DEVELOPMENT OF A STATEWIDE MODEL FOR HEAVY TRUCK FREIGHT MOVEMENT ON EXTERNAL NETWORKS CONNECTING WITH FLORIDA PORTS

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16. Abstract

Analysis of two Florida Seaports has provided critical information about the impacts heavy trucks generated by freight vessel activity can have on the road networks connecting to these seaports. These microscopic network simulation models require application of Artificial Neural Network (ANN) truck trip generation models for these ports by utilizing vessel freight data to determine the necessary input data. A truck trip generation model for Port Canaveral was developed for application of the transferability testing. The methodology for designing a network model with a Florida Seaport as a special generator was developed with the Port of Tampa and the transferability successfully tested with Port Canaveral. The network models were statistically validated at the 95% confidence level. The percent of heavy truck volumes generated by freight activity at the Port of Tampa estimated to use the interstate highways (I-4, I-75, I-275) is 55%. For the Port Canaveral heavy truck volumes, 26% are estimated to use the adjacent interstate highway (I-95) and 18% are estimated to use the major state road (SR 528). These network models can be utilized for transportation planning, intelligent transportation systems (ITS) applications or operations such as incident management scenarios. Both port network models were successfully executed for short term (5 year) forecasting at both ports.

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DISCLAIMER

The opinions, findings and conclusions in this publication are those of the authors and not necessarily those of the Florida Department of Transportation of the US Department of Transportation. This report does not constitute a standard specification, or regulation. This report is prepared in cooperation with the State of Florida Department of Transportation.

EXECUTIVE SUMMARY

The presence of heavy trucks can have a significant impact on the operational efficiency of a highway depending upon the percent of total traffic volume and capacity of the road itself. Florida's seaports generate a high volume of heavy truck traffic on a daily basis. Therefore, it is important to identify which routes from the road networks adjacent to the ports these trucks travel on.

In order to efficiently model the heavy truck traffic generated by a seaport's freight activity on an adjacent highway network, a good methodology must be formulated and followed. The Port of Tampa and the adjacent highway network (6 mile radius) was selected to develop this methodology. This included many high populated residential and industrial areas and the City of Tampa's downtown business district.

To begin the modeling process, a network must be defined. Some initial data was acquired to determine routes that could accommodate the amount of daily truck traffic generated by the seaport. This included traffic volume counts on the access roads to the port both from the field and using a truck trip generation model developed by the University of Central Florida's Transportation Systems Institute in Phase II of this study. Interviews and discussions were also made with agencies associated with the transport of freight in and out of the port's freight terminals to determine routes the truck drivers use when traveling on the adjacent network.

Once the network was defined, a computer model that can accurately simulate the selected network was selected. This is an important step because it dictates the necessary

data which must be obtained. A micro simulation computer model was the type selected and both CORSIM and VISSIM simulation packages were tested.

After the simulation model was selected, all the necessary data required to run the model was collected. This included all available traffic operational features about the road intersections and links as well as the traffic volumes. The traffic volumes for the port require that the port truck trip generation model be executed. This model uses vessel freight data as input. Therefore, vessel data was acquired from the Tampa Port Authority.

The traffic operations data collected was used to code the network in the simulation model. After the network was coded, the traffic volumes were used to construct an origin-destination (O-D) matrix. The initial O-D matrix was created using FDOT traffic volumes and truck counts collected previously at the port in Phase II while field data was being collected to update the selected FDOT data. Analysis of network traffic, field observations, and the information compiled from the interviews and discussions with those associated with the port's freight operations were utilized to distribute the traffic generated by the port's freight activity in the O-D matrix.

Calibration and validation of the two simulation models was done following the completion of the O-D matrix. The network was calibrated with both CORSIM and VISSIM using FDOT and field data. The field data was necessary to insure an accurate network model was fabricated.

Upon determining a successful calibrated O-D matrix, collected field data on predetermined master links was used to statistically verify the accuracy of the model. A master link is a link with a key location around the port and has a high level of daily truck volumes. The Port of Tampa truck trip generation model's output of daily truck counts were used to calculate the total peak hour traffic volume input for the port nodes of the network model. The truck volumes on the master links generated by the network model corresponding to the collected field data were analyzed statistically. Confirmation of the accuracy in which the simulation model replicates the truck volumes was necessary for accomplishing the project's objectives.

Once an accurate model was built, it was used to execute a short-term (5 year) forecast of the truck traffic on the adjacent road network generated by the port's freight activities. A truck trip generation model was executed with forecasted vessel freight data for year 2005. From the model's output, a week of daily truck counts was selected and the traffic volumes for input to the micro simulation model were computed. VISSIM was selected as the micro simulation model for this task due in part to its ease of use. VISSIM's output provided the forecasted traffic volumes for the network links that were used to determine the estimated number of trucks on the network generated by the port's freight activity in year 2005.

To ensure the applicability of this methodology, its transferability was tested on Port Canaveral. The same basic methodology was applied to develop a network model using VISSIM for the port's adjacent road network. The model was successfully calibrated and validated. A truck trip generation model was not previously developed for Port Canaveral. Therefore, one was designed and tested while the network model was developed. The Port Canaveral truck trip generation model was utilized to produce a short-term forecast of the estimated trucks that the port would generate in five years from its freight activity. These truck volumes were used to determine the estimated trucks on the defined network generated by Port Canaveral’s freight activity following the same methodology developed with the Port of Tampa. The study concluded that the developed methodology is completely transferable to any Florida seaport.

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1. INTRODUCTION

Freight transportation is an essential component for the growth of any global economy. The total annual waterborne commerce in short tons for year 2000 for the United States was almost 2.5 billion (1). The State of Florida's freight activity contributes a significant portion to the nation's total annually. Florida's foreign and domestic waterborne commerce totals over 125 million short tons annually. This is over 5% of the nation's total. Florida is ranked 6th in the nation in terms of total short tons but economically, Florida's almost 74 billion in annual international trade accounted for 3.8% of the nation's total in year 2000 (2). Florida was second only to New Orleans. Florida has 1,197 statute miles of coastline and eleven active seaports handling waterborne trade. Among Florida's seaports, the Port of Tampa and Port Canaveral are in the top 100 ports for the nation.

The Port of Tampa is ranked 17th in the nation for total tonnage and handles over 46 million short tons annually for both foreign and domestic trade (1). It is the number one tonnage port in Florida handling over 40% of Florida's total tonnage (2). The majority of Tampa's commodities are classified as bulk. These include phosphate and related products, which accounts for 50% of Tampa's total annual tonnage. Figure 1.1 is a breakdown of Tampa's freight activity by general commodity groups.

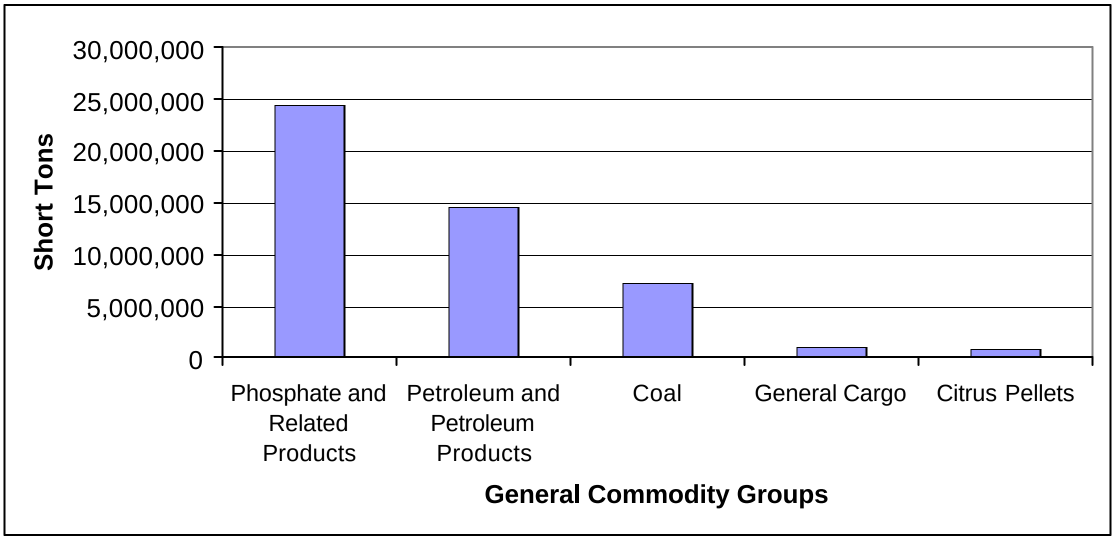


Figure 1.1: Total Annual Short Tons of Port of Tampa's General Commodity Groups (3)

Port Canaveral is ranked 87th in the nation for total tonnage and handles over 4 million short tons annually for both foreign and domestic trade (1). Though this tonnage is much lower than the Port of Tampa, it is 6th in Florida for total tonnage. Port Canaveral is an important Florida seaport because it is quadramodal. Located adjacent to the Kennedy Space Center, it also supports freight transportation into space. Therefore, Port Canaveral has the ability to transport freight by road, rail, air, and space modes of travel. Furthermore, Port Canaveral has a significant opportunity for growth where other Florida ports are nearing capacity in terms of land use. Port Canaveral's major tenants currently have ample storage capacity with anticipated near future growth. This includes a confirmed increase of exported citrus pellets in the next 12 months of 100,000 tons. The port is also actively working on expansion plans for other bulk facilities. These include a slag importer and aggregate distributor that could increase the total annual tonnage of the port by up to 4 million. Figure 1.2 is a breakdown of Canaveral's freight activity by general commodity groups.

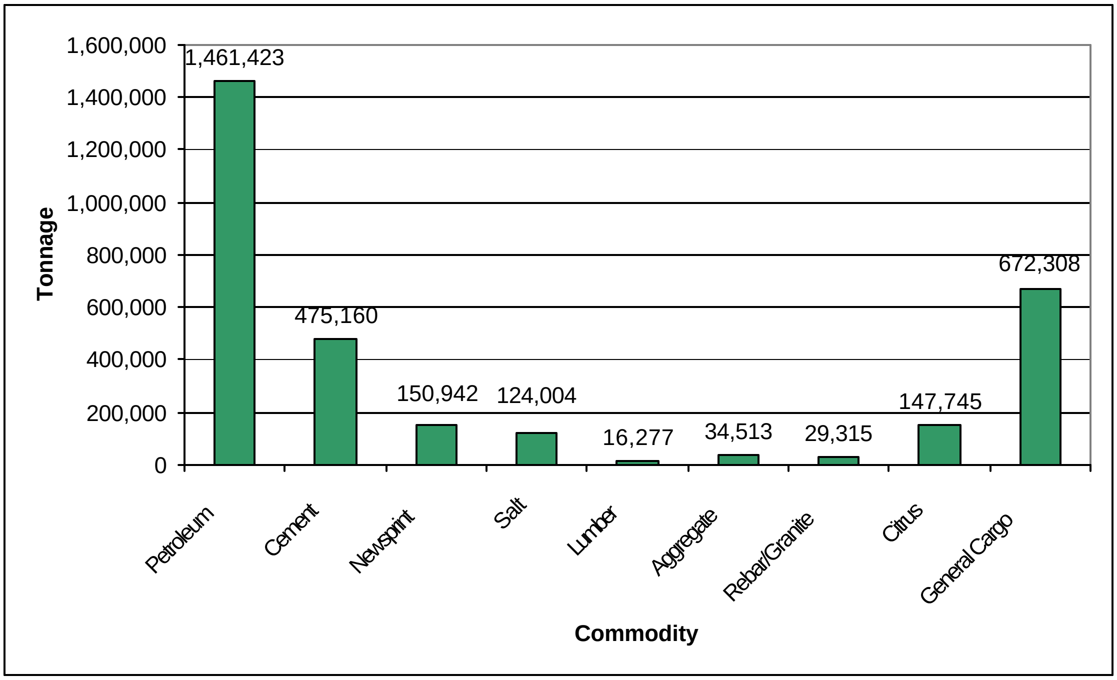


Figure 1.2: Total Annual Short Tons of Port Canaveral's General Commodity Groups (3)

1.1 Truck Traffic Generated by Seaport Freight Activity

Seaports are significant generators of heavy truck traffic. This is directly attributed to the vessel freight activity. Each Florida seaport can be considered a high intermodal traffic generator because at least two modes of transportation are utilized to move cargo at the ports. The highest intermodal traffic is between the vessels and the heavy trucks traveling on Florida's highways.

From field data collected between years 2000 and 2001, Florida's major seaports generate over 10,000 daily heavy truck trips per direction (inbound or outbound) due to port freight activity. These trucks travel on Florida's highway network that connects to these ports. Therefore, it is important to determine which routes the truck drivers use. Defining the road network adjacent to Florida's seaports is useful in examining existing traffic operations, incident management, future planning and can also be utilized with various intelligent transportation systems (ITS) applications including Advanced Traveler Information Systems (ATIS).

In order to utilize a defined network adequately, a methodology for developing a route assignment model of the road network adjacent to a Florida seaport must be developed. This allows the transportation engineer or planner the ability to examine and determine what impacts the seaports are having or will have on the local network traffic. This methodology is also desired to be transferable to other ports as well. To produce an accurate model, a computer simulation package can be utilized.

To develop a methodology for this network modeling approach, Florida's largest seaport, the Port of Tampa, was selected. In year 2000 the Port of Tampa generated over 4,000 daily truck trips per direction from freight activity. To test the transferability of the methodology, Port Canaveral, the Port of Tampa's eastern seaboard neighboring port, was selected. Both ports are centrally located on each of Florida's longitudinal coasts.

2. LITERATURE REVIEW

In 1996 M.G.H. Bell and S. Grosso, University of Newcastle, applied the Path Flow Estimator (PFE) as a stochastic user equilibrium traffic assignment method (4). This provides unique estimates of path flows and travel times from traffic counts and prior origin-destination data. The program was written in the “C” computer language.

The PFE theory considers a two-path network. The relationship between the cost of the two paths and the share of the traffic attracted was determined by the least cost of a link. The input values to the program were links, nodes (intersections), geometric features, traffic counts, signal times and the available origin-destination (O-D) data. The output was path flows and path travel times. The algorithm used in the PFE is iterative, with an inner and outer loop. The path flows were sequentially scaled in the inner loop so the constraints are fulfilled. For the outer loop, link costs were calculated and least cost paths are sought.

The O-D matrix used can be considered as a group of constraints for each iteration. PFE was used in two cities, Turin and Toulouse. It produced poor results in the first city and good results in the latter. The measure of effectiveness was the Mean Absolute Error (MAE). The accepted threshold was within 20% of the measured values for each link.

PFE cannot be used in multi-modal networks. It does not consider different vehicle types (i.e. heavy trucks, passenger cars), driver behaviors or car following theories. The program also does not assign heavy trucks on a road network.

In 1998, R. Boning, G. Eisenbei, C. Gawron, S. Krau, R. Schrader, and P. Wagner, ZPR from Koln, Germany, used microscopic simulation to solve the Dynamic Traffic Assignment (DTA) problem (5). The research was conducted at a research center in Koln, Germany. A comparison between static and dynamic traffic assignment was done. The algorithm used in the simulation-based DTA works as follows: any traveler has a set of routes (usually small) to choose from. Associated with the routes is a probability to choose the traveler's route. After assigning a route to any of the travelers according to these probabilities, a simulation was carried out that leads to the actual travel times. These actual travel times were used to shift the probabilities towards shorter routes. Convergence was reached when these probabilities no longer change. Complication was created because the route choice depends on the traffic conditions which itself depend on the routes chosen. Therefore, the double iteration loop shown in Figure 2.1 was needed.

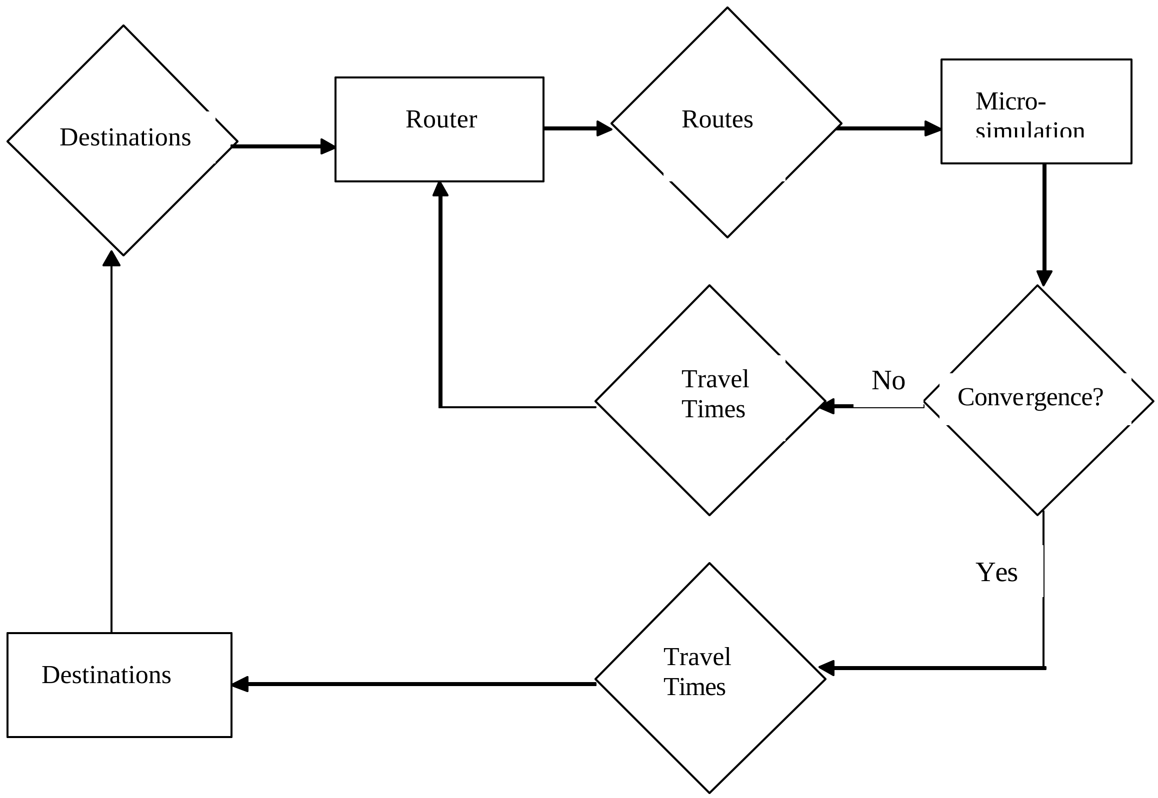


Figure 2.1: The Double Iteration Loop (5)

Finding the routes through a given network, the so-called DTA, can be mathematically formulated as an optimization problem with linear constraints. Using the assumption that individual travelers try to find the shortest or least cost route through a network, the problem was complicated because the travel times on a link depended on the number of cars on that link. The paper concluded that when dealing with a dynamic problem, the classic approach using time independent flows was no longer suitable, because a number of additional dynamic constraints have to be taken into account. To name only the most important ones: 1-spillback phenomena have to be described and 2-the FIFO (First In First Out) condition has to be fulfilled.

A simulation was performed on a German freeway network and urban road network with a static and dynamic O-D matrix provided by the DLR (Department of

Transportation in Germany). It was concluded that the differences found were small. Differences between static and dynamic assignment only showed up when the demand exceeded the capacity during the rush hour and the link travel times could not be adequately described as a static function of the link flows. All travel modes other than passenger cars such as public transportation vehicles, trucks or bicycles were not included in this research. It is not certain what the performance of this simulation methodology would be for application to heavy trucks without extensive further research.

In 1999, Khaled F. Abdelghany and Hani S. Mahmassani have presented a Dynamic Trip Assignment (DTA) simulation model for urban inter-modal transportation networks (6). The model considered different travel modes such as private cars, buses, metro/subway and High Occupancy Vehicles (HOV). The model captured the interaction between mode choice and traffic assignment under different information provision strategies. It implemented a multi-objective assignment procedure in which travelers choose their modes and routes based on a range of evaluation criteria. The model assumed a stochastically diverse set of travelers in terms of their relevant choice criteria and access and response to the supplied information.

In this research the vehicular traffic flow simulation logic in DYNASMART was adapted to represent interactions among transit vehicles and automobiles. This simulation component is a time-based simulation, which moves individual vehicles along links according to local speeds determined consistently with macroscopic traffic stream models (i.e. a speed-density relation, a modified form of Greenshields, was used in this implementation). The number of vehicles on each link was calculated using conservation principles; numbers in each class of vehicles in the traffic mix were kept separate.

Consistently with the macroscopic logic for modeling vehicle interactions, average passenger car equivalent factors were used to convert each vehicle type to the equivalent passenger car units. The resulting equivalent-car concentration was then calculated for each link, and used to estimate the corresponding speed through the speed-density relation. These speeds, updated continually to reflect prevailing conditions, determine vehicular movement on that link. This research however did not include any field data to calibrate or validate the developed model. Furthermore, the developed model did not include truck traffic as a major factor in the traffic assignment. Truck traffic may have a significant influence on the overall study area's operational performance because it included an interstate highway (I-35W). Typically interstates may have a truck volume high enough to influence the traffic operations. Due to these observations, this developed model may not be adequate to meet the required research objectives of the truck-seaport study.

In 2000, Wang, Messmer, and Papgeorgiou presented METANET, a macroscopic simulation program for freeway networks (7). METANET was extended to include user-optimal dynamic traffic assignment (DTA). A derivative of METANET called METANET-DTA was developed which employs iterative algorithms for exact DTA. DTA refers to distributing traffic demand with the same origin-destination (O-D) matrix among alternative routes of a traffic network for all time periods, so that some optimality principles are satisfied. Here, the origin refers not only to origins of a network, but also to internal bifurcation nodes. Based on different optimality principles adopted, DTA is generally classified as user-optimal DTA.

This research studied a complex network of freeways and did not include any of the urban arterials. There were no signalized intersections in the study because of the nature of the simulation program (Macroscopic simulation). METANET-DTA can not be used in truck simulation for a small road network because it does not have the required features to code signalized intersections or account for truck traffic.

In 1998, Peter Vovsha and Shlomo Bekhor, have investigated three models for traffic assignment and route choice (8). The research included three mathematical models to solve the traffic assignment problem. These models were Deterministic User Equilibrium, Stochastic User Equilibrium by Multinomial Logit Route Choice, and Stochastic User Equilibrium by the Link-Nested Logit Model. Numerical examples for these three models were documented as well. It was concluded that the Link-Nested model can be incorporated into a stochastic user equilibrium framework. The numerical examples also showed the clear advantage of the Link-Nested Logit Model over the deterministic and the Multinomial Logit Models with respect to trip loading quality. However, the computational efficiency of the loading procedure was hampered by the multiple repetition of the shortest path searching for each O-D.

This research did not include any collected field data for calibration or validation. Moreover, it did not account for the traffic composition or the special generators (ports, shopping malls, etc.) as major factors affecting the solution of the traffic assignment problem. Therefore, this approach was not applicable for this study.

In 2000 Loren Bloomberg and Jim Dale compared the VISSIM and CORSIM traffic simulation models for a congested network (9). Their paper included modeling of SR 519 using VISSIM and CORSIM. It was concluded that the simulation approach was effective for quantifying the benefits and limitations of different alternatives. The results proved the consistency and reasonableness of the simulation tools, and provided the authors with confidence about the results. The study also included sensitivity analysis. It was also concluded that both models are appropriate for congested arterial street conditions.

The research by Bloomberg and Dale provided evidence that a microscopic simulation approach can be successfully executed for modeling congested networks. The paper did not include the traffic assignment application in CORSIM or VISSIM evaluations. An extension of this modeling approach using two simulation models will be applied for solving the truck route assignment problem at Florida Seaports.

3. METHODOLOGY

The methodology is an application of simulation techniques for solving a dynamic traffic assignment problem. Two different micro simulation packages were investigated for assigning the truck volumes generated by the Port of Tampa on the adjacent road network and consequently on the interstate highways (I-4, I-75 & I-275) in the port's vicinity. CORSIM version 5.0 and VISSIM version 3.5 were the two simulation packages investigated. The developed methodology consisted of the following steps:

1. *Examine road network and conclude a network definition.* The first step is to examine the road network by making field observations, reviewing general traffic information, and compiling data that was previously collected at the port's entrances and exits in Phase II of this study. Also, interviews are conducted with port personnel and trucking companies who are familiar with the port's operation. This provides more details on the actual routes traveled by trucks generated from port freight activity.
2. *Data collection and analysis.* Data related to traffic volumes of turning movements, geometric features, type of control at intersections and signal timing data for all links and nodes of the proposed network are collected. Selection of data sources was prioritized to quality, availability, and feasibility. Field traffic counts for certain links were collected on the road network to calibrate and validate the proposed models. Traffic counts on these selected links were compared with the traffic volumes obtained from the simulation model's output. The data was entered into a database for model development and validation.

3. *Network Coding.* All proposed network links and nodes were coded in the simulation model. The relevant geometric, existing control devices at intersections and traffic features (traffic composition and signal timing) were included.
4. *Model Calibration.* Conduct several runs using an estimated Origin -Destination (O-D) matrix and adjust these matrix volumes in an iterative process to conclude with the best O-D that provides minimum error between field and simulated volumes of the selected links.
5. *Model Validation.* The model must be validated in order to assure that it replicates the actual system. This was accomplished by entering truck volume data (leaving and entering the port) not used during the model development process. Then, the model predicted truck volumes on the selected links were compared with the actual volumes using several statistical tests.
6. *Conclusions.* Interpret the results to establish conclusions and make recommendations for future analysis.
7. *Forecasting.* Execute the best model to determine the truck route assignment for a short term (five year) forecast.

3.1 Background of Study Sites

3.1.1 Port of Tampa

The Port of Tampa boasts some of the highest rated international and domestic shipping facilities in the nation in terms of overall tonnage. Figure 3.1 shows the port's annual tonnage from year 1990 to 1999 (10). Strategically located on Florida's West Coast, the Port of Tampa is linked to rapidly expanding markets in Central and South America, Ukraine, India and Australia through the Panama Canal. The Port of Tampa handles (import and export) the equivalent amount of tonnage as all of Florida's other 13 deepwater ports combined. It has a channel of 43 feet depth, which makes it Florida's deepest port.

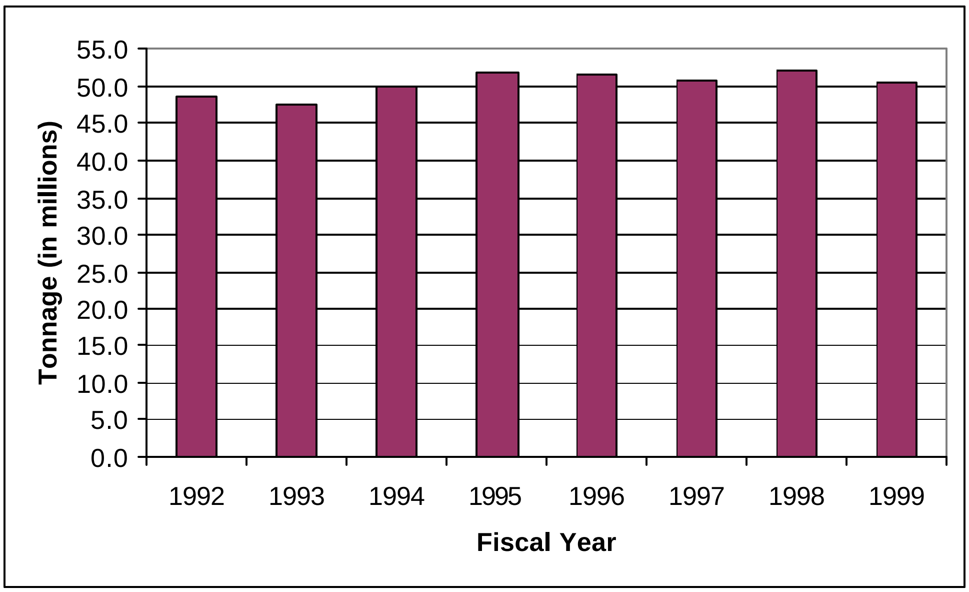


Figure 3.1: Total Tonnage at the Port of Tampa

The Port of Tampa handles various commodity types: general cargo (includes citrus, melons, cars, steel coils, etc) and bulk cargo (includes phosphate rock, fertilizer products, petroleum, cement, citrus pellets and aggregate). The port moves 25 million tons of phosphate and related products annually, more than any other port in the world. It is a high intermodal facility for transporting freight including the majority by truck, rail, and pipeline. It is also a major cruise port in Florida. A list of the site-specific information for this port is:

- Three main freight terminal locations/Five main access roads
    - Hookers Point (20th Street, 22nd Street, Causeway Blvd.)
    - Port Sutton (Port Sutton Rd)
    - Pendola Point (Pendola Point Rd)
- Rail activity present
- Significant petroleum imports in terms of volume
- Insignificant containerized imports/exports in terms of volume. The activity is minimal especially compared to the bulk imports/exports.
- Significant bulk exports, including phosphate products and citrus pellets that are very frequent and in high volumes.

A well-established port with high freight tonnage movement like the Port of Tampa is expected to generate high heavy truck movements around the port and on the major highways in its vicinity.

3.1.2 Port Canaveral

Port Canaveral is located to the East of Central Florida. It has two freight terminals located on port property, a north terminal and south terminal. Access to each of the terminals is independent. SR 401 is used for accessing the North Terminal and George King Boulevard provides access to the South Terminal piers. As of year 2000, Port Canaveral is reaching 5 million tons of total imports and exports. Figure 3.2 shows the import and export trend in tonnage for the port over the last 7 years. Some of the more significant imported commodities are petroleum, cement, newsprint, salt, lumber, slate, granulated sand, drywall, rebar, and granite. Significant exports are concentrate, juice, citrus, cars/trucks, and general cargo.

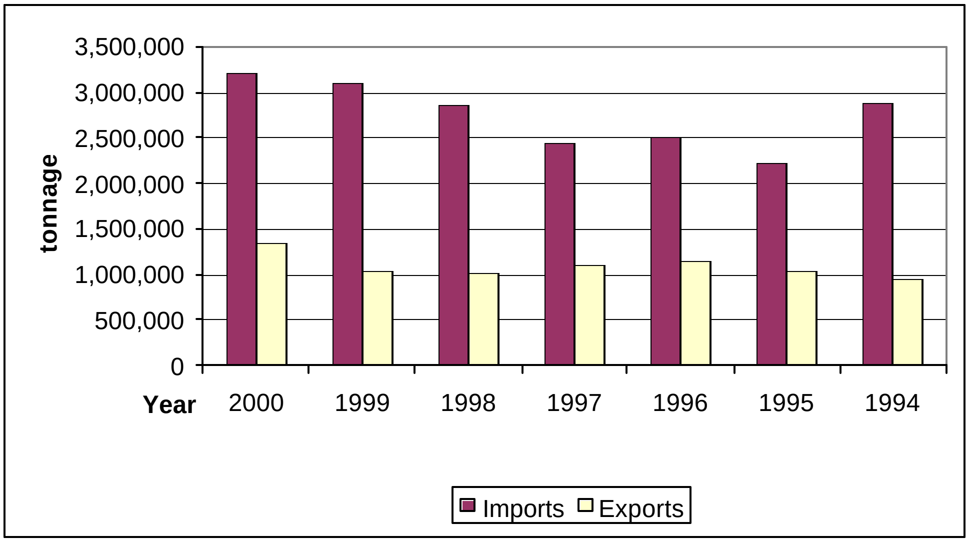


Figure 3.2: Port Canaveral Annual Imported and Exported Tonnage

This is a unique port because of its proximity to the Kennedy Space Center. It has virtually unlimited growth potential due to the possible future increase in space travel and subsequently the necessity to provide an intermodal hub for transporting freight into space. It is also a major cruise port in Florida. A list of the site-specific information for this port is:

- Two main freight terminal locations/two main access roads
    - North Terminal (SR 401)
    - South Terminal (George King Blvd.)
- Significant petroleum imports

- High tonnage cargos (bulk commodities) but infrequent shipments
- Insignificant containerized freight traffic
- Seasonal freight activity (citrus products)
- High storage capacity with many industries utilizing the port as business operations centers including Rinker Materials, Morton Salt, Continental Cement, Coastal Fuels, Ambassador Services, Mid-Florida Freezer.

Port Canaveral generates daily truck traffic due mainly to the high bulk cargo handled here.

4. MODELING

4.1 Develop Route Assignment Model

Recently, there have been many traffic simulation packages developed to simulate a wide array of traffic operations. CORSIM and VISSIM are two examples of existing traffic micro simulation software. This research explores these two simulation packages to investigate their capabilities in truck traffic assignment and to compare the two packages. CORSIM and VISSIM were used as the tools for solving the traffic assignment problem for the Port of Tampa road network. The outcome of the developed modeling methodology and desired simulation package will be applied to Port Canaveral to test the transferability. The following sections will explain the steps conducted to achieve these goals.

4.1.1 Port of Tampa Network Definition

A preliminary road network has been identified for the Port of Tampa using the Microsoft Expedia Street 98 Program. The information obtained from the map program was compared with data from the 1999 FDOT Traffic Information CD. Also, several trips were made to the Port of Tampa to examine the road network through field observations. A sample of these trip reports is provided in Appendix A.

Table 4.1 shows the list of the network nodes and links with their geometric features. The links listed in Table 4.1 were selected because they can accommodate high truck volumes leaving and entering the Port of Tampa area according to the FDOT 1999

CD data. Figure 4.1 displays a diagram of the defined network. Most of the links are interstate highways or state roads that have high capacity due to their geometric features. The lower capacity roads were chosen because they link the major roads in the network (i.e. Madison Avenue, SR 41, and SR 301). Major roads located in this area that are considered main truck routes adjacent to the port are I-4, I-75, I-275, SR 41, SR 618, SR 92, and SR 60. Figure 4.2 shows a map of the Tampa network.

Node#	Description	Link #	Description	Length	Speed Limit	Notes	State Road
1	U.S. Highway 41 / Madison Avenue	1	Node 1 to Node 2	2.62	45 mph	2 Lane highway	--
2	78th street / Madison Avenue	2	Node 2 to Node 3	2.69	35 mph	2 Lane highway	--
3	Madison Avenue / U.S. Highway 301	3	Node 3 to Node 4	0.78	50 mph	2 Lane highway	SR 301
4	U.S. Highway 301 / I-75	4	Node 4 to Node 5	1.45	50 mph	6 Lane divided	SR 301
5	State road 676 / U.S. Highway 301	5	Node 5 to Node 6	0.6	50 mph	6 Lane divided	SR 301
6	Expressway 618 / U.S. Highway 301	6	Node 6 to Node 7	1.34	50 mph	6 Lane divided	SR 301
7	State Highway 60 / U.S. Highway 301	7	Node 7 to Node 8	2.3	50 mph	6 Lane divided	SR 301
8	State Highway 574 / U.S. Highway 301	8	Node 8 to Node 9	1.44	50 mph	4 Lane undivided	--
9	State Highway 574 / I-4	9	Node 9 to Node 10	1.48	55 mph	6 Lane divided	I-4
10	22nd Street / I-4	10	Node 10 to Node 11	1.95	55 mph	4 Lane divided	I-4
11	I-4 / I-275	11	Node 11 to Node 12	1.16	55 mph	4 Lane divided	I-275
12	State Highway 92 / I-275	12	Node 12 to Node 13	3.85	45 mph	6 Lane divided	SR 92
13	State Highway 92 / State Highway 60	13	Node 13 to Node 14	0.68	45 mph	6 Lane divided	SR 92
14	State Highway 92 / State Highway 618	14	Node 14 to Node 15	3.35	65 mph	4 Lane undivided	SR 618
15	State Highway 60 / Expressway 618	15	Node 15 to Node 16	5.61	65 mph	4 Lane divided	SR 618
16	22nd Street / Expressway 618	16	Node 16 to Node 17	1.33	65 mph	4 Lane divided	SR 618
17	State Highway 41 / Expressway 618	17	Node 17 to Node 18	2.15	65 mph	6 Lane divided	SR 41
18	State road 676 / U.S. Highway 41	18	Node 18 to Node 1	1.87	55 mph	6 Lane divided	SR 41
19	State Highway 41 / State Highway 60	19	Node 19 to Node 17	1.49	55 mph	6 Lane divided	SR 41
20	22nd Street / State Highway 60	20	Node 21 to Node 5	1.12	45 mph	4 Lane divided	SR 676
21	State road 676 / 78th street	21	Node 2 to Node 21	1.6	45 mph	2 Lane highway	--
		22	Node 21 to Node 18	3.85	45 mph	2 Lane highway	SR 676
		23	Node 6 to Node 17	2.91	55 mph	6 Lane divided	SR 618
		24	Node 19 to Node 7	0.15	35 mph	6 Lane divided	SR 60
		25	Node 10 to Node 20	1.05	55 mph	4 Lane divided	--
		26	Node 20 to Node 16	2.07	55 mph	6 Lane divided	--
		27	Node 19 to Node 20	3.42	55 mph	6 Lane divided	SR 60
		28	Node 15 to Node 20	0.64	35 mph	2 Lane highway	SR 60
		29	Node 13 to Node 15	3.42	55 mph	6 Lane divided	SR 60
		30	Node 9 to Node 19	3.42	55 mph	6 Lane divided	SR 41

Note: Highlighted cells indicate external nodes.

-- indicates link not identivied as a state road.

Table 4.1: Node and Link Data for the Port of Tampa Road Network

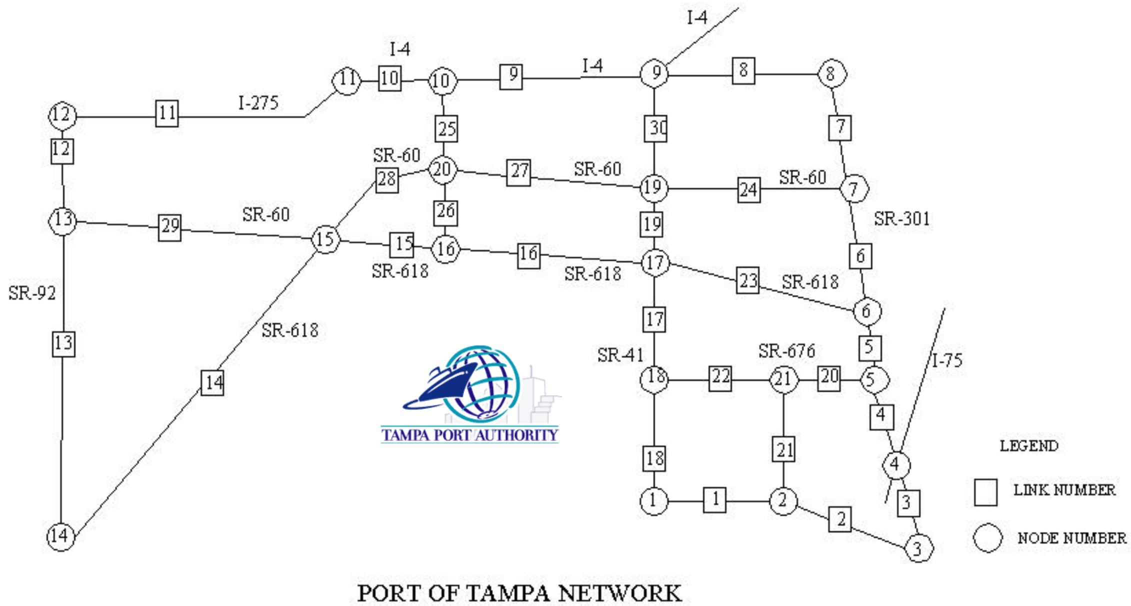


Figure 4.1: Port of Tampa Network Diagram

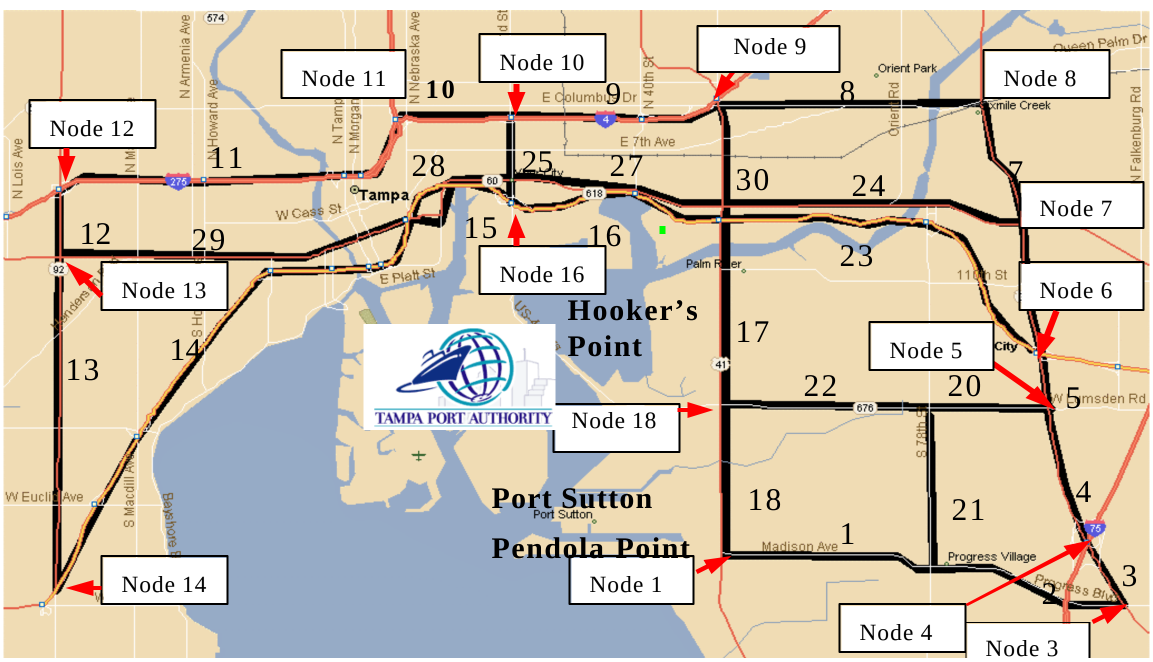


Figure 4.2: Road Network for the Port of Tampa O-D Matrix

(Microsoft Expedia Street 98 CD)

Trips were made to the port area for investigating the defined network. All nodes were checked to determine if there were significant changes in the geometric features on the links from the FDOT data. Also during these trips, interviews were conducted with Port of Tampa personnel and trucking companies who are familiar with the port's freight operations and possible truck routes. It was indicated from interviews with trucking companies that most of the trucks leaving the port from Nodes 1 and 18 are heading towards east (Bone Valley). It was also indicated that most of the trucks leaving the Port from Node 16 are heading towards North (I-4, I-275). See Figure 4.2 for the node locations on the Tampa road network.

The final defined road network was a cordon of about a 6.00-mile radius that included 30 links and 21 nodes, see Figure 4.1. A node is defined as an intersection or an interchange and links are the road segments that connect any two nodes. Figure 4.2 shows the network has 8 freeway links and 22 links on either state roads or urban streets. For a description of the individual links, refer to Table 4.1. Three of the 8 freeway links are on a toll road (SR 618). The network is bounded by SR 301 to the East, I-4 & I-275 to the north, and I-75 is located south east of the network. The nodes identified on the map in Figure 4.2 are external nodes of the network. External nodes are the origin-destination points for the network and make up the Origin-Destination (O-D) matrix used as input to the computer simulation models. These can be a special generator such as a port, an intersection, interchange, or a termination point on a network link that extends outside the selected network boundary.

4.1.2 Port of Tampa Network Data Collection

As mentioned earlier, the required data for coding, calibrating, and validating any simulation model are:

- *Turning movements at each intersection and/or interchange,*
- *Geometric features,*
- *Type of control at an intersection,*
- *Signal timing and*
- *Traffic volumes on each link.*

The City of Tampa and Hillsborough County provided signal-timing data for all the signalized intersections. A sample of this data is shown in Appendix B. Geometric features of the network and signal timing data for all network locations were not available. The missing information about the network geometry and type of control at intersections on the network was obtained during the field trips to the Port of Tampa's surrounding road network. During these trips, all of the proposed network links were driven on to record more data. Speed limits and geometric features were recorded and verified for each network link.

FDOT was contacted to obtain any available truck volumes for the network links. A hard copy of relevant data records from FDOT District 7 was obtained. Table 4.2 includes the data necessary for coding the network that was received from FDOT for the Port of Tampa links on the road network. It also includes the link number, station number according to FDOT's numbering system, Average Annual Daily Traffic (AADT), K factor that is the ratio between the peak hour volume and the daily volume, directional factor (D), and the percent of trucks (T). This data was used to update the data originally recorded from the 1999 FDOT traffic data CD. Due to the fact that, I-275 is the only interstate highway that is directly connected to Hookers Point (through I-4 at Node 10) and is north, I-275 provides service to most of the freight trucks traveling on routes north of Hookers Point (Node 16). This volume of trucks on I-275 (Link 11) is displayed in Table 4.2. However, freight trucks traveling on routes north of Pendola Point through Madison Avenue (Link 1) can use I-75 (at Node 4).

Link Number	Station Number	Source	Age of Data	AADT	K	D	T	Truck Volume
1								
2								
3	0044	District 7 AADT	Mar-00	23500	10.37	54.55	10.68	2510
4	5259	District 7 AADT	Mar-00	17000	10.37	54.55	8.32	1414
5	5260	District 7 AADT	Mar-00	16000	10.37	54.55	7.88	1261
6	5325	District 7 AADT	Mar-00	16500	10.37	54.55	6.81	1124
7	5326	District 7 AADT	Mar-00	17500	10.37	54.55	8.51	1489
8								
9	2026 & 2027	District 7 AADT	Mar-00	64000	9.74	54.48	13.42	8589
10	2028	District 7 AADT	Mar-00	70000	9.74	54.48	10.93	7651
11	2015 & 2016	District 7 AADT	Mar-00	84000	9.74	54.48	10.21	8576
12	5055	District 7 AADT	Mar-00	28000	10.37	54.55	5.01	1403
13	5052	District 7 AADT	Mar-00	18500	10.37	54.55	8.18	1513
14	5244	District 7 AADT	Mar-00	11000	10.37	54.55	8.51	936
15	5277	District 7 AADT	Mar-00	23500	10.37	54.55	8.05	1892
16	5264	District 7 AADT	Mar-00	25000	10.37	54.55	3.63	908
17	0003	District 7 AADT	Mar-00	11000	10.37	54.55	11.6	1276
18	5258	District 7 AADT	Mar-00	9900	10.37	54.55	11.71	1159
19	5104	District 7 AADT	Mar-00	16500	10.37	54.55	10.22	1686
20, 22	0030	District 7 AADT	Mar-00	9500	10.37	54.55	6.86	652
21								
23	5266	District 7 AADT	Mar-00	21000	10.37	54.55	3.1	651
24	5123	District 7 AADT	Mar-00	19500	10.37	54.55	7.68	1498
25	5300 & 5305	District 7 AADT	Mar-00	16000	10.37	54.16	16.72	2675
26	5299 & 5300	District 7 AADT	Mar-00	11500	10.37	51.11	16.72	1923
27	5126	District 7 AADT	Mar-00	14000	10.37	54.55	7.66	1072
28	5131	District 7 AADT	Mar-00	6700	10.37	54.55	6.01	403
29	0029	District 7 AADT	Mar-00	15500	10.37	54.55	7.21	1118
30	5104	District 7 AADT	Mar-00	16500	10.37	54.55	10.22	1686

Shaded cells indicate the missing link data

Table 4.2: FDOT Link Data for the Port of Tampa Road Network

Turning movement volumes for the peak hour were also included in the FDOT traffic operations data. Turning movements were provided for every fifteen minutes of the morning and evening peak periods. Once the available port network data was examined, any remaining traffic volumes necessary for completing the development of the route assignment model were obtained from actual field data collection.

4.1.3 Port of Tampa Field Traffic Data Collection: Freight Terminals

Figure 4.3 shows a layout of the port area. The blue stars indicate the five data collection locations for the truck counts at the freight terminals.

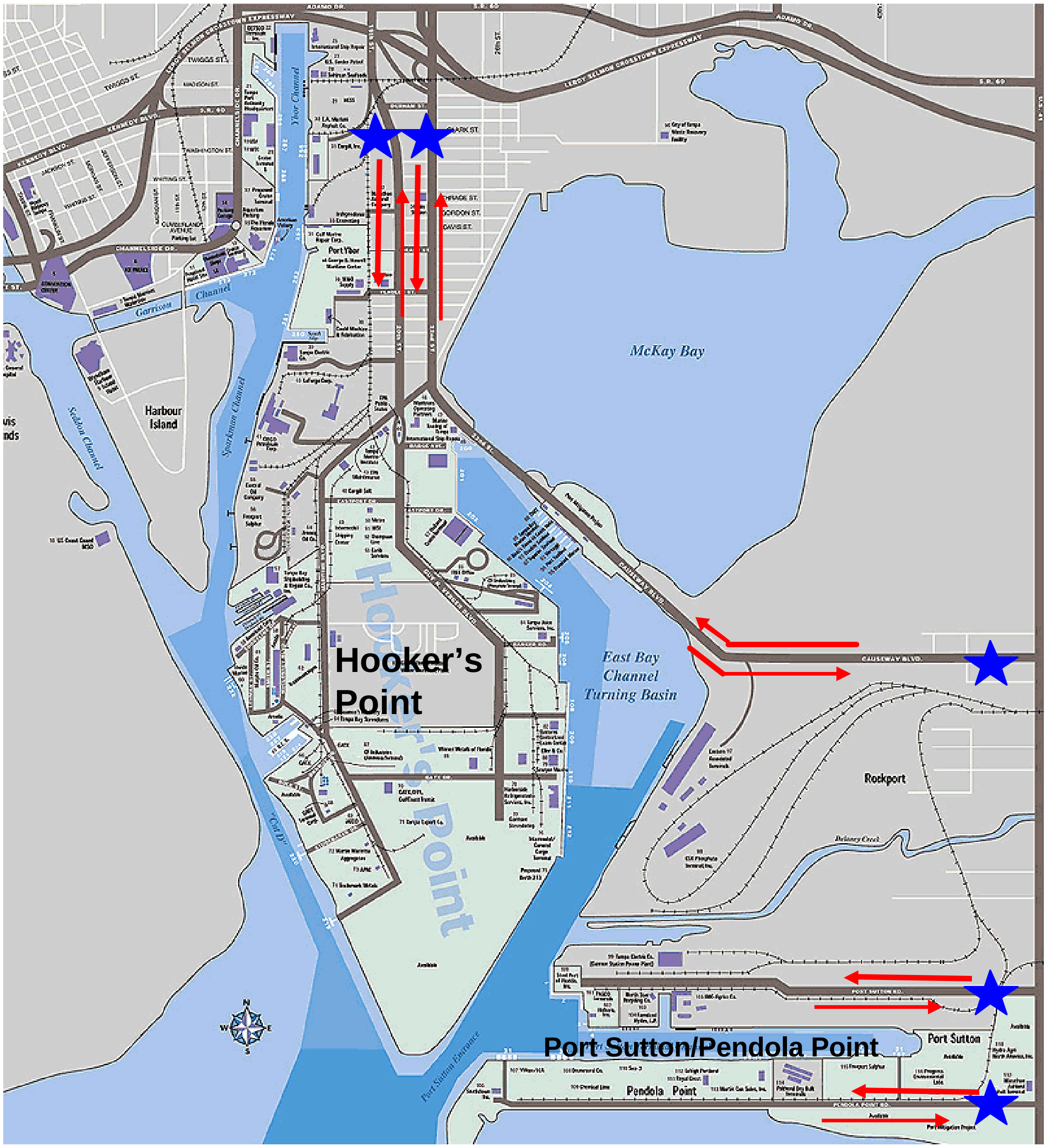


Figure 4.3: Port of Tampa Area Map

Traffic counts that were previously collected during Phase II of this study for the Port of Tampa were utilized in Phase III also. Hourly volumes by vehicle class have been collected for the five sites at the Port of Tampa in Phase II of this Truck Study. Three sites are at Hookers Point (22nd Street, 20th Street and Causeway Boulevard) and two sites are at Pendola Point (Port Sutton Road and Pendola Point Road). Up to 168 days of truck counts were collected at these sites. The total number of days at each site is shown Table 4.3. This data provides truck counts for Nodes 1, 16 and 18. Figure 4.2 displays the road network map with these nodes identified.

