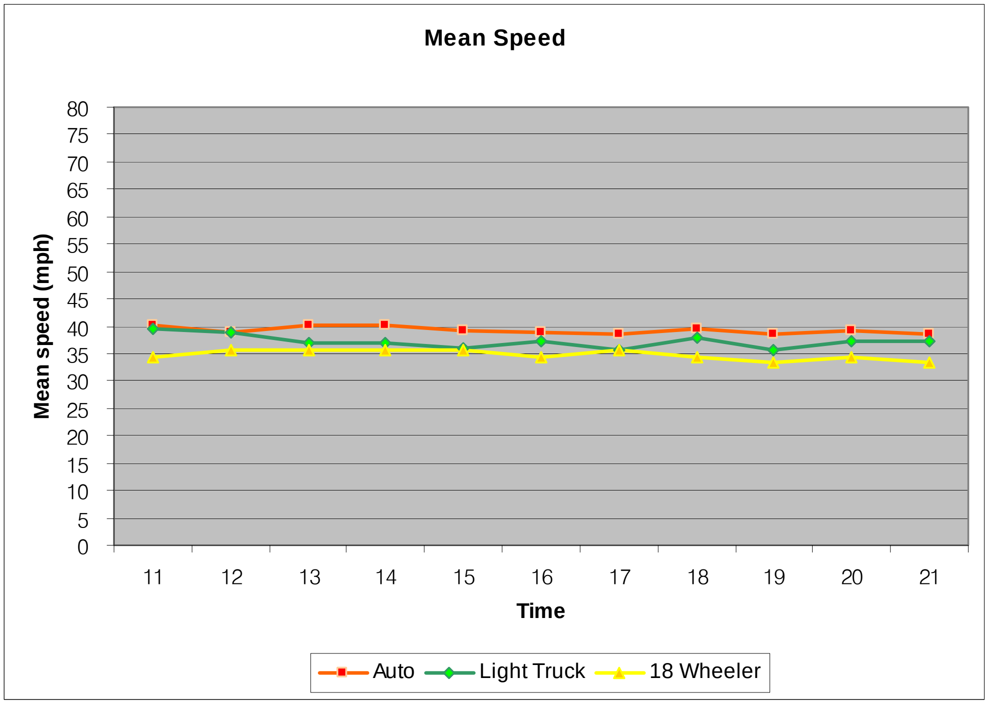


Figure 7-3 - Mean Speed Data (ATb11)

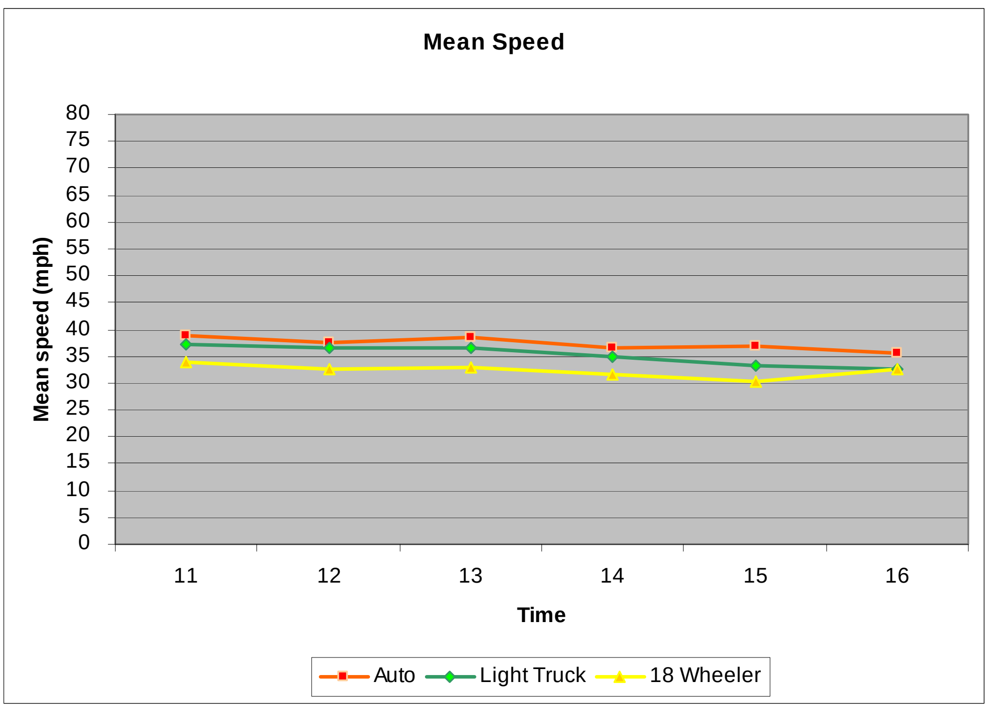


Figure 7-4 - Mean speed data (ATb12)

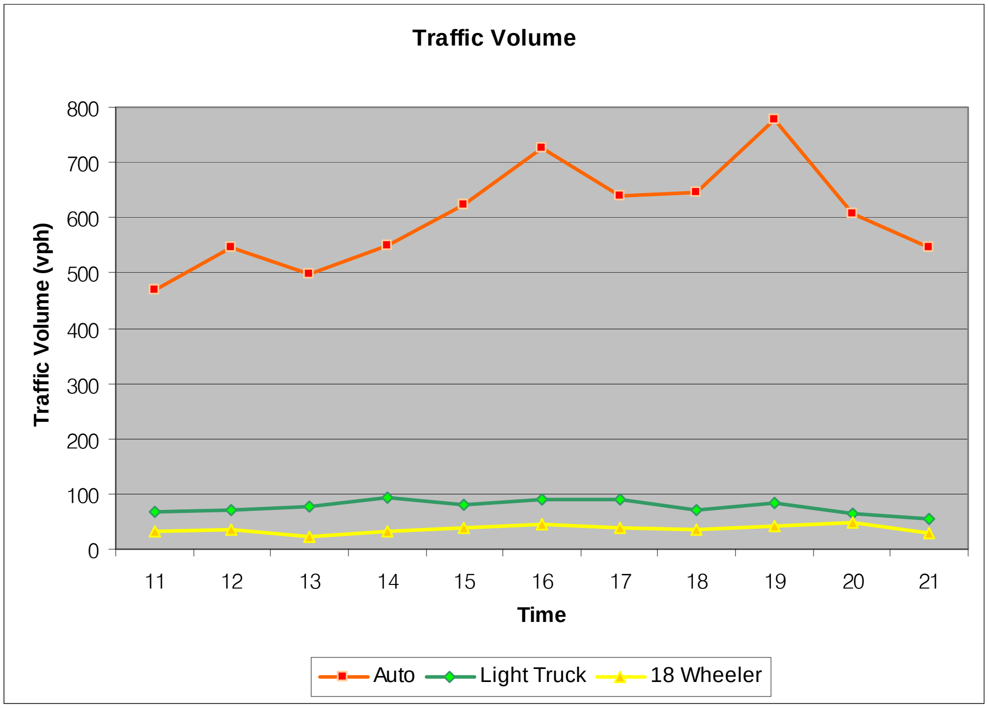


Figure 7-5 - Traffic volume data (ATb11)

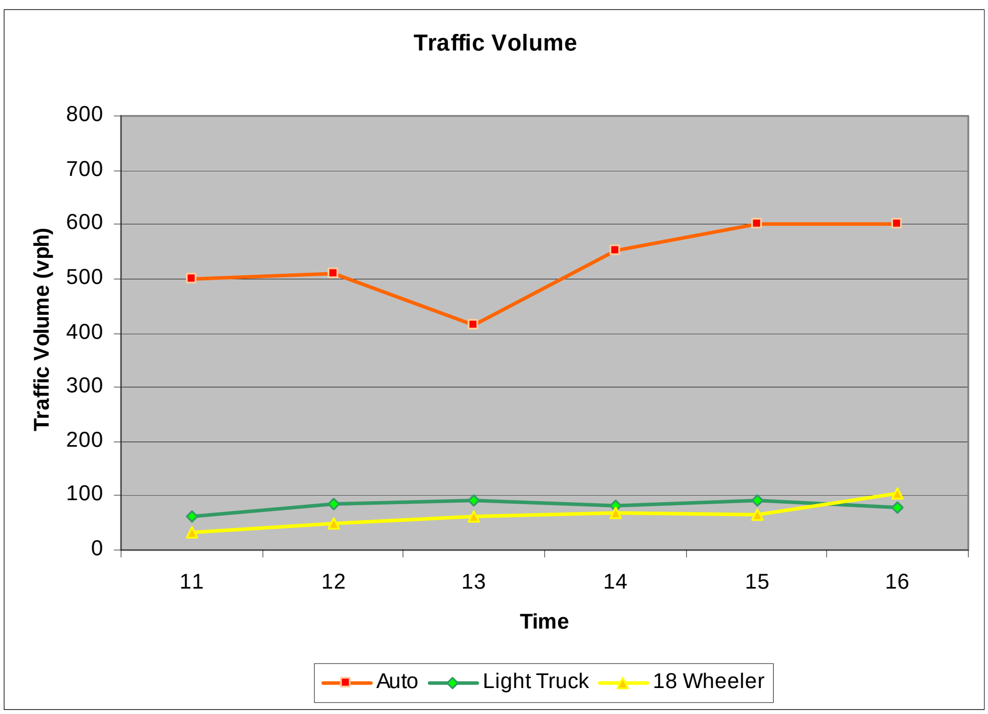


Figure 7-6 - Traffic volume data (ATb12)

- Location 2

The location for tube counter 2 (ATb2) was at Mariposa Rd. near the intersection with Grand Ave. Data collection start and end times for the first day were 10:45 AM, and 10: 15 PM. On the second day, the times were from 10:15 AM to 11:15 PM.

The total vehicle count was 9,007 on the first day and 9,787 for the second day. The mode share was approximately 80 percent autos and 20 percent trucks. The average mean speed was 33.11 mph for the first day and 33.57 mph on the second day. The posted speed limit was 35 mph.

Figure 7-7 and Figure 7-8 show that the variations in mean speed and traffic volumes for location 2 were small for the two days. Using averages by the hour, the minimum average mean speed was 27.55 mph on the first day and 30.60 mph on the second day. The maximum average mean speed was 35.47 mph on the first day and 36.70 mph on the second day. On the first day, a steady increase in traffic volumes occurred until 12:30 PM. This volume was sustained until 7:30 PM, although there slight fluctuations during this time interval. After 7:30 PM, traffic volumes decreased. For the second day, the pattern of traffic volume over time was similar to the first day, with the exception that traffic volume rose until 2:30 PM during the second day. The mean speed of each mode remained approximately the same for the complete day, although there were some slight variations; refer to Figure 7-9 and Figure 7-10. According to Figure 7-11 and Figure 7-12, the traffic volume of the 18-wheelers increased slightly from start time to around 2:00 PM, and then that level was continued until 7:00 PM. Traffic volume decreased slightly after around 7:00 PM.

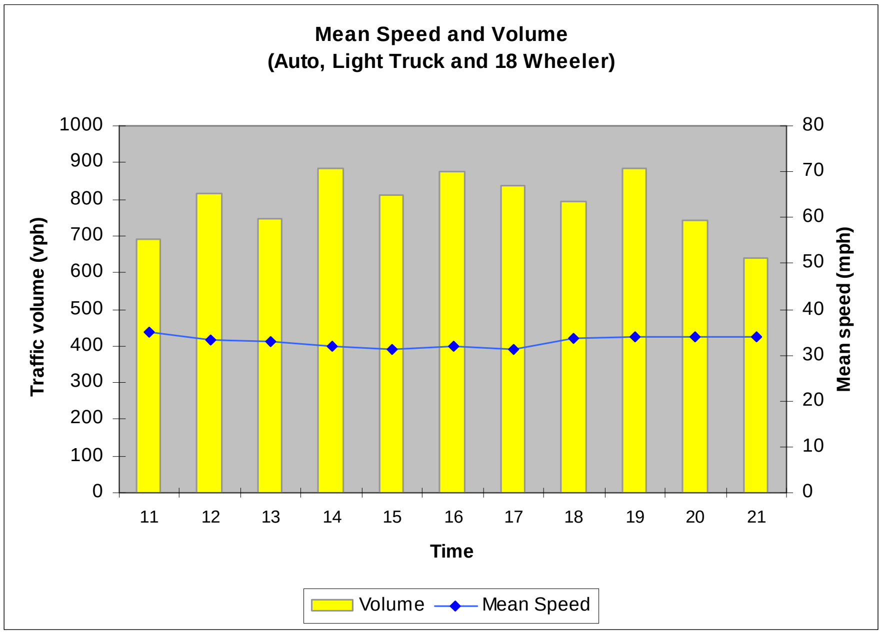


Figure 7-7 - Speed Volume Data (ATb21)

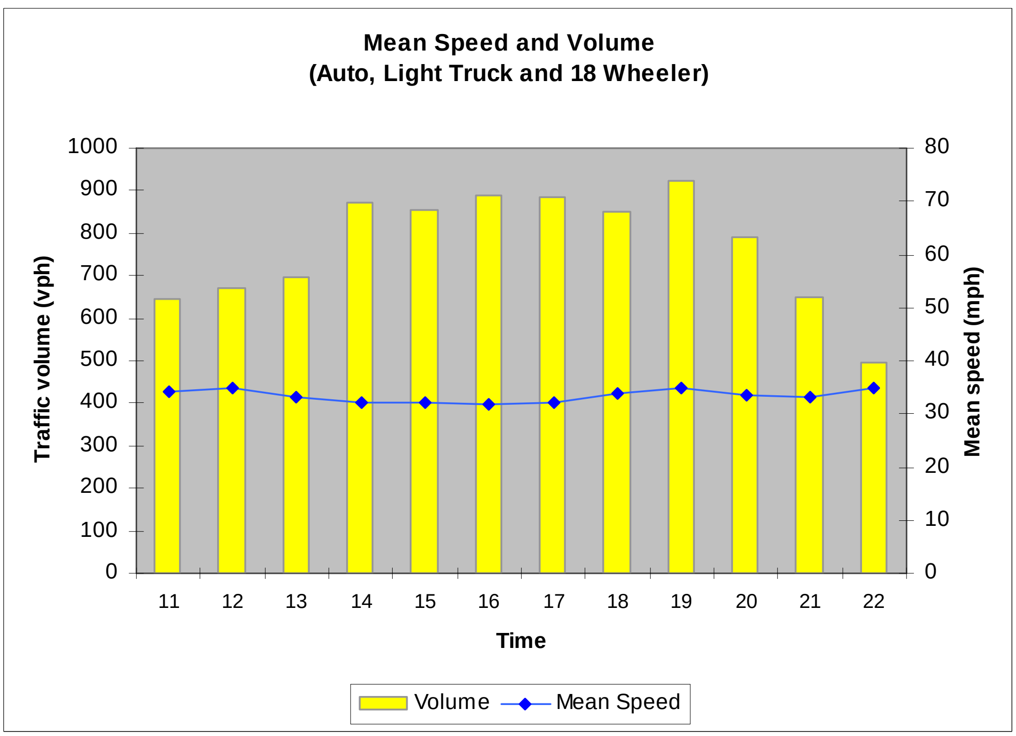


Figure 7-8 - Speed Volume Data (ATb22)

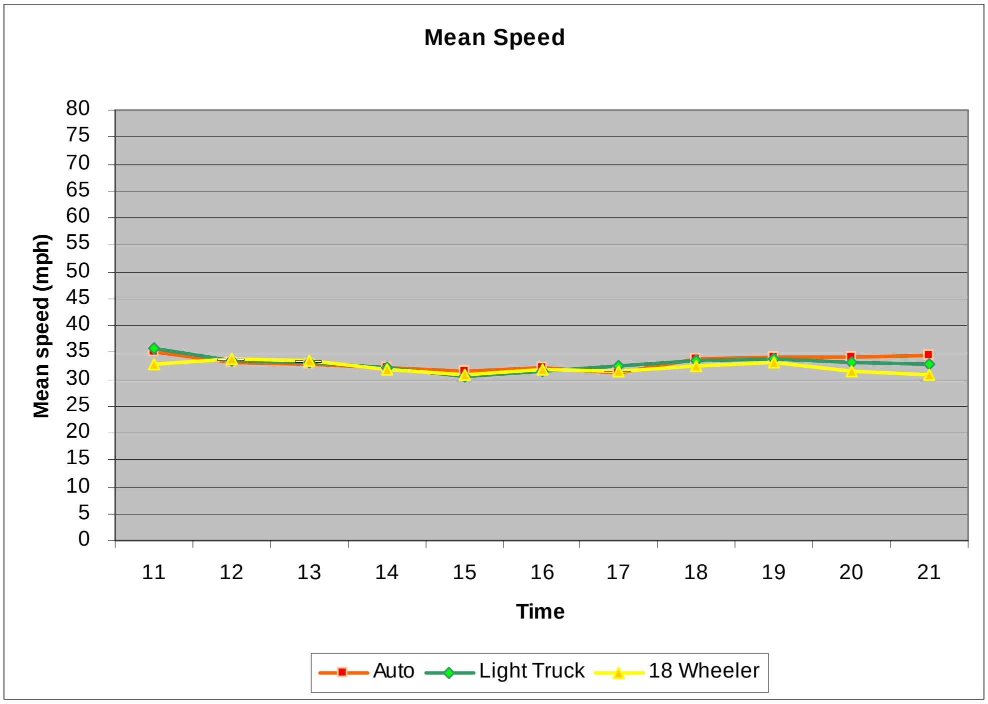


Figure 7-9 - Mean Speed Data (ATb21)

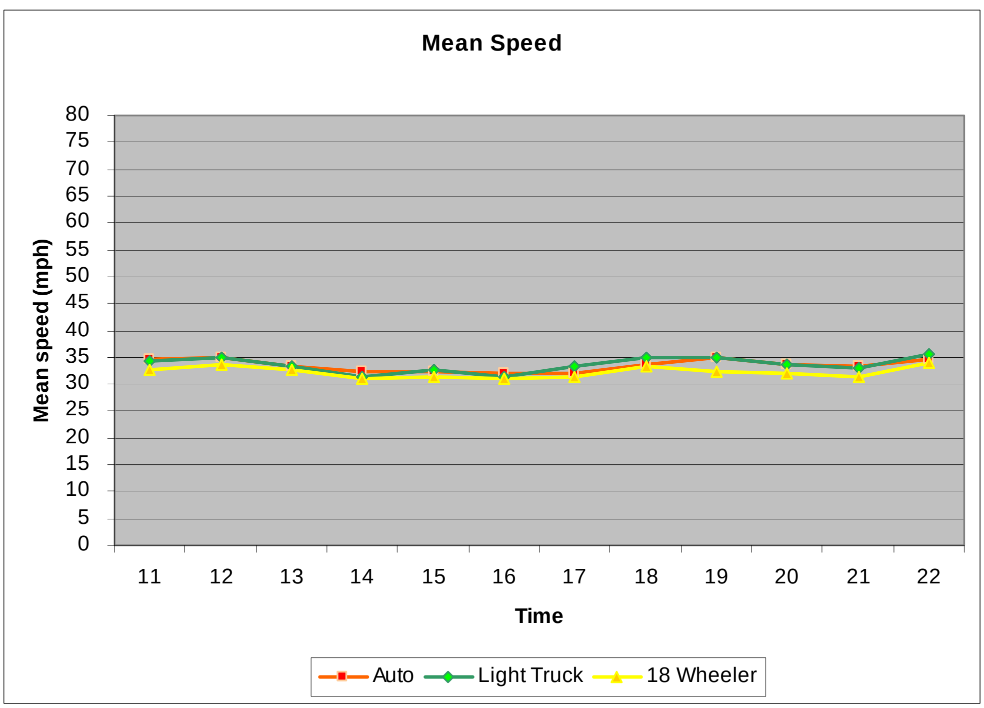


Figure 7-10 - Mean Speed Data (ATb22)

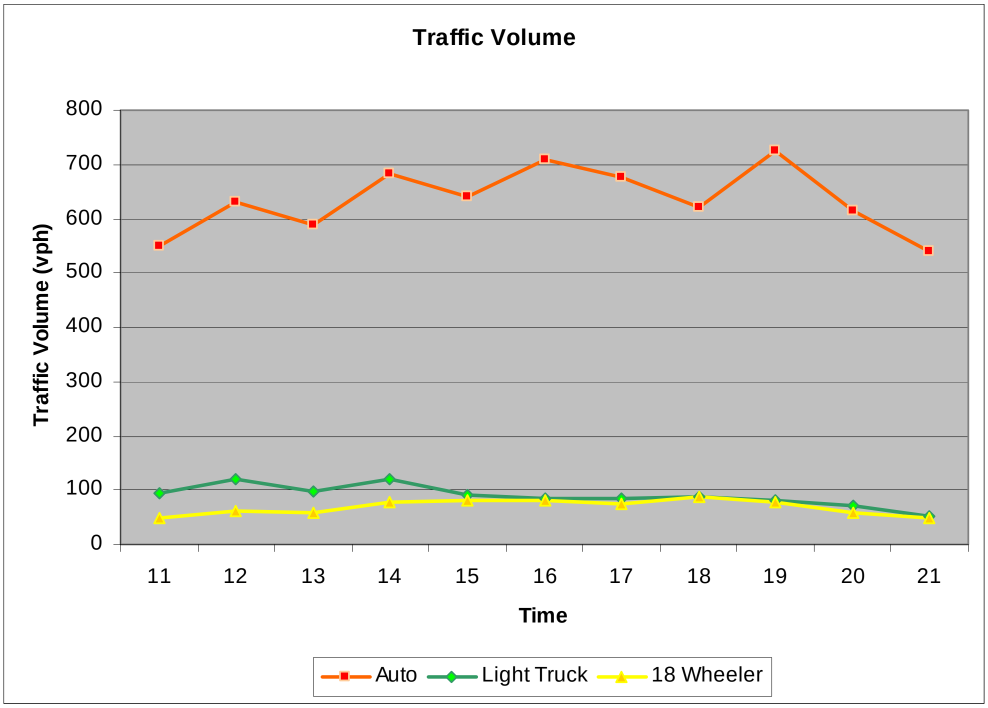


Figure 7-11 - Traffic Volume Data (ATb21)

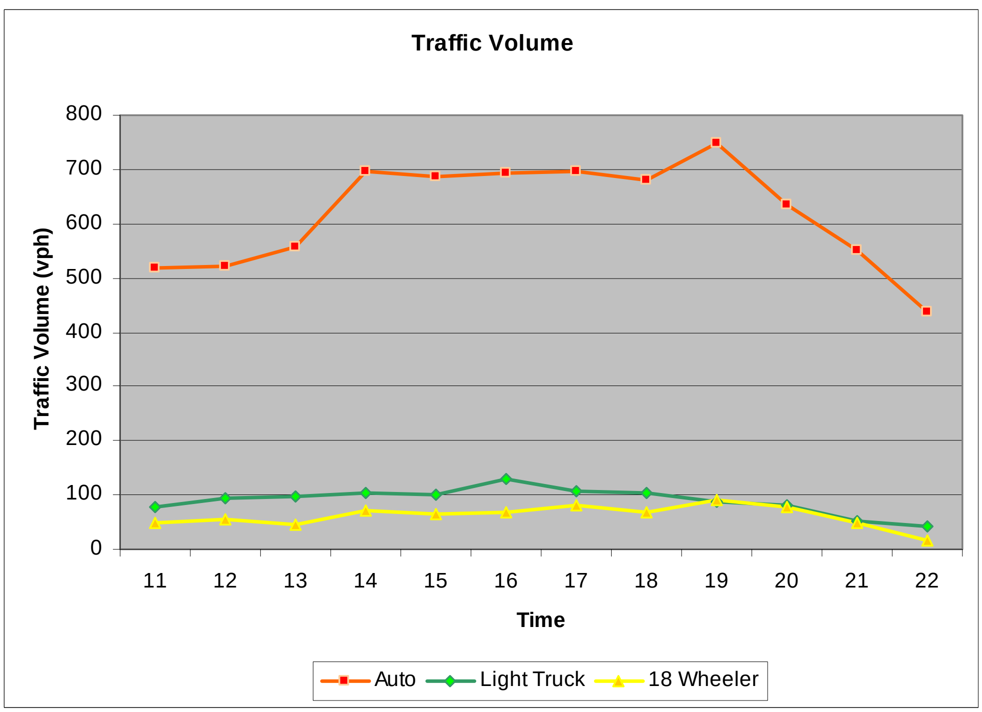


Figure 7-12 - Traffic volume data (ATb22)

- Location 3

The third tube counter was placed at Mariposa Rd. at a location south of the location 2 tube counter, which was also at Mariposa Rd. Data collection on the first day started at 11:30 AM and ended at 10:30 PM and for the second day from 10:15 AM to 11:45 PM.

The total vehicle counts were 4,235 for the first day and 5,113 for the second day. In comparison with locations 1 and 2, total traffic volumes at location 3 were less. The ratio of different modes passing location 3 was also different from the proportions at previously discussed locations. The first-day breakdown was automobiles (43.68 percent) and truck (56.32 percent). On the second day, the mode share gap between auto and truck increased, 37.65 percent for auto and 62.35 percent for truck. The average mean speed was 64.77 mph for the first day, and 67.95 mph for the second day. Although traffic volumes increased on the second day, the average mean speed of the second day showed higher values than those of the first day. The posted speed limit was 45 mph.

On the first day, the variations in mean speed and traffic volume were stable over the time interval, refer to Figure 7-13. On the second day, the mean speed was again approximately the same over the time period, but traffic volumes varied at each time interval. Traffic volumes increased until 5:15 PM, and then decreased thereafter, refer to Figure 7-14. Although traffic volume decreased after 5:15 PM, mean speed stayed almost the same, refer to Figure 7-14.

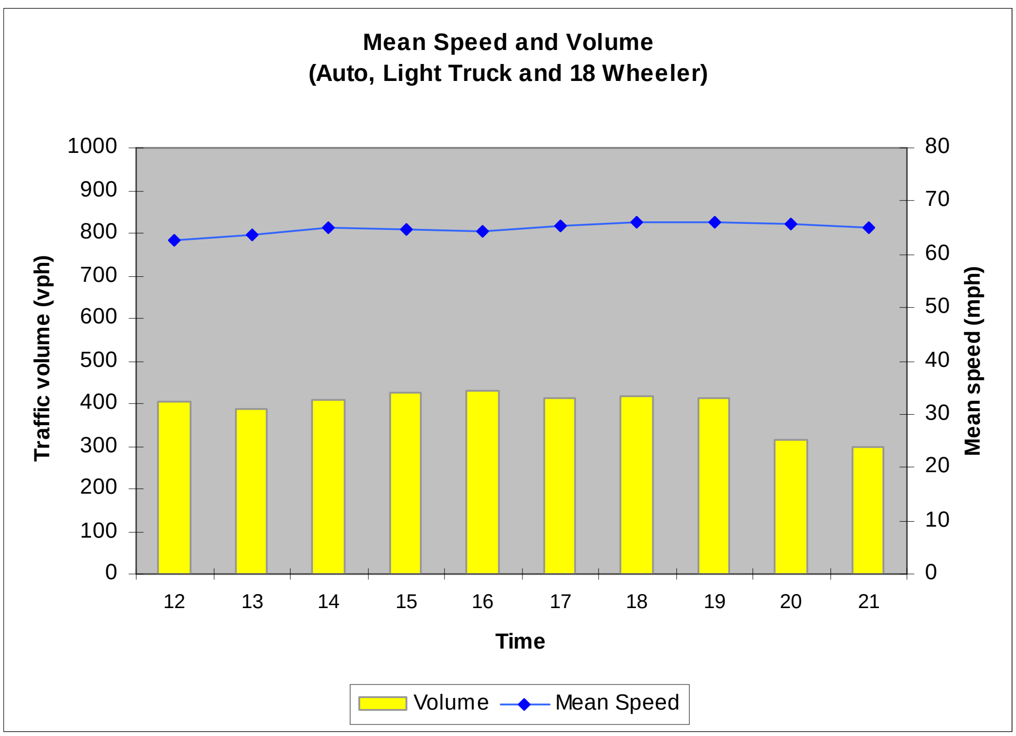


Figure 7-13 - Speed Volume Data (ATb31)

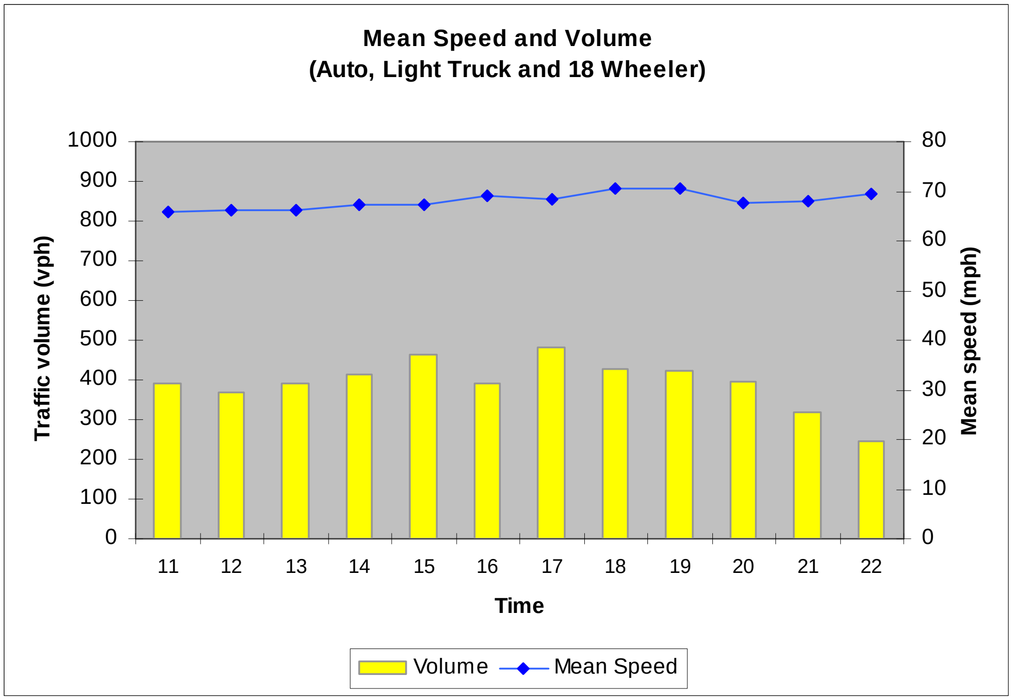


Figure 7-14 - Speed Volume Data (ATb32)

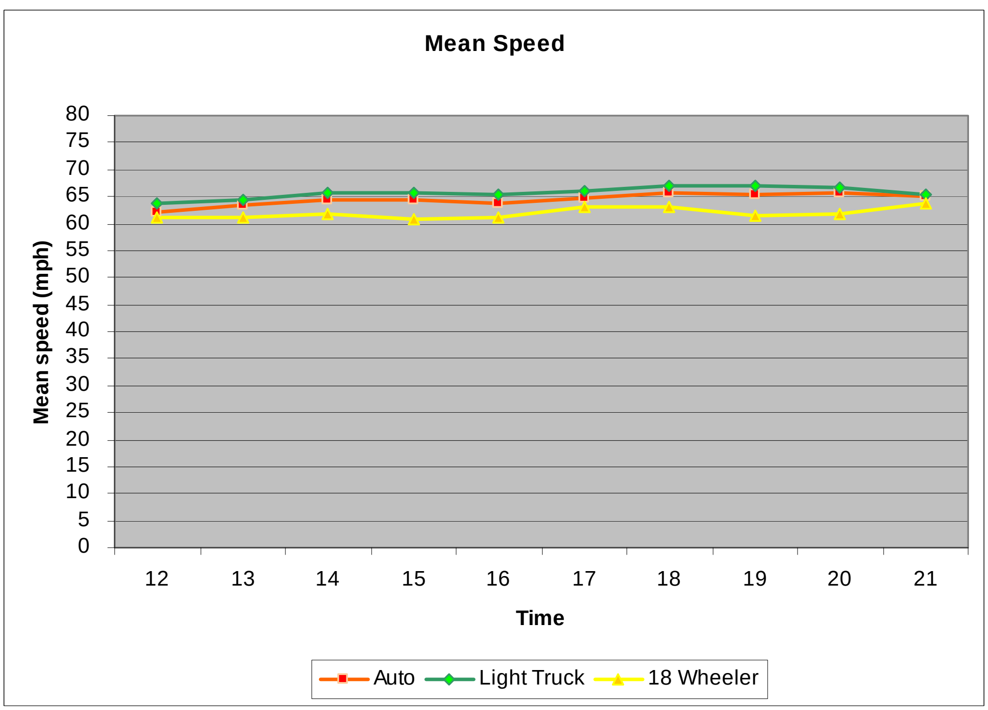


Figure 7-15 - Mean Speed Data (ATb31)

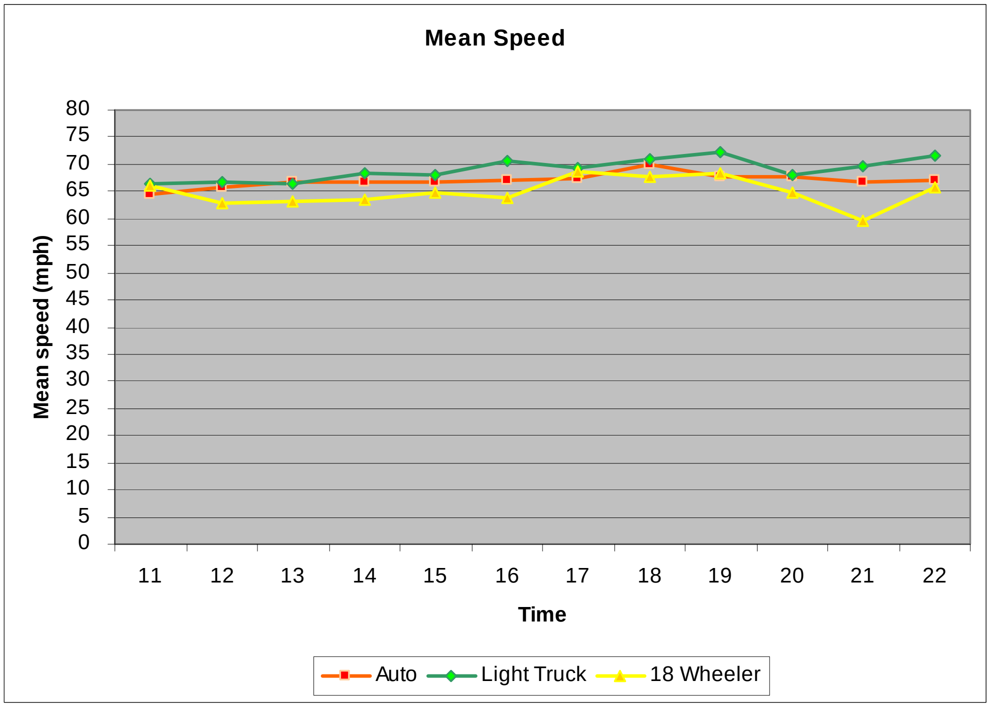


Figure 7-16 - Mean Speed Data (ATb32)

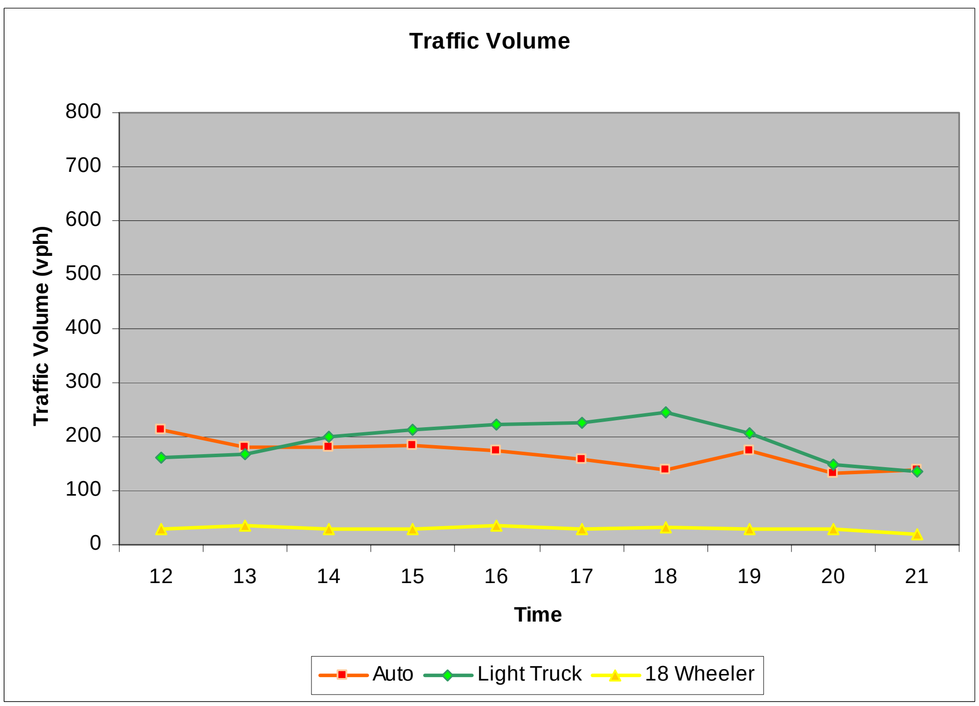


Figure 7-17 - Traffic Volume Data (ATb31)

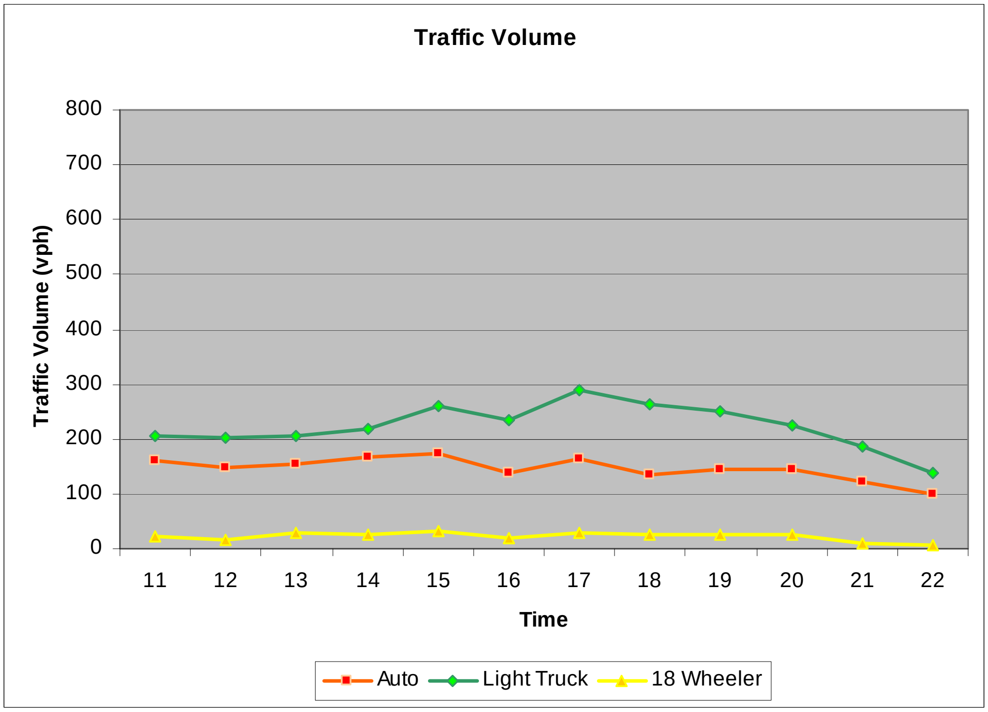


Figure 7-18 - Traffic Volume Data (ATb32)

- Location 4

The location of tube counter 4 was on Mariposa Rd., further south of location 3 and thus closer to the Mariposa POE. On the first day, data collection started at 9:00 AM and ended at 8:15 PM and for the second day from 8:00 AM to 9:30 PM.

A total of 4,615 vehicles was recorded on the first day and 5,452 vehicles on the second day. Total traffic volumes increased in comparison to location 3. The ratio of modes also changed at location 4, so that there were 62.58 percent automobiles and 37.42 percent trucks for the first day. On the second day, there were 66.49 percent automobiles and 33.51 percent trucks. The average mean speed was 52.57 mph for the first day and 52.92 mph for the second day. The speed limit on the road was 45 mph.

Figure 7-19 and Figure 7-20 shows the mean speed remained approximately the same for the two days. Traffic volumes varied, but there was no distinct peak hour. However, traffic volumes decreased after 5:15 PM on the first day and after 6:30 PM on the second day. Some oscillations were observed in the graphs of traffic volume for each mode over time; refer to Figure 7-23 and Figure 7-24. The traffic volume of 18-wheelers increased until 1:00 PM on the first day and to 12:00 PM on the second day, and then remained at that same level until 6:00 PM.

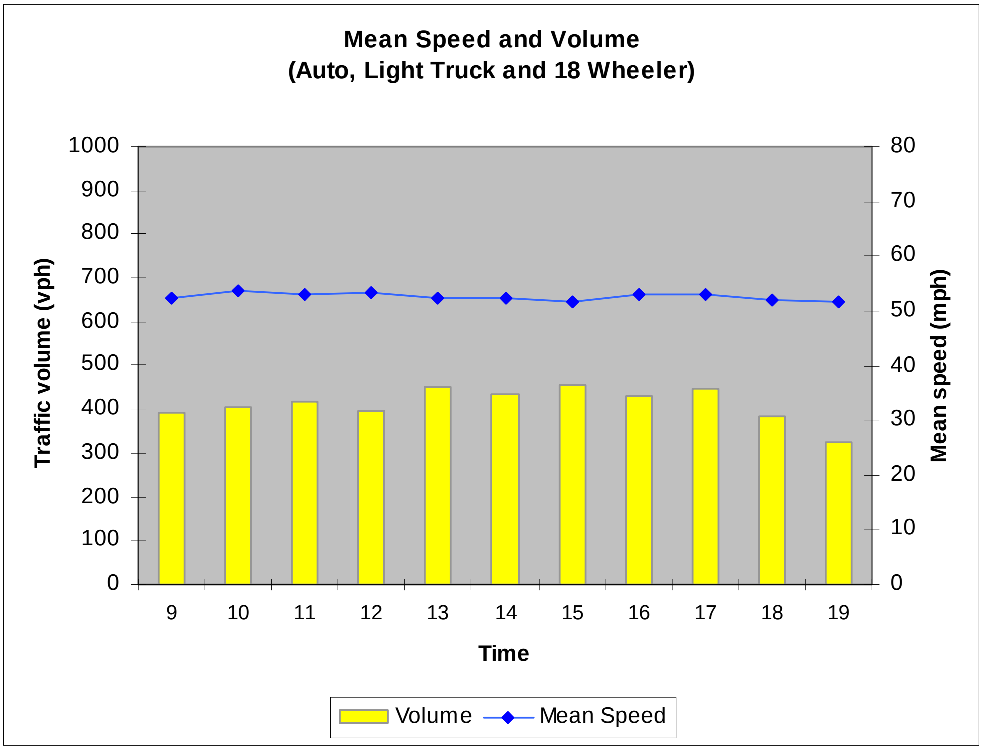


Figure 7-19 - Speed Volume Data (ATb41)

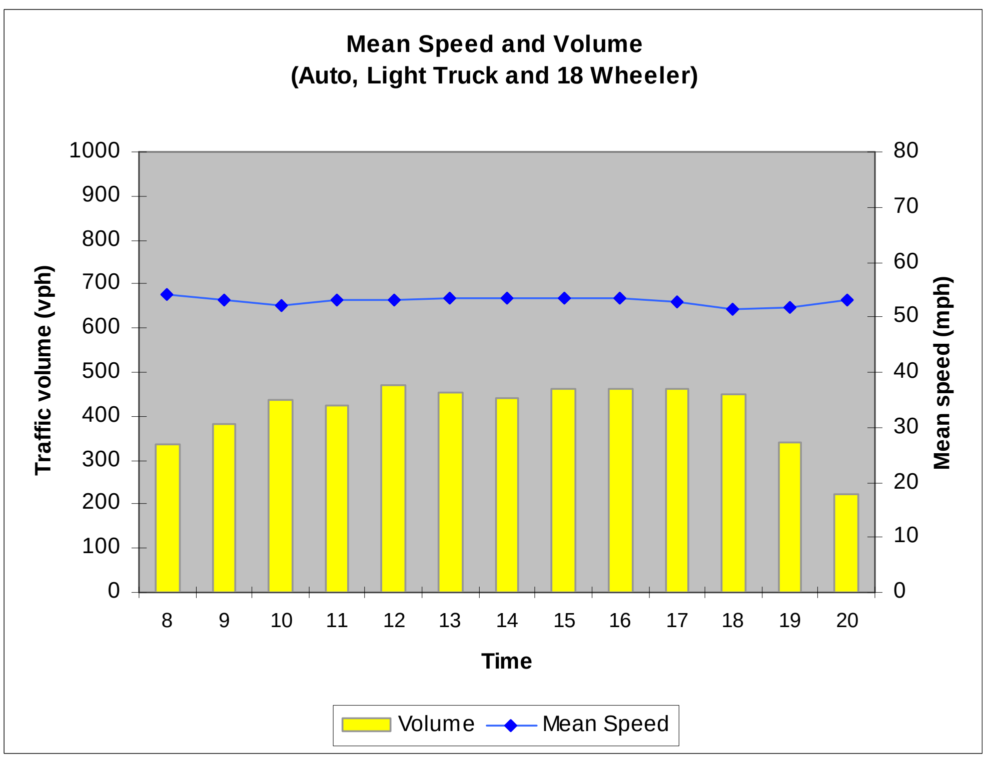


Figure 7-20 - Speed Volume Data (ATb42)

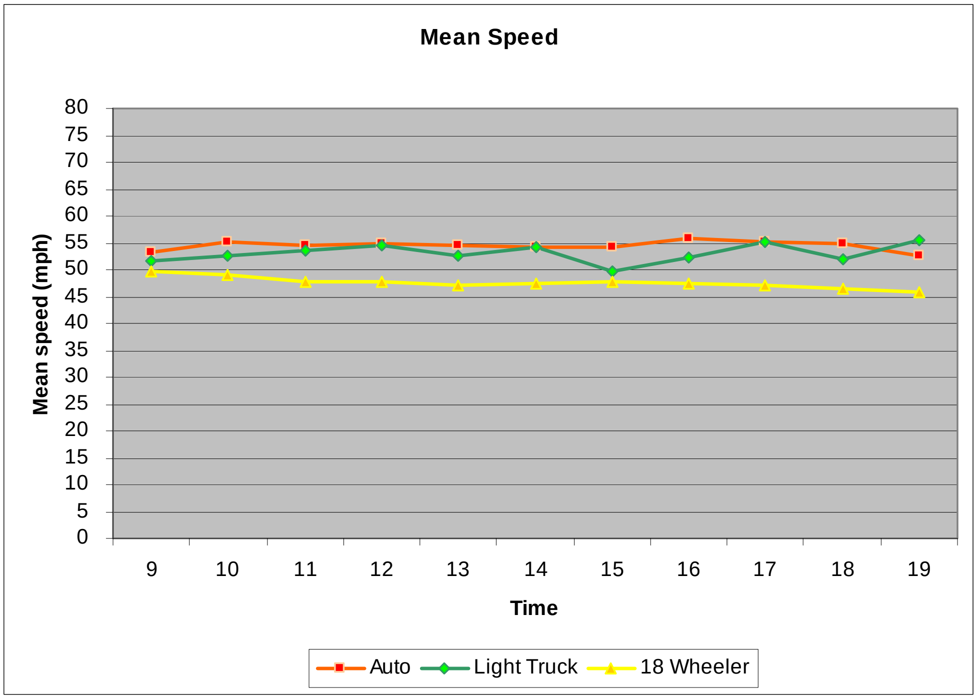


Figure 7-21 - Mean Speed Data (ATb41)

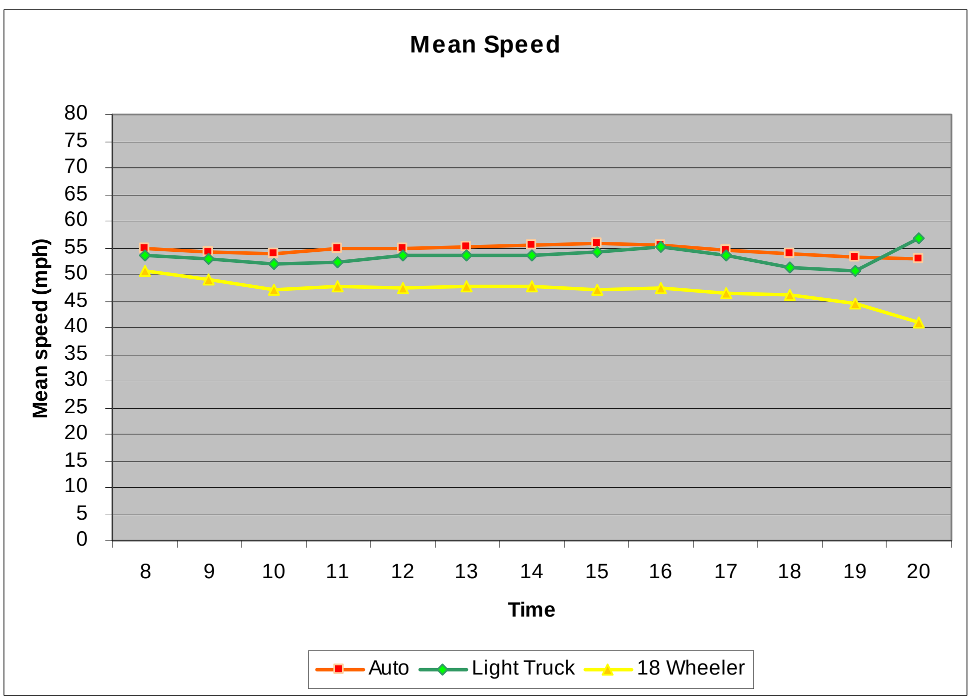


Figure 7-22 - Mean Speed Data (ATb42)

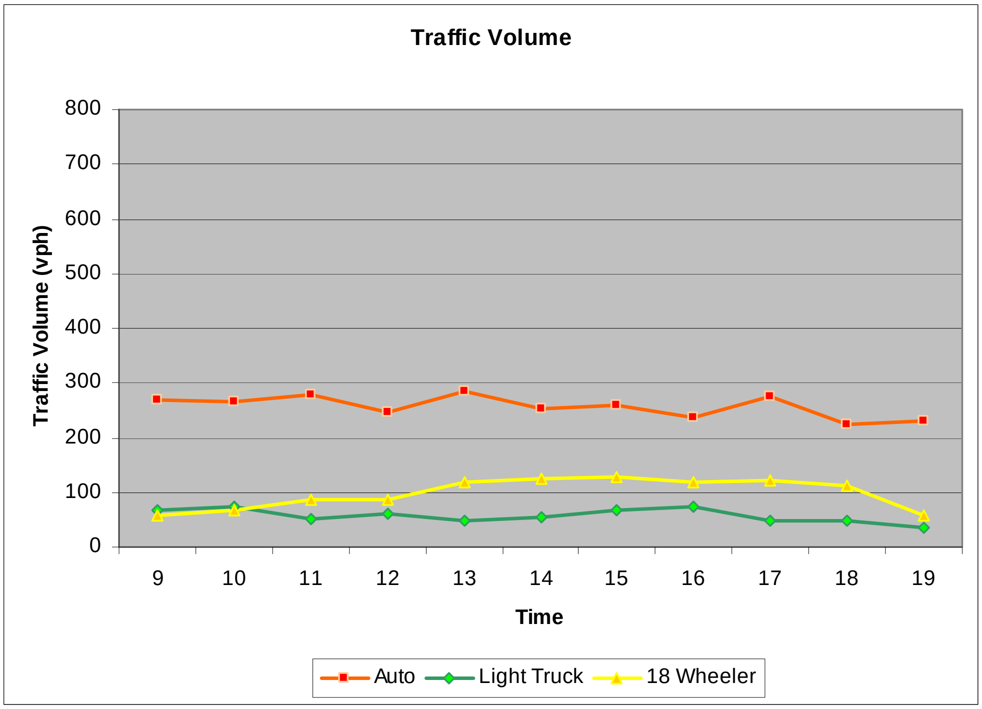


Figure 7-23 - Traffic Volume Data (ATb41)

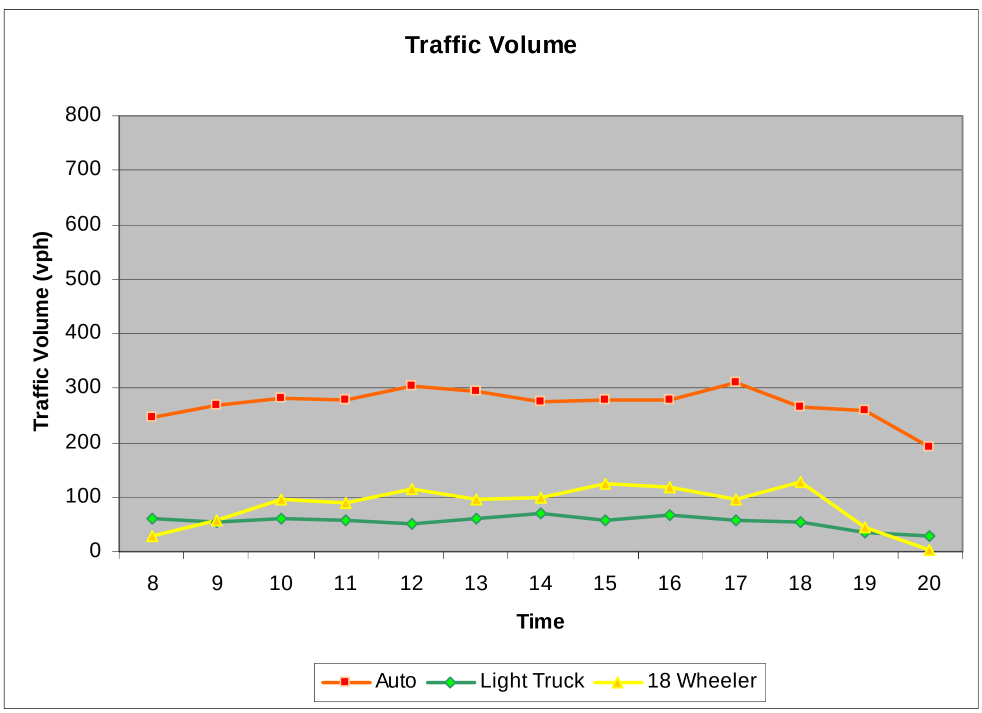


Figure 7-24 - Traffic Volume Data (ATb42)

7.1.2 Intersection Traffic Volumes

- Location 1

Figure 7-25 - IntersectionDesign (AInt1)

The first intersection was located on N. Grand Avenue and E. Baffert Drive. There were two lanes on Grand Avenue road, and one lane on Baffert Drive. On the first day, the total inbound traffic for all modes entering this intersection was 19,737 vehicles during collection time. Of vehicles using the intersection, 81.44 percent originated from Grand Avenue. Total inbound traffic for 18-wheelers was 1,312 vehicles. Of these, approximately 85 percent originated from Grand Avenue. Most traffic using the intersection originated as northbound traffic on Grand Avenue. On the second day, a total of 20,711 vehicles traversed the intersection during the data collection period. Traffic patterns were similar to those of the first day.