Location and Direction	Number of Days
Pendola Point Road - Inbound	168
Pendola Point Road - Outbound	168
Port Sutton Road - Inbound	147
Port Sutton Road - Outbound	147
Causeway Boulevard - Inbound	120
Causeway Boulevard - Outbound	119
22nd Street - Inbound	134
22nd Street - Outbound	106
20th Street - Inbound	122
20th Street - Outbound	151

Table 4.3: Number of Days for Truck Counts Collected on the Port of Tampa's Access Roads during Phase II Study

Peak hour traffic volumes collected from the field at the port's entrances and exits have been compiled and summarized in Table 4.4. These entrances and exits are represented on the network by Node 1 (Pendola Point and Port Sutton), Node 16 (22nd Street and 20th Street), and Node 18 (Causeway Boulevard). The table shows the average peak hour traffic volumes leaving and entering the Port of Tampa. The average peak hour traffic volumes is the arithmetic mean of the peak hour volumes of up to 168 days of data collected during Phase II of this project.

	Average Peak Hourly Volume	
Node & Description	Inbound	Outbound
Node 1 (Pendola and Sutton)	134	125
Node 16 (22nd St.& 20th St.)	1203	1157
Node 18 (Causeway Boulevard)	580	898

Table 4.4: Port of Tampa Average Peak Hourly Traffic Volumes (Phase II)

4.1.4 Port of Tampa Field Traffic Data Collection: Road Network

Traffic volume data was collected for selected links on the Port of Tampa road network for use in calibration and validation of the CORSIM and VISSIM simulation models. Traffic counts on these master links will be compared with the simulated traffic volumes using the estimated Origin-Destination (O-D) matrix to check the applicability of the developed model. A master link is a link with a key location around the port and has a high level of daily truck volumes. Determining a master link should also consider how important it is for trucks to access the port. Based on engineering judgment, for the Port of Tampa a high level of daily trucks was considered over 500 trucks per day for both directions. Data was collected on master links for up to seventy-five days. Four master links were chosen for data collection. These links (see Figure 4.2) are Link 13 (SR 92), Link 17 (50th Street or SR 41), Link 22 (Causeway Boulevard), and link 25 (22^{nd} & 21^{st} Streets).

Link 22 is a direct route between the port and the eastern network boundary and consequently with I-75 using the interchange at Node 4 (SR 301 & I-75). Also, Links 17 & 25 are connecting the port with the northern network boundary and consequently with

I-4 & I-275. Link 25 consists of two different one-way roads. These two roads are 21st street, which carries the traffic from I-4 to the Port of Tampa, and 22nd street, which carries the traffic from the Port of Tampa to I-4. Due to the fact that Link 29 goes through downtown Tampa, no data collection was conducted on this link because it carries virtually no port-generated trucks. The trucks would experience high delay if they traveled through the downtown due to the high number of signalized intersections.

Traffic counts were also conducted at Node 9. Node 9 has been chosen because it connects to Link 9 (part of I-4) that carries a high volume of trucks according to FDOT data (see Table 4.2). Traffic can leave the network at Node 9 using two different roads. The vehicles that are exiting Tampa network at Node 9 use I-4 or SR 41. From SR 41 to the I-4 interchange, it is a two-lane bi-directional road. The I-4 interchange has on and off ramps for both the eastbound and westbound directions. To capture trucks exiting the Tampa network, data was collected north of the SR41/SR574 intersection on SR 41 and the eastbound on-ramp for I-4. The total number of vehicles exiting the network at Node 9 is the summation of the number of vehicles exiting the defined network towards I-4 and vehicles that are heading towards the northbound direction of SR 41.

The data was collected using Metrocount and Diamond Phoenix Traffic Classifiers. The downloaded files were compiled and entered into a Microsoft Excel spreadsheet. See Table 4.5 and Table 4.6 for an inventory of the daily truck counts for each site. Seventy-five daily counts were collected. Some of these days have logged data that displays inconsistent counts or no data was recorded due to equipment damage or failure. Data was divided into two sets. The first set included two thirds of the available data for the field data calibration process. The second set included the remaining third used in the model validation.

			Link 13 (SR 92)		Link 17 (50th St.)		Link 22 (Causway)		Link 25	
			Northbound	Southbound	Northbound	Southbound	Eastbound	Westbound	22nd St.	21st St.
Calibration Set of Data	Sun	13-May	1413	1665		1363		1148	2004	
	Mon	14-May	2161	2773		2052		940	3174	
	Tue	15-May	2201	2841		2086		888	3135	
	Wed	16-May	2230	2857		2108		1524	2993	
	Thu	17-May	2279	2686		2154		1543	3091	
	Fri	18-May		2824		2132		1577	3147	
	Sat	19-May		1840		1679		1578	2078	
	Sun	20-May		1566		1448		1223	1924	
	Mon	21-May		2581				1028	2404	
	Tue	22-May							3170	
	Wed	23-May							3184	
	Thu	24-May							3117	
	Fri	25-May					1519			1591
	Sat	26-May	2574		1620	1788	1164		1912	1404
	Sun	27-May	1936		1347	1517	1067		1875	1191
	Mon	28-May	1919		1840	2009	1126		1762	1010
	Tue	29-May	2832		2070	2558	1468		3150	1556
	Wed	30-May	2457		2143	2595	1499		3137	1584
	Thu	31-May	2595		2208	2231	1527		3048	1607
	Fri	1-Jun	2716		2226	2421	1550			1637
	Sat	2-Jun	2507		1693	1832	1237			1515
	Sun	3-Jun	1957		1394	1477	1046			1181
	Mon	4-Jun	2185		2033	2147				1524
	Tue	5-Jun	2241		2059	2367				1546
	Wed	6-Jun			2117	2526				1526
	Thu	7-Jun			2232	2255				1617
	Fri	8-Jun			2264					1714
	Sat	9-Jun			1725					1488
	Sun	10-Jun			1387					1172
	Mon	11-Jun			2094					1492
	Tue	12-Jun								1563
	Sat	23-Jun	2797	1777	1711		1158	1164		1465
	Sun	24-Jun	2232	1504	1363		1079	961		1128
	Mon	25-Jun	3094	2746	2105		1438	1526	2373	1532
	Tue	26-Jun	2927	2811	2241		1458	1558	3144	1552
	Wed	27-Jun	2657	2714	2203		1503	1578	3149	1560
	Thu	28-Jun	2778	2675	2231		1535	1581	3087	1561
	Fri	29-Jun	2597	2821			1561	1225	3173	1646
	Sat	30-Jun		1853			1220	1225		1405
	Sun	1-Jul		1567			1040	1041		1097
	Mon	2-Jul		2568			1558	1519		1528
	Tue	3-Jul								1502

Note: Empty cells indicate missing data point.

Table 4.5: Inventory of Field Data Daily Truck Counts for the Port of Tampa (Calibration Data Set)

			Link 13 (SR 92)		Link 17 (50th St.)		Link 22 (Causway)		Link 25		Node 9	
			Northbound	Southbound	Northbound	Southbound	Eastbound	Westbound	22nd St.	21st St.	SR 41	I-4 on-Ramp
Validation Set of Data	Thu	5-Jul	2779	2689	2244	2258	1554	1562	3075	1550	2131	369
	Fri	6-Jul	2602	2784	2245	2454	1629	1646	3124	1648	2214	396
	Sat	7-Jul	2506	1838	1670	1807	1303	1199	1961	1368	1572	245
	Sun	8-Jul	2232	1504	1392	1452	1092	1012	1984	1121	1305	202
	Mon	9-Jul	3094	2591	2034	2165	1596	1575	3095	1500	2128	370
	Tue	10-Jul	2927	2806	2054	2386	1375	1464	3071	1510	2154	361
	Wed	11-Jul	2657			2498	1519	1385	2919	1547	2065	369
	Thu	12-Jul	2776			2268	1505	1439		1624	2165	387
	Fri	13-Jul	2600				1572	1485		1683	2212	398
	Sat	14-Jul					1298	1094		1438	1660	262
	Sun	15-Jul					1079	961		1130	1332	202
	Mon	16-Jul	3078	2526	1963	2186	1565	1509	2942	1478	2152	379
	Tue	17-Jul	2898	2707	2433	2165	1643	1562	3099	1535	2156	359
	Wed	18-Jul	2664	2724	2481	2351	1323	1646	3099	1584	2057	382
	Thu	19-Jul	2783	2678	2512	25182	1121	1199	3029	1614	2152	379
	Fri	20-Jul	2598	2762	2324	2268	1580	1012	3178	1654	2192	382
	Sat	21-Jul	2388	1856	1704	1806	1298	1575	1936	1382	1654	257
	Sun	22-Jul	2219	1564	1388	1452	1103	1464	2900	1083	1344	198
	Mon	23-Jul	3080	2714	1996	2197	1603	1385	3117	1430	2160	360
	Tue	24-Jul	2933	2675	2064	2379	1382	1439		1516		
	Wed	25-Jul		2821				1485		1532		
	Thu	26-Jul		2599				1094		1593		
	Fri	27-Jul		2856				961		1651		
	Sat	28-Jul								1419		
	Sun	29-Jul								1085		
	Mon	30-Jul								1458		
	Tue	31-Jul								1487		
	Wed	1-Aug								1224		

Note: Empty cells indicate missing data point.

Table 4.6: Inventory of Field Data Daily Truck Counts for the Port of Tampa (Validation Data Set)

The total number of vehicles (cars and trucks) was compiled for each of the data collection points. Peak hour volumes were also extracted from the collected counts. The peak hour volume for a day is the maximum hourly value during the 24-hour period. This was found to be 5-6 PM. Table 4.7 shows a summary of the average daily and peak hourly traffic volumes (cars and trucks) for the calibration set of days at each location.

Location	Direction	Average Daily Counts	Peak Hourly Volume
I-92 (Link 13)	Northbound	12,159	1,094
	Southbound	13,780	1,240
50th street (Link 17)	Northbound	10,688	802
	Southbound	10,686	855
Causeway Boulevard (Link 22)	Eastbound	7,181	646
	Westbound	6,350	572
22nd street (Link 25)	Northbound	14,360	1,005
21st street (Link 25)	Southbound	7559	718

Table 4.7: Summary of the Calibration Data Set for the Master Links at Port of Tampa Road Network

Peak hour volumes for each link were entered into the SPSS for Windows release 10.0.7 statistical analysis software. A preliminary analysis of the calibration data set was performed using SPSS. A Scheffe's Statistical Test was conducted on the compiled data to see if there was any significant difference between weekdays and weekends. Scheffe's test identifies homogeneous subsets of means that are not different from each other. Pair-wise multiple comparisons test the difference between each pair of means, and yield a matrix where significantly different group means are indicated at a confidence level of 95%. See Appendix C for the SPSS analysis and results. An overview of the analysis for each master link by direction is also included in this subsection.

75 days of counts collected on these master links were analyzed. The inconsistent counts or missing records due to equipment damage or failure were excluded from the calibration data sets selected for each link and direction. Table 4.5 and Table 4.6 can be referenced for the dates data was included for each master link by direction.

For Link 13 (SR 92) northbound, the calibration data set included 23 days. From Scheffe’s Statistical Test at the 95% confidence level, there was no significant difference between truck counts on weekdays and weekends. See Appendix C for the SPSS analysis results. Therefore, all available days were used to calculate the average vehicular volumes. The average daily traffic (cars and trucks) volume northbound on Link 13 was 12,018 vehicles. The average peak hour traffic volume was 1,094 vph and the average number of trucks for the peak hour was 164 trucks.

For Link 13 (SR 92) southbound, the calibration data set included 19 days. From Scheffe's Statistical Test at the 95% confidence level, there was a significant difference between truck counts on weekdays and weekends. See Appendix C for the SPSS analysis results. Therefore, the weekend days were excluded from the data used to calculate the average vehicular volumes. The average daily traffic (cars and trucks) volume southbound on Link 13 was 13,698 vehicles. The average peak hour traffic volume was 1,240 vph and the average number of trucks for the peak hour was 186 trucks.

For Link 17 (50th Street) northbound, the calibration data set included 23 days. From Scheffe's Statistical Test at the 95% confidence level, there was a significant difference between truck counts on weekdays and weekends. See Appendix C for the SPSS analysis results. Therefore, the weekend days were excluded from the data used to calculate the average vehicular volumes. The average daily traffic (cars and trucks) volume northbound on Link 17 was 10,688 vehicles. The average peak hour traffic volume was 802 vph and the average number of trucks for the peak hour was 120 trucks.

For Link 17 (50th street) southbound, the calibration data set included 21 days. From Scheffe's Statistical Test at the 95% confidence level, there was no significant difference between truck counts on weekdays and weekends. See Appendix C for the SPSS analysis results. Therefore, all available days were used to calculate the average vehicular volumes. The average daily traffic (cars and trucks) volume southbound on Link 17 was 10,177 vehicles. The average peak hour traffic volume was 855 vph and the average number of trucks for the peak hour was 128 trucks.

For Link 22 (Causeway Boulevard) eastbound, the calibration data set included 21 days. From Scheffe's Statistical Test at the 95% confidence level, there was no significant difference between truck counts on weekdays and Saturdays. However, there was a significant difference between Sundays and all other days of the week. See Appendix C for the SPSS analysis results. Therefore, all available days except Sundays were used to calculate the average vehicular volumes. The average daily traffic (cars and trucks) volume eastbound on Link 22 was 7,181 vehicles. The average peak hour traffic volume was 646 vph and the average number of trucks for the peak hour was 97 trucks.

For Link 22 (Causeway Boulevard) westbound, the calibration data set included 20 days. From Scheffe's Statistical Test at the 95% confidence level, there was no significant difference between truck counts on weekdays and weekends. See Appendix C for the SPSS analysis results. Therefore, all available days were used to calculate the average vehicular volumes. The average daily traffic (cars and trucks) volume westbound on Link 22 was 6,350 vehicles. The average peak hour traffic volume was 572 vph and the average number of trucks for the peak hour was 86 trucks.

For Link 25 (22nd Street) northbound, the calibration data set included 23 days. From Scheffe's Statistical Test at the 95% confidence level, there was a significant difference between truck counts on weekdays and weekends. See Appendix C for the SPSS analysis results. Therefore, the weekend days were excluded from the data used to calculate the average vehicular volumes. The average daily traffic (cars and trucks) volume northbound on Link 25 was 14,360 vehicles. The average peak hour traffic volume was 1005 vph and the average number of trucks for the peak hour was 151 trucks.

For Link 25 (21st Street) southbound, the calibration data set included 30 days. From Scheffe's Statistical Test at the 95% confidence level, there was a significant difference between truck counts on weekdays and weekends. See Appendix C for the SPSS analysis results. Therefore, the weekend days were excluded from the data used to calculate the average vehicular volumes. The average daily traffic (cars and trucks) volume southbound on Link 25 was 7,559 vehicles. The average peak hour traffic volume was 718 vph and the average number of trucks for the peak hour was 108 trucks.

Data was also collected at Node 9. This captured the volume of vehicles exiting the network at this node. 13 days of data were used for the analysis at this node. These counts were used in the validation of the network model. From Scheffe's Statistical Test at the 95% confidence level, there was a significant difference between truck counts on weekdays and weekends. Therefore, the weekend days were excluded from the data used to calculate the average vehicular volumes. The average daily traffic (cars and trucks) volume exiting the network at this node is 20,484 vehicles. The average peak hour traffic volume was 2,868 vph. These traffic volumes included counts at both the I-4 on-ramp and the northbound direction of SR41.

4.1.5 Port of Tampa Data Collection: Vessel Freight Data

Three months of raw vessel freight data were used to determine the daily number of trucks generated by the port's freight activity that was used for the calibration and validation in the network modeling. The vessel freight data is utilized to derive the daily freight values for input to the Port of Tampa ANN truck trip generation model previously developed in Phase II (11). The Tampa Port Authority provided the necessary vessel freight data for May 1, 2001 through July 31, 2001. The data used for input to the ANN model is displayed from Table 4.8 through Table 4.10 below.

Date	Daily Average Imported Barrels	Sum of Last 7 Days Imported Tons	Daily Exported Tons	Sat	Sun
5/1/2001	7003		18564	0	0
5/2/2001	7003		41061	0	0
5/3/2001	7003		17331	0	0
5/4/2001	7003		21205	0	0
5/5/2001	7003		19445	1	0
5/6/2001	7003		23688	0	1
5/7/2001	7003		38632	0	0
5/8/2001	7003		19788	0	0
5/9/2001	7003		17602	0	0
5/10/2001	7003	334727	23194	0	0
5/11/2001	7003	308380	18731	0	0
5/12/2001	7003	291930	20526	1	0
5/13/2001	7003	356125	19514	0	1
5/14/2001	7003	282419	18999	0	0
5/15/2001	7003	289439	19450	0	0
5/16/2001	7003	316204	17331	0	0
5/17/2001	7003	337369	22194	0	0
5/18/2001	7003	320170	21086	0	0
5/19/2001	7003	375201	19476	1	0
5/20/2001	7003	338453	20111	0	1
5/21/2001	7003	468161	17867	0	0
5/22/2001	7003	464290	19921	0	0
5/23/2001	7003	476470	17596	0	0
5/24/2001	7003	439567	19097	0	0
5/25/2001	7003	432122	17679	0	0
5/26/2001	7003	420102	17723	1	0
5/27/2001	7003	392662	19835	0	1
5/28/2001	7003	312007	20617	0	0
5/29/2001	7003	338566	17513	0	0
5/30/2001	7003	315930	17331	0	0
5/31/2001	7003	308487	18831	0	0

Table 4.8: Port of Tampa Vessel Freight Data (May 2001)

Date	Daily Average Imported	Sum of Last 7 Days	Daily Exported Tons	Sat	Sun
6/1/2001	7107	274621	21198	0	0
6/2/2001	7107	235873	24764	1	0
6/3/2001	7107	296234	23852	0	1
6/4/2001	7107	290962	23406	0	0
6/5/2001	7107	296162	19772	0	0
6/6/2001	7107	286681	27972	0	0
6/7/2001	7107	302585	21690	0	0
6/8/2001	7107	356669	20918	0	0
6/9/2001	7107	390947	19772	1	0
6/10/2001	7107	409591	25098	0	1
6/11/2001	7107	399801	24449	0	0
6/12/2001	7107	418451	21586	0	0
6/13/2001	7107	404085	21127	0	0
6/14/2001	7107	413022	19772	0	0
6/15/2001	7107	372563	24284	0	0
6/16/2001	7107	372160	22747	1	0
6/17/2001	7107	367315	23829	0	1
6/18/2001	7107	371896	19772	0	0
6/19/2001	7107	381628	23489	0	0
6/20/2001	7107	355891	20027	0	0
6/21/2001	7107	357256	22467	0	0
6/22/2001	7107	381615	26097	0	0
6/23/2001	7107	418889	20240	1	0
6/24/2001	7107	406074	22518	0	1
6/25/2001	7107	377606	22229	0	0
6/26/2001	7107	315063	53157	0	0
6/27/2001	7107	330687	21181	0	0
6/28/2001	7107	317786	19772	0	0
6/29/2001	7107	309057	21616	0	0
6/30/2001	7107	239543	19772	1	0

Table 4.9: Port of Tampa Vessel Freight Data (June 2001)

Date	Daily Average Imported	Sum of Last 7 Days	Daily Exported Tons	Sat	Sun
7/1/2001	6972	197154	26391	0	1
7/2/2001	6972	286324	23260	0	0
7/3/2001	6972	320197	23234	0	0
7/4/2001	6972	419477	23406	0	0
7/5/2001	6972	480701	25122	0	0
7/6/2001	6972	437527	23934	0	0
7/7/2001	6972	432876	26434	1	0
7/8/2001	6972	469714	25808	0	1
7/9/2001	6972	407473	25120	0	0
7/10/2001	6972	384559	23234	0	0
7/11/2001	6972	327581	23234	0	0
7/12/2001	6972	297143	24476	0	0
7/13/2001	6972	334903	23560	0	0
7/14/2001	6972	373802	25129	1	0
7/15/2001	6972	368287	64801	0	1
7/16/2001	6972	428630	26058	0	0
7/17/2001	6972	393386	23251	0	0
7/18/2001	6972	365711	23566	0	0
7/19/2001	6972	374954	25206	0	0
7/20/2001	6972	428874	23234	0	0
7/21/2001	6972	409519	23736	1	0
7/22/2001	6972	479318	25866	0	1
7/23/2001	6972	407741	25739	0	0
7/24/2001	6972	494448	51752	0	0
7/25/2001	6972	521712	62538	0	0
7/26/2001	6972	317786	23234	0	0
7/27/2001	6972	309057	23234	0	0
7/28/2001	6972	239543	23234	1	0
7/29/2001	6972	197154	25848	0	1
7/30/2001	6972	286324		0	0
7/31/2001	6972	320197		0	0

Table 4.10: Port of Tampa Vessel Freight Data (July 2001)

4.1.6 Port of Tampa Network Coding: CORSIM

A corridor microscopic simulation model, known as CORSIM, was used to complete the task of truck assignment on the defined road network adjacent to the Port of Tampa. CORSIM is a microscopic simulation model with a module called TA (Traffic Assignment) which converts an Origin-Destination (O-D) trip table into an actual network loading for processing by CORSIM. The model then evaluates demand responses to operational changes. Operational changes may include incidents or signal timing changes. TA uses two optimization techniques in CORSIM. These techniques are the user's optimal assignment and system's optimal assignment. The model applies the shortest path algorithm to assign the volumes on the network links. The input data required for the model are traffic composition, geometric features of the network, signal timing, and an O-D table. CORSIM has two available impedance functions to evaluate travel time on a path-link (group of links on a truck route). The first impedance function (FHWA) is shown below.

$$T = T_0 * \left[1 + a * \left(\frac{V}{C} \right)^b \right]$$

Where

T = Mean travel time on the path-link
T_0 = Free-flow (zero volume) travel time on the path-link
V = Volume on the path-link
C = Capacity of the path-link
a = 0.60, b = 4

The second is the Modified Davidson's impedance function as follows:

$$T = T_0 * \left[1 + a * \frac{V}{(S - V)} \right]$$

If V < b * S

Or

$$T = T_0 * \left[1 + a * \frac{b}{(1 - b)} \right] + a * T_0 \frac{(V - bS)}{\left[S * (1 - b)^2 \right]}$$

If V > b * S

Where

T = Mean travel time on the path-link
T_0 = Free-flow (zero volume) travel time on the path-link
V = Volume on the path-link
C = Capacity of the path-link
S = Path-link saturation rate = 100(C/R)
R = Ratio of Capacity to Saturation rate in %
a = 0.40, b = 0.80

The travel time on a path link includes the time required to traverse the geometric link and the time required at its downstream intersection to perform the desired turning movement. The FHWA impedance function was chosen because it is recommended by the CORSIM manual (12).

CORSIM has two modules for coding the road network. The first module is NETSIM (Surface Street NETwork traffic flow micro SIMulation model). NETSIM is the module used to code arterial roads in the network. The other module is FRESIM (FREeway traffic flow micro SIMulation model). CORSIM Traffic Assignment (TA) does not have the ability to perform traffic assignment to a road network that consists of freeways and arterials (city streets) simultaneously. Therefore, links on freeways (Link numbers 9, 10, 11, 14, 15, 16 & 23) were modeled using the NETSIM module. A relatively high free flow speed (55 mph) was assigned to those links. The higher free flow speed was assigned to links on freeways to match real-life conditions. All network links and nodes at the Port of Tampa were coded in NETSIM. All the geometric data for each link and node (i.e. number of lanes and intersection configurations) were considered during the coding. Signal timing and any existing control devices at intersections (nodes) were incorporated in the model. Initial O-D volumes for the network were estimated. These are the distribution percentages of trucks leaving the port (N_{out}) or coming to the port (N_{in}) on the proposed network based on the information obtained from interviews with local freight operations personnel. These percentages refer to the percent of total trucks for the external nodes of the network that are originating from or destined to the nodes associated directly with the port.

The network coding can be checked visually using the TRAFVU module. TRAFVU is a CORSIM module used for viewing the coded network and performing animation of the network model. A preliminary truck assignment model run was performed on the coded Tampa road network. The network included all the links and nodes defined before for the Port of Tampa road network. Truck assignment was performed by CORSIM and the model run did not produce any errors. A snapshot of the animation obtained from TRAFVU module is shown in Figure 4.4. The snapshot is for the intersection of SR 676 and US 41, one of the five Tampa Port exits located on the western side of this intersection. This run was performed to check the applicability of solving the truck assignment problem.

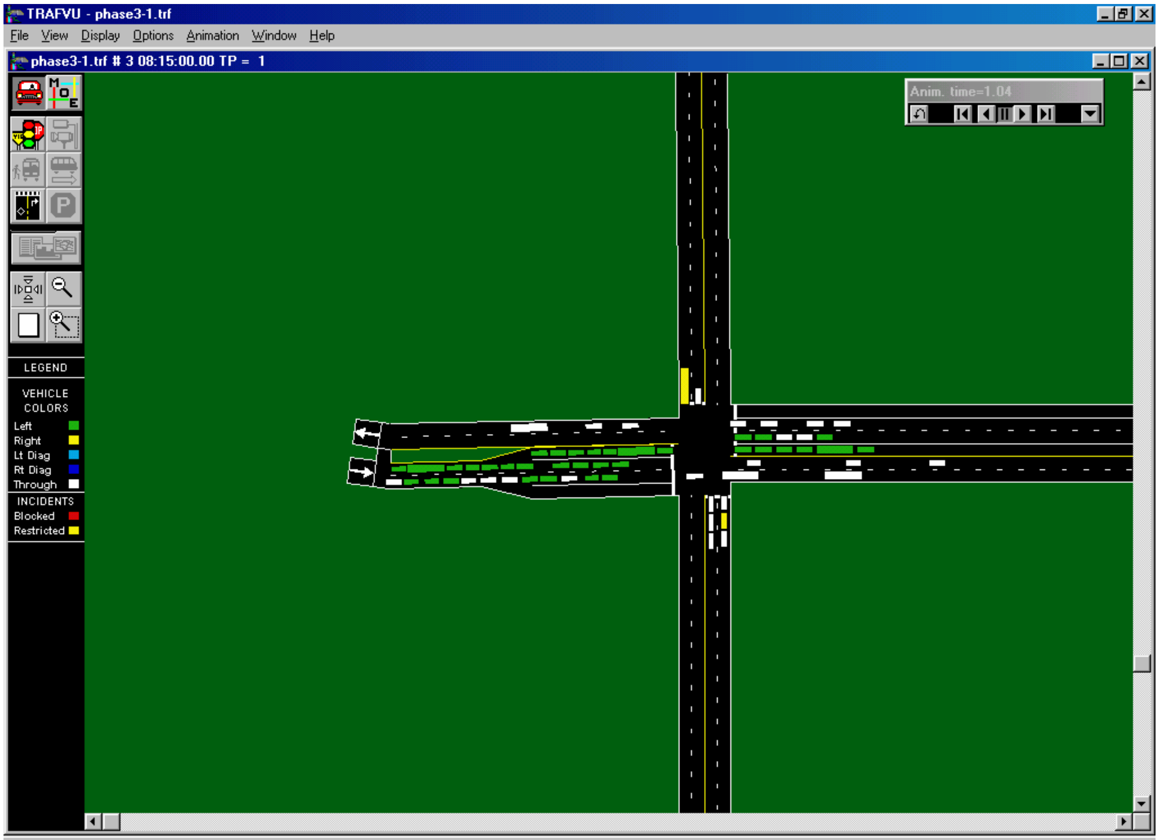


Figure 4.4: Snapshot of the Animation for the Simulated Intersection of State Road 676 and US 41

4.1.7 Port of Tampa Network Coding: VISSIM

Another simulation package known as VISSIM, (version 3.5) was investigated for assignment of trucks on the proposed network. VISSIM is a microscopic simulation model, which has a Dynamic Assignment (DA) module. Nodes and edges have to be defined for the network of interest. Nodes represent intersections or junctions and edges represent link sequences. A sequence of edges on the modeled road network between the starting and the ending point is called a route. Every driver selects a specific route at the departure time. These route choice decisions of all drivers add up to a dynamic assignment of the given transport demand, thus determining the traffic volumes on the road network. These traffic volumes affect travel times on the network. The volumes and travel times are not constant during the simulation period and therefore the fastest routes will not always be the same because of the incremental loading of traffic volumes to the coded network and the stochastic distribution of traffic (Kirchoff's law), which is explained in preceding paragraphs. Drivers however are assumed to have no pre-trip information about the actual travel times in the network. The drivers have empirical knowledge about several routes and the travel times while using these routes during the day.

In VISSIM this empirical information is represented by travel time measurements from preceding simulation runs. Based on the travel time information, the fastest routes between all origins and destinations are computed during each iteration (14). Not all vehicles drive on the fastest routes, but all routes found in the preceding iterations will be used. All vehicles with the same origin-destination (O-D) pair will be distributed on the set of suitable routes according to Kirchoff´s law known from electrical physics:

$$p(route)_j = \frac{tt_j^{-a}}{\sum_{k=1}^{n} tt_k^{-a}} \qquad j = 1 ..n$$

- Where P denotes the probability of using a specific route,
- *n* denotes the number of routes for a given O-D relation and,
- tt_j is the travel time on route "j".

An exponent value (∝) between 3 and 4 are appropriate in most situations (3.5 used for this research). For a given simulation scenario a new set of travel times is assessed during each iteration. During the iterations a growing archive of paths is constructed. This archive contains every path that qualified as a fastest route in at least one iteration. The input data required for the model is an O-D table including the nodes and traffic composition.

Coding a network in VISSIM is more user friendly than coding the same network in CORSIM. Unlike CORSIM, VISSIM does not have the limitation of performing traffic assignment to a network consisting of freeways and city streets. Coding in VISSIM requires a map for the area of interest in "Bitmap" format. The traffic network map was imported to VISSIM and then scaled using the exact length of a network link. After scaling the map to its actual size, links and nodes are overlaid on the map using a friendly drawing and editing tool. The VISSIM model was loaded with the same O-D matrix used in CORSIM. A snapshot of the VISSIM animation for the coded network is shown in Figure 4.5. The snapshot shows the intersection between SR 60 and US 41. This run was performed to check the applicability of the VISSIM model for the network analysis.

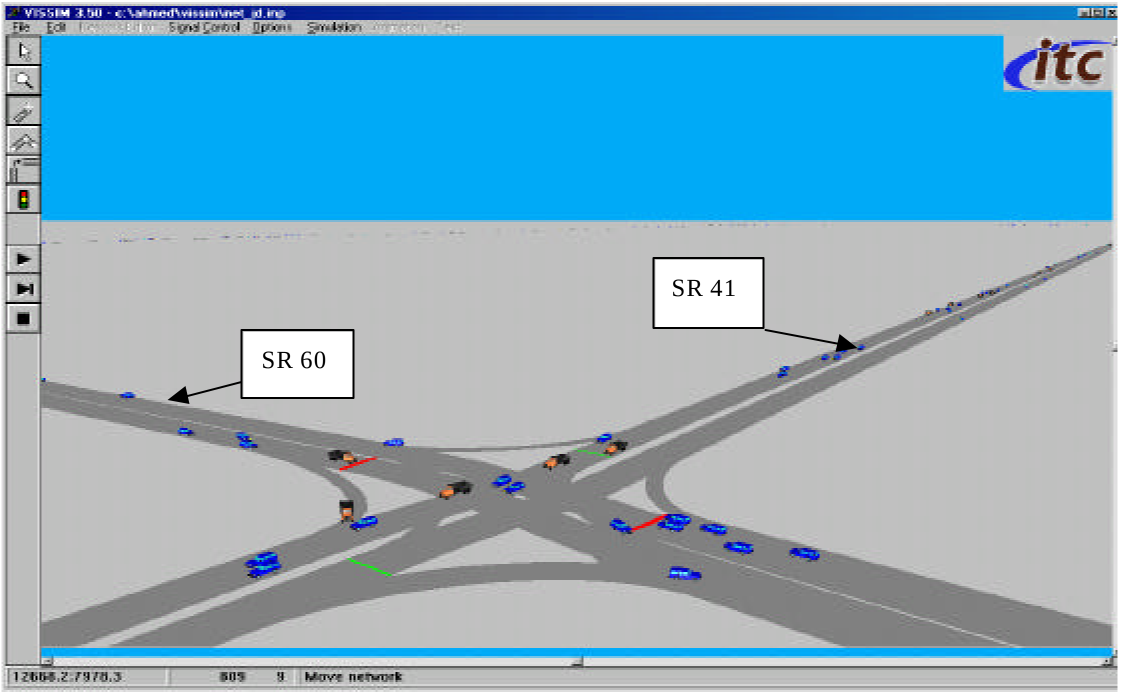


Figure 4.5: Snapshot of VISSIM Animation for the Coded Sub-network

4.2 Route Assignment Model Calibration

The goal of the calibration process is to come up with an Origin-Destination (O-D) matrix that represents the peak hour traffic volumes between the external nodes of the network under study. The external nodes are the nodes at which volumes of traffic may leave or enter the road network under study. For Tampa, these nodes include #'s 1-14, 16, & 18. Three of these external nodes represent the entrances and exits for the Port of Tampa. These are Node 1 (Pendola Point and Port Sutton), Node 16 (22nd St. & 20th St), and Node 18 (Causeway Boulevard). An iterative process was conducted to obtain an O-D matrix that produces minimum error between the master links simulated volumes (including cars and trucks) and volumes obtained from actual (FDOT or field) data for the same links. An iteration consists of running the model with an O-D matrix as input, comparing the output to actual data, and then adjusting the input O-D matrix according to the results of the comparison.

Calibration was done in two consecutive stages using FDOT data and then field data on the selected master links. This calibration process provides application of the methodology for two data sets of slightly different origin. This provides the engineer or planner with confirmation that more than one data set can be used with this methodology. However, the more current field data available, the more precise the results will be in representing the actual traffic conditions of the defined network.

When field data is available, this two-step process can be only a one-step process using only the field data. Initially, calibration for the O-D matrix used in the model (CORSIM or VISSIM) was performed using traffic volumes (including cars and trucks) obtained from FDOT for the master links that are cut by three cordon lines shown in Figure 4.6. These cordon lines are dividing lines around the Port of Tampa. The links cut by the cordon lines are 14, 29, 25, 30, 24, 23 & 22. The FDOT traffic counts provided the required data to build an O-D matrix that was further calibrated with field counts. After an acceptable O-D matrix using the FDOT data was concluded, field data on selected links was used to fine-tune the matrix.

The initial O-D matrix in this process was estimated based on information obtained from trucking companies, FDOT data and the data collected at the Port of Tampa entrances and exits. It was indicated from interviews with trucking companies that most of the trucks leaving the port from Nodes 1 and 18 are heading east towards the Bone Valley. It was also indicated that most of the trucks leaving the port from node 16 are heading north towards I-4 and I-275.

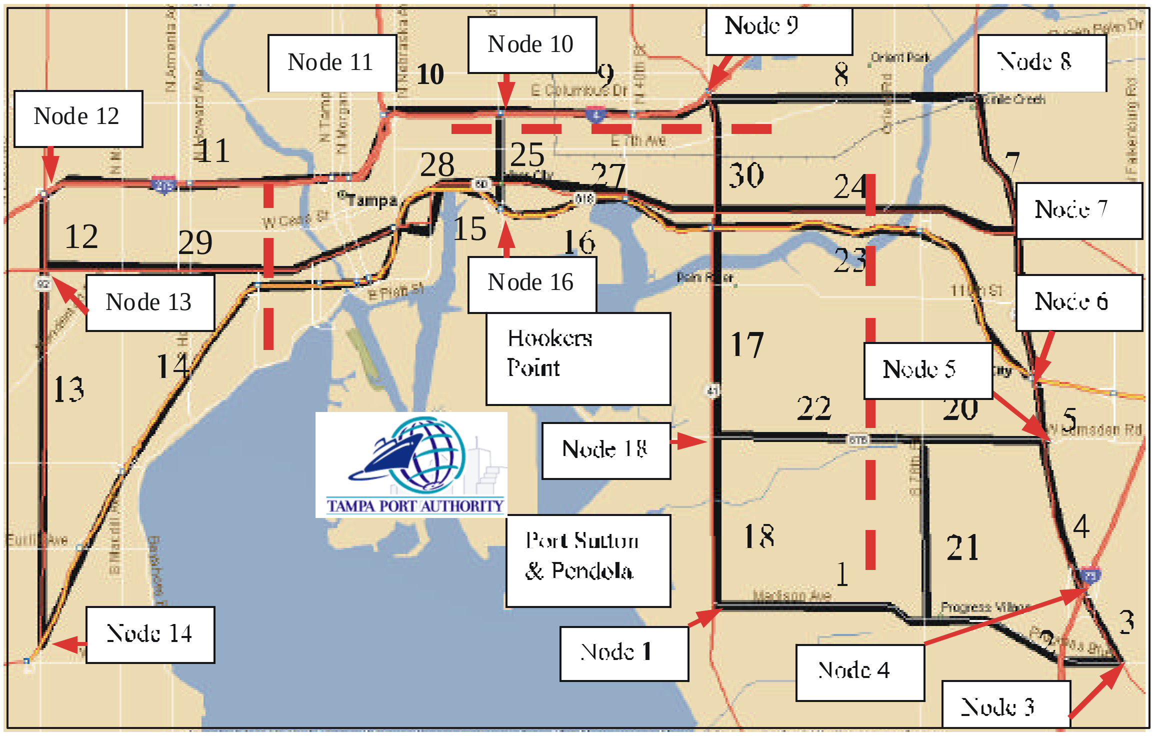


Figure 4.6: Port of Tampa and the Cordon Lines

To start the calibration process, the initial O-D matrix was input into the model (CORSIM or VISSIM). Then, after each model run, the output produced (the link volumes) was compared to the actual data (FDOT or field) to determine if any volumes had errors in excess of a specific threshold (15% for FDOT data and 5% for field data). If any were found, the O-D pair volume related to the shortest path for the link with the highest error was increased or decreased according to the error. This adjustment was the difference between the actual and simulated volumes rounded to the nearest 10 vph. The original O-D matrix was then modified according to this new O-D pair volume and used in the next iteration as model input. If however one of the nodes associated directly with the port is included in the O-D pair volume change, then the other O-D pair volumes associated with the port was adjusted. The purpose of this adjustment is to maintain the total traffic volume leaving or entering the port at this node equivalent to the volume obtained from data collected during Phase II for the same node.

4.2.1 Port of Tampa Network Model Calibration: CORSIM

As explained before, calibration was done in two consecutive steps first using FDOT data and then field data. FDOT calibration for the O-D matrix used in the CORSIM model was performed using traffic volumes obtained from FDOT (see Table 4.2) for the master links cut by the cordon lines. See Figure 4.6 for a map with the cordon lines. The links cut by the cordon lines are #'s 14, 20, 23, 24, 25 & 30. After the final calibration for the O-D matrix using FDOT data was completed, calibration of the O-D matrix was performed using field data collected at a different set of master links (#'s 13, 17, 22, & 25).

The output of each CORSIM run includes the simulated volumes on every link in the network. The O-D matrix was calibrated for each run by comparing traffic volumes obtained from CORSIM output and actual (FDOT or field) data for the master links. This information was used as constraints (adjustment factors) of the O-D matrix. The O-D constraints are

1) The sum of the volumes (including cars and trucks) at the port entrances and exits must be equal to those from Phase II.
2) Simulated volumes (including cars and trucks) on the cordon line links must match volumes obtained from FDOT within the acceptable percent error (15%).

3) Simulated volumes (including cars and trucks) on the cordon line links must match volumes obtained from field data collection within the acceptable percent error (5%).

For the first constraint, inbound and outbound traffic volume data previously collected in years 2000 & 2001 at the port during Phase II were utilized. The average peak hour traffic volumes for the Port of Tampa were summarized previously in Table 4.4. The average peak hour traffic volume is the arithmetic mean of the peak hour volumes for up to 168 days of data collected during Phase II.

To achieve a final (or acceptable) O-D matrix, the volumes for the O-D pairs starting with the initial O-D matrix were adjusted during the calibration process. Only certain links are affected by O-D pair volume changes. This is because the algorithm used in the simulation run is based on the shortest path and user equilibrium. In other words, an increase or decrease in an O-D pair volume will increase or decrease the volumes obtained from the simulation run for the links that are part of the shortest path. For each simulation run, CORSIM calculates T, the mean travel time of all vehicles on a path, for all reasonable paths between every O-D pair and selects the path (or paths) that has (have) minimum T to load it (them) with traffic volumes. So, for links to be selected by CORSIM as shortest path links they must satisfy two conditions.

These conditions are:

1. The links must exist on a possible path between this O-D pair, and
2. The summation of the mean travel time of these links (T) must be the minimum. In other words, these links must be part of the shortest path calculated by the CORSIM model.

CORSIM output includes external and internal nodes, the volumes assigned to the path between the external nodes and the cumulative mean travel time (T) for each node on any one path. In Appendix D, Figure D. 1, selected output values are labeled from a CORSIM output data sample. Two external nodes can have more than one path. However, CORSIM does not produce output for paths that have unreasonable travel times. Therefore, many O-D pairs have only one path output by CORSIM for the Port of Tampa road network. This is a built in feature of the model. The external nodes are nodes at which traffic volumes enter or leave the identified road network. See Appendix D, Table D. 1 for identification of the external node numbers and their corresponding CORSIM coded node numbers. These external nodes indicated in the O-D matrices used as CORSIM input were previously defined on the Port of Tampa road network (see Figure 4.2). Other data output by CORSIM includes turning movements, volumes, and speeds. A sample of this output data is shown in Appendix D, Table D. 2. Only the discharge volume (the total volume on the link) and estimated speed for each link (denoted by its two corresponding nodes) were used. The 2nd, 4th, 6th, and 8th columns on the output show turning movement volumes (right, left, through and diagonal) and percent of the total volume on each link.

Calibration Using FDOT Data

The selected master links (links used in calibration) for the FDOT data are #'s 14, 25, 30, 24, 23 & 20. Link 29 was excluded because it carries virtually no port-generated trucks. This link goes through the downtown area and has many traffic signals thus increasing travel time considerably. Link 20 was substituted for Link 22 because the FDOT data collection site for Causeway Boulevard (Links 22 and 20) was located on

Link 20. See Appendix B for the network definition and a sample of data obtained from FDOT.

Using the FDOT data, 17 iterations were completed. The last five consecutive iterations are explained in the following paragraphs. The input of each consecutive simulation run is an adjusted O-D matrix based on the conclusions from the previous CORSIM output. The output is the simulated flows for all the links in the network. The O-D matrix used in the 13th iteration is shown in the Appendix E Figure E. 1. The absolute percent error between the simulated CORSIM volumes and the FDOT traffic volumes was calculated for each link. The absolute percent error for a certain link equals the difference between the FDOT and simulated volumes divided by the FDOT volume.

$$\%Error = \frac{|FDOT - Simulated|}{FDOT} * 100$$

Thirteenth Iteration:

The calibration table of the thirteenth iteration, Appendix E Table E. 1, shows the highest percent of error for the traffic volume (including cars and trucks) on Link 24 (inbound direction). There was also a high percent error for traffic volumes in the outbound direction of Link 24 and Link 25 and the inbound direction of Link 30. The simulated volume for Link 24 was smaller than the FDOT volume for the same link in the same direction. From the CORSIM output it was concluded that Links 24 and 30 are part of the shortest path between Nodes 7 and 10. The traffic volume (150 shown in bold in the O-D matrix) of the 7-10 O-D pair was increased to obtain higher traffic volumes on

Links 24 and 30. The traffic volume from Node 7 to Node 10 was increased from 150 to 300 vehicles per hour in the 14th iteration. Appendix E, Figure E. 2 shows the O-D matrix with revisions for the 14th iteration.

Fourteenth Iteration:

In Appendix E, Table E. 2 displays the FDOT volumes and the simulated volumes for the master links. The table also includes the new error percentages between the simulated volume concluded from the 14th iteration and the FDOT volumes. The calibration table for the 14th iteration (Appendix E, Table E. 2) shows the percent errors for Links 24 and 30 were reduced significantly. These improvements indicate that the iterations are converging to a final acceptable O-D matrix. The new highest percent error in Table E. 2 is from the traffic volume on Link 24 (outbound direction) at 34.01%. This percent error was 49% in the previous iteration. Another increase to the traffic volume of the 7-10 O-D pair was done to reduce the percent error for Link 24. The traffic volume of the 7-10 O-D pair was increased in the next iteration from 300 to 450 vehicles per hour. Appendix E, Figure E. 3 shows the O-D matrix for the 15th iteration.

Fifteenth Iteration:

Table E. 3 in Appendix E shows significant improvement (reduction) in the percent errors of the traffic volumes on Link 24. The convergence between the simulated output and FDOT volumes for more than one link simultaneously is an indication that the iterative process is converging to the O-D matrix that produces the minimum difference between simulated and FDOT volumes. The highest percent error now is for the traffic volume on Link 14 (outbound direction) at 27.78%. From the CORSIM output it was concluded that Link 14 is part of the shortest path between Nodes 16 and 14. The traffic volume for the 16-14 O-D pair was decreased from 350 to 200 vph to obtain a lower traffic volume on Link 14 in the next (16th) iteration. Appendix E, Figure E. 4 shows the O-D matrix for the 16th iteration. In order to compensate for the reduction at this port node (Node 16), the O-D pair volumes between Node 16 and Nodes 8, 9, 10, 11 & 12 were increased by a total of 150 vehicles per hour. The additional 150 vehicles per hour were distributed between the five nodes (8, 9, 10, 11, & 12) based on the traffic volume percentage each O-D pair contributes to the total volume leaving the port at Node 16.

Sixteenth Iteration:

Table E. 4 in Appendix E includes the FDOT and simulated volumes from the 16th iteration. The percent error for the traffic volume on Link 14 (outbound direction) improved from 27.78% to 14.47%. Table E. 4 shows the highest percent error now is for the traffic volume on Link 24 (outbound direction) at 18.04%. The CORSIM output showed that Link 25 is part of the shortest path between Nodes 10 and 16. The volume of traffic going from Node 10 to Node 16 was reduced from 300 to 150 vph for the next iteration. In order to compensate for the reduction at this port node (Node 16), the O-D pair volumes between Nodes 8, 9, 11, 13, & 14 and Node 16 were increased by a total of 150 vph. The 150 vph increase was distributed between the five nodes (8, 9, 11, 13, & 14) based on the traffic volume percentage each O-D pair contributes to the total volume leaving the port at Node 16. Appendix E, Figure E. 5 shows the O-D matrix for the 17th iteration.

Seventeenth Iteration (Final Iteration for FDOT Data):

Table E. 5 in Appendix E was constructed from the CORSIM output of the 17th iteration similar to those for the previous iterations. The table includes the FDOT and simulated volumes for the same links. The table also includes the new percent errors between the simulated and FDOT volumes. The percent error for the traffic volume on Link 25 (outbound direction) improved from 18.04% to 5.68%. In this iteration, the absolute percent errors for all simulated volumes on the selected master links are less than or equal to 15%. Therefore, the criteria for calibration using FDOT data has been met and no further iterations are necessary.

Calibration Using Field Data

A new group of master links was selected for the second stage of calibration using field data. Field data was collected on this new selected group of master links. These master links are #'s 13, 17, 22, & 25. See Table 4.5 and Table 4.6 for data collected on master links. Master Links 25, 17, and 22 were chosen for model calibration because of the high daily truck volumes and are links to important routes connecting the Port of Tampa to major highways. Link 25 is on 21st and 22nd Streets (both are one-way arterials) and cut by a cordon line. These are north and south routes and important for trucks accessing Hooker's Point. Link 22 on Causeway Boulevard and Link 17 on S.R. 41 are important routes for trucks accessing Port Sutton and Pendola Point. Link 22 is cut by a cordon line and Link 17 is on SR 41, a highway that is cut by a cordon line. Link 17 was chosen instead of Link 30 because it was closer to the port. Furthermore, these are important links for the interstates identified in the network. Link 22 on Causeway Blvd. is a direct route between the port and the eastern network boundary and consequently with I-75 using the interchange of SR 301 & I-75 (Node 4). Links 17 & 25 are connecting the port with the northern network boundary and consequently with I-4 & I-275. Master Link 13 (located on S.R. 92) was chosen because it has the highest daily truck volume (1513 trucks per day) of all non-interstate links on the west side of the defined network (Links 13, 12, 29, 14), see Table 4.2. Link 13 is an essential north/south network link on the west side of the network and necessary to confirm accurate calibration of the entire network.

The field data calibration was performed in three steps.

Step 1:

To start the calibration process, the initial O-D matrix for input to CORSIM was concluded from the 17th iteration using the FDOT data. O-D matrix calibration was performed using two weeks (ten weekdays) selected from the calibration set of days. These days are from 5/28/2001 to 6/01/2001 and from 6/25/2001 to 6/29/2001. These two weeks were chosen because this was the most comprehensive field data available for all the master links (inbound and outbound directions).

Table 4.7 previously displayed shows the entire data set available for calibration. After each CORSIM run, the output produced was compared to the field data from the selected master links to determine if any volumes had errors in excess of 5%. If any were found, the O-D pair volume from the input O-D matrix related to the link with the highest error was increased or decreased according to the error. The lower error criterion of 5.0% was chosen in order to have a higher degree of accuracy.

The same iterative process followed for calibration using the FDOT data was used in calibrating of the O-D matrices with the field data. The output of this process was an O-D matrix for each of the selected calibration days (10 days). The O-D pair volumes of the matrix that represented the existing condition at the Port of Tampa were the average of the relevant O-D pair volumes for the 10 calibrated matrices. There are three constraints for any of the calibrated O-D matrices. These are:

1) The sum of the volumes (trucks only) on the port access roads must be equal to those obtained from Artificial Neural Network (ANN) truck trip generation model developed previously in Phase II.
2) Simulated truck volumes on the selected master links (13, 22, 25 & 30) must match actual field counts for the same master links within the defined percent of error (5%).
3) The simulated truck volume leaving the network at Node 9 should match the average field count at that node (230 trucks). Node 9 was considered important due to the interchange with I-4.

Data for the first constraint was obtained by entering the vessel freight data on that day to the ANN truck trip generation model for the Port of Tampa. The output of the model is the number of trucks leaving or entering the Port of Tampa for each entrance or exit (Nodes 1, 16, and 18). For more details about the ANN model, see the Phase II final report of the Truck Project (11). The daily number of trucks leaving/entering the Port of Tampa during the calibration period is shown in Table F. 1 and Table F. 2, Appendix F. The truck volumes at Nodes 1, 16, and 18 are the daily number of trucks leaving/entering the port at Port Sutton & Pendola Point Roads, 22nd & 20th Streets, and Causeway Boulevard.

The output of the truck trip generation model produces only daily truck volumes. However, the simulation models require peak hourly volumes. Therefore, conversion factors from daily truck volumes to the total traffic volumes and then to the peak hourly volumes were used. The first factor that converts the truck volume to the relevant total traffic volume is the truck factor (T). The truck factors are known for the traffic volume at each of the three entrances and exits (Nodes 1, 16, and 18) from the field counts that were conducted at these locations during the Phase II study. The second factor (K factor) is the ratio between the peak hourly volume and the daily volume. The K factors are also known for each of the three entrances and exits (Nodes 1, 16, and 18) from the field counts conducted at these locations during Phase II. Table 4.11 summarizes the T and K factors for the entrance and exit nodes at the Port of Tampa.

	Inbound		**Outbound**	
Node	**Truck Factor**	**K Factor**	**Truck Factor**	**K Factor**
1	0.4	0.08	0.4	0.08
16	0.2	0.09	0.12	0.1
18	0.23	0.09	0.22	0.09

Table 4.11: T & K Factors for the Port of Tampa

For each day in the calibration data set (5/28/2001 to 6/01/2001 and 6/25/2001 to 6/29/2001), the peak hourly truck volume was calculated using Table 4.11. Multiplying the daily number of trucks by the K factor determines the peak hour truck volume. The truck volumes used in the calibration are shown in Table 4.12.

	Node 1		Node 16		Node 18	
Date	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
5/28/01	43	53	147	183	158	139
5/29/01	44	54	151	185	162	141
5/30/01	44	54	149	185	160	141
5/31/01	44	55	149	187	160	142
6/1/01	43	46	144	156	156	119
6/25/01	40	49	136	168	146	128
6/26/01	44	55	148	187	160	143
6/27/01	44	55	149	187	161	143
6/28/01	41	55	139	188	150	143
6/29/01	44	54	148	185	160	141

Table 4.12: Truck Volumes for the Port of Tampa from the Calibration Data Set

The final calibrated O-D matrix for the Port of Tampa road network using field data was concluded through ten iterations of CORSIM runs for each day of the calibration data set. Each of the obtained O-D matrices was used to conclude the number of trucks on the Port of Tampa network links. The O-D pair volumes were used to calculate the number of trucks using the known percentages of trucks on each of the network links. The ten calibrated O-D matrices indicating only the number of trucks for each O-D pair are shown in Appendix G, Figure G. 1 through Figure G. 10. The final calibration tables for each O-D matrix are also shown in Appendix G, Table G. 1 through Table G. 10.

Step 2:

Once the final O-D matrices were determined for each of the calibration days, a table was constructed that included the simulated and actual field volumes on the master links for each day (5/28/2001 to 6/1/2001 and 6/25/2001 to 6/29/2001). The data is summarized in Table 4.13.

	SR-92 (N)		SR-92 (S)		50th Street (N)		50th Street (S)		Causeway Blvd. (E)		Causeway Blvd. (W)		22nd St		21st St.	
Date	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated
28-May	170	167	165	169	124	129	141	135	110	105	91	88	158	155	117	124
29-May	154	157	169	179	120	124	115	116	91	94	85	89	159	156	118	113
30-May	160	167	163	170	129	123	143	136	93	95	85	88	154	155	115	110
31-May	169	167	161	169	132	134	134	136	95	94	87	90	150	155	119	114
1-Jun	177	169	161	169	134	128	145	138	99	96	91	88	142	148	120	115
25-Jun	179	172			126	129			93	95	87	88	156	155	112	114
26-Jun	174	167			134	128			93	97	83	86	158	156	113	108
27-Jun	159	166			132	126			94	95	89	88	153	155	114	109
28-Jun	167	169			134	128			98	95	90	88	159	154	114	116
29-Jun	167	168			134	128			99	96	80	84			120	115

Note: empty cells in the table indicate equipment failure or data was not available.

Table 4.13: Field and Simulated Truck Volumes on the Master Links (Calibration Data Set)

<u>Step 3:</u>

The simulated and actual volumes on these master links for all the calibration days were compared. The comparisons include visual inspection and a Confidence Interval statistical test. The Confidence Interval (C.I.) is a reliable approach for comparing a simulation model with the real-world system (15). The C.I. was performed for *m* collected independent sets of data from the system and *n* independent sets of data from the model (*m* and *n* can be equal). Let X_j be the average of observations in the *j*th set of system data with mean $\mu_x = E(X_j)$ and let Y_j be the output from the *j*th replication of the simulation model with $\mu_y = E(Y_j)$.

The objective is to build a confidence- interval for:

$$z = m_X - m_Y.$$

Let $m = n$ and pair X_j 's and Y_j's. Let $Z_j = X_j - Y_j$

and let

$$\overline{Z}(n) = \frac{\sum_{j=1}^{n} Z_j}{n}$$

and

$$\text{Var}\left[\overline{Z}(n)\right] = \frac{\sum_{j=1}^{n}\left[Z_j - \overline{Z}(n)\right]^2}{n(n-1)}$$

Then, the approximate 100(1- a) percent C.I. is

$$\overline{Z}(n) \pm t_{n-1,1-a/2}\sqrt{\text{Var}\left[\overline{Z}(n)\right]}$$

If the confidence interval does not include a zero, then the observed difference between μ_x and μ_y is statistically different at level a (15).

The field and CORSIM simulated hourly truck volumes on the master links for the calibration set of days is illustrated graphically from Figure 4.7 to Figure 4.14. The graphical representation is for the visual inspection of the difference between the actual (field) and simulated truck volumes. The graphs suggest that there are no major differences between the simulated and field truck volumes on the selected master links for the calibration set of days.

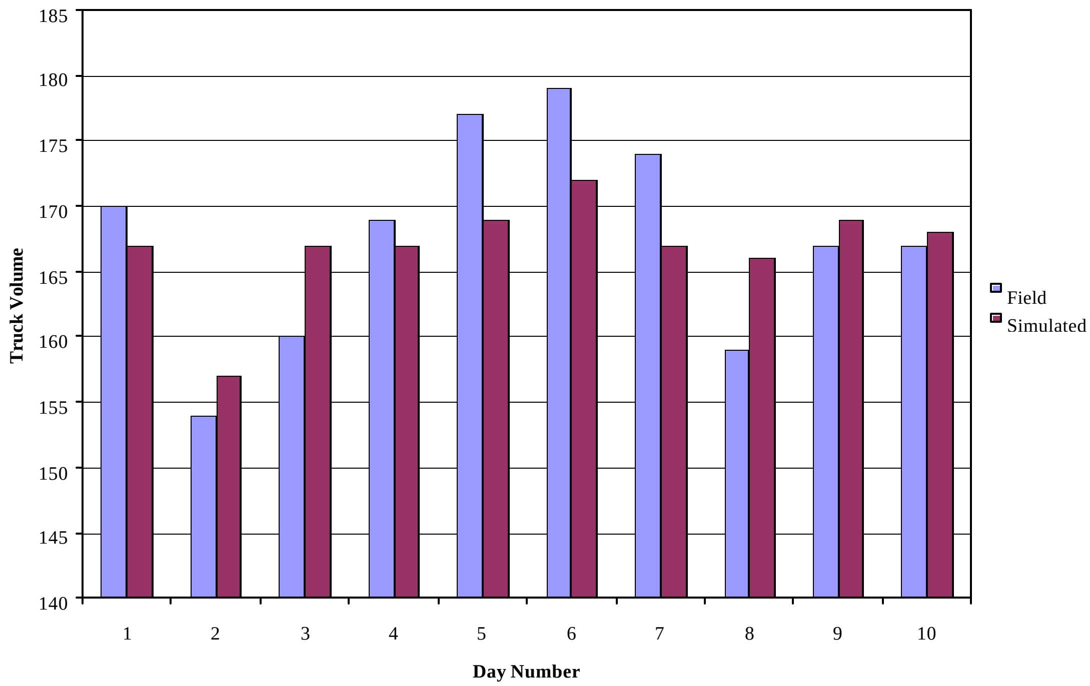


Figure 4.7: Field vs. CORSIM Simulated Truck Volumes on SR 92 Northbound (Calibration)

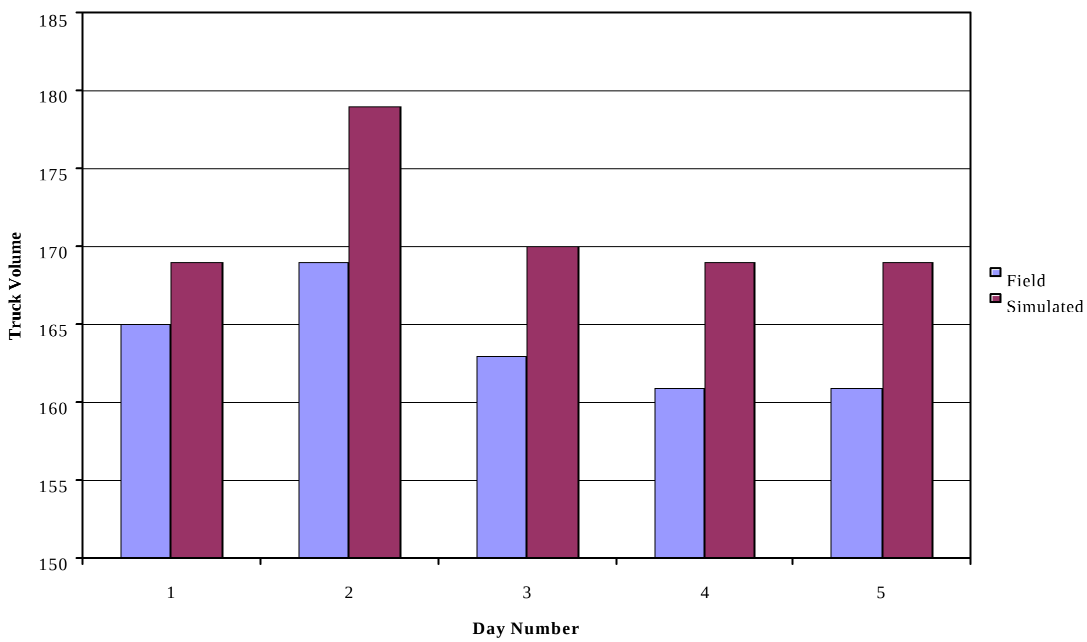


Figure 4.8: Field vs. CORSIM Simulated Truck Volumes on SR 92 Southbound (Calibration)

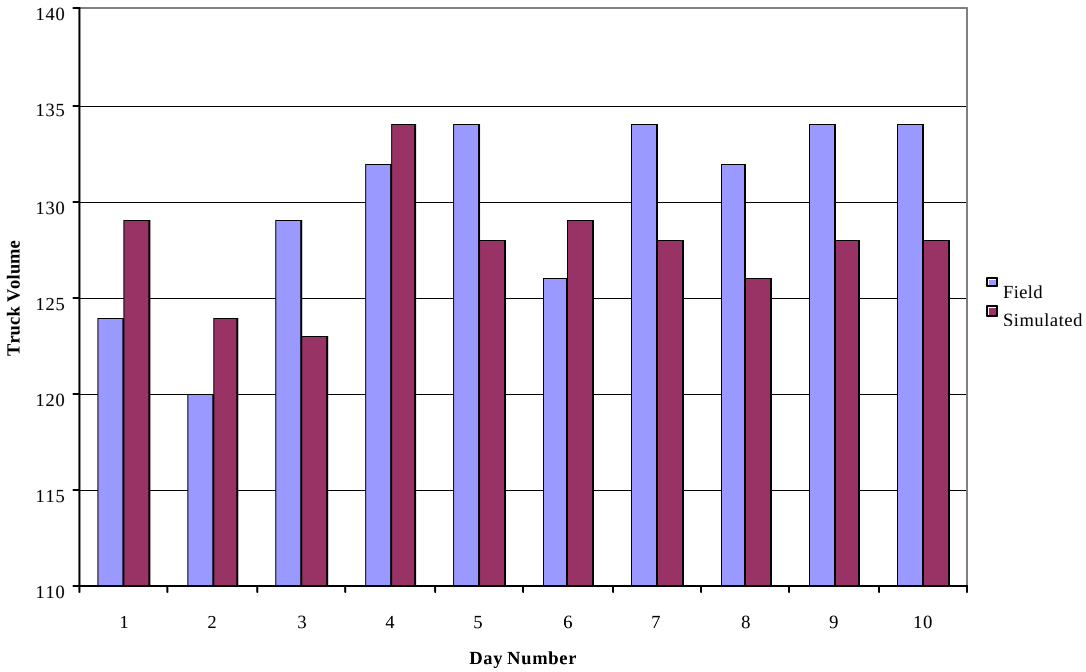


Figure 4.9: Field vs. CORSIM Simulated Truck Volumes on 50th Street Northbound (Calibration)

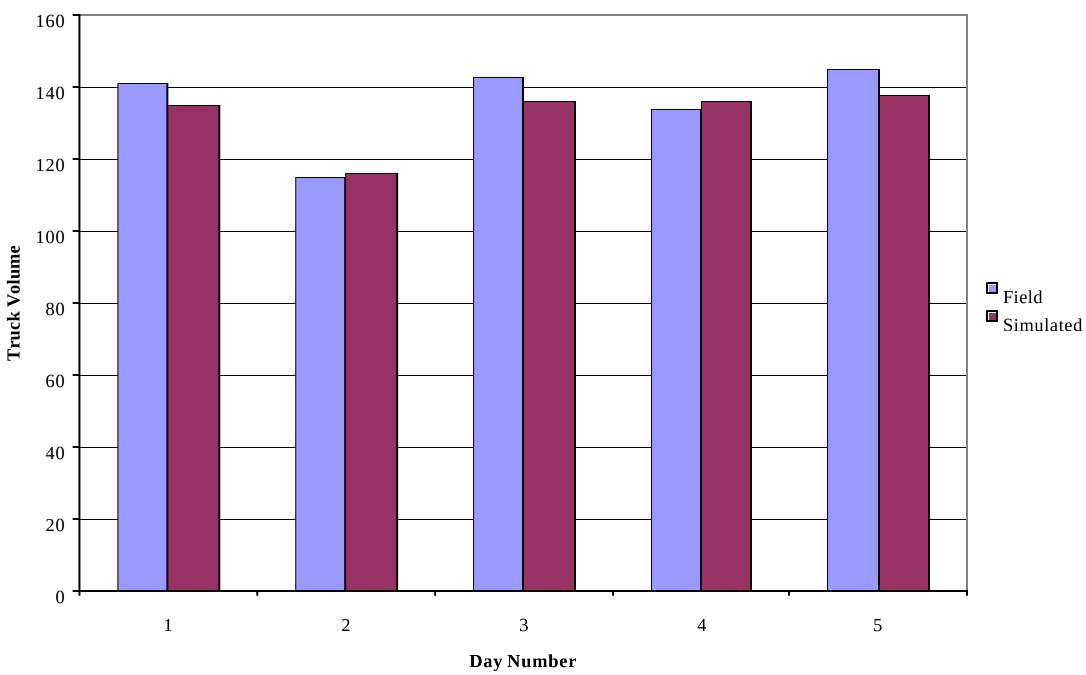


Figure 4.10: Field vs. CORSIM Simulated Truck Volumes on 50th Street Southbound (Calibration)

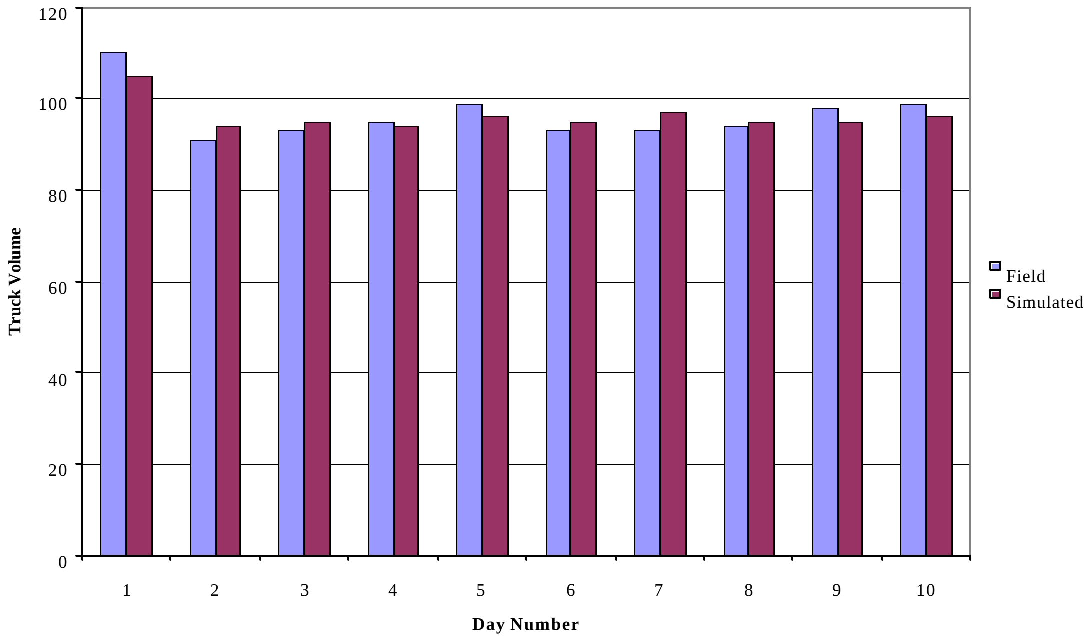


Figure 4.11: Field vs. CORSIM Simulated Truck Volumes on Causeway Boulevard Eastbound (Calibration)

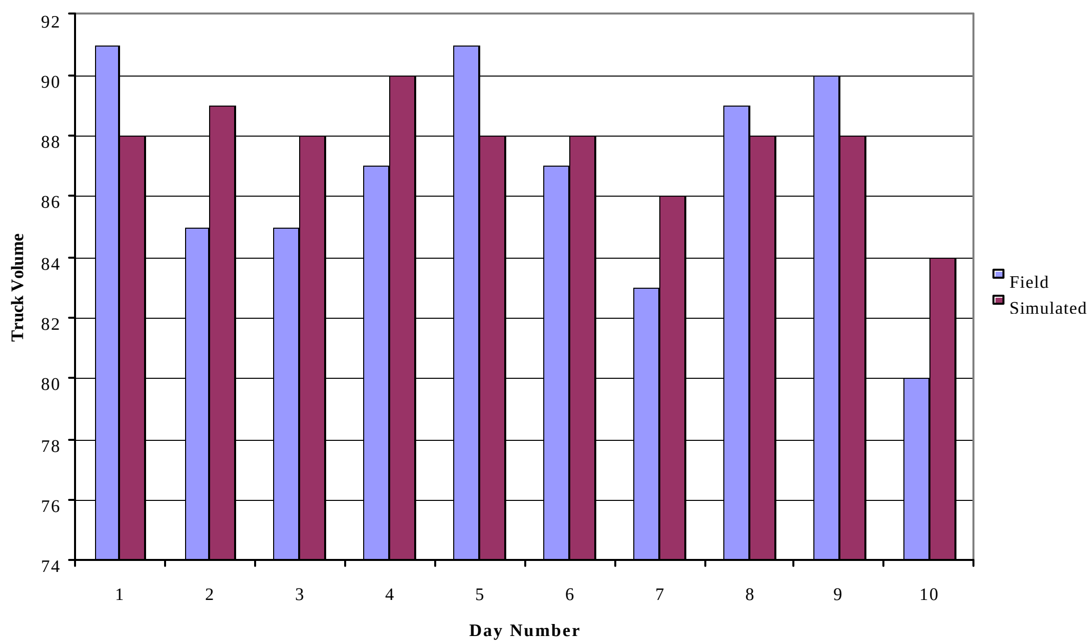


Figure 4.12: Field vs. CORSIM Simulated Truck Volumes on Causeway Boulevard Westbound (Calibration)

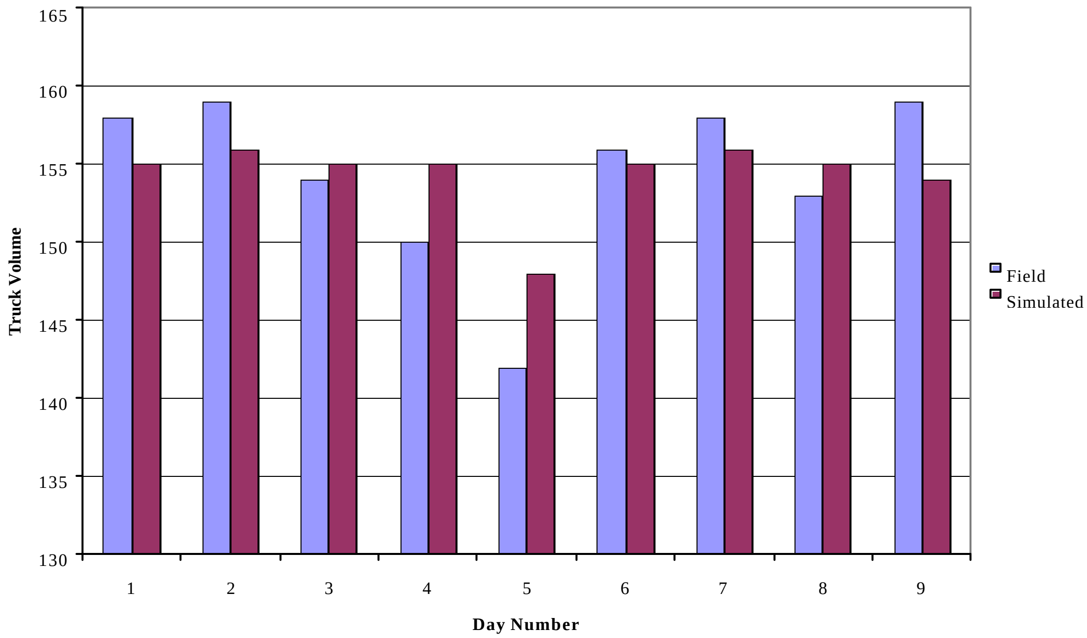


Figure 4.13: Field vs. CORSIM Simulated Truck Volumes on 22nd Street (Calibration)

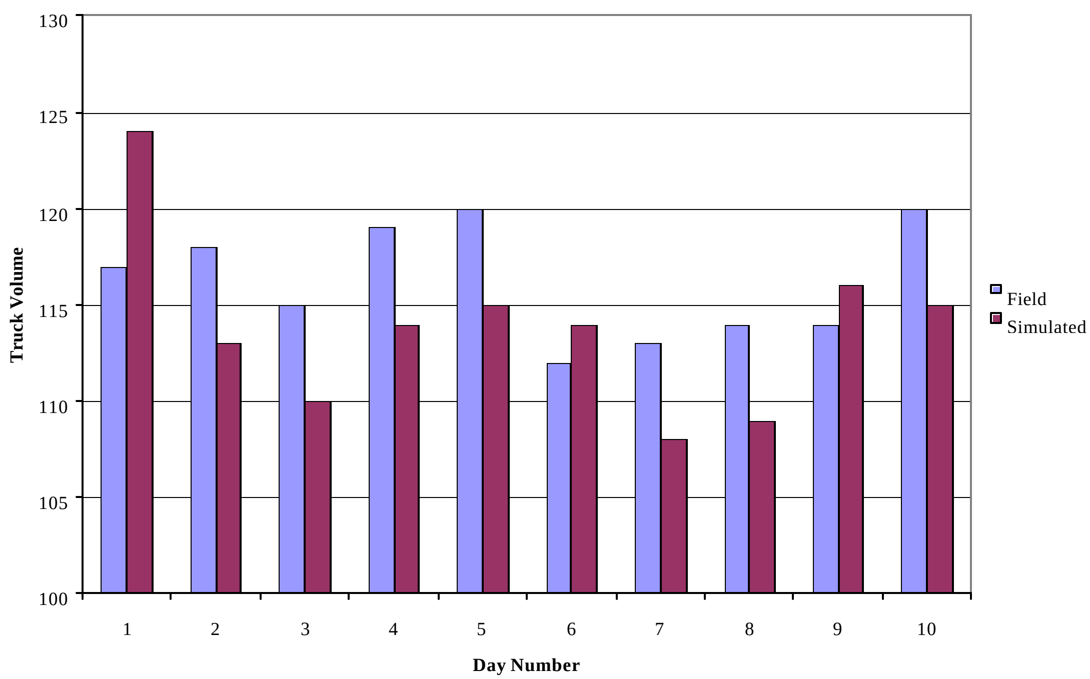


Figure 4.14: Field vs. CORSIM Simulated Truck Volumes on 21st Street (Calibration)

After the visual inspection showed no major differences between the simulated and the actual truck volumes on the master links, a statistical test was performed for each of the master links using the Confidence Interval (C.I.) Statistical Test. In Appendix H, Figure H. 1 through Figure H. 4 shows the C.I. calculations for each master link. Table 4.14 summarizes the C.I. calculations. Upper and lower limits of the confidence interval for each of the master links include zero. Therefore, the C.I. test concludes there is no significant difference between the simulated and actual truck volumes on the master links.

Link Name	Lower Limit of CI	Upper Limit of CI
SR 92 N	-5.1	7.1
SR 92 S	-8.3	11.6
50th St N	-11.8	25.1
50 th St. S	-8.3	11.6
Causeway E	-2.7	2.0
Causeway W	-2.2	4.2
22nd St	-2.7	2.7
21st St	-12.3	26.8

Table 4.14: Confidence Interval Limits for the Truck Volumes on the Master Links (Calibration)

It can be concluded after conducting these two tests (visual inspection and Confidence Interval test) that each of the ten CORSIM calibrated truck O-D matrices replicate the existing conditions of the truck movements for the Port of Tampa at the 95% confidence level.

As mentioned earlier, the O-D matrix that represents the existing conditions for the Port of Tampa road network is the average of the 10 final calibrated O-D matrices. This O-D matrix is shown in Figure 4.15. Nodes 1, 16, and 18 are indicated with "Port" because they are external nodes directly associated with the Port of Tampa. Table 4.15 shows the simulated truck volumes that were calculated from the CORSIM output after loading the network with the final calibrated O-D matrix. Table 4.15 also shows the average of the calibration data set (23 days) of field truck volumes and the absolute percent error between the simulated and field truck volumes for the master links. Two thirds of the field data (23 days) were used for testing the accuracy of the final O-D matrix.

The absolute percent error for every master link is less than 5% (formula shown below). These results conclude that the final O-D matrix (Figure 4.15) represents the real world (existing conditions) for the Port of Tampa road network. Figure 4.16 is a graphical representation of average field and simulated truck volumes for the master links.

$$\%Error = \frac{|Field - Simulated|}{Field} * 100$$

Origin Nodes		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	16 (Port)	18 (Port)	Sum.
	1 (Port)	**0**	**0**	**40**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**53**
	1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**39**	
	3	**20**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
	4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**58**	
	5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**36**	
	6	**8**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
	7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**25**	
	8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
	9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
	10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**16**	**0**	
	11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**38**	**0**	
	12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
	13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**23**	**0**	
	14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**36**	**0**	
	16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**19**	**40**	**80**	**10**	**10**	**18**	**0**	**0**	**181**
	18 (Port)	**0**	**62**	**10**	**41**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**138**
	Sum.	**44**								**230**						**147**	**157**	

Figure 4.15: Final CORSIM Calibrated Trucks Only O-D Matrix

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	Absolute % Error
SR-92	13-N	Northbound	164	165	0.55
	13-S	Southbound	169	177	4.82
50th Street	17-N	Northbound	126	120	4.76
	17-S	Southbound	132	126	4.55
Causeway Blvd	22-E	Eastbound	106	102	4.06
	22-W	Westbound	86	86	0.52
22nd St	25-N	Northbound	151	158	4.98
21st St.	25-S	Southbound	108	113	4.87

(Note: The Average for Up to 23 Days in the Calibration set)

Table 4.15: Field and CORSIM Simulated Hourly Trucks Flows on the Master Links

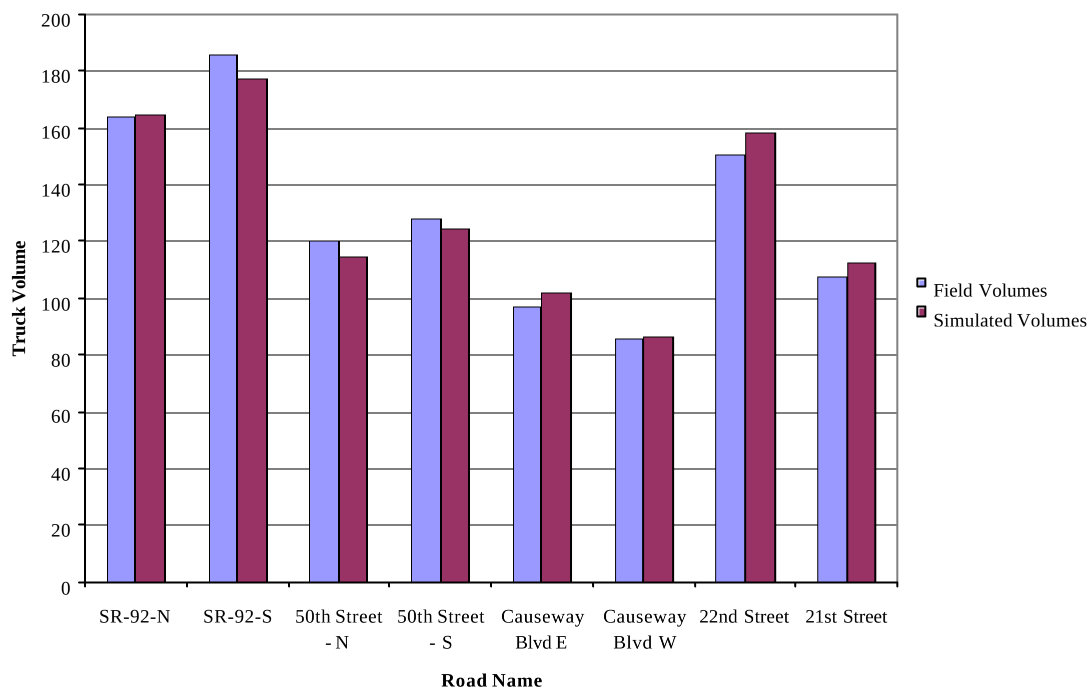


Figure 4.16:Field Vs CORSIM Simulated Truck Volumes for the Master Links (Final Calibrated O-D Matrix)

4.2.2 Port of Tampa Network Model Calibration: VISSIM

For comparison of the two simulation packages, the same calibration procedure used in CORSIM was applied to VISSIM. Calibration of the O-D matrix used in the VISSIM model was performed using the same FDOT data, field data, and selected master links. Also, the same initial O-D matrix for CORSIM was used. The same constraints for the O-D matrix and conditions for the shortest path used in the CORSIM calibration were applied to the VISSIM calibration procedure. However, VISSIM calculates the shortest path between the external nodes of the network and assigns the traffic to different routes based on Kirchoff's law.

$$p(route)_j = \frac{tt_j^{-a}}{\sum_{k=1}^{n} tt_k^{-a}} \quad \text{where } j = 1 \ldots n$$

- Where P denotes the probability of using a specific route,
- *n* denotes the number of routes for a given origin-destination relation and
- tt_j is the travel time on route "j".

An exponent value (∝) of 3.5 was used in this research.

Figure D. 2, shows selected output values from a VISSIM output data sample. The VISSIM output file has the extension VLZ. It contains the travel time section number, the average delay per vehicle at that section, number of vehicles, the average delay per person, and the number of people in these vehicles. Each section represents a predefined data collection point on the road network.

Calibration Using FDOT Data

To obtain the O-D matrix with minimum error using the FDOT data, 17 iterations were performed. The last five consequent iterations are explained in following paragraphs. The input of each consecutive simulation run is an adjusted O-D matrix and the output is the simulated flows for all the links in the network. The initial O-D matrix is the same used for the initial calibration with CORSIM, see Appendix I Figure I. 1. The absolute percent error between the simulated and FDOT traffic volumes is calculated for each link. The absolute percent error for a selected link equals the difference between the FDOT and simulated volumes divided by the FDOT volume (formula shown below).

$$\%Error = \frac{|FDOT - Simulated|}{FDOT} * 100$$

Thirteenth Iteration:

Table I. 1 in Appendix I shows the results from the 13th interation. On Link 24 (inbound) the error is high at 47.39%. This is similar to the error produced in a CORSIM run (Table F. 1). It was concluded from the VISSIM output that Links 24 and 30 are part of the shortest path between Node 7 and Node 10. The traffic volume of the 7-10 O-D pair was increased to obtain higher traffic volumes on Links 24 and 30. The traffic volume going from Node 7 to Node 10 was increased from 150 to 300 vehicles per hour for the 14th iteration, see Appendix I Figure I. 2.

Fourteenth Iteration:

The 14th calibration table (Appendix I Table I. 2) shows that the percent errors for Links 24 and 30 were significantly reduced. These improvements indicate that the iterations are converging to a final acceptable O-D matrix. The new highest percent error in Table I. 2 is for the traffic volume on Link 24 (outbound direction) at 31.31%. This percent error has improved from the previous iteration by 16%. Another increase of 150 vph for the traffic volume of the 7-10 O-D pair was done for Link 24 increasing it from 300 to 450 vph. Figure I. 3 shows the O-D matrix for the 15th iteration.

Fifteenth Iteration:

Table I. 3 in Appendix I is the calibration table resulting from the 15th iteration. The table shows significant improvement (reduction) in the percent error of the traffic volumes on Link 24. The highest percent error is for the traffic volume on Link 14 (outbound direction) at 26.58%. It was concluded from the VISSIM output that Link 14 was part of the shortest path between Node 16 and Node 14. The traffic volume of the 16-14 O-D pair was decreased to obtain a lower traffic volume on Link 14. The traffic volume from Node 16 to Node 14 was reduced from 350 to 200 vph in the next iteration (see Figure I. 4). In order to compensate for the reduction at this port node (Node 16), the O-D pair volumes between Node 16 and Nodes 8, 9, 10, 11, & 12 were increased by 150 vph. The 150 vph increase was distributed between the five nodes (8, 9, 10, 11, & 12) based on the traffic volume percentage each O-D pair contributes to the total volume leaving the port at Node 16.

Sixteenth Iteration:

Table I. 4 in Appendix I is the calibration table resulting from the 16th iteration. The percent error for the traffic volume on Link 14 (outbound direction) improved from 26.58% to 12.63%. The highest percent error was on Link 25 (outbound direction) at 15.93%. The VISSIM output showed that Link 25 was part of the shortest path between Node 10 and Node 16. The traffic volume from Node 10 to Node 16 was reduced from 300 to 150 vph for the 17th iteration (see Figure I. 5). In order to compensate for the reduction at this port node (Node 16), the O-D pair volumes between Nodes 8, 9, 11, 13, & 14 and Node 16 were increased by a total of 150 vph. The 150 vph increase was distributed between the five nodes (8, 9, 11, 13, & 14) based on the traffic volume percentage each O-D pair contributes to the total volume leaving the port at Node 16.

Seventeenth Iteration (Final Iteration):

Table I. 5 in Appendix I is the calibration table resulting from the 17th iteration. The percent error for the traffic on Link 25 (outbound direction) improved from 15.93% to 6.91%. In this iteration, the absolute percent errors for all simulated volumes on the selected master links were less than or equal to 15%. The calibrated O-D matrix of the 17th iteration is the initial O-D matrix for the field data calibration process. The VISSIM

FDOT data calibrated O-D matrix is the same as the CORSIM FDOT data calibrated O-D matrix. VISSIM and CORSIM FDOT data calibrated O-D matrices are identical because both packages use a travel time based algorithm for selecting the shortest path between nodes.

Calibration Using Field Data

The next step is to calibrate (final calibration) the O-D matrix using field data collected for the selected master links (#'s 13, 17, 22, and 25). The same 3-step process used in CORSIM was performed using VISSIM to calibrate the O-D matrices in order to achieve a final O-D matrix for the Port of Tampa road network.

Step 1:

The O-D volumes were modified using the same process explained previously. The simulated volumes on the master links were required to match the field volumes for the same links within an acceptable range of error. The same constraints for the O-D matrices used in the CORSIM calibration were applied in the VISSIM calibration procedure.

The field data calibrated O-D matrix for the Port of Tampa road network was obtained through 7 iterations of VISSIM runs for each day of the calibration data set (5/28/2001 to 6/01/2001 and 6/25/2001 to 6/29/2001). Each of the obtained O-D matrices was used to conclude the number of trucks on the Port of Tampa network links. The O-D pair volumes were used to calculate the number of trucks using the known percentages of trucks on each network link. The final O-D matrices (obtained from the VISSIM calibration) that produced minimum error (5% or less) between the simulated and field truck volumes on the master links are the same as the matrices obtained using CORSIM (Appendix G, Figure G. 1 through Figure G. 10). The final calibration tables for each O-D matrix using VISSIM are shown in Appendix J, Table J. 1 through Table J. 10. The number of iterations to reach the final calibrated O-D matrix using VISSIM (7 iterations) was less than the number required using CORSIM (10 iterations). This difference in the number of iterations between VISSIM and CORSIM is due to the way an O-D matrix is entered in VISSIM. VISSIM's tabular form is more simplified than that for CORSIM (graphical form). Therefore, using CORSIM consumes more time and effort than VISSIM to track the O-D pairs that need to be modified in the calibration process.

Step 2:

Once the final O-D matrices were determined for each of the calibration days, a table was constructed that included the simulated and actual field volumes on the master links for each day selected for calibration (5/28/2001 to 6/1/2001 and 6/25/2001 to 6/29/2001). The data is summarized in Table 4.16.

	SR-92 (N)		SR-92 (S)		50th Street (N)		50th Street (S)		Causeway Blvd. (E)		Causeway Blvd. (W)		22nd St		21st St.	
Date	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated	Field	Simulated
28-May	170	168	165	168	124	126	141	137	110	107	91	89	158	160	117	119
29-May	154	156	169	164	120	123	115	117	91	93	85	87	159	155	118	116
30-May	160	165	163	168	129	131	143	138	93	94	85	86	154	155	115	112
31-May	169	166	161	159	132	130	134	136	95	96	87	89	150	154	119	115
01-Jun	177	172	161	166	134	130	145	139	99	97	91	89	142	147	120	117
25-Jun	179	174			126	129			93	95	87	89	156	153	112	113
26-Jun	174	169			134	131			93	95	83	87	158	157	113	111
27-Jun	159	163			132	128			94	96	89	88	153	155	114	117
28-Jun	167	170			134	136			98	97	90	87	159	155	114	118
29-Jun	167	168			134	130			99	97	80	83			120	117

Table 4.16: Field and VISSIM Simulated Truck Volumes on the Master Links (Calibration)

Step 3:

The simulated and actual volumes on these master links for all the calibration days were compared. The comparisons include visual inspection and a Confidence Interval (C.I.) statistical test.

The field and VISSIM simulated hourly truck volumes on the master links for the calibration days are illustrated graphically from Figure 4.17 to Figure 4.24. The graphical representation is for the visual inspection of the difference between the actual (field) and simulated truck volumes. The graphs suggest that there are no major differences between the simulated and field truck volumes on the selected master links for the calibration days.

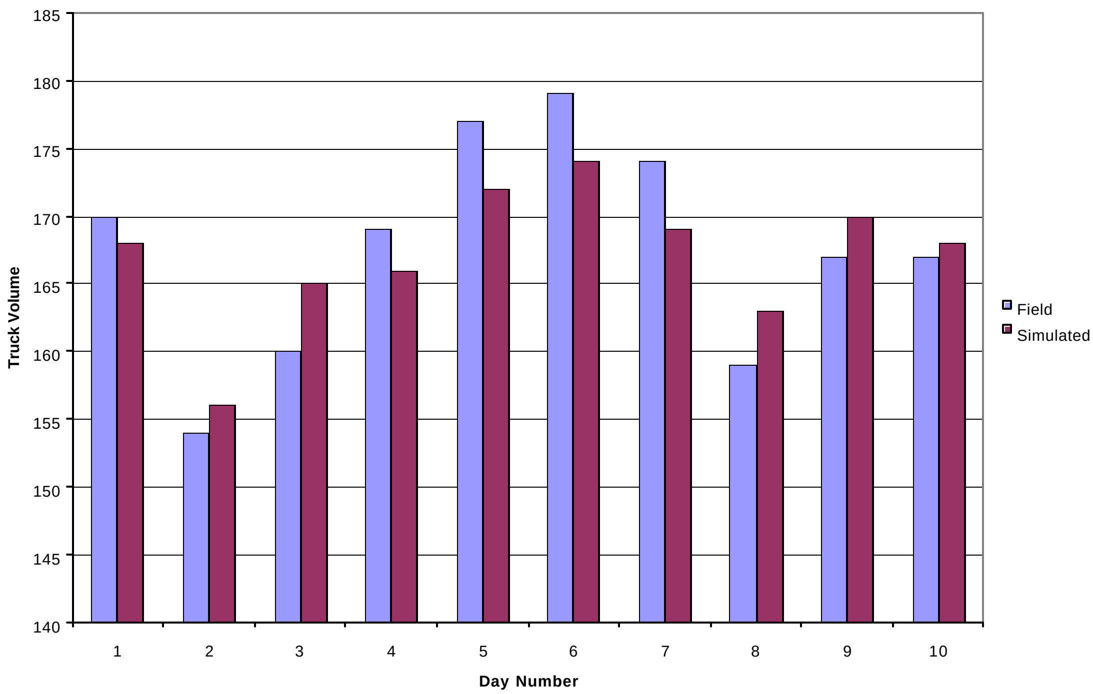


Figure 4.17: Field vs. VISSIM Simulated Truck Volumes on SR 92 Northbound (Calibration)

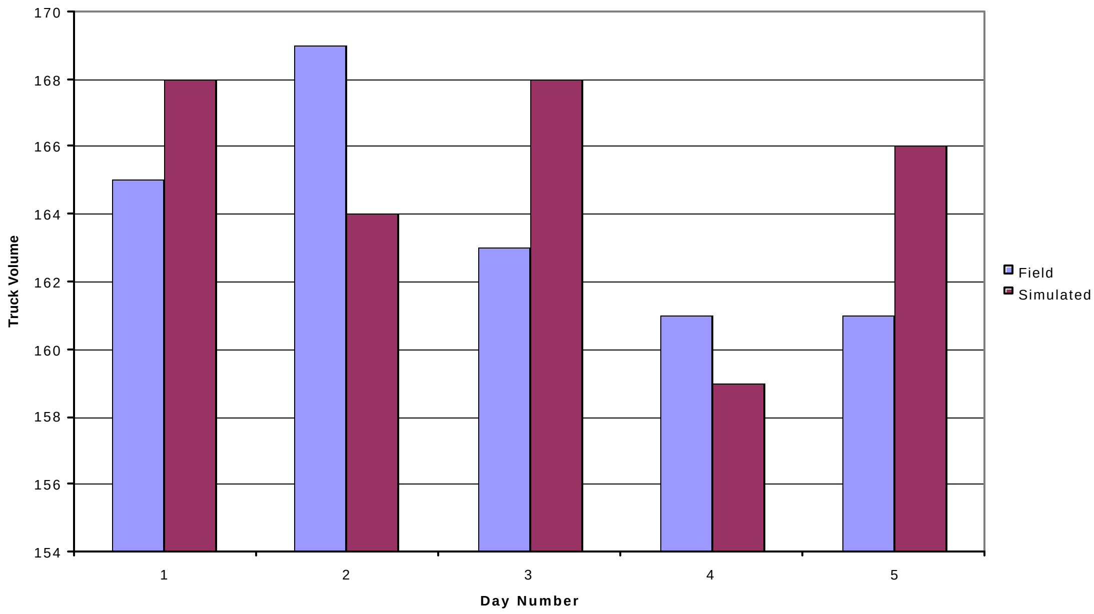


Figure 4.18: Field vs. VISSIM Simulated Truck Volumes on SR 92 Southbound (Calibration)

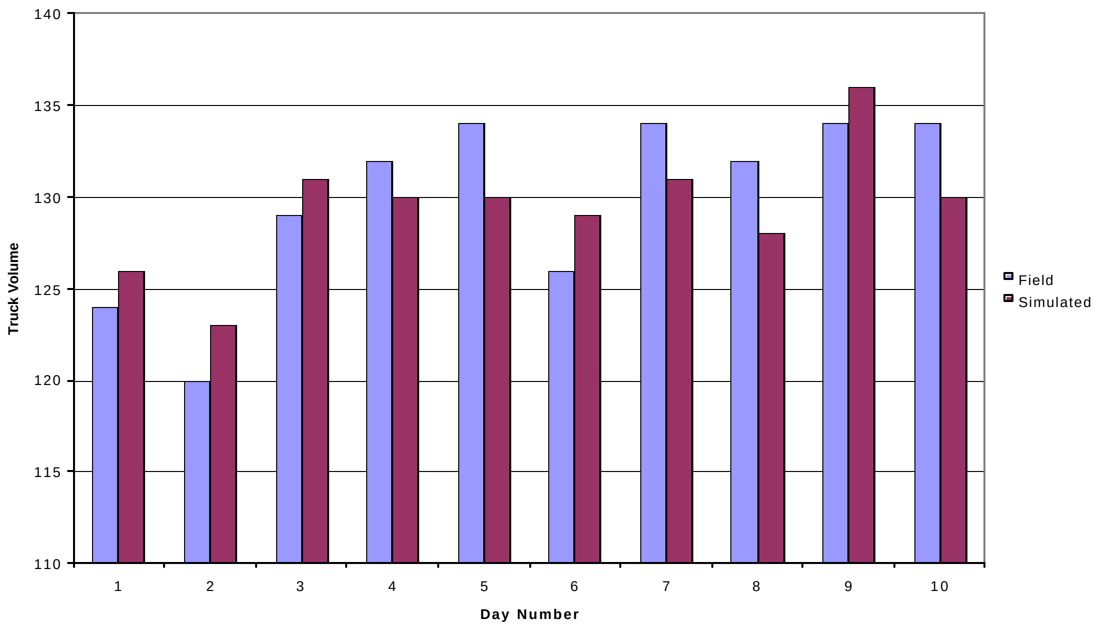


Figure 4.19: Field vs. VISSIM Simulated Truck Volumes on 50th Street Northbound (Calibration)

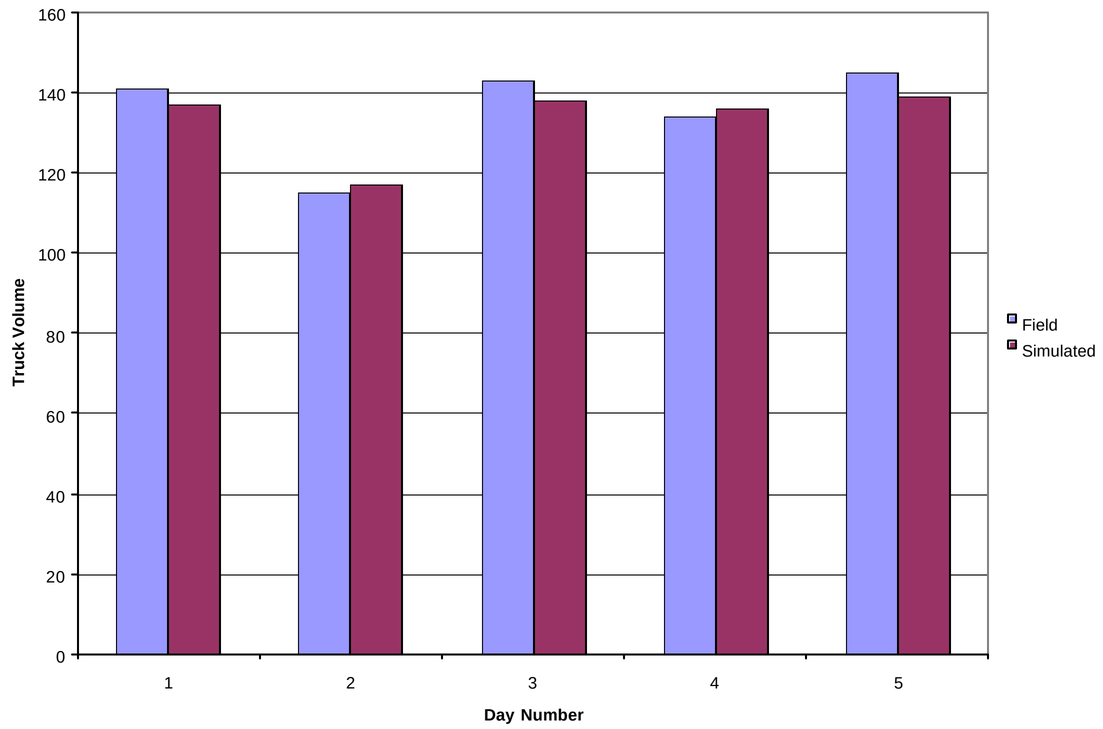


Figure 4.20: Field vs. VISSIM Simulated Truck Volumes on 50th Street Southbound (Calibration)

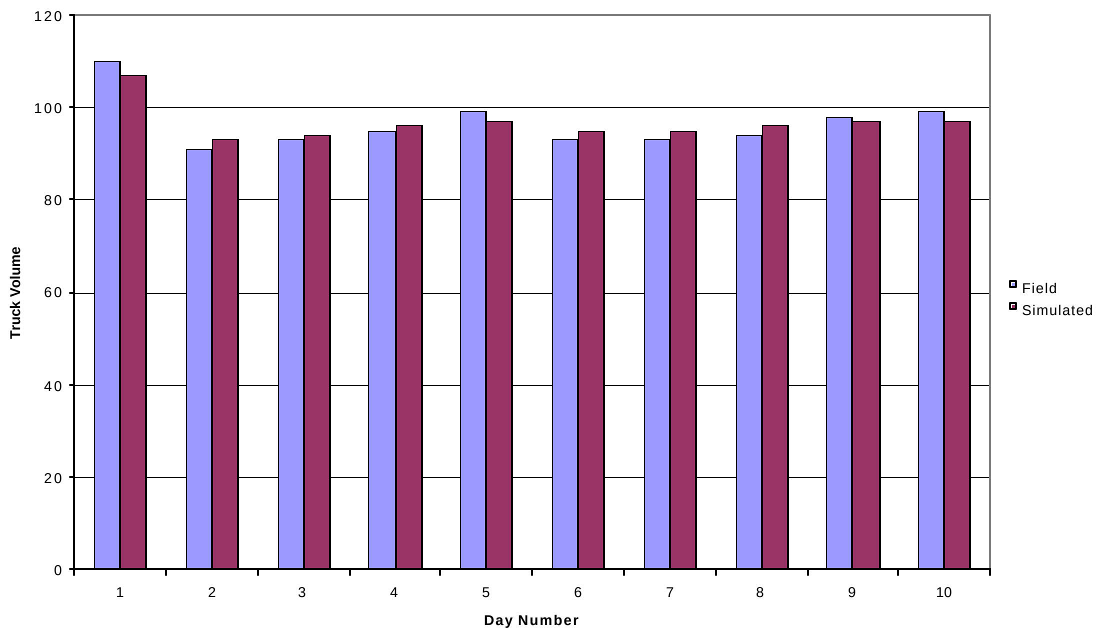


Figure 4.21: Field vs. VISSIM Simulated Truck Volumes on Causeway Boulevard Eastbound (Calibration)

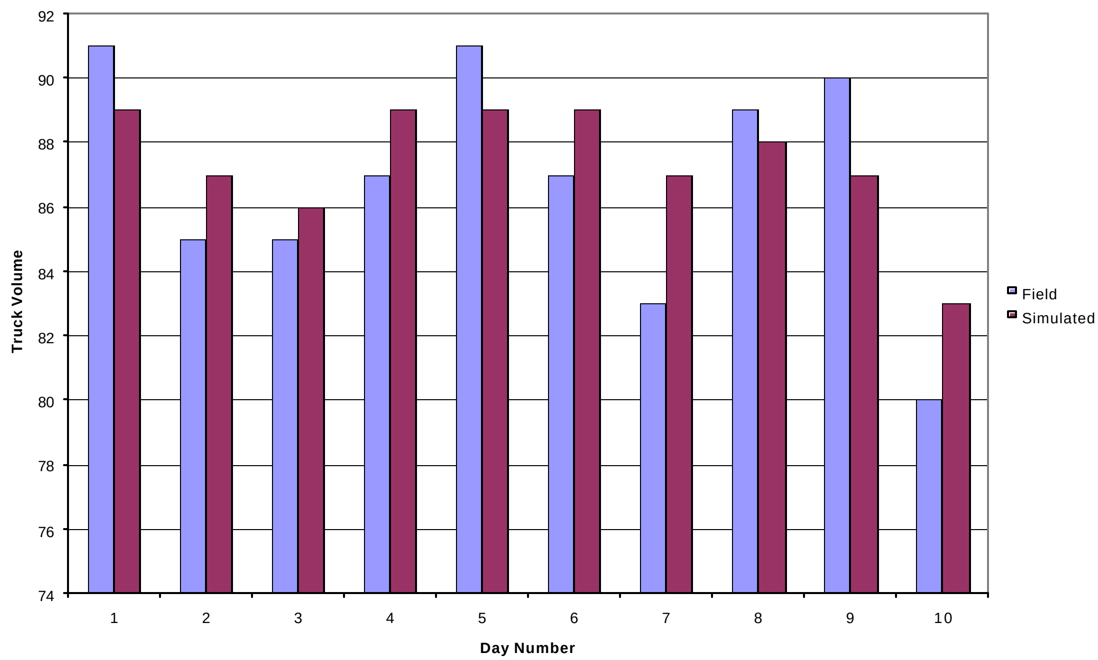


Figure 4.22: Field vs. VISSIM Simulated Truck Volumes on Causeway Boulevard Westbound (Calibration)

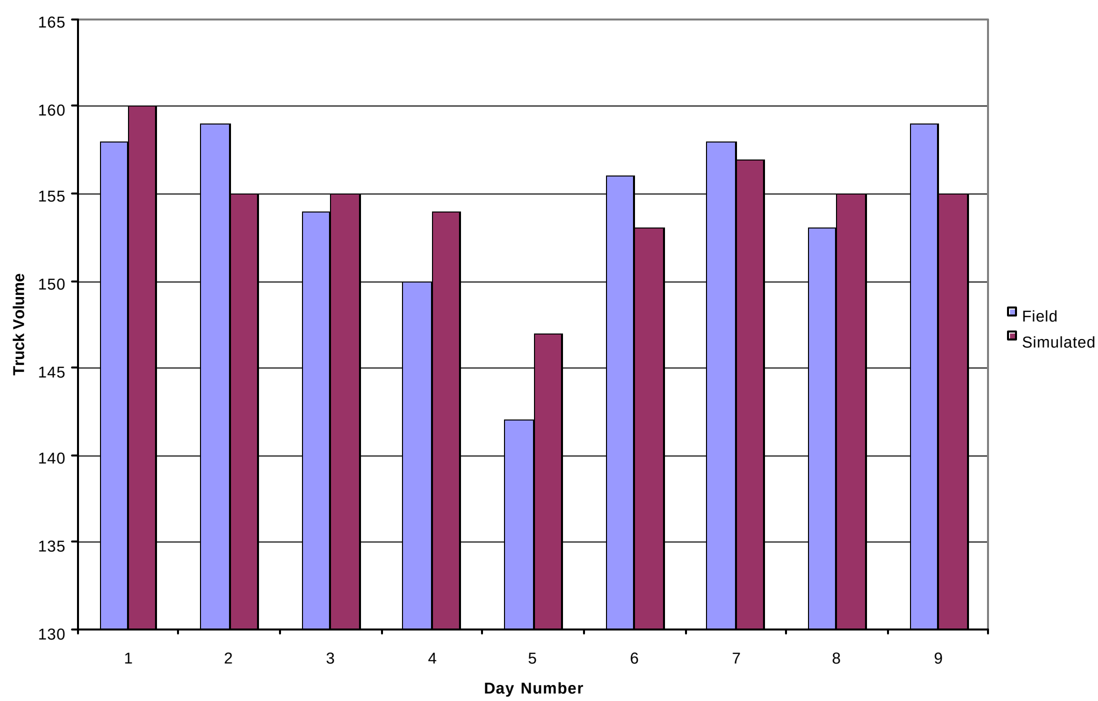


Figure 4.23: Field vs. VISSIM Simulated Truck Volumes on 22nd Street (Calibration)

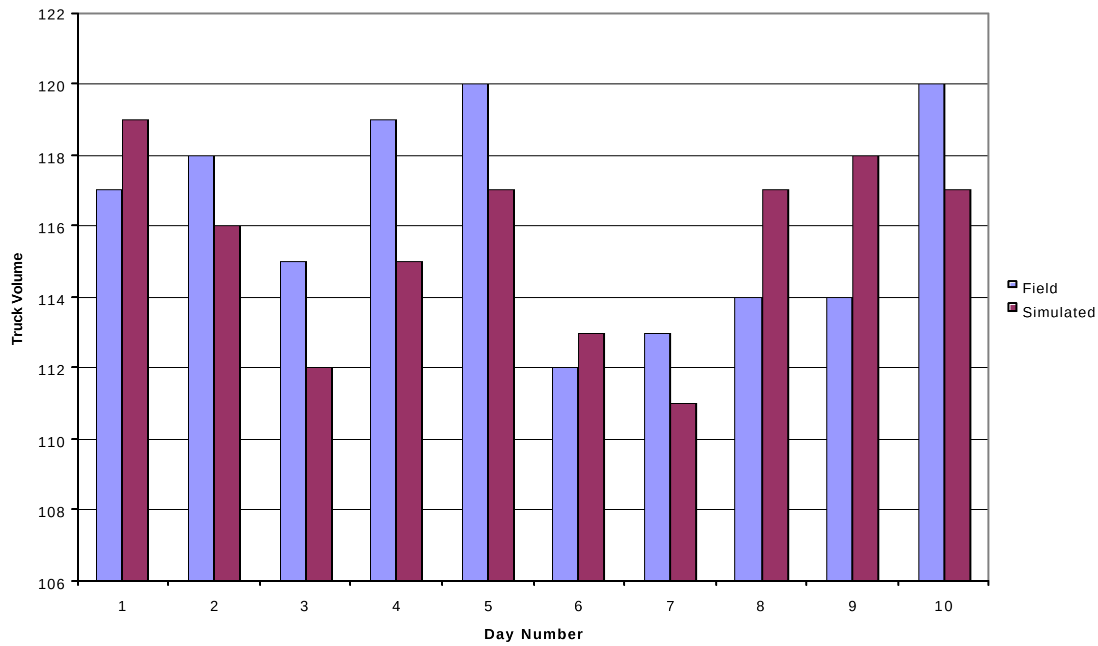


Figure 4.24: Field vs. VISSIM Simulated Truck Volumes on 21st Street (Calibration)

After the visual inspection showed no major differences between the simulated and the actual truck volumes on the master links, a statistical test was performed for each of the master links using the Confidence Interval (C.I.) Statistical Test. In Appendix K, Figure K. 1 through Figure K. 4 shows the C.I. calculations for each master link. Table 4.17 summarizes the C.I. calculations. Upper and lower limits of the confidence interval for each of the master links include zero. Therefore, the C.I. test concludes there is no significant difference between the simulated and actual truck volumes on the master links.