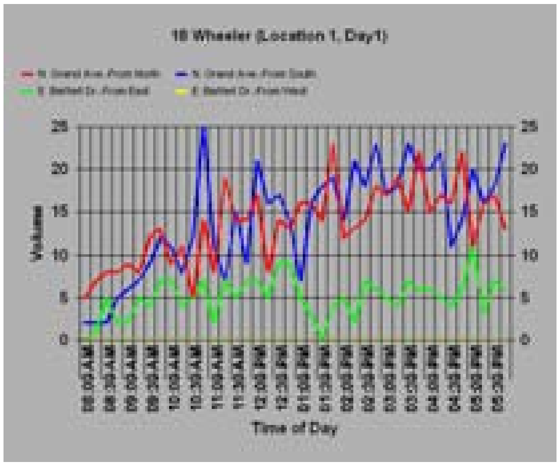


Figure 7-26 - Traffic Volume for 18 Wheeler(AInt11)

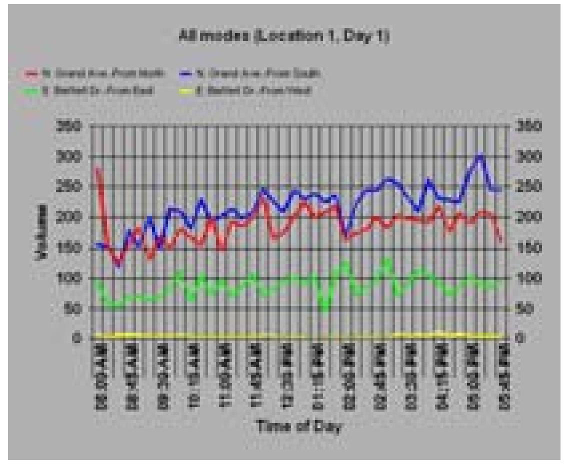


Figure 7-27 - Traffic Volume (AInt11)

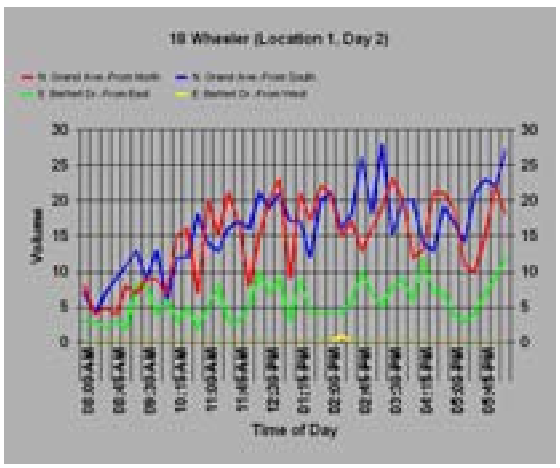


Figure 7-28 - Traffic Volume for 18 Wheeler(AInt12)

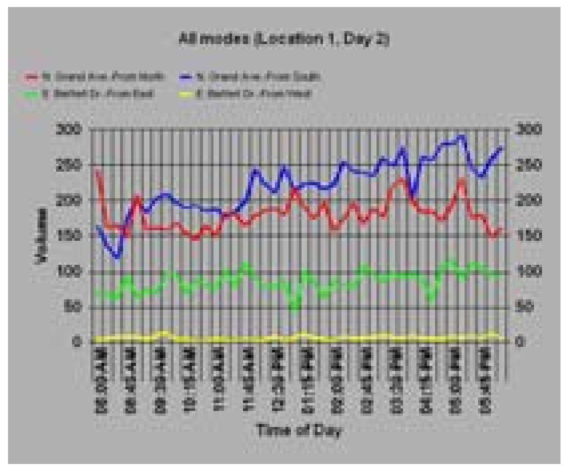


Figure 7-29 - Traffic Volume (AInt12)

- Location 2

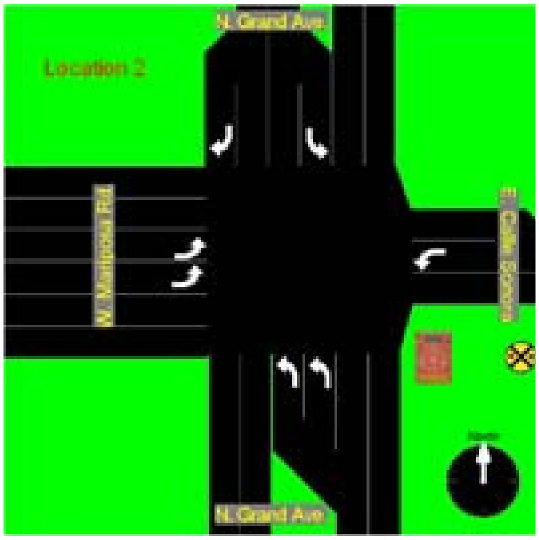


Figure 7-30 - Intersection Design (AInt2)

Data collection was completed for each direction at the intersection of N. Grand Avenue and W. Mariposa Rd. Total inbound traffic for all modes at intersection 2 was 26,541 during the collection period. Of these vehicles, 62.28 percent entered the intersection from Grand Avenue, and 28.25 percent from Mariposa Rd. In terms of 18-wheelers, total inbound volume was 1,520 vehicles per day; 34.8 percent from the north and 44 percent from the west. Most 18-wheeler flows accessed intersection 2 from N. Grand Ave, and then turned right to use the W. Mariposa Rd. or accessed the intersection from Mariposa Rd. and then turned left onto Grand Avenue.

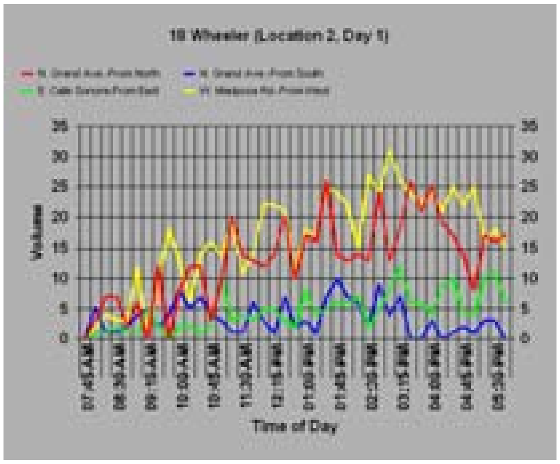


Figure 7-31 - Traffic Volume for 18 Wheeler(AIn-21)

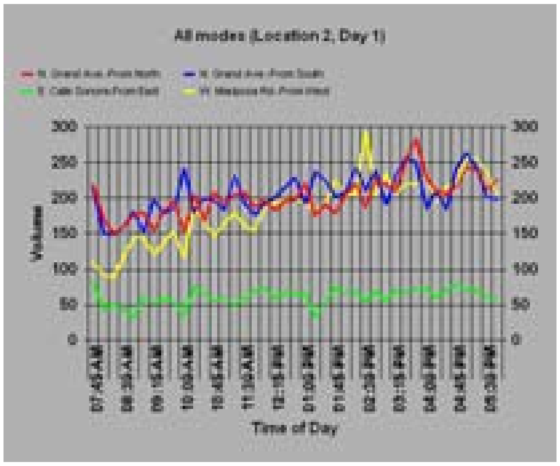


Figure 7-32 - Traffic Volume (AInt21)

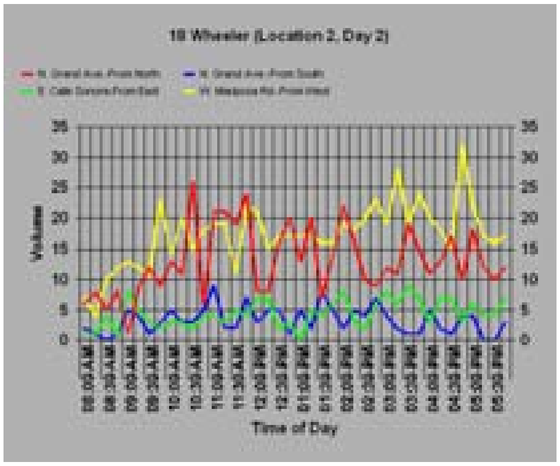


Figure 7-33 - Traffic Volume for 18 Wheeler(AInt22)

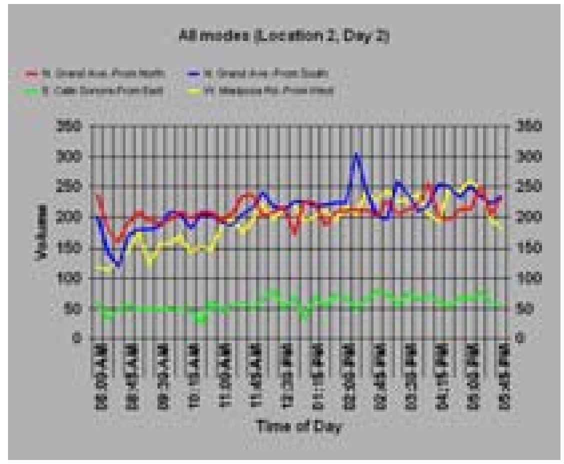


Figure 7-34 - Traffic Volume (AInt22)

- Location 3

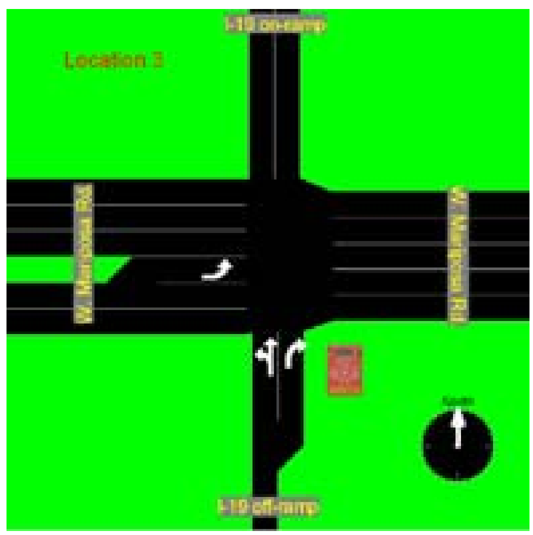


Figure 7-35 - Intersection Design (AInt3)

Intersection 3 was located on Mariposa Rd. and the I-19 northbound on-ramp. There are two lanes on Grand Avenue road and one lane on the I-19 on-ramp. On the first data collection day, 22,979 vehicles used intersection 3. On the second day, 21,742 vehicles were recorded. Since the travel pattern during the two collection days was similar, the directional traffic pattern for the first data collection day is described here. Of total inbound vehicles, 87.25 percent of total inbound vehicles were from Mariposa Rd., where 80 percent of eastbound traffic was through traffic and 20 percent turned right onto I-19. In terms of 18-wheeler flows, 1,973 vehicles entered the intersection; 55 percent was through traffic and 45 percent turned right. The

18-wheeler traffic volumes steadily increased until 4:45 PM. No distinct peak hour occurred during the day.

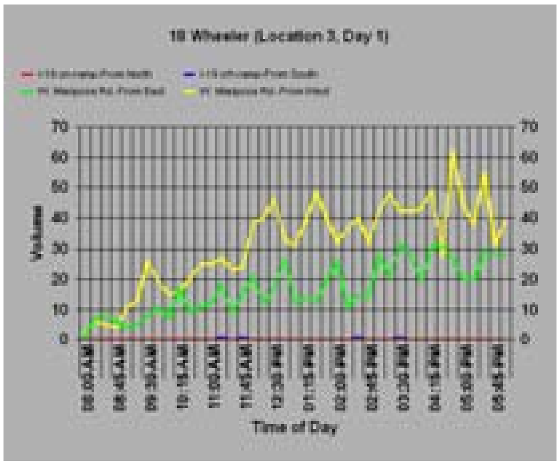


Figure 7-36 - Traffic Volume for 18 Wheeler(AInt31)

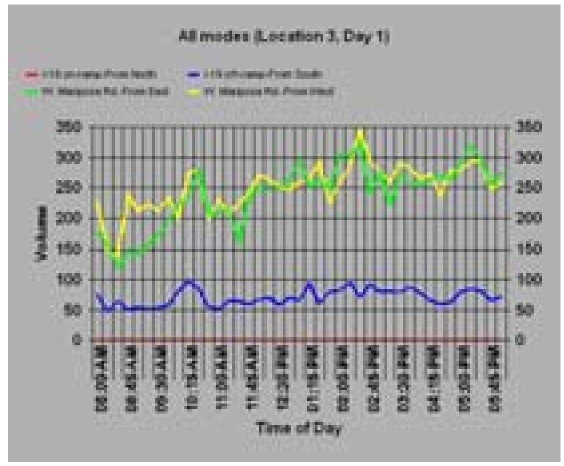


Figure 7-37 - Traffic Volume (AInt31)

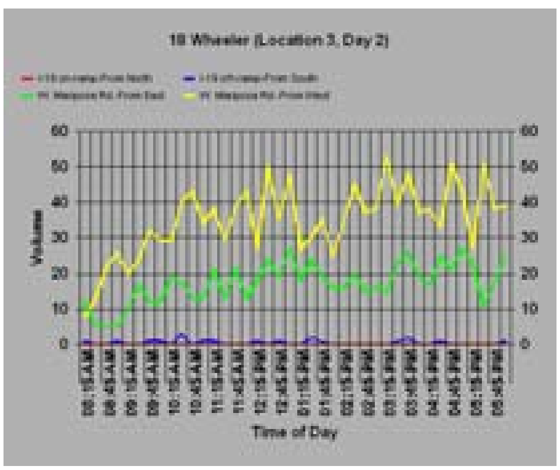


Figure 7-38 - Traffic Volume for 18 Wheeler(AInt32)

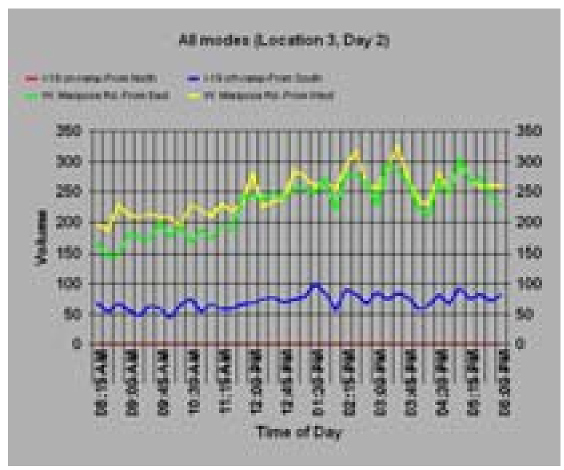


Figure 7-39 - Traffic Volume (AInt32)

- Location 4

Intersection 4 was located on Mariposa Rd. and the I-19 southbound on-ramp. Vehicles using intersection 4 totaled 22, on the first day and 21,912 vehicles on the second day. For the first day, 74.59 percent of inbound flows were through traffic from Mariposa Rd. and 21.41 percent from I-19 turning west onto Mariposa Rd. For 18-wheeler vehicles, 50 percent of total inbound traffic was from the west. Figure 7-42 and Figure 7-44 show that total traffic volume decreased from the starting time to 8:30 AM and then increased, an unusual pattern. In Figure

7-41 and Figure 7-43, 18-wheeler volumes increased sharply until 10:30 AM, and then maintained a steady increase, although there were some fluctuations during the time period.

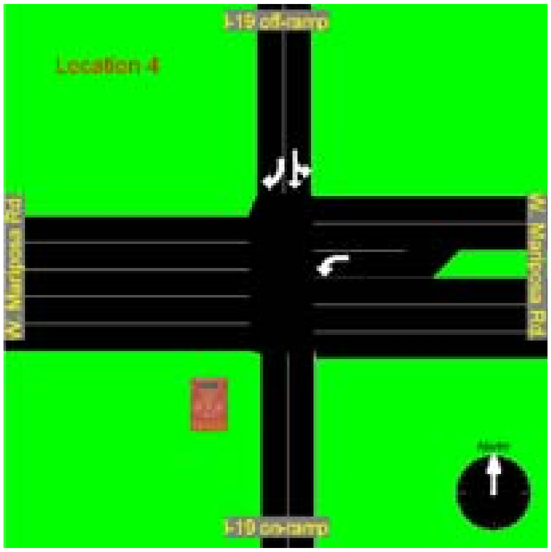


Figure 7-40 - Intersection Design (AInt4)

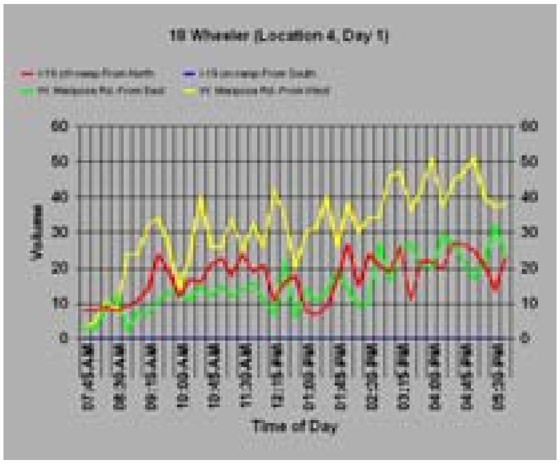


Figure 7-41 - Traffic Volume for 18 Wheeler(AInt41)

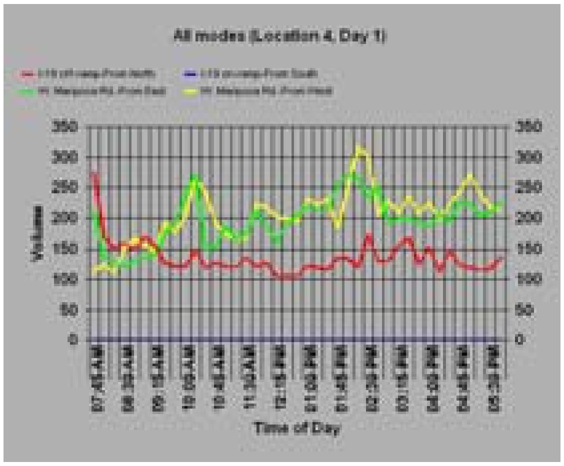


Figure 7-42 - Traffic Volume (AInt41)

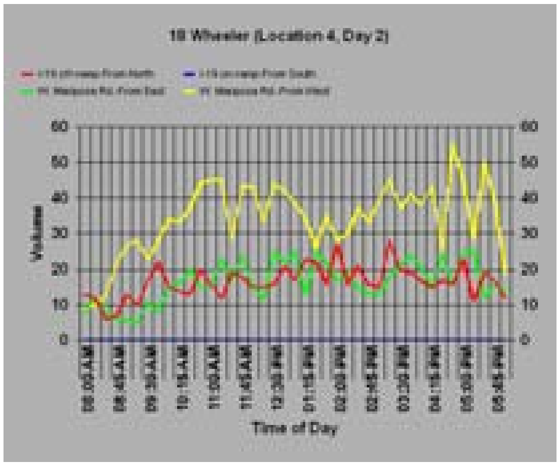


Figure 7-43 - Traffic Volume for 18 Wheeler(AInt42)

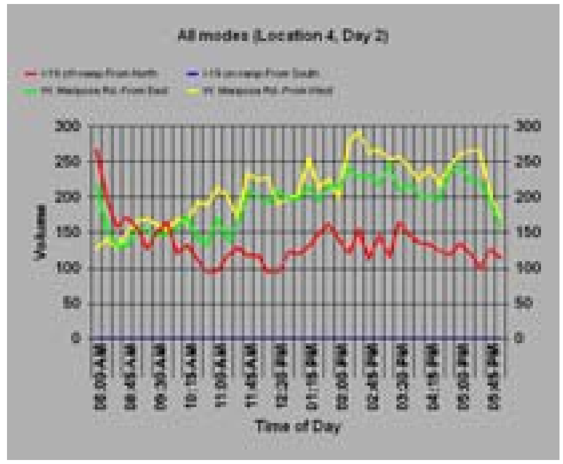


Figure 7-44 - Traffic Volume (AInt42)

- Location 5

The intersection is located at Mariposa Rd. and Frank Reed Rd. There are two lanes in each direction on Mariposa Rd. and one lane in each direction on Frank Reed Rd. Most traffic utilizing intersection 5 originated from Mariposa Rd. On the first day, a total of 19,785 vehicles were recorded where 12.59 percent consisted of 18-wheeler vehicles. Figure 7-46 and Figure 7-48 show that there was no distinct peak hour at this location in terms of 18-wheelers. Volumes of 18-wheelers sharply increased until 9:45 AM and peaked at around 1:45 PM and 4:00 PM.

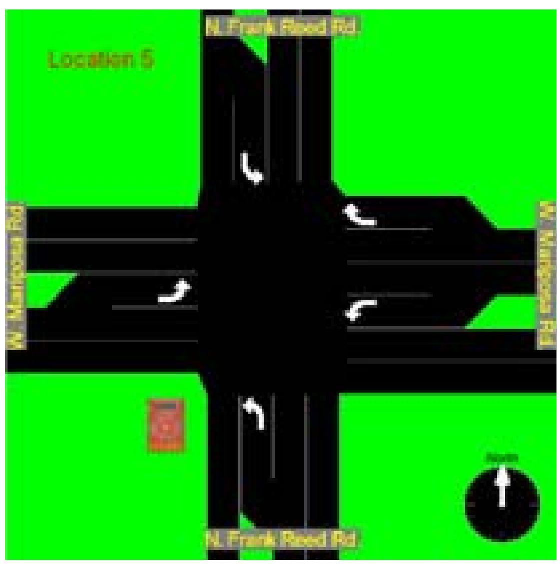


Figure 7-45 - Intersection Design (AInt5)

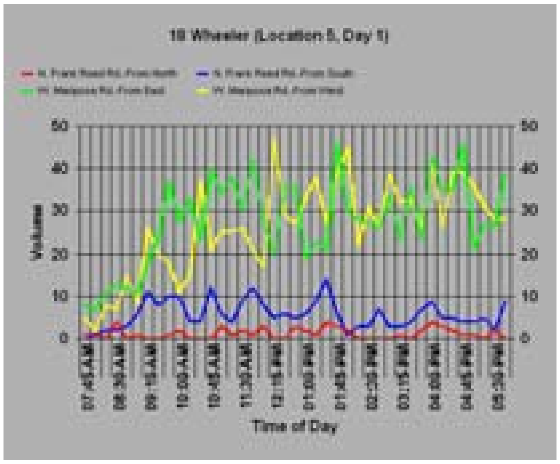


Figure 7-46 - Traffic Volume for 18 Wheeler(AInt51)

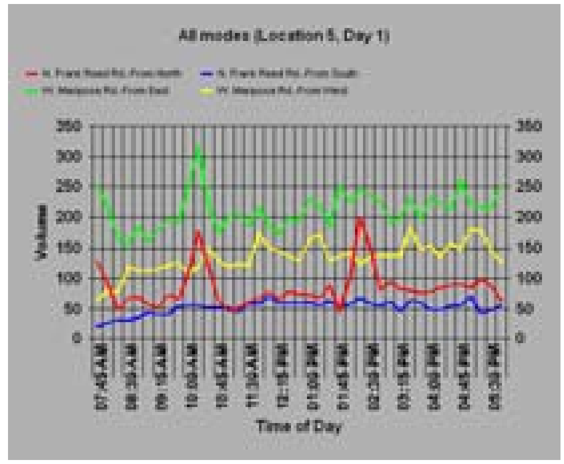


Figure 7-47 - Traffic Volume (AInt51)

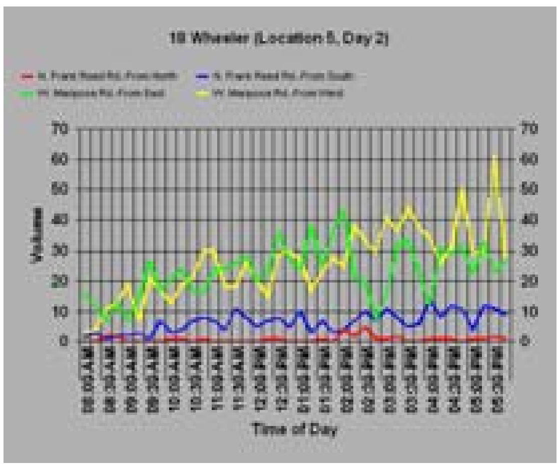


Figure 7-48 - Traffic Volume for 18 Wheeler(AInt52)

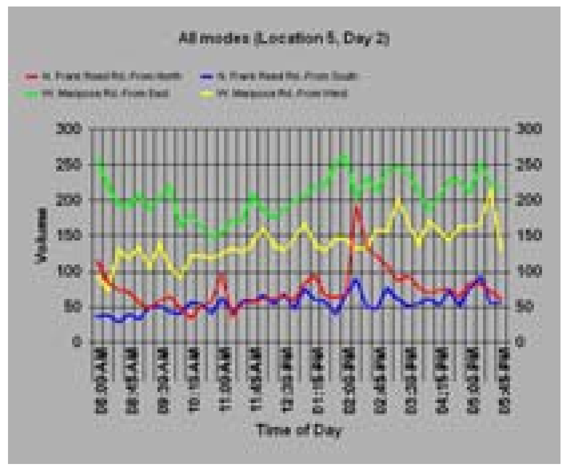


Figure 7-49 - Traffic Volume (AInt52)

- Location 6

Intersection 6 is located on Mariposa Rd. and Industrial Park Drive. On the first day, a total of 12,284 vehicles were counted accessing the intersection with main access originating from traffic traversing Mariposa Rd. On the second day, 12,700 vehicles used the intersection. For the 18-wheeler flows a total of 2,608 vehicles were recorded during the first day and 2,398 on the second day. As was the case for the total number of vehicles, the 18-wheeler vehicles also mainly used Mariposa Rd., as observed in Figure 7-51 and Figure 7-53. On the first day, 18-wheeler traffic volumes steadily increased until 5:00 PM. On the second day, 18-wheeler traffic volumes increased until approximately 12:45 PM and then slightly decreased to a constant level.

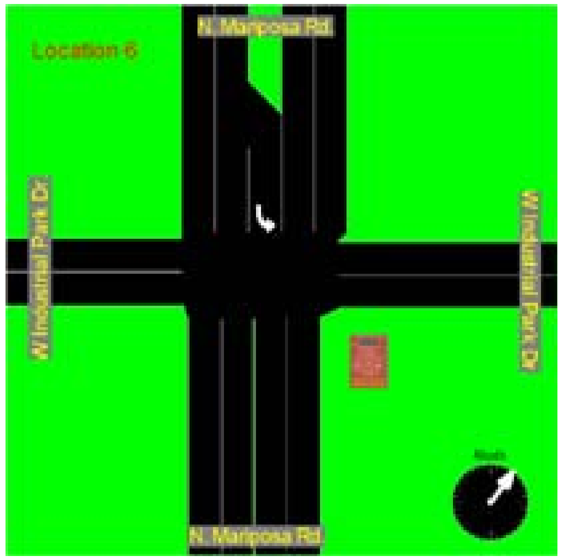


Figure 7-50 - Intersection Design (AInt6)

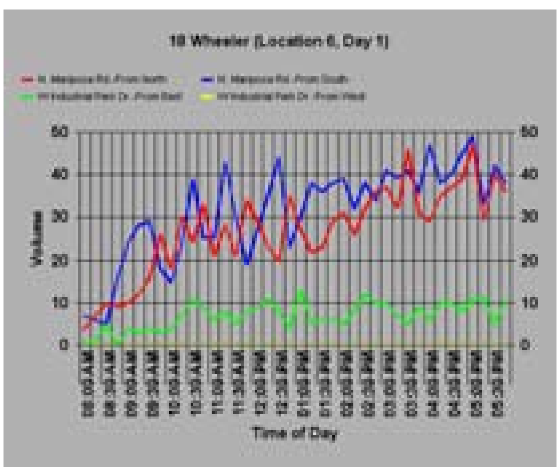


Figure 7-51 - Traffic Volume for 18-Wheeler(AInt61)

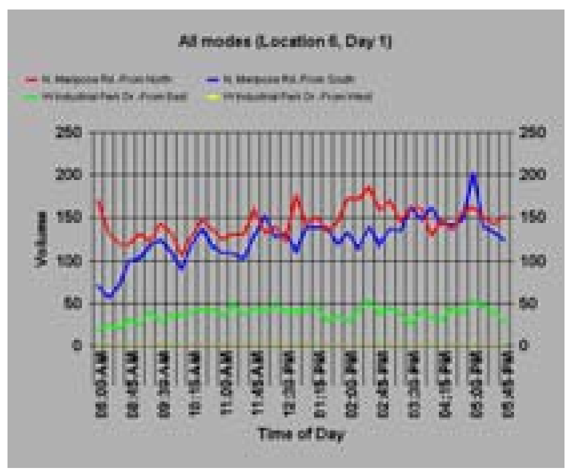


Figure 7-52 - Traffic Volume (AInt61)

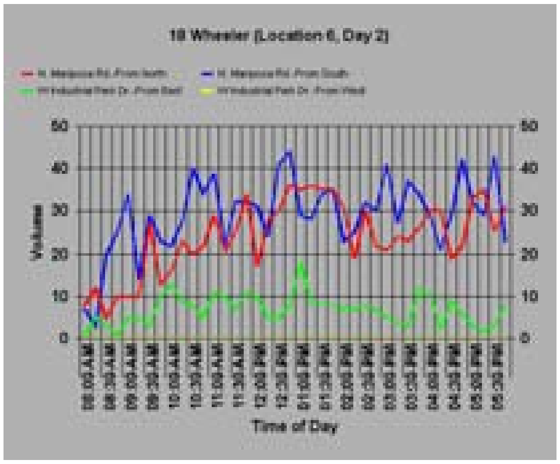


Figure 7-53 - Traffic Volume for 18-Wheeler(AInt62)

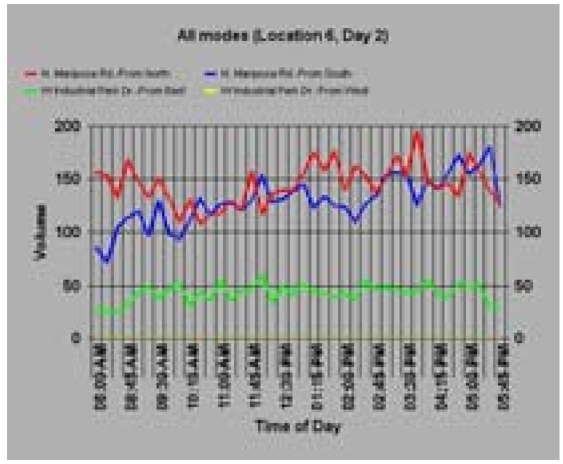


Figure 7-54 - Traffic Volume (AInt62)

- Location 7

Intersection 7 is located on N. Industrial Park Ave. and W. Industrial Park Ave. A total of 3,939 vehicles were recorded at this location on the first day and 4,409 vehicles on the second day. As to 18-wheeler vehicles, 453 and 615 of these vehicles entered the intersection on the first and second day.

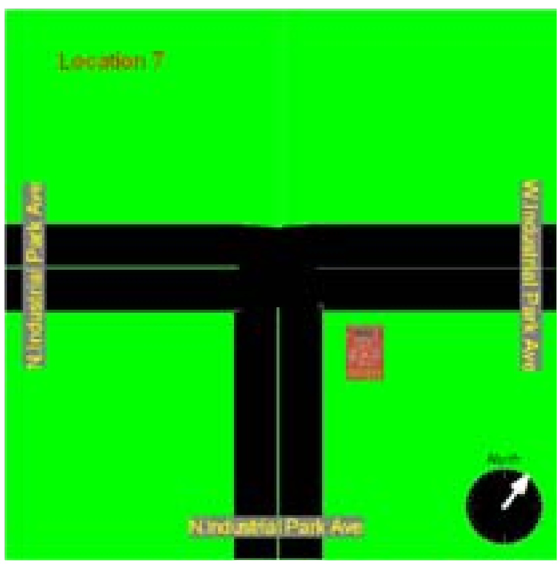


Figure 7-55 - Intersection Design (AInt7)

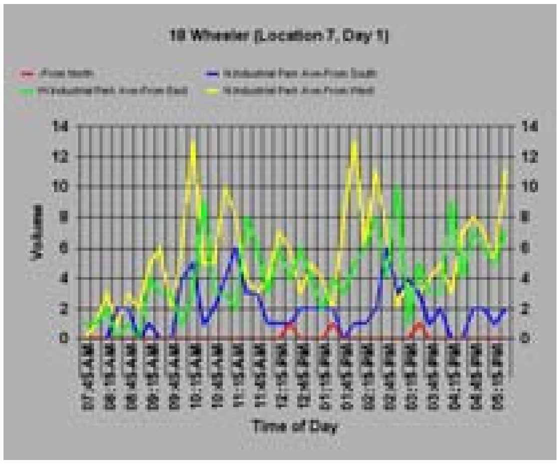


Figure 7-56 - Traffic Volume for 18 -Wheelers(AInt71)

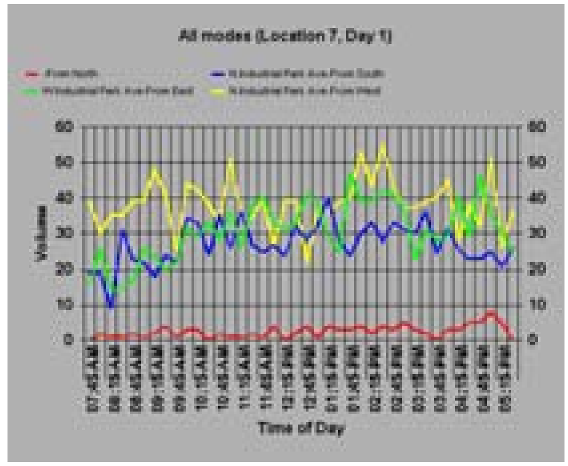


Figure 7-57 - Traffic Volume (AInt71)

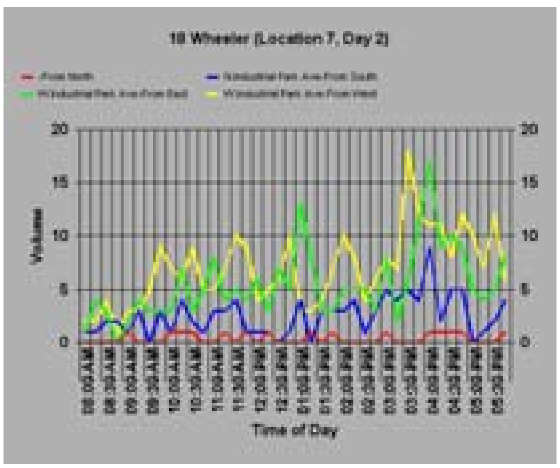


Figure 7-58 - Traffic Volume for 18 -Wheelers(AInt72)

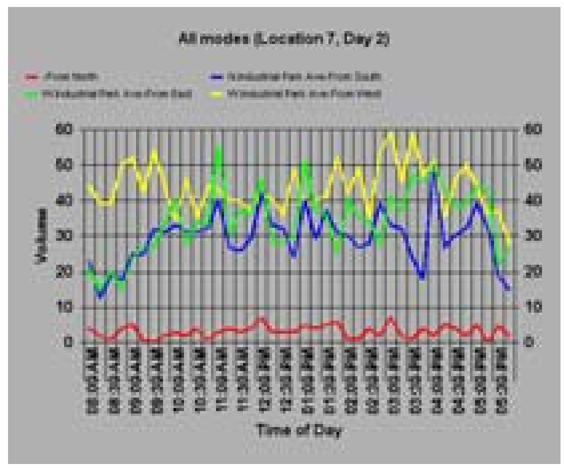


Figure 7-59 - Traffic Volume (AInt72)

- Location 8

Intersection 8 is located on N. Mariposa Rd. and N. Target Range Rd. A total of 11,630 vehicles were recorded on the first day and 12,020 vehicles on the second day. Most inbound traffic originated from Mariposa Rd. For 18-wheeler volumes, 1,913 vehicles were recorded on the first day and 1,901 vehicles on the second day.

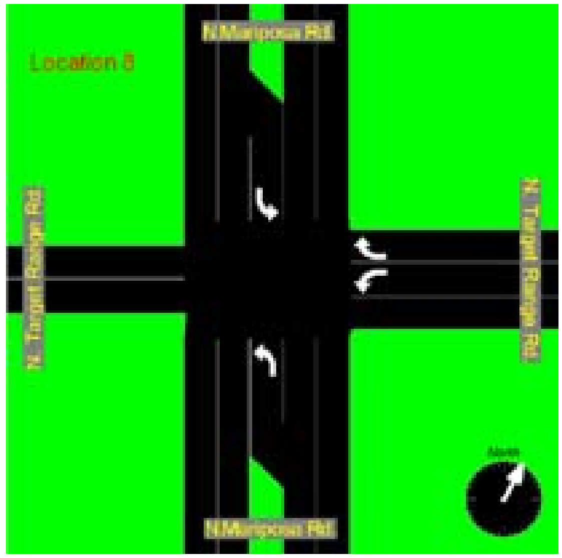


Figure 7-60 - Intersection Design (AInt8)

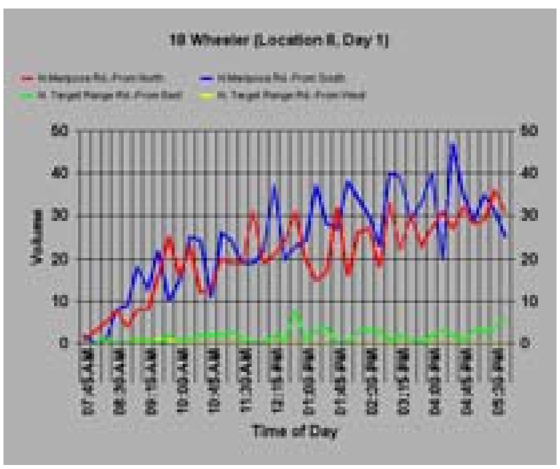


Figure 7-61 - Traffic Volume for 18-Wheeler(AInt81)

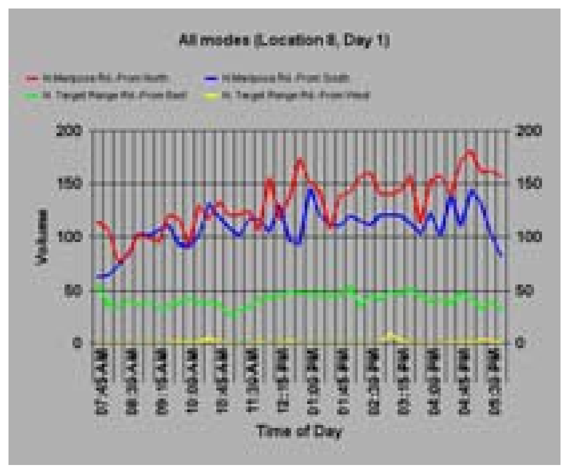
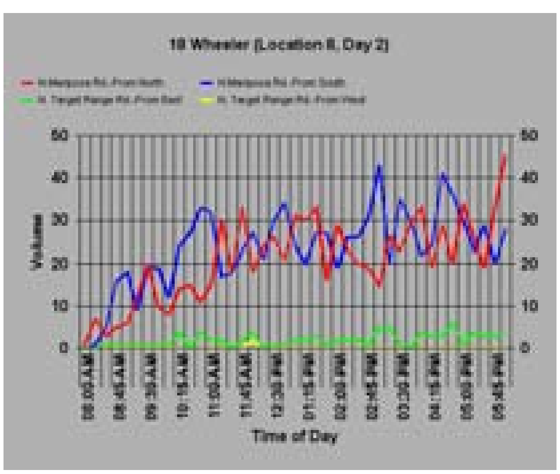


Figure 7-62 - Traffic Volume (AInt81)



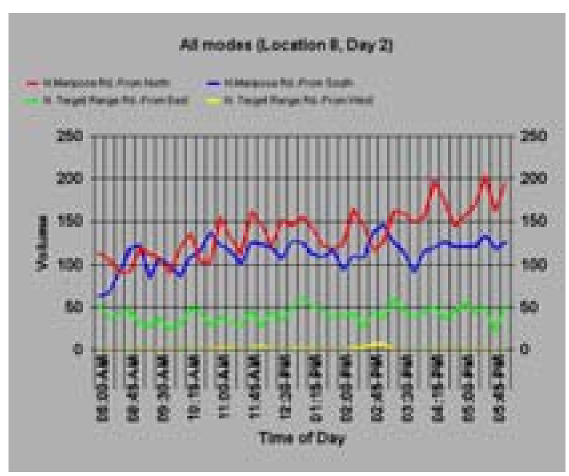


Figure 7-63 - Traffic Volume for 18-Wheeler(AInt82) **Figure 7-64 - Traffic Volume (AInt82)**

7.1.3 Delay Analysis

The intersection turn movement counts provide traffic movement data throughout the day. Inflow and outflow data can be processed to estimate the delay at these locations, providing valuable information about the traffic congestion and delay situations at these locations. Intersections were chosen at important locations to determine the system capacity in the study area.

The intent was to compare the difference between outbound traffic of the former intersection and inbound traffic of the next intersection at 15 minute intervals. The difference in traffic volumes between the two was considered to represent the delay to next intersection. Because there were other small roads between the two intersections, the total amount of inbound traffic was not the same as the amount of outbound traffic throughout the day. The difference between inbound and outbound traffic volume per day was distributed by the ratio of inbound traffic volume at each time period, under the assumption that new injected traffic volume between former intersection and the next intersection is likely to be merged into original outbound traffic from the former intersection uniformly.

The negative value of difference in a delay analysis graph means that discharged traffic volume is bigger than arrived traffic volume. It shows that the capacity of the intersection is enough to process the demand at each time interval. Using the same assumptions and analysis, if the difference is positive, there will be delays at an intersection. The amount of delayed vehicle was represented as a positive value in a graph. Therefore, a big positive value at a time interval indicates that the possibility of having long delay is huge. Further, if the length of the time interval having a positive value is large, it is expected that there was a long delay at an intersection. The characteristics of selected intersection pairs are described briefly in the following figures.

- From AInt6 to AInt 5

For the first day, the length of the time interval with a positive value was not long, but there were some extreme points at 12:00 PM and 5:00 PM. It is inferred that the system capacity was less than the demand at these time intervals. On the second day, there was a long delay from 4:30 PM to 5:30 PM.

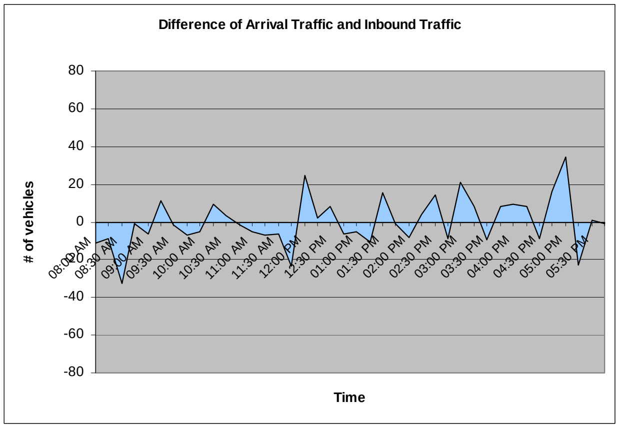


Figure 7-65 - Delay from AInt61 to AInt51

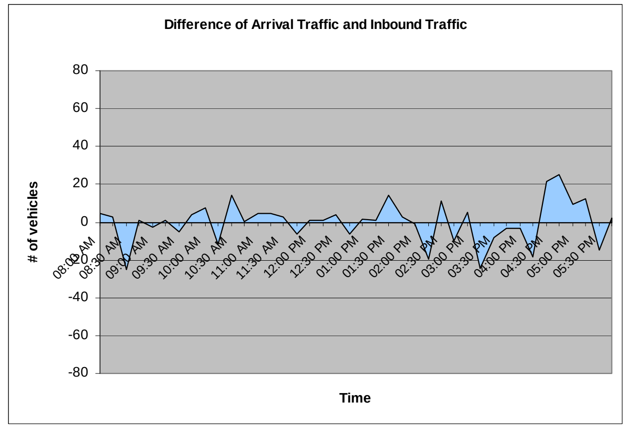


Figure 7-66 - Delay from AInt62 to AInt52

- From AInt 5 to AInt 4

For the first day, there was a long time interval in a graph from 11:00 AM to 1:30 PM. The height of the positive value was not high. On the second day, the time interval is not wide, one can see that there were some extreme points from 1:00 PM to 1:15 PM and from 2:15 PM to 2:30 PM.

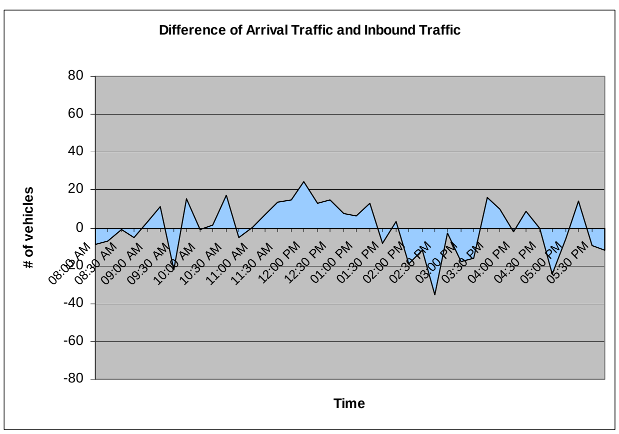


Figure 7-67 - Delay from AInt51 to AInt41

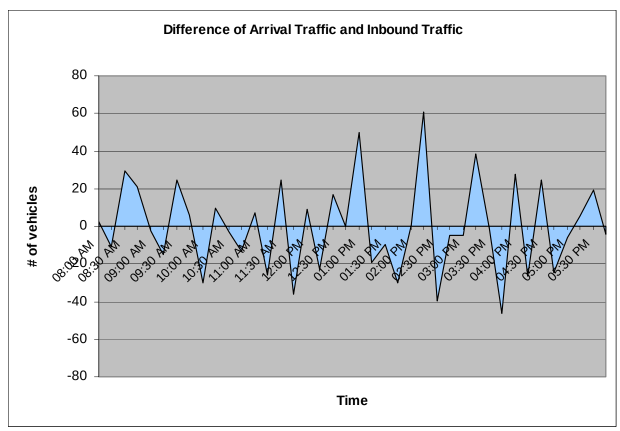
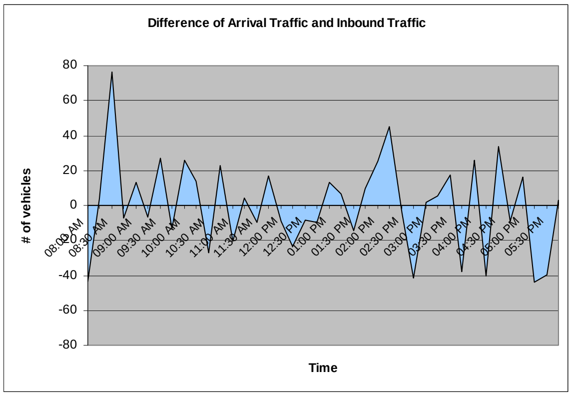


Figure 7-68 - Delay from AInt52 to AInt42

- From AInt 4 to AInt 3

On the first day, the length of each time interval having positive value is not long. However, there were two big values in a graph from 8:30 AM to 8:45 AM, and from 1:45 PM to 2:30 PM. For the second day, there was high probability of having long delay at intersection 3 from 2:45 PM to 5:00 PM.



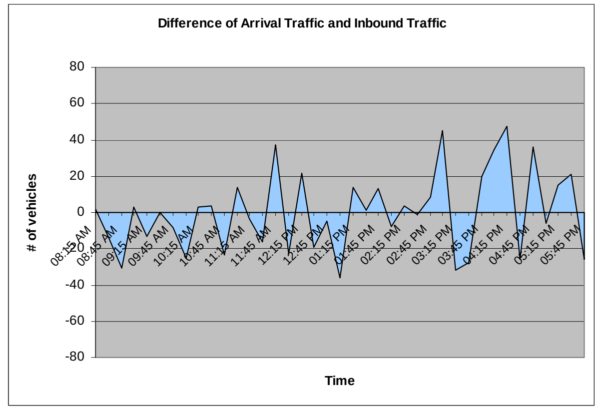
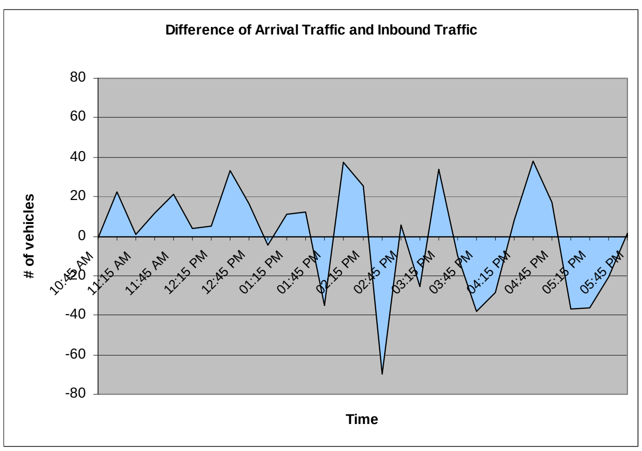


Figure 7-69 - Delay from AInt41 to AInt31

Figure 7-70 - Delay from AInt42 to AInt32

- From ATb 2 to AInt 2

For the first day, positive differences appear over a wide time interval extending from the data collection start time until 1:00 PM, although the height of those differences was not great. After 1:00 PM, there were four intervals showing the high possibility of the existence of delay. The second day did not show the prolonged period of delay evident on the first day, but relatively high positive points were observed at 2:15 PM, 4:15 PM and 5:30 PM.



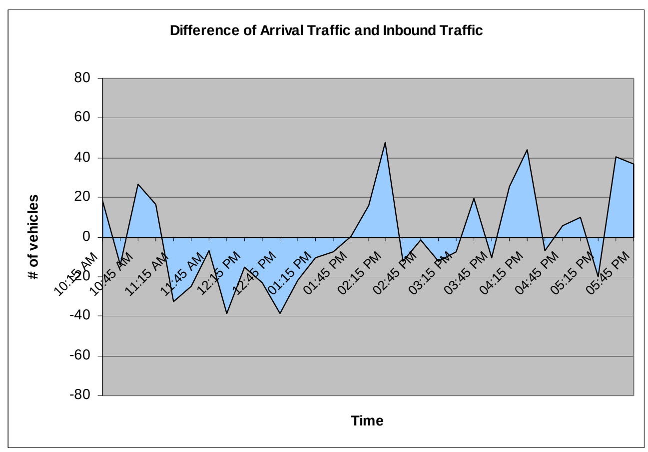


Figure 7-71 - Delay from ATb21 to AInt21

Figure 7-72 - Delay from ATb22 to AInt22

7.2 Nogales, Sonora, Mexico

Traffic volumes for automobiles, light trucks and 18-wheelers were counted separately at eight different locations in Nogales, Sonora, Mexico. We separated traffic volume graphs into two groups to examine the proportion of traffic volume consisting of 18-wheelers. From location 5 to 8, the proportion of traffic volume that was 18-wheelers amounted to less than

5 percent. These locations were named as group 1. The group 1 graphs show that most of the vehicles were automobiles. The second group includes from location 1 to 4. The proportion of 18-wheelers in group 2 was heavy. For example, over 80 percent of vehicles were 18-wheelers at location 4. From this observation, the scale of graphs for each group was set distinctly. These graphs can, thus, help one to understand the traffic volume for the 18-wheelers within the part of the study area in Nogales, Mexico.

Data from location 1 (MCnt1) is given in the charts below for day one and day two. The data collection hours are from 8:30 AM to 7:30 PM on Day One and from 8:30 AM to 6:00 PM on Day Two. Both days had approximately the same volumes for all traffic. The automobile volume line fluctuates at around 80 for each time interval during the day, while the 18-wheelers begin with around 40 at 8:30 AM and end around five at 6:30 PM, and the light trucks average between zero and 20 during the data collection hours.

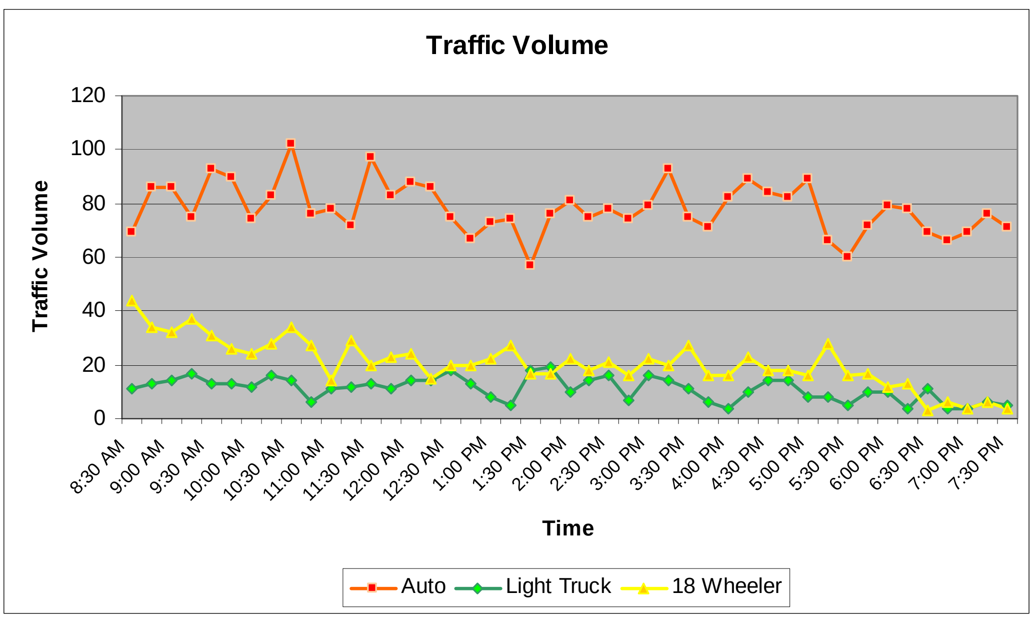


Figure 7-73 - Location 1, Day 1 (MCnt1)

8 METHODOLOGY FOR INTERSECTION DELAY CALCULATION

Delay at an inbound approach at one intersection was estimated by using the cumulative departure curve of the two intersections and was represented by the area between two cumulative graphs, subtracting the area associated with travel time between two points, refer to Figure 8-1. If there is no delay between two points, the shapes of two graphs will be the same, and the area between two points will represent only the travel time[49] between them when no delay is present. If, however, there is delay between upstream and downstream, the slope of the upstream cumulative graphs will be greater than the one of the downstream graph. We can then represent delay by the area between two cumulative graphs after leaving out the travel time area.