Link Name	Lower Limit of CI	Upper Limit of CI
SR 92 N	-3.6	3.4
SR 92 S	-3.4	13.4
50th St N	-3.1	2.2
50 th St. S	-6.6	6.9
Causeway E	-1.4	1.1
Causeway W	-1.7	2.5
22nd St	-2.3	2.5
21st St	-3.3	2.2

Table 4.17: Confidence Interval Limits for the Difference between Actual and VISSIM Simulated Truck Volumes (Calibration)

It can be concluded after conducting these two tests (visual inspection and Confidence Interval test) that each of the ten VISSIM calibrated truck O-D matrices replicate the existing conditions of the truck movements for the Port of Tampa at the 95% confidence level.

As mentioned earlier, the O-D matrix that represents the existing conditions for the Port of Tampa road network is the average of the 10 final calibrated O-D matrices. This O-D matrix is shown in Figure 4.15. Nodes 1, 16, and 18 are indicated with "Port" because they are external nodes directly associated with the Port of Tampa. Table 4.18 shows the simulated truck volumes that were calculated from the VISSIM output after loading the network with the final calibrated O-D matrix. Table 4.18 also shows the average of the calibration data set (23 days) of field truck volumes and the absolute percent error between the simulated and field truck volumes for the master links.

The absolute percent error for every master link is less than 5% (formula shown below). These results conclude that the final O-D matrix (Figure 4.15) represents the real world (existing conditions) for the Port of Tampa road network. Figure 4.25 is a graphical representation of average field and simulated truck volumes for the master links.

$$\%Error = \frac{|Field - Simulated|}{Field} * 100$$

Road Name	Link	Direction	Average Field Trucks Volumes	VISSIM Simulated Trucks Volumes	Absolute % Error
SR-92	13-N	Northbound	164	167	1.77
	13-S	Southbound	169	174	2.96
50th Street	17-N	Northbound	126	123	2.38
	17-S	Southbound	132	128	3.03
Causeway Blvd	22-E	Eastbound	106	103	2.83
	22-W	Westbound	86	88	2.56
22nd St	25-N	Northbound	151	155	2.82
21st St.	25-S	Southbound	108	105	2.51

Note: The Average for Up to 23 Days in the Calibration set

Table 4.18: Field and VISSIM Simulated Truck Volumes of the Master Links

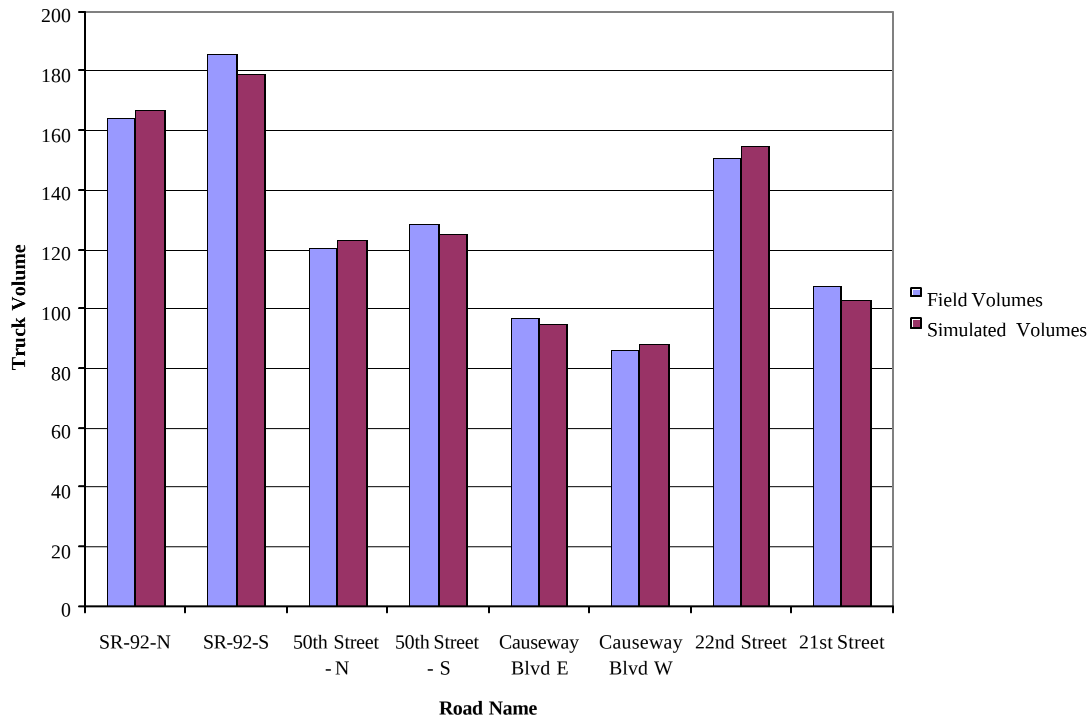


Figure 4.25: Field and VISSIM Simulated Volumes for the Master Links

4.3 Route Assignment Model Validation

The purpose of the validation step is to check the applicability of the developed models to any day other than the set of days used in the calibration process. The 11 weekdays selected for validation (7/5/2001 to 7/10/2001 and 7/16/ 2001 to 7/23/2001) is from the data in Table 4.6. The validation data set should be comprehensive for all data collection locations. The validation process was performed for both CORSIM and VISSIM models independently. The general steps to perform the validation are as follows:

Step 1:

Feed the model with the number of trucks leaving or entering on the Port of Tampa's access roads for each of the days in the validation data set. All other O-D pair volumes are the same as those in the final calibrated O-D matrix (Figure 4.15). The port's access roads are represented in the O-D matrix by Node 1 (Port Sutton and Pendola Point Roads), Node 16 (22nd and 20th Street), and Node 18 (Causeway Boulevard). The number of trucks leaving and entering the port for any day was obtained by entering the vessel freight data for that day into the truck trip generation model for the Port of Tampa (11). The output of this model is the number of trucks leaving or entering the Port of Tampa for each of the access roads (Nodes 1, 16, and 18). The daily number of trucks leaving/entering the Port of Tampa in July 2001 (validation period) is shown in Appendix F, Table F. 1 & Table F. 2.

The truck trip generation model produces only daily truck volumes. However, the simulation models require peak hourly volumes. Therefore, conversion factors from daily truck volumes to the total traffic volumes and then to the peak hourly volumes were used. The first factor that converts the truck volume to the relevant total traffic volume is the truck factor (T). The truck factors are known for the traffic volume at each of the three entrances and exits (Nodes 1, 16, and 18) from the field counts that were conducted at these locations during Phase II of the project. The second factor (K factor) is the ratio between the peak hourly volume and the daily volume. The K factors are also known for each of the three entrances and exits (Nodes 1, 16, and 18) from the field counts conducted at these locations during Phase II. Table 4.19 summarizes the T and K factors for the entrance and exit nodes at the Port of Tampa.

	Inbound		Outbound	
Node	**Truck Factor**	**K Factor**	**Truck Factor**	**K Factor**
1	0.4	0.08	0.4	0.08
16	0.2	0.09	0.12	0.1
18	0.23	0.09	0.22	0.09

Table 4.19: T & K Factors for the Port of Tampa

For each day in the validation data set (from 7/5/2001 to 7/10/2001 and from 7/16/ 2001 to 7/24/2001), the peak hourly truck volume was calculated using **Error! Reference source not found.**. Multiplying the daily number of trucks by the K factor determines the peak hour truck volume. The truck volumes used in the validation process are shown in Table 4.20.

	Node 1		Node 16		Node 18	
Date	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
7/5/01	44	40	152	198	110	136
7/6/01	43	40	144	198	105	136
7/9/01	41	39	139	196	101	135
7/10/01	40	39	135	195	98	134
7/16/01	42	40	143	197	104	135
7/17/01	40	39	136	196	99	134
7/18/01	39	39	133	196	97	134
7/19/01	40	39	135	195	98	134
7/20/01	42	40	143	197	104	135
7/23/01	41	34	139	170	101	117
7/24/01	45	34	153	171	112	117
7/25/01	47	40	158	200	115	137

Table 4.20: Total Number of Trucks Entering and Leaving the Port of Tampa on Validation Set of Days

Step 2

Run the simulation model and obtain the simulated volumes on the master links.

Step 3

Compare the simulated and actual (field) volumes on these master links for all the days in the validation data set. The comparisons include visual inspection and a Confidence Interval (C.I.) statistical test.

4.3.1 Port of Tampa Model Validation: CORSIM

One CORSIM simulation run for each of the validation days was performed (total of 11 runs). The input for each run was an O-D matrix that represented the peak hour for each validation day. The truck O-D matrices for the peak hour of the validation set (7/5/2001 to 7/10/2001 and 7/16/2001 to 7/24/2001) are shown in Appendix L, Figure L. 1 through Figure L. 11. The total number of trucks leaving or entering the Port of Tampa at Nodes 1, 16, & 18 were obtained from ANN truck trip generation model (see Table 4.20). The number of trucks leaving or entering the Port of Tampa was distributed between the different nodes with the same percentages used in the calibrated O-D matrix. The simulated and field truck volumes on the master links for each day of the validation data set are shown in Table 4.21.

	SR-92 (N)		SR-92 (S)		50th Street (N)		50th Street (S)		Causeway (E)		Causeway (W)		22nd st		21st St	
Dates	**Field**	**Simulated**	**Field**	**Simulated**	**Field**	**Simulated**	**Field**	**Simulated**	**Field**	**Simulated**	**Field**	**Simulated**	**Field**	**Simulated**	**Field**	**Simulated**
07/05/2001	208	218	242	237	168	160	161	160	140	133	130	124	184	178	127	126
07/06/2001	234	224	211	221	168	161	154	156	127	121	124	118	196	190	137	132
07/09/2001	222	220	233	236	153	155	153	160	130	124	120	116	184	178	142	137
07/10/2001	223	219	253	239	154	156	191	184	124	118	124	119	182	178	123	127
07/16/2001	217	220	227	233	147	153	175	167	124	120	136	131	164	170	120	126
07/17/2001	230	224	220	230	182	174	173	165	148	141	124	118	197	189	126	122
07/18/2001	219	220	231	234	186	179	170	162	119	121	118	115	192	184	150	143
07/19/2001	216	220	228	236	188	181	171	163	101	104	108	114	186	181	133	127
07/20/2001	214	220	241	234	174	156	161	157	122	123	91	95	184	190	157	131
07/23/2001	242	230	230	236	150	155	167	160	121	116	125	119	178	184	136	132
07/24/2001	230	222	221	228	155	157	161	160	124	119	123	125	198	189	121	125

Table 4.21: Field and Simulated Truck Volumes of the Master Links

The field and CORSIM simulated truck volumes for the master links are illustrated graphically from Figure 4.26 to Figure 4.33. The graphical representation is for the visual inspection to observe the difference between the actual (field) and simulated truck volumes. The graphs suggest that there are no major differences between the simulated and the field truck volumes of the master links on the validation set of days (11 weekdays).

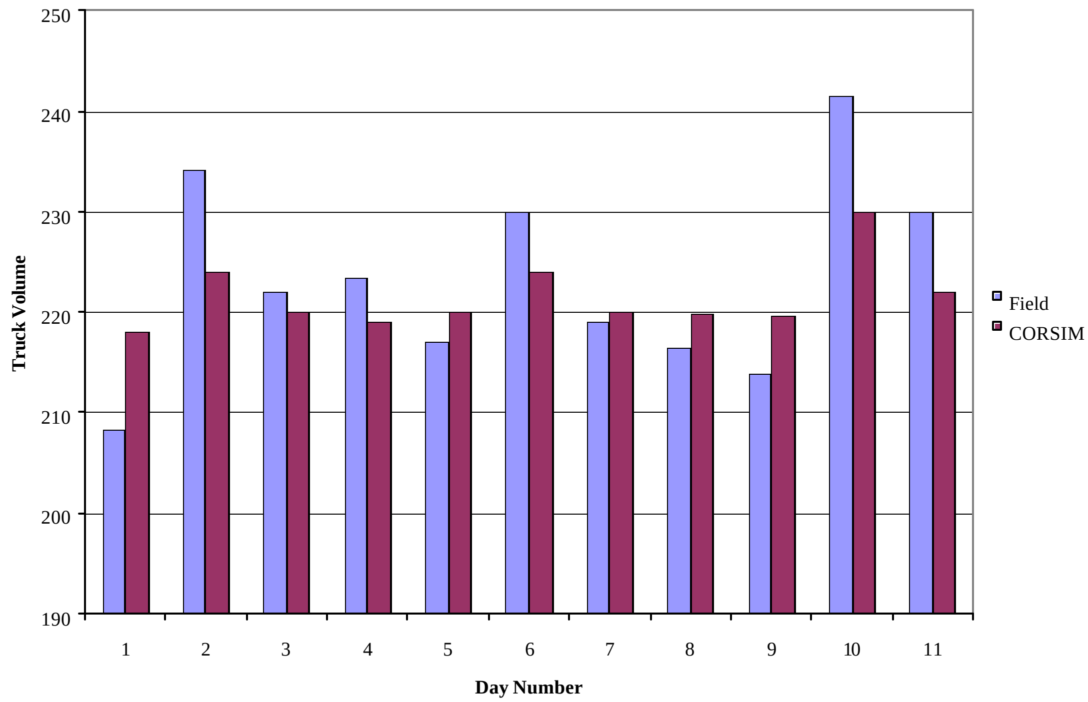


Figure 4.26: Field vs. CORSIM Simulated Truck Volumes on SR 92 Northbound (Validation)

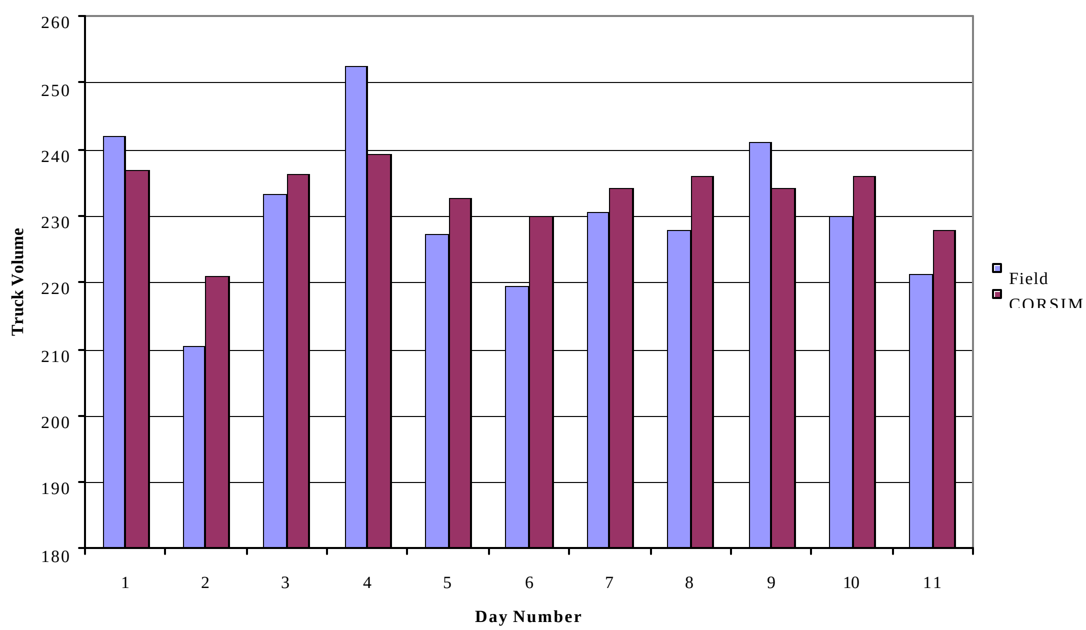


Figure 4.27: Field vs. CORSIM Simulated Truck Volumes on SR 92 Southbound (Validation)

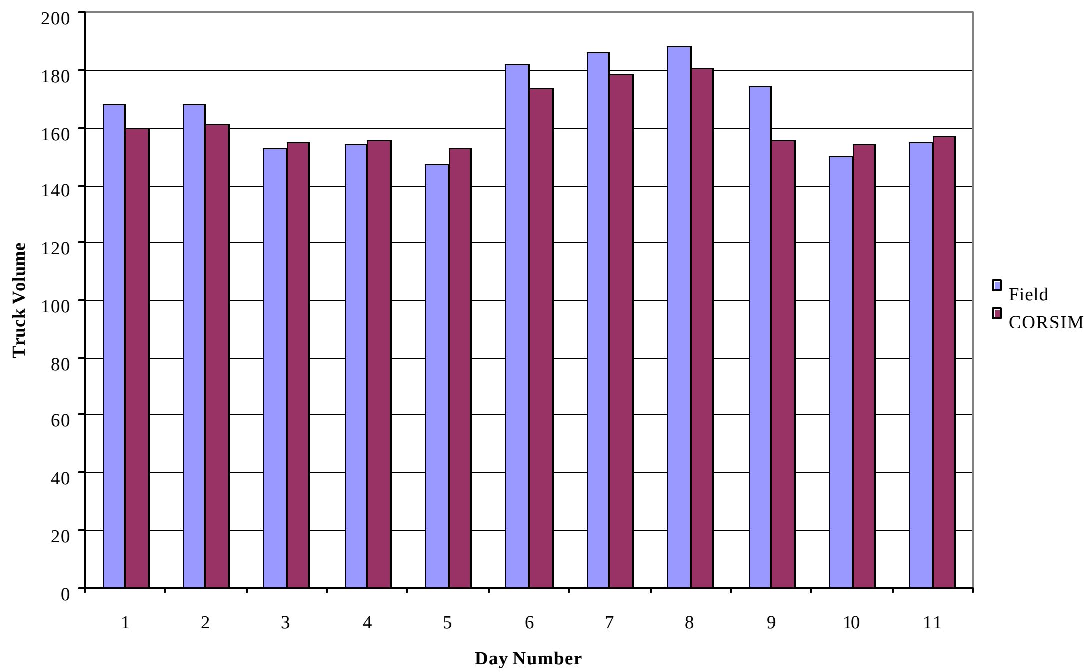


Figure 4.28: Field vs. CORSIM Simulated Truck Volumes on 50th Street Northbound (Validation)

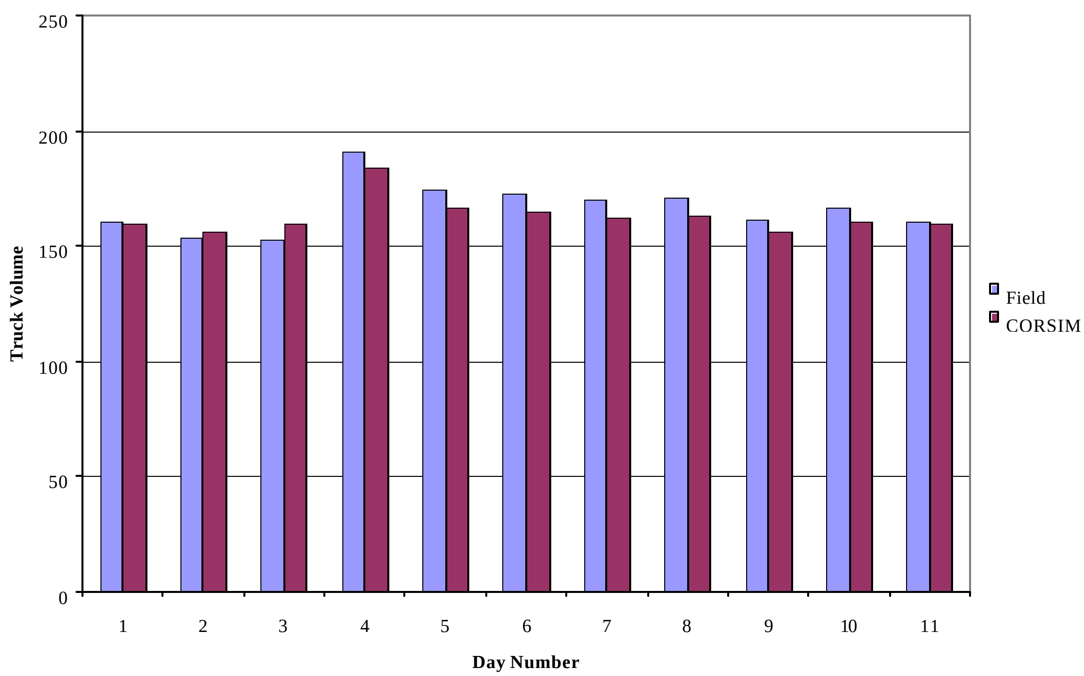


Figure 4.29: Field vs. CORSIM Simulated Truck Volumes on 50th Street Southbound (Validation)

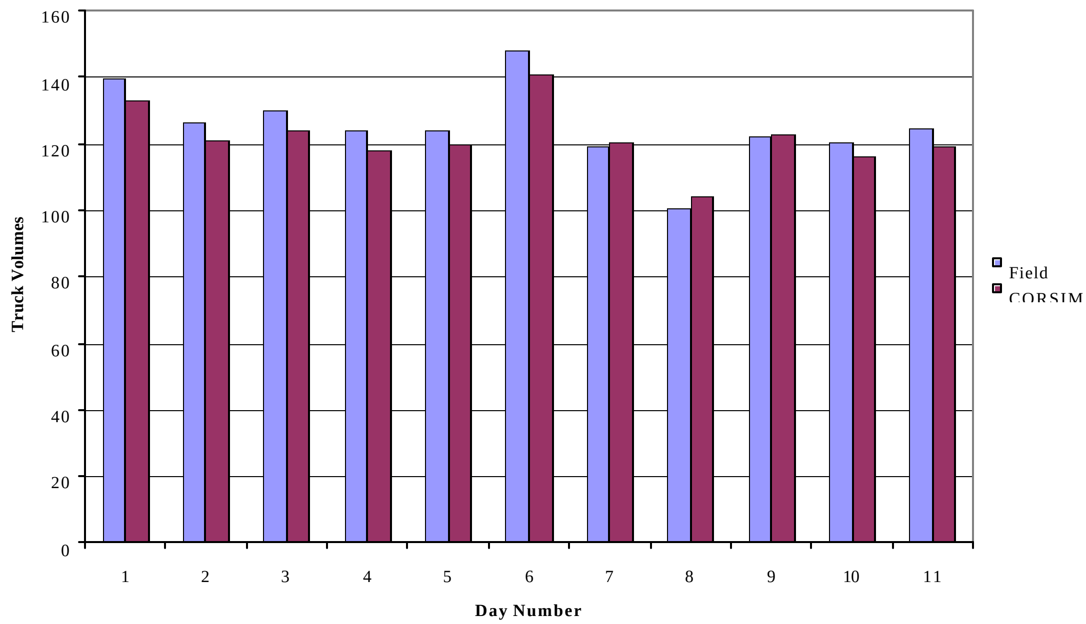


Figure 4.30: Field vs. CORSIM Simulated Truck Volumes on Causeway Blvd Eastbound (Validation)

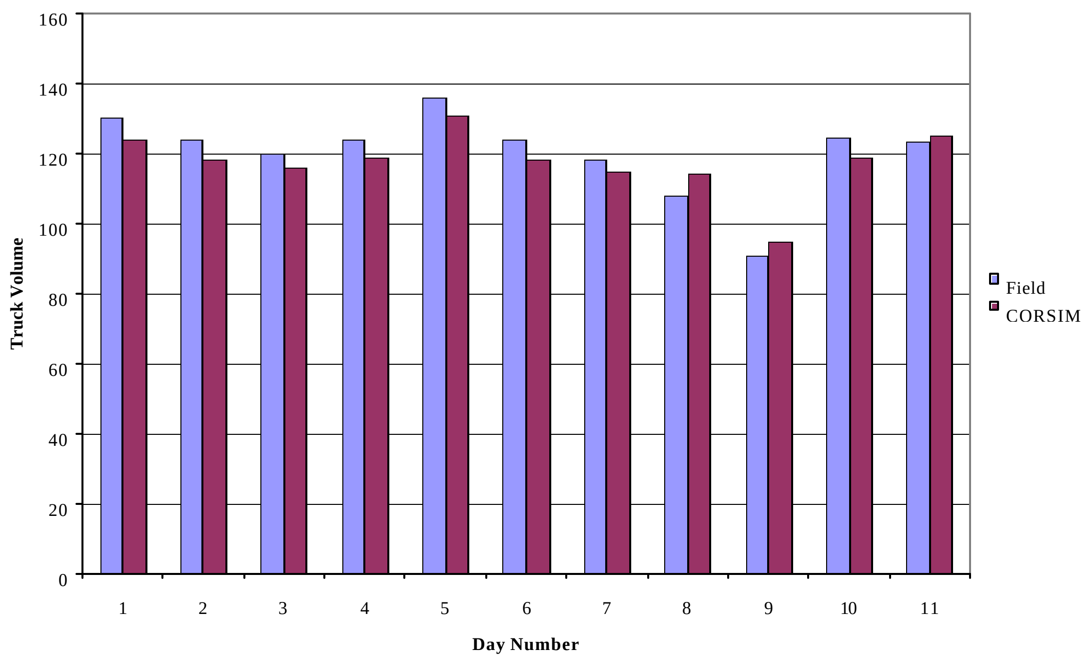


Figure 4.31: Field vs. CORSIM Simulated Truck Volumes on Causeway Blvd Westbound (Validation)

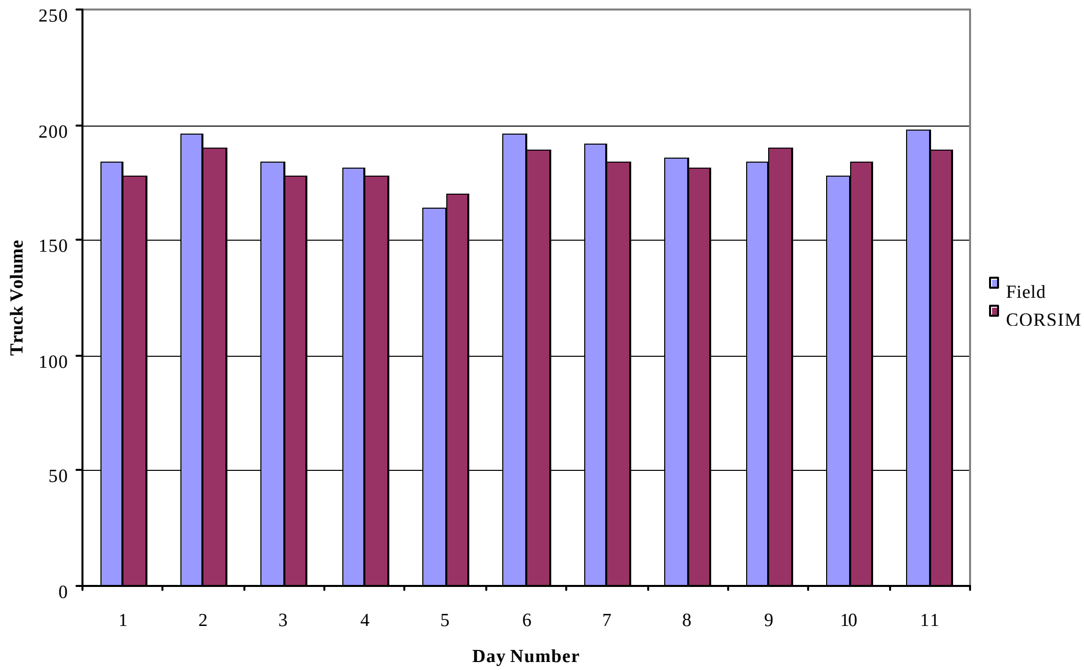


Figure 4.32: Field vs. CORSIM Simulated Truck Volumes on 22nd Street (Validation)

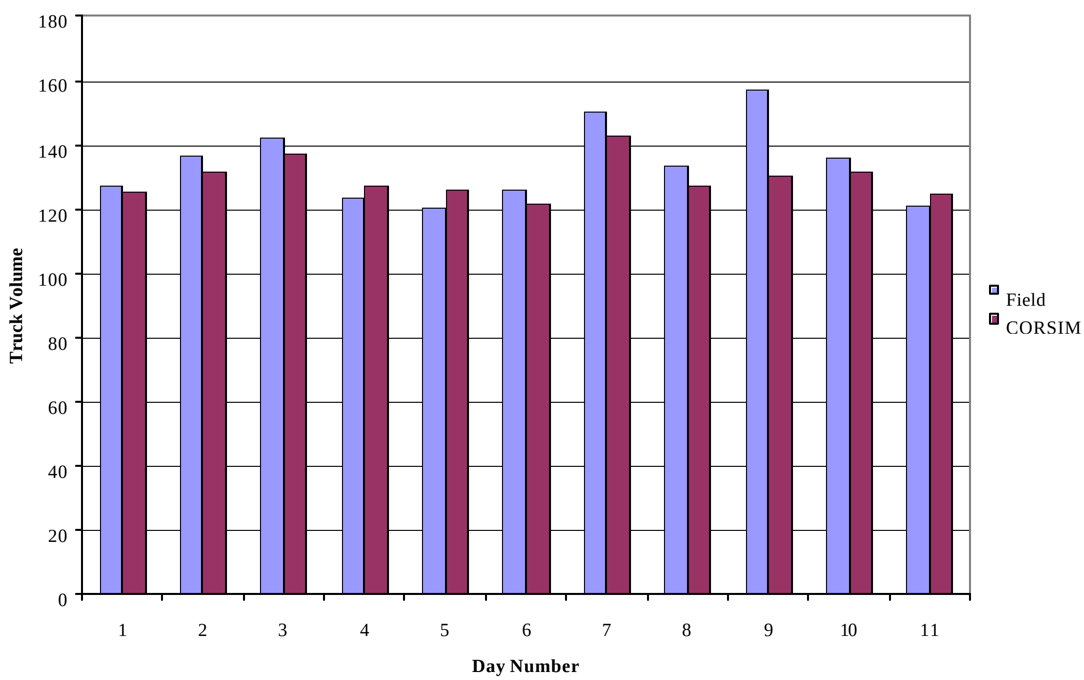


Figure 4.33: Field vs. CORSIM Simulated Truck Volumes on 21st Street (Validation)

After the visual inspection showed no major differences between the simulated and the actual truck volumes on the master links, a statistical test was performed for each of the master links using the Confidence Interval (C.I.) Statistical Test. In Appendix M, Figure M. 1 to Figure M. 4 shows the C.I. calculations for each master link. Table 4.22 summarizes the C.I. calculations. Upper and lower limits of the confidence interval for each of the master links include zero. Therefore, the C.I. test concludes there is no significant difference between the simulated and actual truck volumes on the master links.

Link Name	Lower Limit of CI	Upper Limit of CI
SR 92 N	-9.2	5.6
SR 92 S	-8.7	16.8
50th St N	-26.8	12.7
50 th St. S	-16.0	7.6
Causeway E	-25.8	12.6
Causeway W	-26.3	12.7
22nd St	-18.9	10.7
21st St	-23.1	11.5

Table 4.22: Confidence Interval Limits for the Difference between Actual and CORSIM Simulated Truck Volumes

It can be concluded after conducting these two tests (visual inspection and Confidence Interval test) that each of the ten CORSIM calibrated truck O-D matrices replicate the existing conditions of the truck movements for the Port of Tampa at the 95% confidence level.

4.3.2 Port of Tampa Model Validation: VISSIM

The same validation steps for CORSIM were conducted using VISSIM. One VISSIM simulation run for each of the validation days was performed (total of 11 runs). The input for each run was an O-D matrix that represented the peak hour for each validation day. The truck O-D matrices for the peak hour of the validation set (7/5/2001 to 7/10/2001 and 7/16/2001 to 7/24/2001) are shown in Appendix L, Figure L. 1 to Figure L. 11. The total numbers of trucks leaving or entering the Port of Tampa at Nodes 1, 16, & 18 were obtained from the truck trip generation model (Table 4.20). The number of trucks leaving or entering the Port of Tampa were distributed between the different nodes with the same percentages used in the calibrated O-D matrix. The VISSIM simulated and field truck volumes on the master links for each day of the validation data set are shown in Table 4.23.

Date	SR-92 (N) Field	SR-92 (N) VISSIM	SR-92 (S) Field	SR-92 (S) VISSIM	50th Street (N) Field	50th Street (N) VISSIM	50th Street (S) Field	50th Street (S) VISSIM
7/5/2001	208	212	242	243	168	162	161	165
7/6/2001	234	229	211	215	168	171	154	155
7/9/2001	222	217	233	239	153	149	153	148
7/10/2001	223	220	253	246	154	153	191	180
7/16/2001	217	226	227	235	147	146	175	168
7/17/2001	230	234	220	211	182	186	173	163
7/18/2001	219	217	231	237	186	187	170	177
7/19/2001	216	214	228	231	188	192	171	164
7/20/2001	214	212	241	240	174	170	161	158
7/23/2001	242	244	230	234	150	153	167	164
7/24/2001	230	238	221	216	155	154	161	157

Date	Causeway Blvd (E) Field	Causeway Blvd (E) VISSIM	Causeway Blvd (W) Field	Causeway Blvd (W) VISSIM	22nd Street Field	22nd Street VISSIM	21st Street Field	21st Street VISSIM
7/5/2001	140	134	130	124	184	179	127	130
7/6/2001	127	126	124	123	196	192	137	135
7/9/2001	130	125	120	120	184	176	142	137
7/10/2001	124	118	124	123	182	179	123	125
7/16/2001	124	121	136	137	164	167	120	125
7/17/2001	148	148	124	126	197	185	126	126
7/18/2001	119	114	118	125	192	184	150	154
7/19/2001	101	105	108	113	186	178	133	128
7/20/2001	122	118	91	93	184	178	157	156
7/23/2001	121	118	125	126	178	181	136	129
7/24/2001	124	119	123	122	198	189	121	123

Table 4.23: Field and VISSIM Simulated Truck Volumes of the Master Links

The field and VISSIM simulated truck volumes for the master links are illustrated graphically from Figure 4.34 to Figure 4.41. The graphical representation is for the visual inspection to observe the difference between the actual (field) and simulated truck volumes. The graphs suggest that there are no major differences between the simulated and the field truck volumes of the master links on the validation set of days (11 weekdays).

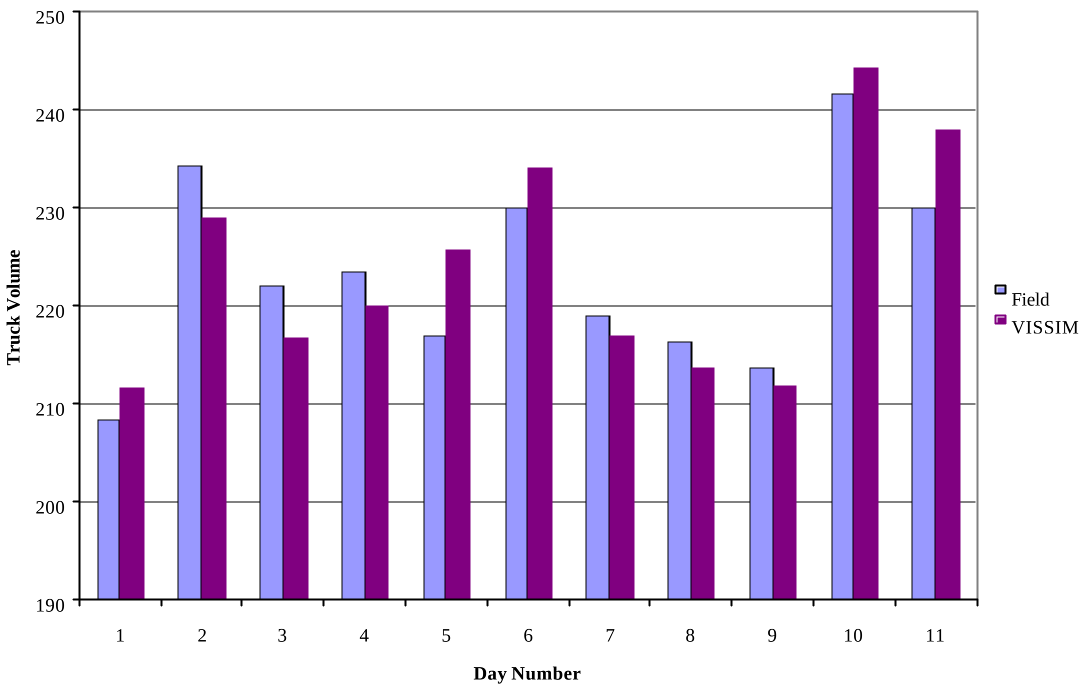


Figure 4.34: Field vs. VISSIM Simulated Truck Volumes on SR 92 Northbound (Validation)

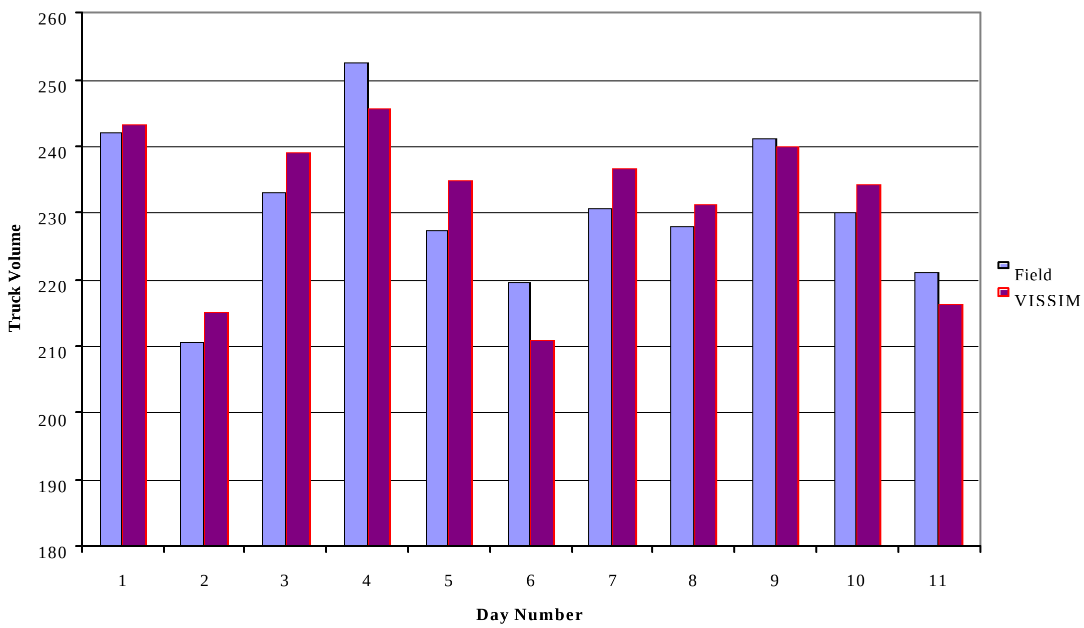


Figure 4.35: Field vs. VISSIM Simulated Truck Volumes on SR 92 Southbound (Validation)

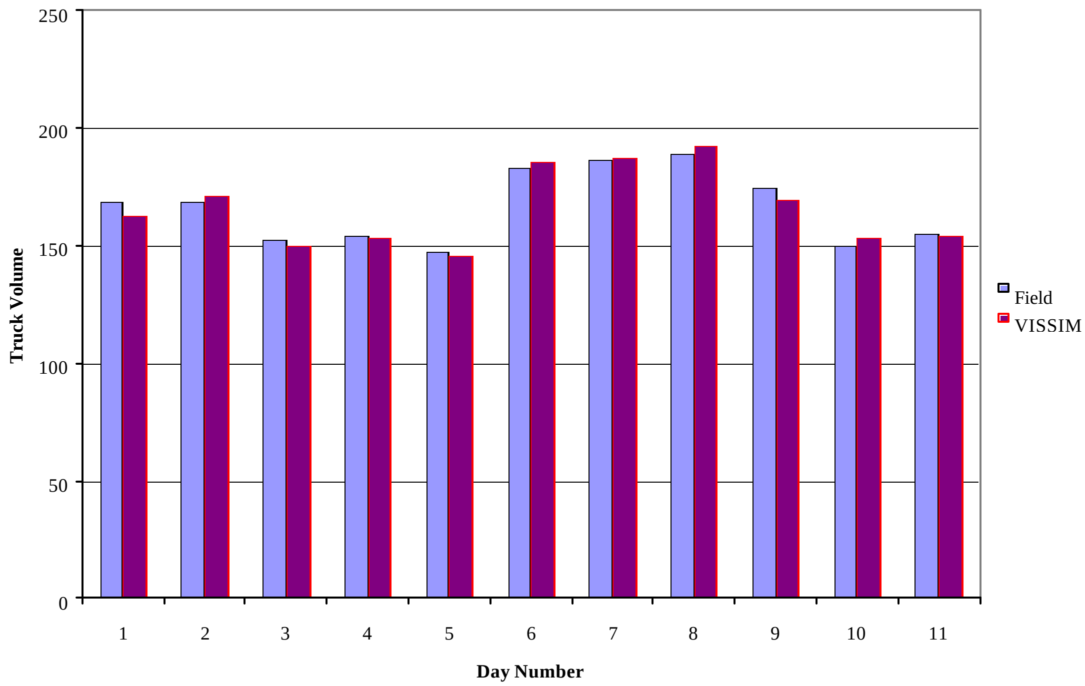


Figure 4.36: Field vs. VISSIM Simulated Truck Volumes on 50th Street Northbound (Validation)

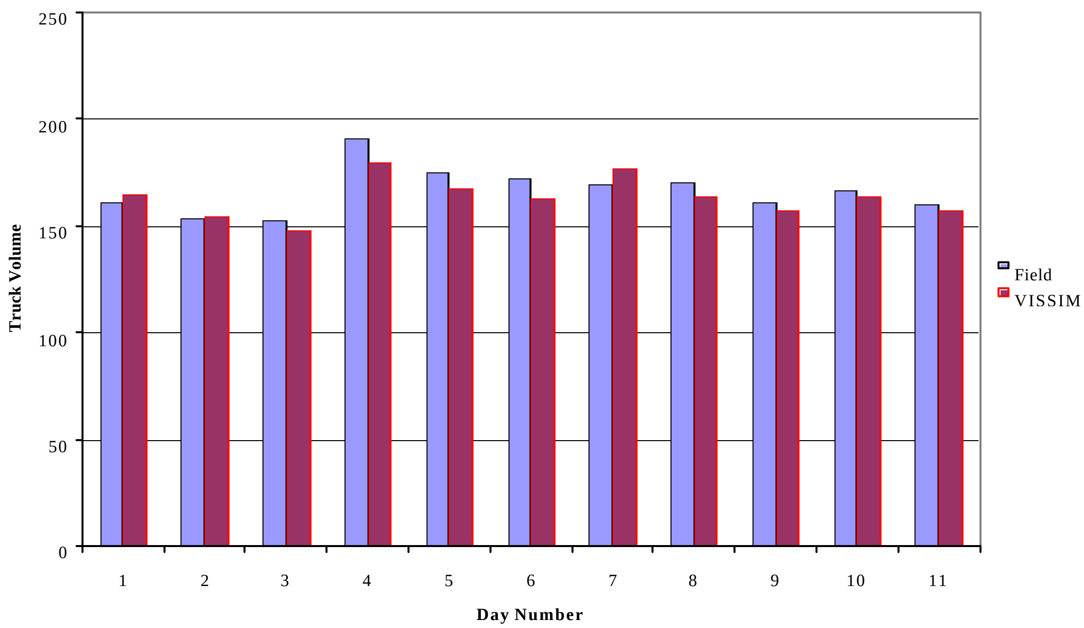


Figure 4.37: Field vs. VISSIM Simulated Truck Volumes on 50th Street Southbound (Validation)

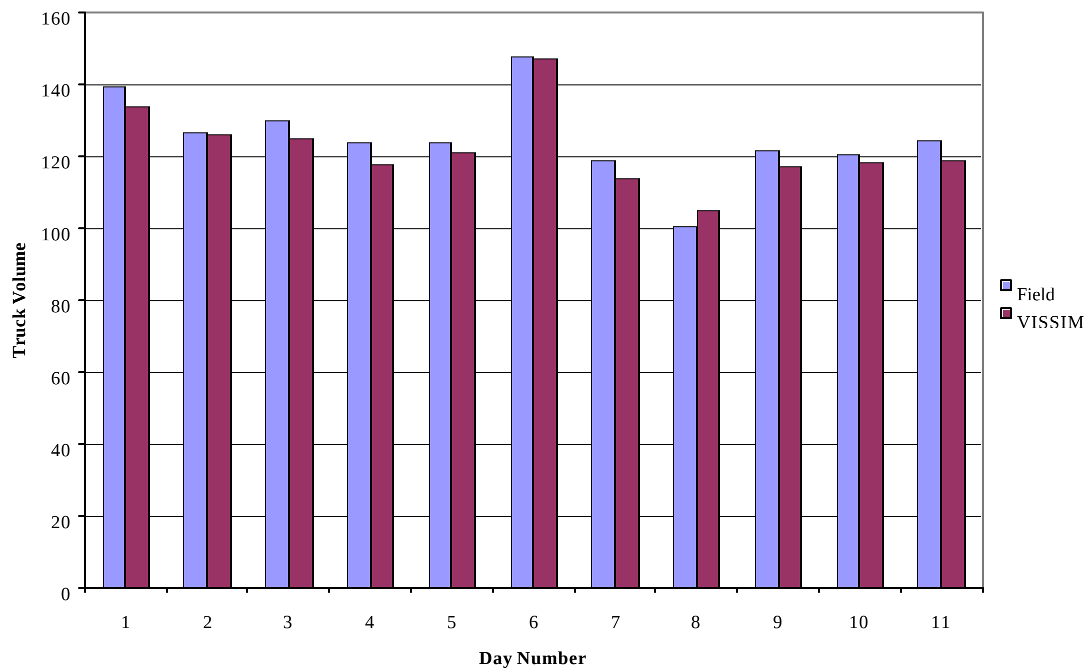


Figure 4.38: Field vs. VISSIM Simulated Truck Volumes on Causeway Blvd Eastbound (Validation)

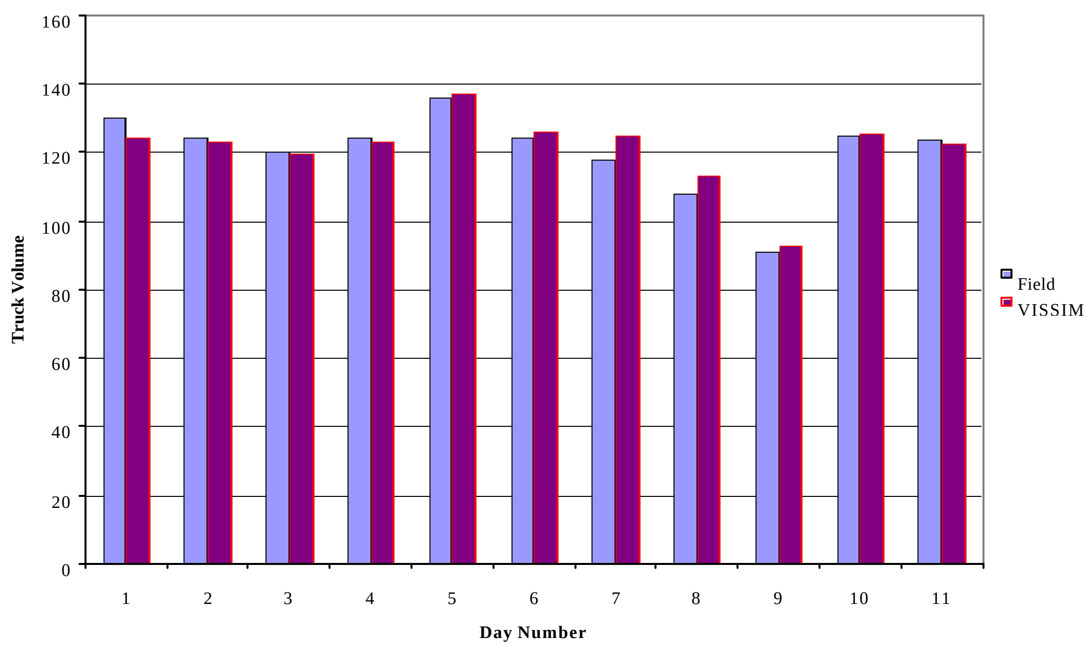


Figure 4.39: Field vs. VISSIM Simulated Truck Volumes on Causeway Blvd Westbound (Validation)

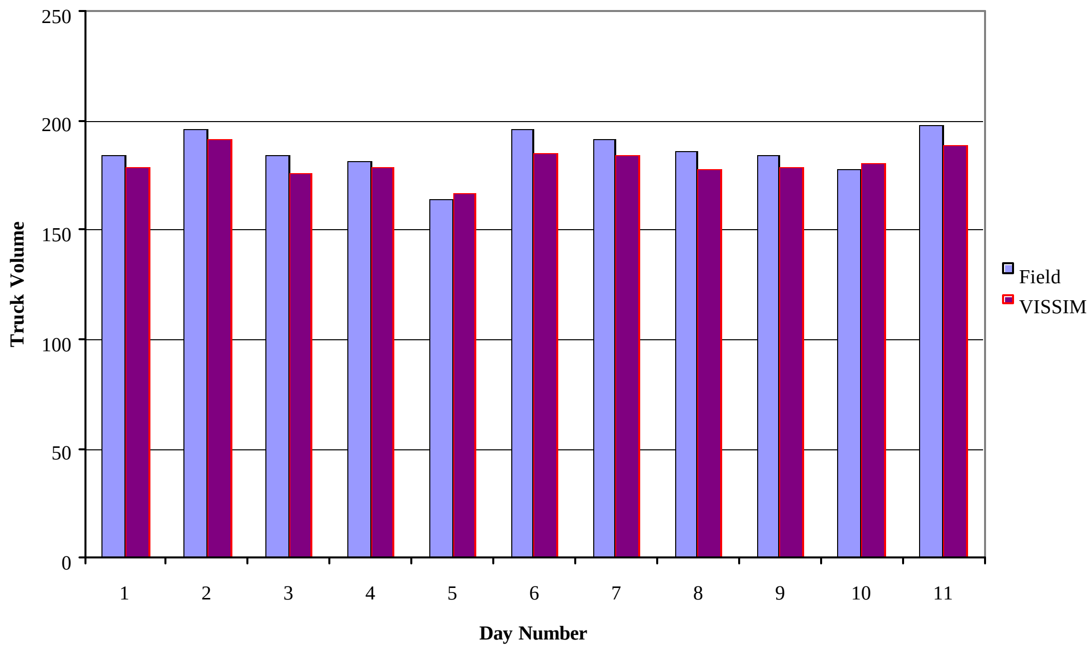


Figure 4.40: Field vs. VISSIM Simulated Truck Volumes on 22nd Street (Validation)

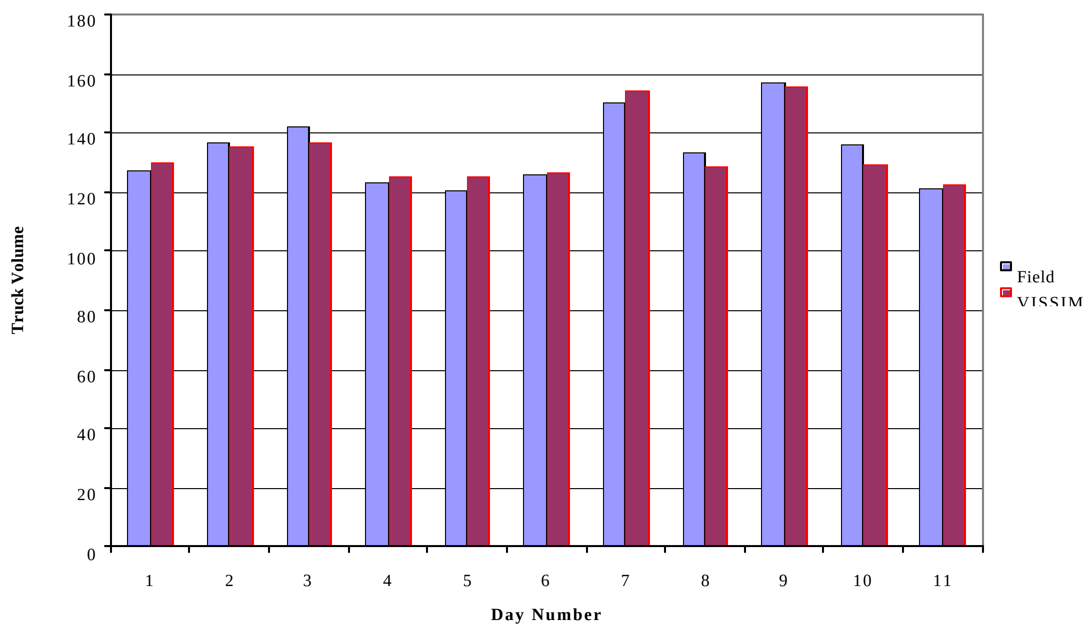


Figure 4.41: Field vs. VISSIM Simulated Truck Volumes on 21st Street (Validation)

After the visual inspection showed no major differences between the simulated and the actual truck volumes on the master links, a statistical test was performed for each of the master links using the Confidence Interval (C.I.) Statistical Test. In Appendix M, Figure M. 5 to Figure M. 8 shows the C.I. calculations for each master link. Table 4.24 summarizes the C.I. calculations. Upper and lower limits of the confidence interval for each of the master links include zero. Therefore, the C.I. test concludes there is no significant difference between the simulated and actual truck volumes on the master links.