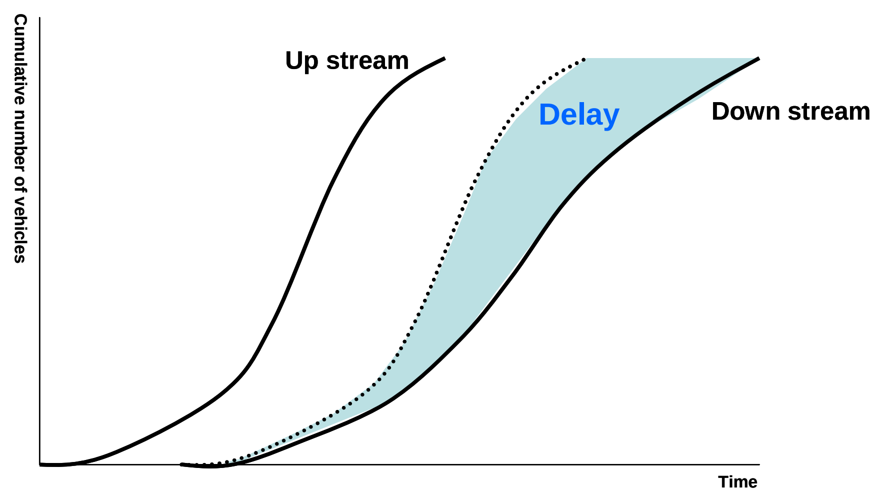


Figure 8-1 – Total delay between consecutive intersections

Total delay or average delay shows the amount of delay at an intersection during collection hour. In order to diagnose the traffic flow condition at an intersection, it is helpful to analyze the flow by a number of short time-periods rather than the whole time duration. Since the condition varies over time, one should focus on the time period having the worst traffic condition. For this reason, we calculated time point delay at major intersections and compared the results. How to obtain time point delay at major intersections is illustrated in Figure 8-2.

From the cumulative graphs for upstream and downstream, we obtained basic information in terms of time and cumulative number of vehicles at each time. In Figure 8-2, the x value represents time, and the y value indicates the cumulative number of vehicles. Because

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[49] The travel time was calculated by considering the posted speed limit and the distance.

there was no information about the times which have the same cumulative numbers of vehicles for both graphs, we interpolate y values of upstream into a downstream cumulative graph. The difference between two time points having the same y value describes actual travel time of a vehicle between two intersections. We finally calculated delay of a vehicle which drove from up-node to down-node by subtracting a travel time[50] between two locations from estimated travel time. Using this procedure, as illustrated in Figure 8-2, the delay for the 24,745th vehicle in upstream is exhibited.

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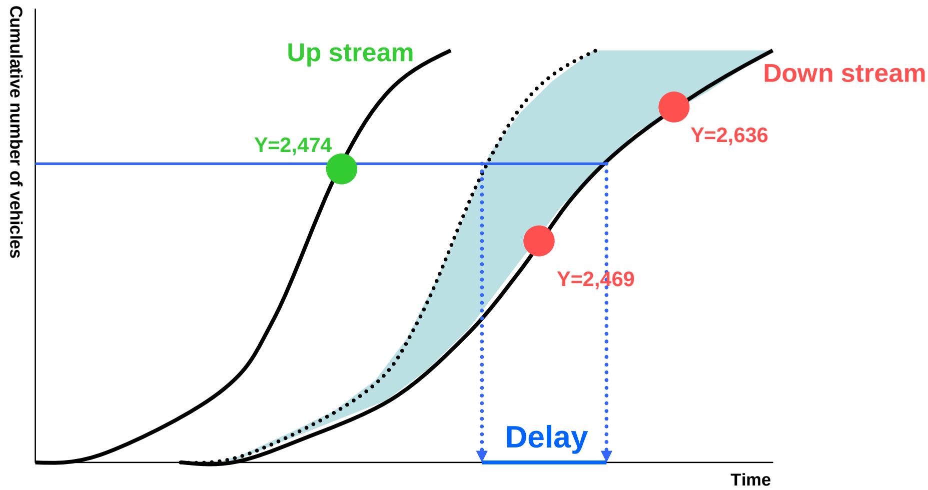


Figure 8-2 – The calculation of point delays

Chiu, Y.-C., E. Nava, H. Zheng and B. Bustillos (2008). DynusT User's Manual (http://dynust.net/wikibin/doku.php).

Louis Berger Group and Performa (2007). Program Development Study Mariposa Port of Entry. Nogales, AZ, U.S. General Service Administration**:** 87.

[50] The travel time was calculated by considering the posted speed limit and the distance.

9 TRAFFIC COUNT RAW DATA

9.1 Nogales, Arizona. USA.

9.1.1 Pneumatic Tube Count Datasets

9.1.1.1 Day 1

- Location 1

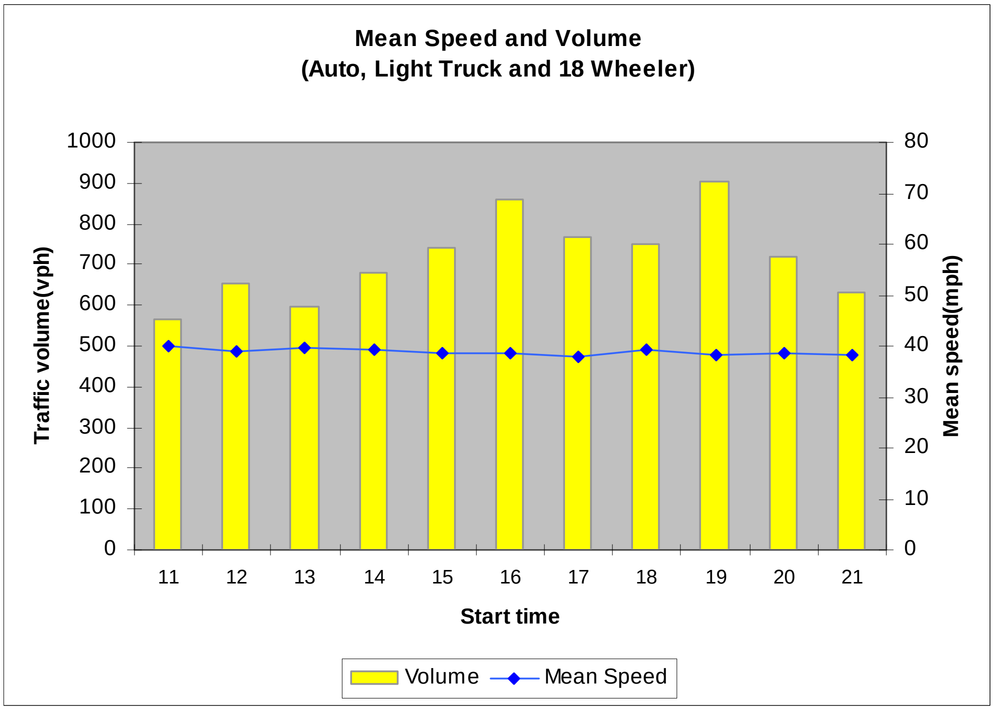


Figure 9-1 - Speed and volume data (ATb-11)

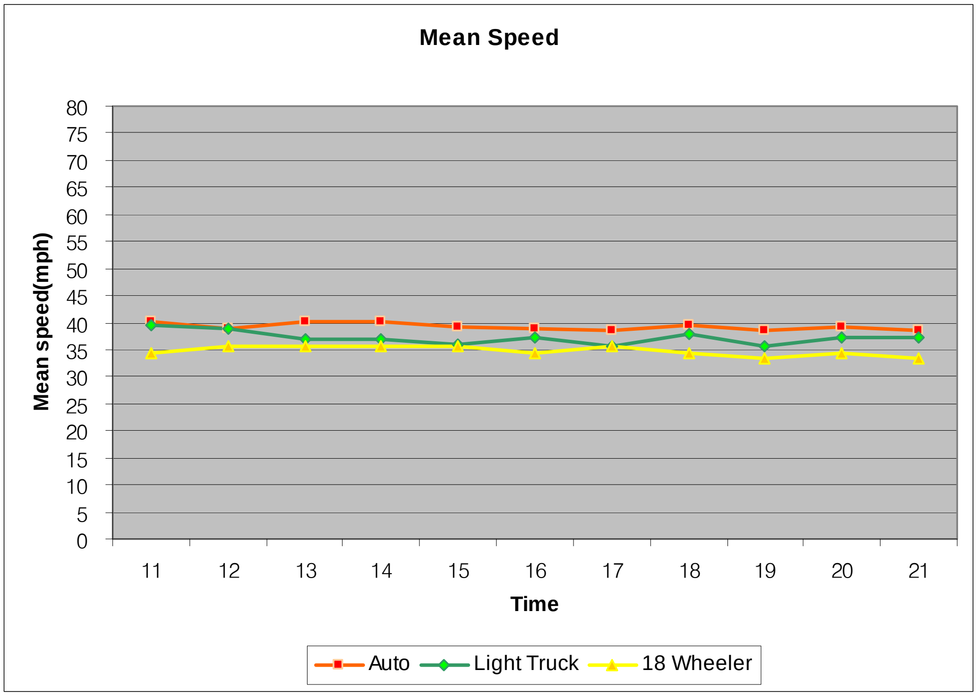


Figure 9-2 - Mean speed data (ATb-11)

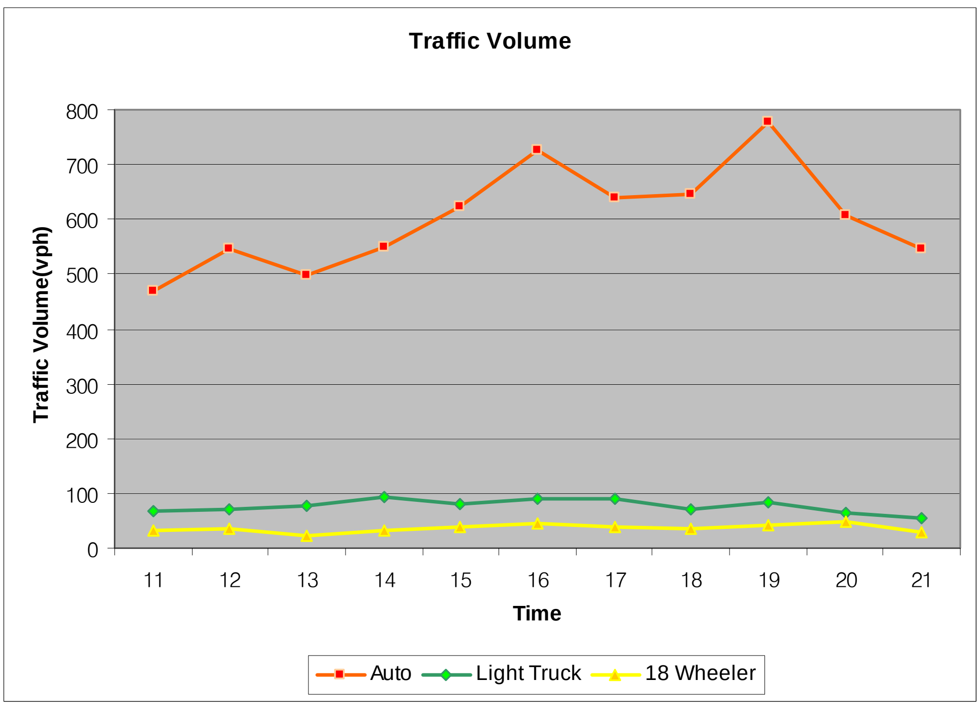


Figure 9-3 - Traffic volume data (ATb-11)

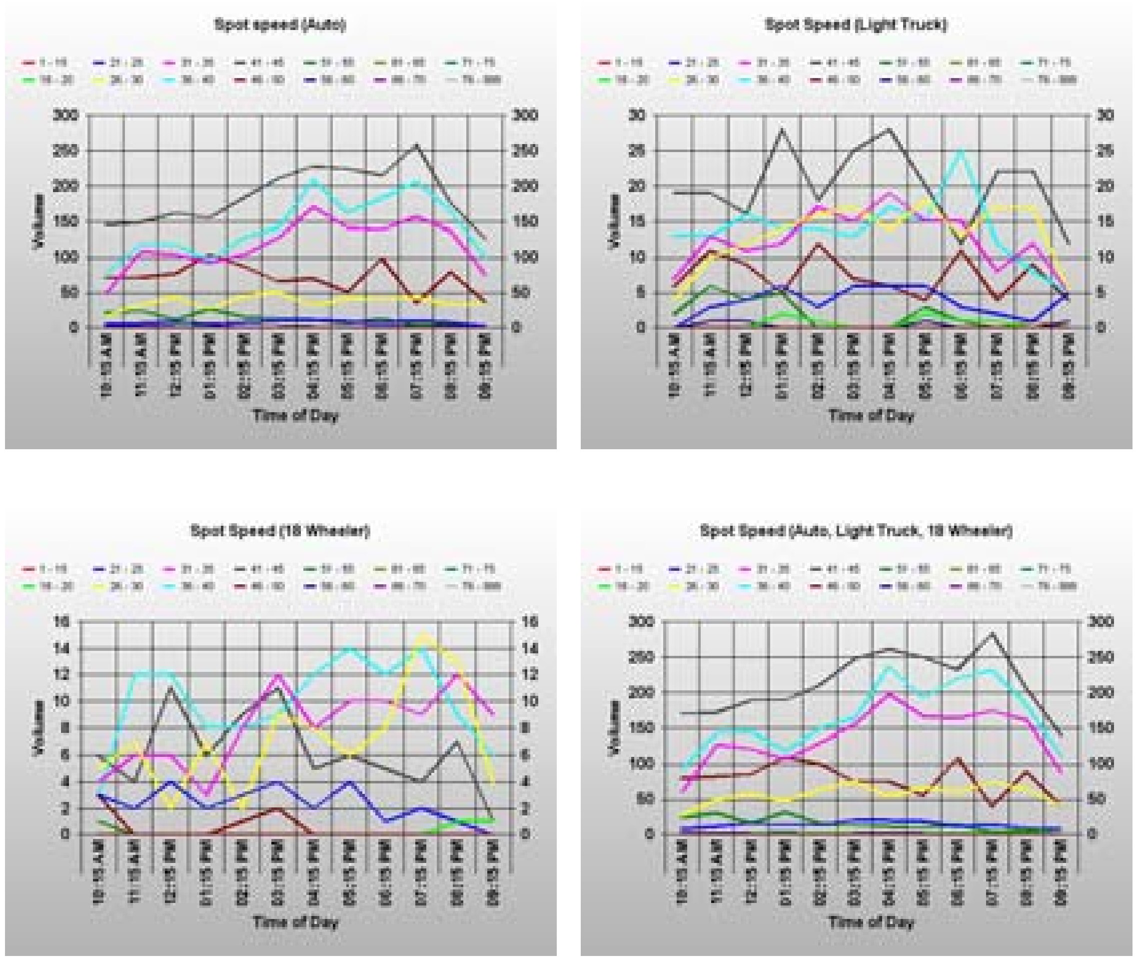


Figure 9-4 - Volume data per speed interval (ATb-11)

- Location 2

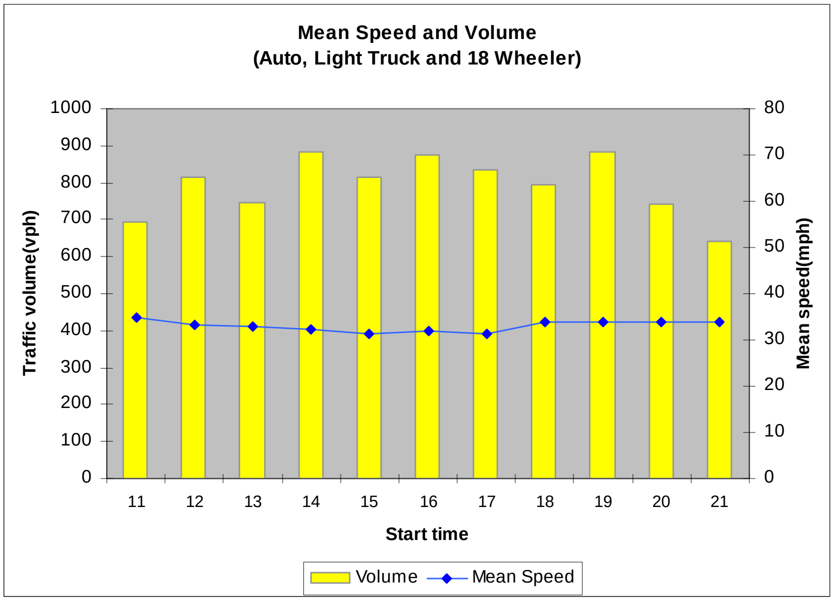


Figure 9-5 - Speed and volume data (ATb-21)

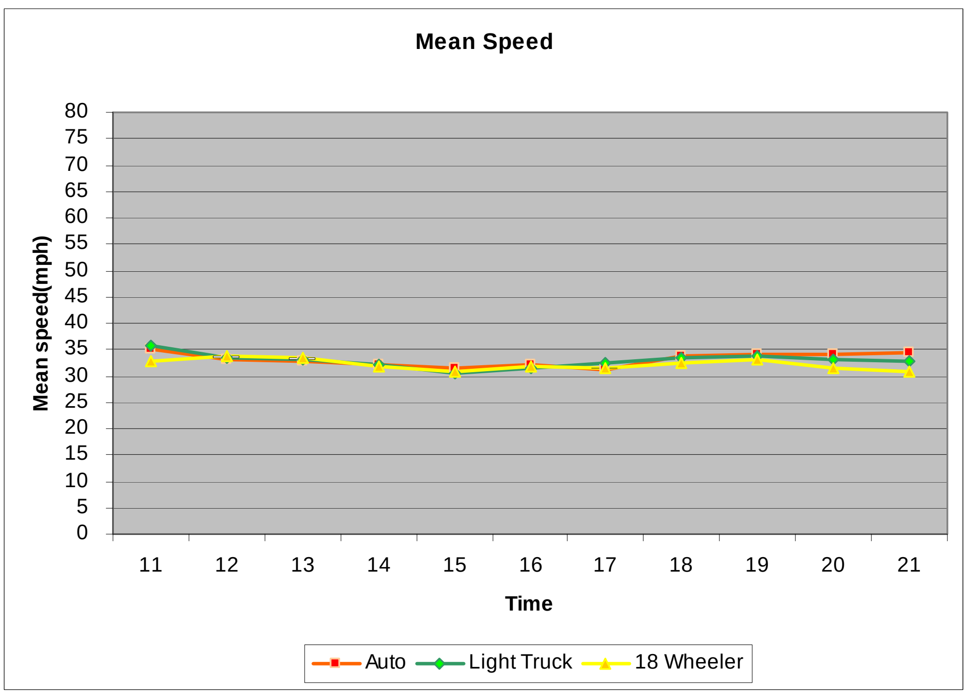


Figure 9-6 - Mean speed data (ATb-21)

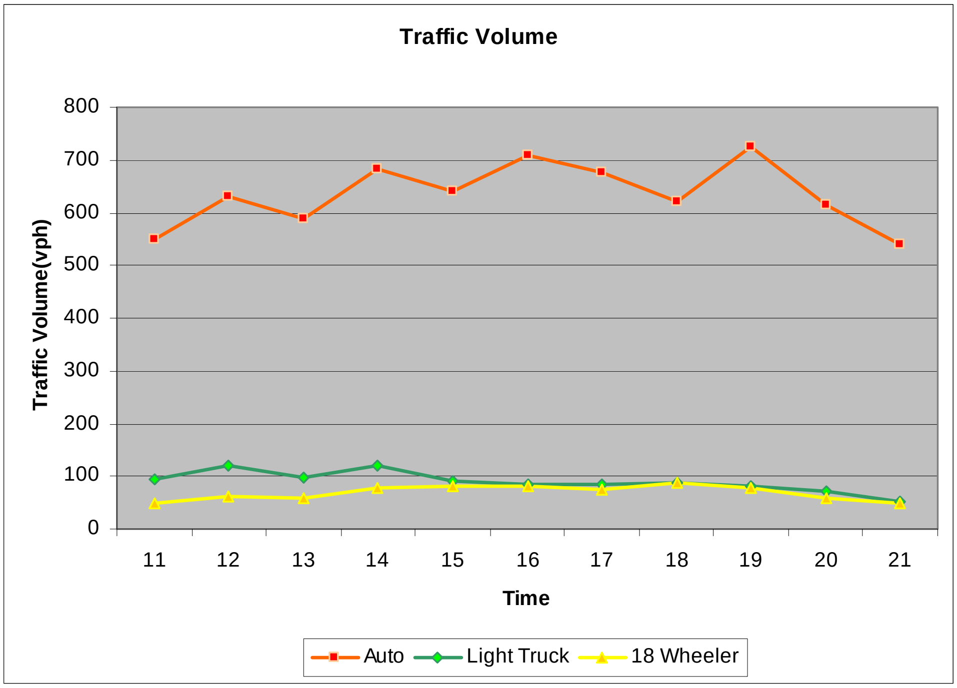
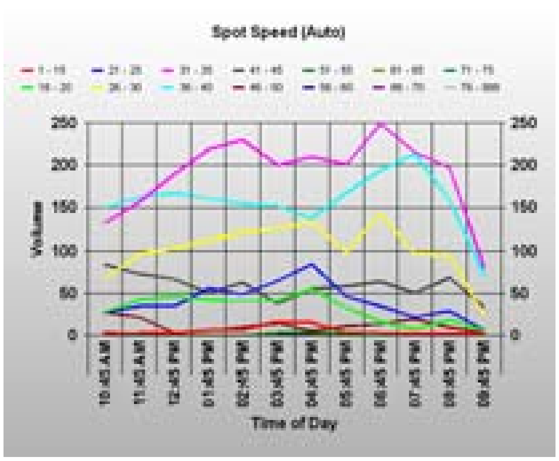
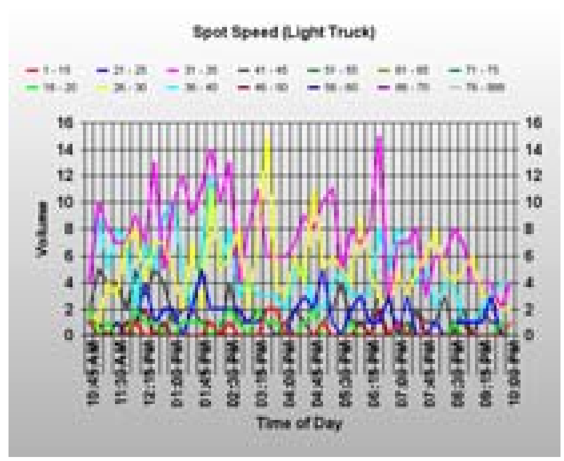


Figure 9-7 - Traffic volume data (ATb-21)





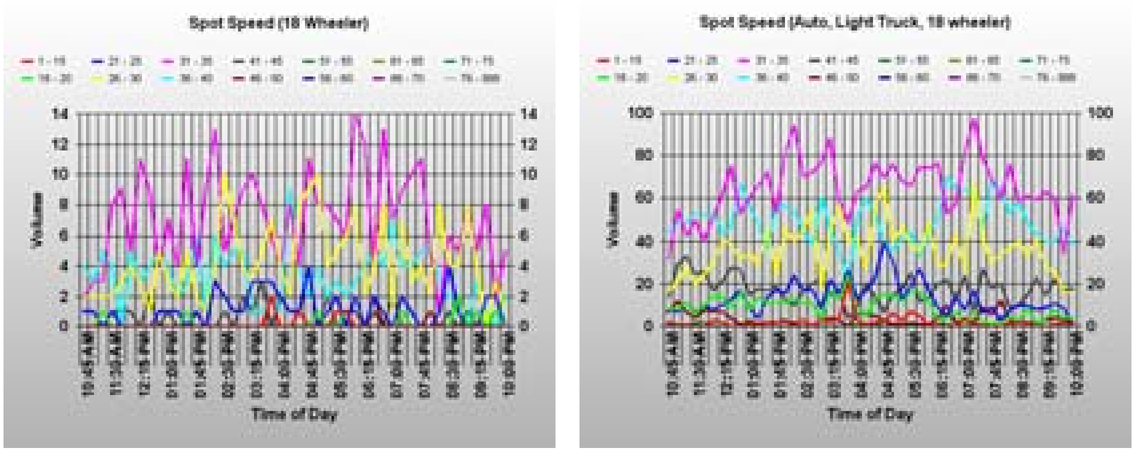


Figure 9-8 - Volume data per speed interval (ATb-21)

- Location 3

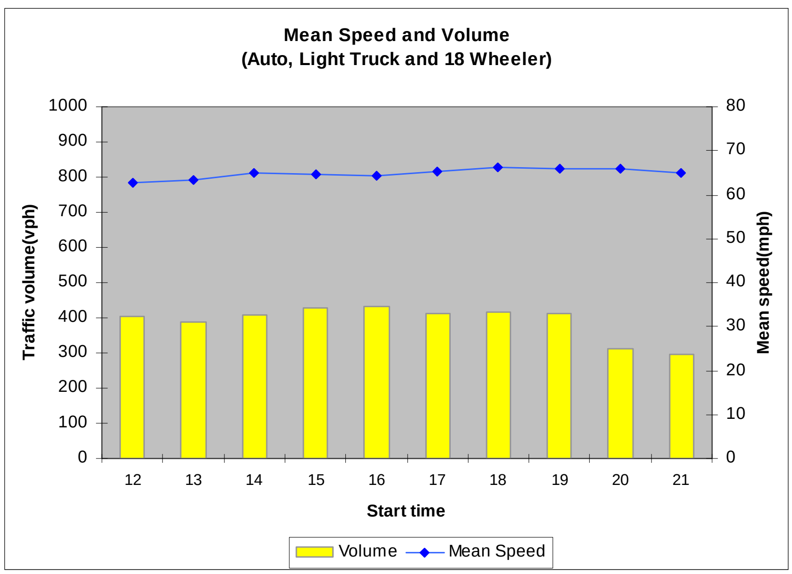


Figure 9-9 - Speed and volume data (ATb-31)

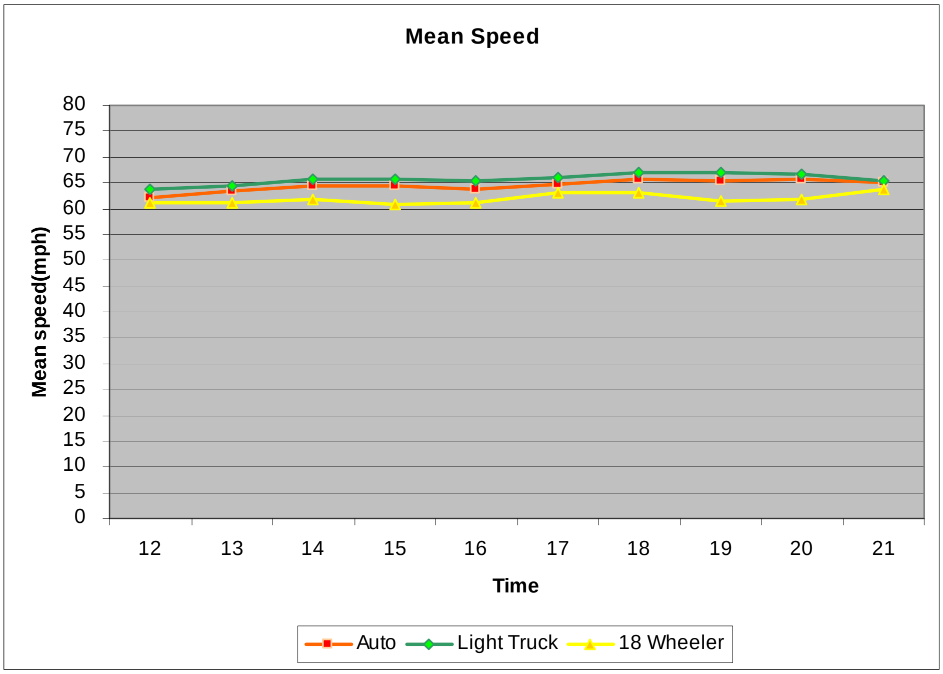


Figure 9-10 - Mean speed data (ATb-31)

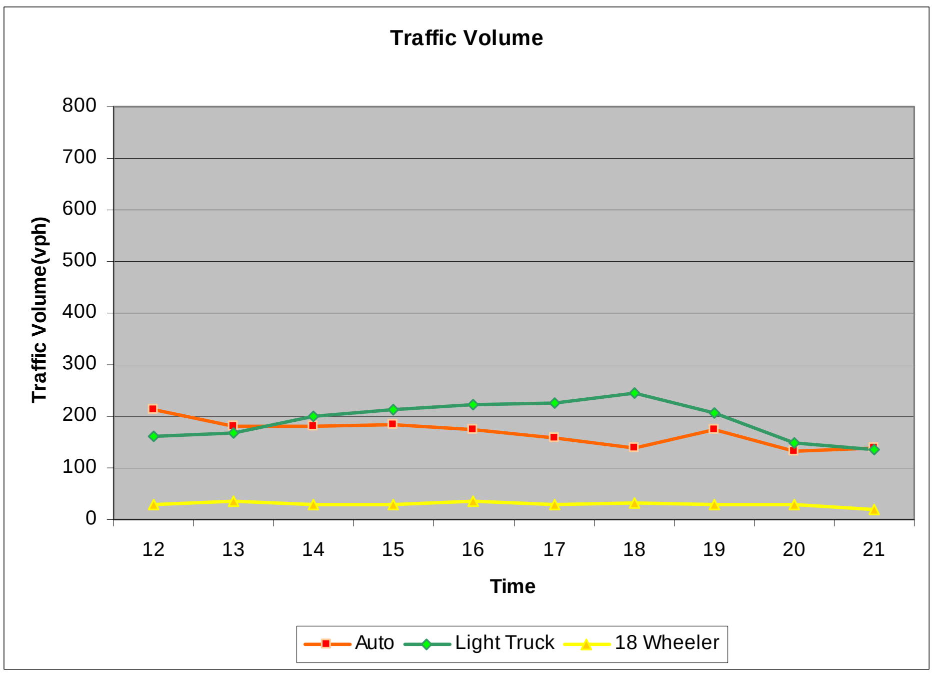


Figure 9-11 - Traffic volume data (ATb-31)

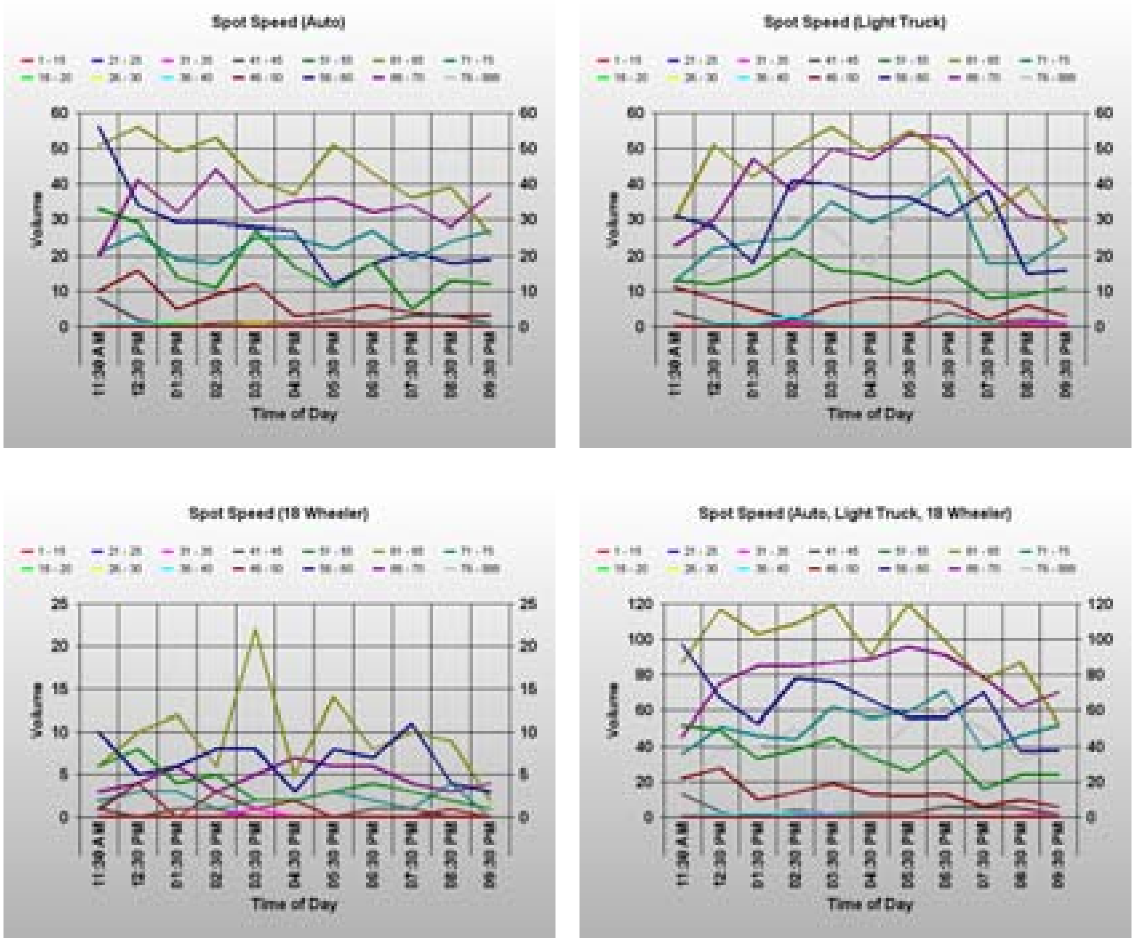


Figure 9-12 - Volume data per speed interval (ATb-31)

- Location 4

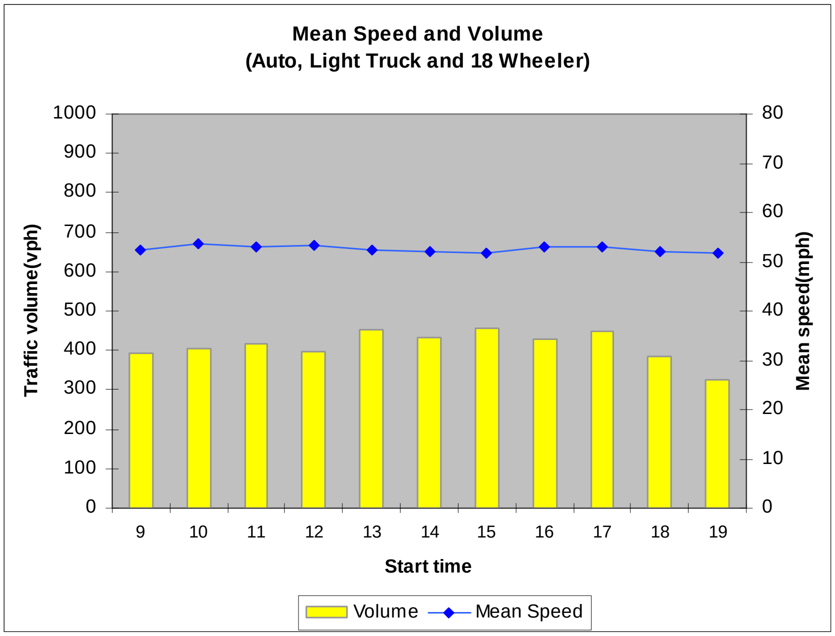


Figure 9-13 - Speed and volume data (ATb-41)

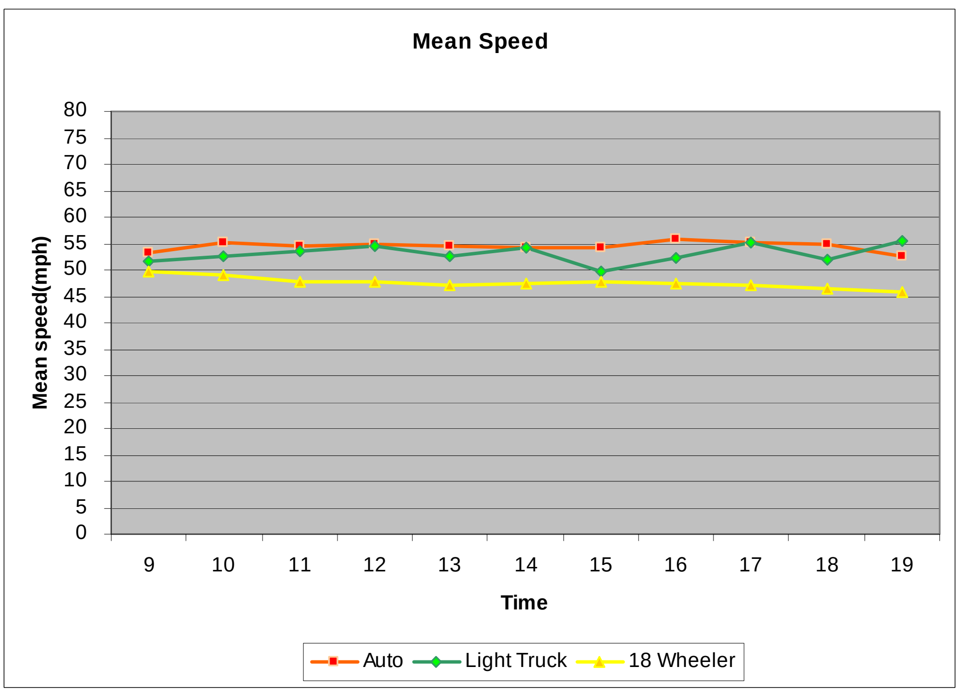


Figure 9-14 - Mean speed data (ATb-41)

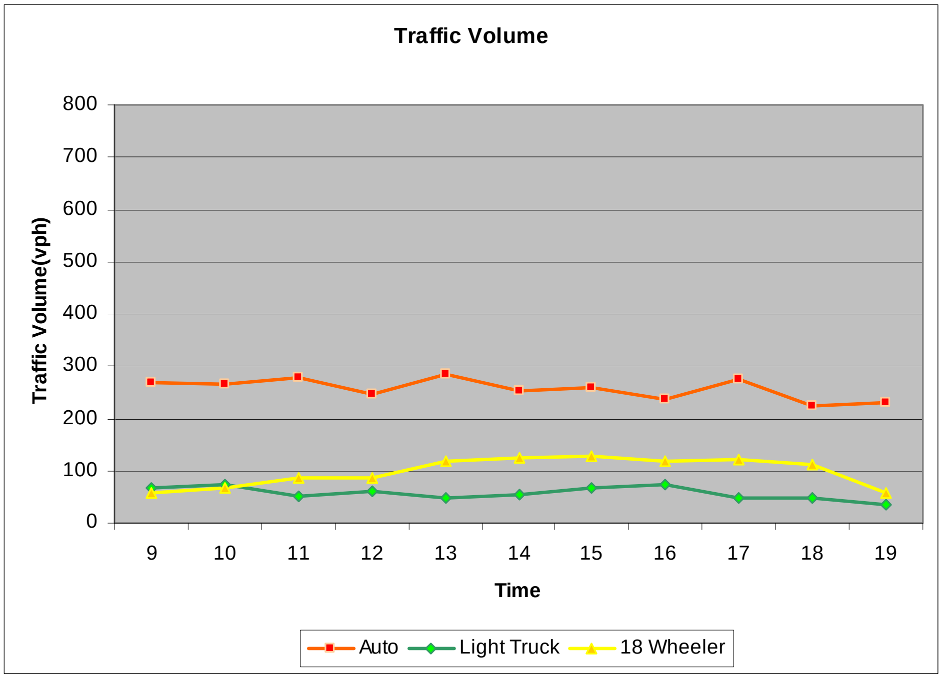


Figure 9-15 - Traffic volume data (ATb-41)

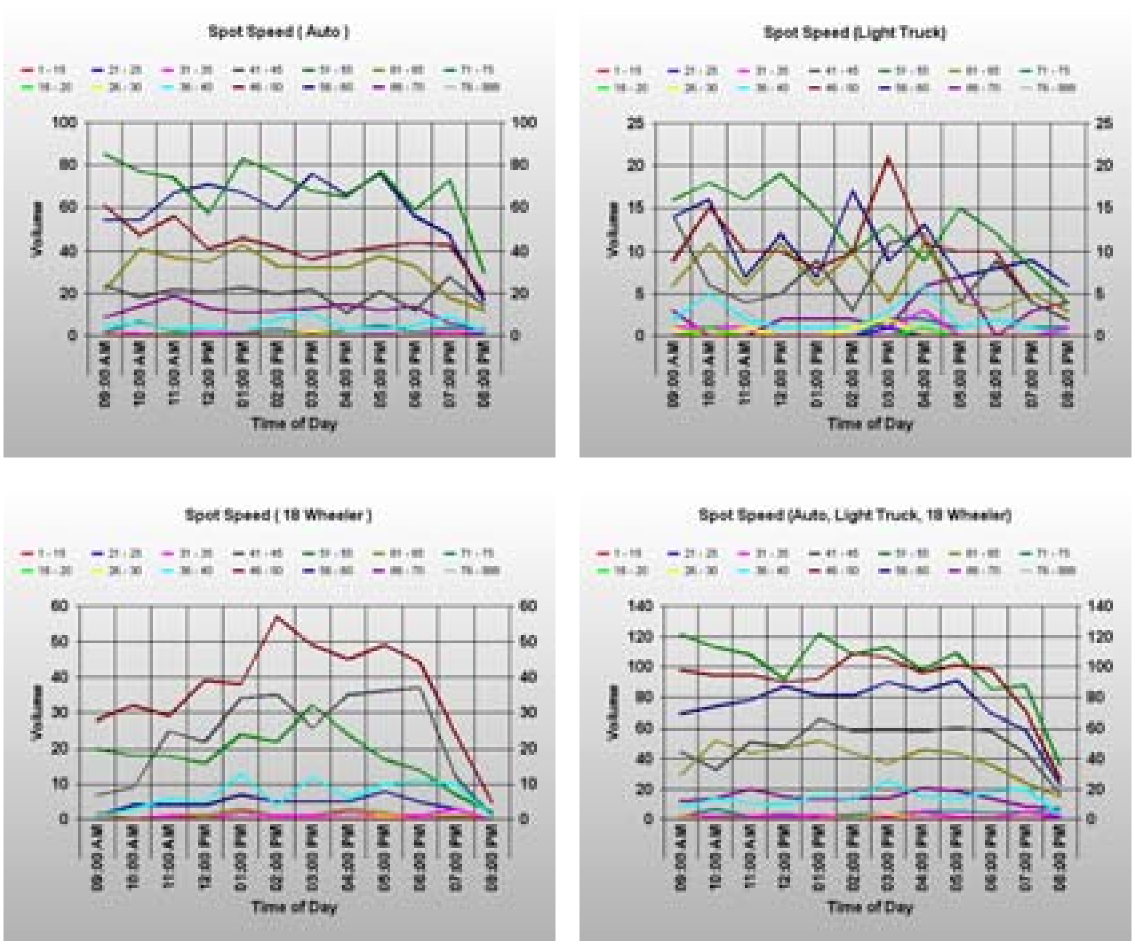


Figure 9-16 - Volume data per speed interval (ATb-41)

9.1.1.2 Day 2

- Location 1

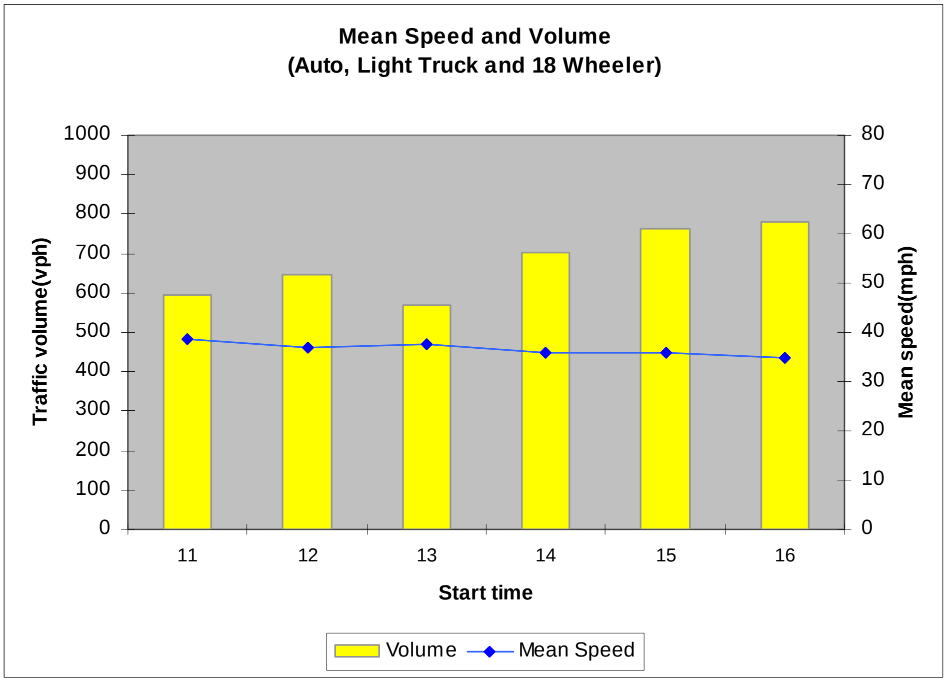


Figure 9-17 - Speed and volume data (ATb-12)

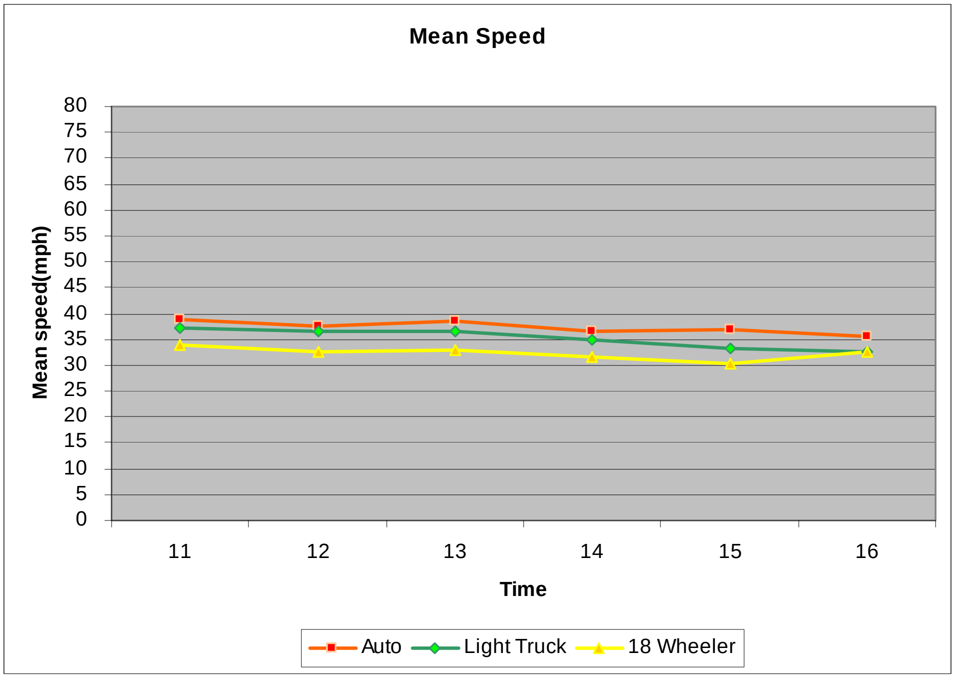


Figure 9-18 - Mean speed data (ATb-12)

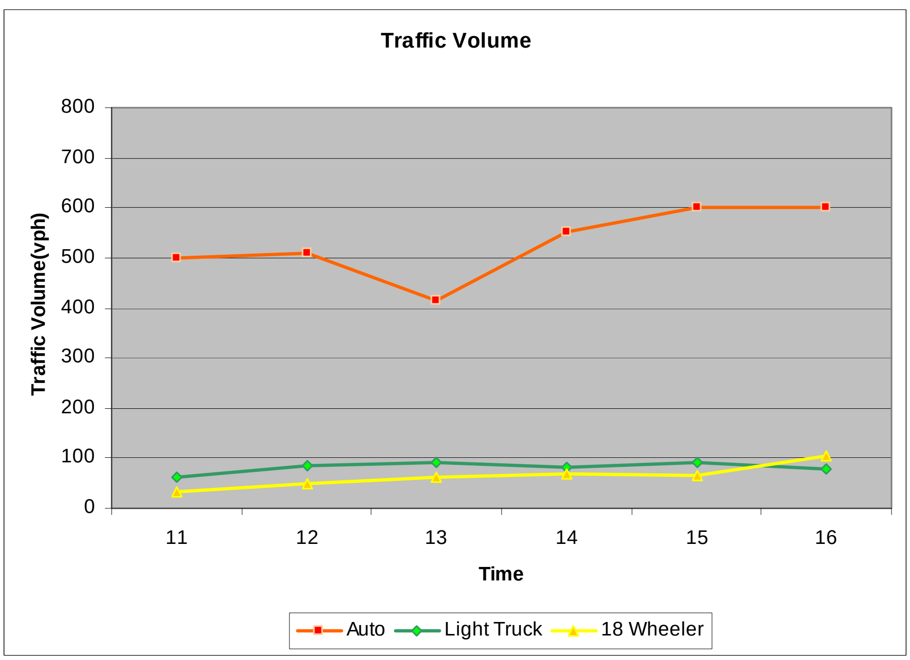


Figure 9-19 - Traffic volume data (ATb-12)

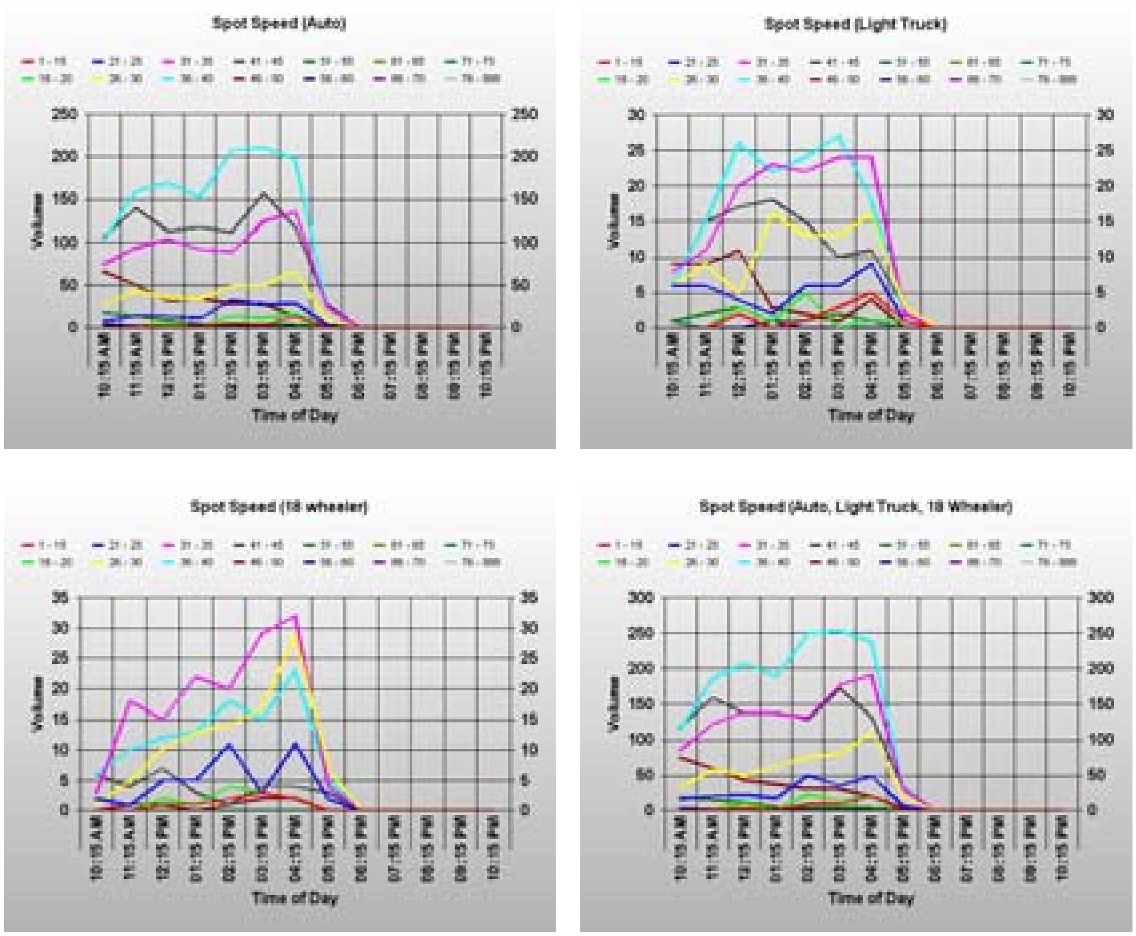


Figure 9-20 - Volume data per speed interval (ATb-12)

- Location 2

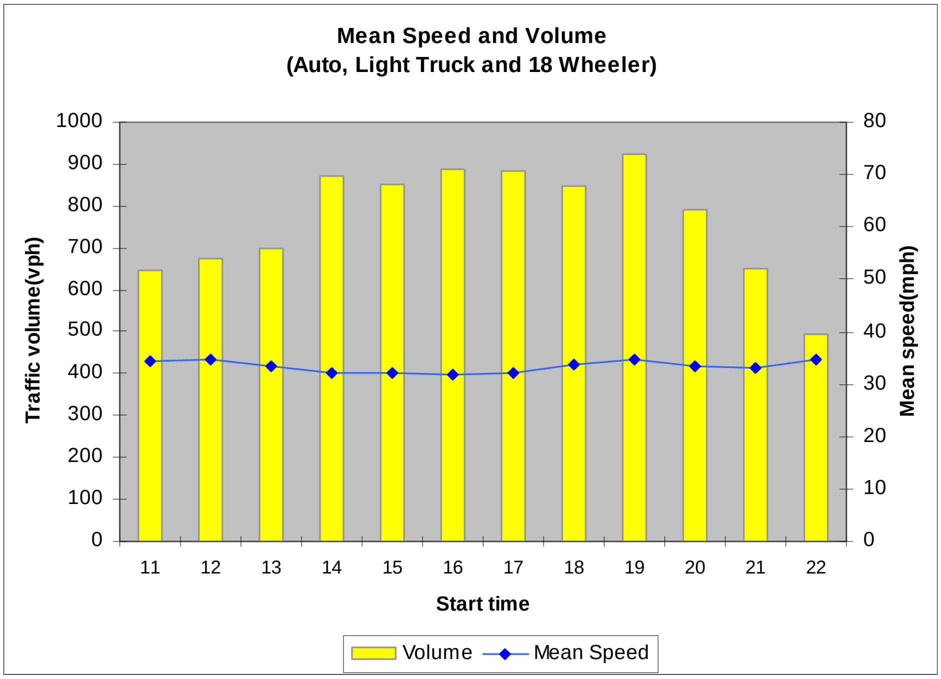


Figure 9-21 - Speed and volume data (ATb-22)

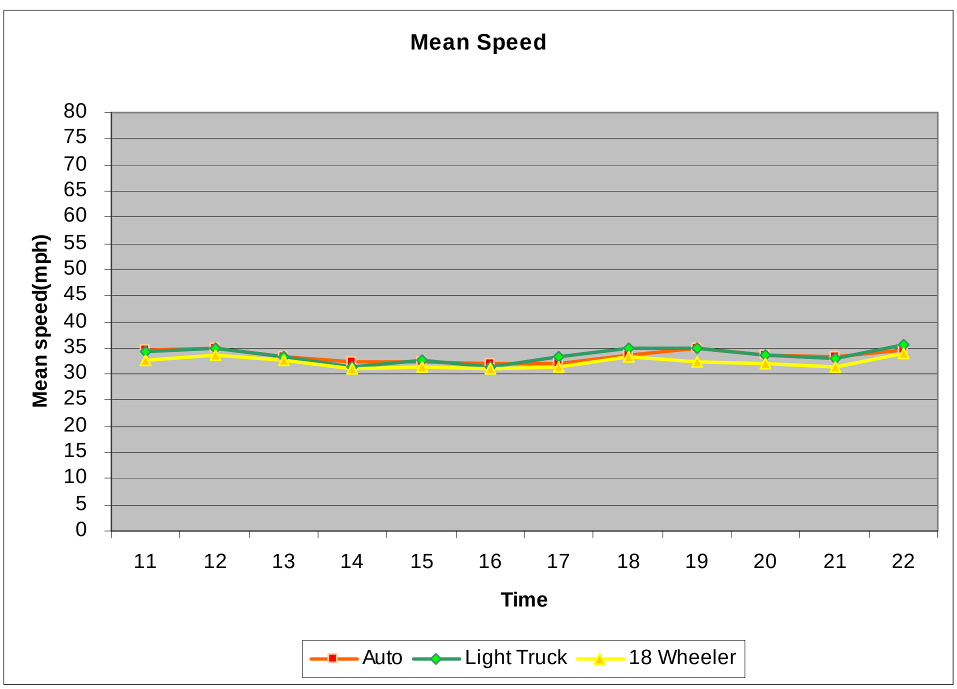


Figure 9-22 - Mean speed data (ATb-22)

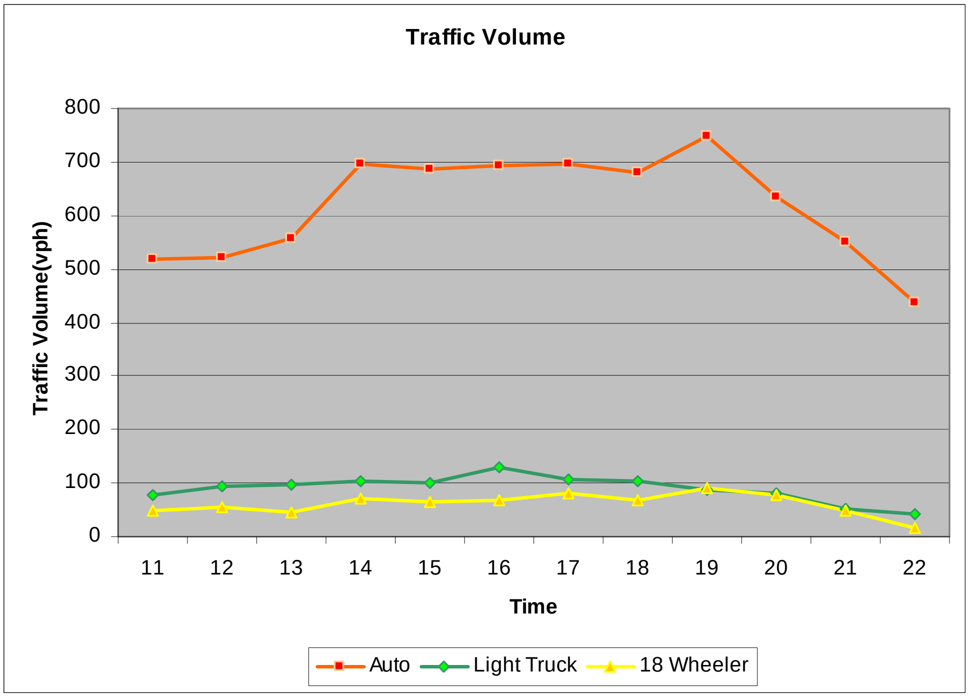
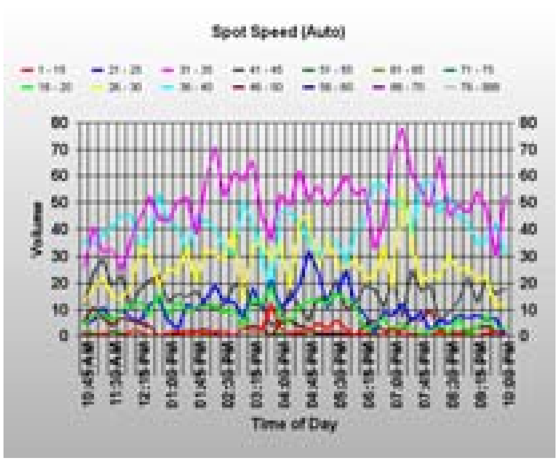
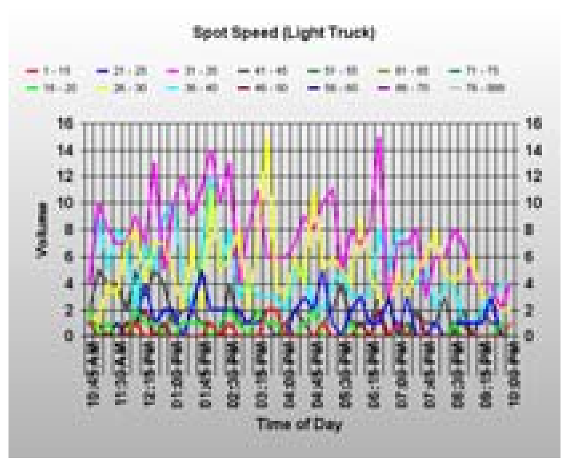
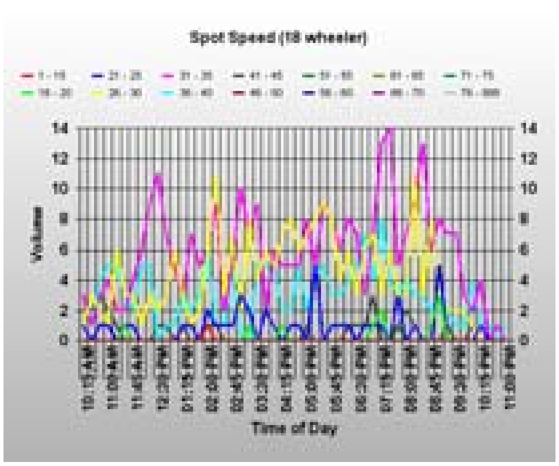


Figure 9-23 - Traffic volume data (ATb-22)







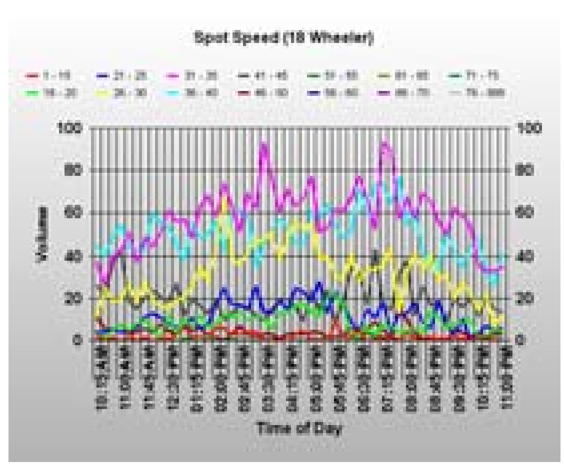


Figure 9-24 - Volume data per speed interval (ATb-22)

- Location 3

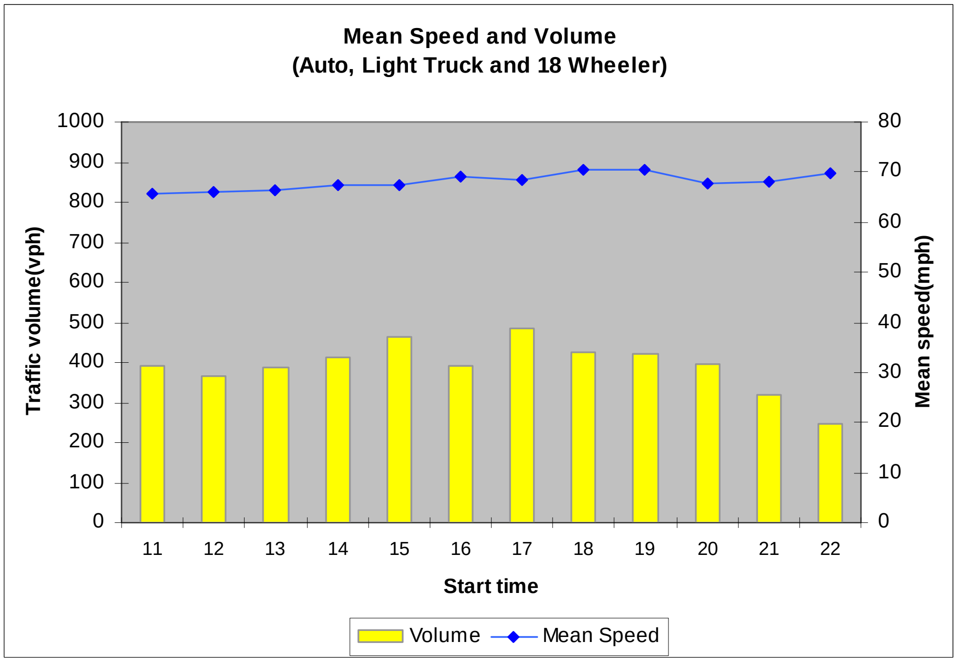


Figure 9-25 - Speed and volume data (ATb-32)

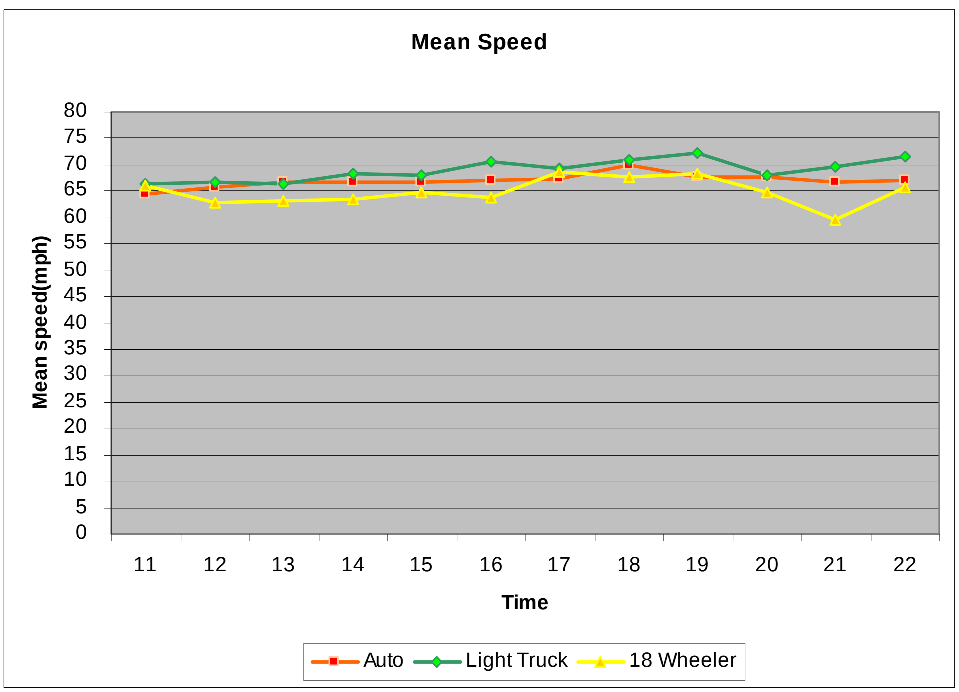


Figure 9-26 - Mean speed data (ATb-32)

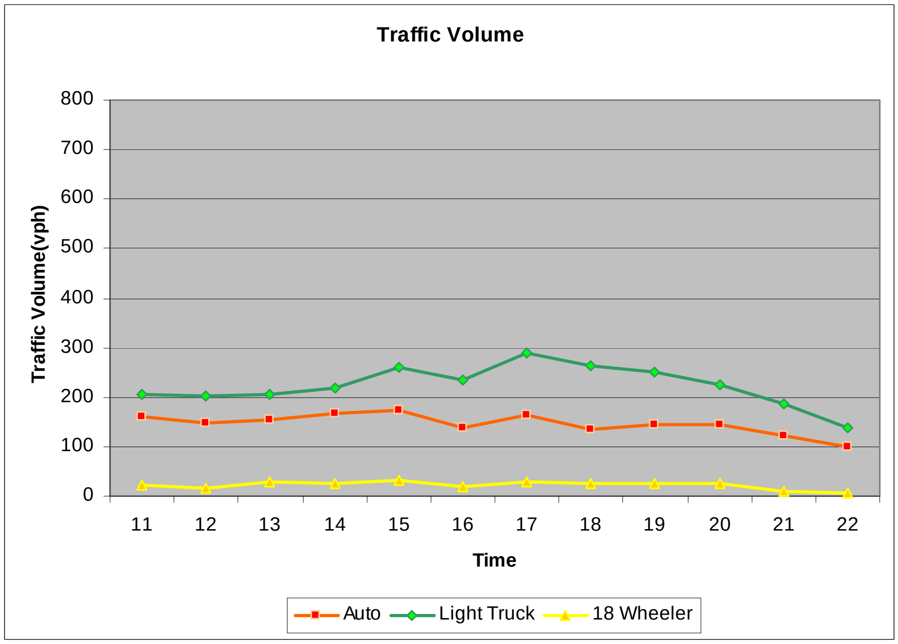


Figure 9-27 - Traffic volume data (ATb-32)

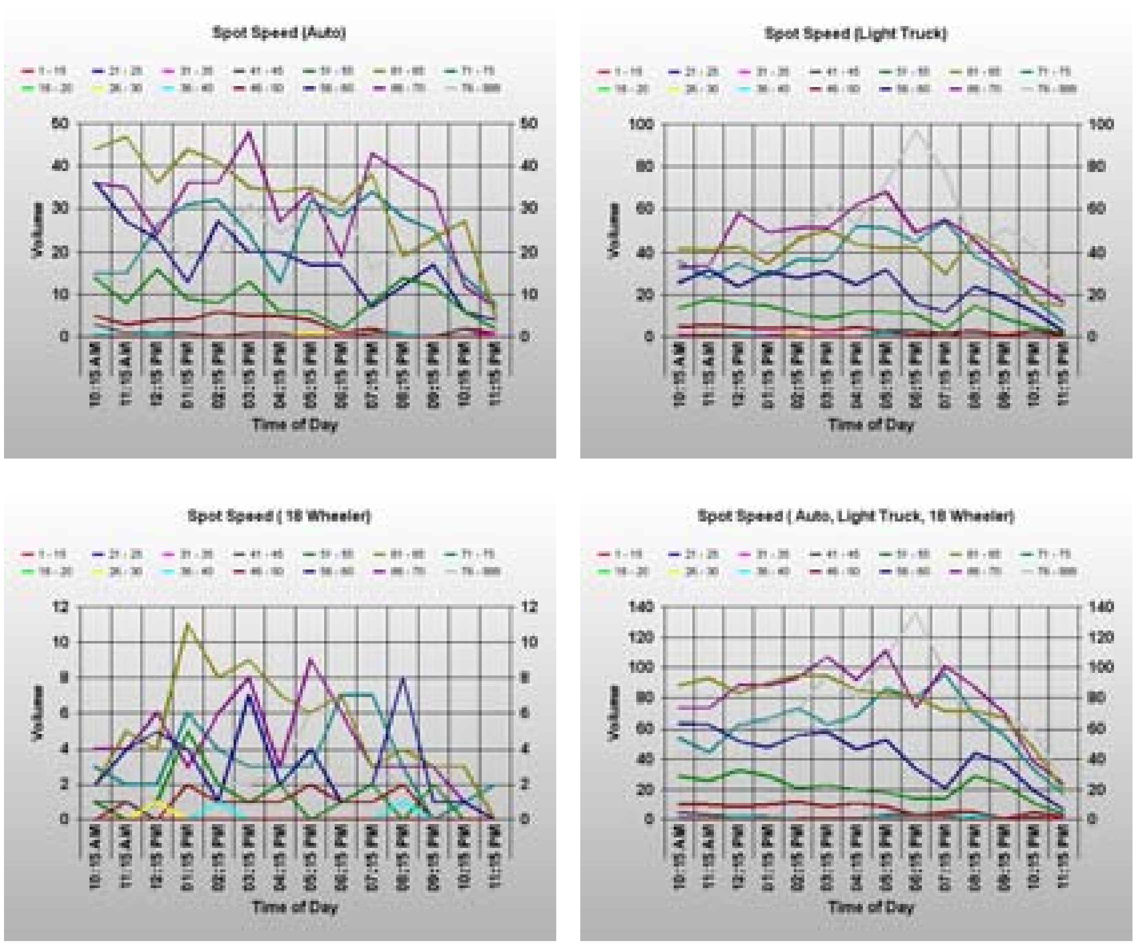


Figure 9-28 - Volume data per speed interval (ATb-32)

- Location 4

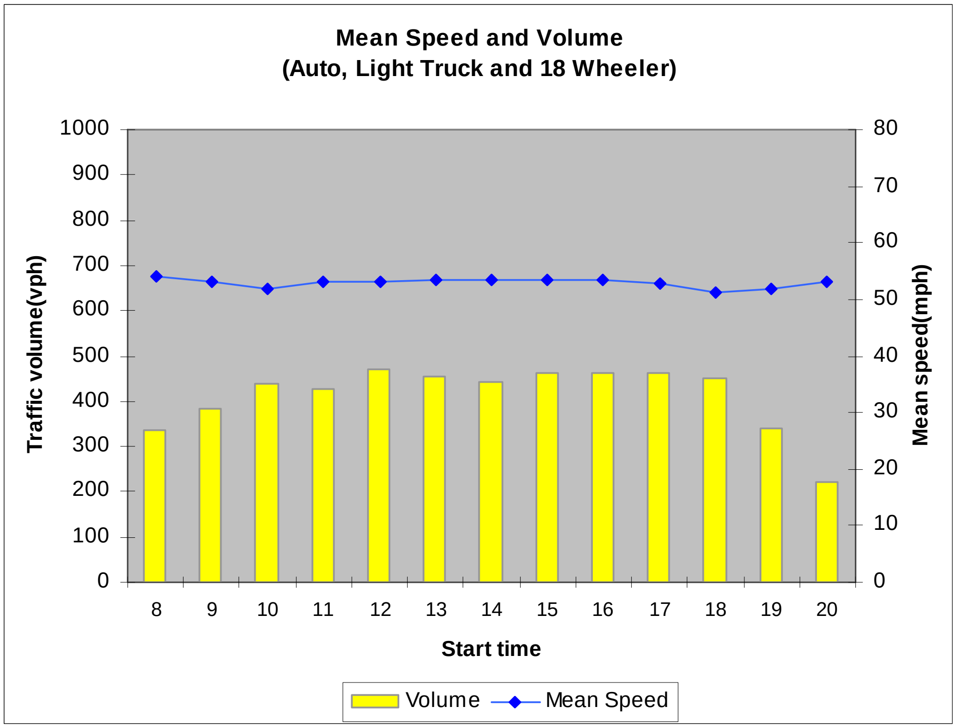


Figure 9-29 - Speed and volume data (ATb-42)

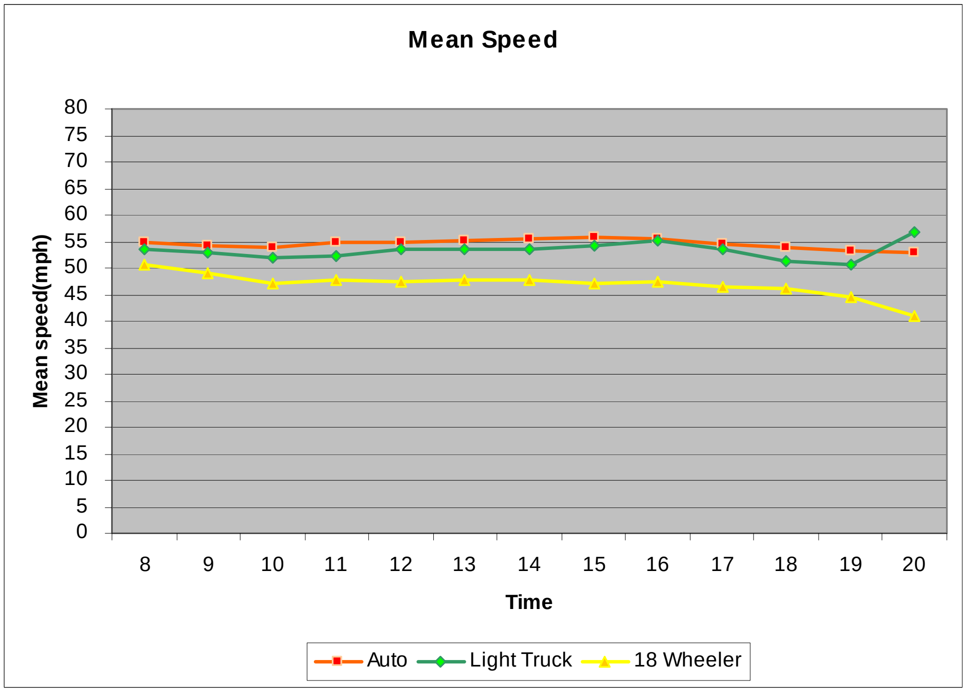


Figure 9-30 - Mean speed data (ATb-42)

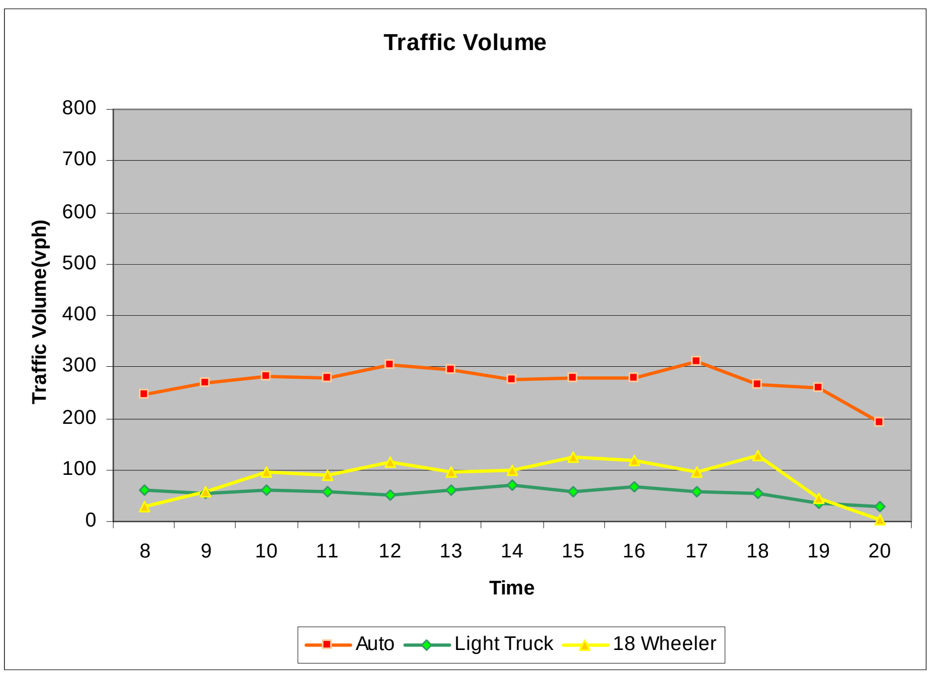


Figure 9-31 - Traffic volume data (ATb-42)

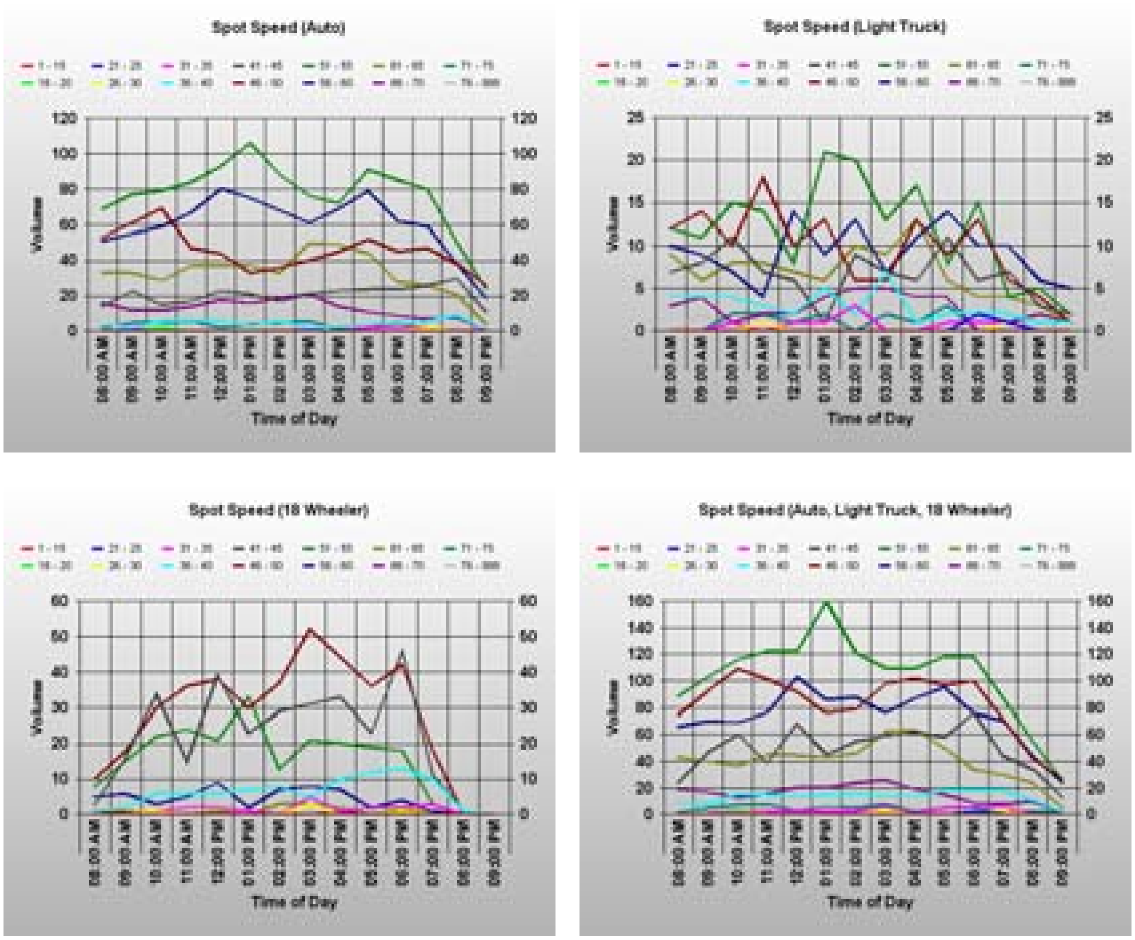


Figure 9-32 -Volume data per speed interval (ATb-42)

9.1.2 Intersection Traffic Volumes

9.1.2.1 Day 1

- Location 1

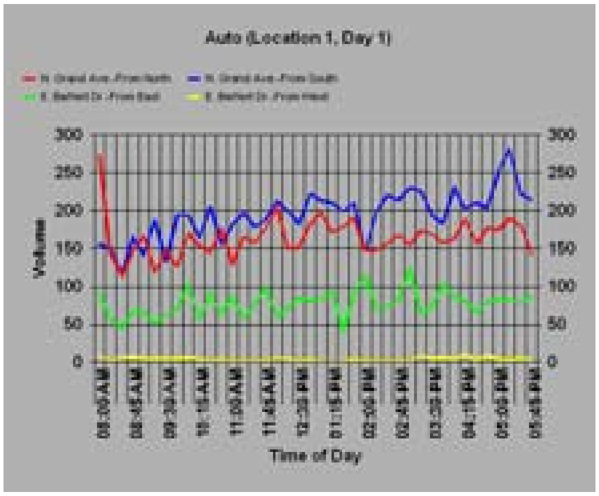


Figure 9-33 - Traffic volume for Auto (AInt-11)

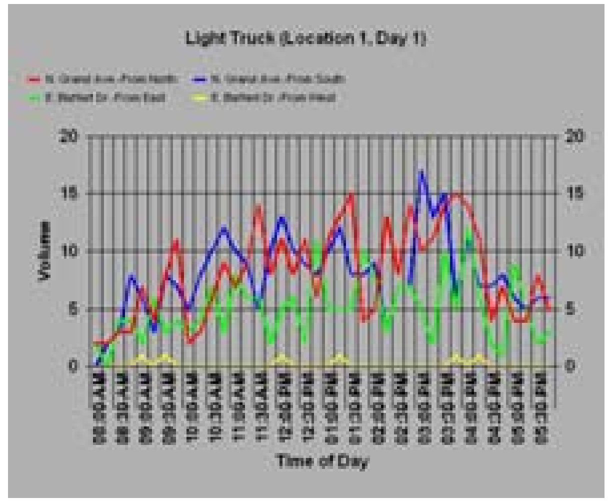


Figure 9-34 - Traffic volume for Light Truck (AInt-11)

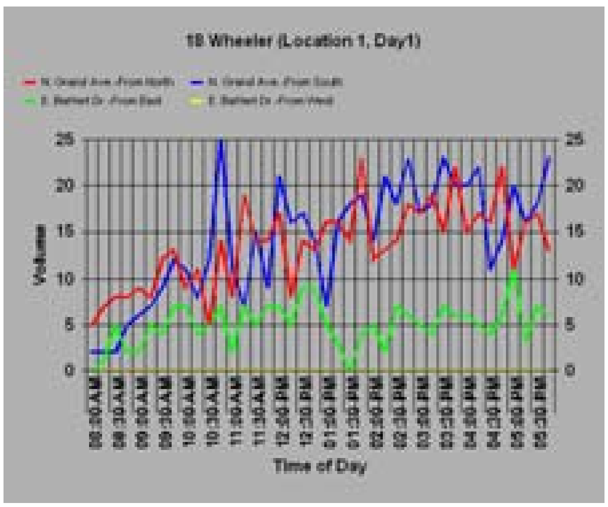


Figure 9-35 - Traffic volume for 18 wheeler (AInt-11)

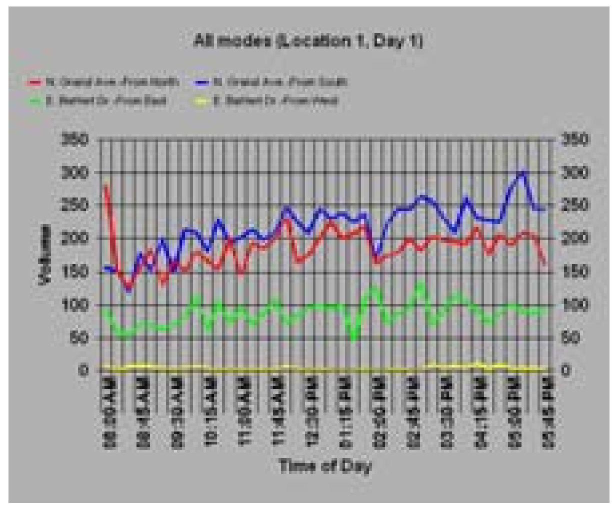


Figure 9-36 - Traffic volume for all modes (AInt-11)

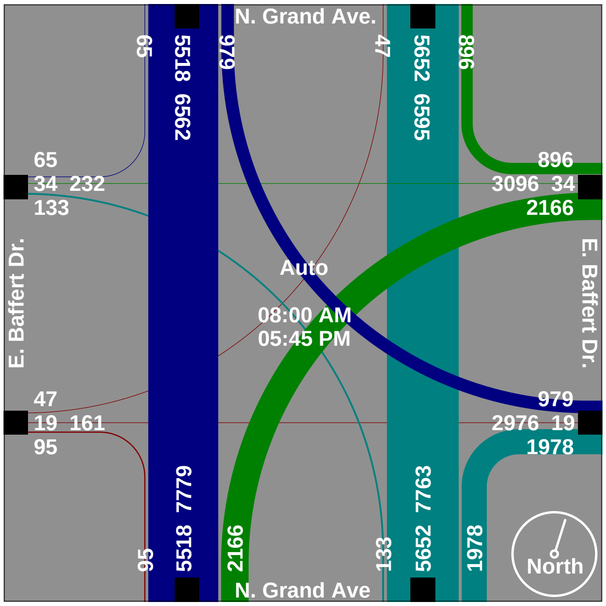


Figure 9-37 - Variable width graph for Auto (AInt-11)

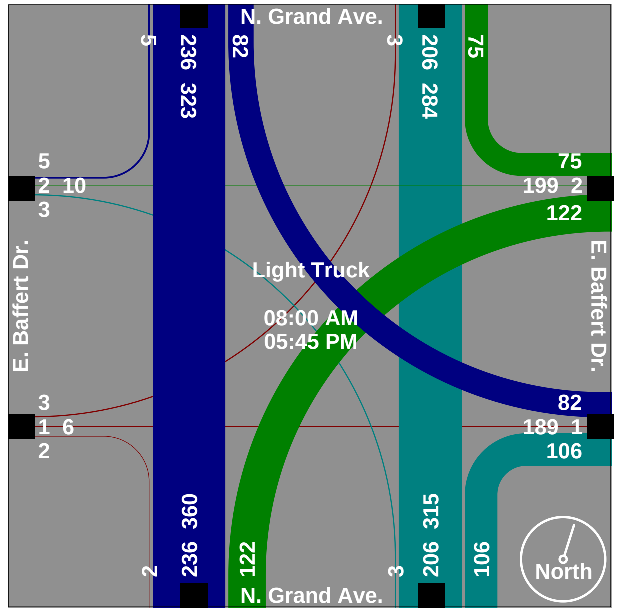


Figure 9-38 - Variable width graph for Light Truck (AInt-11)

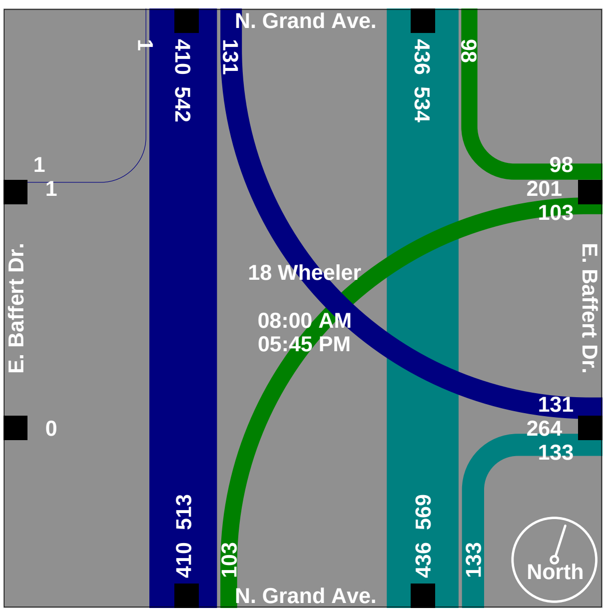


Figure 9-39 - Variable width graph for 18 Wheeler (AInt-11)

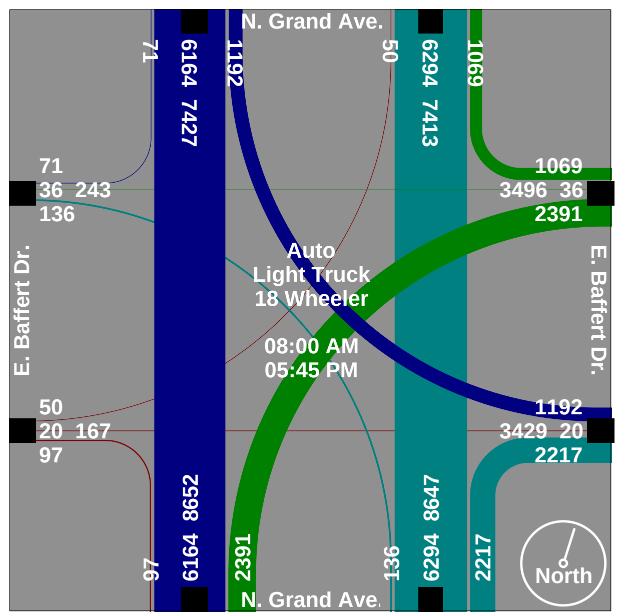


Figure 9-40 – Variable width graph (AInt-11)

- Location 2

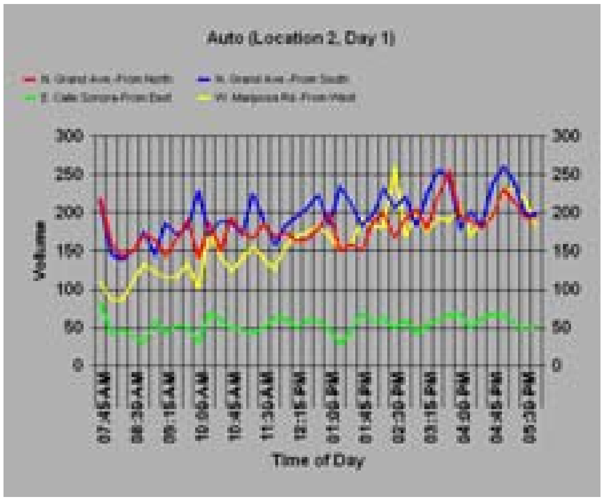


Figure 9-41 - Traffic volume for Auto (AInt-21)

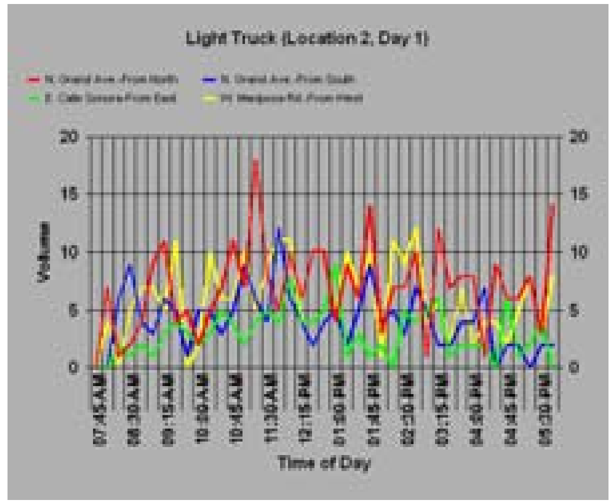


Figure 9-42 - Traffic volume for Light Truck (AInt-21)

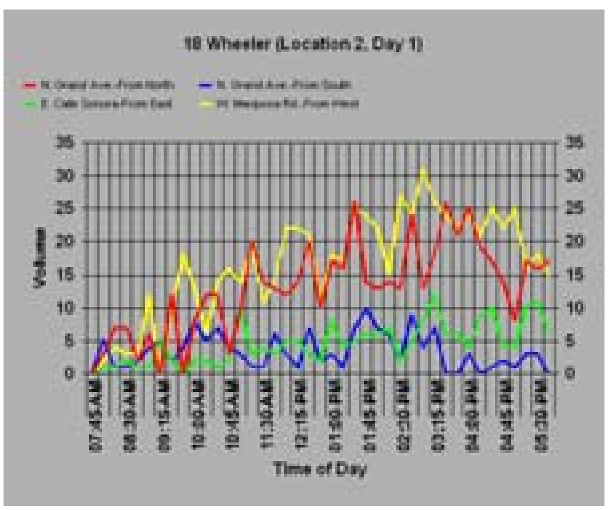


Figure 9-43 - Traffic volume for 18 wheeler (AInt-21)

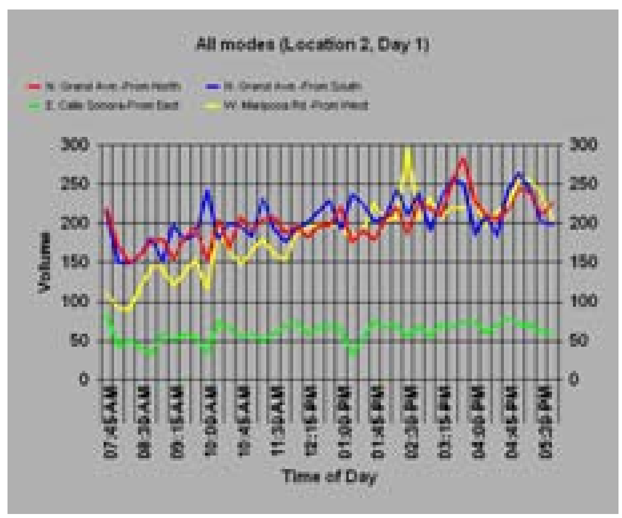


Figure 9-44 - Traffic volume (AInt-21)

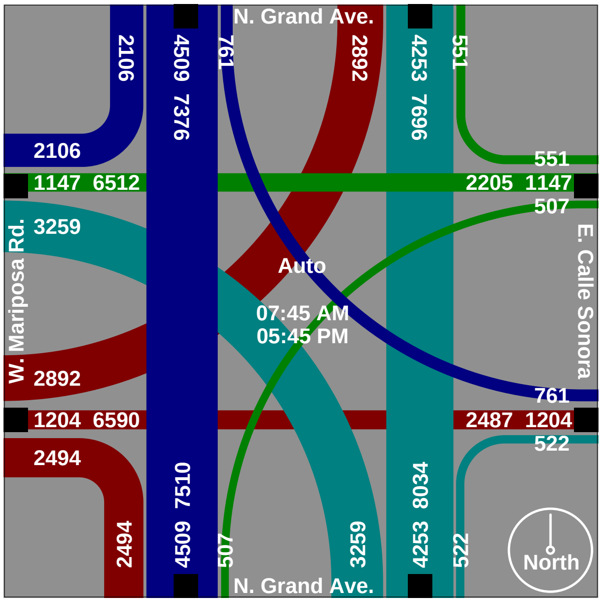


Figure 9-45 - Variable width graph for Auto (AInt-21)

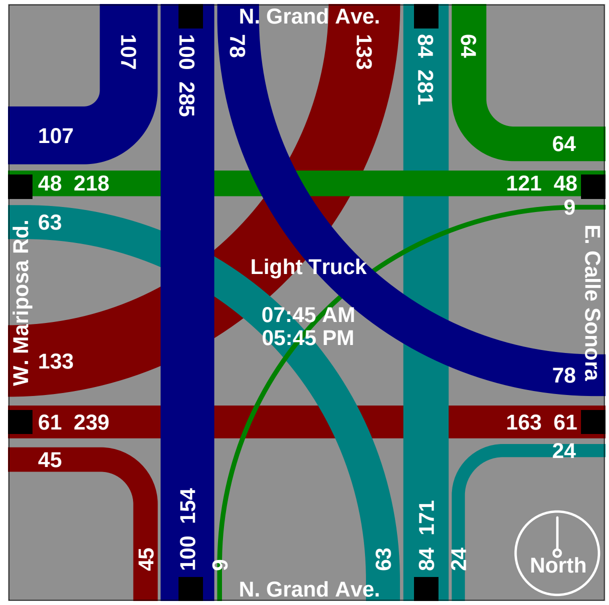


Figure 9-46 - Variable width graph for Light Truck (AInt-21)

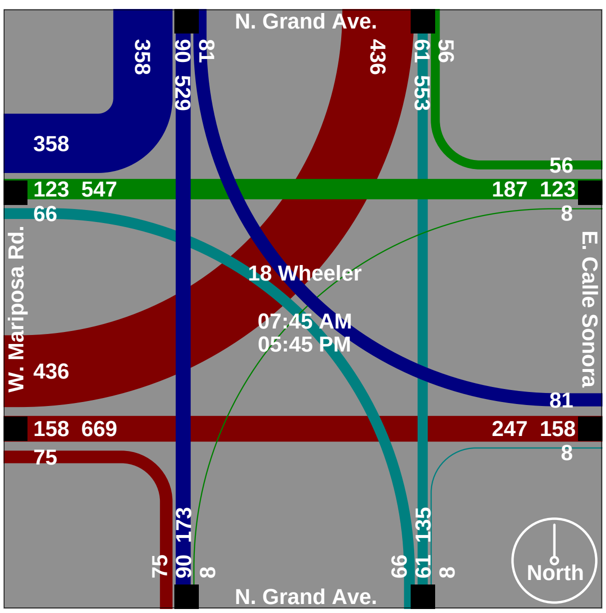


Figure 9-47 - Variable width graph for 18 Wheeler (AInt-21)

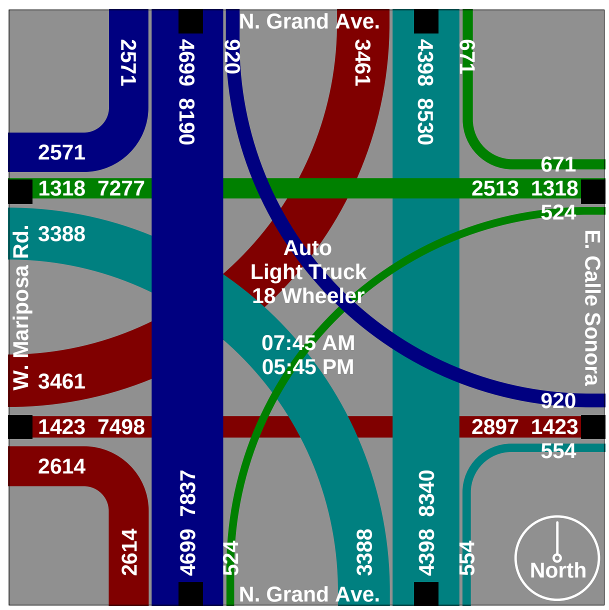


Figure 9-48 - Variable width graph (AInt-21)

- Location 3

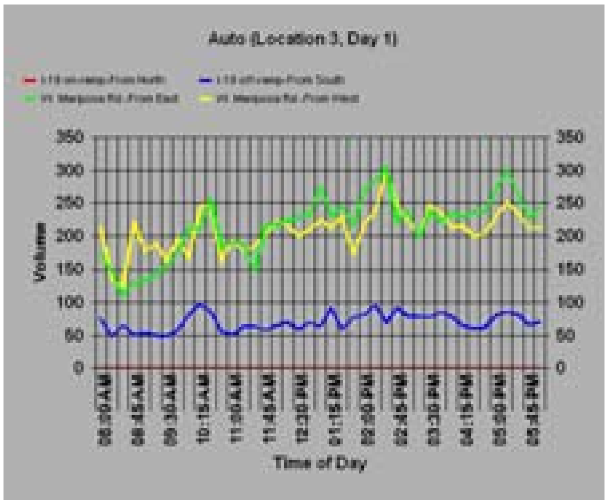


Figure 9-49 - Traffic volume for Auto (AInt-31)

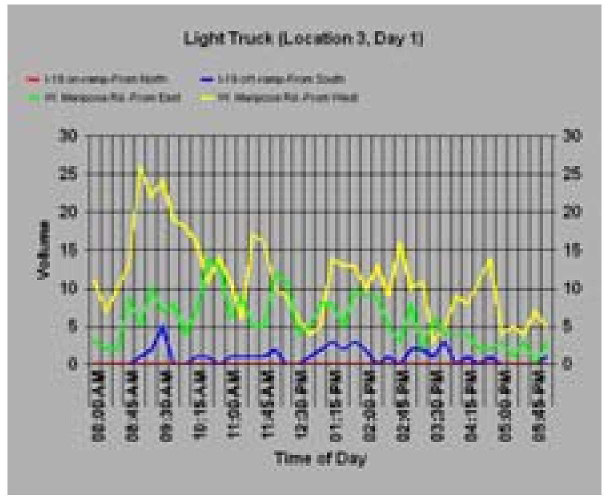


Figure 9-50 - Traffic volume for Light Truck (AInt-31)

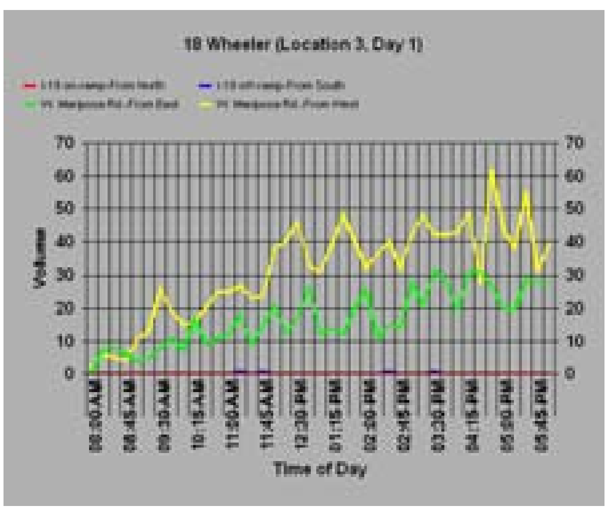


Figure 9-51 - Traffic volume for 18-wheelers (AInt-31)

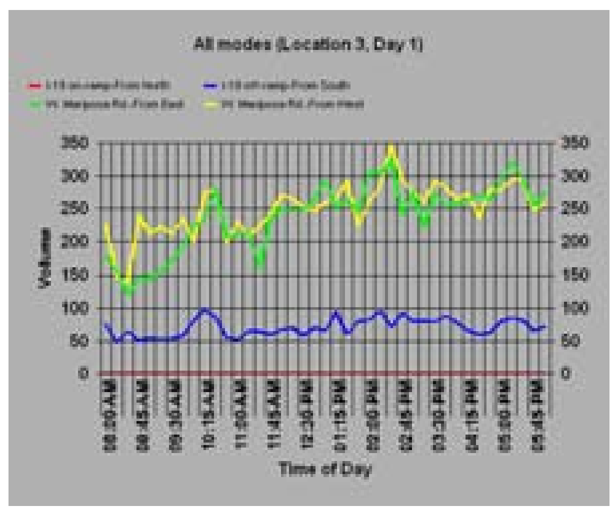


Figure 9-52 - Traffic volume (AInt-31)

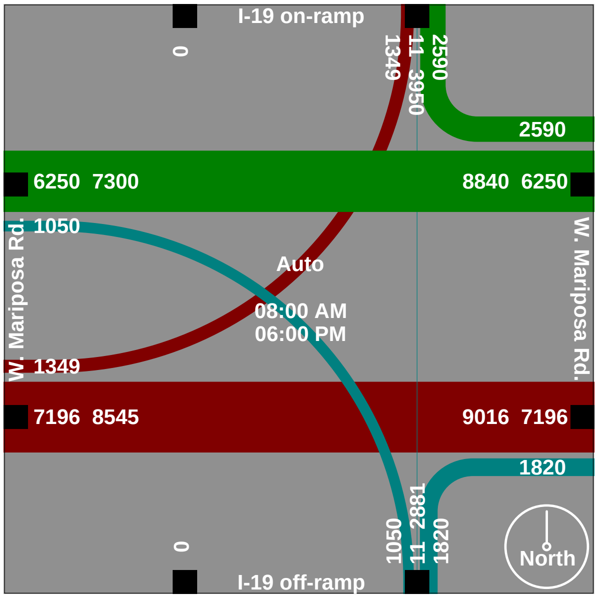


Figure 9-53 - Variable width graph for Auto (AInt-31)

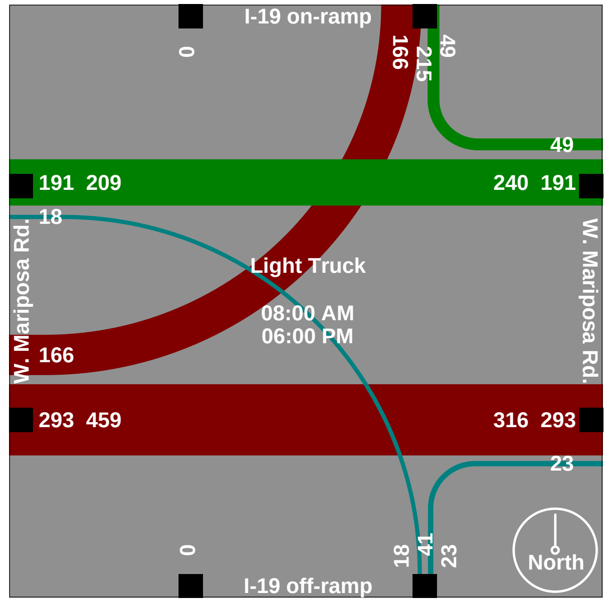


Figure 9-54 - Variable width graph for Light Truck (AInt-31)

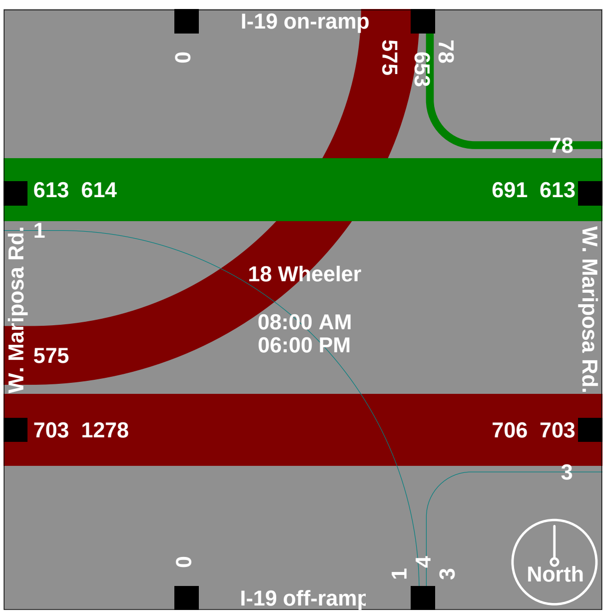


Figure 9-55 -Variable width graph for 18-wheelers (AInt-31)

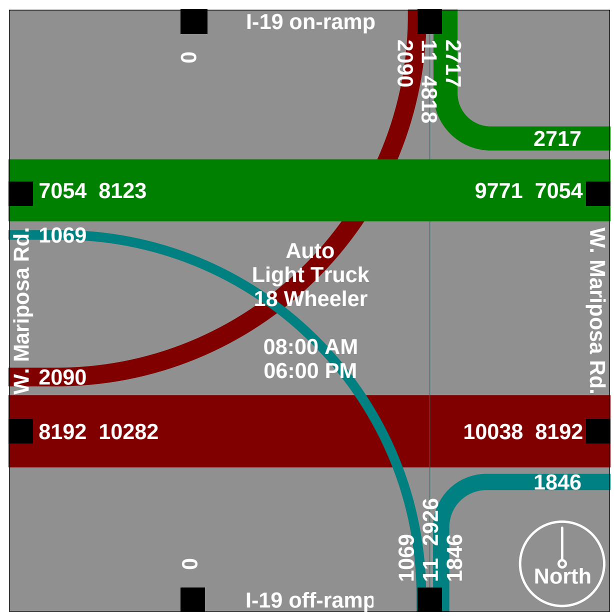


Figure 9-56 - Variable width graph for all modes (AInt-31)