Link Name	Lower Limit of CI	Upper Limit of CI
SR 92 N	-9.0	6.6
SR 92 S	-5.4	9.3
50th St N	-5.3	10.2
50 th St. S	-17.5	8.5
Causeway E	-20.0	9.0
Causeway W	-5.6	6.8
22nd St	-23.1	10.4
21st St	-4.3	4.3

Table 4.24: Confidence Interval Limits for the Difference between Actual and VISSIM Simulated Truck Volumes

It can be concluded after conducting these two tests (visual inspection and Confidence Interval test) that each of the ten VISSIM calibrated truck O-D matrices replicate the existing conditions of the truck movements for the Port of Tampa at the 95% confidence level.

4.3.3 Port of Tampa Route Assignment Model Preliminary Conclusions

The O-D matrix that represents the existing conditions for the Port of Tampa road network is shown in Figure 4.42.

		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	16 (Port)	18 (Port)	Sum.
Origin Nodes	1 (Port)	0	0	40	0	0	13	0	0	0	0	0	0	0	0	0	0	53
	1 south	0	0	0	50	0	0	20	0	53	10	0	0	0	0	0	39	
	3	20	0	0	100	0	0	0	100	0	0	0	0	0	0	0	0	
	4	0	0	100	0	0	0	0	0	32	0	0	0	0	0	0	58	
	5	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	
	6	8	0	0	0	0	0	0	0	51	60	0	78	0	0	0	0	
	7	0	0	0	0	0	0	0	0	26	152	0	260	0	0	0	25	
	8	0	0	76	0	0	0	0	0	0	0	0	0	0	0	0	0	
	9	0	143	0	4	0	150	10	0	0	0	0	200	0	10	24	0	
	10	0	15	0	0	0	100	30	0	0	0	0	0	40	30	16	0	
	11	0	0	0	0	0	0	0	0	0	0	0	60	0	0	38	0	
	12	0	0	0	0	0	80	120	0	20	0	60	0	0	216	10	0	
	13	0	0	0	0	0	0	0	0	0	10	0	0	0	0	23	0	
	14	0	0	0	0	0	0	0	0	30	40	0	79	0	0	36	0	
	16 (Port)	0	0	0	0	0	0	0	5	19	40	80	10	10	18	0	0	181
	18 (Port)	0	62	10	41	10	0	8	8	0	0	0	0	0	0	0	0	138
	Sum.	44								230						147	157	

Figure 4.42: Existing Conditions O-D matrix for the Port of Tampa

It was observed from the final O-D matrix that the total number of trucks leaving the Port of Tampa at Node 16 (22nd St and 20th St) during the peak hour is 181 trucks. The number of trucks leaving the Port of Tampa from Node 16 and traveling towards Node 11 (I-4 & I-275 interchange) is 80 trucks (44% of total number of trucks leaving at Node 16). Link 10 (I-4) is part of the shortest path between Node 16 and Node 11. This means that 44% of trucks (80 trucks) leaving the port at Node 16 are using I-4 towards I-275. The final O-D matrix also shows that 22% of the trucks (40 trucks) leaving the port at Node 16 are traveling towards Node 10 (I-4 & 22nd St. interchange). The number of trucks leaving the Port from Node 16 and traveling towards Node 9 (interchange between

I-4 and SR 41) is 19 trucks. It was concluded that 77% of the trucks leaving the port at Node 16 (142 trucks) are using I-4 during the peak hour.

The number of trucks leaving the Port of Tampa at Node 18 (Causeway Boulevard) during the peak hour is 138 trucks. The number of trucks that are leaving the Port of Tampa from Node 18 and traveling towards Node 1 (SR 41 south) is 62 trucks (45% of the total trucks leaving the port at Node 18). Also, the number of trucks leaving the Port of Tampa at Causeway Boulevard and traveling towards Node 4 (I-75) is 41 trucks. This means that 29% of the trucks leaving the port from Node 18 are using Causeway Boulevard to access I-75.

The number of trucks leaving the Port of Tampa at Node 1 (Pendola Point and Port Sutton) in the peak hour is 53 trucks. The number of trucks leaving the port at Node 1 and traveling towards Node 3 (SR 301) is 40 trucks (75% of the total trucks leaving at this node). Only 13 trucks originating from the port at Node 1 will exit the network at Node 6 (SR 618).

The number of trucks entering the Port of Tampa at Node 16 (22nd St. and 20th St.) during the peak hour is 147 trucks. The number of trucks entering the Port and originating from Node 9 (SR 41 and I-4 interchange) is 24 trucks (16% of the total trucks entering the port at Node 16). The number of trucks entering the port and originating from Node 11 (I-275/I-4 interchange) is 38 trucks (25% of the total trucks entering the port at Node 16). Since Links 9 and 10 are both I-4 links and are part of the shortest path between Nodes 9-16 and 11-16, it was determined that 43% of the trucks (62 trucks) entering the port at Node 16 are using I-4.

The number of trucks entering the Port of Tampa at Node 18 (Causeway Boulevard) during the peak hour is 157 trucks. The number of trucks entering the port at Node 18 and originating from Node 1 (SR 41 south) is 39 trucks (25% of the total trucks entering the port at Node 18). Also, the number of trucks entering the Port of Tampa on Causeway Boulevard and originating from Node 4 (I-75) is 58 trucks (38%). The number of trucks entering the port at Node 18 that are coming from Node 5 (intersection between SR 301 and Causeway Boulevard) is 36 trucks (23% of the total trucks entering the port at the Causeway Boulevard entrance).

The number of trucks entering the Port of Tampa at Node 1 (Pendola Point and Port Sutton) in the peak hour is 44 trucks. The number of trucks entering the port at Node 1 and originating from node 3 (SR 301) is 20 trucks (45% of the total trucks entering the port at this node). The number of trucks entering the port at Node 1 and originating from Node 5 (intersection between SR 301 and Causeway Boulevard) is 16 trucks (36% of the total trucks entering at this node). Table 4.25 summarizes these conclusions.

		I-4		I-275		I-75	
Direction	Total	Number of Trucks	Percentage	Number of Trucks	Percentage	Number of Trucks	Percentage
Outbound	372	142	38%	80	22%	41	11%
Inbound	348	78	22%	38	11%	20	6%

Note: % refers to trucks entering/leaving at the indicated interstate node

Table 4.25: Peak Hour Truck Volumes on the Interstate Highways Generated by Port of Tampa Freight Activity

Table 4.25 shows the total number of trucks leaving the Port of Tampa during the peak hour (372 trucks) and the number of trucks using each of the adjacent interstate highways. It also shows the percentages of the total truck volumes entering or leaving the Port of Tampa and using the different interstate highways.

The existing major routes for trucks generated by the Port of Tampa's freight activity are the highlighted routes shown in Figure 4.43. One of these routes is SR 676. This route connects the Port of Tampa (Node 18) with SR 301 & I-75 and carries (40 trucks per hour) about 30% of the trucks leaving the port from Node 18. Another route is on 22nd Street that connects the Port of Tampa (Node 16) with I-4 and consequently to I-275. This route carries (154 trucks per hour) 78% of the trucks leaving the port from Node 16.

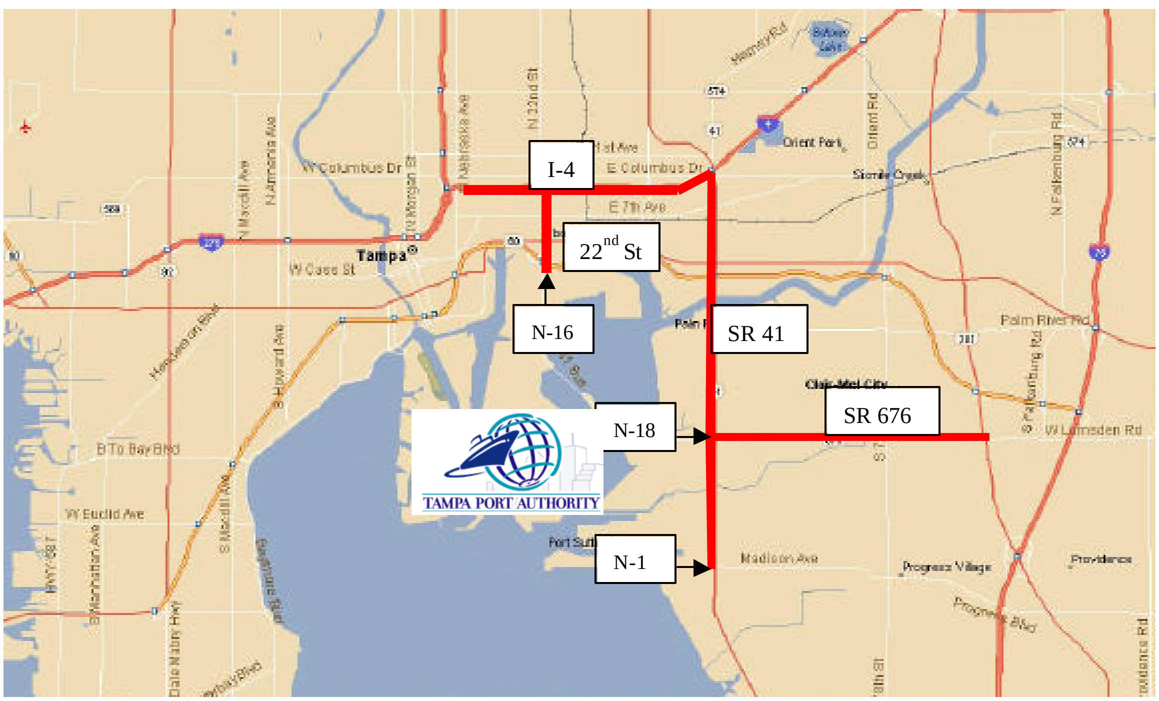


Figure 4.43: Major Truck Routes on the Port of Tampa Road Network

From the comparison between the CORSIM and VISSIM simulation packages, both can be used to solve a truck assignment problem through simulation. Both packages produced similar results; however VISSIM is more user friendly than CORSIM. The truck volumes from the field are compared to both the CORSIM and VISSIM simulated output values for the selected master links during the peak hour for the validation data set and are presented graphically in Figure 4.44 to Figure 4.51.

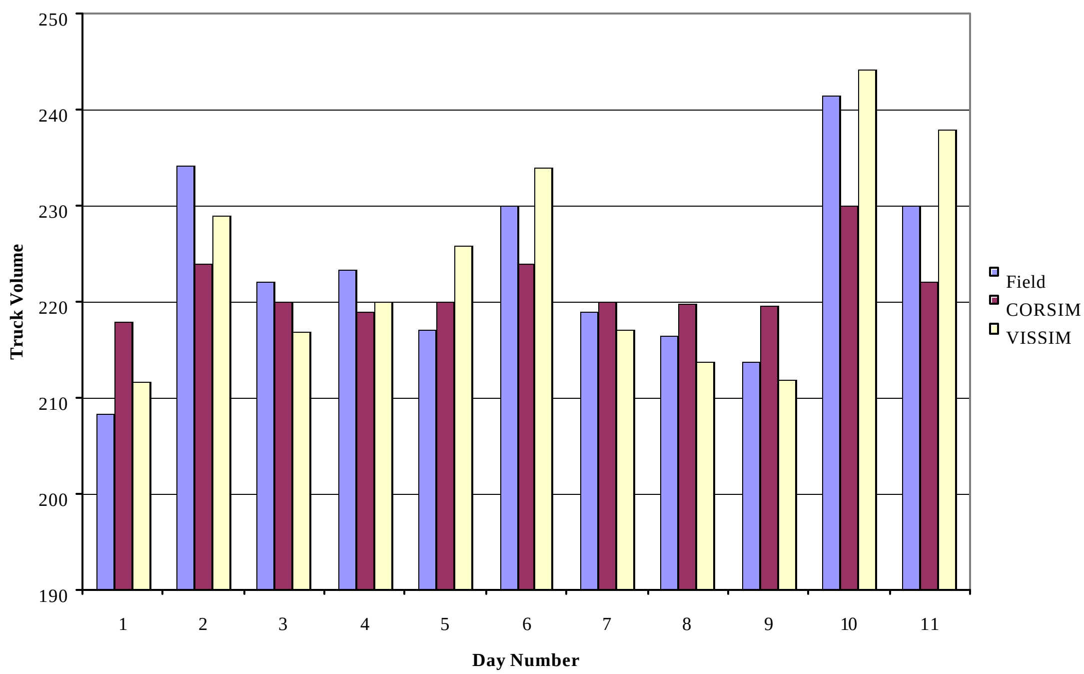


Figure 4.44: Field, CORSIM Simulated and VISSIM Simulated Truck Volumes for SR 92 Northbound

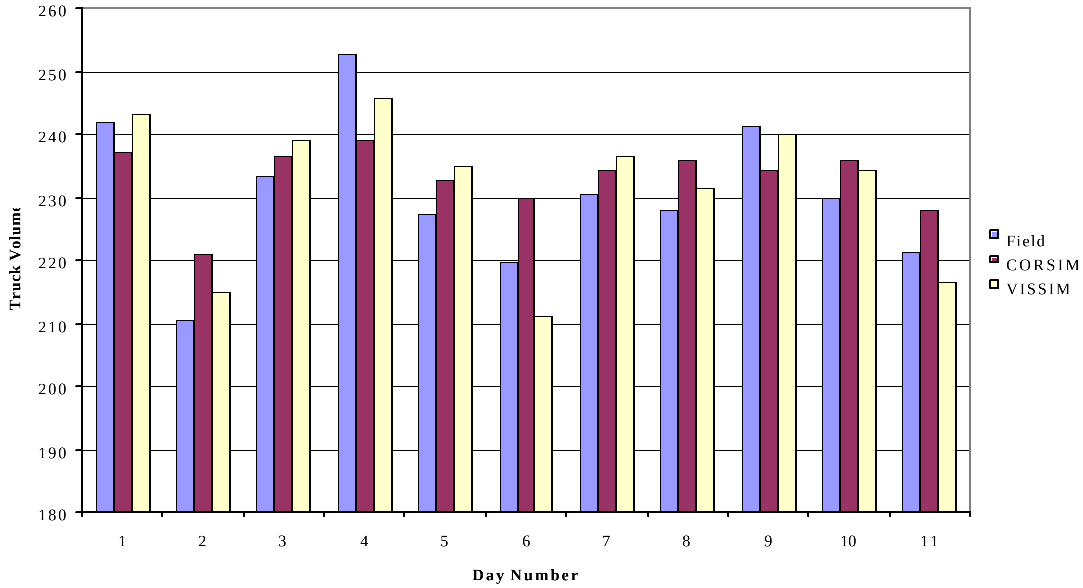


Figure 4.45: Field, CORSIM Simulated and VISSIM Simulated Truck Volumes for SR 92 Southbound

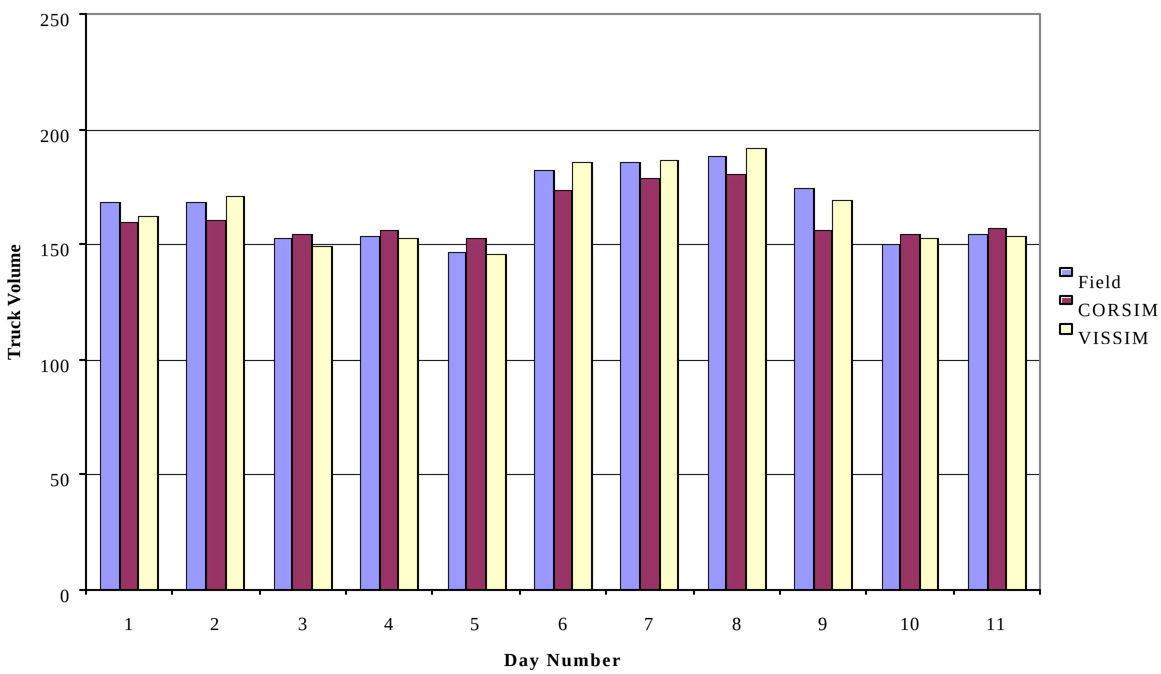


Figure 4.46: Field, CORSIM Simulated and VISSIM Simulated Truck Volumes for 50th Street Northbound

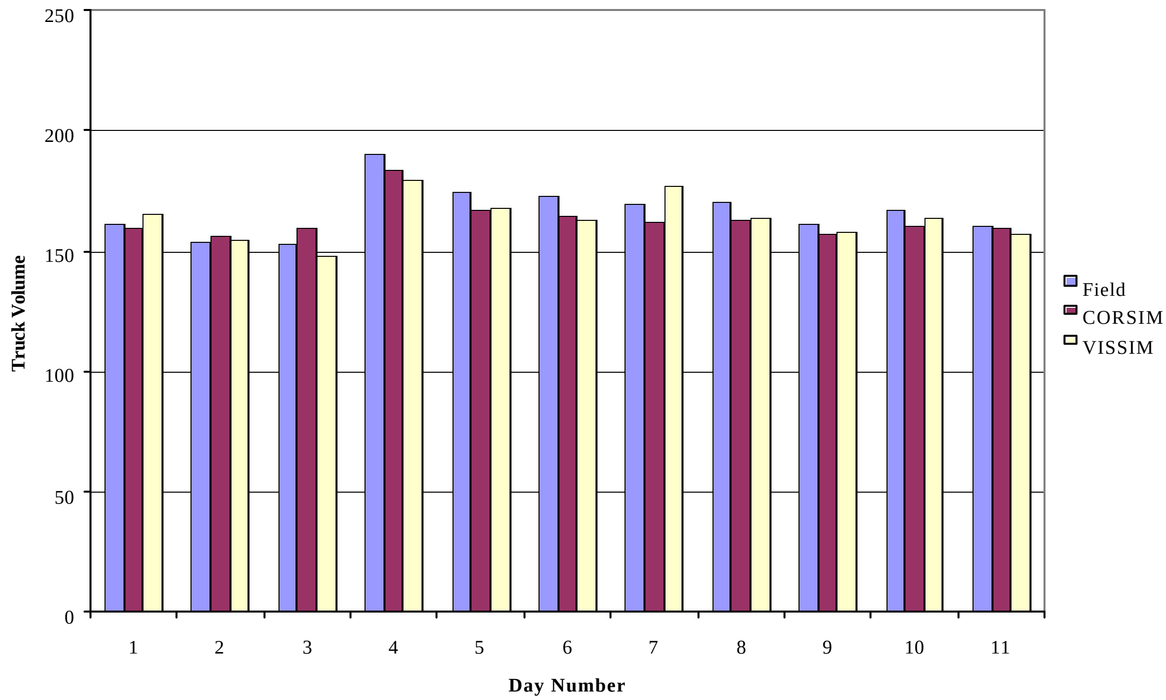


Figure 4.47: Field, CORSIM Simulated and VISSIM Simulated Truck Volumes for 50th Street Southbound

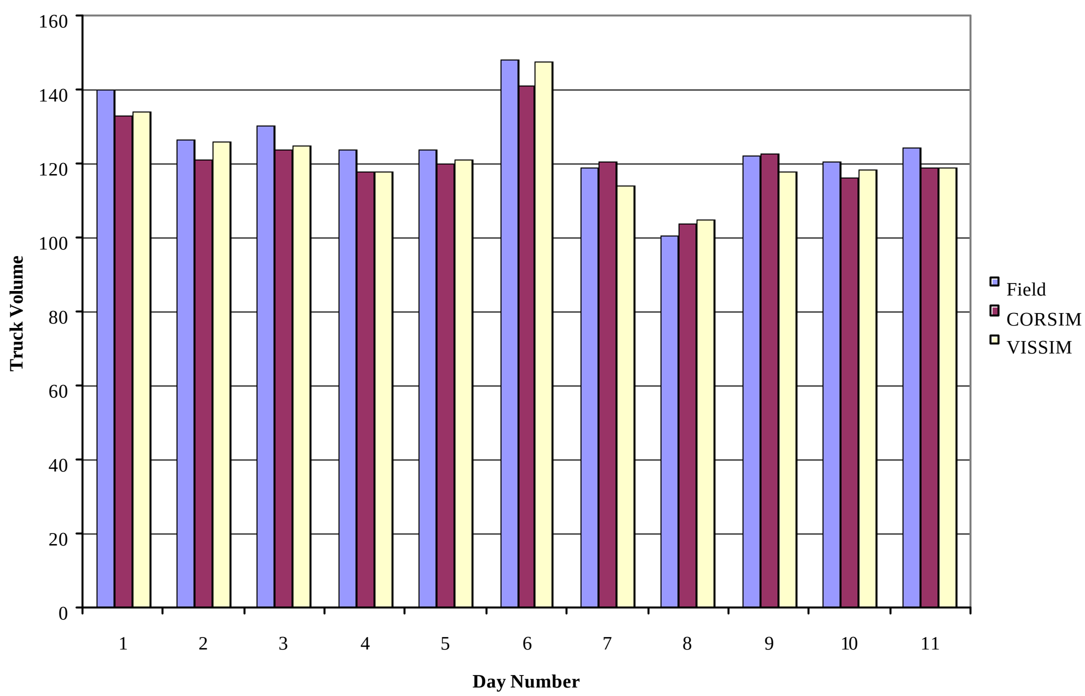


Figure 4.48: Field, CORSIM Simulated and VISSIM Simulated Truck Volumes for Causeway Boulevard Eastbound

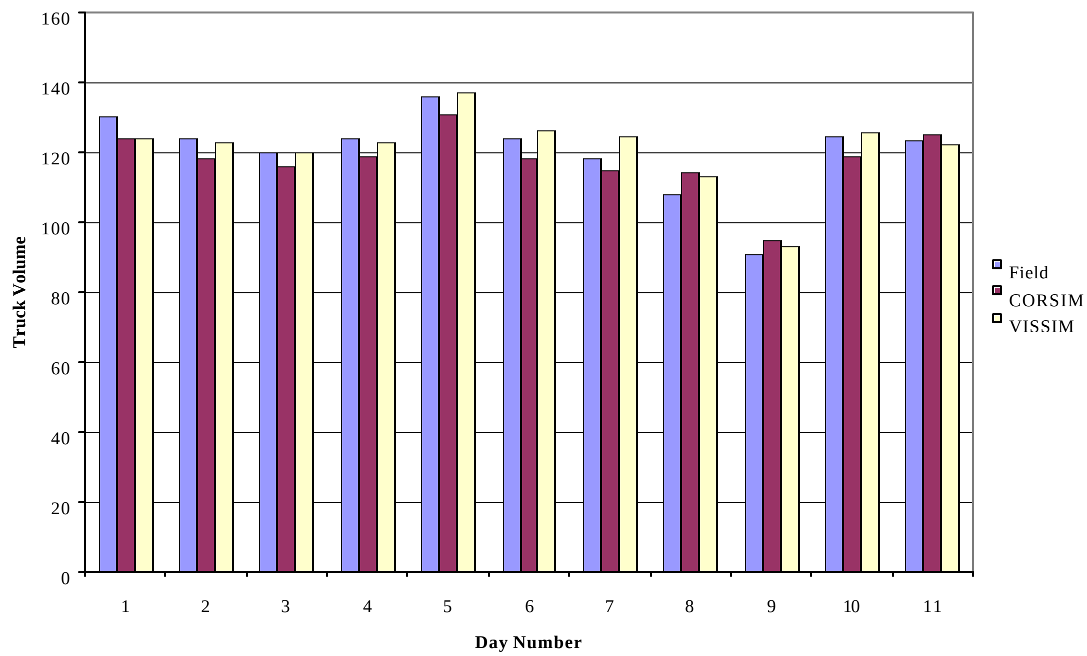


Figure 4.49: Field, CORSIM Simulated and VISSIM Simulated Truck Volumes for Causeway Boulevard Westbound

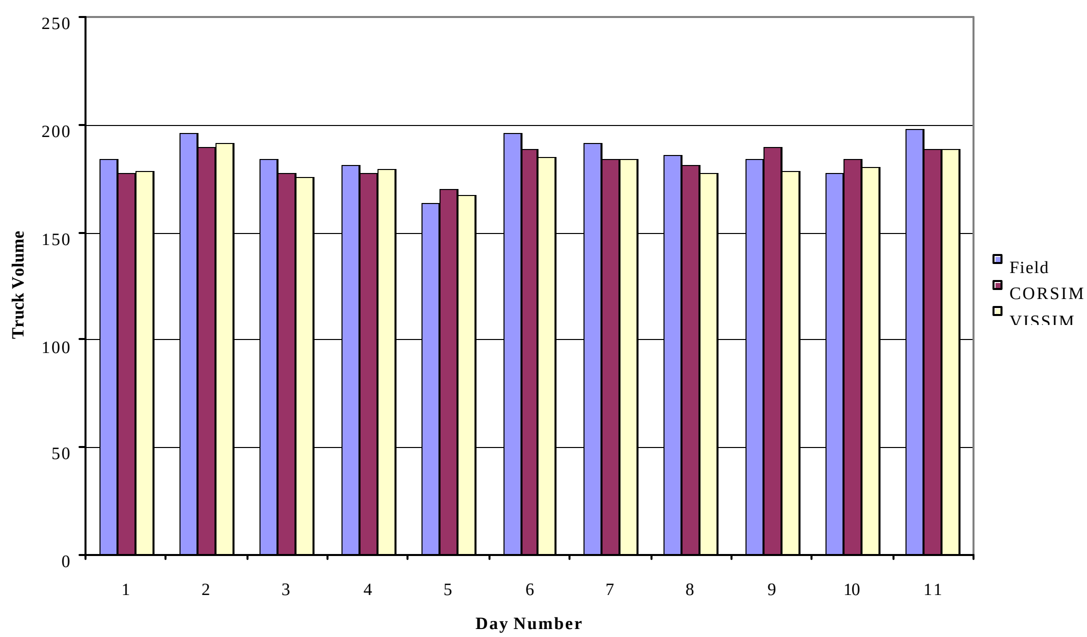


Figure 4.50: Field, CORSIM Simulated and VISSIM Simulated Truck Volumes for 22^{nd} Street

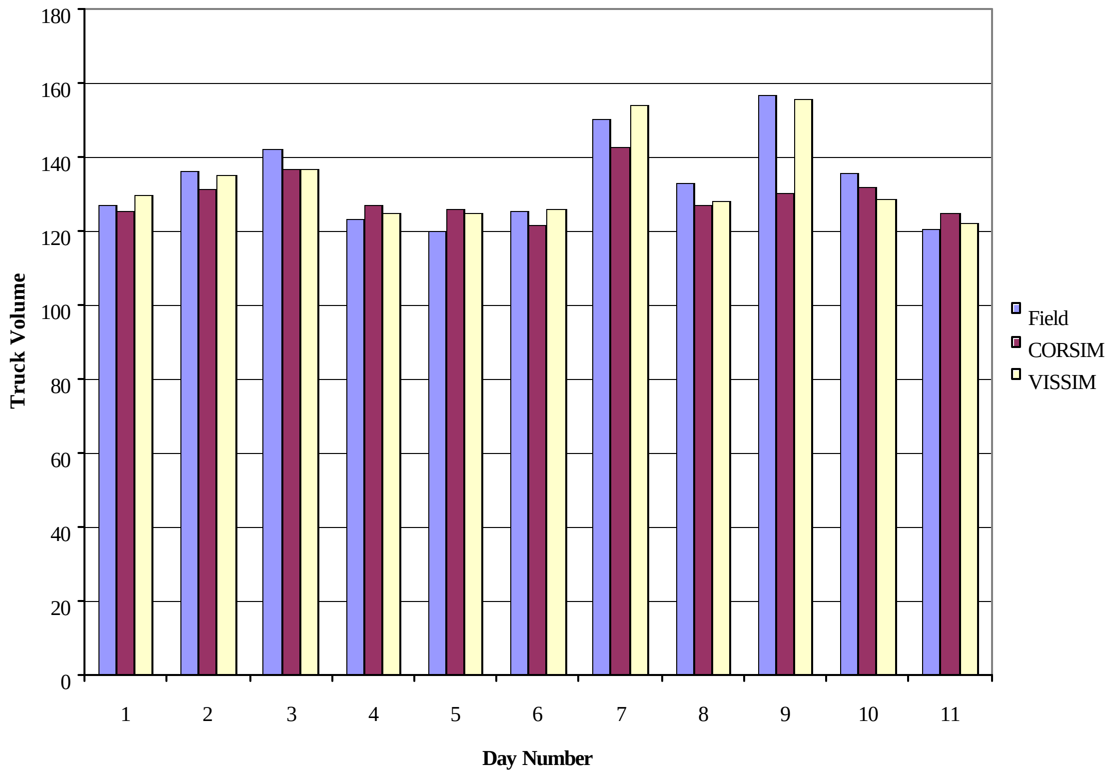


Figure 4.51: Field, CORSIM Simulated and VISSIM Simulated Truck Volumes for 21st Street

Unlike CORSIM, freeways and city streets can be coded simultaneously in VISSIM while using the traffic assignment module in both packages. Therefore, VISSIM may be more accurate in replicating the existing conditions than CORSIM. The VISSIM animation module has more features than CORSIM. For example, 3-D animation is available in VISSIM but not in CORSIM. This is beneficial because the more accurate the animation the easier it is to determine the locations of the problems on the network and the unrealistic vehicle movements. The VISSIM model was used in forecasting the Port of Tampa road network traffic due to its ease of execution.

4.4 Forecasting

As mentioned previously, the VISSIM model was selected for estimating the future number of trucks on the Port of Tampa road network. There are four steps to perform the forecasting process. These are detailed in the following subsection.

4.4.1 Port of Tampa Network Forecasting

Step 1:

An estimate of the truck volumes leaving or entering the Port of Tampa was completed for selected days from July 2005. These entrances and exits are represented in the O-D matrix by three nodes, Node 1 (Port Sutton and Pendola Point Roads), Node 16 (22^{nd} and 20^{th} Street), and Node 18 (Causeway Boulevard). The number of trucks at these nodes for any day can be obtained from the artificial neural network (ANN) truck trip generation model previously developed for the Port of Tampa during Phase II (11). The input to the ANN model was forecasted vessel freight data for year 2005. This forecast data was from Phase II of this project. The output of the ANN model is the number of trucks leaving or entering the Port of Tampa for each entrance or exit (Nodes 1, 16, and 18). The forecasted daily number of trucks leaving/entering the Port of Tampa for the month of July in 2005 is shown in Appendix N, Table N. 1 & Table N. 2. The existing T and K factors were assumed to remain the same for year 2005.

The number of trucks generated by the Port of Tampa was estimated for the first five weekdays in July 2005 using the Port of Tampa ANN model. For each day in this period (from 7/1/2005 to 7/7/2005), the peak hourly volume and its relevant number of trucks were calculated using the T & K factors from Table 4.19. Multiplying the daily number of trucks by the K factor produces the peak hour truck volumes. The truck volumes used in the forecasting process are shown in Table 4.26.

		Node 1		Node 16		Node 18	
Day	Dates	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
Friday	7/1/05	48	55	162	188	116	143
Monday	7/4/05	47	50	160	170	115	129
Tuesday	7/5/05	48	60	163	206	117	157
Wednesday	7/6/05	48	59	162	200	116	152
Thursday	7/7/05	44	50	151	170	108	130

Table 4.26: Port of Tampa Forecasted Peak Hour Truck Volumes (July 2005)

Step 2:

The growth in the number of trucks at the Port of Tampa area was necessary to compute a growth factor. This growth factor was estimated by dividing the average of the forecasted truck volumes leaving/entering the port in the peak hour for a week from July 2005 by the average number of trucks currently leaving or entering the port in the same month. Table 4.27 shows the average number of trucks entering (inbound) or leaving (outbound) the Port of Tampa for the month of July in year 2001 and the average of the forecasted number of trucks entering/leaving the port for the month of July in year 2005. The percentage of growth (G) equals the difference between the average of the number of trucks generated by the port between years 2001 & 2005 (for the same month) divided by the average number of trucks generated by the port in the same month of the base year (2001). The formula is displayed below. Table 4.27 shows the calculation results for the average percent growth in the number of trucks at the Port of Tampa.

$$G = \frac{Trucks2005 - Trucks2001}{Trucks2001} * 100$$

	Average Number of Trucks	
	Inbound	Outbound
July Year 2001	295	370
July Year 2005	321	384
Percentage of Growth	8%	4%
Average Percentage of Growth	**6%**	

Table 4.27: Average Percentage of Growth in the Number of Trucks

<u>Step 3:</u>

The O-D matrix for the forecast days in July 2005 was determined by multiplying all the volumes of the final O-D matrix for current conditions excluding the volumes for the port nodes (#'s 1, 16, & 18) by 1.06 (1 + growth factor). The port nodes are changed according to the estimated traffic volumes computer from the output of the ANN model.

<u>Step 4:</u>

The forecasted number of trucks leaving or entering the port at Nodes 1, 16, & 18 shown in Table 4.26 was distributed between the different nodes. The forecasted truck volumes are distributed using the existing percent of trucks for each O-D pair from the total. The O-D matrices for the first five weekdays of July 2005 (excluding the July 4th holiday) are shown in Figure 4.52 to Figure 4.55.

		Destination Nodes																
		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum**
Origin Nodes	**1 (Port)**	**0**	**0**	**40**	**0**	**0**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**55**
	1 south	**0**	0	0	53	0	0	21	0	56	11	0	0	0	0	**0**	**30**	
	3	**22**	0	0	106	0	0	0	106	0	0	0	0	0	0	**0**	**0**	
	4	**0**	0	106	0	0	0	0	0	34	0	0	0	0	0	**0**	**40**	
	5	**18**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**29**	
	6	**8**	0	0	0	0	0	0	0	54	64	0	83	0	0	**0**	**0**	
	7	**0**	0	0	0	0	0	0	0	27	161	0	276	0	0	**0**	**20**	
	8	**0**	0	81	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
	9	**0**	152	0	4	0	159	11	0	0	0	0	212	0	11	**25**	**0**	
	10	**0**	16	0	0	0	106	32	0	0	0	0	0	42	32	**11**	**0**	
	11	**0**	0	0	0	0	0	0	0	0	0	0	64	0	0	**48**	**0**	
	12	**0**	0	0	0	0	85	127	0	21	0	64	0	0	229	**11**	**0**	
	13	**0**	0	0	0	0	0	0	0	0	11	0	0	0	0	**25**	**0**	
	14	**0**	0	0	0	0	0	0	0	32	42	0	84	0	0	**42**	**0**	
	16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**20**	**40**	**85**	**10**	**10**	**19**	**0**	**0**	**188**
	18 (Port)	**0**	**63**	**11**	**42**	**11**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**144**
	Sum	**48**														**162**	**119**	

Figure 4.52: Forecasted O-D Matrix for July 1, 2005

		Destination Nodes																
		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum**
Origin Nodes	**1 (Port)**	**0**	**0**	**37**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**50**
	1 south	**0**	0	0	53	0	0	21	0	56	11	0	0	0	0	**0**	**28**	
	3	**22**	0	0	106	0	0	0	106	0	0	0	0	0	0	**0**	**0**	
	4	**0**	0	106	0	0	0	0	0	34	0	0	0	0	0	**0**	**43**	
	5	**17**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**29**	
	6	**8**	0	0	0	0	0	0	0	54	64	0	83	0	0	**0**	**0**	
	7	**0**	0	0	0	0	0	0	0	27	161	0	276	0	0	**0**	**16**	
	8	**0**	0	81	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
	9	**0**	152	0	4	0	159	11	0	0	0	0	212	0	11	**25**	**0**	
	10	**0**	16	0	0	0	106	32	0	0	0	0	0	42	32	**11**	**0**	
	11	**0**	0	0	0	0	0	0	0	0	0	0	64	0	0	**46**	**0**	
	12	**0**	0	0	0	0	85	127	0	21	0	64	0	0	229	**11**	**0**	
	13	**0**	0	0	0	0	0	0	0	0	11	0	0	0	0	**25**	**0**	
	14	**0**	0	0	0	0	0	0	0	32	42	0	84	0	0	**42**	**0**	
	16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**18**	**38**	**77**	**8**	**8**	**17**	**0**	**0**	**170**
	18 (Port)	**0**	**54**	**10**	**39**	**9**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**129**
	Sum	**47**														**160**	**115**	

Figure 4.53: Forecasted O-D Matrix for July 5, 2005

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum**
1 (Port)	**0**	**0**	**43**	**0**	**0**	**17**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**60**
1 south	**0**	0	0	53	0	0	21	0	56	11	0	0	0	0	**0**	**28**	
3	**22**	0	0	106	0	0	0	106	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	106	0	0	0	0	0	34	0	0	0	0	0	**0**	**45**	
5	**18**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**29**	
6	**8**	0	0	0	0	0	0	0	54	64	0	83	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	27	161	0	276	0	0	**0**	**16**	
8	**0**	0	81	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	152	0	4	0	159	11	0	0	0	0	212	0	11	**25**	**0**	
10	**0**	16	0	0	0	106	32	0	0	0	0	0	42	32	**11**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	64	0	0	**49**	**0**	
12	**0**	0	0	0	0	85	127	0	21	0	64	0	0	229	**11**	**0**	
13	**0**	0	0	0	0	0	0	0	0	11	0	0	0	0	**25**	**0**	
14	**0**	0	0	0	0	0	0	0	32	42	0	84	0	0	**42**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**23**	**46**	**91**	**10**	**10**	**22**	**0**	**0**	**206**
18 (Port)	**0**	**66**	**12**	**45**	**14**	**0**	**10**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**157**
Sum	**48**														**163**	**117**	

Figure 4.54: Forecasted O-D Matrix for July 6, 2005

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum**
1 (Port)	**0**	**0**	**43**	**0**	**0**	**16**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**59**
1 south	**0**	0	0	53	0	0	21	0	56	11	0	0	0	0	**0**	**28**	
3	**22**	0	0	106	0	0	0	106	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	106	0	0	0	0	0	34	0	0	0	0	0	**0**	**44**	
5	**18**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**29**	
6	**8**	0	0	0	0	0	0	0	54	64	0	83	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	27	161	0	276	0	0	**0**	**16**	
8	**0**	0	81	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	152	0	4	0	159	11	0	0	0	0	212	0	11	**25**	**0**	
10	**0**	16	0	0	0	106	32	0	0	0	0	0	42	32	**11**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	64	0	0	**48**	**0**	
12	**0**	0	0	0	0	85	127	0	21	0	64	0	0	229	**11**	**0**	
13	**0**	0	0	0	0	0	0	0	0	11	0	0	0	0	**25**	**0**	
14	**0**	0	0	0	0	0	0	0	32	42	0	84	0	0	**42**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**22**	**43**	**90**	**10**	**10**	**21**	**0**	**0**	**200**
18 (Port)	**0**	**64**	**12**	**44**	**13**	**0**	**10**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**153**
Sum	**48**														**162**	**116**	

Figure 4.55: Forecasted O-D Matrix for July 7, 2005

4.4.2 Port of Tampa Network Forecasting Conclusions

The O-D matrix of July 7th 2005 (Figure 4.55) shows the total number of trucks leaving the Port of Tampa at Node 16 (22nd St. and 20th St.) during the peak hour is 200 trucks. The number of trucks leaving the port from Node 16 and traveling towards Node 11 (I-4/I-275 interchange) is 90 trucks (45% of the total truck volume leaving at Node 16). Link 10 (I-4) is part of the shortest path between Node 16 and Node 11. This indicates that 45% of the trucks (90 trucks) leaving the port at Node 16 are using I-4 in the direction of I-275. The final O-D matrix also shows that 22% of the trucks (43 trucks) leaving the port at Node 16 are traveling in the direction of Node 10 (I-4 & 22nd St. ramps). The number of trucks exiting the port from Node 16 and traveling towards Node 9 (interchange between I-4 and 22nd St.) is 22 trucks. Also, 77% of the trucks leaving the port from Node 16 (155 trucks) are using the I-4 during the peak hour. The number of trucks leaving the port from Node 16 and using I-4 is estimated to increase from 142 (existing conditions) to 155 trucks in July 2005 (9% increase).

The number of trucks leaving the Port of Tampa at Node 18 (Causeway Boulevard) during the peak hour is 153 trucks. The number of trucks leaving the Port of Tampa from Node 18 and traveling towards Node 1 (SR 41 south) is 64 trucks (42% of the total trucks leaving the port at Node 18). Also, the number of trucks leaving the Port of Tampa at Causeway Boulevard and heading towards Node 4 (I-75) is 43 trucks. This means that 28% of the trucks leaving the port from Node 18 are using Causeway Boulevard to access I-75. The number of trucks leaving the port from Node 18 and using I-75 will increase slightly from 41 trucks (existing conditions) to 43 trucks in July 2005.

The number of trucks leaving the Port of Tampa at Node 1 (Pendola Point and Port Sutton) in the peak hour is 59 trucks. The number of trucks leaving the port at Node 1 and traveling towards Node 3 (SR 301) is 43 trucks (72% of the total trucks leaving at Node 1). Only 16 trucks originating from the port at Node 1 will exit the network at Node 6 (SR 618). The number of trucks leaving the port from Node 1 and using SR 301 will increase slightly from 41 trucks (existing conditions) to 43 trucks in July 2005.

The number of trucks entering the Port of Tampa at Node 16 (22nd St. and 20th St.) during the peak hour is 162 trucks. The number of trucks entering the port and originating from Node 9 (SR 41/I-4 interchange) is 25 trucks (16% of the total trucks entering the port at Node 16). The number of trucks entering the port and originating from Node 11 (I-275/I-4 interchange) is 48 trucks (29% of the total trucks entering the Port at Node 16). Since Links 9 and 10 are both I-4 links and are part of the shortest path between Nodes 9-16 and 11-16, it was determined that 45% of the trucks (73 trucks) entering the port at Node 16 are using I-4. This shows an increase from 62 trucks (existing conditions) to 73 trucks in July 2005 (17% increase).

The number of trucks entering the Port of Tampa at Node 18 (Causeway Boulevard) during the peak hour is 116 trucks. The number of trucks entering the port at Node 18 and originating from Node 1 (SR 41 south) is 28 trucks (27% of the total trucks entering the port at Node 18). The number of trucks entering the port at Causeway Boulevard and originating from Node 4 (I-75) is 44 trucks (38%). Therefore, 38% of the trucks entering the port at Causeway Boulevard are using I-75. Also, the number of trucks entering the port at Node 18 and coming from Node 5 (intersection between SR 301 and Causeway Boulevard) is 29 trucks (27% of the total trucks entering the port at

Causeway Boulevard). These numbers have decreased compared to the existing conditions.

The number of trucks entering the Port of Tampa at Node 1 (Pendola Point and Port Sutton) in the peak hour is 48 trucks. The number of trucks entering the port at Node 1 and originating from Node 3 (SR 301) is 22 trucks (45% of the total trucks entering the port at Node 1). The number of trucks entering the port at Node 1 and originating from Node 5 (intersection between SR 301 and Causeway Boulevard) is 18 trucks (36% of the total trucks entering at Node 1). These truck volumes have increased slightly when compared to the existing conditions. Table 4.28 summarizes these short term forecasting results.

		I-4		I-275		I-75	
Direction	Total	Number of Trucks	Percentage	Number of Trucks	Percentage	Number of Trucks	Percentage
Outbound	423	155	37%	90	22%	43	11%
Inbound	329	73	22%	48	15%	44	14%

Table 4.28: Forecasted Peak Hour Truck Volumes on the Interstate Highways Generated by Port of Tampa Freight Activity

Table 4.28 shows the total number of trucks leaving the Port of Tampa during the peak hour on July 5th 2005 (423 trucks) and the number of trucks using each of the adjacent interstate highways. It also shows the percentage of trucks using these interstate highways. 37% of the total number of trucks leaving the Port of Tampa are using I-4 and 22% of the total number of trucks leaving the port are using I-275. For inbound trucks, 22% of the total trucks coming to the Port of Tampa are using I-4, 15% are using I-275, and 14% are using I-75.

4.5 Sensitivity Analysis

Introduction

Four scenarios have been studied using VISSIM for a sensitivity analysis on the Port of Tampa road network. For each scenario, average travel time and average delay have been calculated for the entire network and for the major truck routes connected to the port. Average travel time and average delay were chosen as measures of effectiveness (MOEs) for each run because they are commonly used for measuring the performance of a transportation system (14). Average travel time for a link/route on a road network is the average time used for all vehicles to traverse this link from beginning (origin) to the end (destination) during a specific period of time (usually peak hour). Average delay for a link/route on a road network is the difference between the average travel time during a specific period of time and the average travel time during the off-peak period (free flow conditions). The major truck routes for the Port of Tampa road network include SR 41 (Links 17 and 30), 21st & 22nd Streets (Link 25), I-4 (Links 9, 10, and 11), and Causeway Boulevard (Links 22 and 20). Figure 4.56 shows the Port of Tampa road network with the major truck routes identified with purple highlight lines.