- Location 4

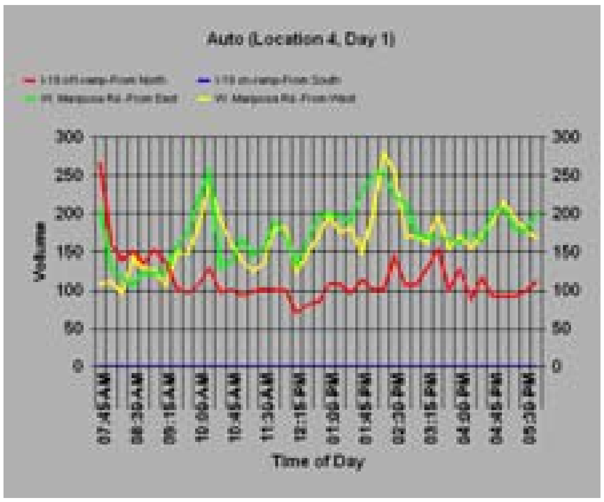


Figure 9-57 - Traffic volume for Auto (AInt-41)

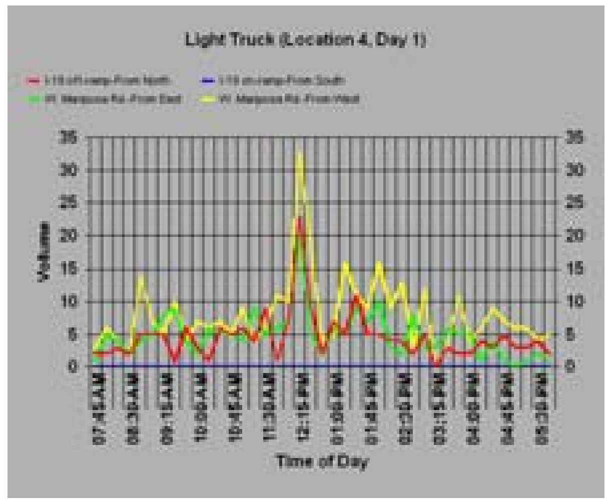


Figure 9-58 - Traffic volume for Light Truck (AInt-41)

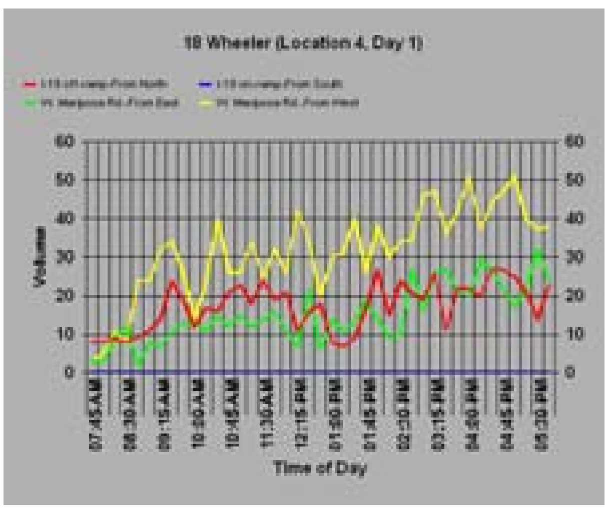


Figure 9-59 - Traffic volume for 18-wheelers (AInt-41)

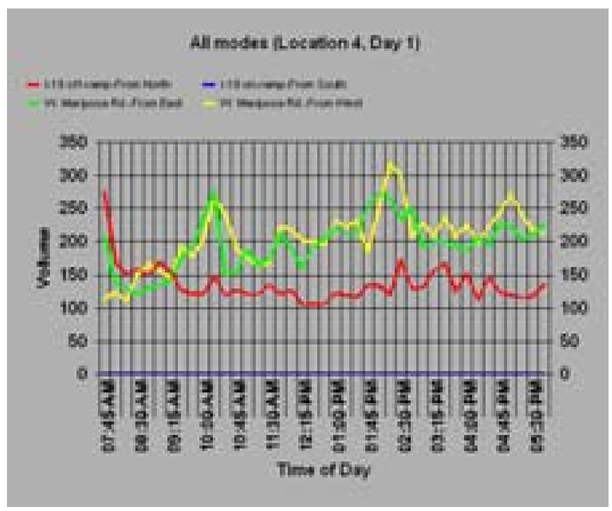


Figure 9-60 - Traffic volume (AInt-41)

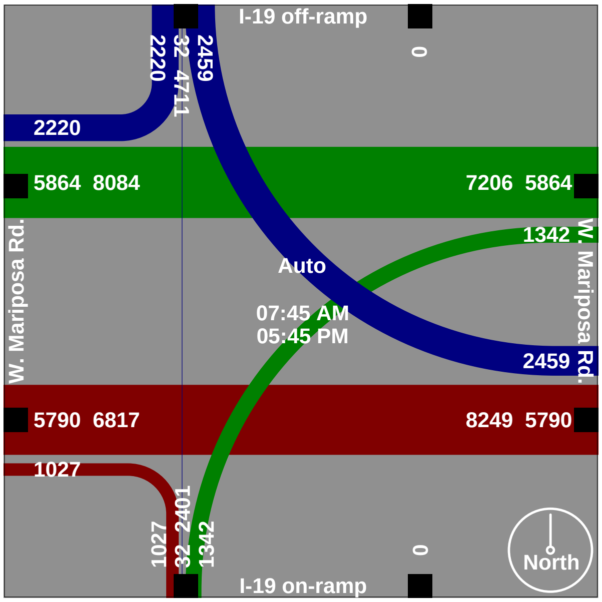


Figure 9-61 - Variable width graph for Auto (AInt-41)

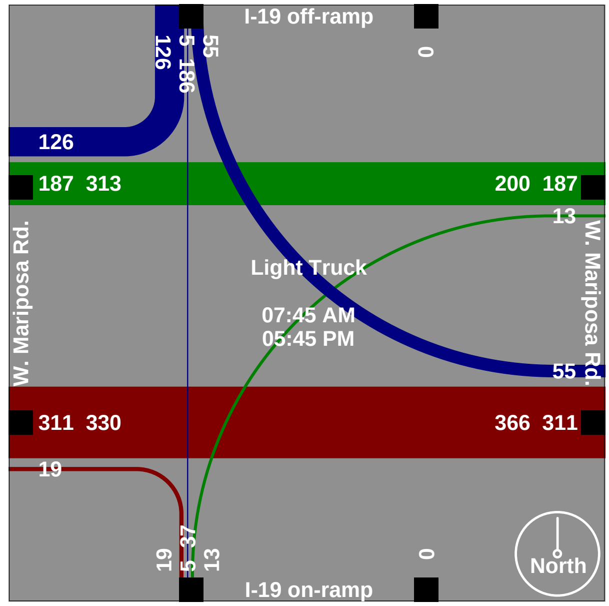


Figure 9-62 – Variable width graph for Light Truck(AInt-41)

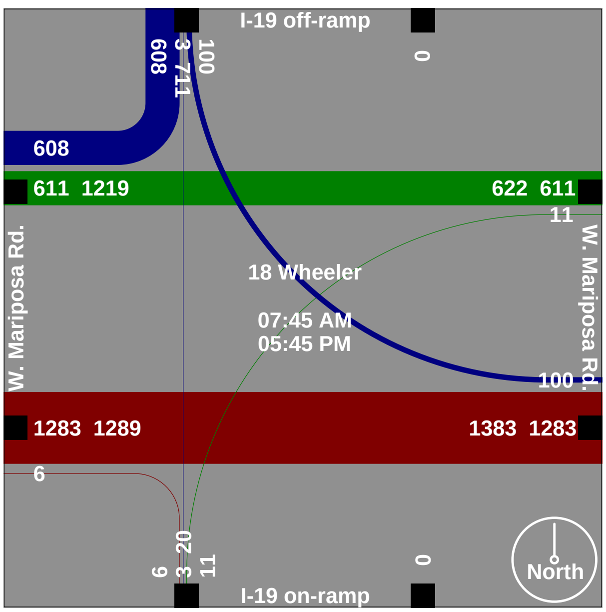


Figure 9-63 –Variable width graph (AInt-41)

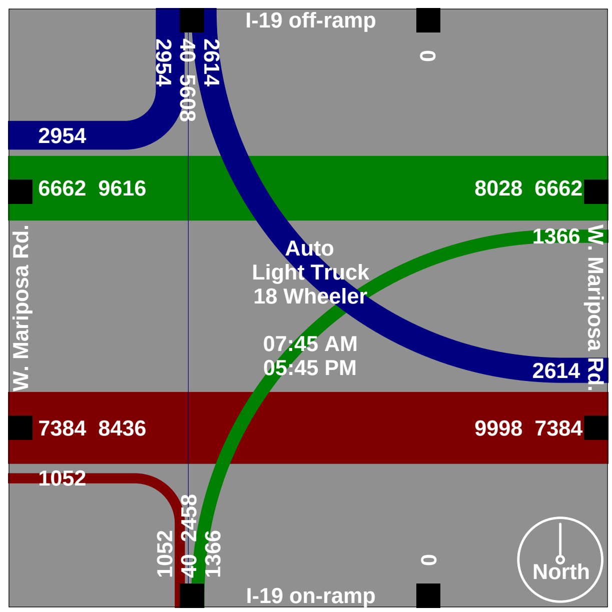


Figure 9-64 – Variable width graph (AInt-41)

- Location 5

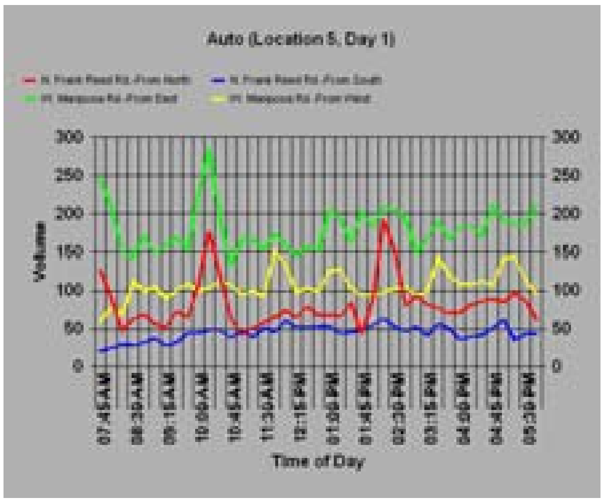


Figure 9-65 - Traffic volume for Auto (AInt-51)

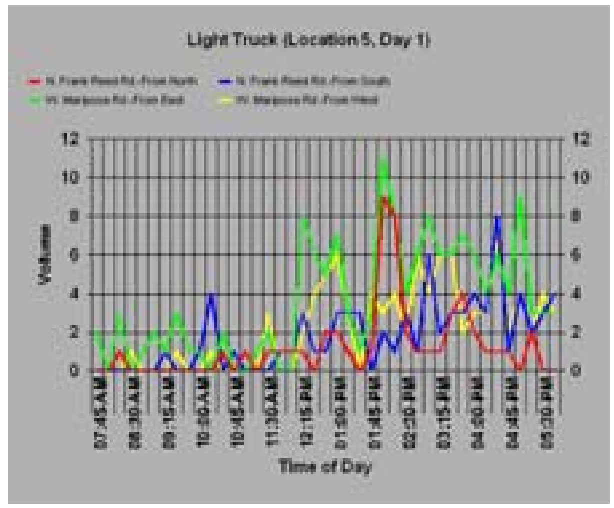


Figure 9-66 - Traffic volume for Light Truck (AInt-51)

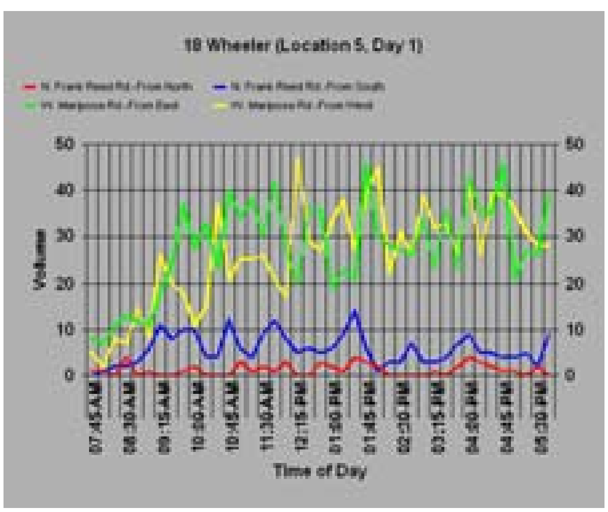


Figure 9-67 - Traffic volume for 18 wheeler (AInt-51)

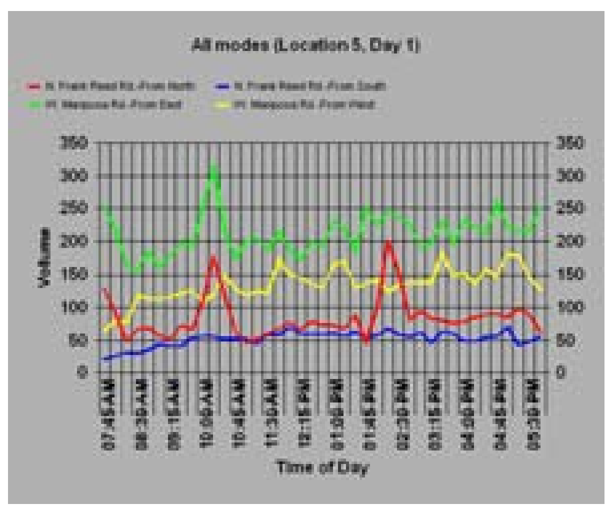


Figure 9-68 - Traffic volume (AInt-51)

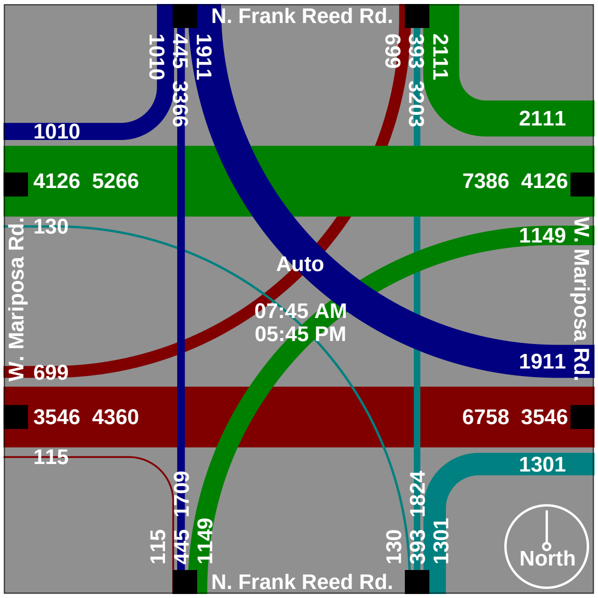


Figure 9-69 - Variable width graph for Auto (AInt-51)

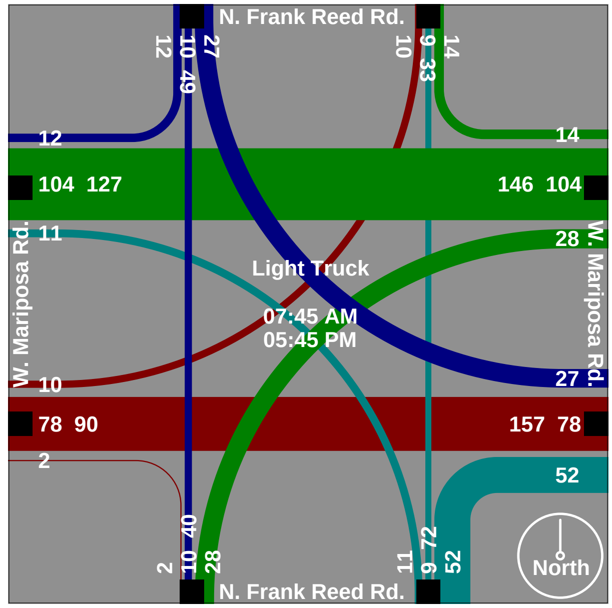


Figure 9-70 - Variable width graph for Light Truck (AInt-51)

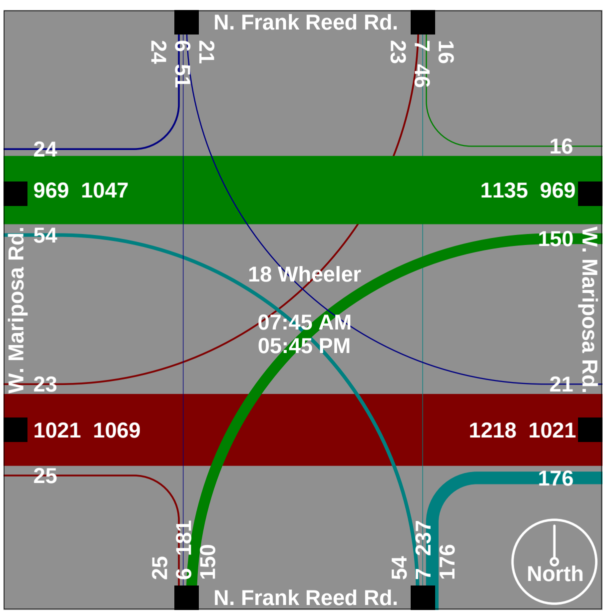


Figure 9-71 - Variable width graph for 18 Wheeler (AInt-51)

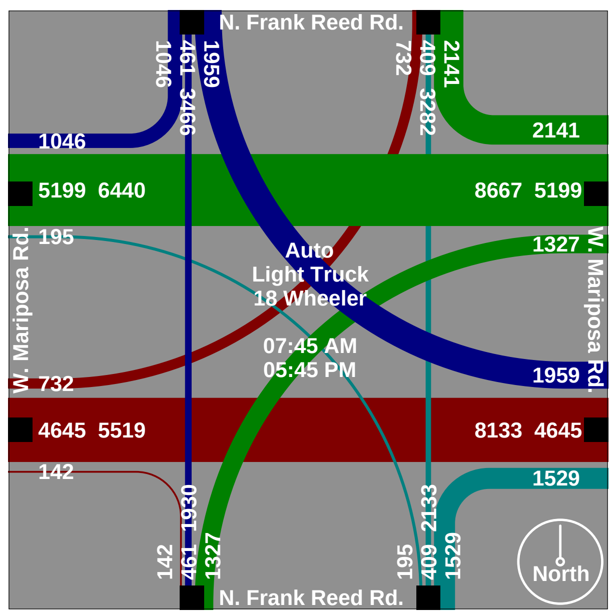


Figure 9-72 – Variable width graph (AInt-51)

- Location 6

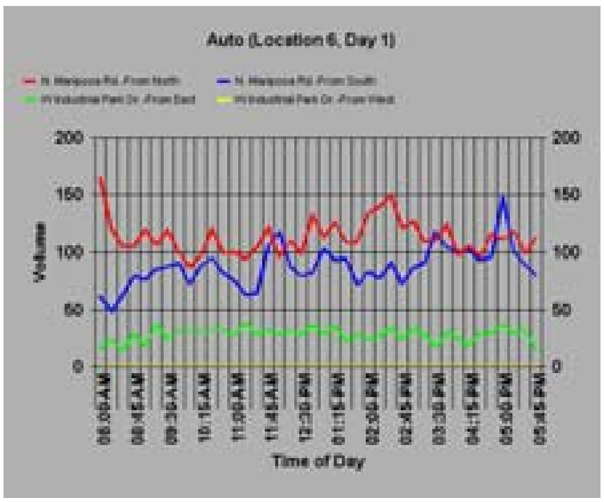


Figure 9-73 - Traffic volume for Auto (AInt-61)

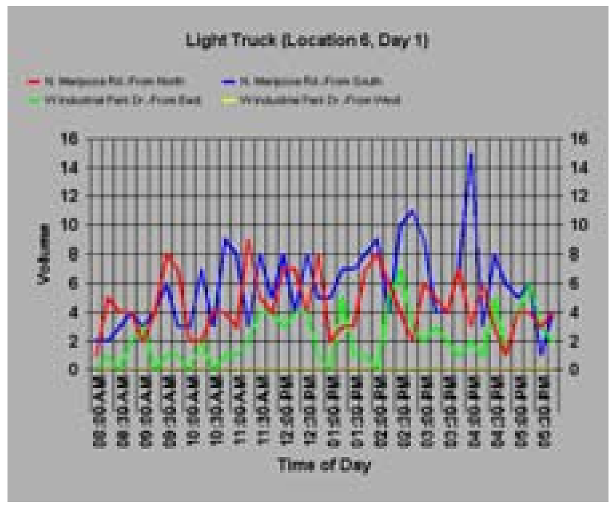


Figure 9-74 - Traffic volume for Light Truck (AInt-61)

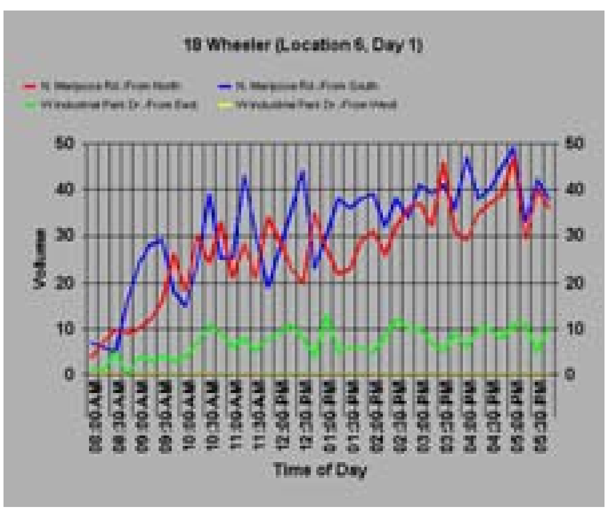


Figure 9-75 - Traffic volume for 18 wheeler (AInt-61)

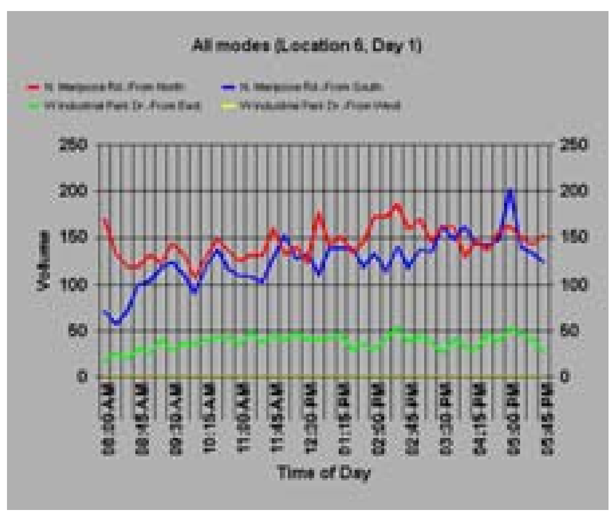


Figure 9-76 - Traffic volume (AInt-61)

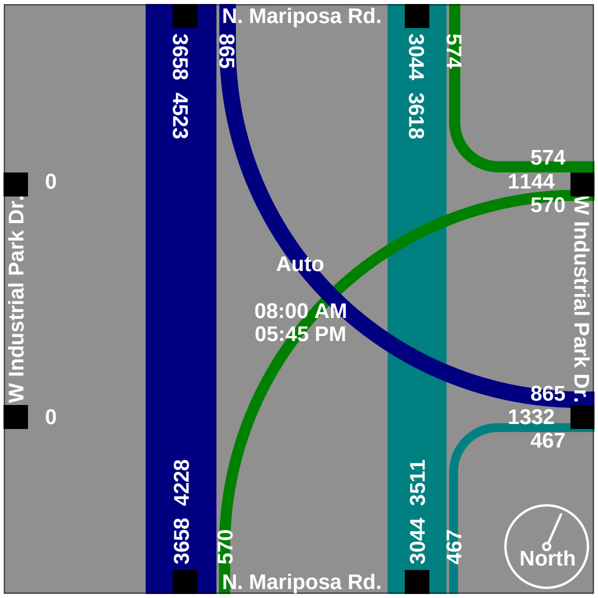


Figure 9-77 - Variable width graph for Auto (AInt-61)

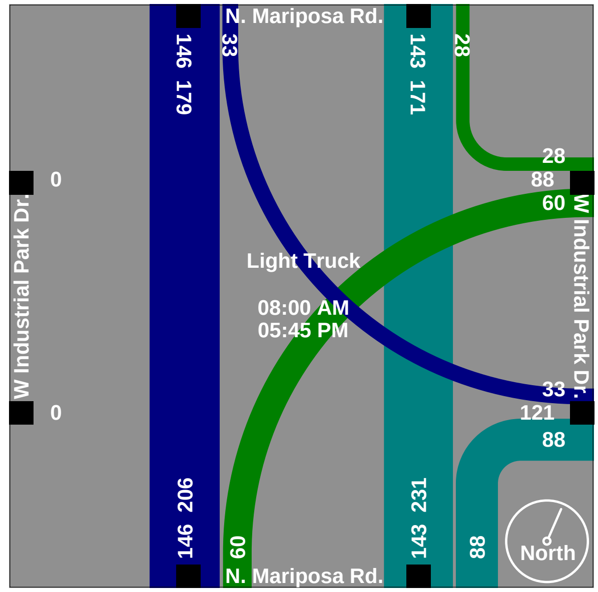


Figure 9-78 -Variable width graph for Light Truck (AInt-61)

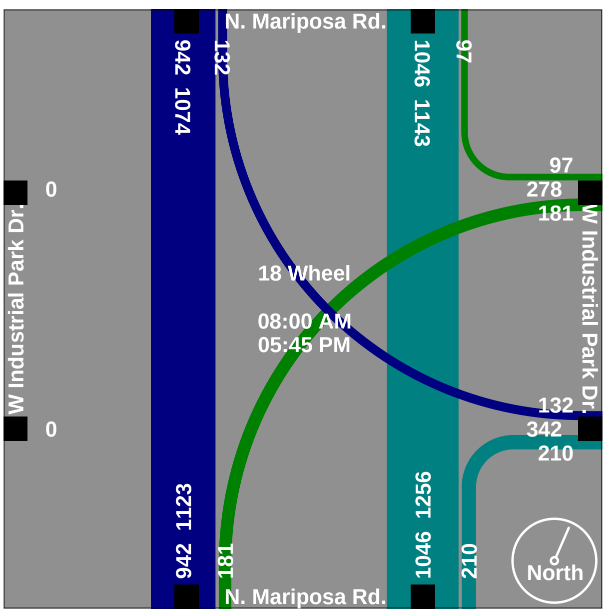


Figure 9-79 - Variable width graph for 18 wheeler (AInt-61)

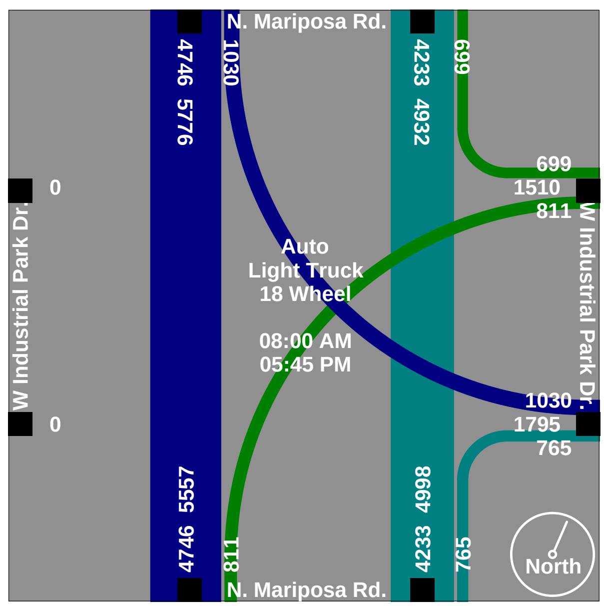


Figure 9-80 - Variable width graph for all modes (AInt-61)

- Location 7

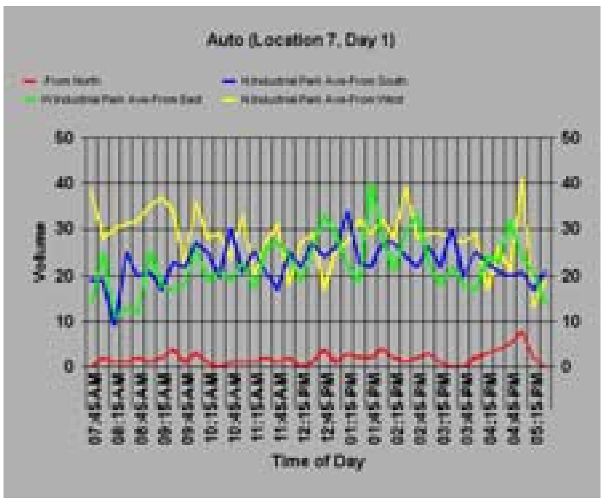


Figure 9-81 - Traffic volume for Auto (AInt-71)

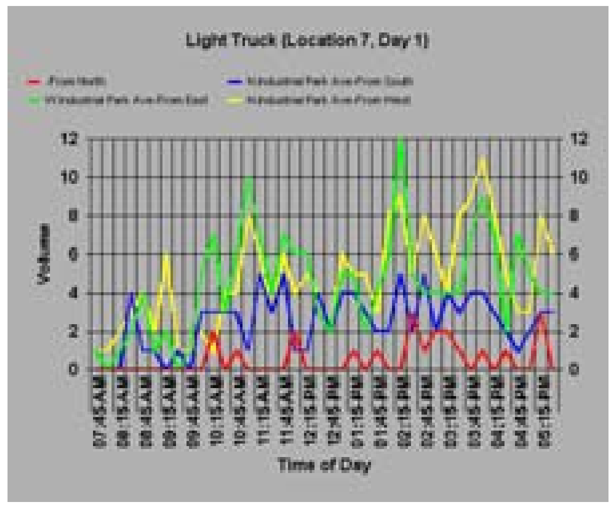


Figure 9-82 - Traffic volume for Light Truck (AInt-71)

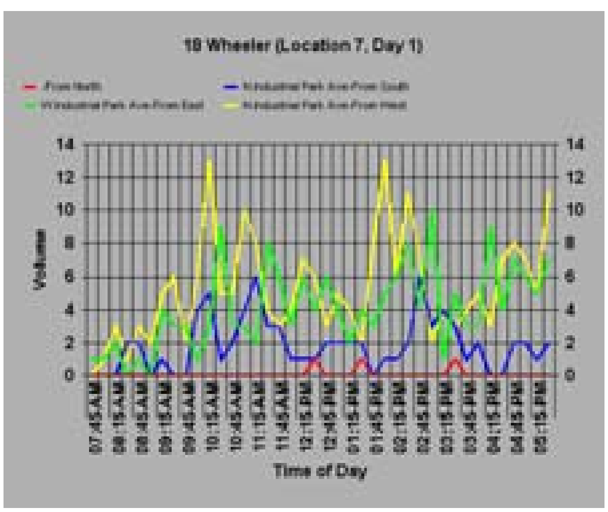


Figure 9-83 - Traffic volume for 18-wheelers(AInt-71)

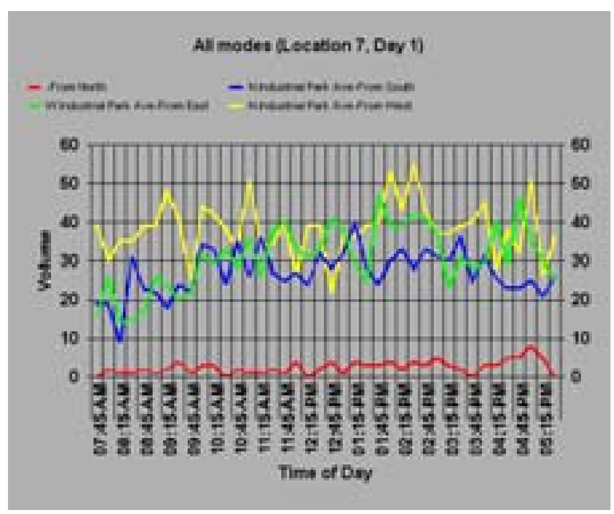


Figure 9-84 - Traffic volume (AInt-71)

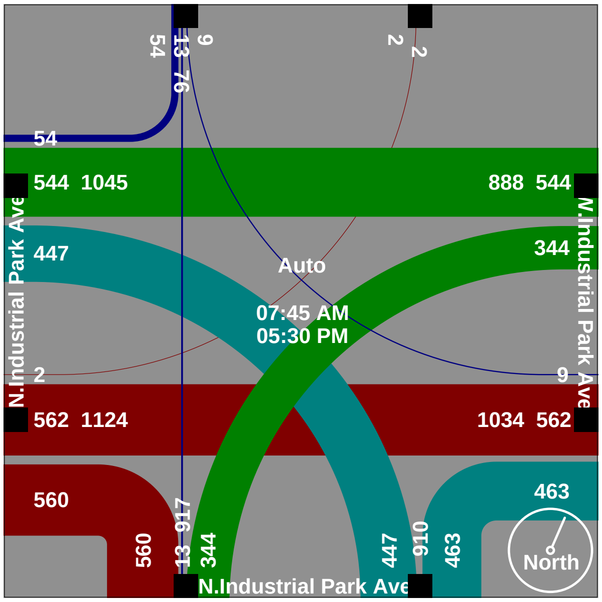


Figure 9-85 - Variable width graph for Auto (AInt-71)

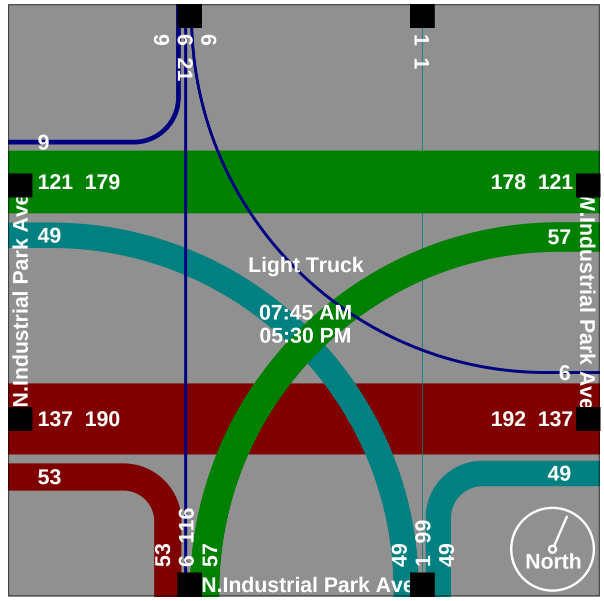


Figure 9-86- Variable width graph for Light Truck (AInt-71)

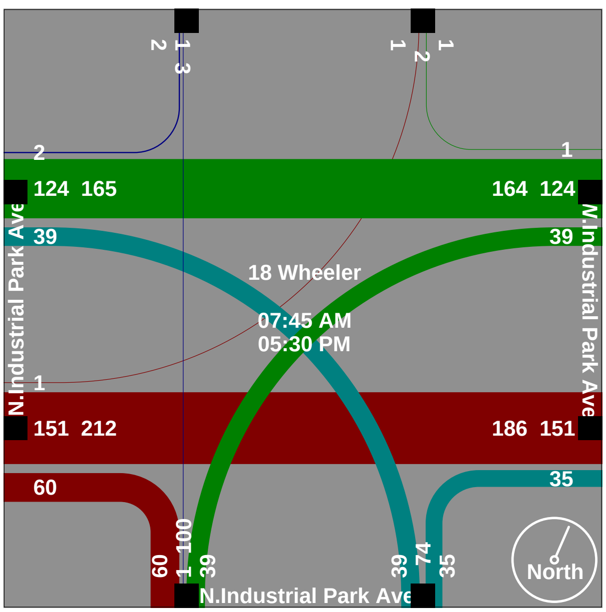


Figure 9-87 - Variable width graph for 18 wheeler (AInt-71)

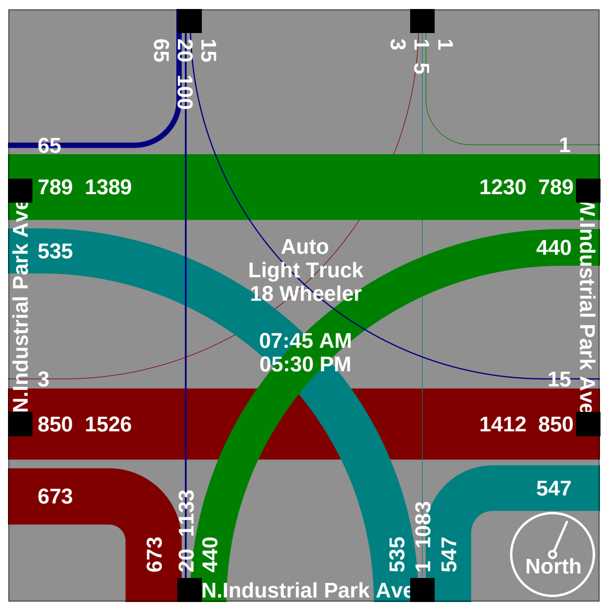


Figure 9-88 - Variable width graph for all modes (AInt-71)

- Location 8

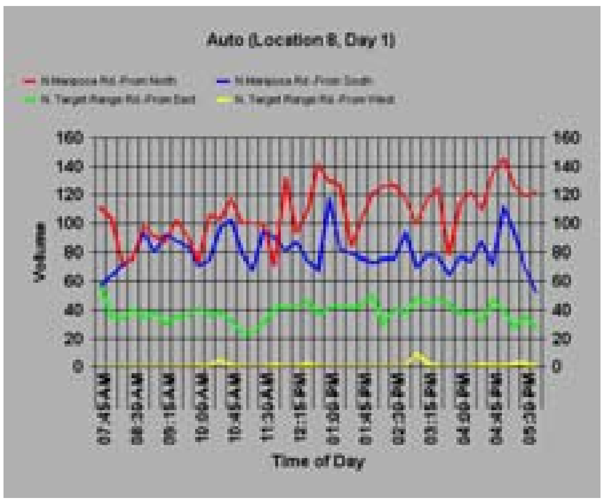


Figure 9-89 - Traffic volume for Auto (AInt-81)

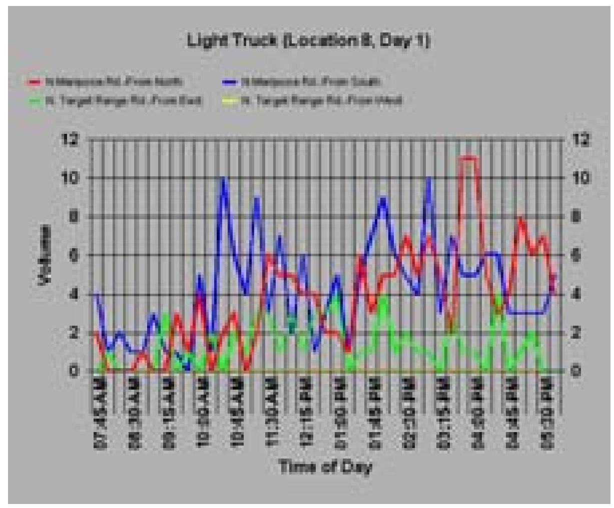


Figure 9-90 Traffic volume for Light Truck (AInt-81)

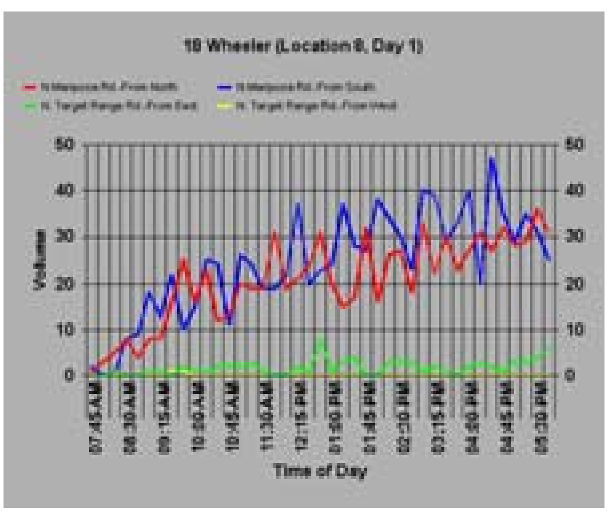


Figure 9-91 - Traffic volume for 18-wheelers(AInt-81)

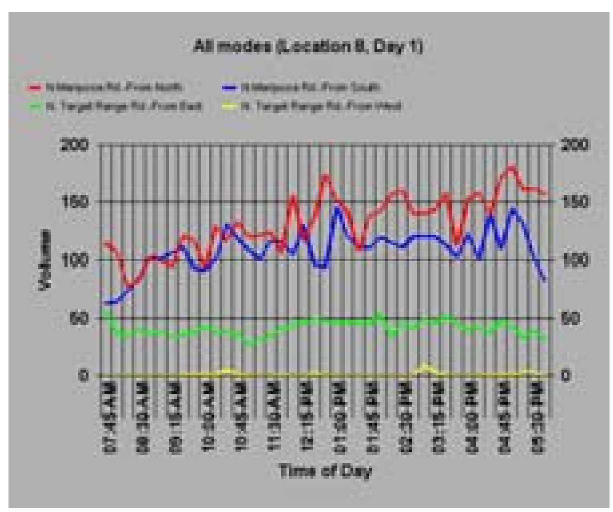


Figure 9-92 - Traffic volume for all modes (AInt-81)

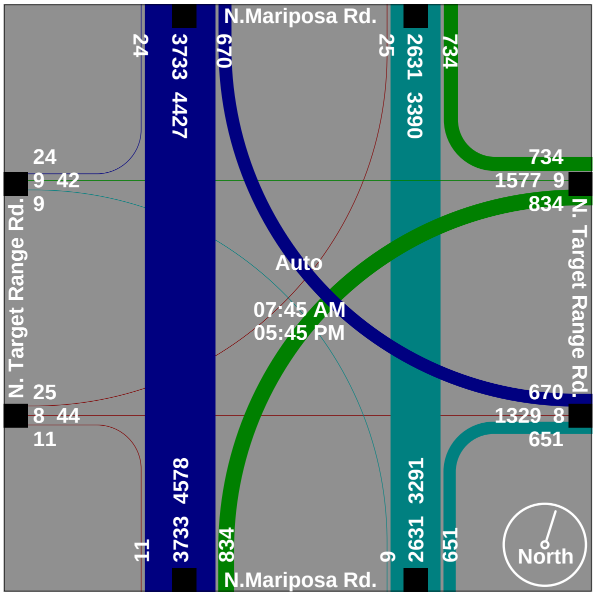


Figure 9-93 - Variable width graph for Auto (AInt-81)

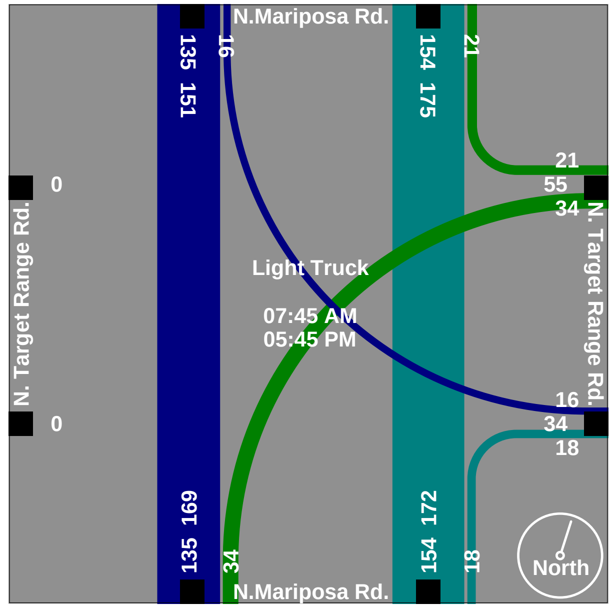


Figure 9-94 - Variable width graph for Light Truck (AInt-81)

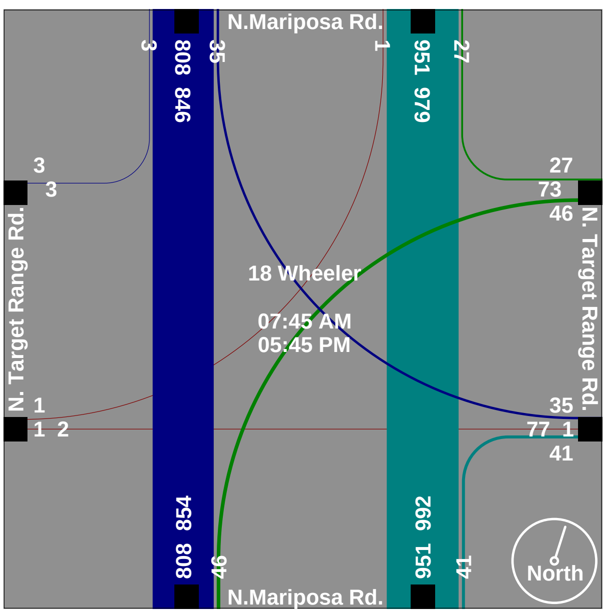


Figure 9-95 - Variable width graph for 18 wheeler (AInt-81)

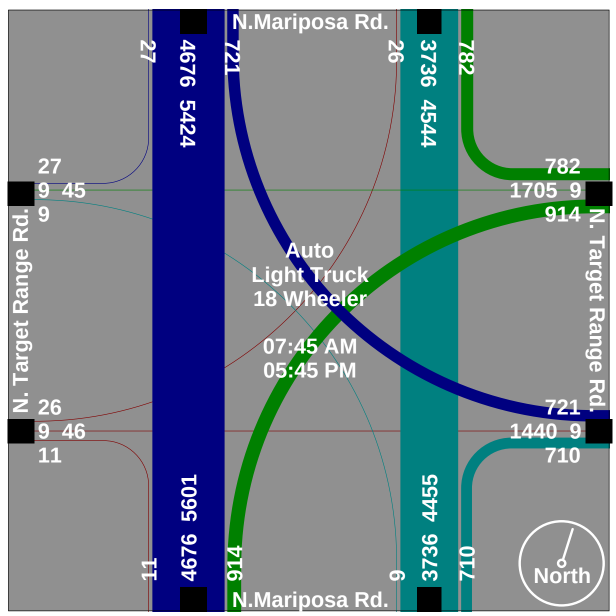


Figure 9-96 - Variable width graph for all modes (AInt-81)

9.1.2.2 Day 2

- Location 1

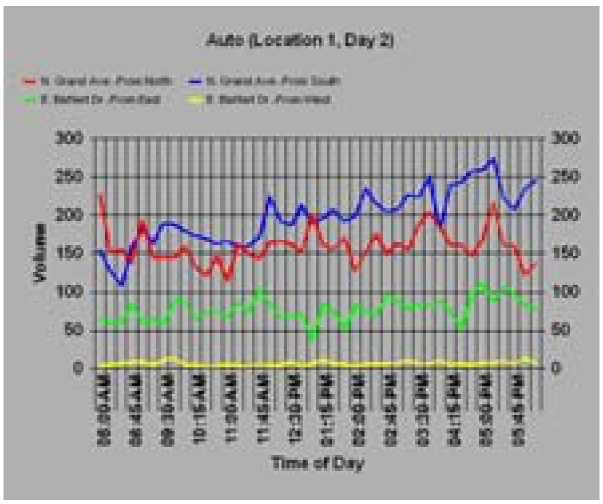


Figure 9-97 - Traffic volume for Auto (AInt-12)

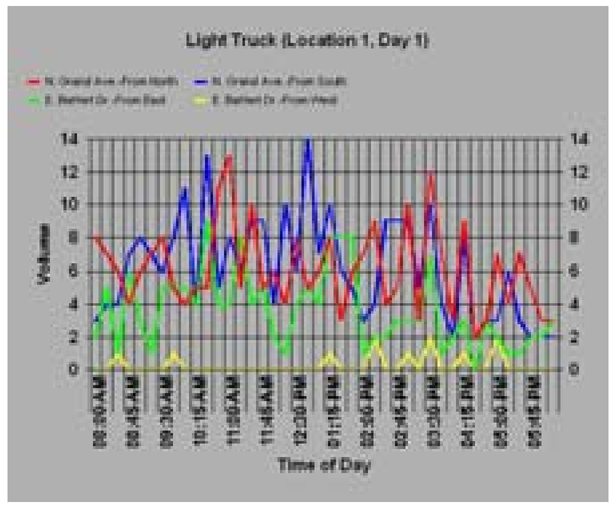


Figure 9-98- Traffic volume for Light Truck (AInt-12)

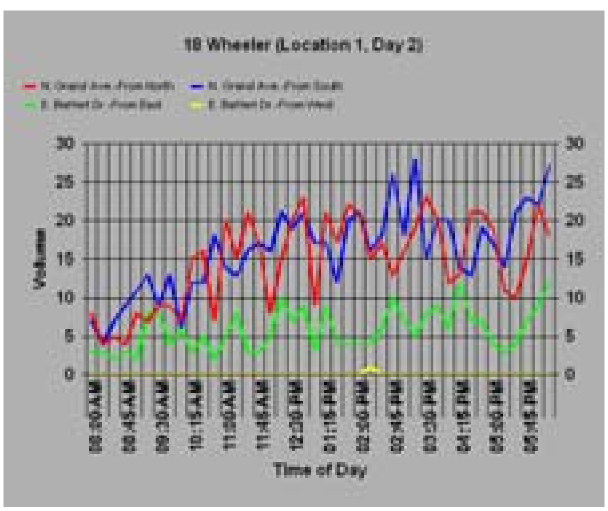


Figure 9-99 -Traffic volume for 18-wheelers (AInt-12)

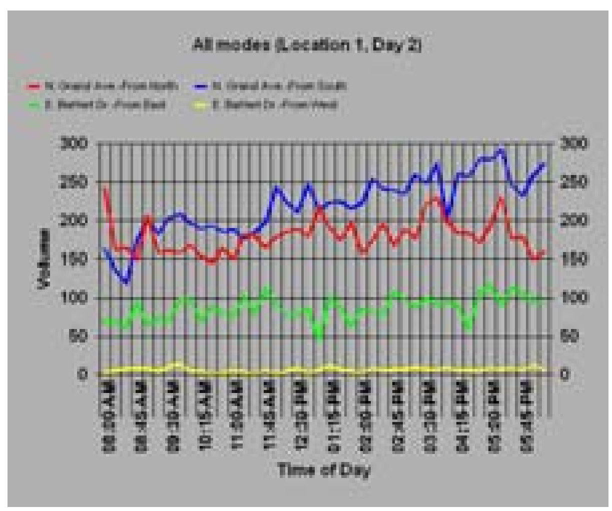


Figure 9-100 - Traffic volume for all modes (AInt-12)

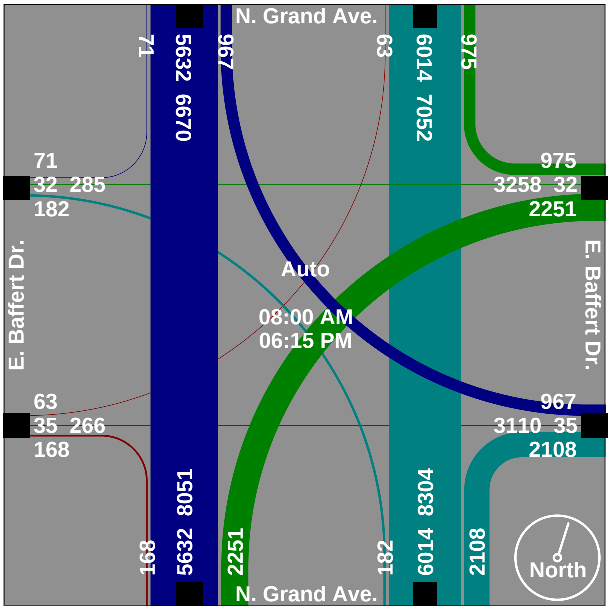


Figure 9-101 - Variable width graph for Auto (AInt-12)

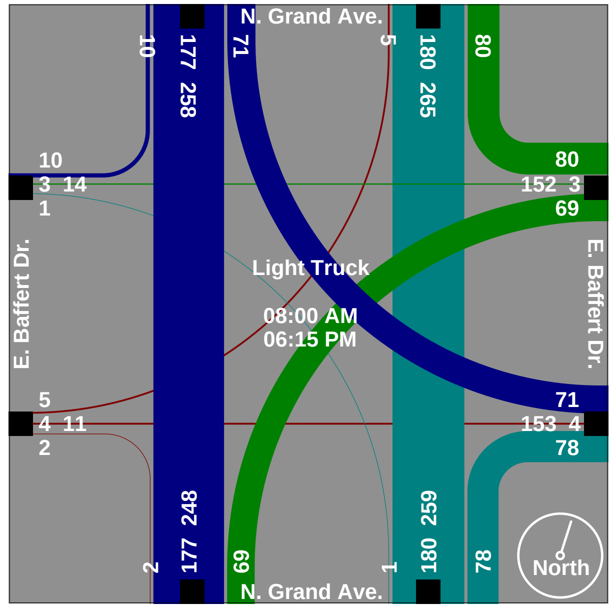


Figure 9-102 - Variable width graph for Light Truck (AInt-12)

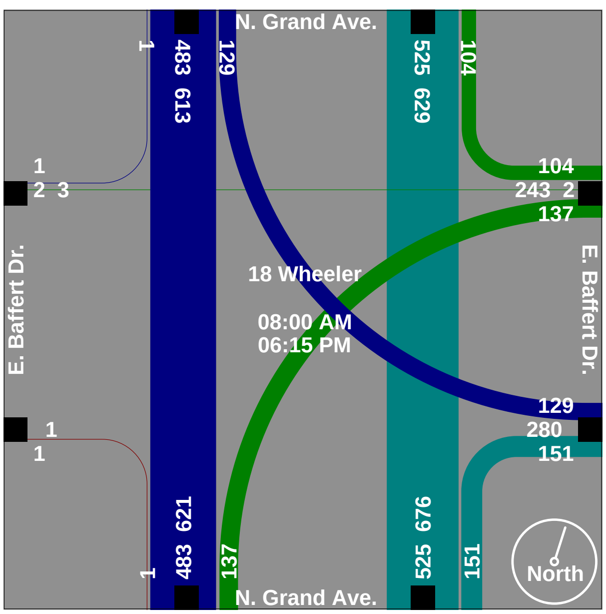


Figure 9-103 - Variable width graph for 18 wheeler (AInt-12)

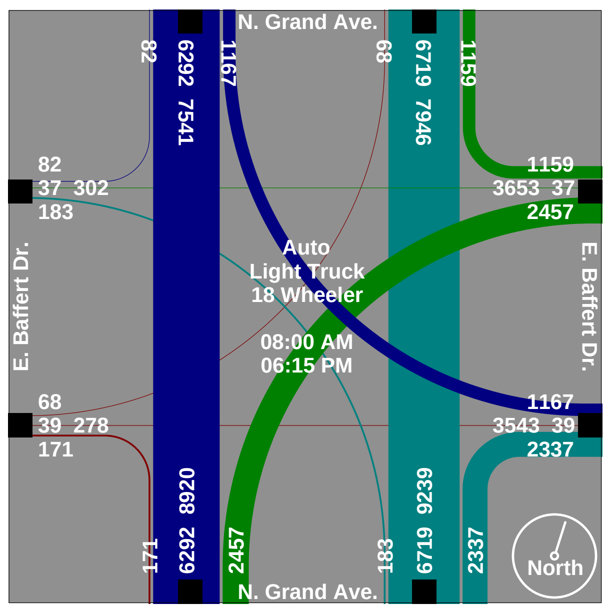


Figure 9-104 - Variable width graph for all modes (AInt-12)

- Location 2

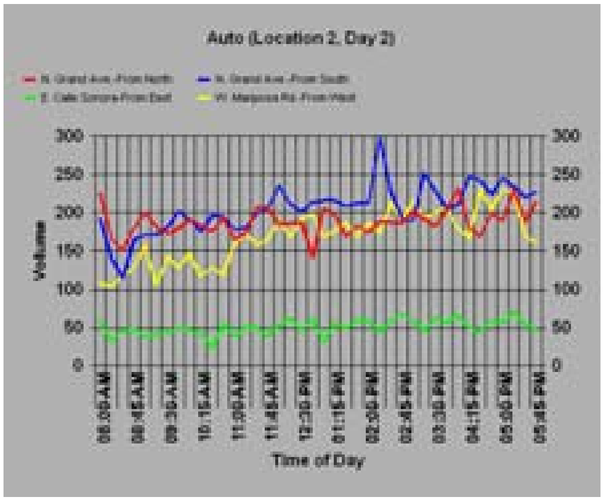


Figure 9-105 - Traffic volume for Auto (AInt-22)

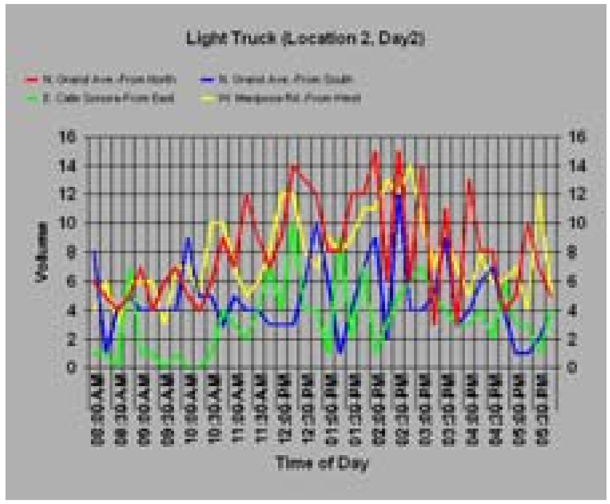


Figure 9-106 - Traffic volume for Light Truck (AInt-22)

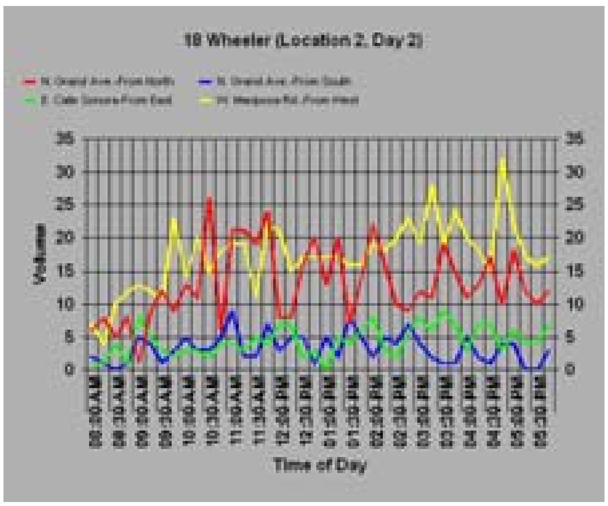


Figure 9-107 - Traffic volume for 18-wheelers (AInt-22)

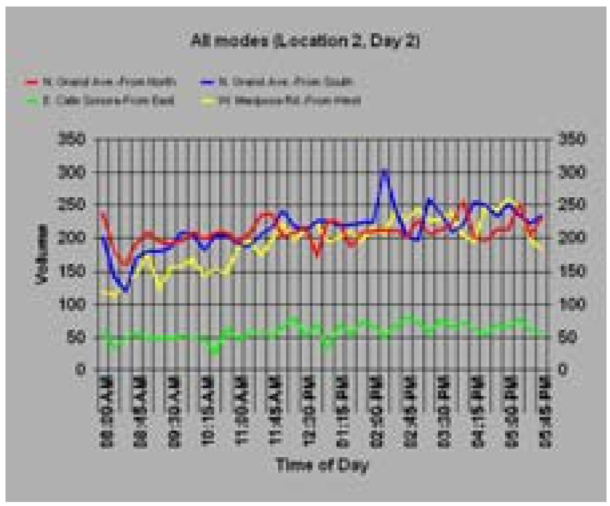


Figure 9-108 - Traffic volume for all modes (AInt-22)

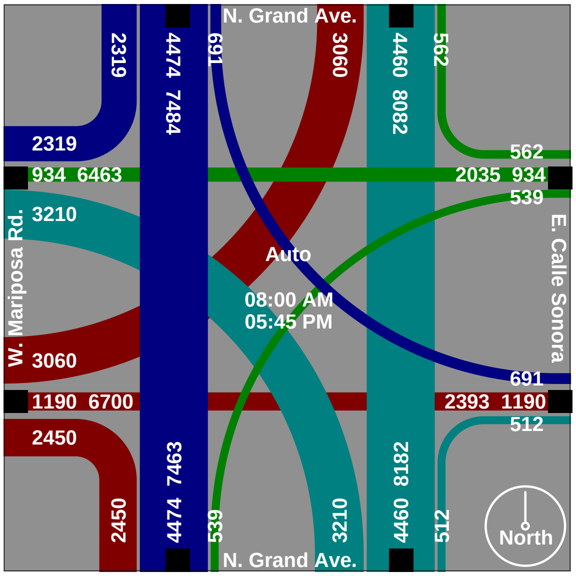


Figure 9-109 - Variable width graph for Autos (AInt-22)

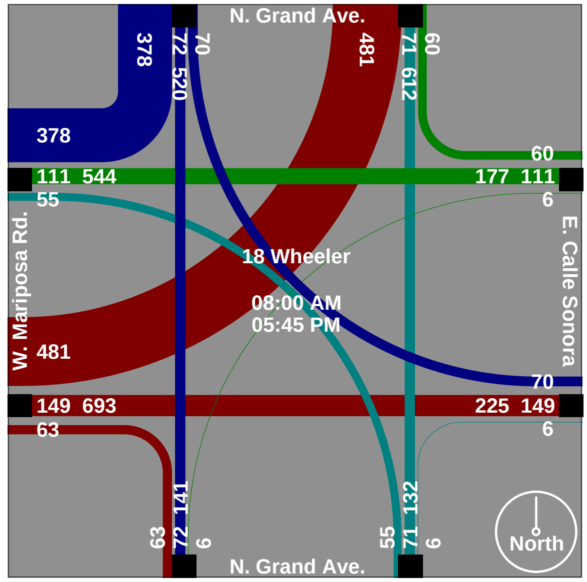


Figure 9-110 - Variable width graph for 18-wheelers (AInt-22)

- Location 3

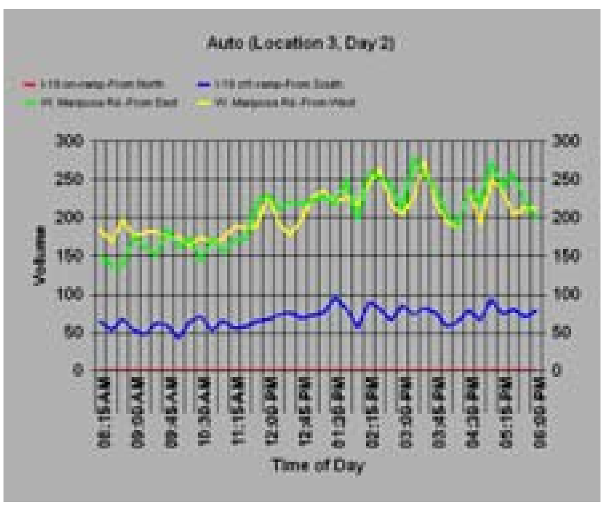


Figure 9-111 - Traffic volume for Autos (AInt-32)

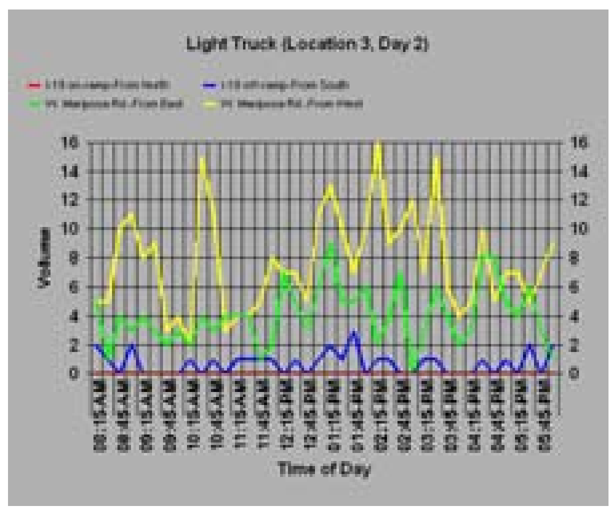
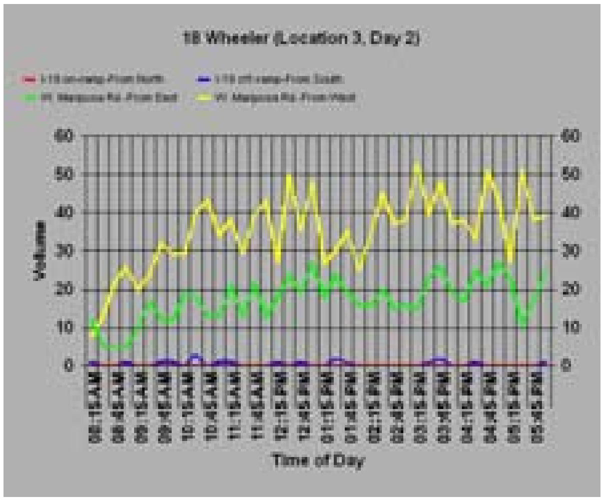


Figure 9-112 - Traffic volume for Light Truck (AInt-32)



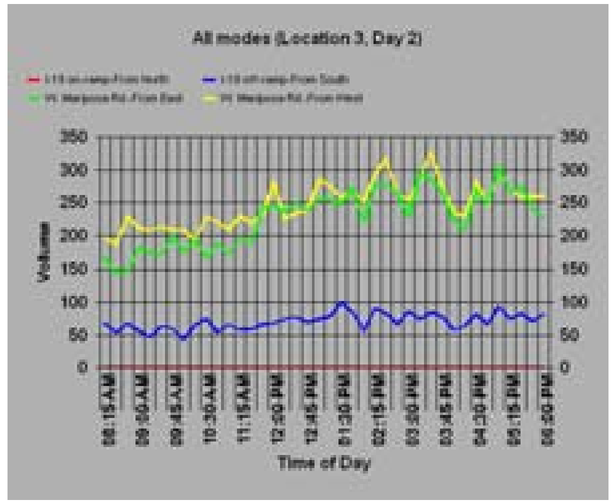
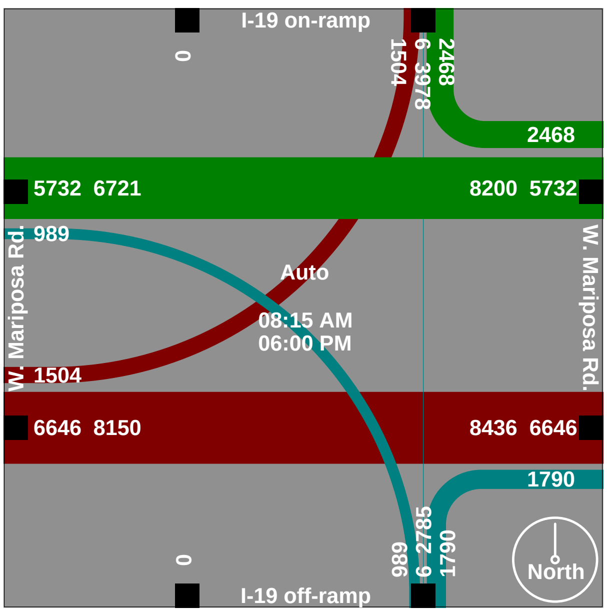


Figure 9-113 -Traffic volume for 18-wheelers (AInt-32)

Figure 9-114 - Traffic volume for all modes (AInt-32)



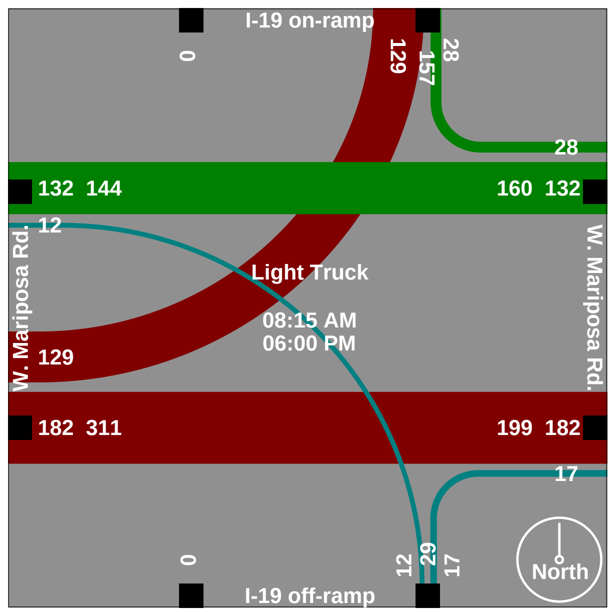


Figure 9-115 - Variable width graph for Autos (AInt-32)

Figure 9-116 - Variable width graph for Light Trucks (AInt-32)

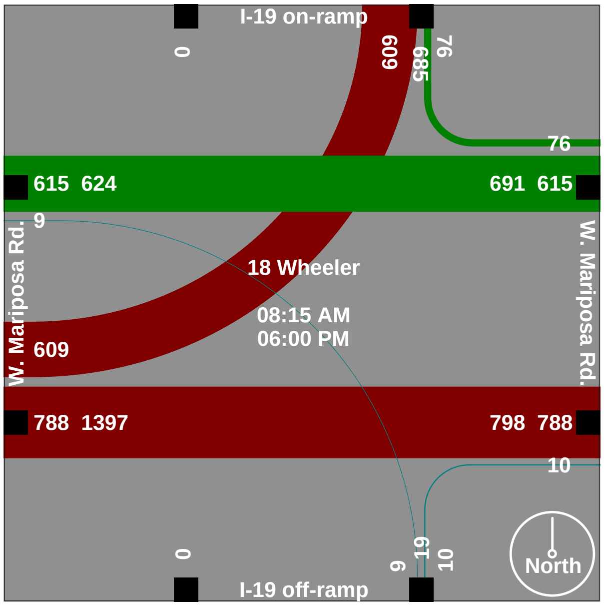


Figure 9-117 - Variable width graph for 18-wheelers (AInt-32)

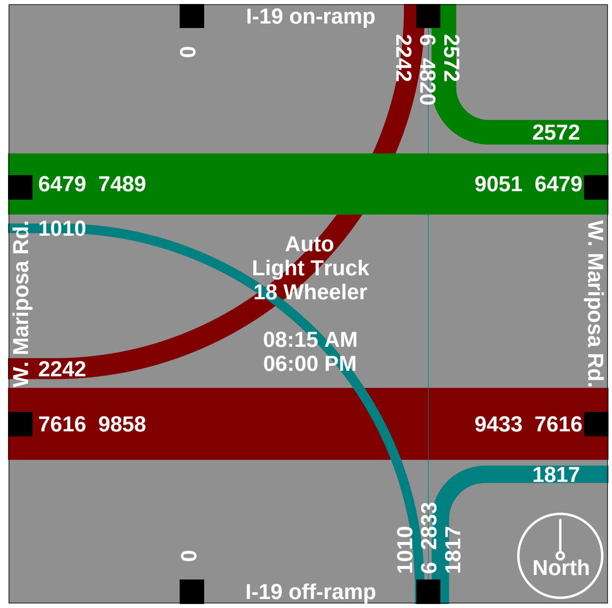


Figure 9-118 - Variable width graph for all modes (AInt-32)

- Location 4

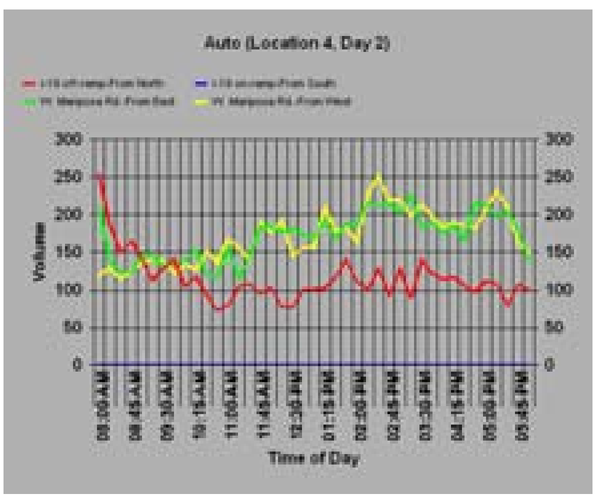


Figure 9-119 - Traffic volume for Autos (AInt-42)

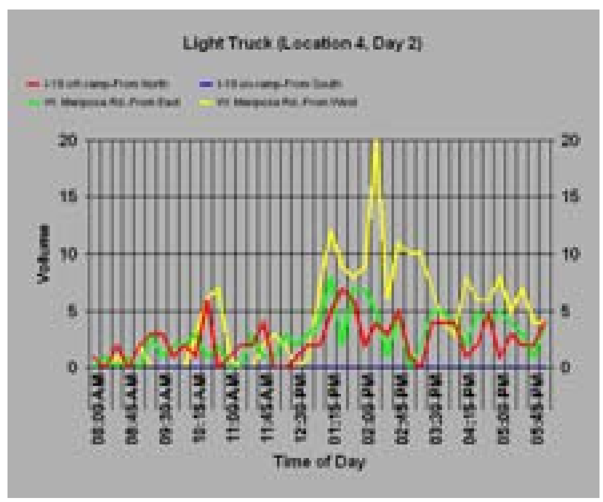


Figure 9-120 - Traffic volume for Light Trucks (AInt-42)

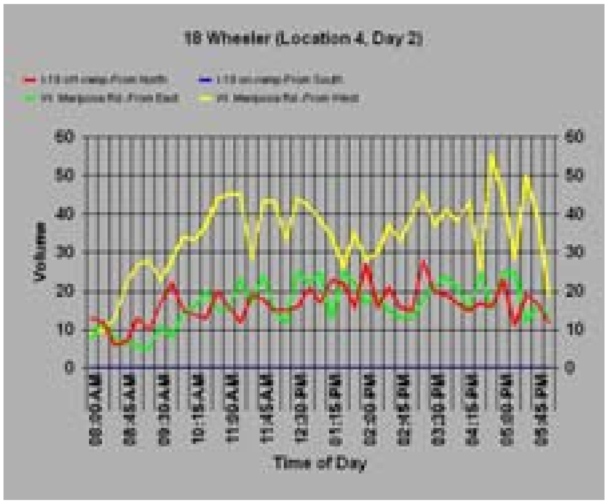


Figure 9-121 - Traffic volume for 18-wheelers (AInt-42)

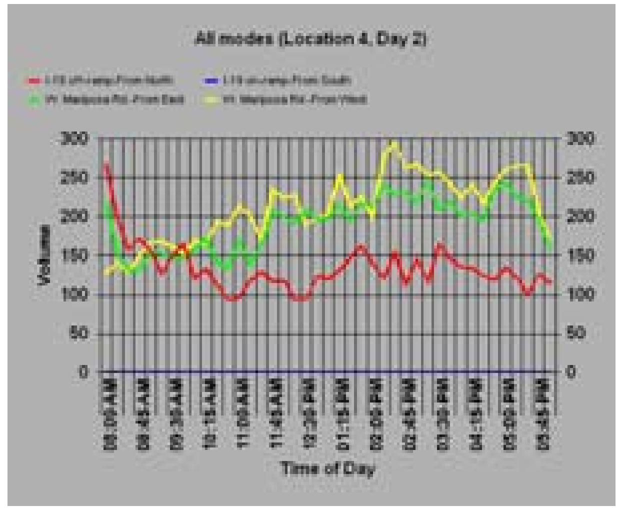


Figure 9-122 - Traffic volume for all modes (AInt-42)

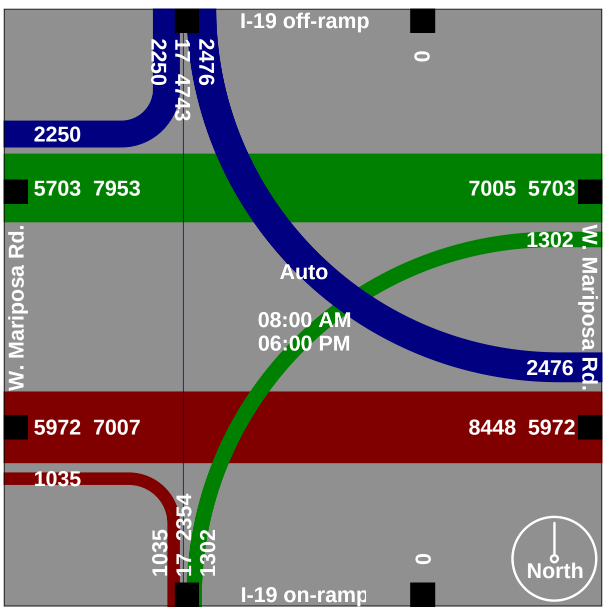


Figure 9-123 - Variable width graph for Autos (AInt-42)

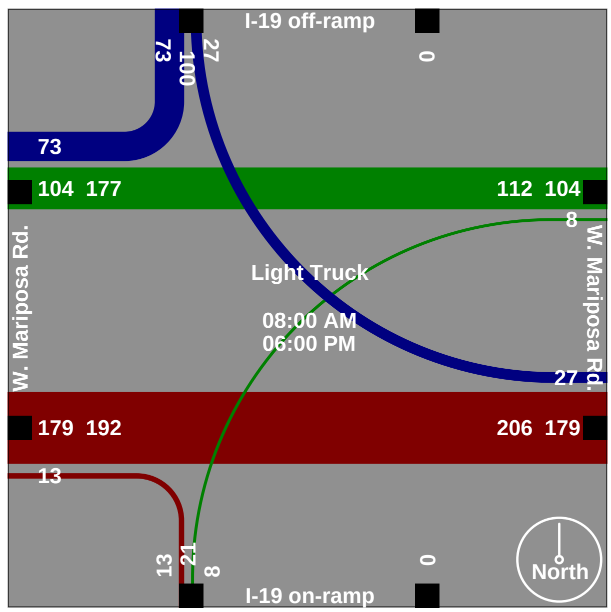


Figure 9-124 - Variable width graph for Light Trucks (AInt-42)

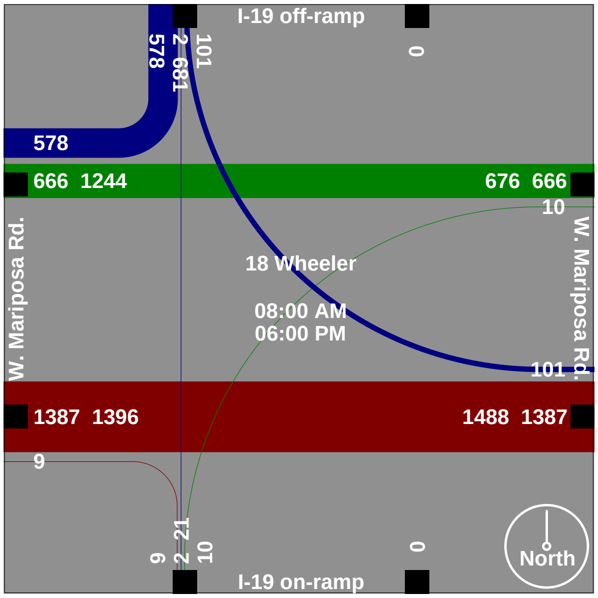


Figure 9-125 - Variable width graph for 18-wheelers (AInt-42)

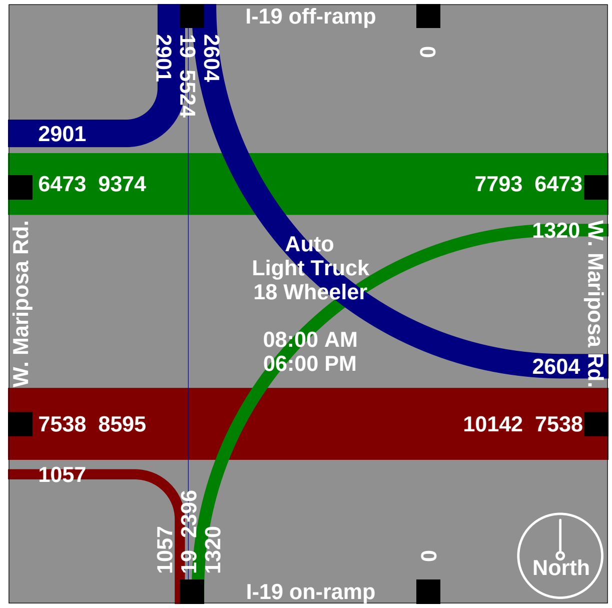


Figure 9-126 - Variable width graph for all modes (AInt-42)

- Location 5

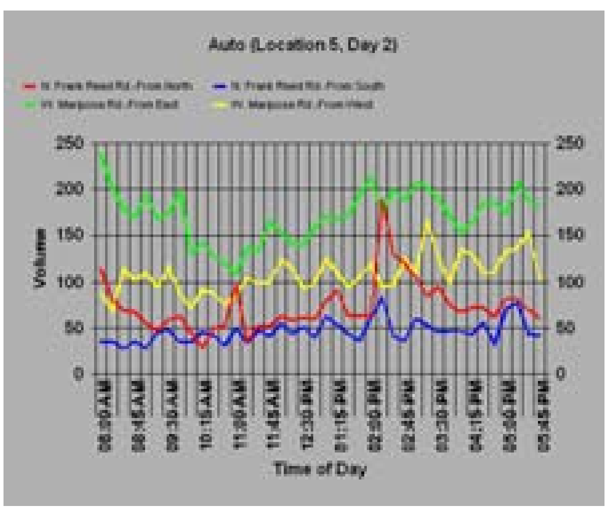


Figure 9-127 - Traffic volume for Auto (AInt-52)

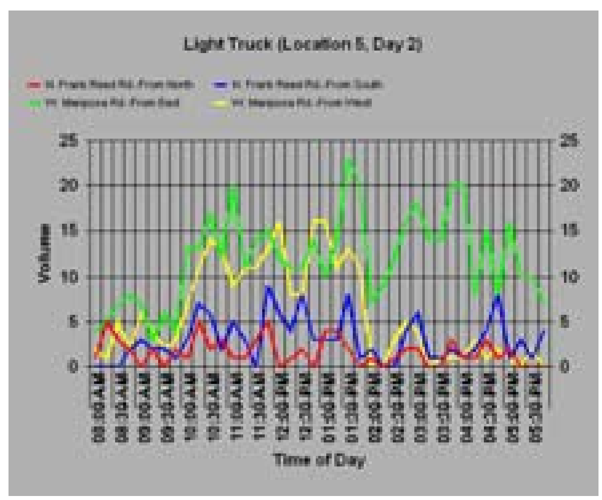


Figure 9-128 - Traffic volume for Light Truck (AInt-52)

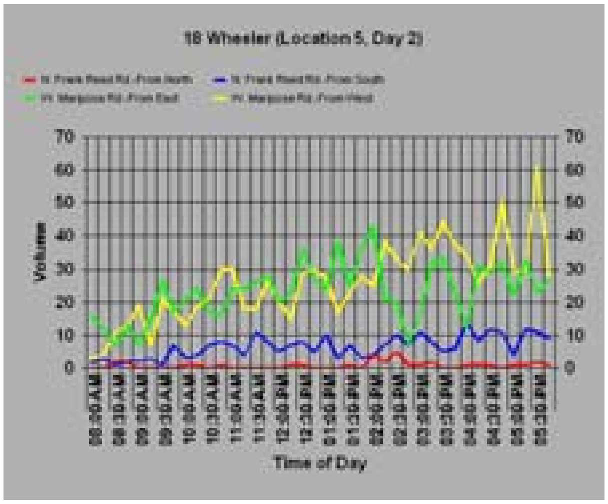


Figure 9-129 - Traffic volume for 18 wheeler (AInt-52)

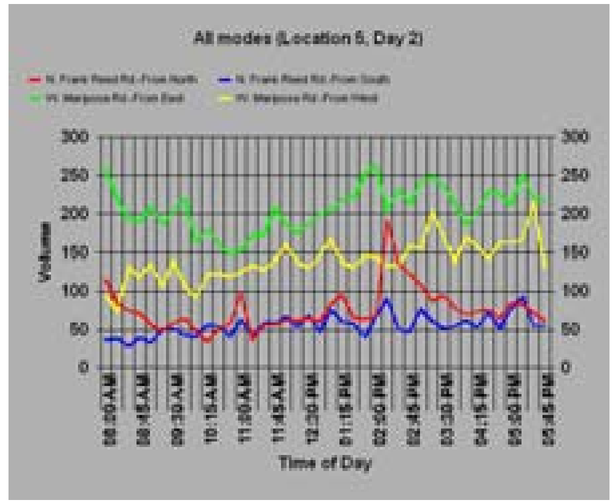


Figure 9-130 - Traffic volume for all modes (AInt-52)

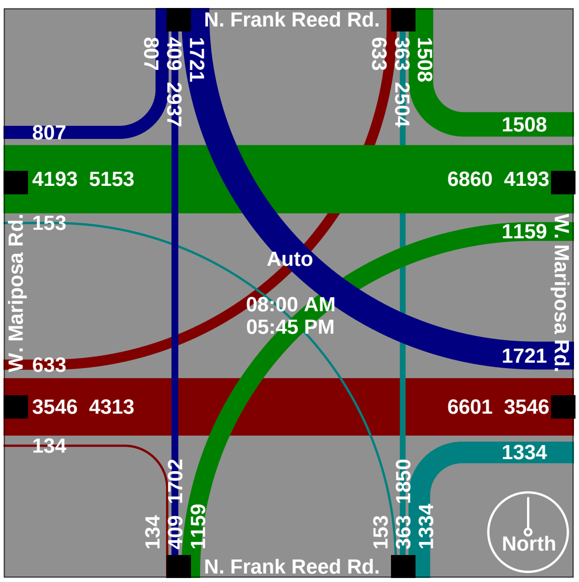


Figure 9-131 - Variable width graph for Auto (AInt-52)

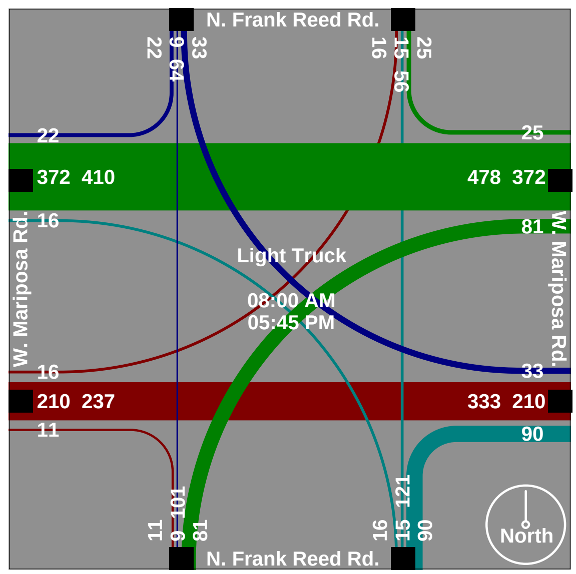


Figure 9-132 - Variable width graph for Light Truck (AInt-52)

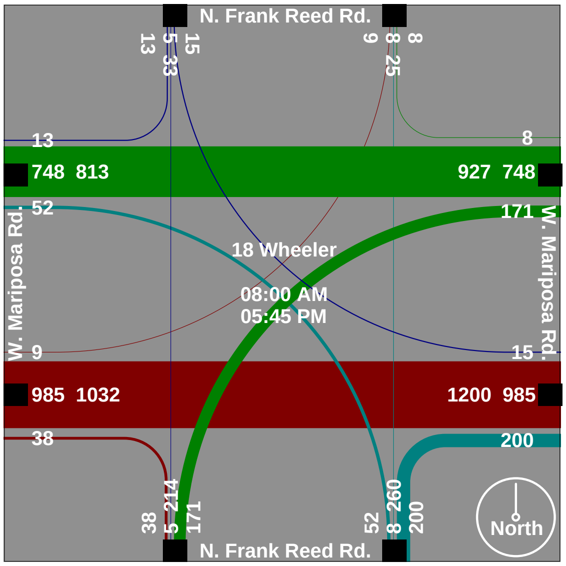


Figure 9-133 - Variable width graph for 18 wheeler (AInt-52)

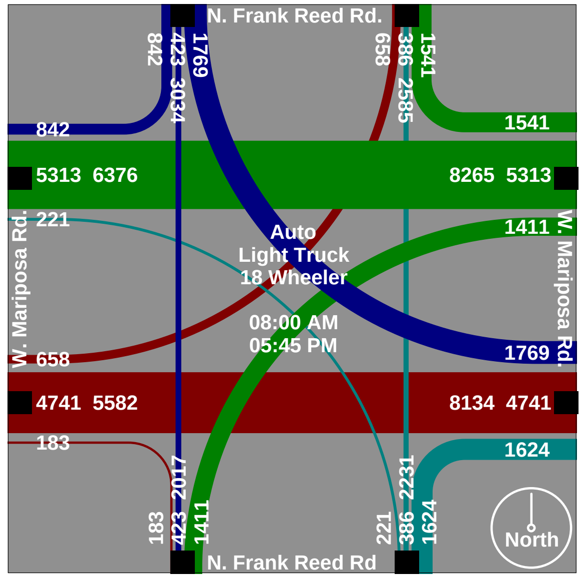


Figure 9-134 - Variable width graph for all modes (AInt-52)

- Location 6

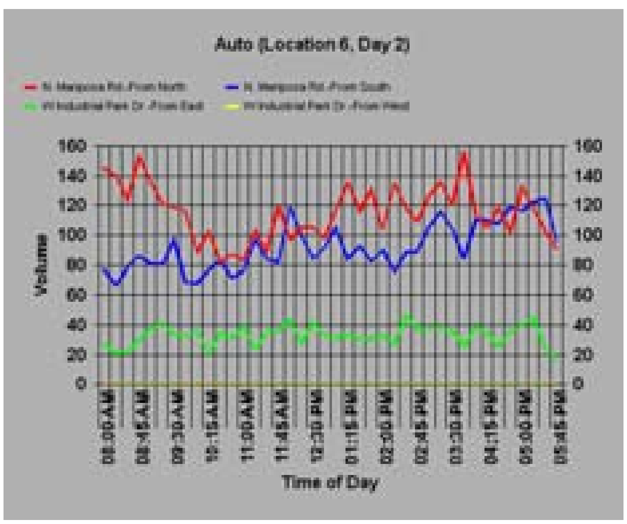


Figure 9-135 - Traffic volume for Auto (AInt-62)

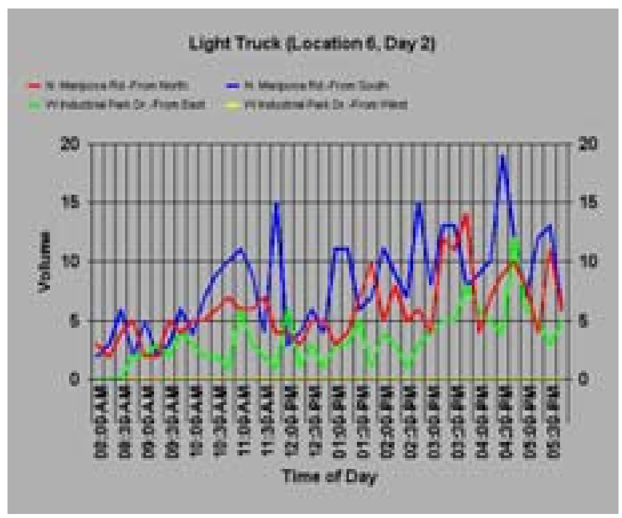


Figure 9-136 - Traffic volume for Light Truck (AInt-62)

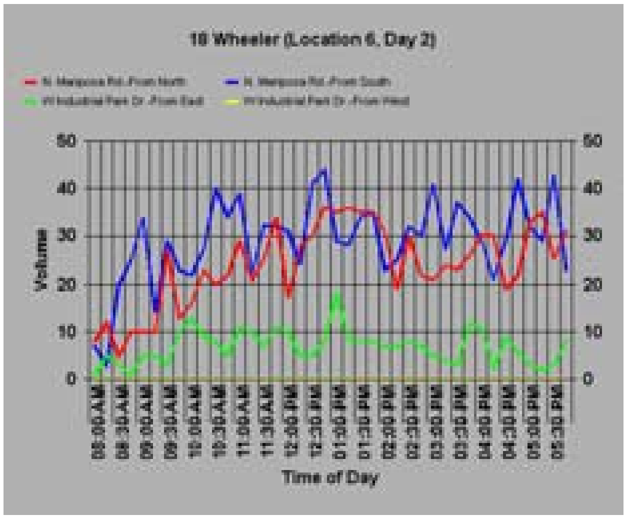


Figure 9-137 - Traffic volume for 18 wheeler (AInt-62)

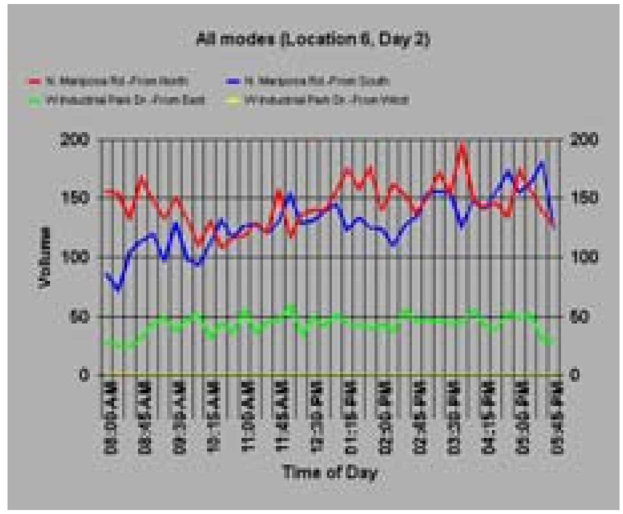


Figure 9-138 - Traffic volume for all modes (AInt-62)

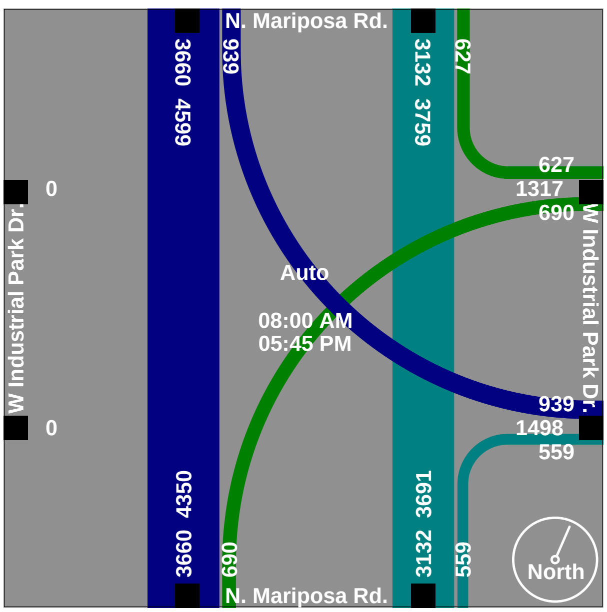


Figure 9-139 - Variable width graph for Auto (AInt-62)

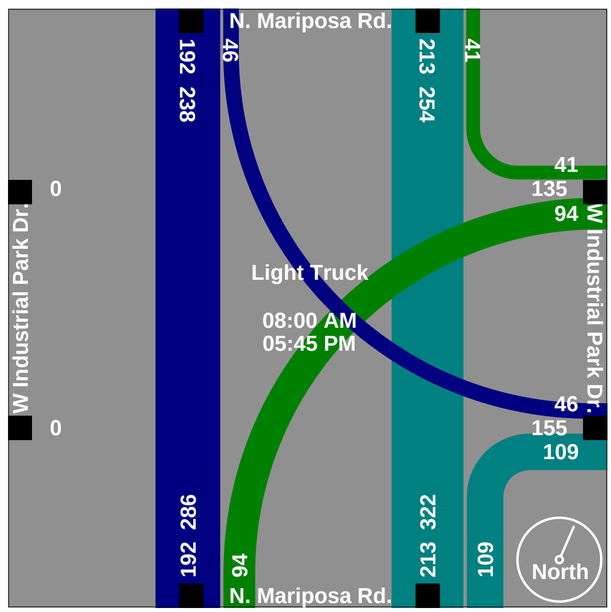


Figure 9-140 - Variable width graph for Light Truck (AInt-62)

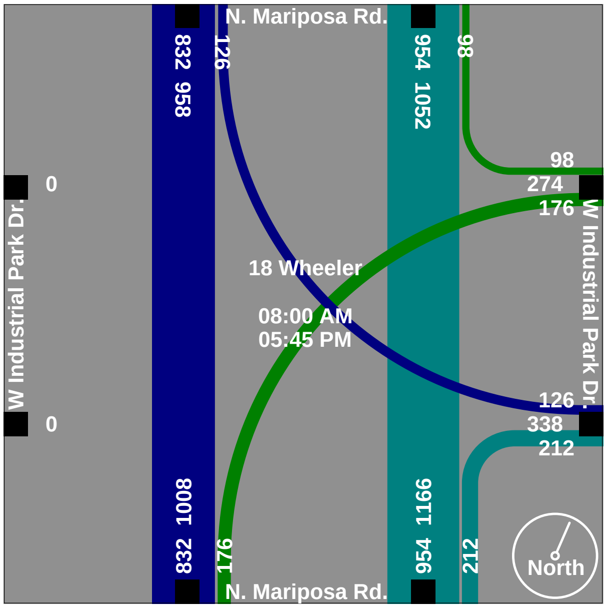


Figure 9-141 - Variable width graph for 18 wheeler (AInt-62)

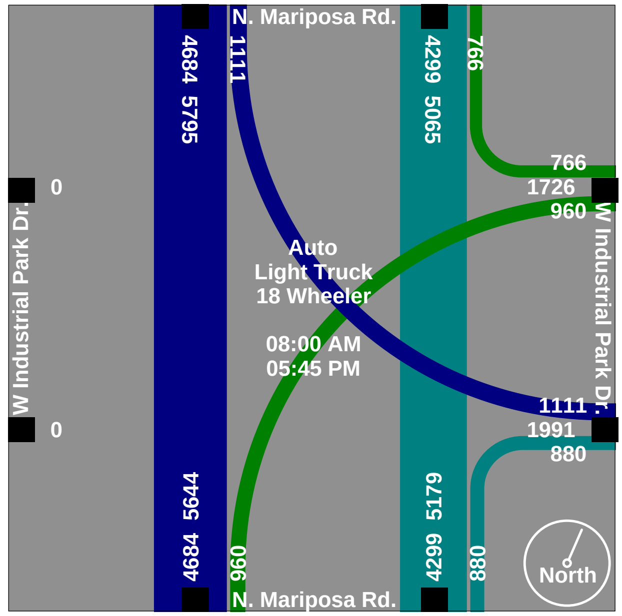


Figure 9-142 - Variable width graph for all modes (AInt-62)

- Location 7

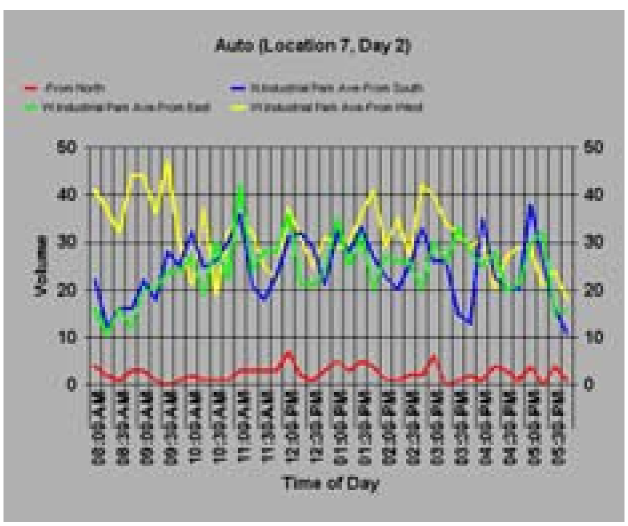


Figure 9-143 - Traffic volume for Auto (AInt-72)

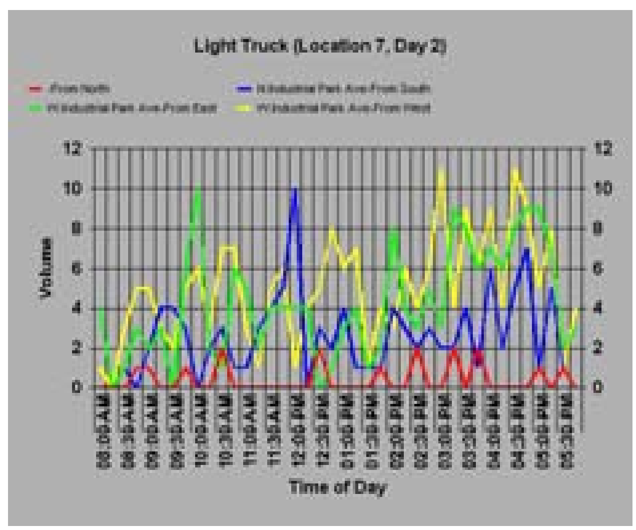


Figure 9-144 - Traffic volume for Light Truck (AInt-72)

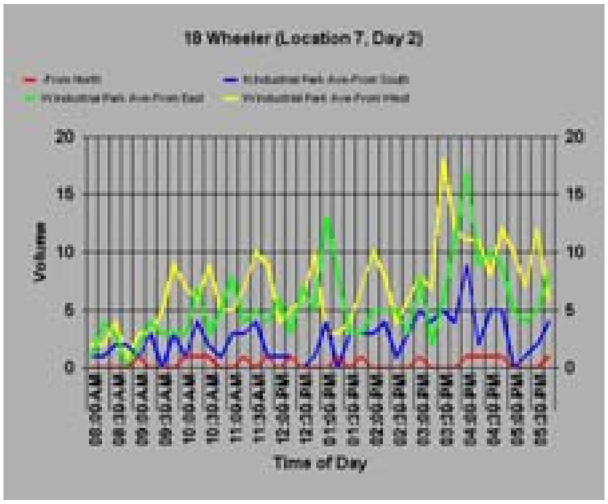


Figure 9-145 - Traffic volume for 18 wheeler (AInt-72)

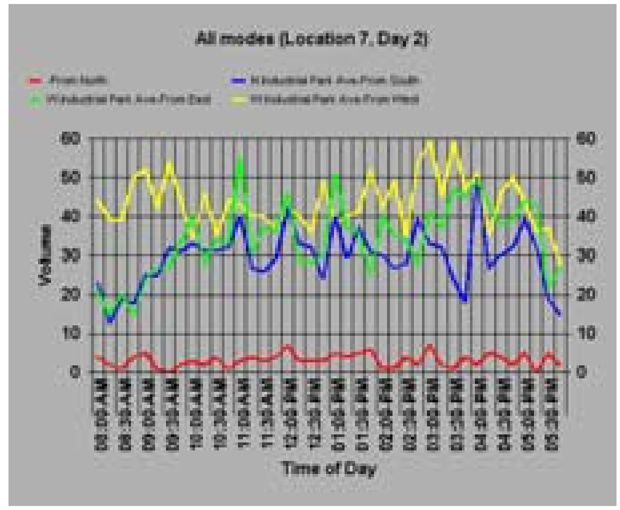


Figure 9-146 - Traffic volume for all modes (AInt-72)

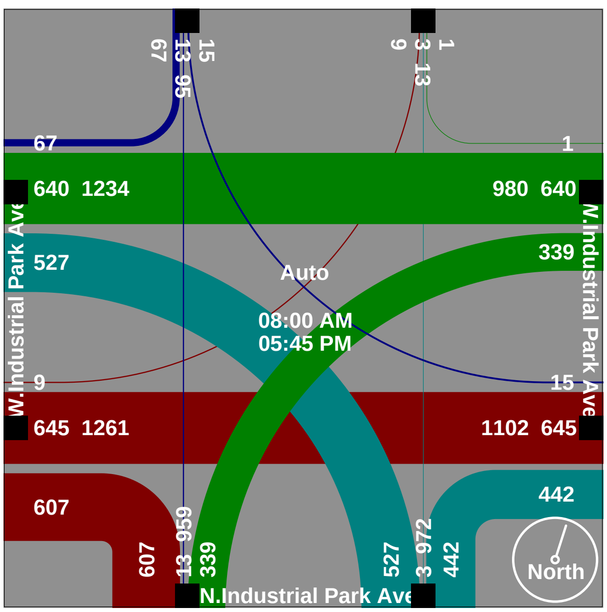


Figure 9-147 - Variable width graph for Auto (AInt-72)

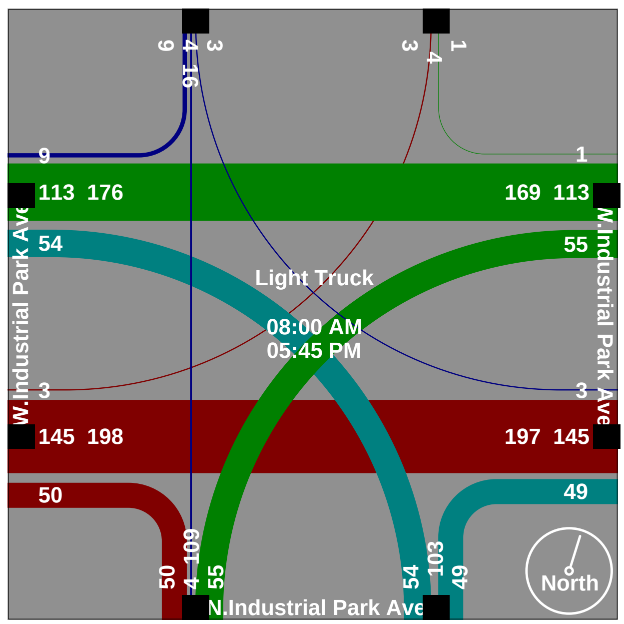


Figure 9-148 - Variable width graph for Light Truck (AInt-72)

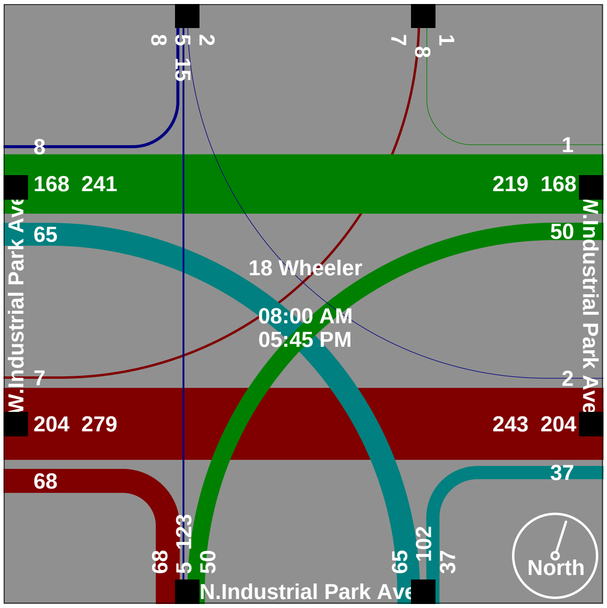


Figure 9-149 - Variable width graph for 18 wheeler (AInt-72)

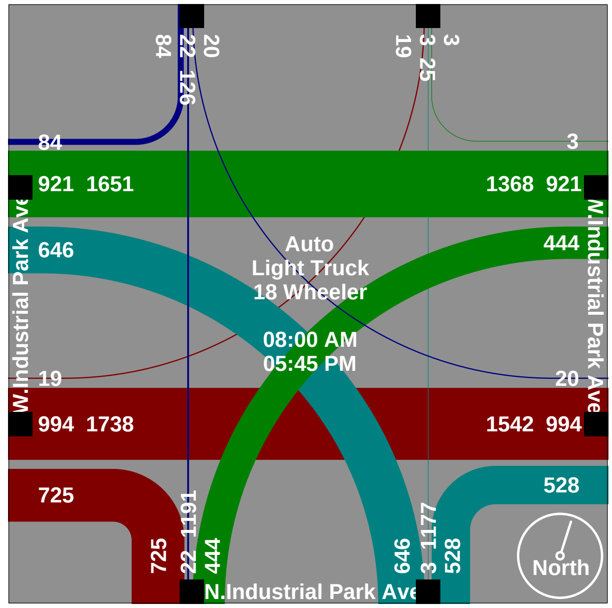


Figure 9-150 - Variable width graph for all modes (AInt-32)

- Location 8

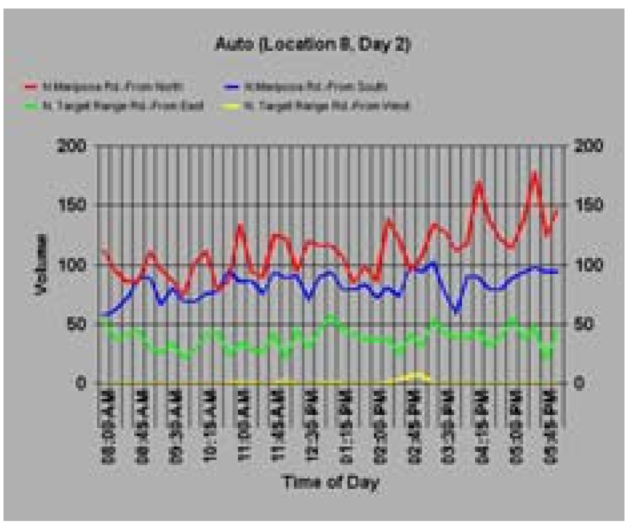


Figure 9-151 - Traffic volume for Auto (AInt-82)