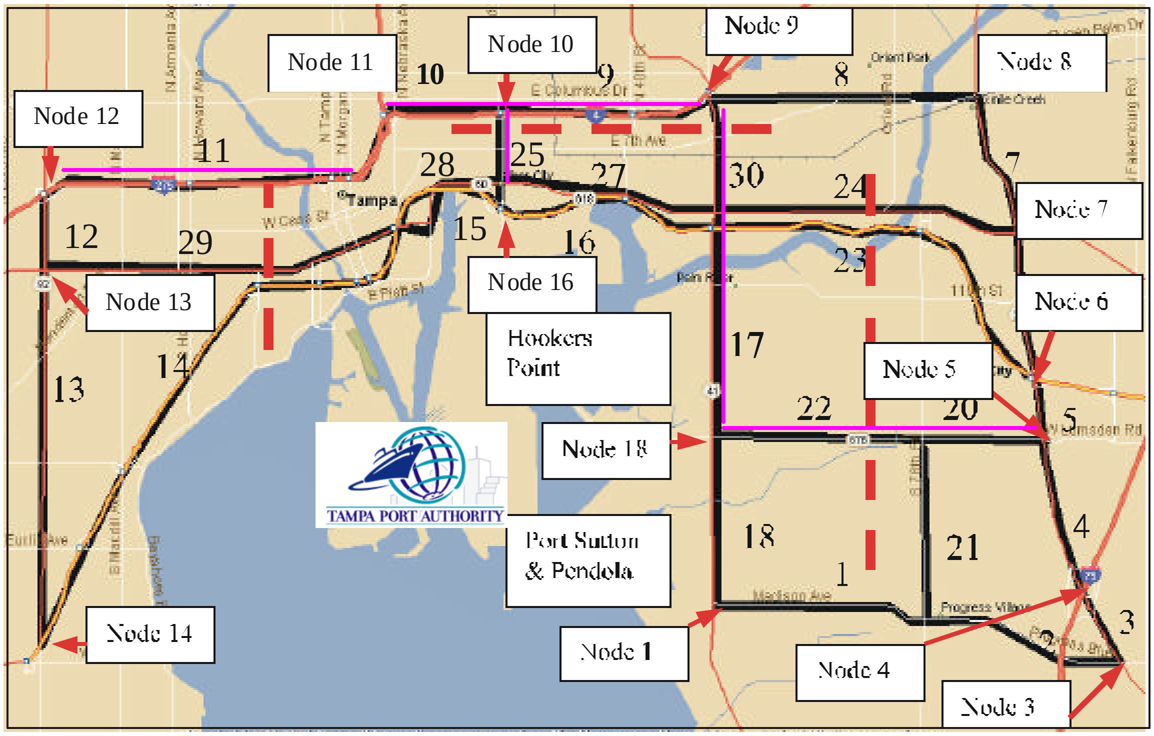


Figure 4.56: The Port of Tampa Road Network

For each scenario, average travel time and average delay were obtained from VISSIM output for the entire network and for the major trucks routes. The highlighted volumes in the existing condition O-D matrix shown in Figure 4.57 represent the O-D pairs associated with the major routes. The average travel time and average delay for the entire network was calculated by averaging the travel time or the average delay for all the network links.

Causeway Boulevard (Links 20 & 22) is part of the shortest path associated with the O-D pairs 18-3, 4-18, 18-4, 5-18, 18-5, and 7-18. 22nd and 21st Streets (Link 25) are part of the shortest path associated with the O-D pairs 9-16, 16-9, 10-16, 16-10, 11-16, and 16-11. Interstate 4 (Links 9 &10) is part of the shortest path associated with the O-D pairs 9-16, 16-9, 11-16, and 16-11. SR 41 (Links 30 & 17) is part of the shortest path associated with the O-D pairs 7-18, 9-16, and 16-19.

		Destination Nodes															
		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**
Origin Nodes	**1 (Port)**	0	0	40	0	0	13	0	0	0	0	0	0	0	0	0	0
	1 south	0	0	0	50	0	0	20	0	53	10	0	0	0	0	0	39
	3	20	0	0	100	0	0	0	100	0	0	0	0	0	0	0	0
	4	0	0	100	0	0	0	0	0	32	0	0	0	0	0	0	**58**
	5	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**36**
	6	8	0	0	0	0	0	0	0	51	60	0	78	0	0	0	0
	7	0	0	0	0	0	0	0	0	26	152	0	260	0	0	0	**25**
	8	0	0	76	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	143	0	4	0	150	10	0	0	0	0	200	0	10	**24**	0
	10	0	15	0	0	0	100	30	0	0	0	0	0	40	30	**16**	0
	11	0	0	0	0	0	0	0	0	0	0	0	60	0	0	**38**	0
	12	0	0	0	0	0	80	120	0	20	0	60	0	0	216	10	0
	13	0	0	0	0	0	0	0	0	0	10	0	0	0	0	23	0
	14	0	0	0	0	0	0	0	0	30	40	0	79	0	0	36	0
	16 (Port)	0	0	0	0	0	0	0	5	**19**	**40**	**80**	10	10	18	0	0
	18 (Port)	0	62	**10**	**41**	**10**	0	8	8	0	0	0	0	0	0	0	0

Figure 4.57: Port of Tampa Road Network O-D Matrix for Existing Conditions

4.5.1 Scenario 1 (Base Scenario)

The first scenario evaluated the existing conditions of the network using the measures of effectiveness (average travel time and average delay). This scenario was used as a base for the comparisons between different scenarios. The Port of Tampa road network was used in this run without any changes to the geometry or the traffic operation parameters. The average travel time for the entire network is 329 seconds/vehicle. See Appendix O, Table O. 1 for average travel times and average delays for each link. The average travel times between the major O-D pairs are shown in Figure 4.58. The O-D pairs associated with port Node 16 are highlighted. The average delay for the entire network is 113 seconds/vehicle. The average delay for the same O-D pairs is shown in Figure 4.59. See Figure 4.56 for the major truck routes for this scenario.

Nodes	3	4	5	9	10	11	16	18
4								462
5								346
7								568
9							354	
10							115	
11							350	
16				342	167	361		
18	548	441	353					

Figure 4.58: Average Travel Time (sec/veh) Between Major O-D Pairs (Base Scenario)

Nodes	3	4	5	9	10	11	16	18
4								145
5								117
7								229
9							45	
10							39	
11							58	
16				40	30	53		
18	232	132	113					

Figure 4.59: Average Delay (sec/veh) on the Major Truck Routes (Base Scenario)

4.5.2 Scenario 2

The second scenario adds one lane for the north and south directions of Link 25 (22nd Street and 21st Street). No changes to the geometry or the traffic operation parameters except for the addition of one lane for both directions of Link 25 were made to the network. The same O-D matrix from the base scenario was used.

The average travel time for the entire network is 302 sec/veh. The average travel time for the entire network decreased from 329 to 302 sec/veh (8% reduction). See Appendix O, Table O. 2 for the average travel times and average delays for each link. The average travel times between the major O-D pairs are shown in Figure 4.60. It can be noted that the average travel time between Node 16 (port node) and Nodes 9, 10, and 11 (I-4 Nodes) declined significantly (approximately a 50% reduction). See shaded cells in Figure 4.58 & Figure 4.60 for comparisons. The travel times between all other O-D pairs did not change significantly.

Nodes	3	4	5	9	10	11	16	18
4								477
5								357
7								570
9							215	
10							76	
11							170	
16				208	86	186		
18	539	459	372					

Figure 4.60: Average Travel Time (sec/veh) Between Major O-D Pairs (Scenario 2)

The average delay for the entire network in the second scenario is 94 sec/veh. A 12% decrease in the average delay for the entire network was observed (from 107 to 94 sec/veh). The average delay for the O-D pairs associated with the major truck routes are shown in Figure 4.61. The average delay between Node 16 (port node) and Nodes 9, 10, and 11 (I-4 Nodes) declined significantly (approximately 50%). The cells in Figure 4.59 & Figure 4.61 are shaded for comparative purposes. The delay between all other O-D pairs had virtually no change.

Nodes	3	4	5	9	10	11	16	18
4								136
5								124
7								235
9							30	
10							14	
11							21	
16				23	18	46		
18	235	124	119					

Figure 4.61: Average Delay (sec/veh) on the Major Truck Routes (Scenario 2)

Scenario 2 concludes that adding one lane to Link 25 (22nd Street and 21st Street) will reduce the average delay and average travel time for not only the major truck routes but for the entire network as well. Figure 4.62 highlights the major truck routes for this scenario.

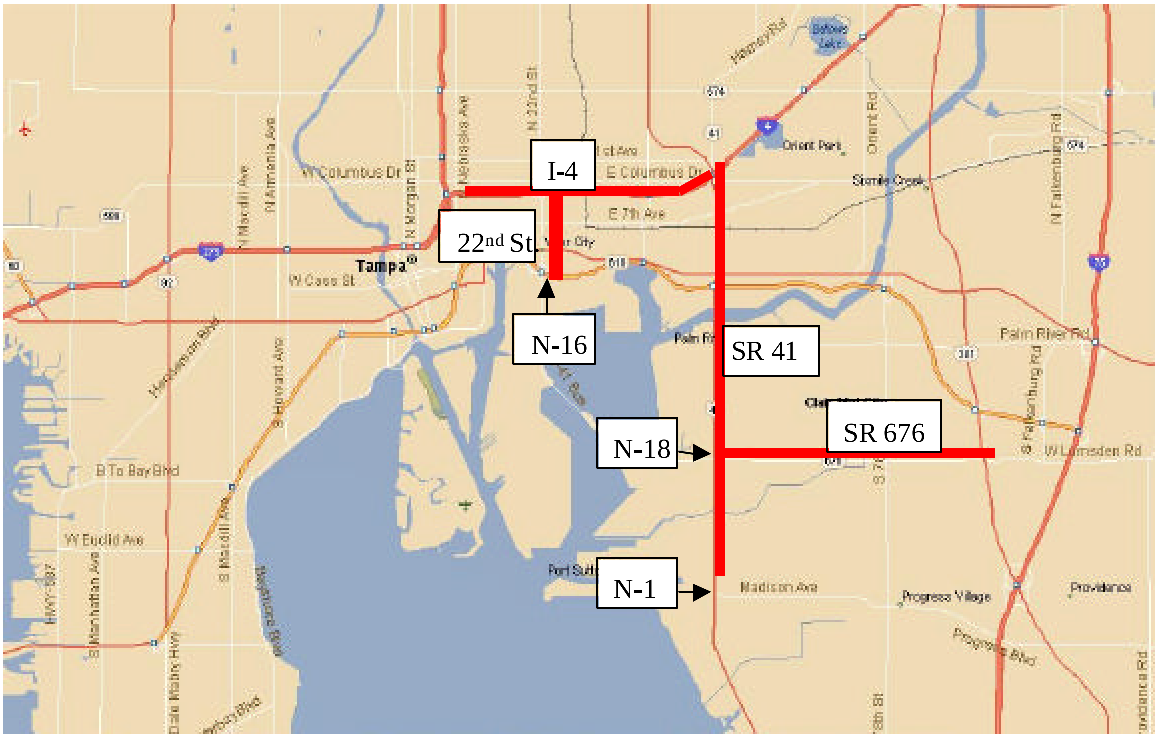


Figure 4.62: Major Truck Routes on the Port of Tampa Road Network (Scenario 2)

4.5.3 Scenario 3

The third scenario evaluates the network if the truck traffic was diverted from Link 25. This scenario does not allow trucks to use 22nd or 21st Streets (the segment between the port (Node 16) and I-4 (Node 10)). The Port of Tampa road network was used in this run without any changes to the geometry or the traffic operation parameters except for eliminating truck traffic on Link 25.

From the simulation results, the average travel time for the entire network is 348 sec/veh. Appendix O, Table O. 3 shows the average travel times and average delays for each link. The average travel time for the entire network increased from 329 to 348 sec/veh (6% increase). The average travel times between the major O-D pairs are shown in Figure 4.63. The average travel time between Node 16 (the port) and Nodes 9, 10, and

11 (I-4 Nodes) declined significantly. The shaded cells in Figure 4.58 & Figure 4.63 can be referenced for individual comparisons. All other travel times between the major O-D pairs have increased. This is because all the truck traffic has been diverted from Link 25 to the other available routes. This truck diversion increases the percentage of trucks on other links and consequently the travel time on these routes also increases.

Nodes	3	4	5	9	10	11	16	18
4								476
5								359
7								651
9							312	
10							102	
11							189	
16				299	76	196		
18	537	461	367					

Figure 4.63: Average Travel Time (sec/veh) Between Major O-D Pairs (Scenario 3)

The average delay for the entire network in the third scenario is 113 sec/veh. Due to the prohibition of trucks on Link 25, the network average delay increased by 5% (from 107 to 113 sec/veh). However, the average delay between Node 16 (the port) and Nodes 9, 10, and 11 (I-4 Nodes) decreased significantly (approximately 50%). The average delays for the O-D pairs associated with the major truck routes are shown in Figure 4.64. The cells in Figure 4.59 & Figure 4.64 are shaded for comparative purposes. All other average delays between the major O-D pairs have increased. This is because all the truck traffic has been diverted from Link 25 to the other routes. This truck diversion increases the percentage of trucks on other links and consequently the delay on these routes increases.

Nodes	3	4	5	9	10	11	16	18
4								136
5								124
7								224
9							41	
10							7	
11							21	
16				32	18	38		
18	230	128	131					

Figure 4.64: Average Delay (sec/veh) on the Major Truck Routes (Scenario 3)

It can be concluded that prohibiting truck traffic on Link 25 (22nd Street and 21st Street) will increase the average delay and the average travel time for the major truck routes and the entire network. Due to the current high truck traffic in the base scenario, these results are expected. Figure 4.65 highlights the major truck routes for this scenario.

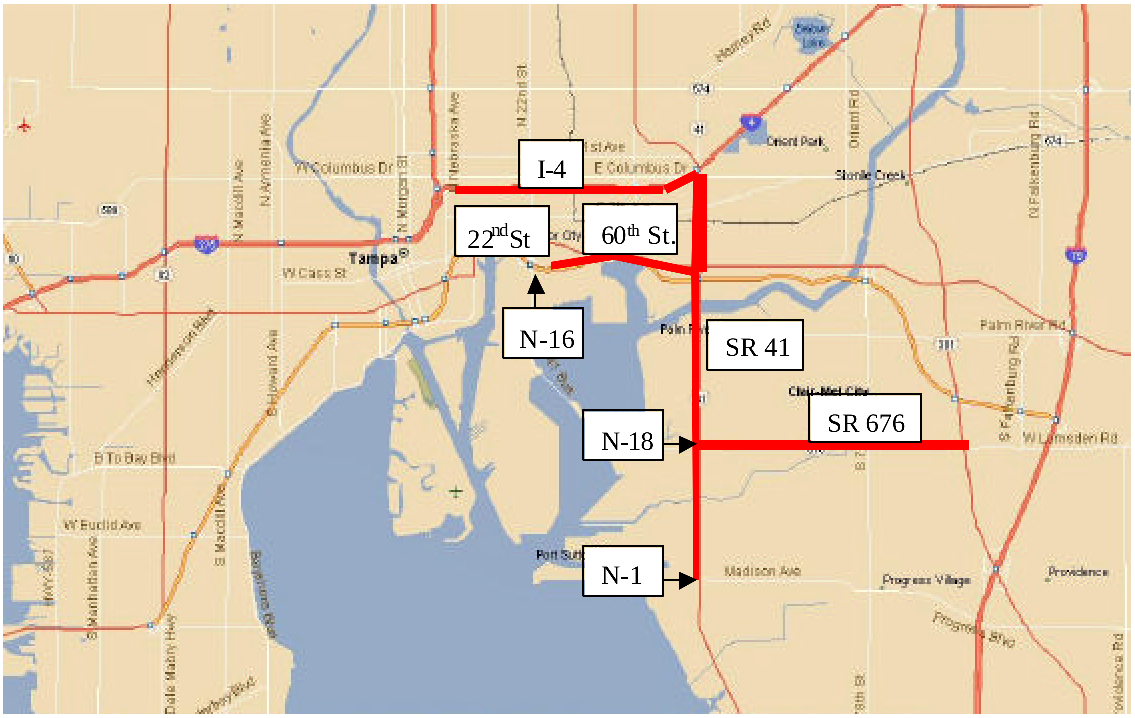


Figure 4.65: Major Truck Routes on the Port of Tampa Road Network (Scenario 3)

4.5.4 Scenario 4

The fourth scenario evaluates the network using the same measures of effectiveness (average travel time and average delay) for an incident occurrence on Link 25 (22nd Street). Link 25 was reduced from two lanes to one for 22nd Street north of the port (Node 16). One lane on 22nd Street would be blocked due to the incident. No other modifications to the geometry or the traffic operation parameters were done to the Port of Tampa road network.

The average travel time for the entire network is 397 sec/veh. See Appendix O, Table O. 4 for average travel times and average delays for each link. The average travel time for the entire network increased from 329 to 397 sec/veh (17% increase). The average travel times between the major O-D pairs are shown in Figure 4.66. The average travel time between Node 16 (the port) and Nodes 9, 10, and 11 (I-4 Nodes) increased significantly. The cells in Figure 4.58 & Figure 4.66 are shaded for comparative purposes. All other travel times between the major O-D pairs have also increased. This is because all the traffic has been diverted from Link 25 to other routes.

Nodes	3	4	5	9	10	11	16	18
4								470
5								363
7								642
9							351	
10							119	
11							358	
16				456	239	481		
18	553	452	369					

Figure 4.66: Average Travel Time (sec/veh) Between Major O-D Pairs (Scenario 4)

The average delay for the entire network is 128 sec/veh. This incident increased the average delay for the entire network by 16% (from 107 to 128 sec/veh). The average delay between Node 16 (the port) and Nodes 9, 10, and 11 (I-4 Nodes) increased significantly (approximately 60%). The average delays for the same O-D pairs are shown in Figure 4.67. The cells in Figure 4.59 & Figure 4.67 are shaded for comparative purposes. Also, all other average delays between the major O-D pairs have increased. This is because all traffic has been diverted from Link 25 to other routes.

Nodes	3	4	5	9	10	11	16	18
4								156
5								120
7								243
9							47	
10							42	
11							61	
16				63	49	84		
18	243	138	126					

Figure 4.67: Average Delay (sec/veh) on the Major Truck Routes (Scenario 4)

It can be concluded that blocking one lane of 22nd Street for the entire traffic will increase the average delay and the average travel time significantly for both the major truck routes and for the entire network. This is expected considering 22nd St. (Link 25) carries an estimated vehicular volume of 1,000 vehicles during the peak hour. Figure 4.68 highlights the major truck routes for this scenario.

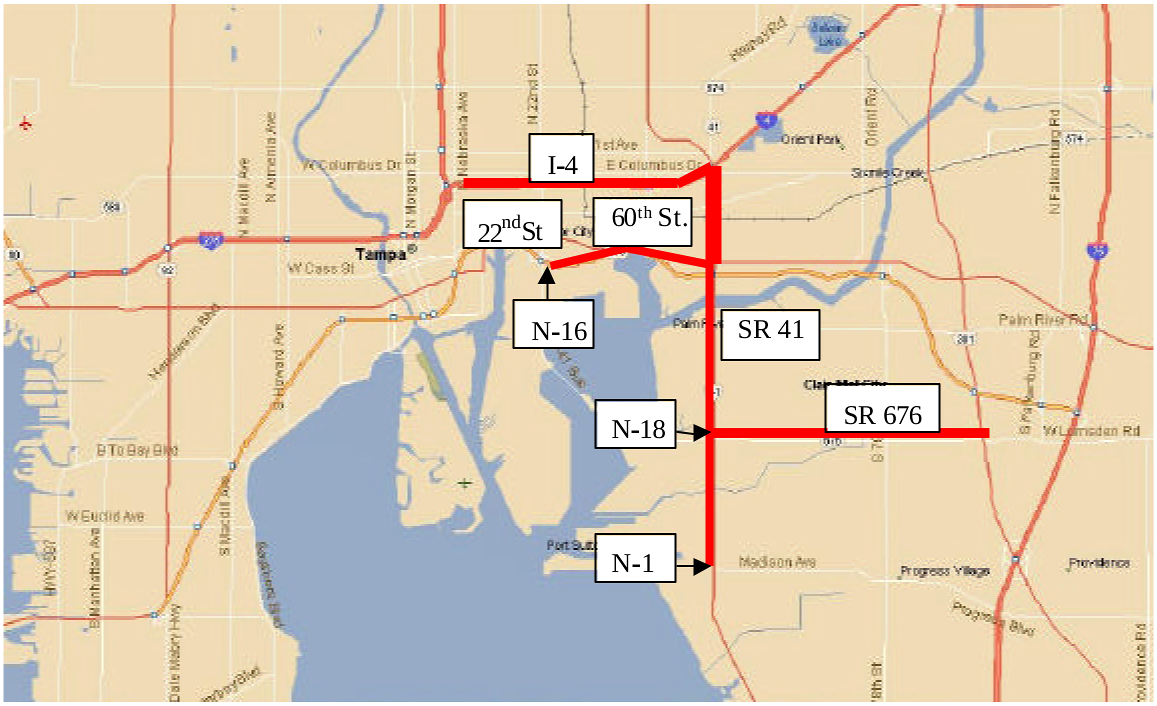


Figure 4.68: Major Truck Routes on the Port of Tampa Road Network (Scenario 4)

5. TRANSFERABILITY

5.1 Develop Route Assignment Model

The results from the Port of Tampa route assignment modeling provided supporting conclusions that VISSIM is easier to use for building a road network. Therefore, VISSIM was selected to test the transferability of the methodology developed with the Port of Tampa. The same general methodology steps for modeling the trucks generated by the Port of Tampa's freight activity were followed for Port Canaveral.

5.1.1 Port Canaveral Network Definition

The road network connecting to Port Canaveral has been defined based on FDOT's 1999 Traffic Data CD and observations of the surrounding area roads that can accommodate heavy trucks. Table 5.1 lists the data extracted from the FDOT data CD. A number of trips were made to the Cape Canaveral area to investigate the network. Figure 5.1 is a map of the surrounding area.

Link #	Start Node	End Node*	FDOT Site #	AADT	K-Factor	D-Factor	T-Factor
1	node 1	node 4	359	48500	10.31	53.65	5.87
9	node 1	-	362	26500	10.31	53.65	4.75
8	node 1	-	360	38000	10.31	53.65	5.87
2	node 1	node 2	361	37000	10.31	53.65	2.56
2	node 1	node 2	280	32500	10.31	53.65	5.2
10	node 2	node 7	13	39000	10.31	53.65	1.61
10	node 2	node 7	1007	31500	10.31	53.65	2.64
10	node 2	node 7	5153	26000	10.31	53.65	1.61
3	node 3	node 2	5119	32500	10.31	53.65	1.61
3	node 3	node 2	5069	16500	10.31	99.99	1.61
3	node 3	node 2	5071	24500	10.31	99.99	1.61
12	node 3	-	353	36000	10.31	53.65	4.53
5	node 3	node 5	5068	26000	10.31	53.65	13.97
5	node 3	node 5	78	21000	10.31	53.65	13.97
5	node 3	node 5	80	22000	10.31	53.65	13.97
14	node 5	-	365	55500	10.64	57.14	20.45
16	node 5	-	385	13300	10.31	53.65	13.97
6	node 5	node 6	366	42000	10.64	57.14	21.33
6	node 5	node 6	368	42500	10.64	57.14	21.23
15	node 6	-	399	16900	10.31	53.65	13.76
13	node 6	-	401	33000	10.64	57.14	21.23
7	node 6	node 4	400	19600	10.31	53.65	13.76
7	node 6	node 4	377	26000	10.31	53.65	5.16
11	node 4	-	403	33500	10.31	53.65	4.53
4	node 4	node 3	187	39000	10.31	53.65	4.53
4	node 4	node 3	5064	35000	10.31	53.65	4.53
4	node 4	node 3	5124	29000	10.31	53.65	4.53
4	node 4	node 3	5125	26500	10.31	53.65	3.34
17	node 7	-	5115	40500	10.31	53.65	5.87
17	node 7	-	135	38500	10.31	53.65	5.87
17	node 7	-	5182	38500	10.31	53.65	5.87
17	node 7	-	5181	26500	10.31	53.65	5.87
17	node 7	-	354	28000	10.31	53.65	5.87
* the "-" indicates exit from the network.							
K-Factor: ratio between the peak hourly volume and daily volume.							
D-Factor: directional factor							
T-Factor: converts a truck volume to the relevant total traffic volume.							

Table 5.1: 1999 FDOT Traffic CD Data for the Port Canaveral Network

Figure 5.1: Cape Canaveral Area Map

Figure 5.2 is a diagram of the network. Table 5.2 lists the links and nodes for the Port Canaveral network with their corresponding descriptions. Most of the links are interstate highways or state roads that have high capacity due to their geometric features. No other major routes used by the trucks transporting freight to and from the port have been identified. Internal nodes are locations on the identified network where traffic can travel from one link to another. These are road intersections or interchanges. External nodes are the origin-destination points for the network and make up the Origin-Destination (O-D) matrix used as input to the computer simulation model. An external node can be a special generator such as a port, an intersection, interchange, or a termination point on a network link that extends outside the selected network boundary. Due to the difference in complexity between Tampa and Cape Canaveral the level of detail for Tampa was much greater than the Port Canaveral road network. Furthermore, the Cape Canaveral area is less urbanized than Tampa thus attributing to the differences in the defined network. These differences are a desired component for testing the transferability of the methodology to a different port network.

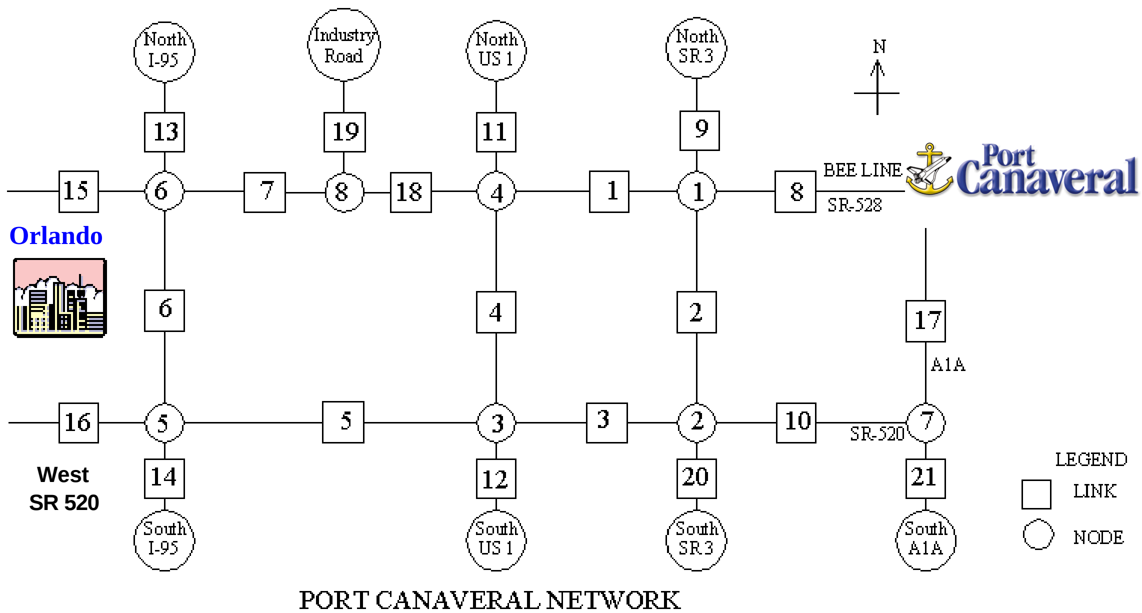


Figure 5.2: Port Canaveral Truck Route Network

Link #	Link Description
1	SR 528 (between SR 3 and US 1)
2	SR 3 (between SR 528 and SR 520)
3	SR 520 (between SR 3 and US 1)
4	US 1 (between SR 528 and SR 520)
5	SR 520 (between US 1 and I 95)
6	I 95 (between SR 528 and SR 520)
7	SR 528 (between Industry Rd and I 95)
8	SR 528 (between Port Canaveral and SR 3)
9	SR 3 (North of SR 528)
10	SR 520 (East of SR 3)
11	US 1 (North of SR 528)
12	US 1 (South of SR 528)
13	I 95 (North of SR 528)
14	I 95 (South of SR 520)
15	SR 528 (between Orlando and I 95)
16	SR 520 (West of I 95)
17	SR A1A (North of SR 520)
18	SR 528 (between US 1 and Industry Rd)
19	Industry Rd (North of SR 528)
20	SR 3 (South of SR 528)
21	SR A1A (South of SR 520)

Node #	Internal Node Description
1	SR 528 and SR 3
2	SR 520 and SR 3
3	SR 520 and US 1
4	SR 528 and US 1
5	SR 520 and I 95
6	SR 528 and I 95
7	SR 520 and SR A1A
8	SR 528 and Industry Rd

External Nodes
West SR 520
South I-95
North I-95
South US 1
North US 1
South SR 3
North SR 3
South A1A
Orlando
Port Canaveral
Industry Road

Table 5.2: Port Canaveral Network Links and Nodes

5.1.2 Port Canaveral Network Data Collection

Data supplied by the Brevard County Traffic Division and the City of Cocoa were used with field data and observations to build the Port Canaveral network. The City of Cocoa provided a minimal set of turning movement data and results from a couple of local traffic studies.

Signal timing sheets were provided for eight intersections. These sheets documented the green time allocated for each direction. They also included the geometric features of each intersection. The geometric features included number of lanes, left turn bays, right turn bays, and the configuration of the intersection (i.e. islands, medians). Table 5.3 lists the data received from Brevard County by node number and intersection. The date field is when the data was most recently updated, according to Brevard County. All other data necessary for developing the model were obtained through observations in the field.

In order to build the initial O-D matrix, the 1999 FDOT Traffic CD data was utilized. Table 5.1 summarized the traffic data for the Port Canaveral network from the FDOT Traffic CD. This traffic data combined with the link and node information was the data used to build the initial model and begin the calibration.

Node	Intersection	Signal Timing	Geometric Features	Date	Source
1	SR 3 & SR 528 WB Ramp	Available	Available	Jul-01	Brevard County
1	SR 3 & SR 528 EB Ramp	Available	Available	Jul-01	Brevard County
2	SR 3 & SR 520	Available	Available	Jan-02	Brevard County
3	US 1 & SR 520	Available	Available	May-00	Brevard County
4	US 1 & SR 528 WB Ramp	Available	Available	May-00	Brevard County
4	US 1 & SR 528 EB Ramp	Available	Available	May-00	Brevard County
5	SR 520 & I-95 SB Ramp	Available	Available	May-00	Brevard County
5	SR 520 & I-95 NB Ramp	Available	Available	May-00	Brevard County

Table 5.3: Brevard County Traffic Data Inventory

5.1.3 Port Canaveral Field Traffic Data Collection: Freight Terminals

Data collection began on September 20th, 2001 at the north and south freight terminals and was completed at the end of March 2002. Figure 5.3 shows a layout of the port area. The blue stars indicate the data collection locations for the truck counts at the north and south freight terminals.

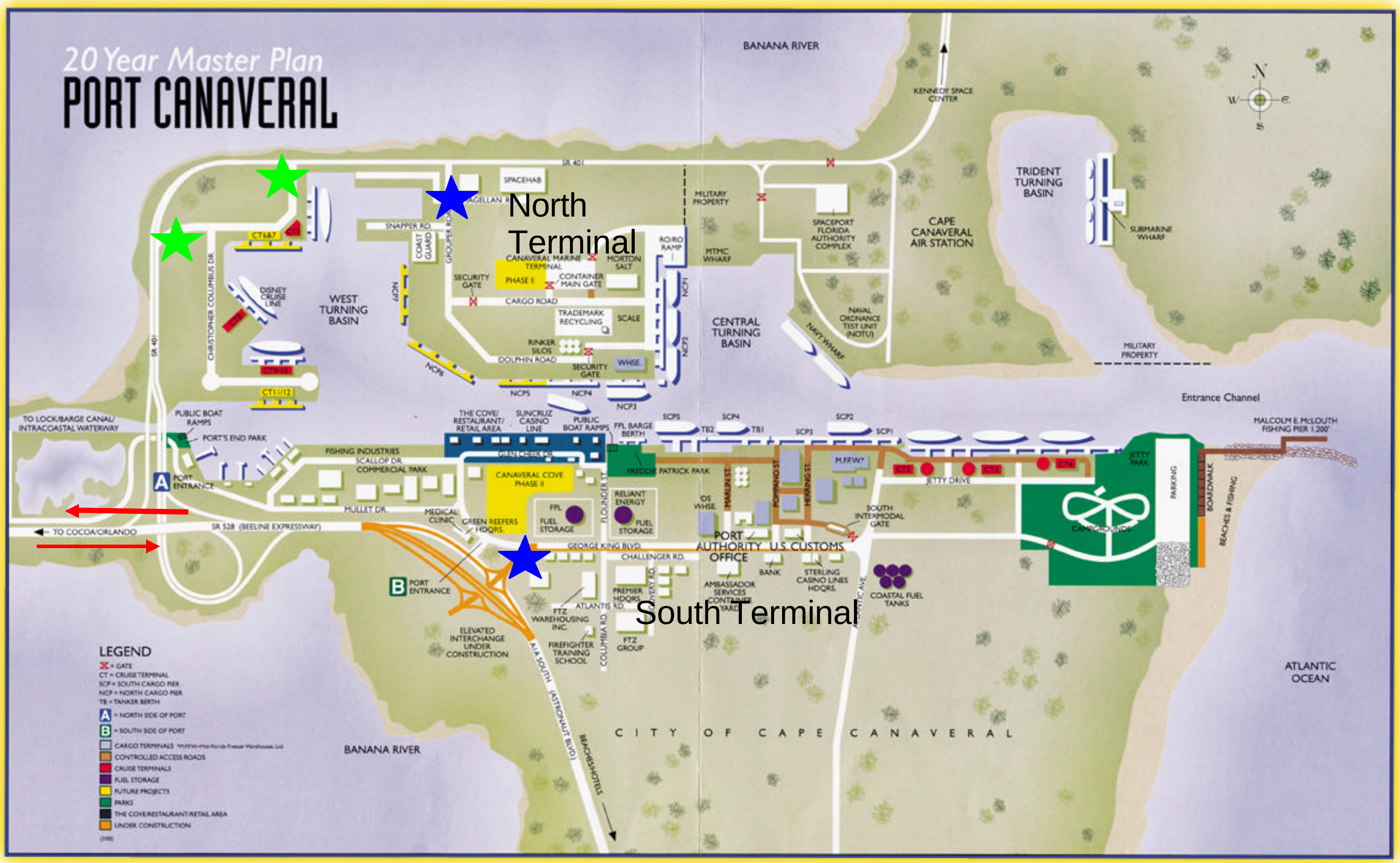


Figure 5.3: Port Canaveral Map

A data collection period from Friday, September 21st 2001 to December 3rd, 2001 was done for the cruise terminals (indicated by green stars in Figure 5.3) to determine if there is significant truck traffic. Compared to the freight terminals, the truck traffic is insignificant. Furthermore, the cruise terminal truck traffic is not directly related to the vessel freight activity at the freight terminals. Figure 5.4 displays the results of the data collected at the cruise terminals compared to the freight terminals. The breaks in the data lines represent periods where data was not available. This was due to equipment failure or an incomplete day (not a full 24 hours).

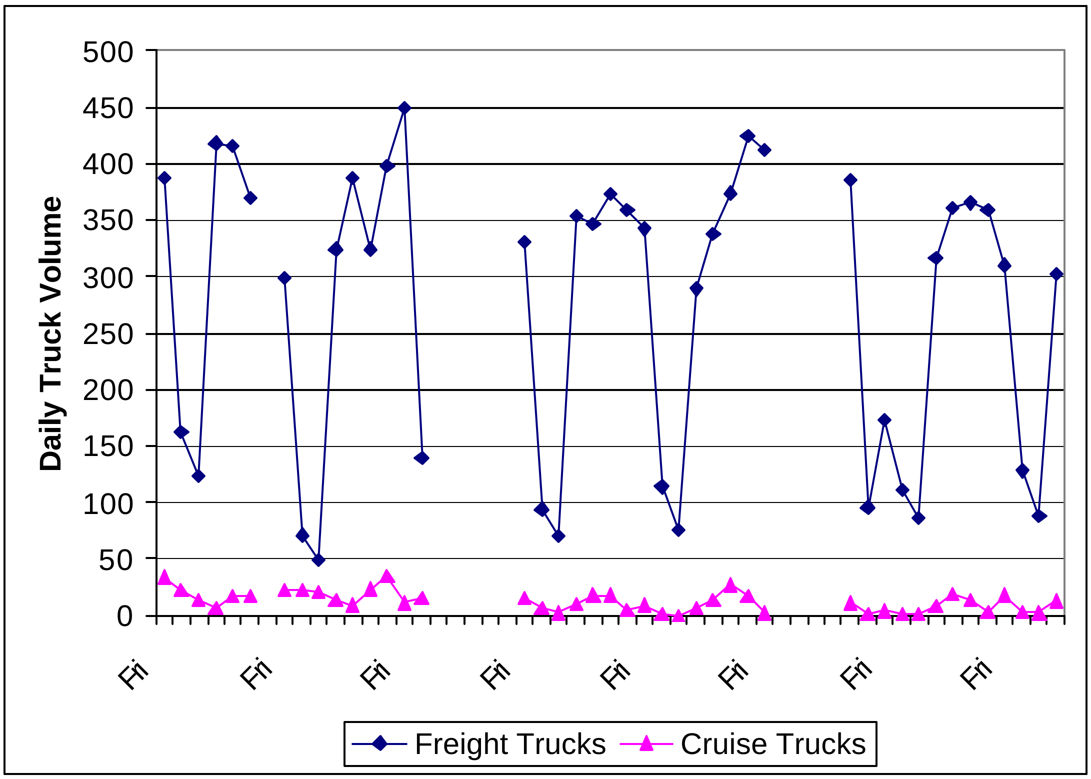


Figure 5.4: Port Canaveral Freight and Cruise Terminal Daily Truck Volumes

Data collection was conducted at the freight terminals for 245 days. The total number of complete weekdays and weekend days of daily truck volumes is separated by direction. 102 complete weekdays and 40 complete weekends have been collected for the inbound direction and 90 complete weekdays and 35 complete weekends for the outbound direction. These include both the North and South Terminals. A complete day is considered any day when data for both locations was collected without errors for a 24-hour period. A 24-hour period is from midnight (12:00 AM) of one day to the following day. The Artificial Neural Network (ANN) truck trip generation port model is structured with two separate internal models, one for inbound trucks and one for outbound trucks. Table 5.4 details the collected data at each terminal by direction.

Terminal Location	**Total Number of Days**	**Number of Week Days**	**Number of Weekend Days**	**Begin Date**	**End Date**
South – in	156	112	44	Sep 20, 2001	Mar 31, 2002
South – out	161	115	46	Sep 20, 2001	Mar 31, 2002
North – in	177	125	52	Sep 20, 2001	Mar 31, 2002
North - out	146	104	42	Sep 20, 2001	Mar 31, 2002

Table 5.4: Truck Count Data Inventory for Port Canaveral Freight Terminals

Figure 5.5 shows the trend of total inbound and outbound daily truck volumes for the data collected from September 2001 through March 2002. The two adjacent low points throughout the graph indicate the weekend days. The gap between the data is when the data was incomplete. Initial comparison between the North and South Terminals indicates the South Terminal has over 50% more trucks. From previous discussions with port officials, these truck counts seem reasonable. Furthermore, the increasing trend in truck volumes through March 2002 reflects the seasonal traffic including the citrus products.

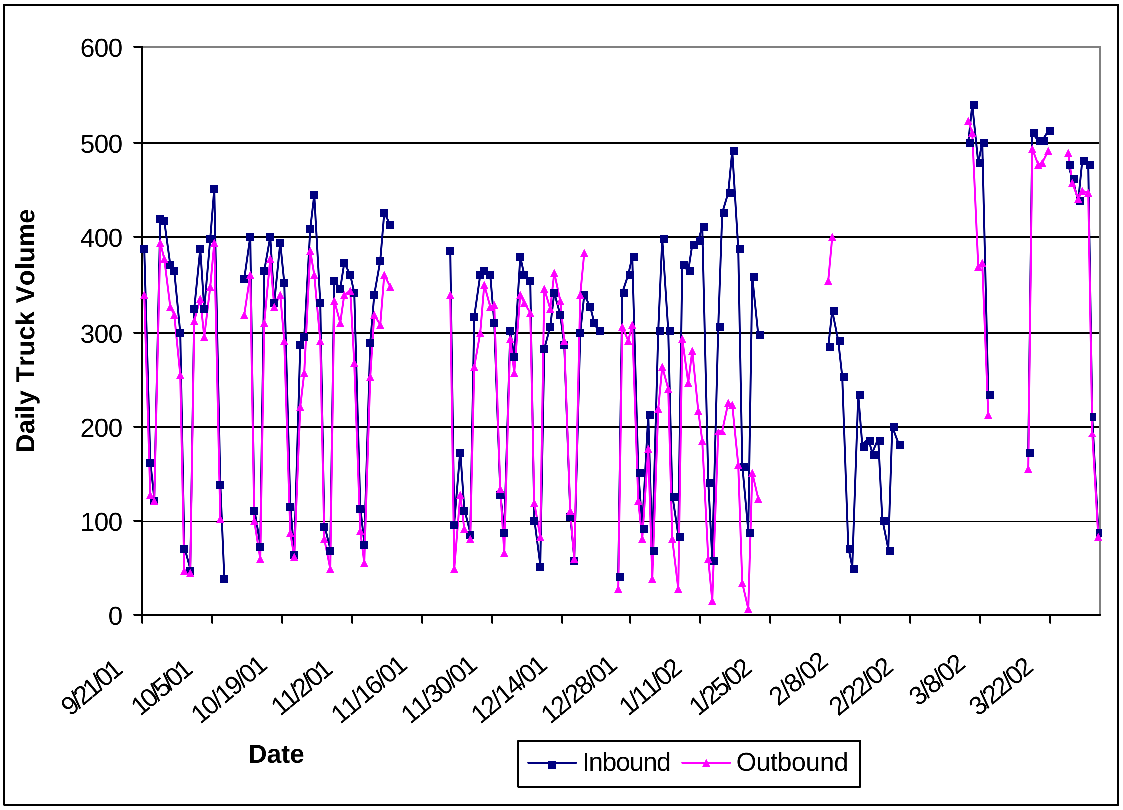


Figure 5.5: Port Canaveral Freight Terminal Daily Truck Volumes

5.1.4 Port Canaveral Field Traffic Data Collection: Road Network

The data collection locations on the Port Canaveral road network for use in calibration and validation of the developed model were selected based on the necessity to capture a significant portion of the truck traffic that are not local trips generated by the freight operations at the port. A local trip is a trip generated by the port's freight activity but does not leave the Cape Canaveral area surrounding the network. An example of a local trip would be between the port and the Rinker Cement facility on Industry Road (Link #19). This was concluded through communications with the Canaveral Port Authority contacts and local tenants handling the freight operations at the port.

The selected locations capture the truck traffic generated by the port's freight activity that travel on major highways linked to the defined network that are utilized for long distance interstate and intrastate travel. Interstate 95 (I-95) and State Road 528 (SR 528) were identified as major truck routes. Port generated trucks travel these routes to carry freight imported and/or exported at the port by vessel to areas outside the local Cape Canaveral road network.

Industry Road has some truck activity due to the large Rinker Cement facility but any truck traffic generated from Rinker's port facilities are captured by the selected data collection locations. US 1 was previously considered because of the rail terminal north of SR 528. However, interviews with the operators have determined that truck volumes generated by the port activity are local trips between the rail terminal and the port. Furthermore, truck traffic generated by port freight activity that also visits the rail terminal is captured on the network by the new data collection locations. Though SR 520 does not carry any significant port generated truck traffic, it has been included as part of the Port Canaveral modeled network for purposes of Intelligent Transportation Systems (ITS) applications. SR 520 is a viable alternate truck route that can be utilized in the event of a disruption to the SR 528 route. Figure 5.2 previously displayed is a diagram of the network and Table 5.2 lists the links and nodes for the Port Canaveral network with their corresponding descriptions.

The network data collection sites, which were used for the calibration and validation of the Port Canaveral network model, were located at node number 6 and link numbers 7 and 8. A total of eight sites were utilized for the network modeling calibration and validation along with the freight terminal traffic volume data. These eight sites are described in Table 5.5 and identified on the network in Figure 5.6. Traffic on SR 528 (Link #15) that is originating from or destined to Central Florida and the Orlando area was calculated from sites N6-ONa, N6-ONb and L7E for eastbound traffic and from sites N6-OFa, N6-OFb and L7W for westbound traffic.

Site ID	Description	Link #	Node #
N6-Onb	I-95 southbound off-ramp (SR 528 on-ramp)	N/A	6
N6-Ona	I-95 northbound off-ramp (SR 528 on-ramp)	N/A	6
L7E	SR 528 eastbound (near I-95)	7	N/A
L8E	SR 528 eastbound (near port)	8	N/A
L8W	SR 528 westbound (near port)	8	N/A
L7W	SR 528 westbound (near I-95)	7	N/A
N6-Ofa	I-95 northbound on-ramp (SR 528 off-ramp)	N/A	6
N6-Ofb	I-95 southbound on-ramp (SR 528 off-ramp)	N/A	6

N/A: not applicable to this Site ID (can only be a link or node)

Table 5.5: Network Data Collection Site ID and Description

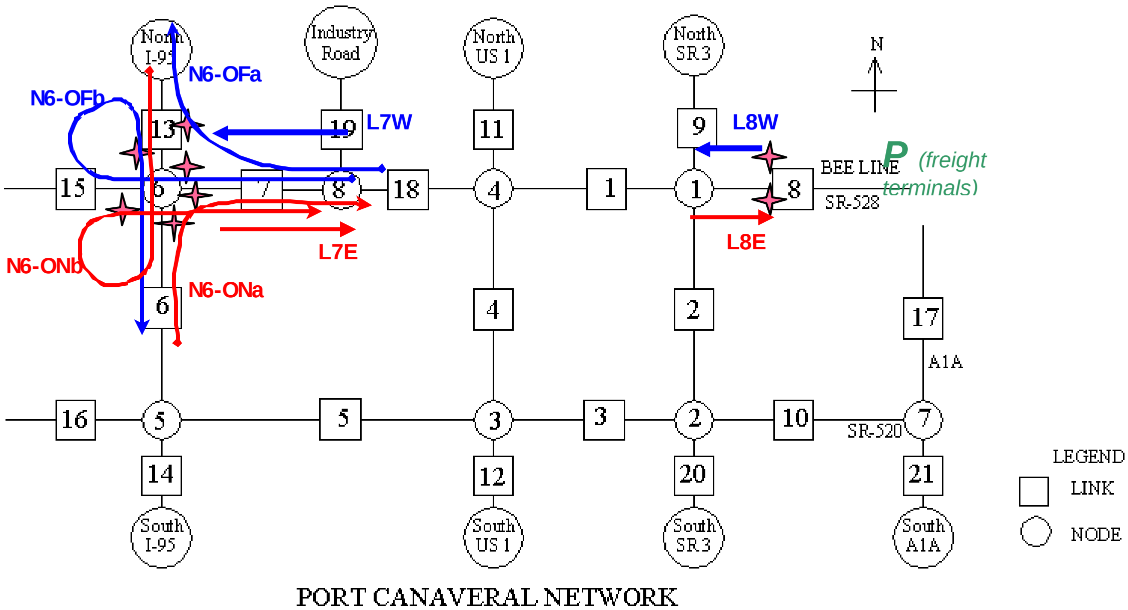


Figure 5.6: Data Collection Sites (Site IDs) on Port Canaveral Truck Route Network

5.1.5 Port Canaveral Data Collection: Vessel Freight Data

Due to the fact that Port Canaveral was not part of Phase II, a truck trip generation model was not previously developed for this port. Therefore, not only was it necessary to have historical data for forecasting future estimates of vessel freight activity, current freight data was also necessary. This current data was utilized to build an Artificial Neural Network (ANN) truck trip generation model for Port Canaveral following the same methodology developed in Phase II of this study (11).

Current freight data has been received for the months corresponding to the freight terminal truck counts. Daily vessel freight records have been received from August 30, 2001 to April 15, 2002. These include 273 individual vessel records. The list of commodity types and corresponding unit of measure presently being handled at the port are listed in Table 5.6. This vessel freight data was used as input for building the Port Canaveral ANN truck trip generation model. Figure 5.7 and Figure 5.8 display the significant commodities for both imported and exported freight. It is important to recognize significant commodity types because changes in them can significantly influence the number of trucks at the port.

Exports

Commodity	Unit Type
Diesel	BBLS
20' Container (Empty)	Each
20' Container (Loaded)	Each
20' Tank Containers (Loaded)	Each
Cars/Boats	Tons
Citrus	Tons
Gen'l Misc	Tons
PCS Equipment	Tons
Pickup	Tons
Sand	Tons
SS Juice	Tons
Truck/Trailers	Tons
Trucks	Tons
Trucks, Etc	Tons
Vehicles	Tons

Imports

Commodity	Unit Type
#6 Oil	BBLS
64 Grade	BBLS
AC-30	BBLS
Diesel	BBLS
Oil	BBLS
Prem Gas	BBLS
Reg.Unl. Gas	BBLS
Sp.Unl. Gas	BBLS
Spug	BBLS
Unknown	BBLS
Lumber	BDFT
20' Container (Empty)	Each
20' Container (Unloaded)	Each
Accomm. Units	Tons
Bagged Cement	Tons
Cement	Tons
Empty Bins	Tons
Empty Drums/Bins	Tons
Gen'l Misc	Tons
Hooper	Tons
Newsprint	Tons
Pumice	Tons
Rebar	Tons
Salt	Tons
Scrap Steel	Tons
Treatment Plant	Tons
Wrapper & Headers	Tons

Table 5.6: Port Canaveral Commodity Types

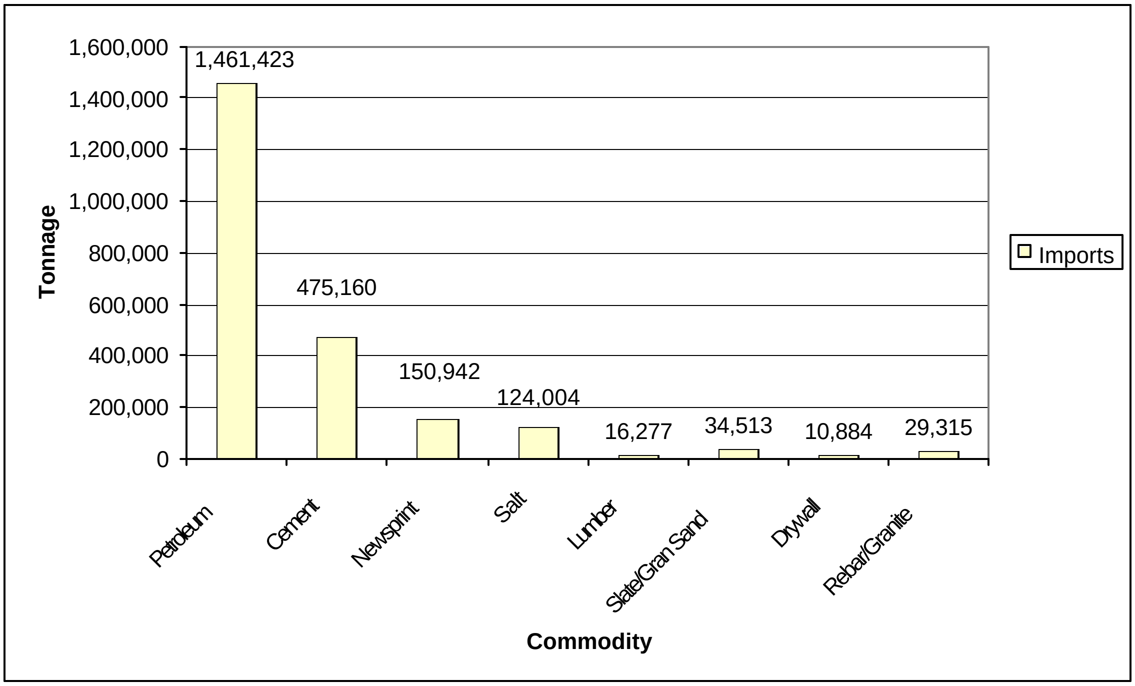


Figure 5.7: Port Canaveral Significant Imported Commodities

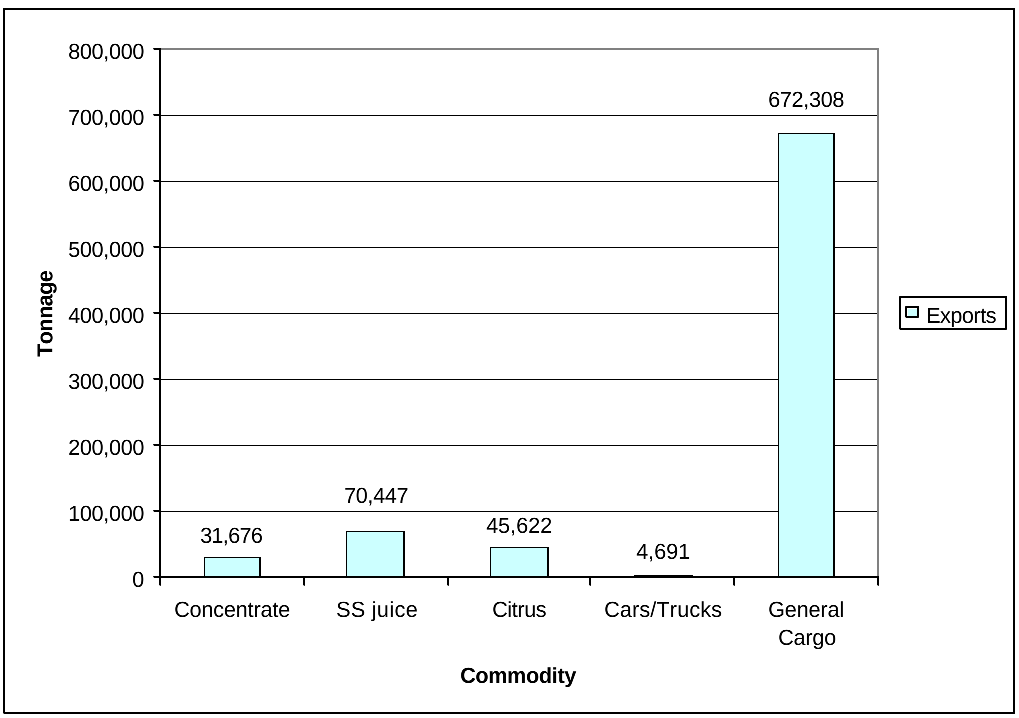


Figure 5.8: Port Canaveral Significant Exported Commodities

5.1.6 Port Canaveral Network Coding: VISSIM

The data obtained from FDOT, the local public agencies and the field was used to code the network in VISSIM. The same process outlined for the Port of Tampa model was followed. Once the initial VISSIM model was coded, the traffic counts were utilized for the calibration and validation.

5.2 Route Assignment Model Calibration

5.2.1 Port Canaveral Network Model Calibration: VISSIM

The same methodology for calibration and validation developed for the Port of Tampa and successfully applied was followed for Port Canaveral network modeling. A cordon line was drawn around the port indicated by a green line in Figure 5.9. This cordon line was used to select the initial links for tracking the total vehicles in and out of the port and also confirmed selection of the master links utilized in the calibration and validation steps. The links cut by the cordon line were used in determining the initial O-D matrix. Then, the master links were used to complete the calibration.

Due to Port Canaveral's limited access routes, only three master links were identified for the port located on SR 528 (Bee Line Toll Road). Figure 5.9 shows a Cape Canaveral area map with the cordon line and the master links. The master links are Links #7, #8, and #15. Though SR 520 to A1A is a possible access route to the port, it was not selected as a master link due to the fact that virtually no heavy trucks generated by the port's freight activity use this route for travel. It is a possible alternate route that could be used with ITS applications but not applicable for the present calibration. This was concluded previously from site investigation and interviews with individuals involved in the local freight industry.

Figure 5.9: Cape Canaveral Area Map

The surrounding area was investigated further to confirm the selection of the master links. The average daily truck traffic at the port's freight terminals is 339 trucks per day. This information along with information provided by port authority officials and tenants involved in the local freight industry as well as FDOT traffic data confirmed the use of SR 528 by port generated heavy trucks. The FDOT traffic data provided information on the hourly truck volumes for the Port Canaveral network links. Furthermore, the use of I-95 was also determined for port generated heavy trucks traveling north and south. Therefore, SR 528 and I-95 are concluded to be major truck routes for the Port Canaveral Network. The data collection sites at the on and off ramps between SR 528 and I-95 provided the necessary data for successfully modeling the network and determining the number of heavy trucks generated by the port using I-95.

Calibration Using FDOT Data

The initial O-D matrix concluded using the FDOT data is displayed in Figure 5.10. The O-D matrix field titles of Figure 5.10 indicate the external nodes of the network that are indicated in Figure 5.2, previously displayed. The Port freight terminals identify the freight terminal traffic volume in the O-D matrix. The traffic at the port not directly associated with the freight activity is included in the matrix as local port traffic. Local port traffic is all traffic entering and leaving the port on George King Blvd. and SR 401 excluding the port freight terminal traffic volumes at the sites indicated previously in Figure 5.3. The FDOT data used for this initial calibration is displayed in Table 5.7. No FDOT data was available for the selected Master Link #15. The PM peak hour (4:00-5:00) was found to be highest and used for the model development.

Calibration O/D		Local Port Traffic	North SR 3	North US 1	North I-95	West SR 520	South US 1	South SR 3	South A1A	Industry Road	Orlando	South I-95	Port (Freight Term.)	Prod.
		LT	S1	U1	I1	R2	U2	S2	A2	IN	O	I2	P	
Local Port Traffic	LT	0	350	350	600	10	150	150	1000	5	300	400	5	3320
North SR 3	S1	150	0	10	10	40	10	1200	100	5	100	10	30	1665
North US 1	U1	150	10	0	10	50	1100	10	100	5	100	10	30	1575
North I-95	I1	250	10	10	0	300	10	10	40	5	350	1000	40	2025
West SR 520	R2	10	40	10	800	0	100	100	300	5	10	500	5	1880
South US 1	U2	100	200	900	10	200	0	10	300	5	50	10	10	1795
South SR 3	S2	100	400	10	10	100	10	0	340	5	50	10	10	1045
South A1A	A2	600	300	200	250	500	400	200	0	5	10	500	10	2975
Industry Road	IN	30	10	10	10	10	10	10	10	0	10	10	30	150
Orlando	O	150	200	200	400	10	175	175	10	20	0	400	30	1770
South I-95	I2	100	10	10	1000	400	10	10	500	5	250	0	10	2305
Port (Freight Term.)	P	5	80	80	200	10	40	40	20	30	50	20	0	575
Att.		1645	1610	1790	3300	1630	2015	1915	2720	95	1280	2870	210	

Figure 5.10: Initial Port Canaveral O-D Matrix

Site ID	Link #	Description	Direction	Peak Hour Traffic Volume
L7E	7	SR 538 eastbound (just east of I-95 ramps)	Inbound	937
L8E	8	SR 528 eastbound (near port)	Inbound	1816
L8W	8	SR 528 westbound (near port)	Outbound	2102
L7W	7	SR 528 westbound (just east of I-95 ramps)	Outbound	1084

Table 5.7: FDOT PM Peak Hour Traffic Volumes (Calibration Data)

Calibration Using Field Data

Once the initial O-D matrix was determined, calibration continued using field data including data collected for the identified master links (Links #7, #8, and #15). Link #15 is the through traffic on SR 528 just west of I-95. It does not include the SR 528 eastbound traffic that exits SR 528 west of I-95 or the SR 528 westbound traffic that enters SR 528 west of I-95. The field data set spans the time period from April 13, 2002 through May 10, 2002. Not all days of data collection were used due to incomplete data sets. Incomplete data sets were days/time periods when the tubes were damaged or a malfunction in the classifier or equipment.

Table 5.8 summarizes the inventory of data collected by location. This table denotes the inventory of successful days for data collection. Unsuccessful days include events when the tubes were damaged or there was a malfunction in the classifier or equipment. This initial data set along with the initial O-D matrix using the FDOT traffic CD data provides the information for determining a revised origin-destination (O-D) matrix for the network modeling.

Site ID	Total Number of Days	Begin Date	End Date
N6-Onb	38	April 13, 2002	June 11, 2002
N6-Ona	42	April 13, 2002	June 11, 2002
L7E	35	April 13, 2002	June 11, 2002
L8E	27	April 13, 2002	June 11, 2002
L8W	36	April 13, 2002	June 11, 2002
L7W	37	April 13, 2002	June 11, 2002
N6-Ofa	39	April 13, 2002	June 11, 2002
N6-Ofb	41	April 13, 2002	June 11, 2002

Table 5.8: Truck Count Data Inventory for Port Canaveral Network

From the field data inventory as displayed in Table 5.8, the average PM peak hour traffic volumes were computed. The PM peak was concluded after analyzing the hourly traffic volumes collected from the field traffic counters. The data used for calibration are included in Table 5.9. Table 5.9 displays the total vehicular volume including heavy trucks because VISSIM requires total number of all vehicles on the network for simulation.

Once the model is calibrated and validated, the heavy truck volumes generated by the port's freight activity is determined from the total traffic volume results. From Scheffe's statistical test between weekdays, it was determined at the 95% confidence level that no significant difference between days of the week exists. The results of this test are provided in Appendix P. Therefore, the hourly traffic volume for the PM peak at each field data collection site was used to determine an average value.

Figure 5.11 displays a diagram of the network with the data collection sites identified including Site ID. The master links (denoted with blue) display significant truck volumes. For Link 7, the average number of trucks per day was 663 eastbound and

881 westbound. For Link 8, the average number of trucks per day was 703 eastbound and 750 westbound. The average peak hour traffic volume for the freight terminals at the port during the study period was 320 vph inbound and 620 vph for the outbound.

Site ID	Link #	Description	Direction	Peak Hour Traffic Volume
L15E	15	SR 538 eastbound (just west of I-95 ramps)	Inbound	513
L7E	7	SR 538 eastbound (just east of I-95 ramps)	Inbound	833
L8E	8	SR 528 eastbound (near port)	Inbound	977
L8W	8	SR 528 westbound (near port)	Outbound	2333
L7W	7	SR 528 westbound (just east of I-95 ramps)	Outbound	1221
L15W	15	SR 528 westbound (just west of I-95 ramps)	Outbound	587

Table 5.9: Port Canaveral Network Field Data (Calibration)

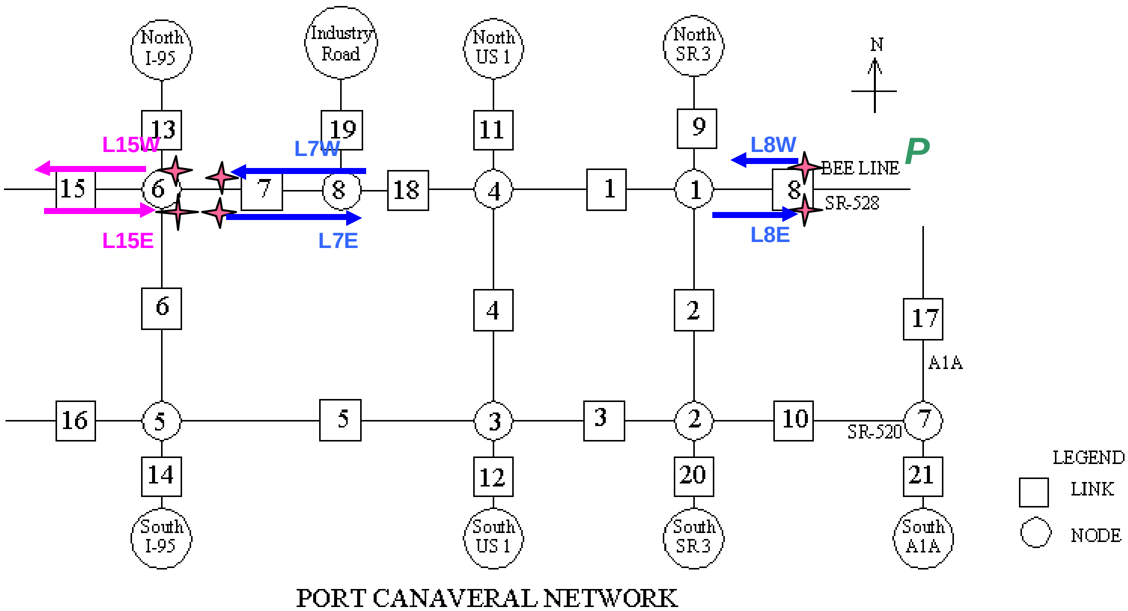


Figure 5.11: Calibration Data (Site IDs) on Port Canaveral Truck Route Network

The traffic data collected at Port Canaveral's north and south freight terminals were used for the input traffic volumes of the network model for the port node of the O-D matrix. This traffic volume represents traffic generated from the activity at the port's freight terminals. Table 5.10 displays this data.

Location	Inbound	Outbound
Freight Terminals	320	620

Table 5.10: Average PM Peak Hour Traffic Volume

After 35 iterations were performed for the developed network model, the final O-D matrix was concluded. The final calibrated O-D matrix for the Port Canaveral road network is displayed in Figure 5.12. The calibration results compared to the field data are shown in Table 5.11. As previously done for the Port of Tampa, the O-D matrix was used to conclude the number of trucks on the Port Canaveral network links. The O-D pair volumes are used to calculate the number of trucks from the known percentages of trucks on each of the network links. Table 5.11 shows the field traffic volumes and the absolute percent error between the simulated and field traffic volumes for the master links.

$$\%Error = \frac{|Field - Simulated|}{Field} * 100$$

The absolute percent error for every master link is less than 5%. This low percent error provides concluding evidence that the final O-D matrix (Figure 5.12) represents the real world (existing conditions) for the Port Canaveral road network. Figure 5.13 is a graphical representation comparing the field and VISSIM Model results for each of the data collection sites.

Calibration O/D		Local Port Traffic	North SR 3	North US 1	North I-95	West SR 520	South US 1	South SR 3	South A1A	Industry Road	Orlando	South I-95	Port (Freight Term.)	Prod.
		LT	S1	U1	I1	R2	U2	S2	A2	IN	O	I2	P	
Local Port Traffic	LT	0	600	600	850	10	250	250	1000	250	950	100	5	4865
North SR 3	S1	500	0	10	10	40	10	1500	100	150	150	100	30	2600
North US 1	U1	400	10	0	10	100	1500	10	100	150	150	100	30	2560
North I-95	I1	280	10	10	0	400	10	10	40	40	350	1400	40	2590
West SR 520	R2	10	40	10	500	0	100	100	300	60	10	500	5	1635
South US 1	U2	150	10	1500	50	600	0	10	300	40	100	10	5	2775
South SR 3	S2	150	1500	10	50	400	10	0	340	40	100	10	5	2615
South A1A	A2	800	300	300	50	300	400	500	0	40	100	500	10	3300
Industry Road	IN	100	10	10	10	10	10	10	10	0	10	400	100	680
Orlando	O	270	250	200	400	10	150	100	10	40	0	400	50	1880
South I-95	I2	170	10	10	1500	600	10	10	500	150	150	0	40	3150
Port (Freight Term.)	P	20	80	80	120	10	20	20	20	80	120	50	0	620
Att.		2850	2820	2740	3550	2480	2470	2520	2720	1040	2190	3570	320	

Figure 5.12: Final Calibrated Port Canaveral O-D Matrix

				Peak Hour Traffic Volume		
Site ID	Link #	Description	Direction	Field Value	VISSIM Results	% Error
L15E	15	SR 538 eastbound (just west of I-95 ramps)	Inbound	513	519	1.16%
L7E	7	SR 538 eastbound (just east of I-95 ramps)	Inbound	833	825	0.97%
L8E	8	SR 528 eastbound (near port)	Inbound	977	994	1.71%
L8W	8	SR 528 westbound (near port)	Outbound	2333	2237	4.29%
L7W	7	SR 528 westbound (just east of I-95 ramps)	Outbound	1221	1258	2.94%
L15W	15	SR 528 westbound (just west of I-95 ramps)	Outbound	587	569	3.16%

Table 5.11: Port Canaveral Calibration Results of Field and Simulated Hourly Traffic Volumes

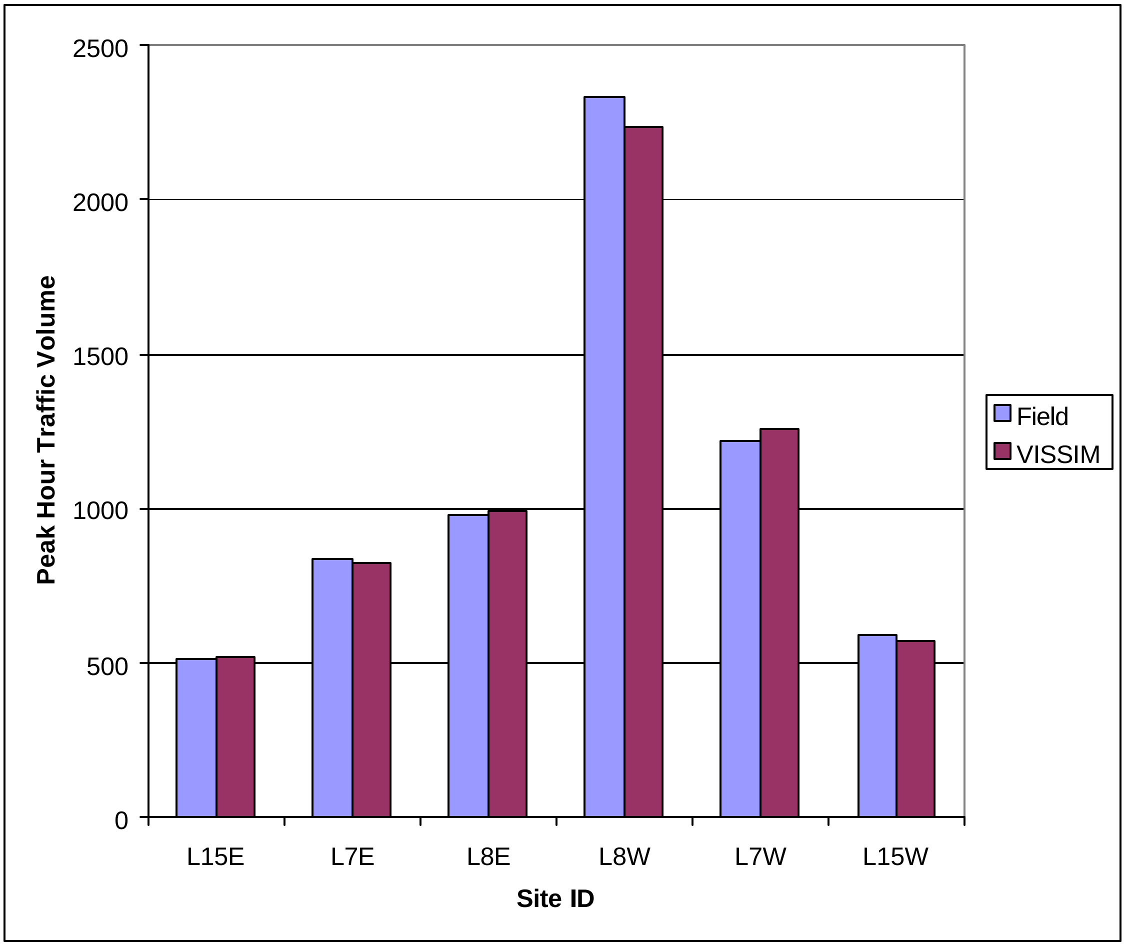


Figure 5.13: Port Canaveral Calibration Results of Field and Simulated Hourly Traffic Volumes

5.3 Route Assignment Model Validation

5.3.1 Port Canaveral Network Model Validation: VISSIM

The same steps outlined for the Port of Tampa used to validate the calibrated network model were followed for the Port Canaveral calibrated network model. Eleven days of field data collection were used for the validation. The validation data set is shown in Table 5.12. This data is also the peak hour total traffic volumes including the heavy truck volumes in vehicles per hour (vph). The inbound direction is eastbound and the outbound direction is westbound (denoted in Site ID by E or W). The corresponding peak hour total traffic volumes for the freight terminal locations (port node) are displayed in Table 5.13.

			Site ID					
Day #	Date	Direction	L15E	L7E	L8E	L8W	L7W	L15W
1	29-Apr-02	Inbound	459	758	929	--	--	--
		Outbound	--	--	--	2197	1120	569
2	30-Apr-02	Inbound	473	776	844	--	--	--
		Outbound	--	--	--	2347	1183	591
3	1-May-02	Inbound	484	792	891	--	--	--
		Outbound	--	--	--	2314	1148	591
4	2-May-02	Inbound	462	763	940	--	--	--
		Outbound	--	--	--	2361	1181	585
5	3-May-02	Inbound	493	842	969	--	--	--
		Outbound	--	--	--	2070	1197	662
6	13-May-02	Inbound	437	724	837	--	--	--
		Outbound	--	--	--	2007	1079	557
7	14-May-02	Inbound	442	728	831	--	--	--
		Outbound	--	--	--	2092	1052	498
8	15-May-02	Inbound	495	812	905	--	--	--
		Outbound	--	--	--	2216	1135	550
9	28-May-02	Inbound	449	809	858	--	--	--
		Outbound	--	--	--	2032	1080	550
10	6-Jun-02	Inbound	516	850	885	--	--	--
		Outbound	--	--	--	2387	1193	568
11	10-Jun-02	Inbound	461	773	881	--	--	--
		Outbound	--	--	--	2022	1258	692

-- denotes the direction not applicable (locations are eastbound or westbound)

Table 5.12: Port Canaveral Network Field Data in vph (Validation)

Day #	Date	Direction	Hourly Traffic Volume	Hourly Truck Volume
1	29-Apr-02	Inbound	270	27
		Outbound	504	50
2	30-Apr-02	Inbound	262	26
		Outbound	552	55
3	1-May-02	Inbound	314	31
		Outbound	622	62
4	2-May-02	Inbound	375	38
		Outbound	616	62
5	3-May-02	Inbound	398	40
		Outbound	595	60
6	13-May-02	Inbound	288	29
		Outbound	477	48
7	14-May-02	Inbound	306	31
		Outbound	476	48
8	15-May-02	Inbound	254	25
		Outbound	541	54
9	28-May-02	Inbound	281	28
		Outbound	517	52
10	6-Jun-02	Inbound	339	34
		Outbound	583	58
11	10-Jun-02	Inbound	271	27
		Outbound	484	48

Table 5.13: Port Canaveral Freight Terminal Data in vph (Validation)

Once the model was run for each of the validation days using the Port Canaveral Freight Terminal total traffic volumes as input to VISSIM, the results of each model run were summarized. The resulting truck volumes for SR 528 are displayed in Table 5.14. A graphical representation comparing these data is shown in Figure 5.14 through Figure 5.19. The Port Canaveral VISSIM model results were compared to the field data. Figure 5.14 through Figure 5.19 provide the graphs for the visual inspection.

			Location					
			SR 528 (Link # 7)*		SR 528 (Link # 8)*		SR 528 (Link # 15)*	
Day #	**Date**	**Direction**	**Field**	**VISSIM**	**Field**	**VISSIM**	**Field**	**VISSIM**
1	29-Apr-02	Inbound	29	32	18	18	10	11
		Outbound	55	61	42	42	37	36
2	30-Apr-02	Inbound	29	31	21	23	7	8
		Outbound	52	55	43	40	26	24
3	1-May-02	Inbound	32	33	28	30	13	14
		Outbound	52	58	49	48	29	27
4	2-May-02	Inbound	29	31	17	18	10	11
		Outbound	46	50	53	50	14	14
5	3-May-02	Inbound	29	28	13	14	8	9
		Outbound	51	53	41	44	24	21
6	13-May-02	Inbound	29	33	20	23	11	13
		Outbound	59	67	106	116	39	38
7	14-May-02	Inbound	28	32	34	40	7	8
		Outbound	48	57	115	120	14	15
8	15-May-02	Inbound	35	36	35	37	16	17
		Outbound	55	61	124	123	28	29
9	28-May-02	Inbound	24	24	36	40	5	6
		Outbound	42	48	130	140	20	20
10	6-Jun-02	Inbound	26	25	20	22	9	9
		Outbound	55	59	117	107	30	30
11	10-Jun-02	Inbound	25	27	19	21	9	10
		Outbound	67	67	111	121	44	35

* denotes a master link

Table 5.14: Port Canaveral Validation Results of Field and Simulated Hourly Truck Volumes on SR 528

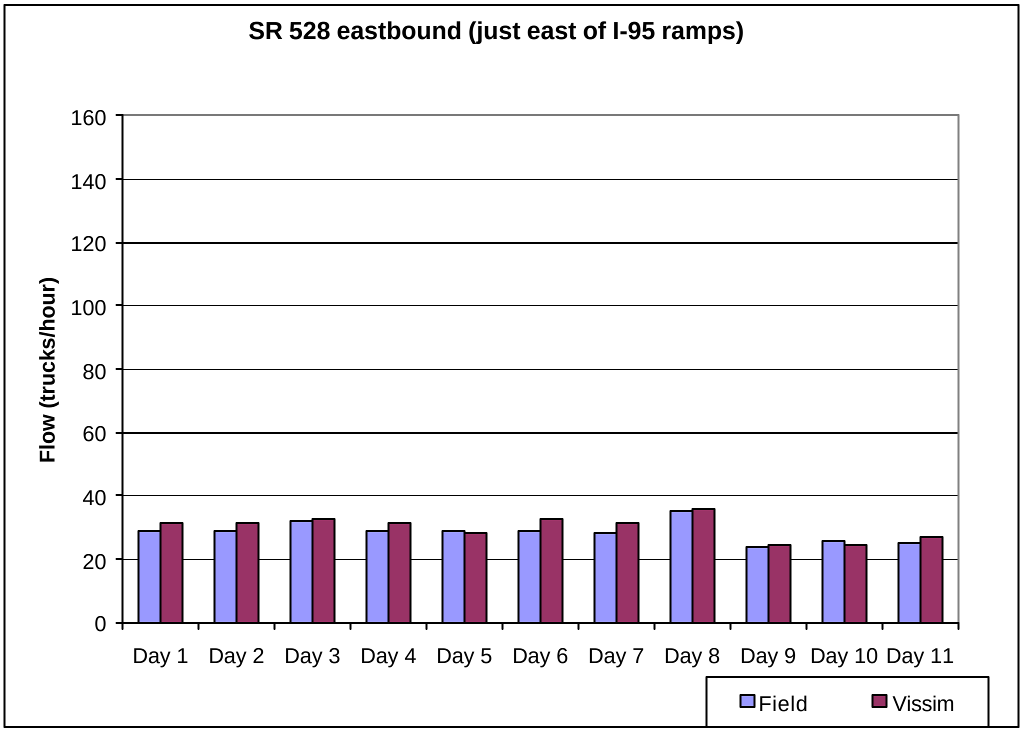


Figure 5.14: Port Canaveral Validation Results of Field and Simulated Hourly Inbound Truck Volumes on SR 528 (Link #7)

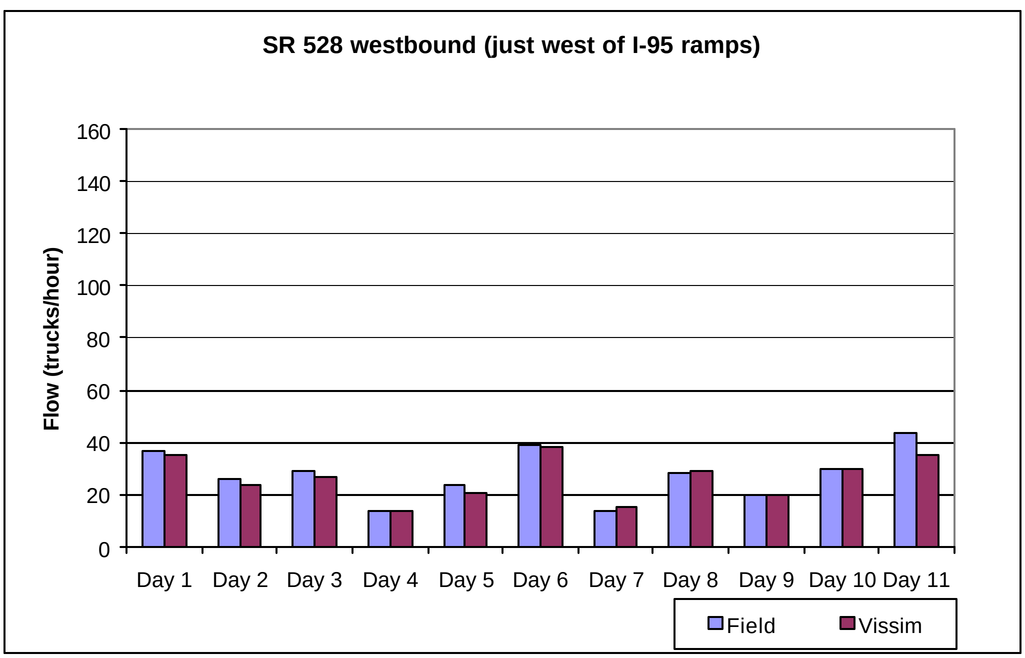


Figure 5.15: Port Canaveral Validation Results of Field and Simulated Hourly Outbound Truck Volumes on SR 528 (Link #7)

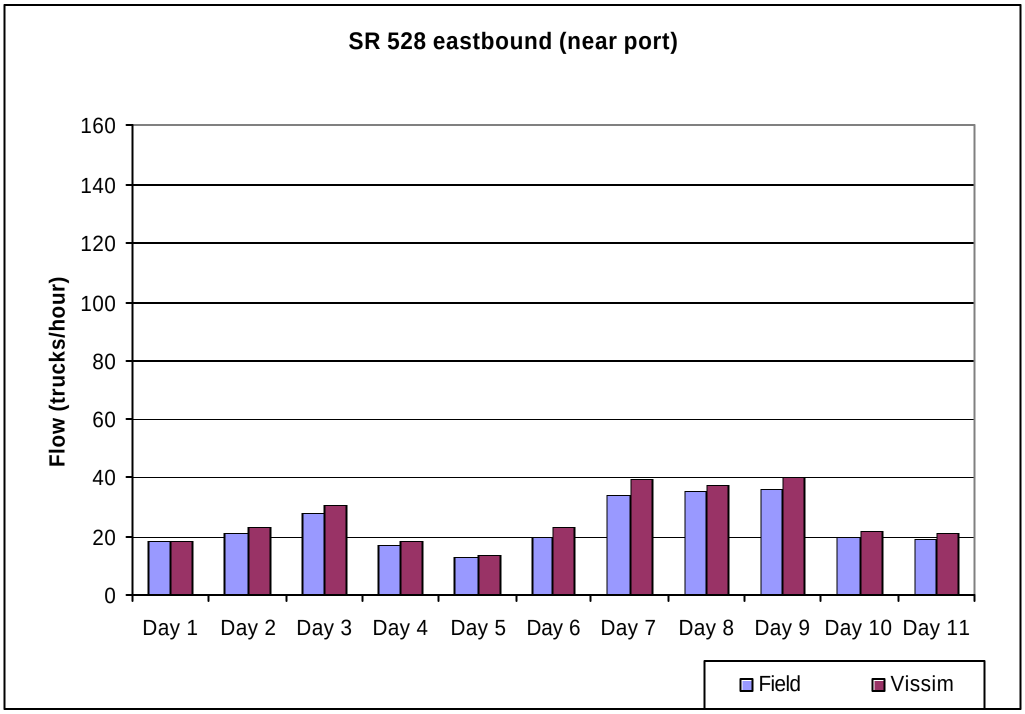


Figure 5.16: Port Canaveral Validation Results of Field and Simulated Hourly Inbound Truck Volumes on SR 528 (Link #8)

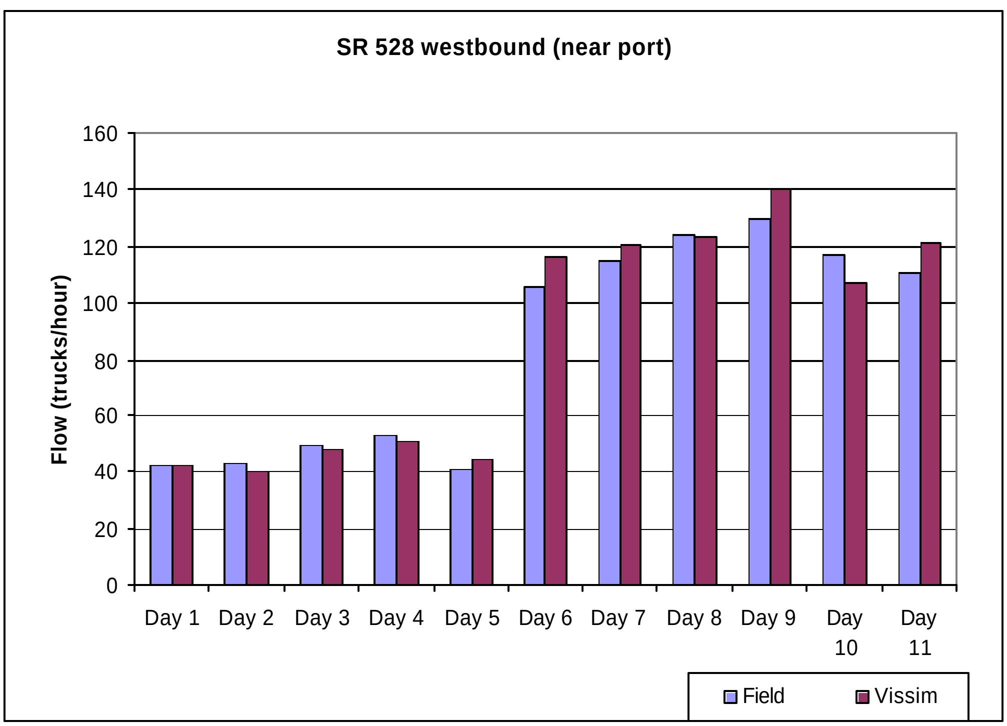


Figure 5.17: Port Canaveral Validation Results of Field and Simulated Hourly Outbound Truck Volumes on SR 528 (Link #8)

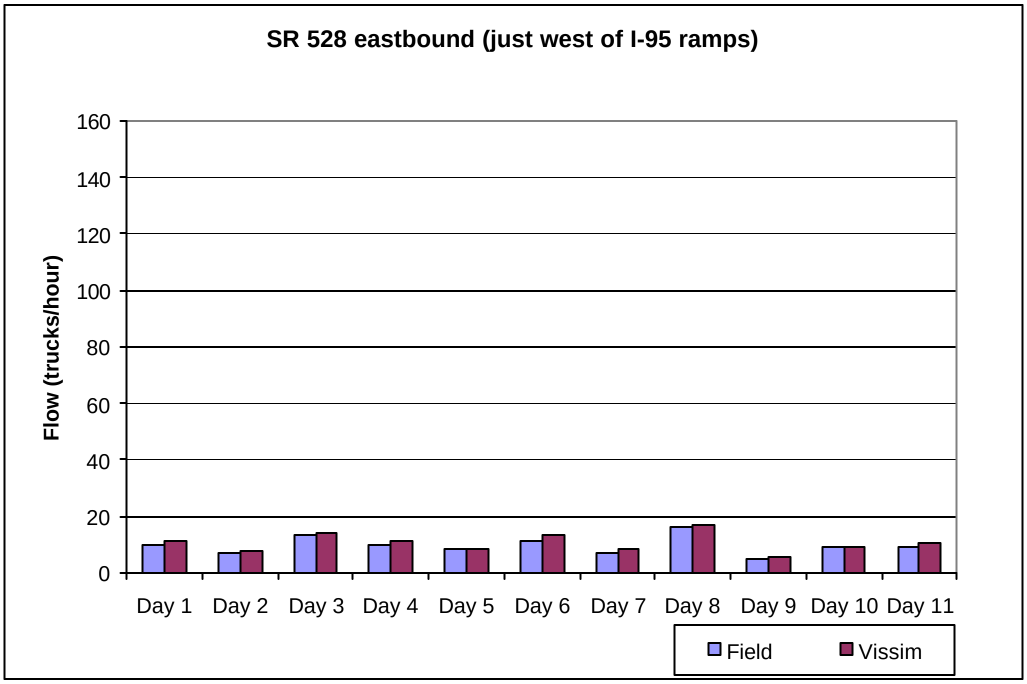


Figure 5.18: Port Canaveral Validation Results of Field and Simulated Hourly Inbound Truck Volumes on SR 528 (Link #15)

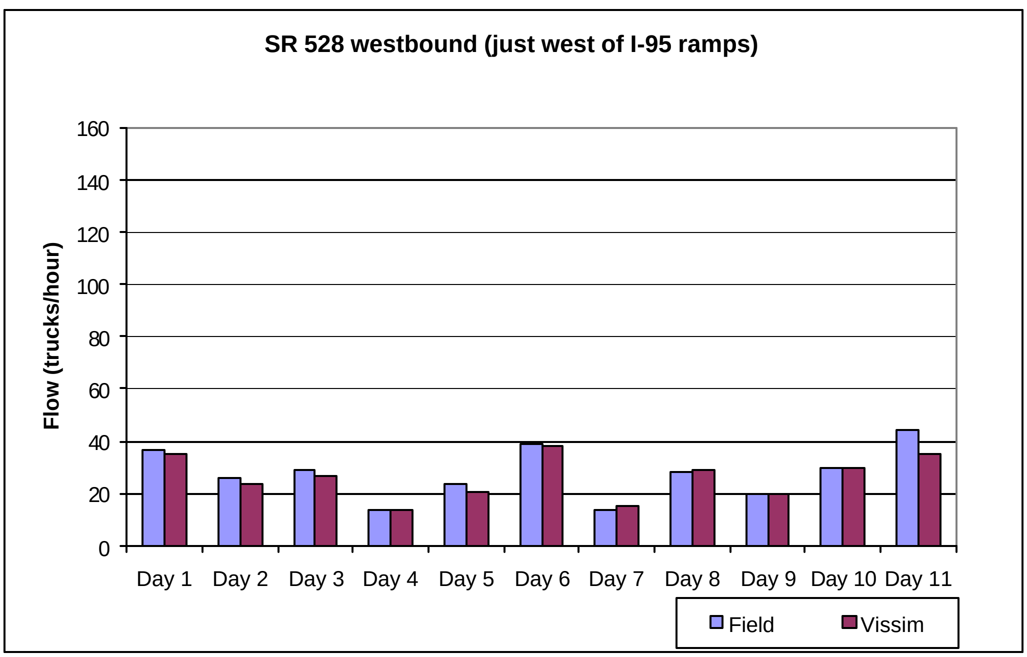


Figure 5.19: Port Canaveral Validation Results of Field and Simulated Hourly Outbound Truck Volumes on SR 528 (Link #15)

After the visual inspection showed no major differences between the simulated and the actual truck volumes on the master links, a statistical test was performed for each of the master links using the Confidence Interval (C.I.) Statistical Test. Table 5.15 summarizes the C.I. calculations. Upper and lower limits of the confidence interval for each of the master links include zero. Therefore, the C.I. test concludes there is no significant difference between the simulated and actual truck volumes on the master links.

Link Name (#)	Direction	Lower Limit	Upper Limit
SR 528 (#7)	Inbound	-4.58	1.49
near port	Outbound	-10.62	0.80
SR 528 (#8) east	Inbound	-10.01	5.46
of I-95 ramps	Outbound	-36.80	33.20
SR 528 (#15)	Inbound	-3.75	1.75
west of I-95 ramps	Outbound	-6.55	9.46

Table 5.15: Confidence Interval Limits for the Actual and VISSIM Simulated Truck Volumes

It can be concluded after conducting these two tests (visual inspection and C.I. test) that the VISSIM Port Canaveral road network model replicates the existing conditions of truck movements at the 95% confidence level. From the validation results it is concluded that the O-D matrix in Figure 5.12 is the final O-D matrix and produces simulation results representative of present traffic conditions. Furthermore, this network model has been shown to perform accurately when utilizing traffic volumes generated by Port Canaveral's freight terminals, therefore this model can be used for short-term forecasting. The conclusion for truck volumes on the routes identified as those traveled by trucks that haul freight in and out of the port that is imported and exported by vessel were detailed in Table 5.14. These are non-local truck trips.

For trucks destined to Port Canaveral generated by the port's vessel freight activity, 15.6% use SR 528 (eastbound), 12.5% use I-95 traveling northbound (coming from areas south of SR 528) and 12.5% use I-95 traveling southbound (coming from areas north of SR 528). For trucks originating from Port Canaveral, 19.4% use SR 528 (westbound), 19.4% use I-95 traveling northbound (going to areas north of SR 528) and 8.1% use I-95 traveling southbound (going to areas south of SR 528).

The network model has also captured port generated local truck trips. 12.9% of the truck traffic generated by the port's freight activity travel to Industry Road and 31.3% of the trucks destined to the port are coming from Industry Road. This Industry Road truck traffic is attributed to the large Rinker cement facility. Also, 12.9% of the trucks were local trips to US1 and 9.4% of the truck trips to the port were from US1. This truck traffic is attributed to the rail terminal located just northwest of SR 528.

5.4 Forecasting

In order to accurately forecast the number of port generated heavy trucks carrying freight on the Port Canaveral road network, an accurate number of heavy trucks generated by port vessel freight activity is essential. The Port Canaveral truck trip generation model accurately produces this data. The model was developed by utilizing the Artificial Neural Network modeling (ANN) methodology developed in Phase II (11). These ANN models accurately produce the daily heavy truck movements inbound and outbound for the seaports by using daily vessel freight data as input to the model. The same basic methodology used to develop the ANN models for the ports of Palm Beach, Everglades, Tampa and Jacksonville have been applied to Port Canaveral.

5.4.1 Port Canaveral ANN Model Development (Calibration)

The Port Canaveral ANN model was trained (calibrated) with data selected from the inventory of data collected between Sept. 20, 2001 and March 31, 2002. This inventory of data includes both vessel freight data provided by the Canaveral Port Authority and heavy truck counts collected from the field. On March 7th, 2002, a presentation was made to the port authority. One of the outcomes of this meeting verified the accuracy of the daily truck counts taken from the field data. It was also stated that presently, container traffic at the port is very minimal and there is no indication for the near future that this would change. Due to the information provided by the port authority and the insignificant amount of containerized freight, these records were excluded from the model. Also, in order to more accurately model the trucks, the imported petroleum products (barrels) were converted to tons with a conversion factor provided by the Canaveral Port Authority and included with the imported tons. The ANN model data set is provided in Table 5.16. Shaded records indicate weekend days.

	Heavy Trucks		Vessel Freight Data		
Date	Inbound	Outbound	Imported Lumber	Imported Tons	Exported Tons
29-Sep-01	71	46	0	3136.8720	0
30-Sep-01	49	--	0	361.8720	0
6-Oct-01	139	--	0	3757.8720	0
7-Oct-01	39	--	0	361.8720	0
11-Oct-01	355	318	187657	5284.7200	28
13-Oct-01	112	--	0	2487.9280	236
14-Oct-01	--	59	0	1250.9280	0
15-Oct-01	364	310	187657	3214.9280	236
17-Oct-01	--	326	187657	2566.2960	236
19-Oct-01	352	--	187657	5885.2960	264
20-Oct-01	116	--	0	5727.2960	248
21-Oct-01	66	61	0	1465.2960	0
22-Oct-01	286	221	187657	5885.2960	28
23-Oct-01	295	257	187657	5886.2960	28
26-Oct-01	331	290	239882	6084.2400	285
27-Oct-01	94	--	0	5353.4240	257
28-Oct-01	70	48	0	1103.4240	0
29-Oct-01	354	333	239882	5719.4240	486
30-Oct-01	346	310	239882	5719.4240	486
31-Oct-01	373	339	239882	6274.1600	485
1-Nov-01	--	343	239882	6798.9920	485
3-Nov-01	114	89	0	3112.9920	201
4-Nov-01	76	54	0	2182.9920	0
6-Nov-01	338	318	266190	4725.5520	227
7-Nov-01	374	307	266190	4772.5520	238
8-Nov-01	--	360	266190	4772.5520	227
9-Nov-01	--	347	266190	3702.7040	227
21-Nov-01	--	339	266190	6116.1280	0
26-Nov-01	316	--	304296	7860.0080	40
27-Nov-01	--	298	225000	7861.0080	40
28-Nov-01	--	350	225000	7861.0080	172
29-Nov-01	359	326	225000	8304.0080	172
30-Nov-01	310	329	225000	7749.2720	172
1-Dec-01	128	133	0	6555.4400	132
2-Dec-01	88	66	0	2197.4400	0
3-Dec-01	302	--	225000	4438.9280	504
4-Dec-01	274	--	38106	4438.9280	504
8-Dec-01	101	117	0	3217.3280	543
9-Dec-01	--	82	0	2267.3280	0
10-Dec-01	283	--	38106	6535.3280	584
13-Dec-01	--	333	316595	6534.3280	584
14-Dec-01	--	291	316595	6609.3280	210
15-Dec-01	--	109	0	6503.3280	209
16-Dec-01	58	58	0	2634.3280	0

-- denotes 24 hour count not available

Table 5.16: Port Canaveral ANN Model Data

	Heavy Trucks		Vessel Freight Data		
Date	Inbound	Outbound	Imported Lumber	Imported Tons	Exported Tons
17-Dec-01	300	340	316595	6870.3280	209
18-Dec-01	340	384	316595	6870.3280	210
19-Dec-01	327	--	316595	8177.2560	0
20-Dec-01	309	--	316595	8177.2560	0
21-Dec-01	301	--	316595	8177.2560	0
26-Dec-01	--	306	278489	4644.3760	805
27-Dec-01	--	290	278489	5430.6160	799
28-Dec-01	378	308	309083	4896.6160	1181
29-Dec-01	152	119	0	5422.6160	1155
30-Dec-01	93	80	0	1904.6160	0
5-Jan-02	127	79	0	4923.4880	501
6-Jan-02	84	27	0	1480.0800	0
7-Jan-02	370	--	418629	5781.0800	147
8-Jan-02	364	--	418629	5781.0800	147
9-Jan-02	392	--	418629	4613.0800	490
10-Jan-02	396	--	418629	6525.0800	491
11-Jan-02	411	--	418629	6829.0800	549
12-Jan-02	142	--	0	5283.2720	523
13-Jan-02	58	--	0	2388.2720	12
14-Jan-02	--	194	140140	6283.2720	550
18-Jan-02	388	--	284329	8560.9840	746
19-Jan-02	158	--	0	7680.9840	719
20-Jan-02	89	--	0	2769.9840	4
21-Jan-02	358	--	284329	9065.8240	407
5-Feb-02	284	354	215929	6817.2000	179
7-Feb-02	291	--	215929	7209.6560	876
8-Feb-02	253	--	215929	7586.8160	876
11-Feb-02	234	--	215929	6861.6240	876
6-Mar-02	539	510	441720	8810.0000	941
7-Mar-02	477	--	441720	8201.0000	1186
8-Mar-02	499	--	441720	7807.5440	1146
18-Mar-02	510	493	441720	9115.7360	812
19-Mar-02	--	475	411793	9115.7360	812
20-Mar-02	501	477	411793	9871.7360	812
21-Mar-02	512	490	419958	9802.3840	266
25-Mar-02	476	488	419958	9926.0320	244
26-Mar-02	461	457	419958	9925.0320	244
27-Mar-02	438	439	419958	9925.0320	244
28-Mar-02	481	448	397665	7349.0320	244
29-Mar-02	475	446	397665	7530.5360	244
30-Mar-02	211	192		4932.7360	244
31-Mar-02	89	82	0	2318.7360	0

-- denotes 24 hour count not available

Table 5.16: Port Canaveral ANN Model Data (con't)

As documented in the Phase II Final Report, it is evident that each seaport has unique characteristics (11). Port Canaveral also has characteristics that make it unique compared to the other Florida seaports. There is virtually no containerized freight, petroleum imports are significant (but a significant quantity is utilized for power plant consumption), building materials are a significant freight commodity including lumber, and there is significant seasonal citrus commodities. Other characteristics of Port Canaveral are its very high growth potential and storage capacity. Therefore, storage was a necessary consideration for development of the ANN model for this port. A number of interviews were conducted with the port's tenants to determine the storage duration of the significant commodity types. These commodity types were determined from the individual daily vessel records. The storage duration is reflected in the concluding data set shown in Table 5.16. Turnaround times for the major commodities that are regularly imported or exported were obtained and used to distribute the commodities over the specified period of time before used as input to the ANN model. These commodities included cement products for the Rinker and Continental companies, imported lumber, imported petroleum products for the Coastal Petroleum Company, salt for Morton Salt, and Citrus exports.

In order to determine the variables for the model, recognizing any significant differences in daily port activity is necessary. Therefore, a Kolmogorov-Smirnov (K-S) test for normality was done on the daily truck data. Once the data was determined to be normally distributed, a Scheffe's statistical test was conducted on the daily truck volumes between each day of the week. It was found at the 95% confidence level that there is no significant difference between daily heavy truck volumes for any weekday (Monday through Friday). However, there was a significant difference between a weekday and a weekend day. The results of this test can be seen in Appendix P. This concluded the significance in the day of the week for model development. This information was also useful in determining the structure of the model and the input data for calibration.

From regression analysis, the independent variables for the model were concluded. The input variables for calibrating the Port Canaveral ANN model are listed in Table 5.17 below.

Independent Variables	Dependent Variables
Imported Lumber (ImpBDFT)	Inbound Trucks
Imported Tons* (ImpTons)	Outbound Trucks
Exported Tons (ExpTons)	
Saturday (Sat)	
Sunday (Sun)	

* includes petroleum products converted to tons

Table 5.17: Input Variables for the Port Canaveral ANN Model

There were 81 records consisting of both independent and dependent variables used in calibration. The independent variables basically consist of vessel freight data, date and day of the week. The dependent variables are the daily inbound and outbound heavy truck volumes and corresponding date. The final ANN model structure is shown in Figure 5.20. The ANN model consists of an input layer, a hidden layer, and an output layer. These layers are the components of the ANN model for computation. The hidden layer is an additional internal model computation interval that performs a more detailed analysis of the data.

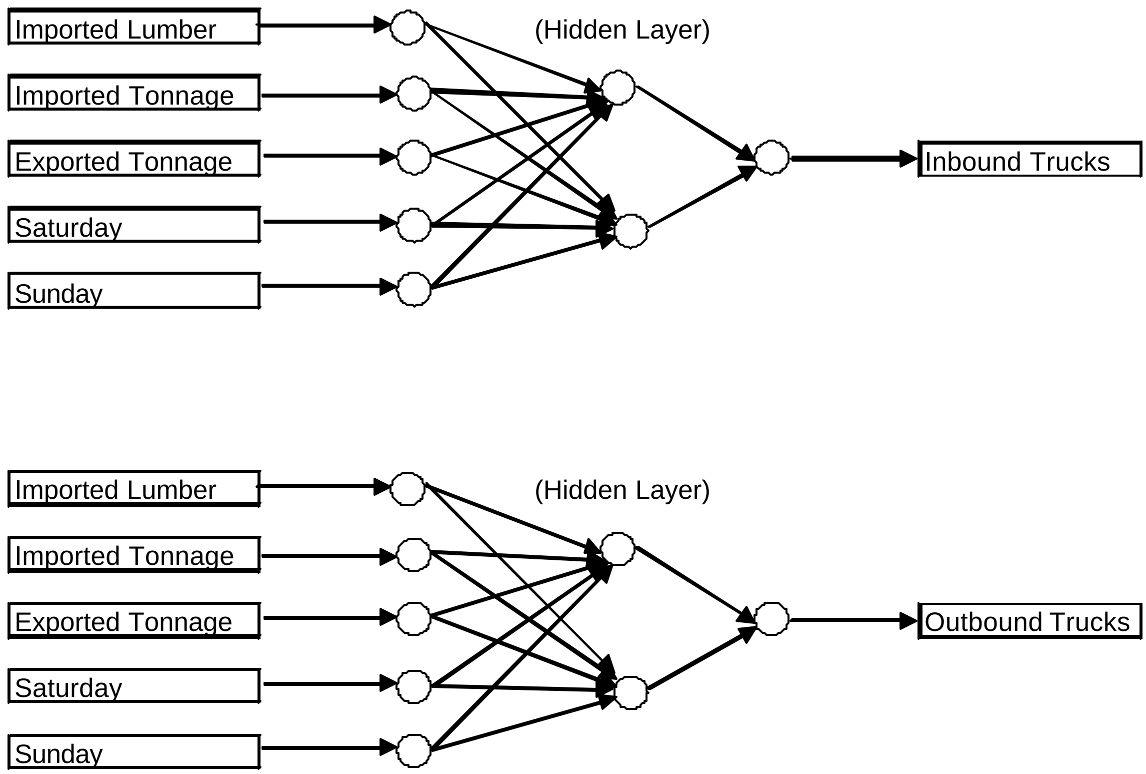


Figure 5.20: Port Canaveral ANN Model Structure

5.4.2 Port Canaveral ANN Model Development (Validation)

For validating the calibrated Port Canaveral ANN model, 45 data records were used. The independent variables were the input to the model. The model output (dependent variables: inbound and outbound daily trucks) was compared to the corresponding field collected daily truck volumes for each output record by date. A statistical T-test was conducted on this data at the 95% confidence level. No significant difference was found between the field data and model results. The results of the statistical analysis are included in Appendix Q. The data is shown in Table 5.18. Figure 5.21 and Figure 5.22 display the comparison graphically.