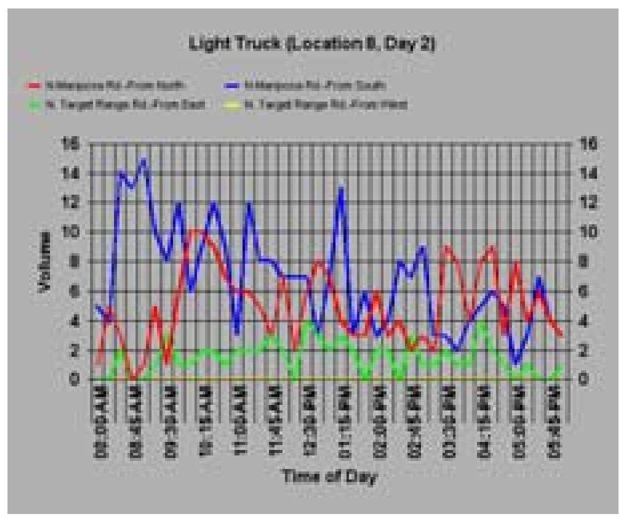
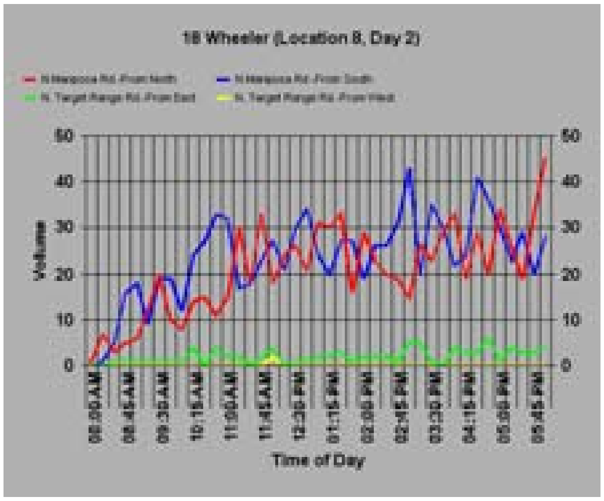


Figure 9-152 - Traffic volume for Light Truck (AInt-82)



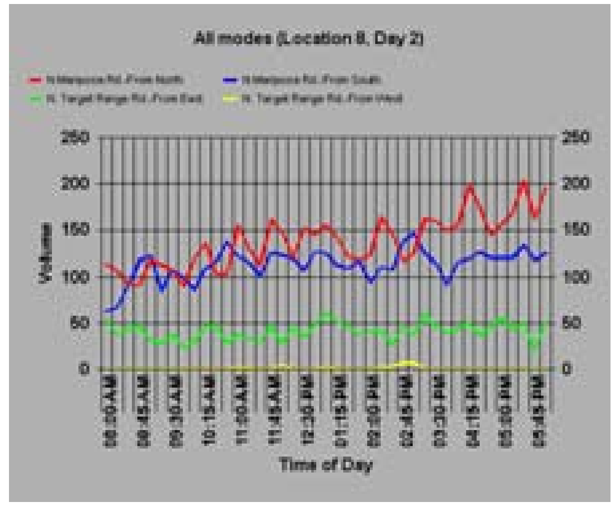
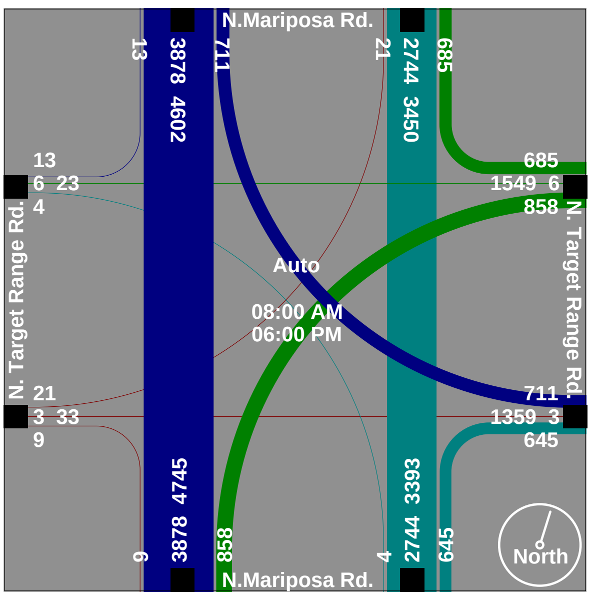


Figure 9-153 - Traffic volume for 18 wheeler (AInt-82)

Figure 9-154 - Traffic volume for all modes (AInt-82)



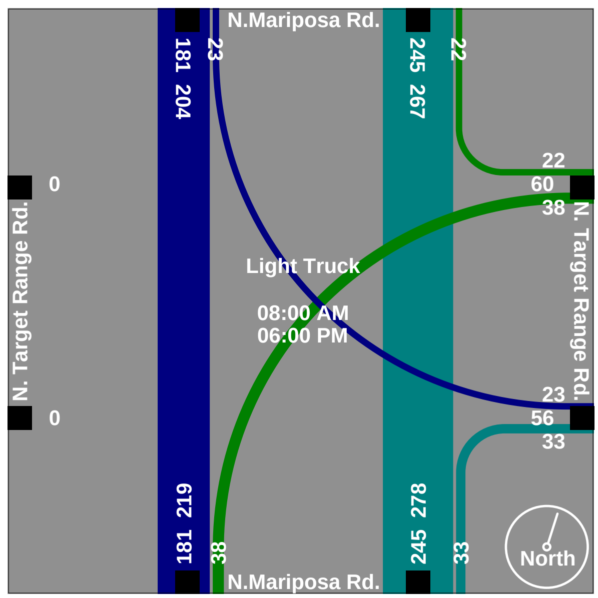


Figure 9-155 - Variable width graph for Auto (AInt-82)

Figure 9-156 - Variable width graph for Light Truck (AInt-82)

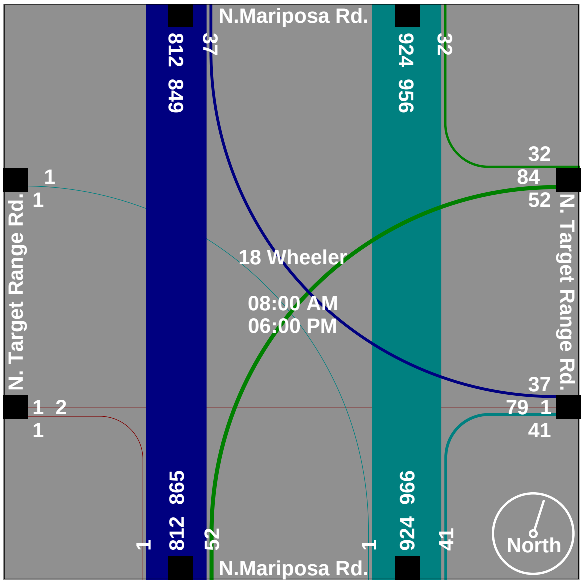


Figure 9-157 - Variable width graph for 18 wheeler (AInt-82)

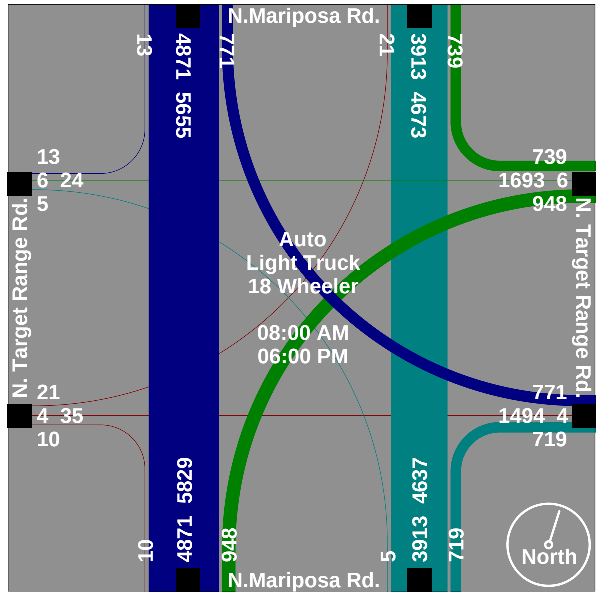


Figure 9-158 - Variable width graph for all modes (AInt-82)

9.1.3 Delay Analysis

9.1.3.1 Day 1

- From AInt 6 to AInt 5

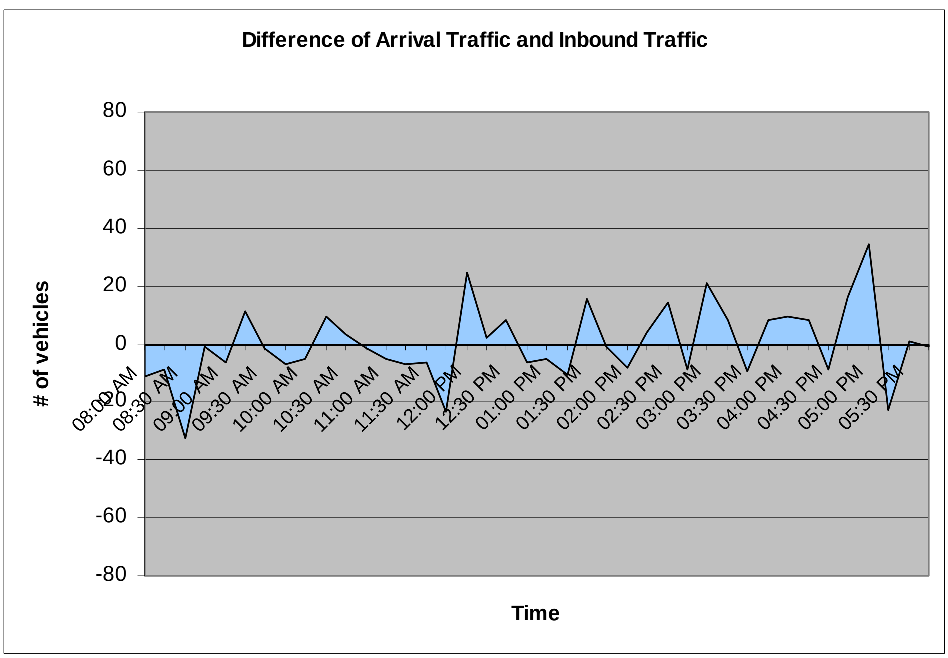


Figure 9-159 - Delay from AInt 6 to AInt 5 (Day 1)

- From AInt 5 to AInt 4

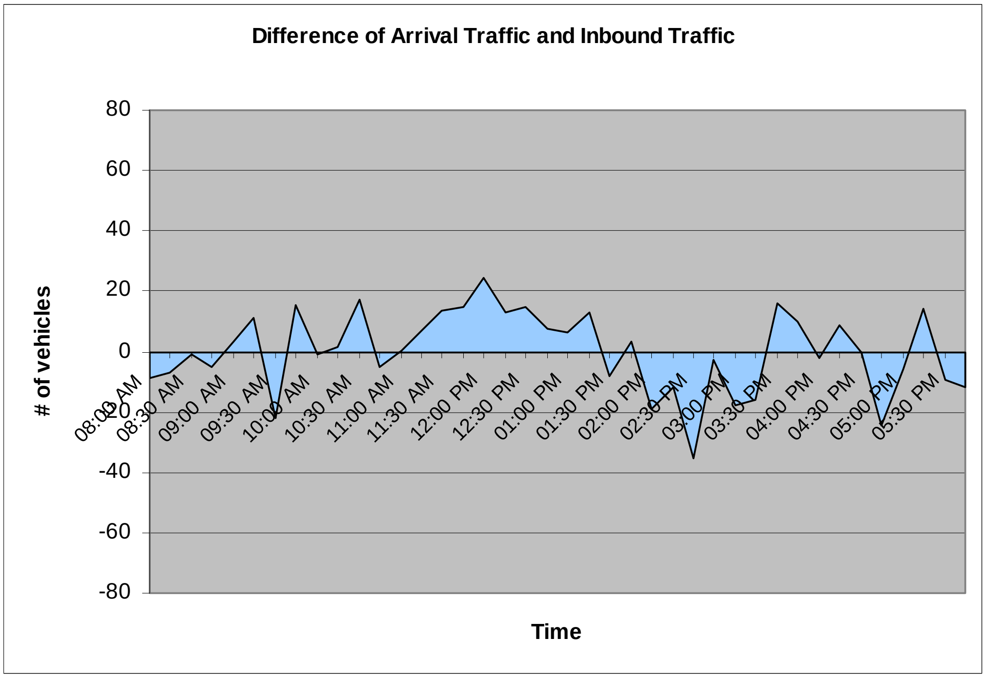


Figure 9-160 - Delay from AInt 5 to AInt 4 (Day 1)

- From AInt 4 to AInt 3

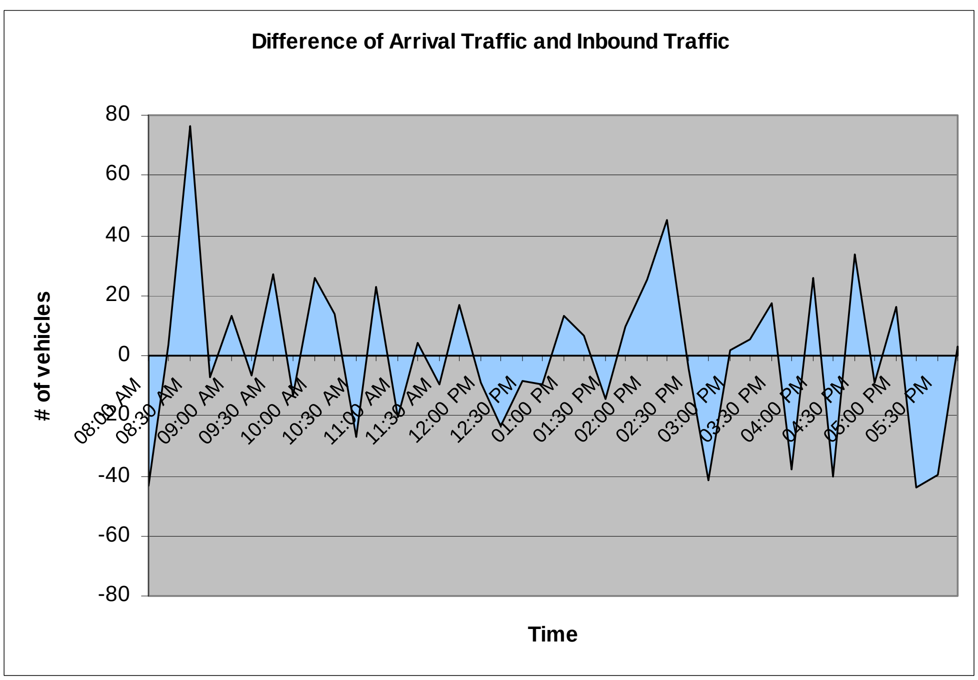


Figure 9-161 - Delay from AInt 4 to AInt 3 (Day 1)

- From ATb 2 to AInt 2

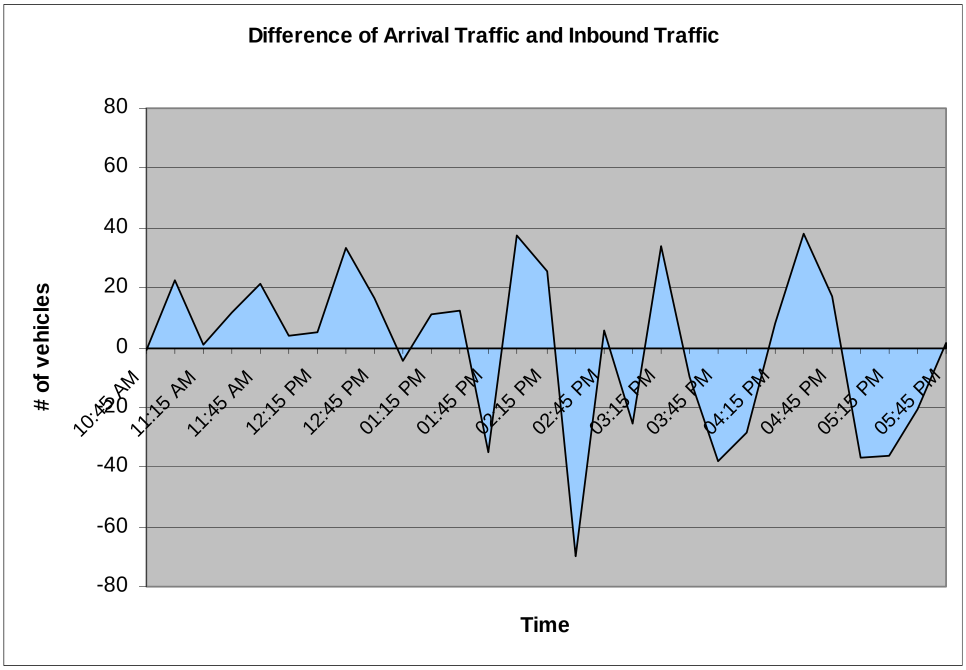


Figure 9-162 - Delay from ATb 2 to AInt 2 (Day 1)

9.1.3.2 Day 2

- From AInt 6 to AInt 5

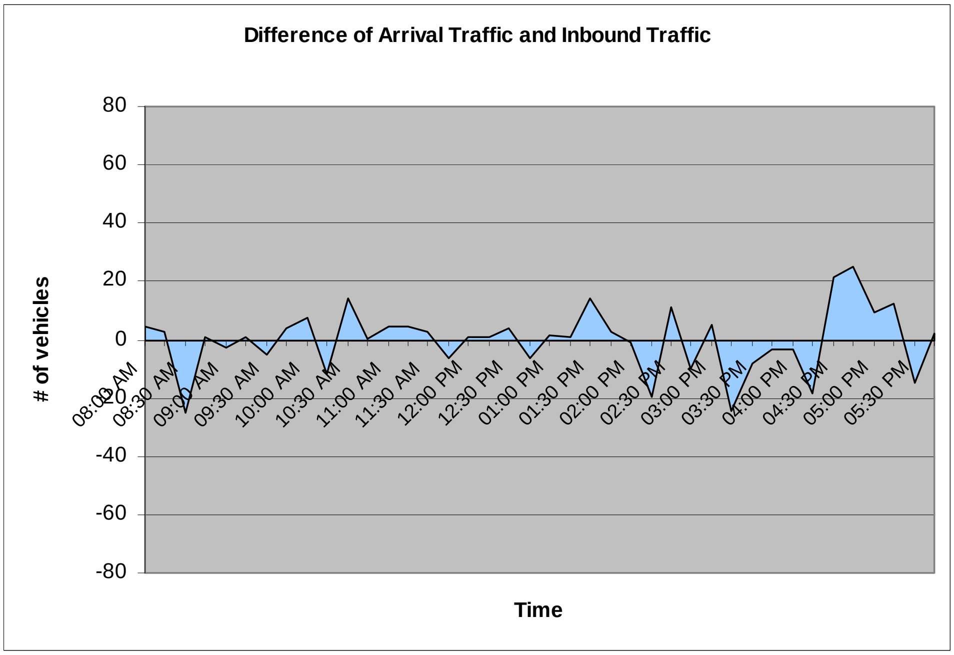


Figure 9-163 - Delay from AInt 6 to AInt 5 (Day2)

- From AInt 5 to AInt 4

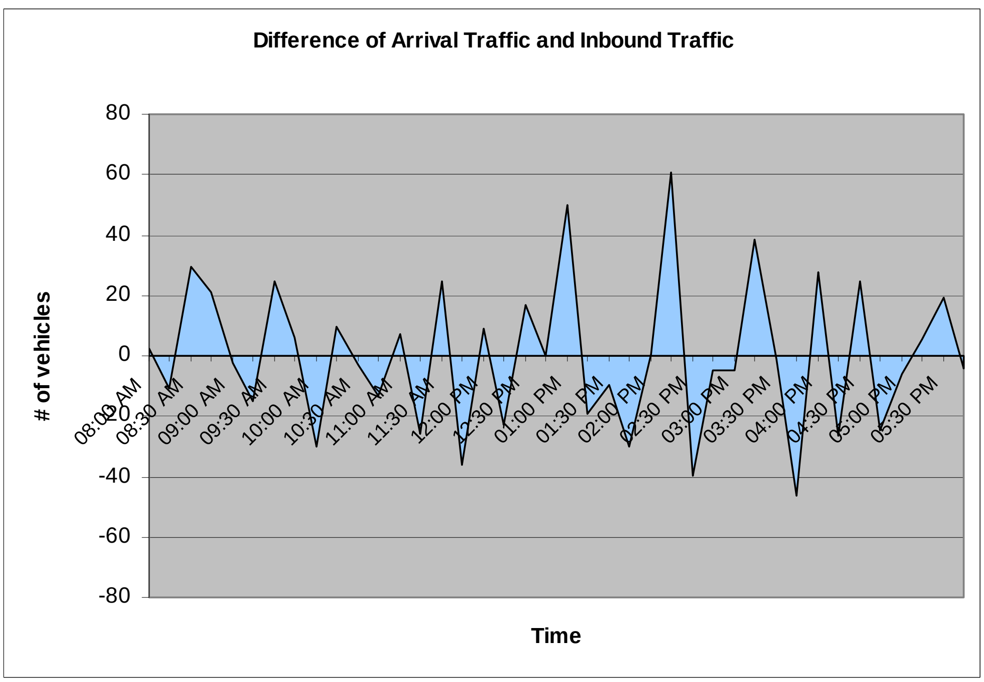


Figure 9-164 - Delay from AInt 5 to AInt 4 (Day 2)

- From AInt 4 to AInt 3

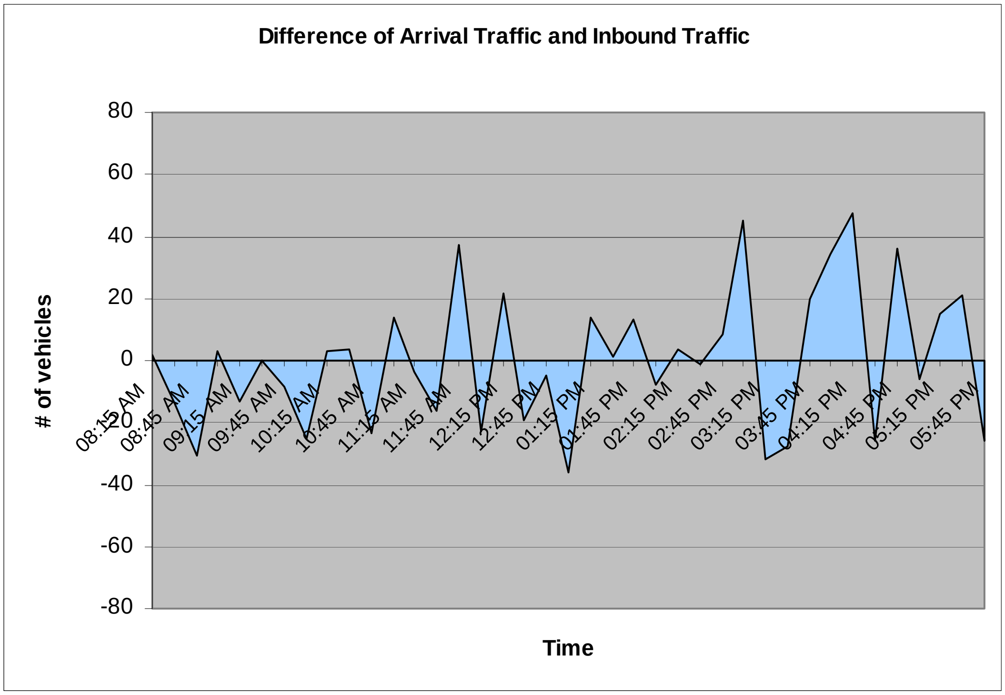


Figure 9-165 - Delay from AInt 4 to AInt 3 (Day 2)

- From ATb 2 to AInt 2

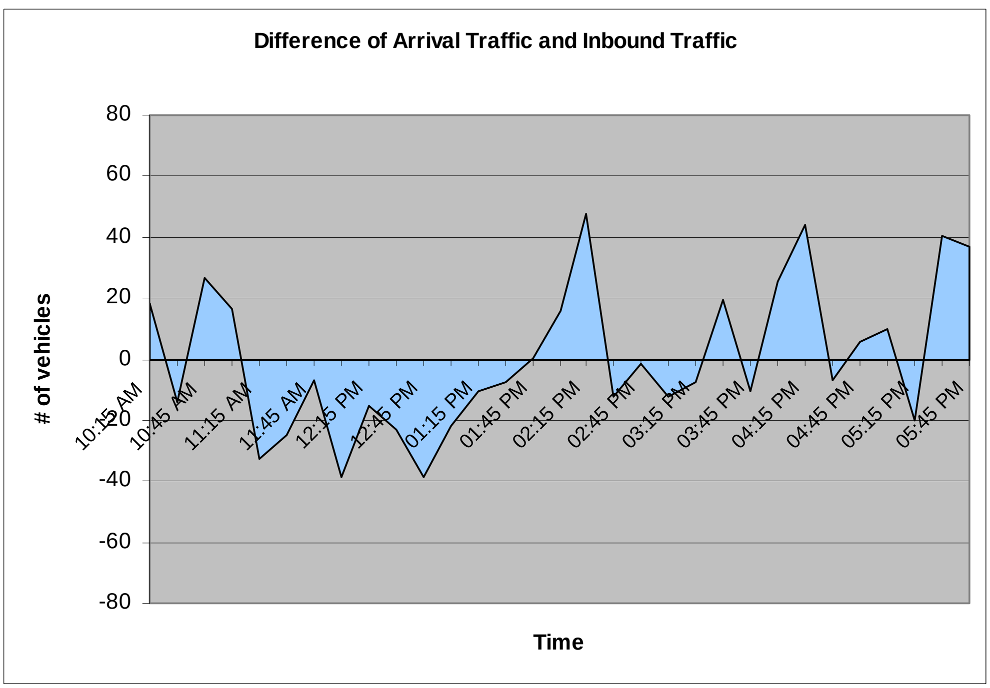


Figure 9-166 - Delay from ATb B to AInt 2 (Day 2)

9.2 **Nogales, Sonora. Mexico.**

9.2.1 Manual Traffic Counts

9.2.1.1 Day 1

- Location 1

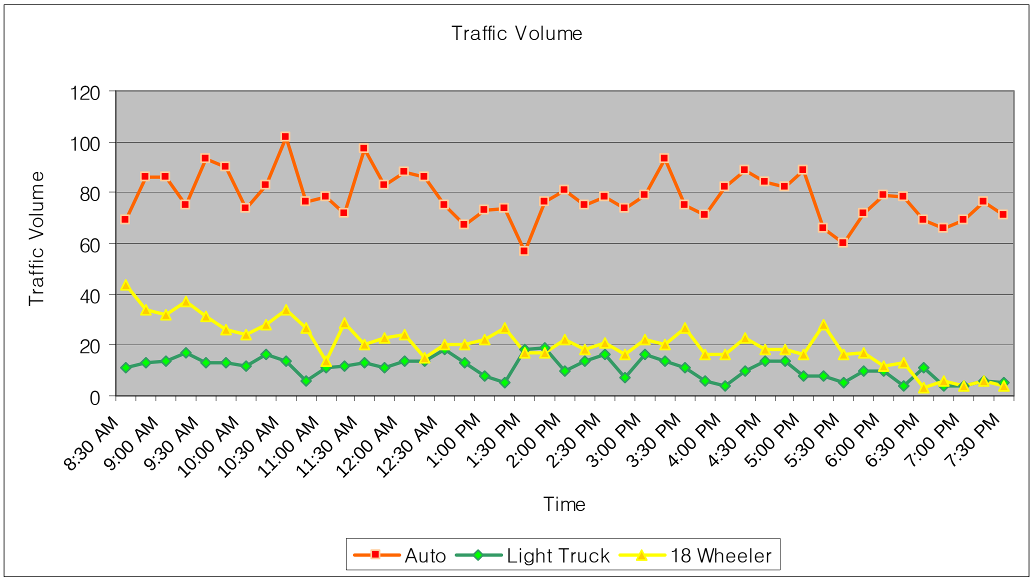


Figure 9-167 - Traffic volume data (MCnt-11)

- Location 2

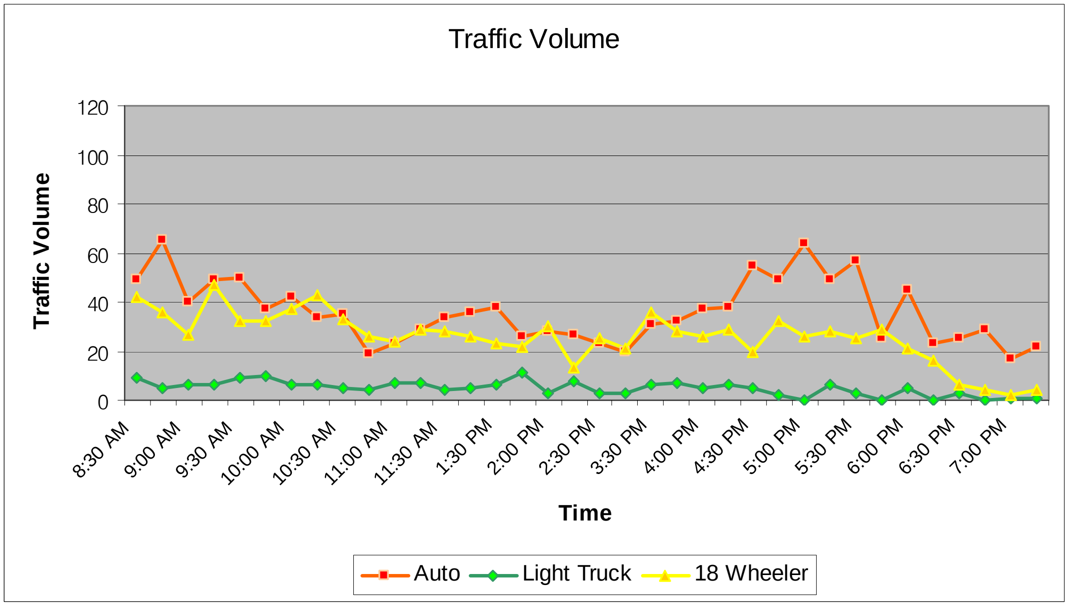


Figure 9-168 - Traffic volume data (MCnt-21)

- Location 3

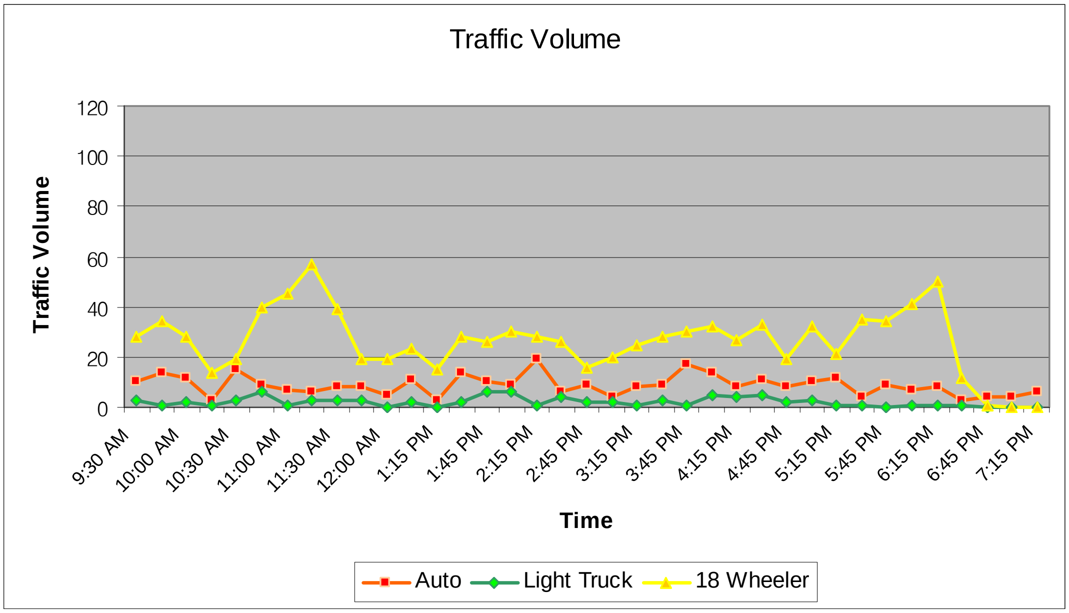


Figure 9-169 - Traffic volume data (MCnt-31)

- Location 4

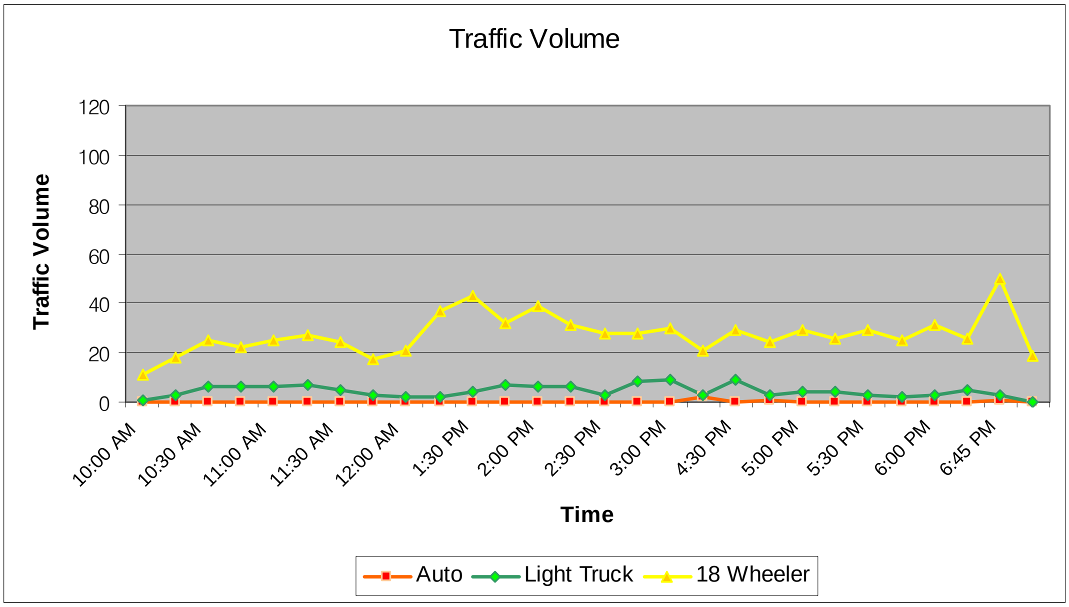


Figure 9-170 - Traffic volume data (MCnt-41)

- Location 5

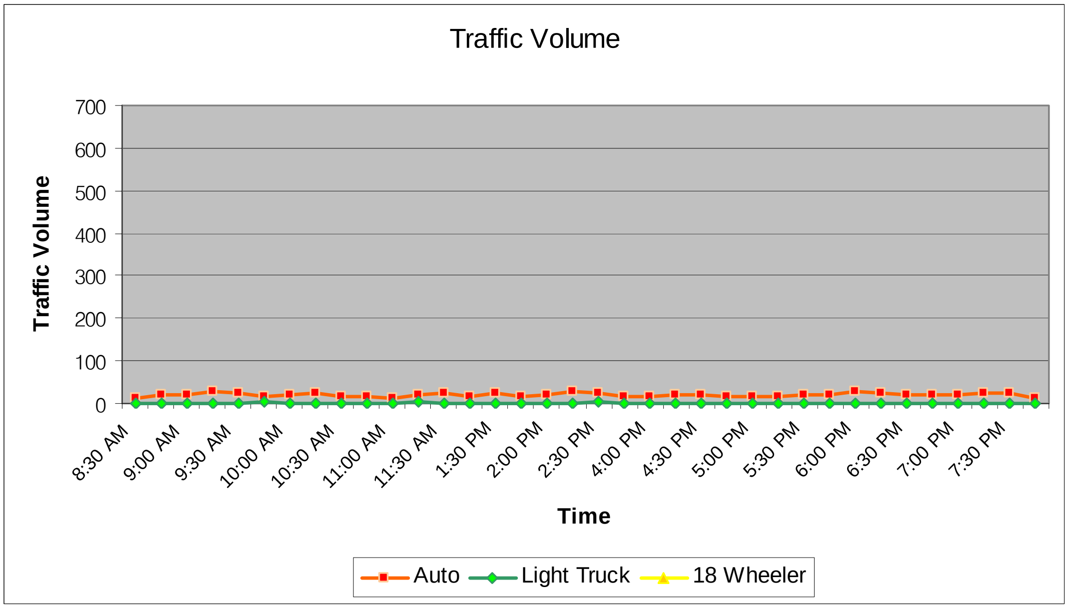


Figure 9-171 - Traffic volume data (MCnt-51)

- Location 6

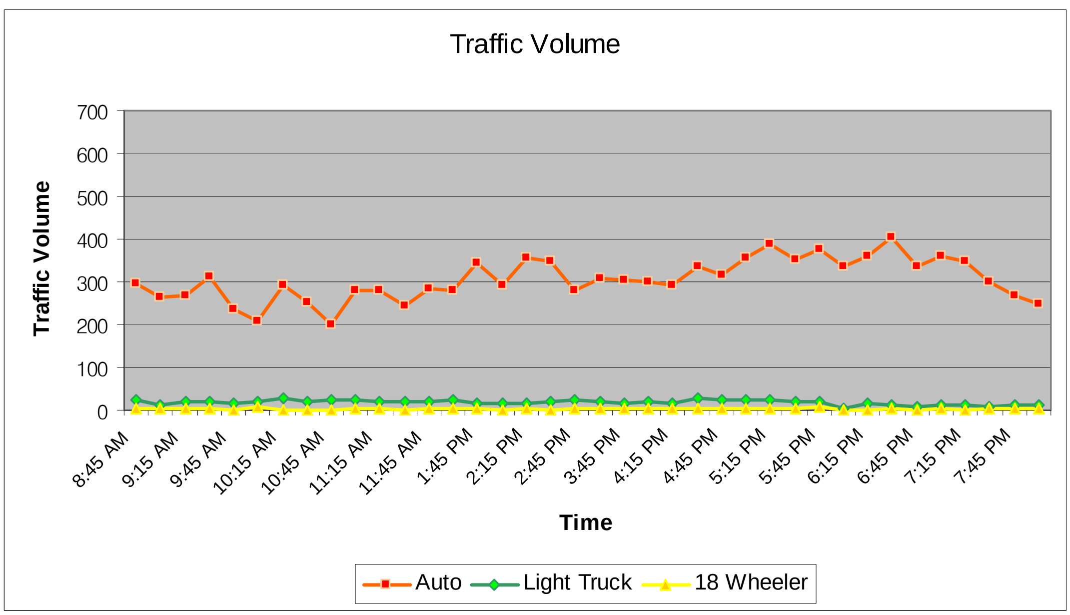


Figure 9-172 - Traffic volume data (MCnt-61)

- Location 7

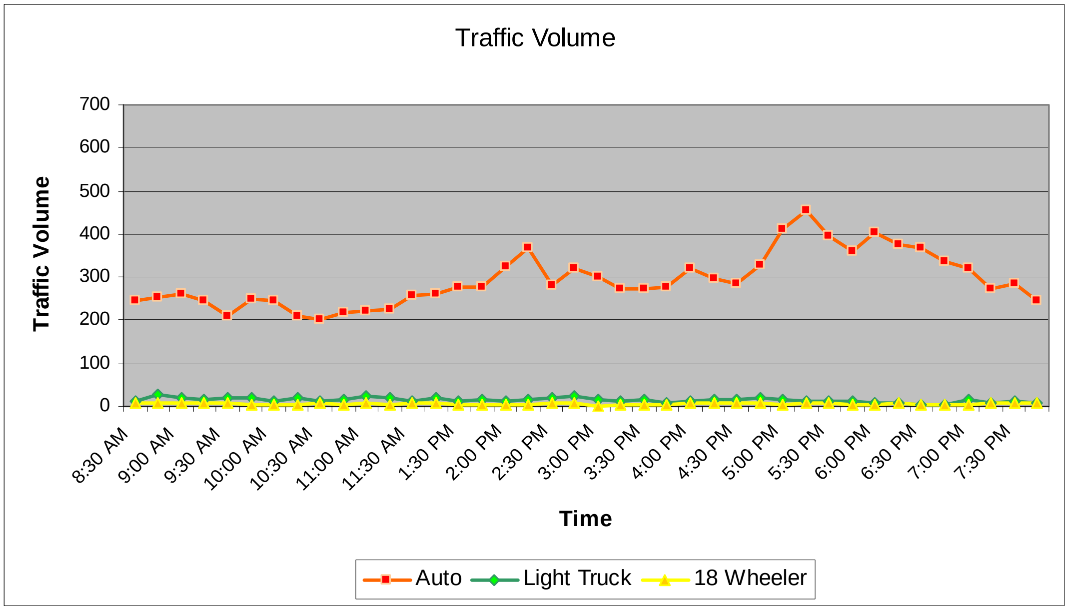


Figure 9-173 - Traffic volume data (MCnt-71)

- Location 8

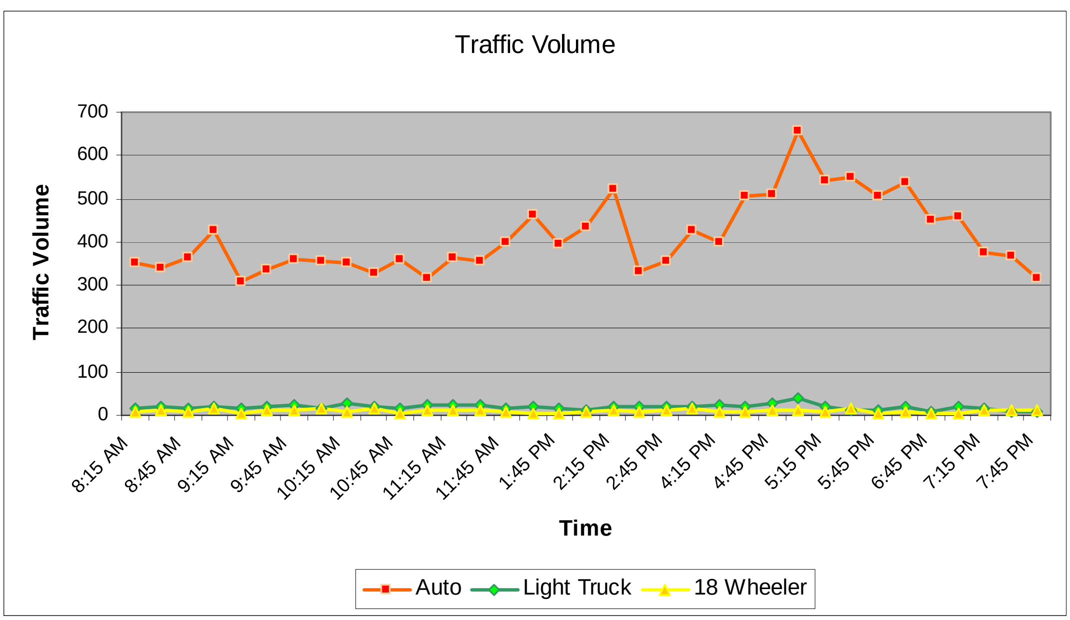


Figure 9-174 - Traffic volume data (MCnt-81)

9.2.1.2 Day 2

- Location 1

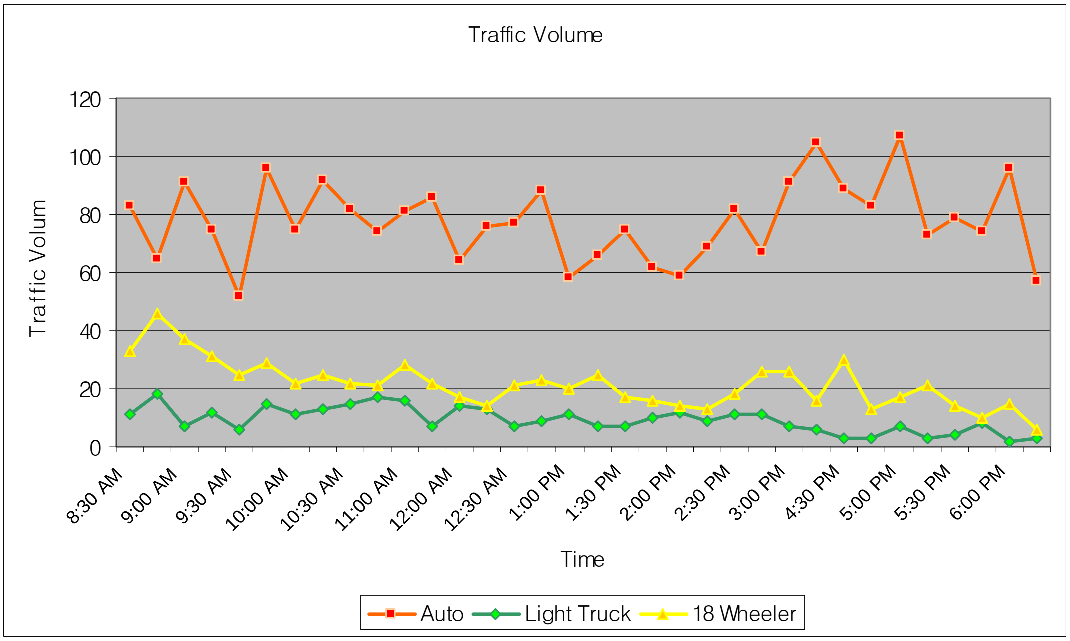


Figure 9-175 - Traffic volume data (MCnt-12)

- Location 2

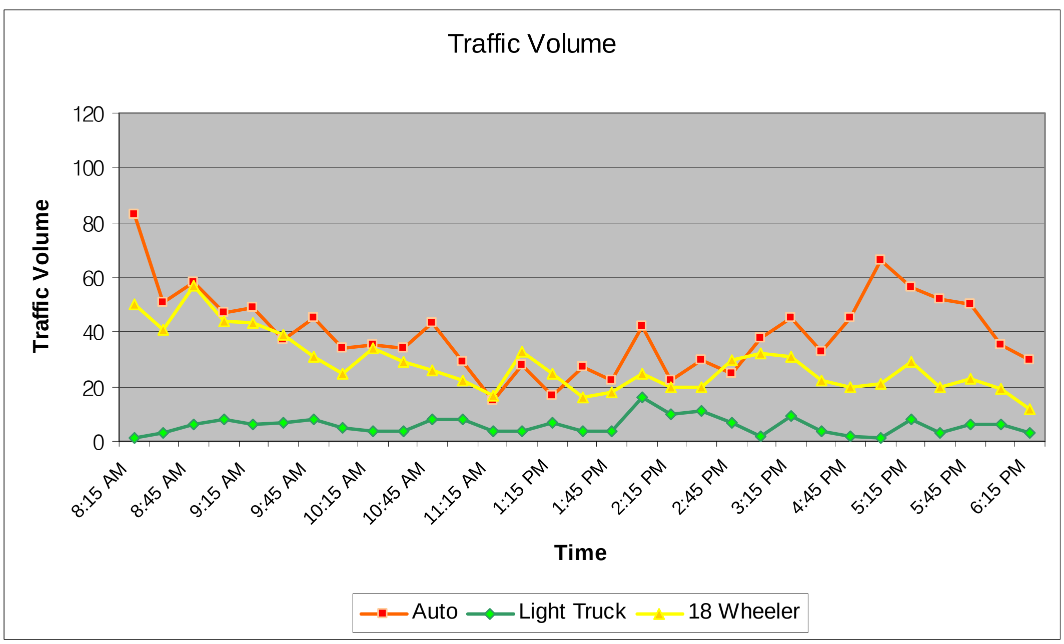


Figure 9-176 - Traffic volume data (MCnt-22)

- Location 3

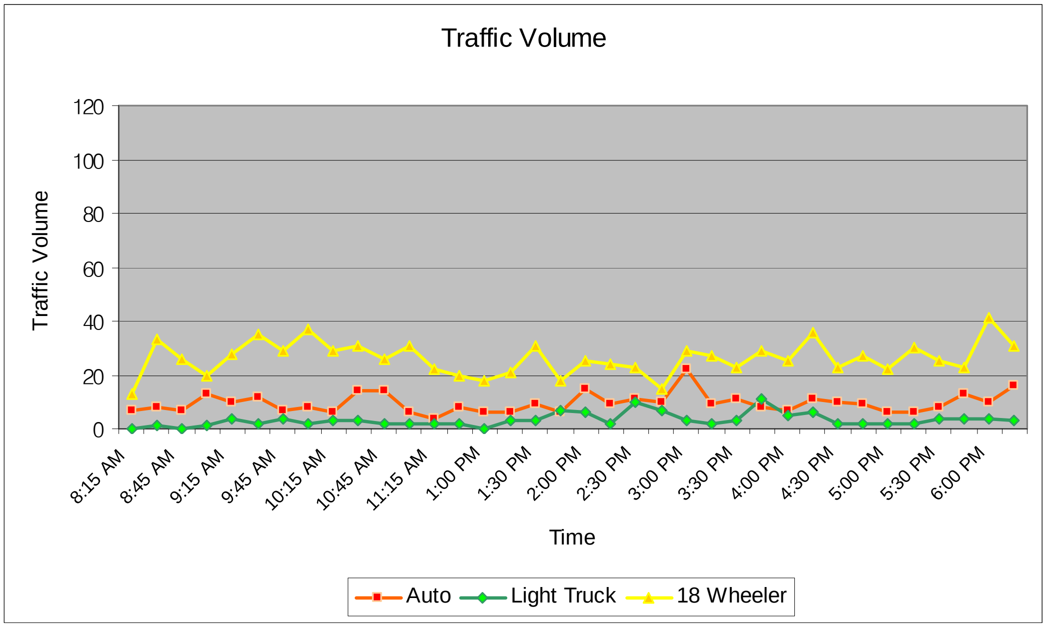


Figure 9-177 - Traffic volume data (MCnt-32)

- Location 4

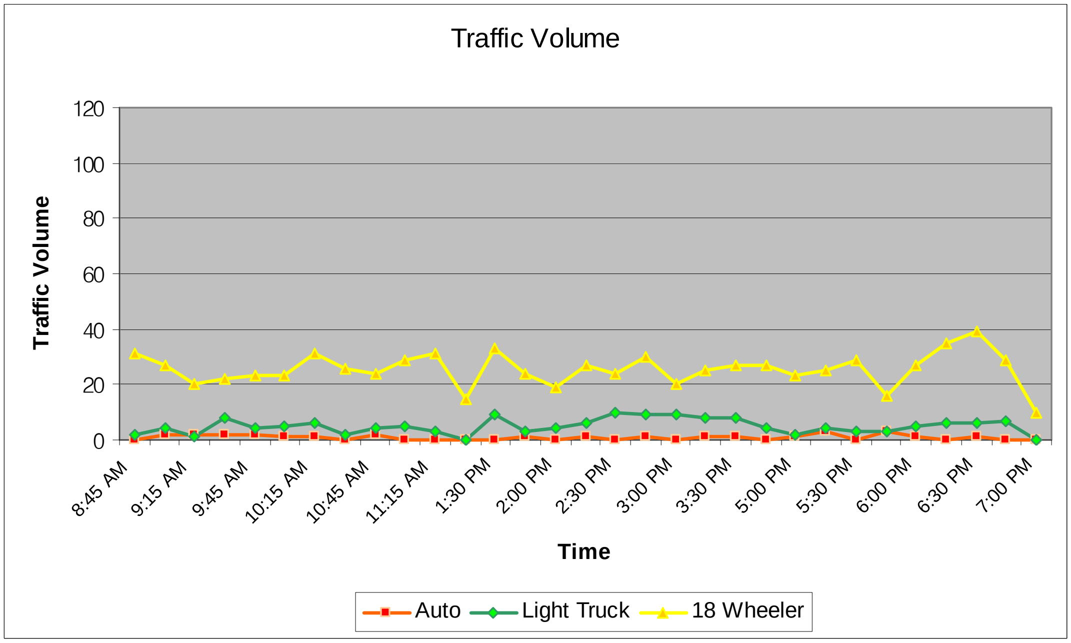


Figure 9-178 - Traffic volume data (MCnt-42)

- Location 5

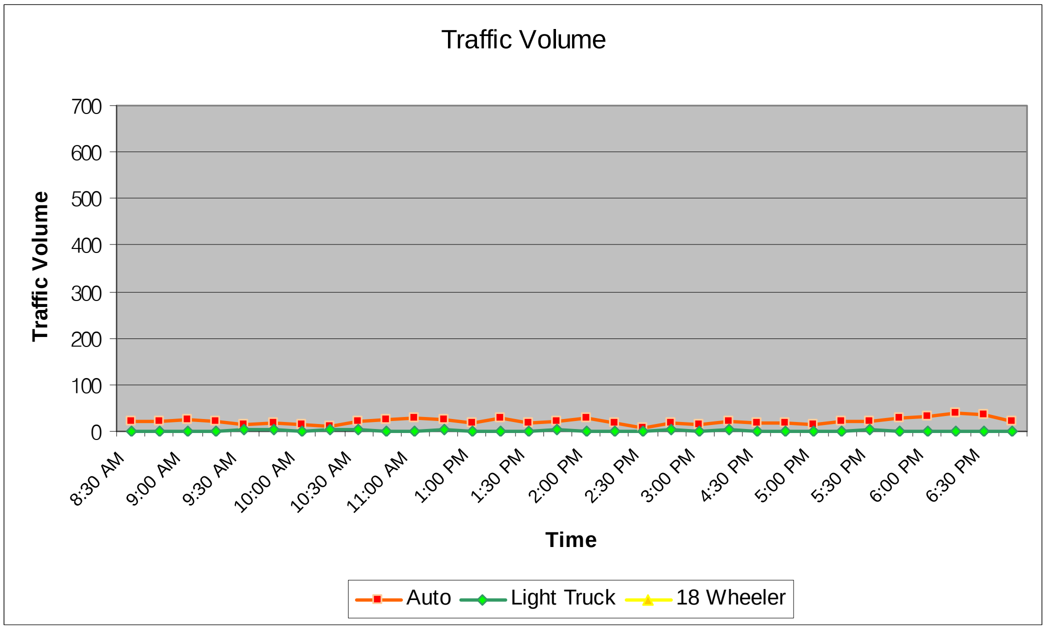


Figure 9-179 - Traffic volume data (MCnt-52)

- Location 6

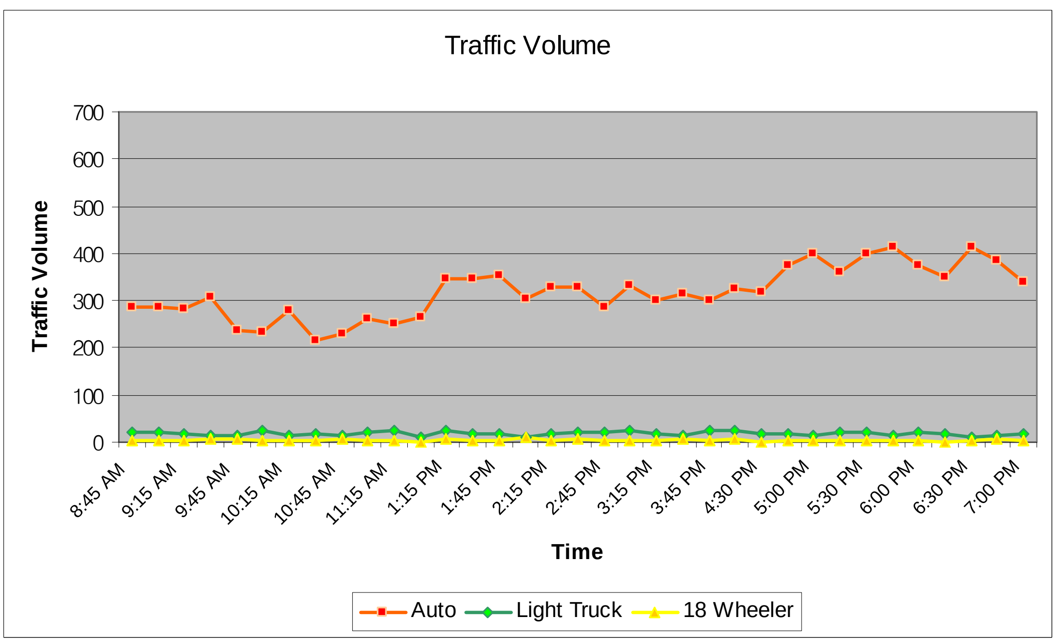


Figure 9-180 - Traffic volume data (MCnt-62)

- Location 7

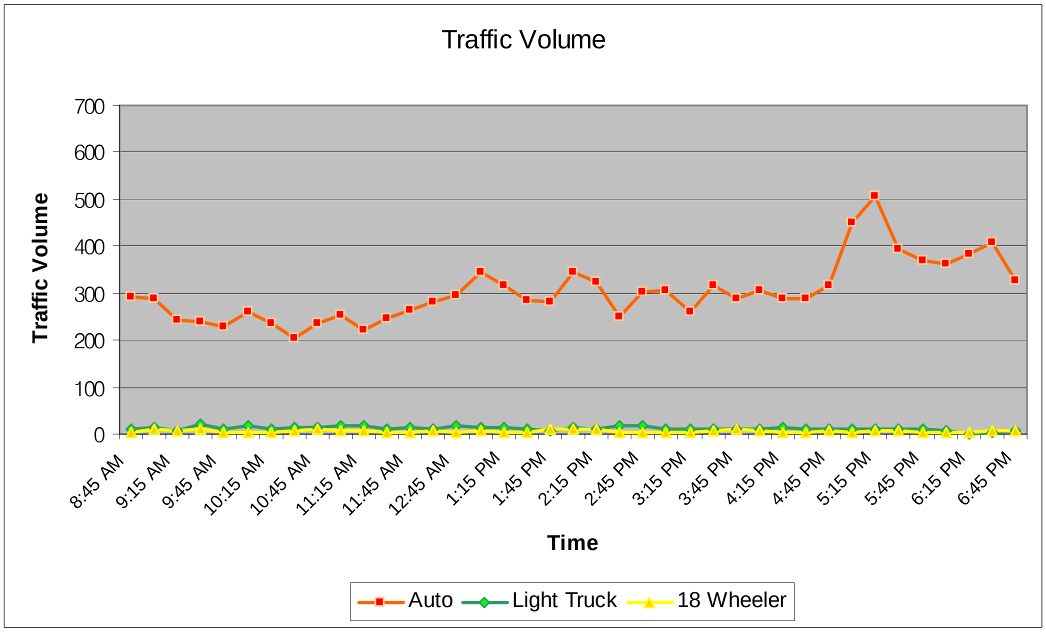


Figure 9-181 - Traffic volume data (MCnt-72)

- Location 8

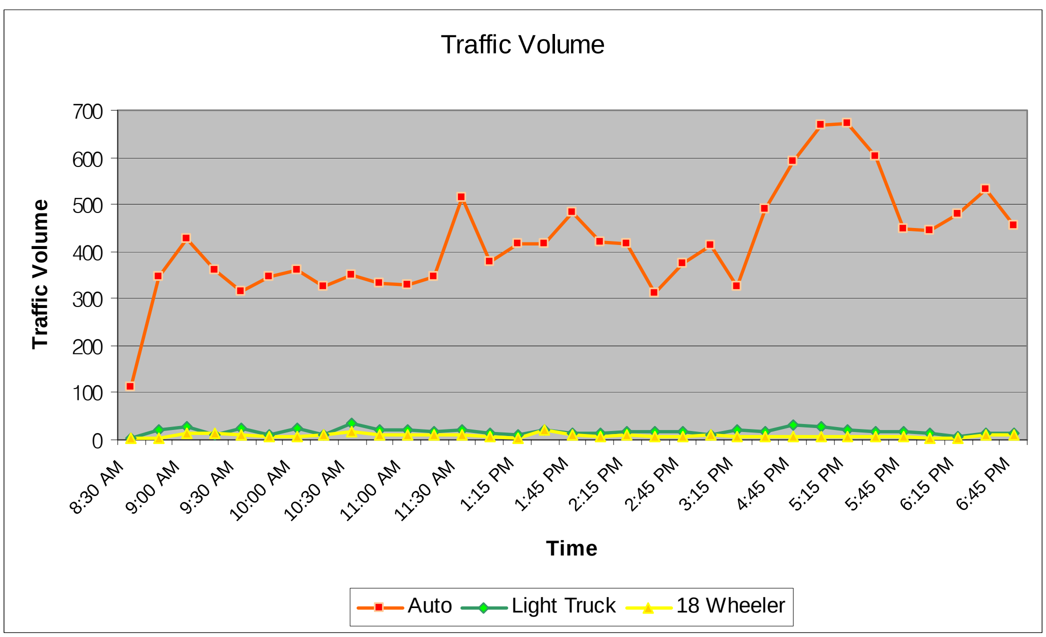


Figure 9-182 - Traffic volume data (MCnt-82)

9.3 **Delay analysis at Intersections**

9.3.1 Day 1

- From AInt 6 to AInt 5

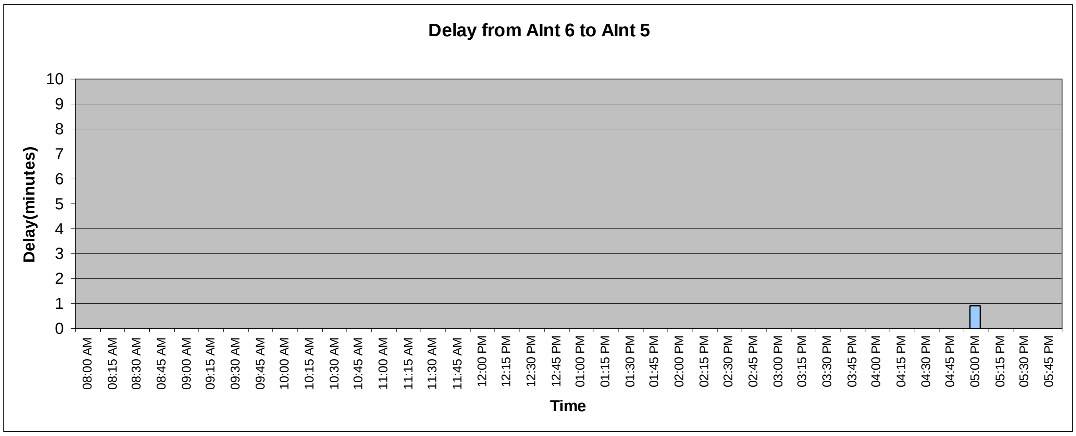


Figure 9-183 - Point delay from AInt 6 to AInt 5 (Day 1)

- From AInt 5 to AInt 4

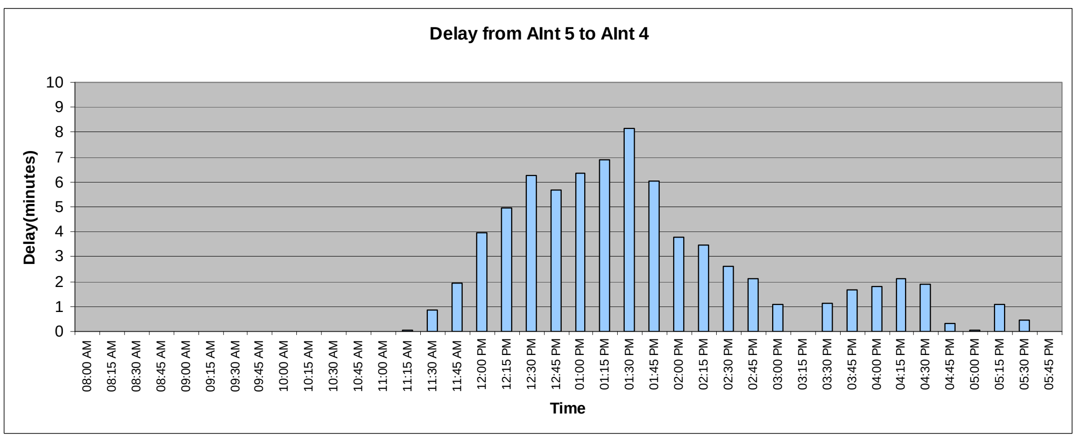


Figure 9-184 - Point delay from AInt 5 to AInt 4 (Day 1)

- From AInt 4 to AInt 3

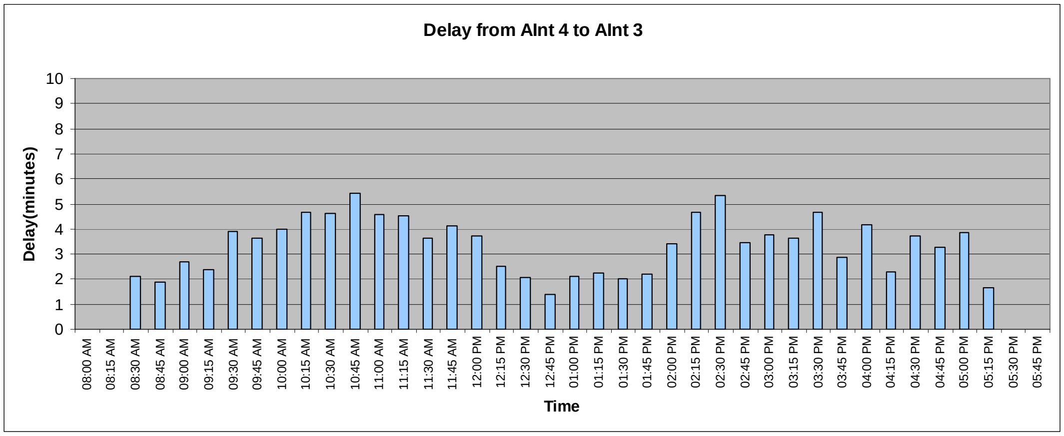


Figure 9-185 - Point delay from AInt 4 to AInt 3 (Day 1)

- From ATb 2 to AInt 2

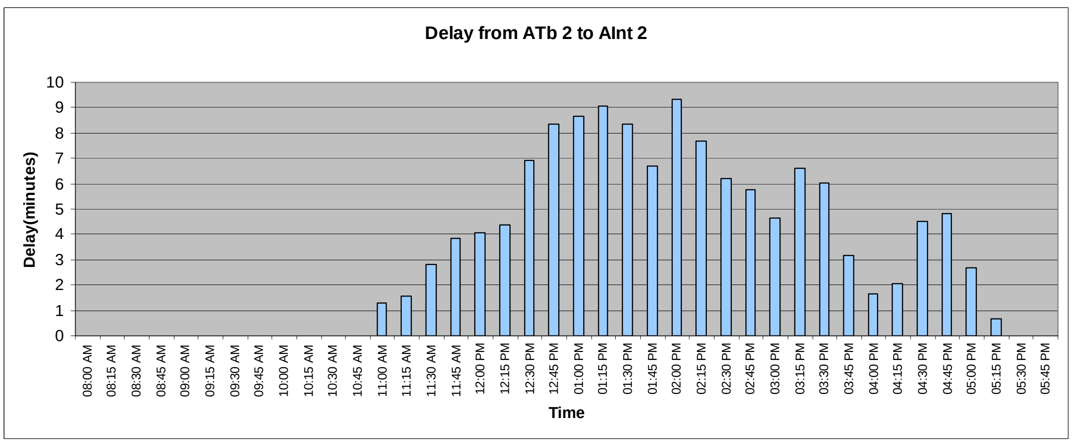


Figure 9-186 - Point delay from ATb 2 to AInt 2 (Day 1)

9.3.2 Day 2

- From AInt 6 to AInt 5

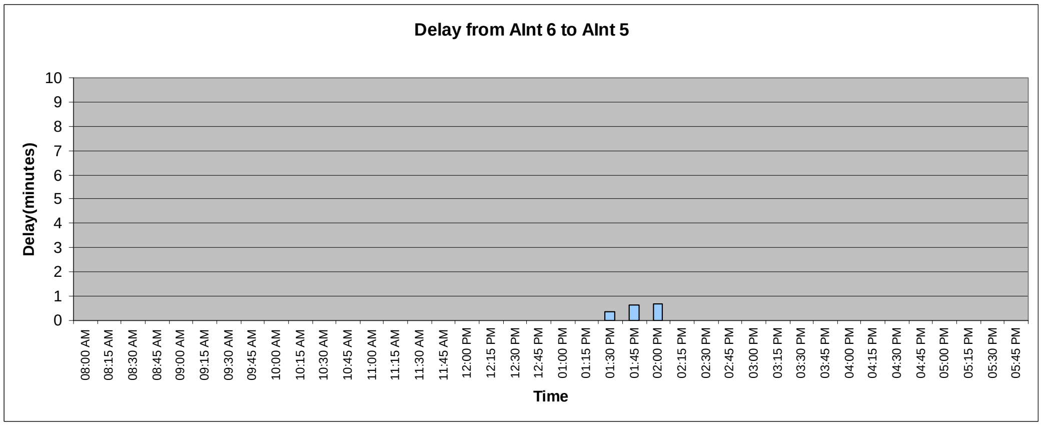


Figure 9-187 - Point delay from AInt 6 to AInt 5 (Day 2)

- From AInt 5 to AInt 4

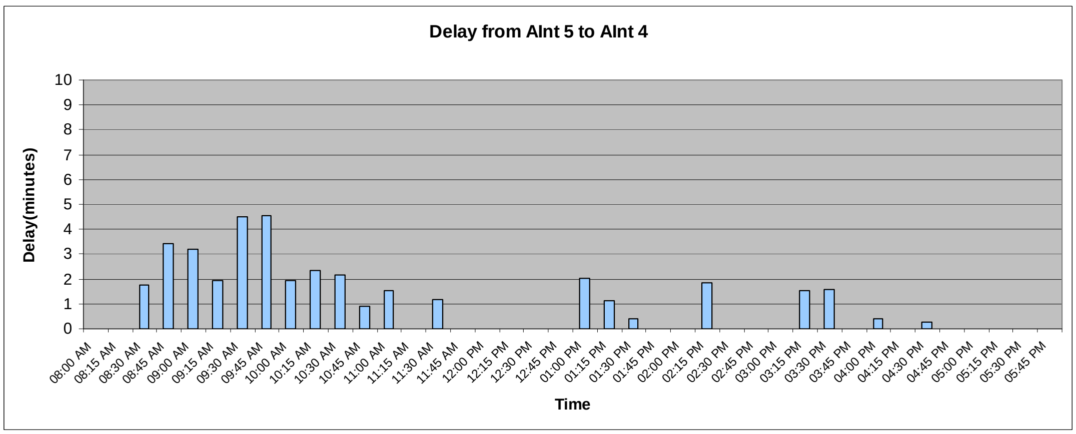


Figure 9-188 - Point delay from AInt 5 to AInt 4 (Day 2)

- From AInt 4 to AInt 3

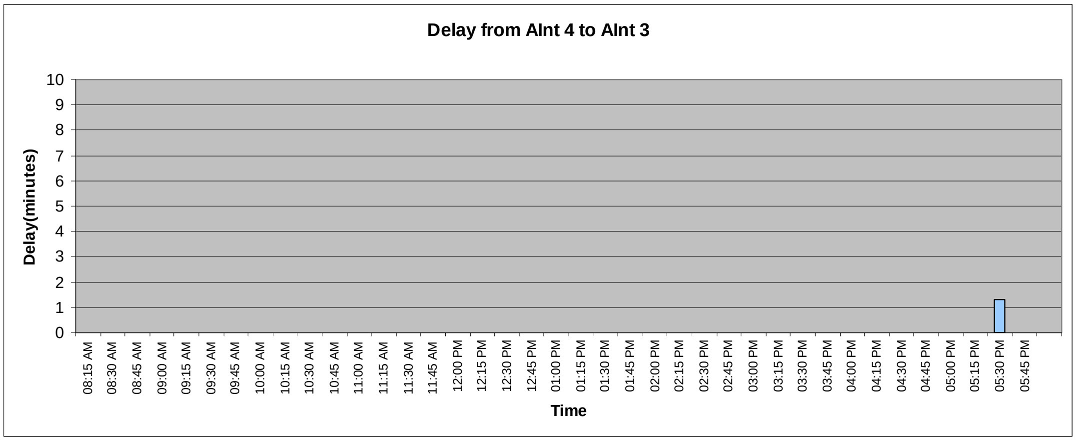


Figure 9-189 - Point delay from AInt 4 to AInt 3 (Day 2)

- From ATb 2 to AInt 2

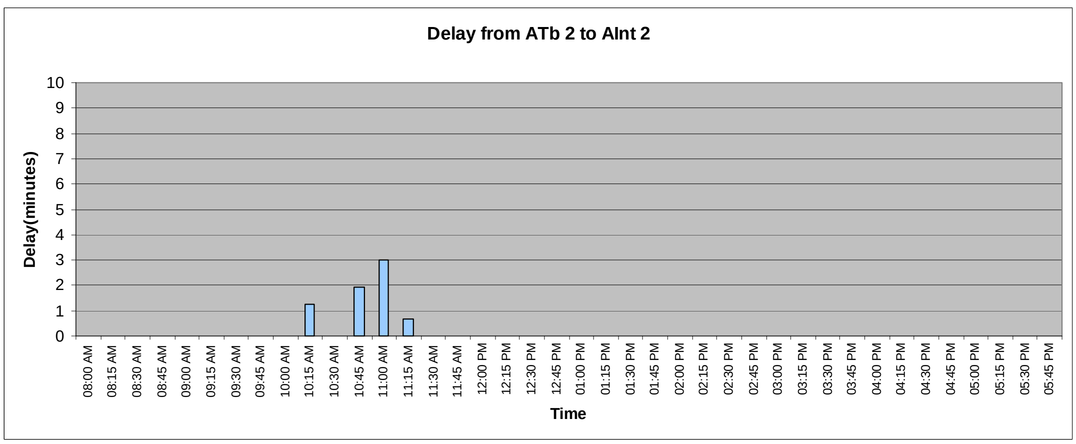


Figure 9-190 - delay from ATb 2 to AInt 2 (Day 2)

9.4 **Delay Analysis from License Plate Datasets**

9.4.1 Travel Time before Mariposa Port of Entry

9.4.1.1 Day 1

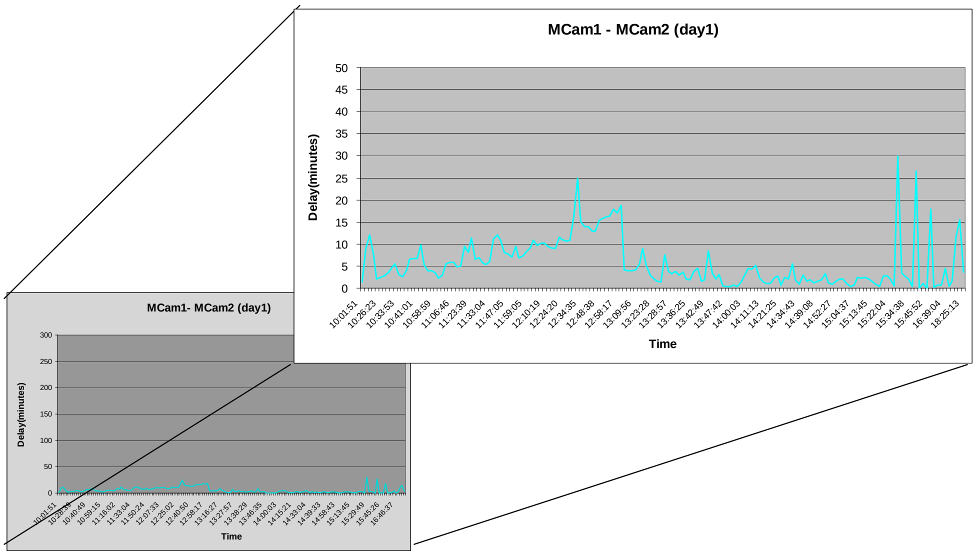


Figure 9-191 - Travel time from MCam1 to MCam2 (day1)

9.4.1.2 Day 2

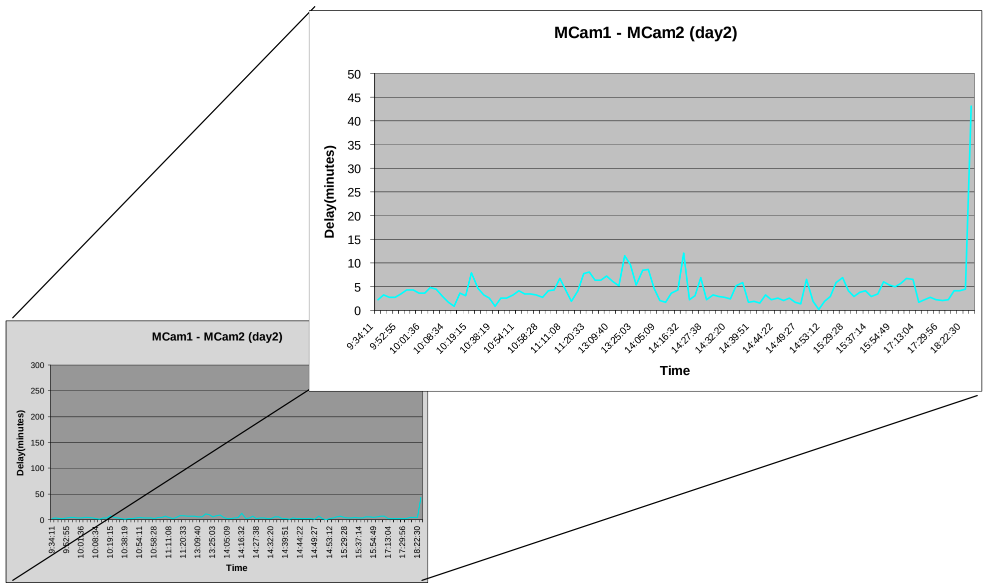


Figure 9-192 - Travel time from MCam1 to MCam2 (day2)

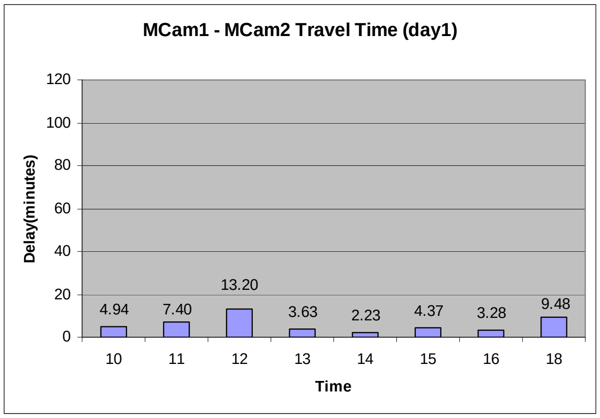


Figure 9-193 - Average travel time from MCam1 to MCam2

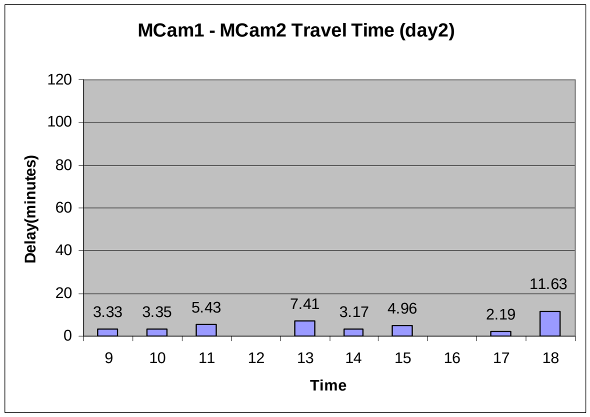


Figure 9-194 - Average travel time from MCam1to MCam2

9.4.2 Travel Time including Inspection

Table 9-1 - Matching sets including inspection time

The first day	The second day
• MCam1 – ACam2 • MCam1 – ACam4 • MCam2 – ACam2 • MCam2 – Acam4	• MCam1-ACam1 • MCam2 – ACam1

9.4.2.1 Day 1

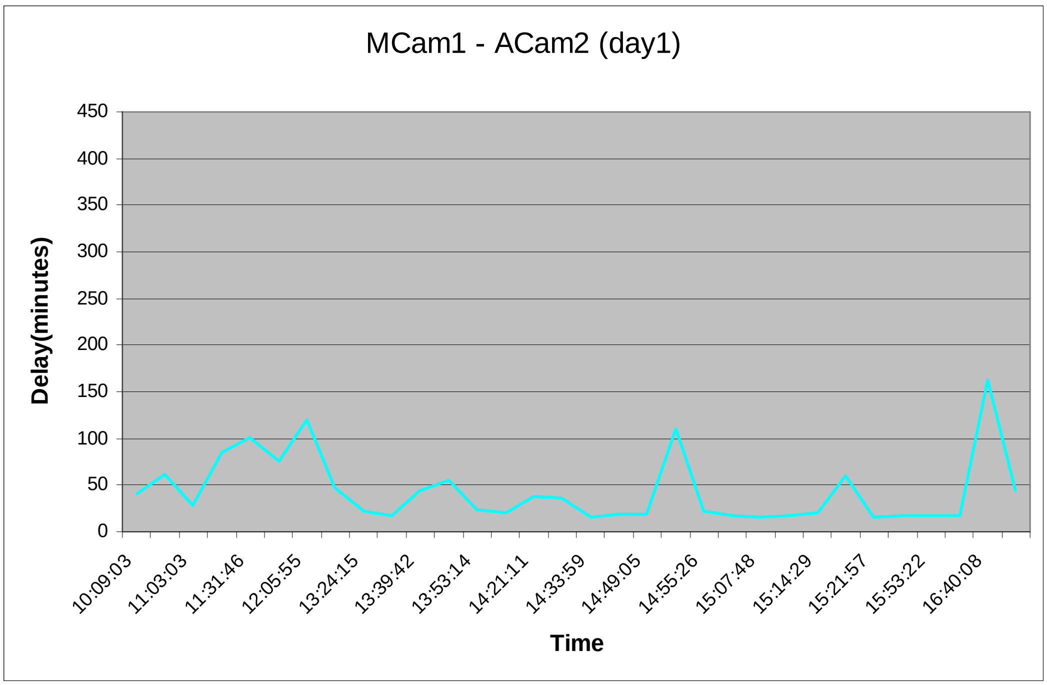


Figure 9-195 - Travel time from MCam1 to ACam2

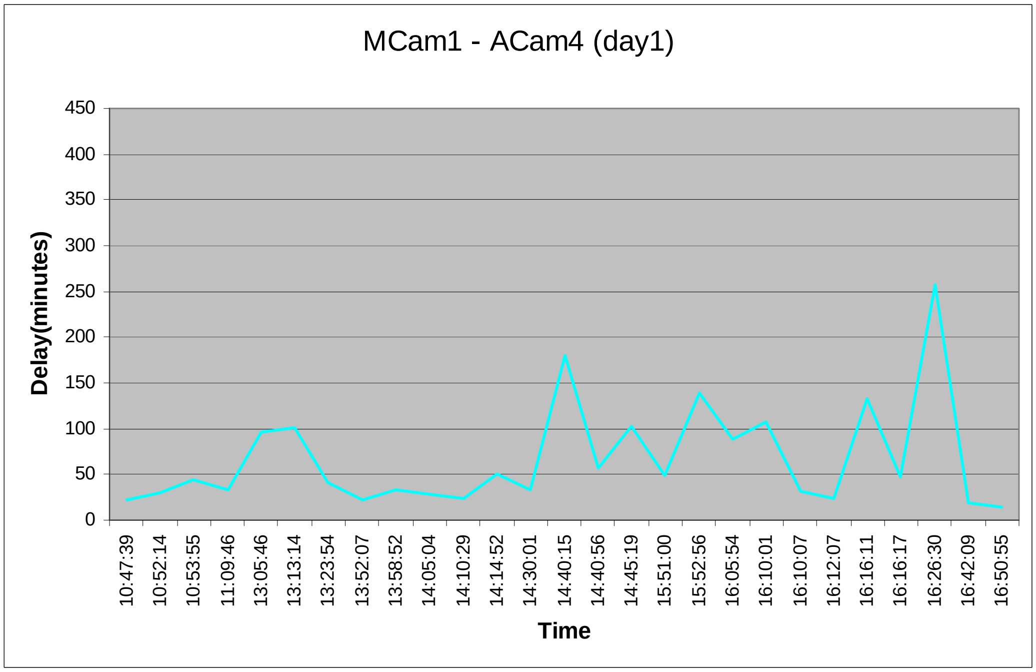


Figure 9-196 - Travel time from MCam1 to ACam4

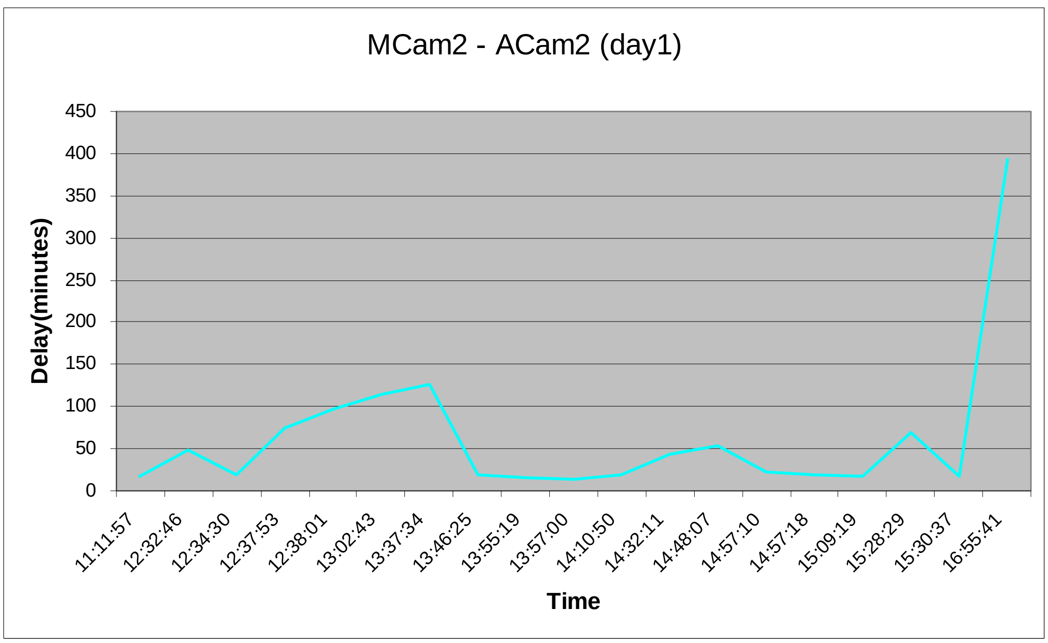


Figure 9-197 - Travel time from MCam2 to ACam2

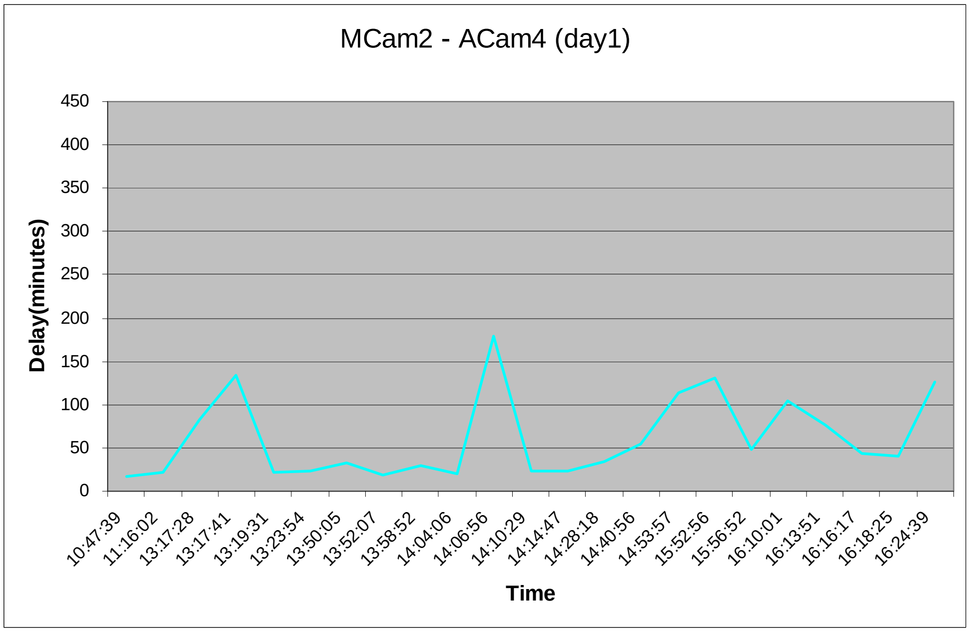


Figure 9-198 - Travel time from MCam2 to ACam4

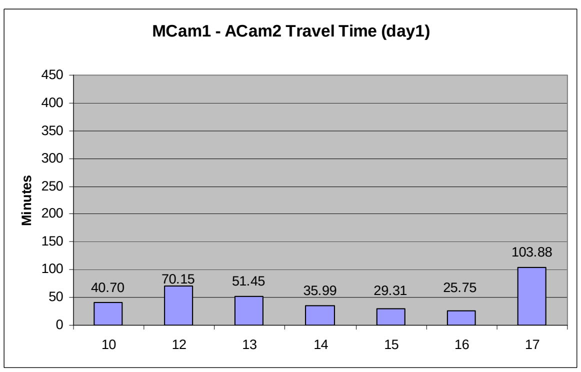


Figure 9-199 - Average travel time from MCam1 to ACam2

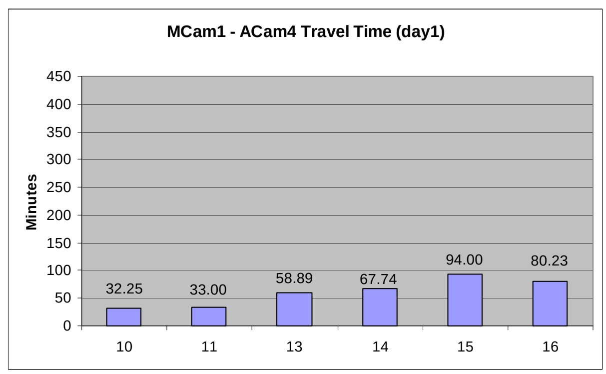


Figure 9-200 - Average travel time from MCam1 to ACam4

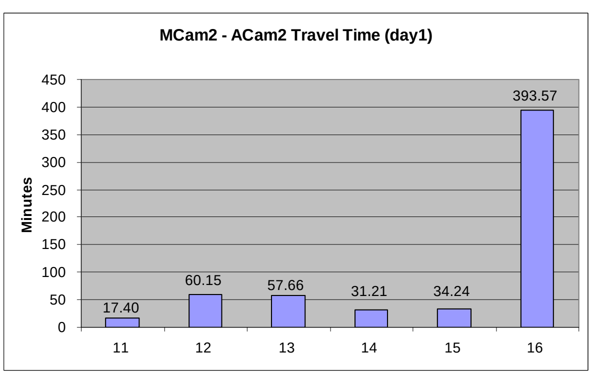


Figure 9-201 - Average travel time from MCam2 to ACam2

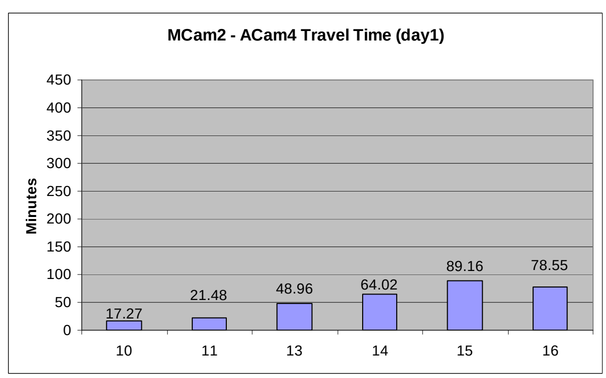


Figure 9-202 - Average travel time from MCam2 to ACam4

9.4.2.2 Day 2

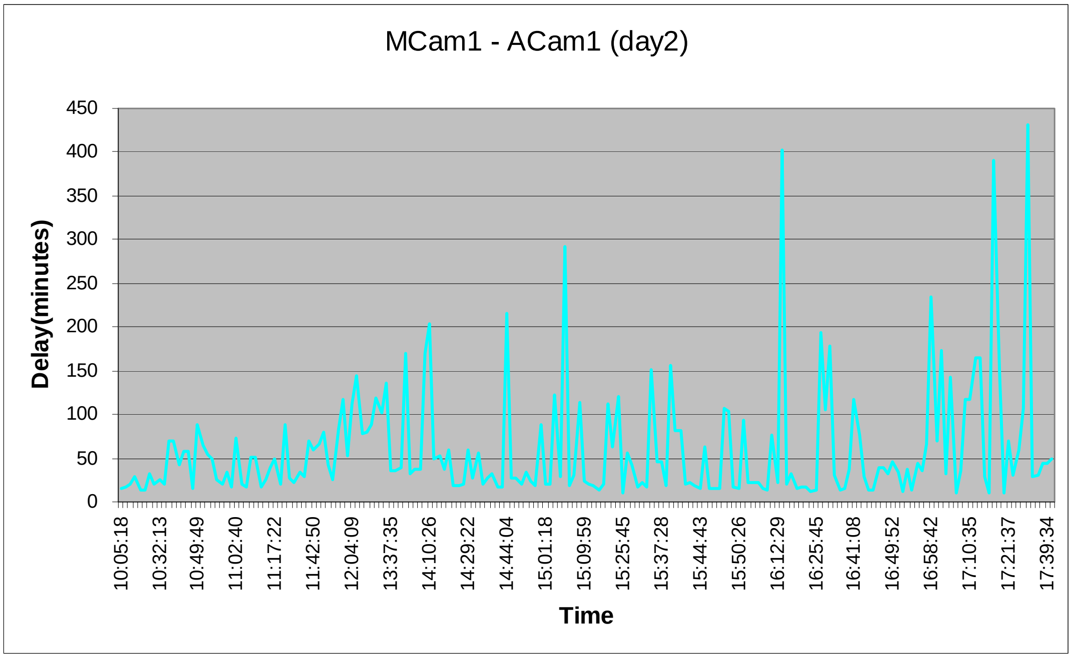


Figure 9-203 - Travel time from MCam1 to ACam1

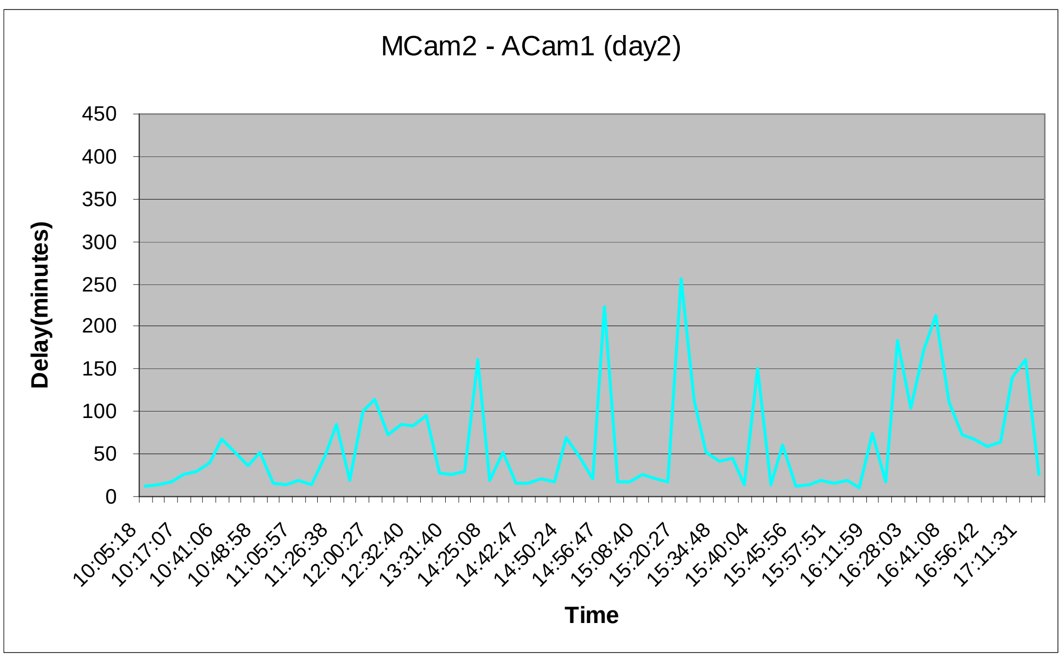


Figure 9-204 Travel time from MCam2 to ACam1

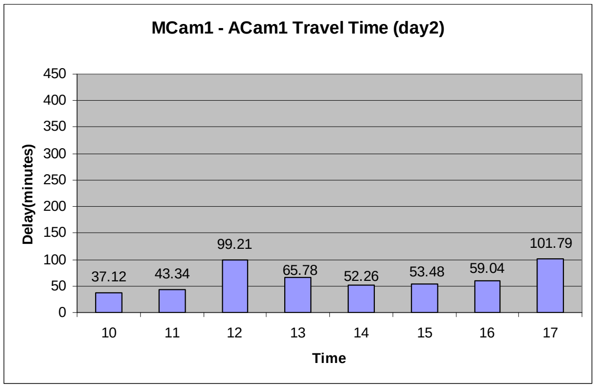


Figure 9-205 - Average travel time from MCam1 to ACam1

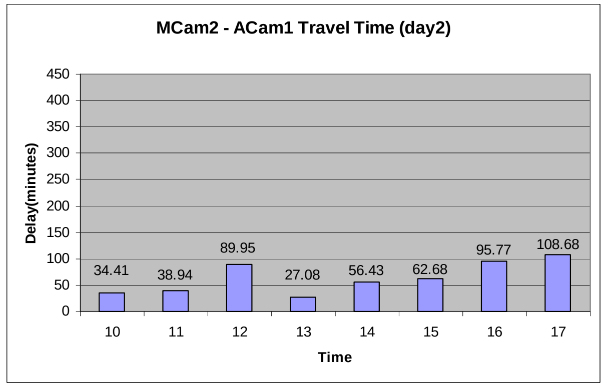


Figure 9-206 - Average travel time from MCam2 to ACam1

9.4.3 Travel time after an inspection

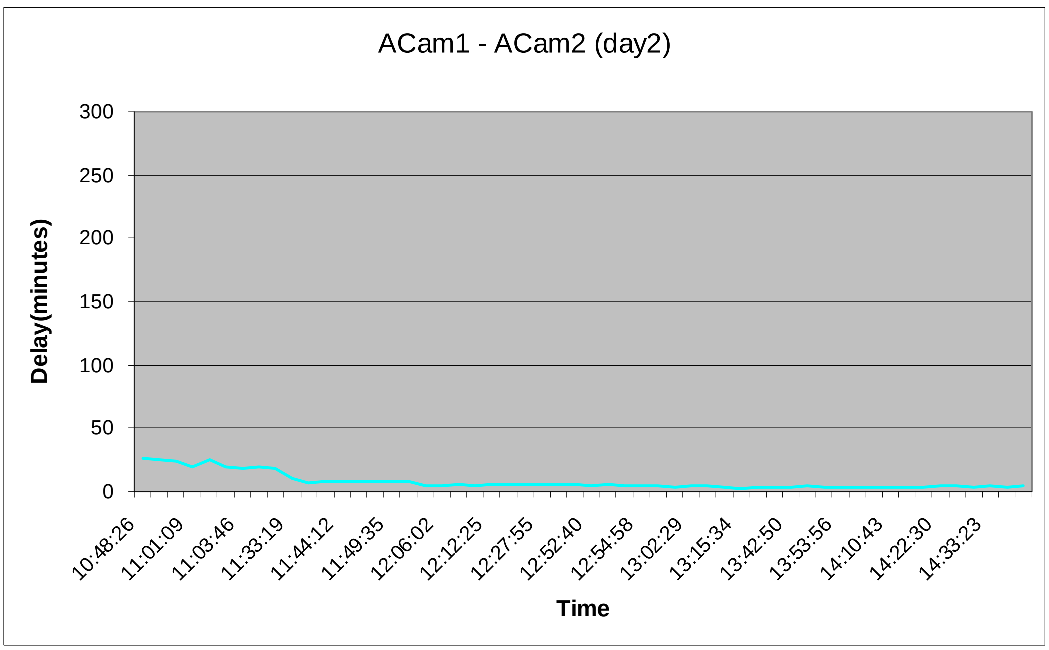


Figure 9-207 Travel time from ACam1 to ACam2

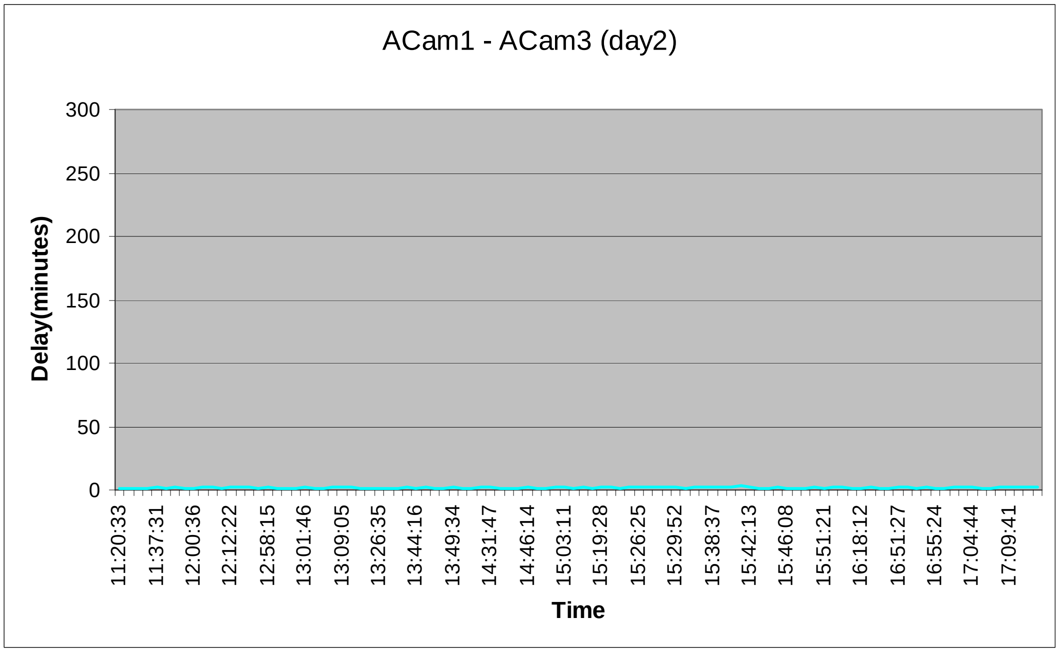


Figure 9-208 Travel time from ACam1 to ACam3

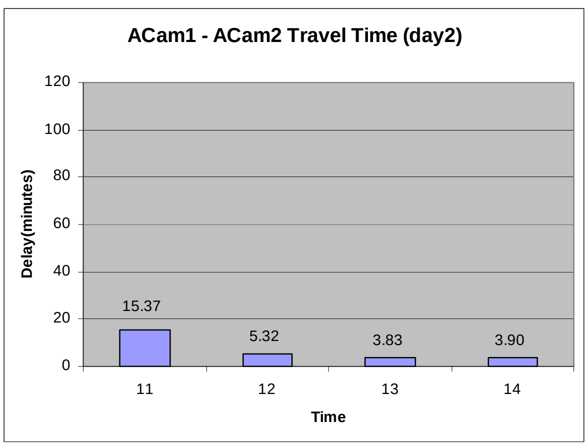


Figure 9-209 - Average travel time from ACam1 to ACam2

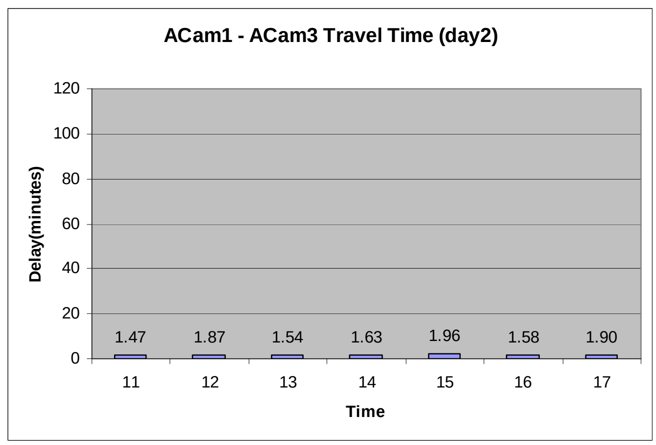


Figure 9-210 - Average travel time from ACam1 to ACam3

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ACRONYMS

ADOT – The Arizona Department of Transportation (ADOT) is the state agency responsible for ensuring a safe, efficient, and cost-effective air and road transportation system in Arizona. ADOT administers state and federal motor vehicle regulations and provides oversight in design, construction and maintenance of Arizona's transportation infrastructure. ADOT also administers the federally-funded railroad crossing safety improvement program and coordinates with railroads to ensure that no unexpected delays or expenses occur during construction of transportation infrastructure as a result of conflicts with railroad facilities.

CBP – U. S. Bureau of Customs and Border Protection (CBP) is the entity within the U.S. Department of Homeland Security responsible for securing the borders of the United States while facilitating legal trade and travel. CBP's work at and between ports of entry includes stopping inadmissible people and illicit goods, admitting legitimate travelers into the U.S., enforcing U.S. import and export laws and regulations to ensure compliance, collecting customs duties and fostering safe travel and anti-terrorism efforts.

C-TPAT – The Customs-Trade Partnership Against Terrorism (C-TPAT) is a program of Customs and Border Protection (CBP) under which importers who apply and meet certain security standards are provided expedited processing benefits for the goods they import.

This program is a public/private partnership in which CBP works with importers, carriers, brokers, and other industry sectors toward a security-conscious environment from manufacture through transportation and importation to ultimate distribution. Businesses must ensure the integrity of their security practices and communicate and verify the security guidelines of their business partners within the supply chain. Begun in November 2001, C-TPAT has more than 7,500 members and also enables the business community and CBP to exchange anti-terrorism ideas and information. Details at:
http://www.cbp.gov/xp/cgov/import/commercial_enforcement/ctpat/

E-Manifest – The Electronic Truck Manifest (e-manifest) is a part of the Customs and Border Protection (CBP) commercial trade processing system entitled Automated Commercial Environment (ACE), which connects CBP, the trade community and participating government agencies via secure electronic processing. E-manifest capability is fully operational at 99 U.S. land border ports of entry. Carriers or third parties, such as customs brokers or border processing centers, can file e-manifests; they must do so before the truck arrives at the port of entry. E-manifests provide CBP with advance cargo information, so officials can begin pre-screening trucks and shipments, while dedicating more time to inspecting high risk cargo. When a truck then approaches the primary booth, the e-manifest is automatically retrieved along with the matching pre-filed entries about the conveyance, equipment, crew and shipment details and including in-bond requests and other declarations for the CBP officer to view and process. On average, e-manifests are processed 33 percent faster than paper manifests. In addition, the system stores details about trucks, drivers, etc., eliminating the need to re-enter certain required data for each trip of that truck or driver. (Efforts are underway for a comparable electronic manifest program for rail and sea cargo this year; for air cargo, CBP recently approved the design for an e-manifest to be implemented next year, with the aim of eventually having an integrated multi-modal e-manifest system.)

FAST – Free and Secure Trade (FAST) is an expedited commercial clearance program for known low-risk shipments entering the U.S. from Canada and Mexico. FAST processing is available, as of late 2007, at 55 land border ports of entry and usually includes dedicated lanes, reduced number of inspections which results in reduced delay, and priority for Customs and Border Protection (CBP) inspections. Access to the FAST program with expedited FAST processing is available only if the whole supply chain qualifies under the Customs-Trade Partnership Against Terrorism (C-TPAT) program, so that an approved driver carries eligible goods for an approved carrier, importer and shipper.

This program is meant to expedite secure passage of commercial vehicles across international borders between the U.S. and Canada and the U.S. and Mexico. Pre-registered progam participants, having cleared all background checks and safety compliances, are eligible to use dedicated FAST lanes at border crossings, thus moving more quickly through inspection. In addition, a FAST participant may submit electronic manifests to CBP half an hour prior to arrival at a U.S. land border port of entry, while other truck carriers are required to submit electronic manifests one hour prior to arrival.

GSA – The General Services Administration (GSA) is the U.S. federal government's main acquisition entity with responsibility for a variety of federal purchases, for developing, administering, and evaluating compliance with related policies, regulations and standards throughout the federal government and for ensuring that the government obtains good value. Among GSA's services are acquisition of supplies and equipment and arranging to build or lease space to be used by government agencies. (GSA manages more than one-fourth of the federal government's total procurement dollars for goods and services.)

I-10 – Interstate 10 (I-10) is a part of the U.S. federal interstate highway system. It runs for 2460 miles from Florida to California and is the southernmost east-west, coast-to-coast interstate highway in the United States. In Arizona, it passes through both Tucson and Phoenix. In Tucson an interchange ramp connects I-10 with the northern terminus of Interstate 19 (I-19), which leads south to its termination at the US-Mexico border at Nogales, Arizona.

I-19 – Interstate 19 (I-19) is a part of the U.S. federal interstate highway system. It runs southward for 100 kilometers (63.35 miles) from its beginning at Interstate 10 (I-10) in Tucson, Arizona, to its termination at the US-Mexico border at Nogales, Arizona. Distance measurements on I-19 are signposted in kilometers, not miles.

NAFTA – North American Free Trade Agreement (NAFTA), which went into effect in January 1994, created a free trade zone among the U.S., Canada and Mexico to facilitate the movement of trade in goods and services and the flow of investment. This agreement has eliminated most tariffs among the signatory countries and has provisions for protection of intellectual property.

POE – A Port of Entry (POE) is any U.S. government facility at a land border, seaport or airport where individuals, goods and vehicles can be processed for authorized entry into U.S. territory. Processing of goods at POEs includes, among other things, enforcement of U.S. federal import and export laws and regulations, and agriculture inspections aimed at protecting the U.S. from potential carriers of animal and plant pests or diseases that could cause serious damage to America's crops, livestock, pets, and the environment.

POV – Privately-owned vehicles (as distinguished from commercial vehicles).

SR 189 – State Route 189 (SR 189) is part of Arizona's state highway system. SR 189 is completely within the town of Nogales, Arizona, and serves as an important surface street, called Mariposa Rd. SR-189 is about three miles in length, beginning at Interstate 19 (I-19) and running south to the U.S.-Mexico border.

USDA – The United States Department of Agriculture (USDA) is a cabinet-level department of the U.S. federal government with multiple responsibilites with respect to food, agriculture, natural resources, and related issues. Among these are expanding markets for agricultural products and improving access to foreign markets for U.S. farm products. USDA also provides foreign food assistance and supplies technical agricultural research and development assistance to developing and transition economies—including helping them bring their sanitary standards up to par with those of major import markets so they can sell their agricultural commodities internationally to the U.S. and other markets. USDA's responsibilities include enhancing food safety by taking steps to reduce the prevalence of foodborne hazards from farm to table, keeping crop and animal pests and diseases out of the U.S., managing those inside U.S. borders and protecting the farm and food sector, as well as consumers, from both accidental and intentional threats that might impact the food supply.

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