	Inbound Trucks			Outbound Trucks	
Date	Field	Model	Date	Field	Model
29-Sep-01	71	95	21-Oct-01	61	64
30-Sep-01	49	47	22-Oct-01	221	310
26-Oct-01	331	328	23-Oct-01	257	310
27-Oct-01	94	139	26-Oct-01	290	342
28-Oct-01	70	62	28-Oct-01	48	59
29-Oct-01	354	332	29-Oct-01	333	312
30-Oct-01	346	332	30-Oct-01	310	312
31-Oct-01	373	340	31-Oct-01	339	305
26-Nov-01	316	372	27-Nov-01	298	354
18-Dec-01	340	374	28-Nov-01	350	357
19-Dec-01	327	381	29-Nov-01	326	363
20-Dec-01	309	381	30-Nov-01	329	356
21-Dec-01	301	381	15-Dec-01	109	124
28-Dec-01	378	329	16-Dec-01	58	81
29-Dec-01	152	121	17-Dec-01	340	384
30-Dec-01	93	78	18-Dec-01	384	384
18-Jan-02	388	343	26-Dec-01	306	242
19-Jan-02	158	130	27-Dec-01	290	245
21-Jan-02	358	398	28-Dec-01	308	253
8-Feb-02	253	301	29-Dec-01	119	137
11-Feb-02	234	292	18-Mar-02	493	488
18-Mar-02	510	434			
25-Mar-02	476	470			
26-Mar-02	461	470			

shaded cells denote weekends

Table 5.18: Port Canaveral ANN Model Validation Data

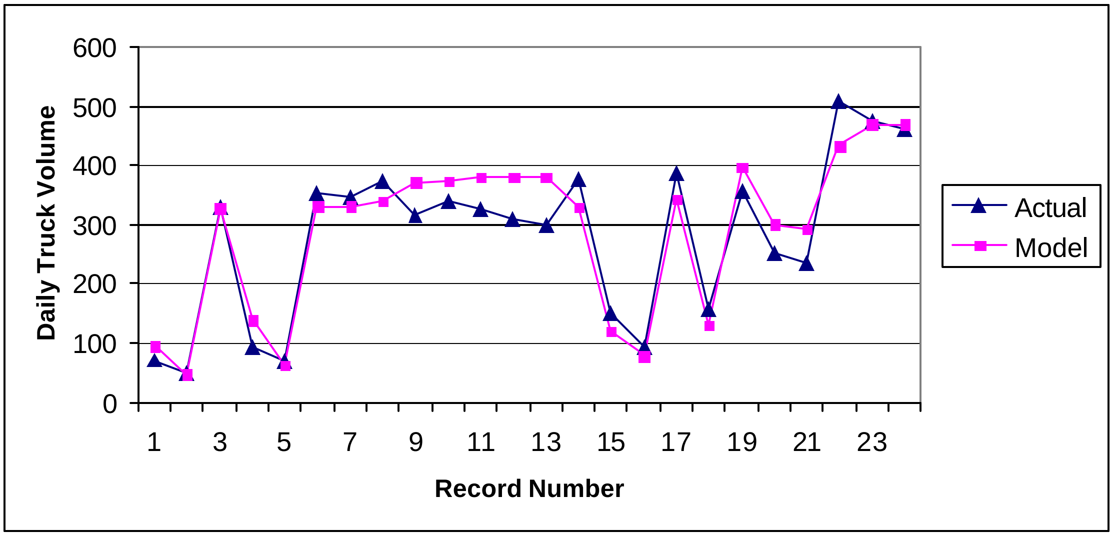


Figure 5.21: Port Canaveral ANN Model Validation Data (Inbound Trucks)

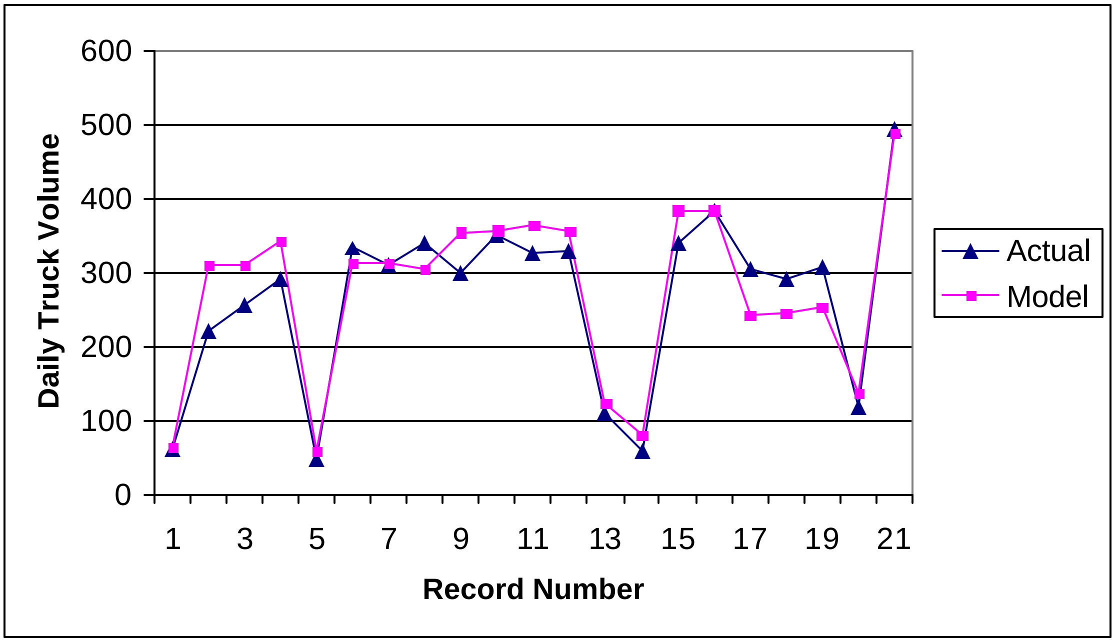


Figure 5.22: Port Canaveral ANN Model Validation Data (Outbound Trucks)

5.4.3 Port Canaveral ANN Model (Forecasting)

To obtain the necessary input for modeling the Port Canaveral road network to determine future truck volumes, the Port Canaveral ANN model must first be executed. From the historical vessel data provided by the Canaveral Port Authority, an Auto Regression Integrated Moving Average (ARIMA) time series model was developed to produce short-term forecasts of freight vessel data (11). This methodology was previously developed in Phase II of this study.

The historical vessel data was available only as units of tons. The Canaveral Port Authority provided 85 months of historical monthly vessel records. Table 5.19, which displays the historical data used in forecasting the vessel data for the five years following, lists the freight in the same variable groups used for the ANN model development. Lumber was grouped in one field and all other general commodities were combined under the imported or exported "tons" fields including petroleum products. Figure 5.23 and Figure 5.24 show the historical trends for this freight vessel data.

	Imports		Exports
Date	Tons	Lumber*	Tons
Oct-1994	130523	0	128264
Nov-1994	192686	1878	53303
Dec-1994	190845	1597	82769
Jan-1995	135791	0	122553
Feb-1995	253386	0	99961
Mar-1995	164250	2057	88155
Apr-1995	184706	2300	79360
May-1995	137154	2461	74492
Jun-1995	201527	553	91506
Jul-1995	174059	552	99384
Aug-1995	193302	2307	57687
Sep-1995	269697	2205	61221
Oct-1995	169195	2663	98547
Nov-1995	161475	551	82828
Dec-1995	164952	2184	81660
Jan-1996	223180	626	114731
Feb-1996	180239	627	122004
Mar-1996	227131	4309	119638
Apr-1996	252334	1300	86025
May-1996	212593	2622	104065
Jun-1996	220196	643	94868
Jul-1996	328302	4461	73645
Aug-1996	240153	647	95747
Sep-1996	122661	3257	80534
Oct-1996	183543	2475	75114
Nov-1996	248878	641	89428
Dec-1996	213091	2715	98123
Jan-1997	191709	642	125313
Feb-1997	202405	846	100303
Mar-1997	217770	2334	115165
Apr-1997	148477	630	79774
May-1997	254460	2883	95268
Jun-1997	186864	689	98482
Jul-1997	167145	3383	89353
Aug-1997	228967	485	68588
Sep-1997	187416	3077	64641
Oct-1997	287425	660	77127
Nov-1997	206288	2638	60649
Dec-1997	156901	598	84254
Jan-1998	179717	569	94258
Feb-1998	146290	2590	81046
Mar-1998	177944	632	88744
Apr-1998	272988	2237	106531
May-1998	258188	657	63198
Jun-1998	296760	4891	83977
Jul-1998	328203	637	104768
Aug-1998	296254	640	97881
Sep-1998	254025	3959	66495
Oct-1998	300552	643	92832
Nov-1998	215772	978	81392
Dec-1998	247529	666	72594
Jan-1999	270944	666	93638
Feb-1999	230159	659	88014
Mar-1999	209640	659	114748
Apr-1999	237350	638	108324
May-1999	303937	621	74819
Jun-1999	288803	625	72393
Jul-1999	264500	639	74467
Aug-1999	267523	519	76828
Sep-1999	267520	625	85295
Oct-1999	278487	654	79582
Nov-1999	223814	659	125305
Dec-1999	133509	0	91525
Jan-2000	269404	592	108097
Feb-2000	311010	3188	126118
Mar-2000	251089	676	112853
Apr-2000	287772	648	128858
May-2000	308010	610	116467
Jun-2000	195108	601	132478
Jul-2000	267401	614	122791
Aug-2000	377128	569	124262
Sep-2000	300228	612	77657
Oct-2000	288471	708	88088
Nov-2000	284940	596	84379
Dec-2000	195271	675	123283
Jan-2001	340282	662	105491
Feb-2001	307041	589	111018
Mar-2001	262586	593	112418
Apr-2001	271706	4718	102919
May-2001	214689	0	98750
Jun-2001	339217	577	98384
Jul-2001	298684	6411	95597
Aug-2001	274760	2727	102087

* measured in short tons

Table 5.19: Port Canaveral Historical Freight Vessel Data

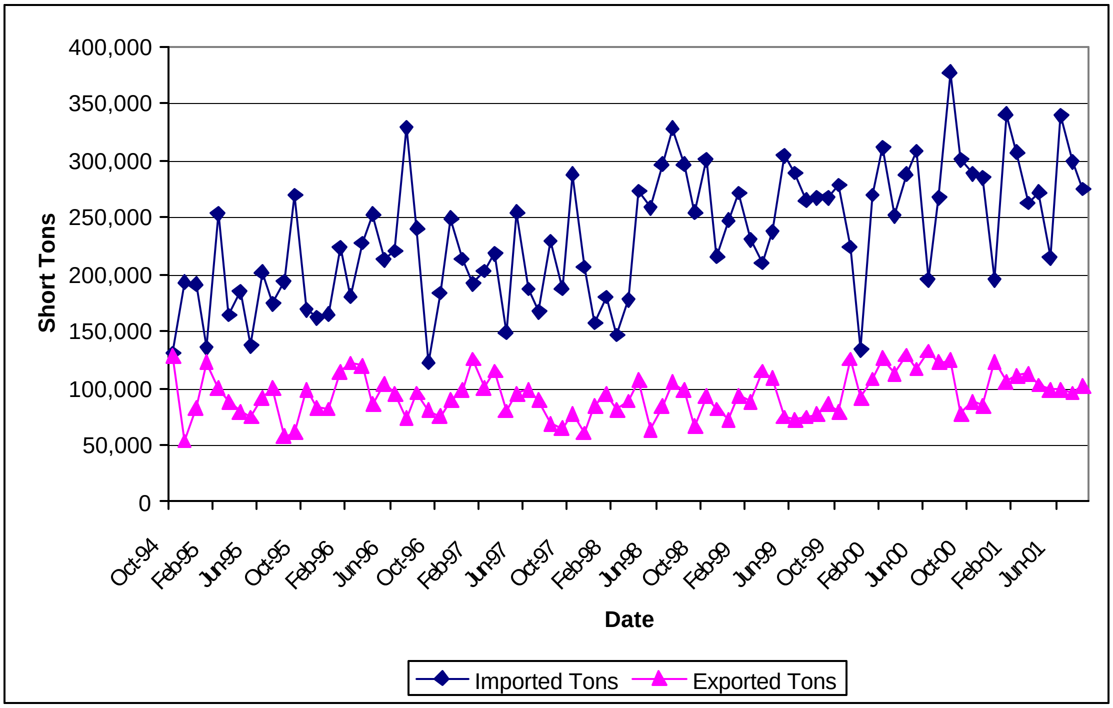


Figure 5.23: Port Canaveral Monthly Historical Vessel Data Trend (General Commodity Tonnage)

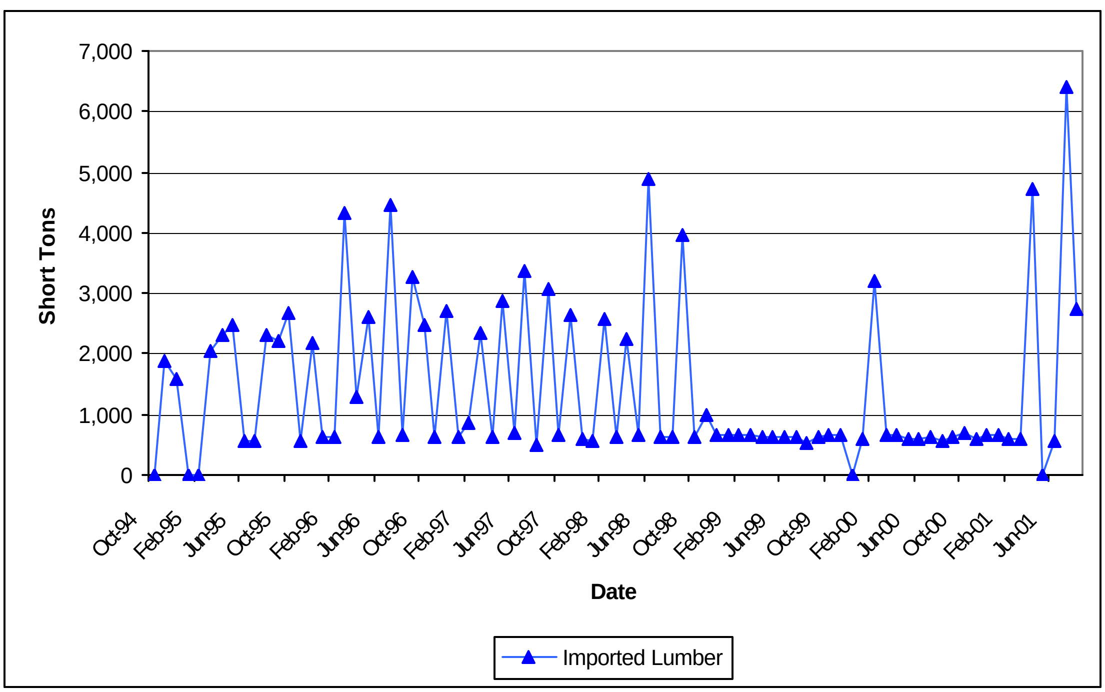


Figure 5.24: Port Canaveral Monthly Historical Vessel Data Trend (Lumber)

The ARIMA model was executed to produce a short term five year forecast of the vessel freight data at Port Canaveral. The fields selected were those used as input to the ANN truck trip generation model. The data is produced for monthly totals just as the historical data was provided. Then, the current daily data (provided by the port authority as individual vessel records) is analyzed to determine a daily distribution for each of the forecasted fields.

Current complete months of data were available for November 2001 through March 2002. The daily distribution from each of these months was applied to the corresponding forecasted months to obtain daily forecast values that were used as input to the ANN model. Table 5.20 displays the monthly forecasted vessel freight data. Table 5.21 through Table 5.23 are the results from applying the daily distribution for one week (Monday to Friday) from each month of the forecasted data. This was the data that is used by the ANN model to generate the daily truck volumes corresponding to each of these weekdays. Forecasted lumber tonnage was converted to a Board Feet (BDFT) estimate based on a conversion factor from the daily distribution of the current lumber measured in BDFT. This was necessary in order to input the correct independent variable for lumber by unit type (BDFT) into the ANN model. Figure 5.25 and Figure 5.26 display the trends for the vessel data including the forecasted data. Figure 5.27 shows the percent change of the forecasted freight variables. All commodities are predicted to increase for Port Canaveral. This is consistent with the future growth plans of the port authority that has been confirmed during several discussions with port authority personnel.

Table 5.24 through Table 5.26 are the forecasted daily truck volume results of the ANN model. Figure 5.28 shows the trend of truck volumes from current year 2002 through forecasted year 2006. It also captures the seasonal variations at the port Figure 5.29 graphically displays the change in trucks between the current truck volumes collected and the forecasted ANN data.

Month/ Year	**Imported** Tonnage	Lumber*	**Exported** Tonnage	**Month/ Year**	**Imported** Tonnage	Lumber*	**Exported** Tonnage
Jan-02	305360	4094	102670	Jul-04	360670	4885	108420
Feb-02	306480	3657	102070	Aug-04	362460	4918	108600
Mar-02	312970	4096	102860	Sep-04	364260	4951	108790
Apr-02	311740	3987	103290	Oct-04	366050	4984	108970
May-02	313080	3947	103850	Nov-04	367840	5018	109150
Jun-02	316840	4122	104130	Dec-04	369630	5051	109330
Jul-02	317540	4059	104340	Jan-05	371420	5084	109510
Aug-02	318990	4110	104320	Feb-05	373220	5117	109700
Sep-02	321600	4176	104320	Mar-05	375010	5151	109880
Oct-02	323050	4169	104500	Apr-05	376800	5184	110060
Nov-02	324630	4223	104680	May-05	378600	5217	110240
Dec-02	326740	4257	104930	Jun-05	380390	5250	110420
Jan-03	328440	4279	105160	Jul-05	382170	5284	110610
Feb-03	330120	4323	105380	Aug-05	383970	5317	110790
Mar-03	332030	4352	105550	Sep-05	385760	5350	110970
Apr-03	333810	4384	105700	Oct-05	387560	5383	111150
May-03	335540	4421	105870	Nov-05	389350	5417	111330
Jun-03	337380	4451	106040	Dec-05	391140	5450	111520
Jul-03	339180	4485	106220	Jan-06	392930	5483	111700
Aug-03	340950	4519	106410	Feb-06	394720	5516	111880
Sep-03	342750	4552	106610	Mar-06	396510	5550	112060
Oct-03	344550	4585	106790	Apr-06	398310	5583	112240
Nov-03	346330	4619	106970	May-06	400100	5616	112430
Dec-03	348120	4652	107150	Jun-06	401900	5649	112610
Jan-04	349920	4685	107330	Jul-06	403690	5683	112790
Feb-04	351710	4718	107510	Aug-06	405470	5716	112970
Mar-04	353500	4751	107690	Sep-06	407270	5749	113160
Apr-04	355300	4785	107870	Oct-06	409060	5782	113340
May-04	357080	4818	108060	Nov-06	410850	5816	113520
Jun-04	358880	4851	108240	Dec-06	412650	5849	113700

* measured in short tons

Table 5.20: Port Canaveral Monthly Forecasted Vessel Data

Month/ Year	Day	Imported Lumber (BDFT)	Tonnage (Tons)	Exported Tonnage (Tons)	Month/ Year	Day	Imported Lumber (BDFT)	Tonnage (Tons)	Exported Tonnage (Tons)
Jan-02	Monday	418629	8287.488	976.4178	Jan-03	Monday	437598.1	8938.183	1000.098
	Tuesday	418629	8287.488	976.4178		Tuesday	437598.1	8938.183	1000.098
	Wednesday	418629	7182.565	3254.726		Wednesday	437598.1	7732.053	3333.661
	Thursday	418629	8991.309	3261.368		Thursday	437598.1	9706.471	3340.465
	Friday	418629	9278.892	3646.622		Friday	437598.1	10020.4	3735.061
Feb-02	Monday	215929	11435.34	1365.306	Feb-03	Monday	255269.3	12295.3	1409.582
	Tuesday	215929	12451.85	1365.306		Tuesday	255269.3	13396.23	1409.582
	Wednesday	215929	13417.86	1372.934		Wednesday	255269.3	14442.48	1417.456
	Thursday	215929	13416.45	6681.611		Thursday	255269.3	14440.97	6898.287
	Friday	215929	14342.45	6681.611		Friday	255269.3	15443.89	6898.287
Mar-02	Monday	193298	12690.65	5088.118	Mar-03	Monday	205403.6	13479.66	5221.182
	Tuesday	193298	12689.05	5088.118		Tuesday	205403.6	13478.02	5221.182
	Wednesday	441720	12689.05	5088.118		Wednesday	469383.4	13478.02	5221.182
	Thursday	441720	11054.52	6412.867		Thursday	469383.4	11714.08	6580.576
	Friday	441720	9998.498	6196.581		Friday	469383.4	10574.45	6358.634
Nov-02	Monday	568720.5	8600.245	5642.926	Nov-03	Monday	621924.4	9186.526	5766.371
	Tuesday	354724	11085.19	5642.926		Tuesday	387908.5	11854.27	5766.371
	Wednesday	354724	11161.3	5916.371		Wednesday	387908.5	11934.65	6045.799
	Thursday	354724	11161.3	5642.926		Thursday	387908.5	11934.65	5766.371
	Friday	354724	8541.264	5642.926		Friday	387908.5	9129.544	5766.371
Dec-02	Monday	240247.9	10357.87	4271.787	Dec-03	Monday	262493.4	11072.01	4362.165
	Tuesday	40688.39	10357.87	4271.787		Tuesday	44455.88	11072.01	4362.165
	Wednesday	40688.39	9933.057	4932.897		Wednesday	44455.88	10624.69	5037.262
	Thursday	40688.39	7191.527	4932.897		Thursday	44455.88	7682.568	5037.262
	Friday	40688.39	8567.35	4941.372		Friday	44455.88	9159.058	5045.917

Table 5.21: Port Canaveral Daily Forecasted Vessel Data (Year 2002-2003)

Month/ Year	Day	Imported Lumber (BDFT)	Tonnage (Tons)	Exported Tonnage (Tons)
Jan-04	Monday	479084.7	9503.289	1020.736
	Tuesday	479084.7	9503.289	1020.736
	Wednesday	479084.7	8232.44	3402.452
	Thursday	479084.7	10312.8	3409.396
	Friday	479084.7	10643.57	3812.135
Feb-04	Monday	278618.4	13071.85	1438.073
	Tuesday	278618.4	14252.27	1438.073
	Wednesday	278618.4	15374.1	1446.107
	Thursday	278618.4	15372.51	7037.719
	Friday	278618.4	16447.87	7037.719
Mar-04	Monday	224244	14358.16	5327.04
	Tuesday	224244	14356.42	5327.04
	Wednesday	512437	14356.42	5327.04
	Thursday	512437	12465.74	6713.996
	Friday	512437	11244.22	6487.554
Nov-04	Monday	675653.5	9768.85	5883.887
	Tuesday	421420.6	12619.52	5883.887
	Wednesday	421420.6	12704.04	6169.01
	Thursday	421420.6	12704.04	5883.887
	Friday	421420.6	9714.464	5883.887
Dec-04	Monday	285021.1	11788.16	4450.914
	Tuesday	48271.17	11788.16	4450.914
	Wednesday	48271.17	11317.87	5139.746
	Thursday	48271.17	8175.286	5139.746
	Friday	48271.17	9752.375	5148.578

Month/ Year	Day	Imported Lumber (BDFT)	Tonnage (Tons)	Exported Tonnage (Tons)
Jan-05	Monday	519886.1	10069.1	1041.468
	Tuesday	519886.1	10069.1	1041.468
	Wednesday	519886.1	8733.342	3471.56
	Thursday	519886.1	10919.96	3478.645
	Friday	519886.1	11267.63	3889.564
Feb-05	Monday	302180.1	13844.44	1467.367
	Tuesday	302180.1	15104.36	1467.367
	Wednesday	302180.1	16301.76	1475.564
	Thursday	302180.1	16300.09	7181.079
	Friday	302180.1	17447.9	7181.079
Mar-05	Monday	243079.7	15238.11	5435.372
	Tuesday	243079.7	15236.29	5435.372
	Wednesday	555479.9	15236.29	5435.372
	Thursday	555479.9	13218.94	6850.533
	Friday	555479.9	11915.6	6619.486
Nov-05	Monday	729382.6	10351.09	6001.403
	Tuesday	454932.7	13384.56	6001.403
	Wednesday	454932.7	13473.23	6292.22
	Thursday	454932.7	13473.23	6001.403
	Friday	454932.7	10299.26	6001.403
Dec-05	Monday	307543.1	12504.55	4540.071
	Tuesday	52085.5	12504.55	4540.071
	Wednesday	52085.5	12011.31	5242.701
	Thursday	52085.5	8668.135	5242.701
	Friday	52085.5	10345.89	5251.709

Table 5.22: Port Canaveral Daily Forecasted Vessel Data (Year 2004-2005)

Month/ Year	**Day**	**Imported** Lumber (BDFT)	Tonnage (Tons)	**Exported** Tonnage (Tons)
Jan-06	Monday	560697.8	10635.27	1062.295
	Tuesday	560697.8	10635.27	1062.295
	Wednesday	560697.8	9234.502	3540.985
	Thursday	560697.8	11527.54	3548.211
	Friday	560697.8	11892.12	3967.348
Feb-06	Monday	325747.7	14616.54	1496.527
	Tuesday	325747.7	15955.95	1496.527
	Wednesday	325747.7	17228.93	1504.887
	Thursday	325747.7	17227.17	7323.784
	Friday	325747.7	18447.43	7323.784
Mar-06	Monday	261915.3	16117.69	5543.209
	Tuesday	261915.3	16115.78	5543.209
	Wednesday	598522.7	16115.78	5543.209
	Thursday	598522.7	13971.77	6986.446
	Friday	598522.7	12586.6	6750.815
Nov-06	Monday	783125.1	10933.12	6119.459
	Tuesday	488453.1	14149.39	6119.459
	Wednesday	488453.1	14242.19	6415.996
	Thursday	488453.1	14242.19	6119.459
	Friday	488453.1	10883.86	6119.459
Dec-06	Monday	330065.1	13220.71	4628.821
	Tuesday	55899.82	13220.71	4628.821
	Wednesday	55899.82	12704.48	5345.186
	Thursday	55899.82	9160.854	5345.186
	Friday	55899.82	10939.21	5354.37

Table 5.23: Port Canaveral Daily Forecasted Vessel Data (Year 2006)

Month/ Year	Day	Inbound	Outbound	Month/ Year	Day	Inbound	Outbound
Jan-02	Monday	420	459	Jan-03	Monday	439	480
Jan-02	Tuesday	420	459	Jan-03	Tuesday	439	480
Jan-02	Wednesday	525	394	Jan-03	Wednesday	546	413
Jan-02	Thursday	550	420	Jan-03	Thursday	573	441
Jan-02	Friday	574	436	Jan-03	Friday	598	457
Feb-02	Monday	379	312	Feb-03	Monday	413	342
Feb-02	Tuesday	393	326	Feb-03	Tuesday	428	358
Feb-02	Wednesday	406	340	Feb-03	Wednesday	443	373
Feb-02	Thursday	686	499	Feb-03	Thursday	731	536
Feb-02	Friday	699	512	Feb-03	Friday	745	551
Mar-02	Monday	581	431	Mar-03	Monday	605	452
Mar-02	Tuesday	581	431	Mar-03	Tuesday	605	452
Mar-02	Wednesday	708	537	Mar-03	Wednesday	739	564
Mar-02	Thursday	755	553	Mar-03	Thursday	787	579
Mar-02	Friday	730	532	Mar-03	Friday	760	556
Nov-02	Monday	746	549	Nov-03	Monday	788	584
Nov-02	Tuesday	671	494	Nov-03	Tuesday	705	522
Nov-02	Wednesday	686	503	Nov-03	Wednesday	720	532
Nov-02	Thursday	672	495	Nov-03	Thursday	706	523
Nov-02	Friday	636	458	Nov-03	Friday	668	484
Dec-02	Monday	530	394	Dec-03	Monday	556	416
Dec-02	Tuesday	428	309	Dec-03	Tuesday	445	323
Dec-02	Wednesday	457	322	Dec-03	Wednesday	474	337
Dec-02	Thursday	420	283	Dec-03	Thursday	434	295
Dec-02	Friday	439	303	Dec-03	Friday	455	316

Table 5.24: Port Canaveral Daily Forecasted Truck Volumes (Year 2002-2003)

Month/ Year	Day	Inbound	Outbound	Month/ Year	Day	Inbound	Outbound
Jan-04	Monday	469	515	Jan-05	Monday	499	541
Jan-04	Tuesday	469	515	Jan-05	Tuesday	499	541
Jan-04	Wednesday	578	439	Jan-05	Wednesday	609	466
Jan-04	Thursday	606	469	Jan-05	Thursday	639	497
Jan-04	Friday	632	486	Jan-05	Friday	665	514
Feb-04	Monday	437	364	Feb-05	Monday	461	386
Feb-04	Tuesday	453	381	Feb-05	Tuesday	478	404
Feb-04	Wednesday	469	397	Feb-05	Wednesday	495	421
Feb-04	Thursday	763	564	Feb-05	Thursday	795	591
Feb-04	Friday	778	579	Feb-05	Friday	811	607
Mar-04	Monday	632	475	Mar-05	Monday	659	499
Mar-04	Tuesday	632	475	Mar-05	Tuesday	659	499
Mar-04	Wednesday	779	597	Mar-05	Wednesday	818	631
Mar-04	Thursday	826	612	Mar-05	Thursday	866	645
Mar-04	Friday	798	588	Mar-05	Friday	836	619
Nov-04	Monday	829	618	Nov-05	Monday	871	652
Nov-04	Tuesday	738	551	Nov-05	Tuesday	772	579
Nov-04	Wednesday	754	561	Nov-05	Wednesday	788	589
Nov-04	Thursday	739	552	Nov-05	Thursday	773	581
Nov-04	Friday	699	510	Nov-05	Friday	730	536
Dec-04	Monday	582	439	Dec-05	Monday	608	461
Dec-04	Tuesday	461	338	Dec-05	Tuesday	477	352
Dec-04	Wednesday	491	352	Dec-05	Wednesday	508	366
Dec-04	Thursday	448	307	Dec-05	Thursday	462	318
Dec-04	Friday	470	330	Dec-05	Friday	486	343

Table 5.25: Port Canaveral Daily Forecasted Truck Volumes (Year 2004-2005)

Month/ Year	Day	Inbound	Outbound
Jan-06	Monday	528	568
Jan-06	Tuesday	528	568
Jan-06	Wednesday	640	492
Jan-06	Thursday	671	525
Jan-06	Friday	698	543
Feb-06	Monday	485	408
Feb-06	Tuesday	503	427
Feb-06	Wednesday	521	445
Feb-06	Thursday	827	618
Feb-06	Friday	844	635
Mar-06	Monday	686	523
Mar-06	Tuesday	686	523
Mar-06	Wednesday	858	665
Mar-06	Thursday	905	677
Mar-06	Friday	874	651
Nov-06	Monday	912	687
Nov-06	Tuesday	805	608
Nov-06	Wednesday	822	618
Nov-06	Thursday	807	609
Nov-06	Friday	761	562
Dec-06	Monday	634	483
Dec-06	Tuesday	494	367
Dec-06	Wednesday	524	381
Dec-06	Thursday	476	330
Dec-06	Friday	501	356

Table 5.26: Port Canaveral Daily Forecasted Truck Volumes (Year 2006)

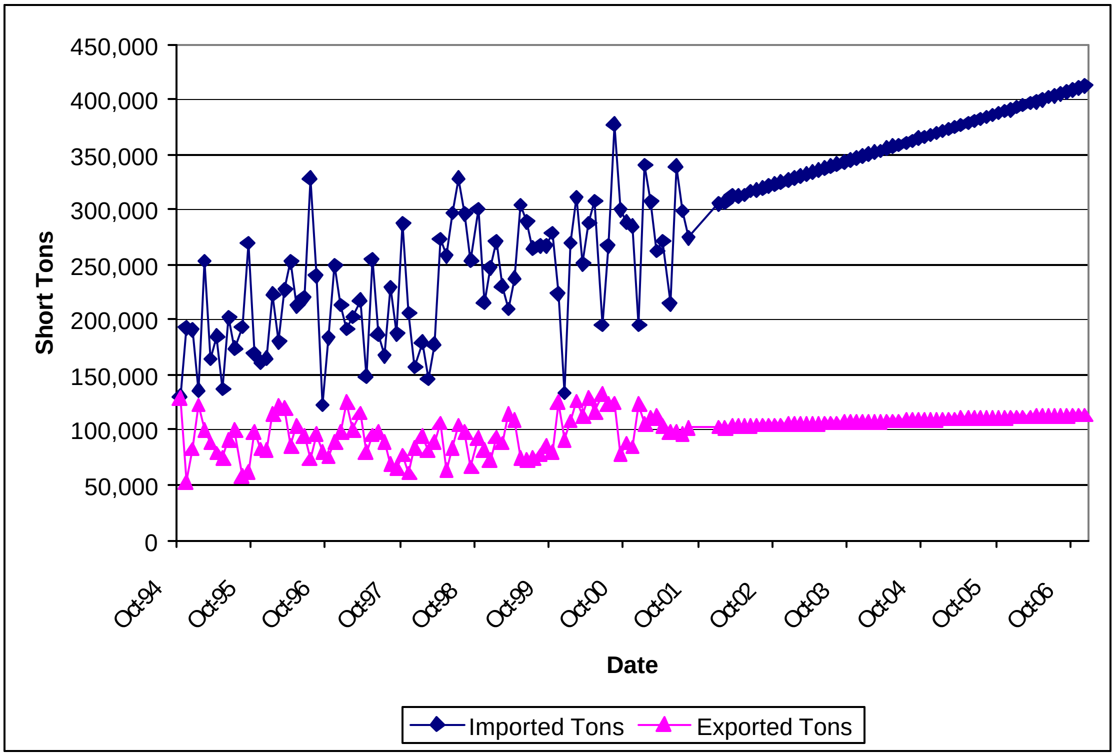


Figure 5.25: Port Canaveral Vessel Data Trend (General Commodity Tonnage)

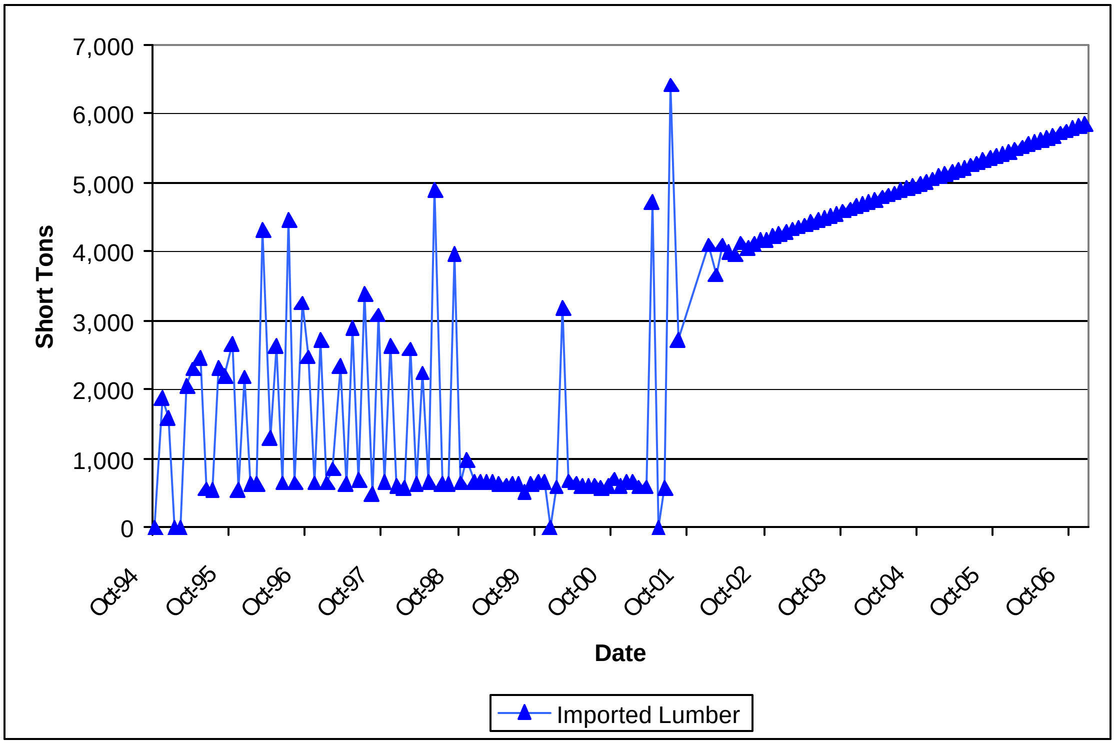


Figure 5.26: Port Canaveral Monthly Vessel Data Trend (Lumber)

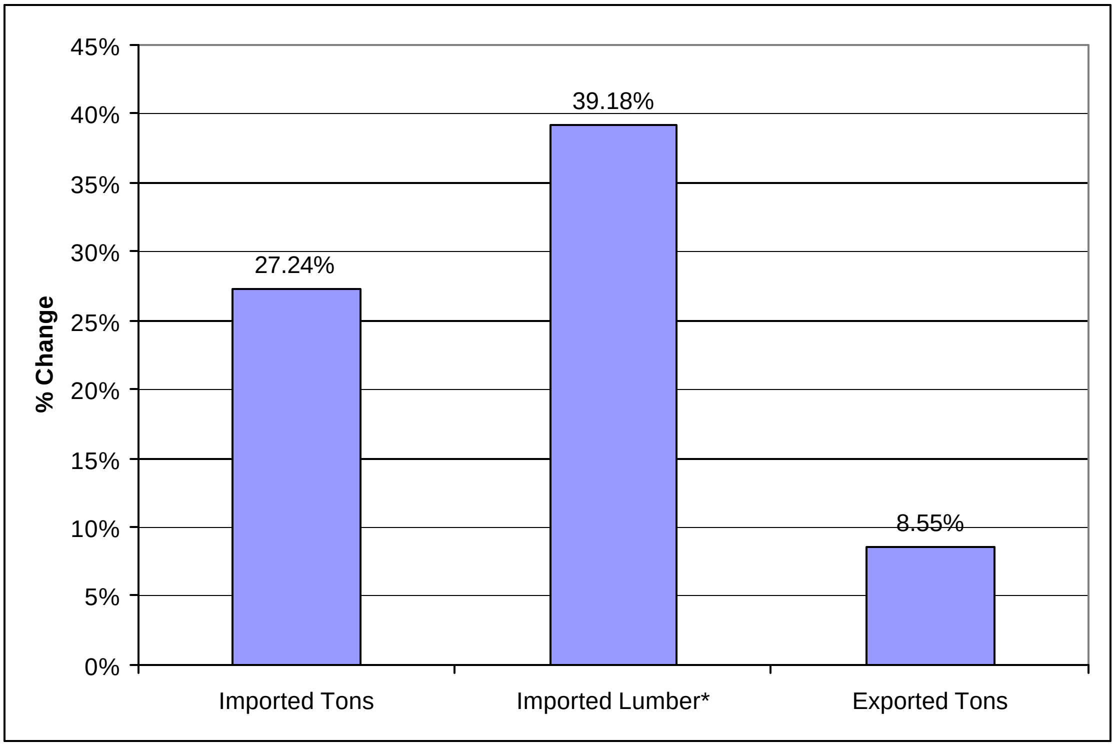
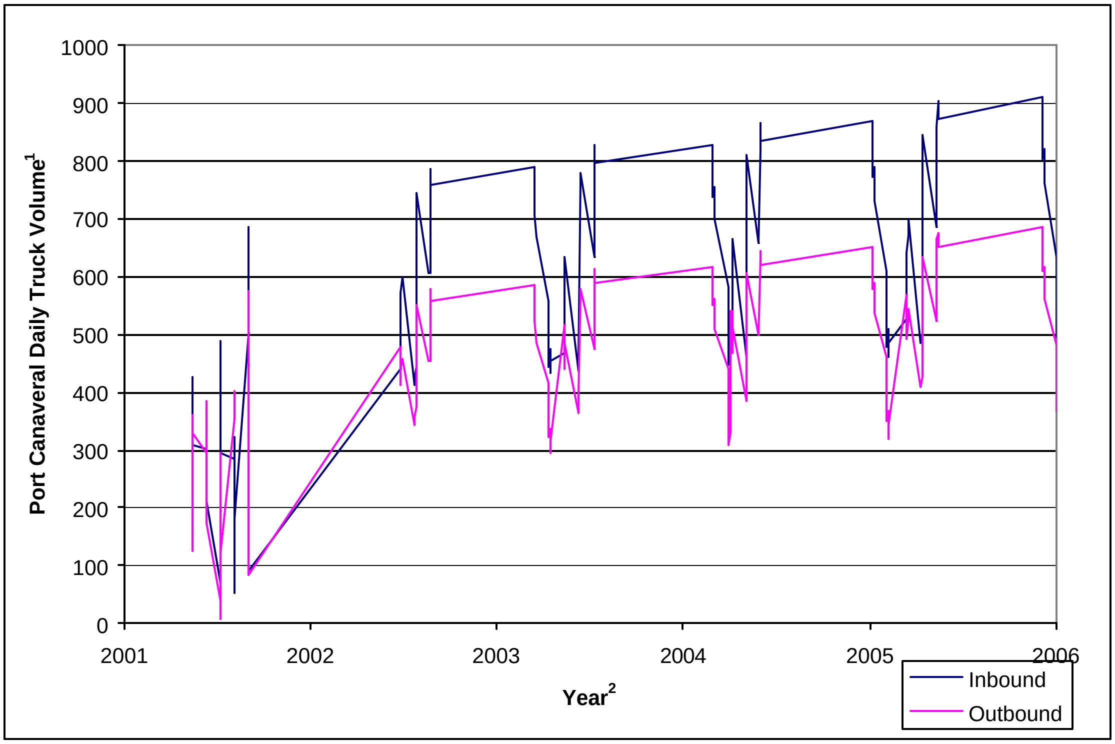


Figure 5.27: Port Canaveral Forecasted Change in Freight Movements (2002-2006)



1 excludes weekends

2 annual counts using one week from each month of the year (84 data points)

Figure 5.28: Port Canaveral Forecasted Truck Movements (2002-2006)

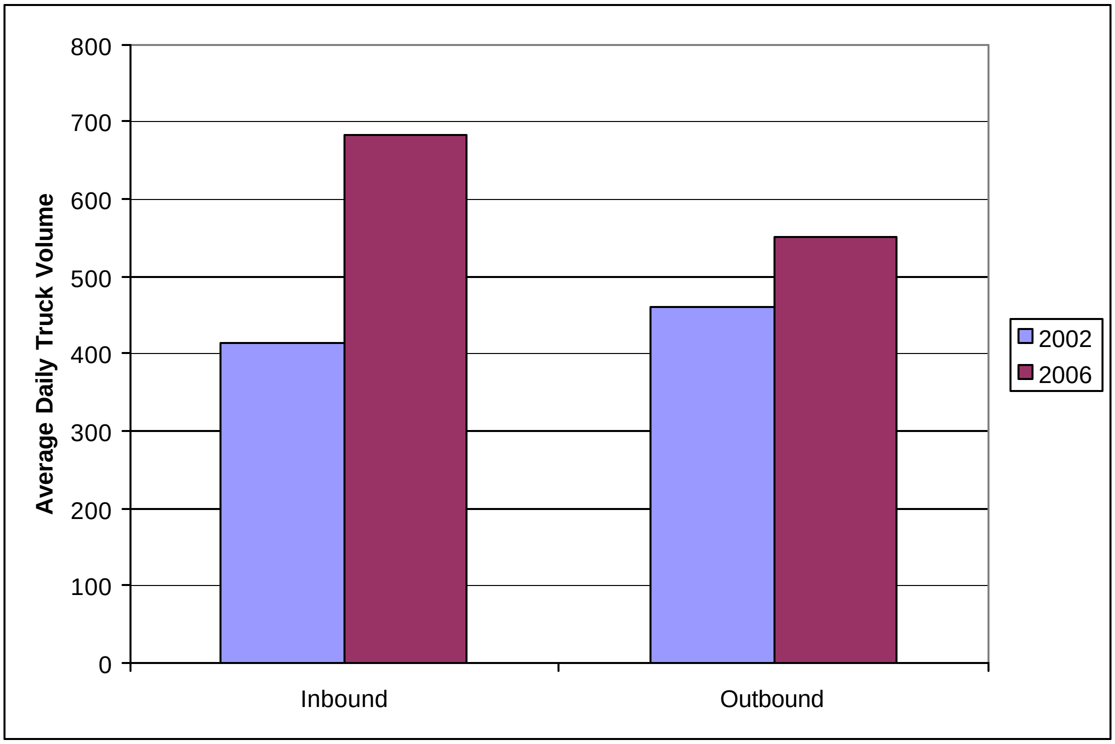


Figure 5.29: Port Canaveral Change in Forecasted Truck Movements (2002-2006)

5.4.4 Port Canaveral Network Forecasting

Once the forecasted daily truck volumes generated by Port Canaveral vessel freight activity were determined, they must be converted to peak hourly traffic volumes. In order to execute the VISSIM network model, it requires hourly traffic volumes that include all vehicle types. The methodology developed for the Tampa model was applied to Port Canaveral. This procedure is detailed previously in section 4.4 for the Port of Tampa. A selection of data from the ANN forecast results were used to compute the necessary hourly traffic volumes. These results are shown in Table 5.27.

		Inbound		Outbound	
Date	Day of the Week	Peak Hour Traffic	Peak Hour Trucks	Peak Hour Traffic	Peak Hour Trucks
Jan-06	Monday	345	35	797	80
Jan-06	Tuesday	345	35	797	80
Jan-06	Wednesday	418	42	690	69
Jan-06	Thursday	438	44	737	74
Jan-06	Friday	456	46	762	76

Table 5.27: Port Canaveral Freight Terminal Hourly Traffic Volumes for Year 2006

Also, to estimate the change in traffic volumes on the network, the growth factor was calculated from the growth in truck volumes using the same methodology from the Tampa analysis. The growth factor was calculated from both inbound and outbound truck volumes for two months and an average percent of growth determined. The percent growth was found to be 38.13%.

Once the peak hourly traffic volumes generated by Port Canaveral's freight vessel activity are estimated and the growth factor applied to the network volumes, an O-D matrix for each of the 5 days of forecasted daily truck data was concluded. According to the ANN Port Canaveral truck trip generation modeling results from the January 2006 data selection for trucks destined to Port Canaveral generated by the port's vessel freight activity, 15.4% use SR 528 (eastbound), 12.4% use I-95 traveling northbound (coming from areas south of SR 528) and 12.4% use I-95 traveling southbound (coming from areas north of SR 528). For trucks originating from Port Canaveral, 19.3% use SR 528 (westbound), 19.3% use I-95 traveling northbound (going to areas north of SR 528) and 8.0% use I-95 traveling southbound (going to areas south of SR 528).

The network model has also captured port generated local truck trips. 12.8% of the truck traffic generated by the port's freight activity travel to Industry Road and 30.9%

of the trucks destined to the port are coming from Industry Road. This Industry Road truck traffic is attributed to the large Rinker cement facility. Also, 12.8% of the trucks were local trips to US1 and 9.3% of the truck trips to the port were from US1. This truck traffic is attributed to the rail terminal located just northwest of SR 528. The results of the forecasting on the network are shown in Table 5.28.

			Location		
			SR 528 (Link # 7)*	**SR 528 (Link # 8)***	**SR 528 (Link # 15)***
Date	**Weekday**	**Direction**	**VISSIM**	**VISSIM**	**VISSIM**
Jan-06	Monday	Inbound	43	27	14
		Outbound	71	56	27
Jan-06	Tuesday	Inbound	43	27	14
		Outbound	71	56	27
Jan-06	Wednesday	Inbound	43	28	15
		Outbound	72	55	28
Jan-06	Thursday	Inbound	43	27	14
		Outbound	72	55	29
Jan-06	Friday	Inbound	45	28	14
		Outbound	73	55	28

* denotes a master link

Table 5.28: Port Canaveral Network Peak Hour Truck Volumes (Year 2006)

6. CONCLUSIONS AND RECOMMENDATIONS

A microscopic simulation computer modeling approach was successfully utilized in the development of a methodology for modeling Florida seaport generated heavy trucks on a road network adjacent to the seaport. Two micro simulation-modeling packages were evaluated in the methodology development using data from the Port of Tampa. Both CORSIM and VISSIM produced acceptable results when compared to truck volumes collected from the field at the port and selected locations on the defined road network. A short-term forecast of truck volumes was performed to examine the increase of trucks on the road network due to an increase in seaport generated truck volumes. The transferability of this methodology was successfully tested for Port Canaveral.

Once the appropriate road network was defined, the computer models were calibrated with FDOT and field collected traffic volumes. These traffic volumes consisted of heavy trucks only and total vehicular traffic (all vehicle types). After the models were calibrated, a validation was performed and statistically verified at the 95% confidence level. The validation was conducted with actual field collected truck volumes not used in the calibration.

The results of the network modeling and analysis indicated that an average of 720 heavy trucks generated by the Port of Tampa's freight activity travel on the defined network during the peak hour (5-6 PM). From this total truck traffic, 55% of these trucks travel between the port's freight terminals and the connecting interstate highways (I-4, I-275, I-75). Interstate 4 was found to serve the highest percent of trucks generated by the port. For trucks traveling to the port, 22% of the total trucks are estimated to come from I-4 and 38% leaving the port are destined to I-4. Also, due to the high volumes of phosphate products handled at the Port of Tampa, Causeway Boulevard serves an estimated 250 trucks during the peak hour generated by the port's freight activity.

The comparison between CORSIM and VISSIM results indicated that both computer simulation packages produce similar results. Overall however, VISSIM is more user friendly, takes less time to develop a model, and the animation is better including 3-D animation features. CORSIM does provide an overall network evaluation value whereas VISSIM does not. But, this can be obtained from the VISSIM results with a minor computation step. CORSIM also currently has a more user friendly signal coding module but VISSIM developers were working on improving this. VISSIM was concluded to be a better computer package for application to the network modeling and selected to conduct the short term forecasting for the Port of Tampa and also the transferability testing on Port Canaveral.

To conduct a short-term forecast of the truck traffic estimated on the identified routes used by trucks generated by the Port of Tampa in year 2005, a truck trip generation model previously developed for the Port of Tampa was executed. The results from this model were used to determine the input for the developed Port of Tampa road network model. A growth factor of 6% was calculated for the defined road network based on estimated growth at the port.

From the analysis of results for the short term forecast on the Port of Tampa road network, the overall heavy truck traffic on the defined network generated by the port was estimated to increase by 4.5%. This low increase is attributed to the previous forecasted results of the minute increase in freight activity for the port. Most of the truck volumes related to the interstate highways show only minor incremental increases during the peak hour. Interstate 75 displayed the largest increase from 6% to 14% of the total trucks generated by the port.

A sensitivity analysis was conducted on the defined network to test the developed methodology for intelligent transportation systems (ITS) applications such as Advanced Traveler Information Systems (ATIS) or incident management. Four scenarios were conducted including a base scenario. Average travel time and delay for the entire network were selected as the measures of effectiveness (MOEs).

The existing conditions (base scenario) produced an average travel time for the network of 329 sec/veh and an average delay of 113 sec/veh. Scenario 2, which was adding one lane for each direction to the access roads north of Hookers Point (22nd and 21st Streets), decreased the average network travel time by 8% and the average delay by 12%. Scenario 3 evaluated the network if the trucks were prohibited from using 22nd and 21st Streets. Compared to the base scenario, the average travel time increased by 6% and the average delay increased by 5% for the entire network. However, the travel time and delay have decreased by approximately 50% for the routes between Hooker's Point and the Interstates to the north (I-4 and I-275) using 22nd and 21st Streets. Scenario 4 examines the network with an incident occurrence on 22nd Street where one lane is closed to through traffic. Compared to the base scenario, the average travel time increased by 17% and the average delay increased by 16% for the entire network.

After the developed methodology was successfully tested and implemented for short term forecasting with the Port of Tampa, the methodology was applied to Port

Canaveral. Port Canaveral's network was smaller than Tampa and the port generates much lower traffic volumes overall. Port Canaveral also has lower freight activity than Tampa.

The Port of Tampa has a number of main truck routes directly feeding into the port whereas Port Canaveral has only SR 528. There is another route to the south (SR A1A to SR 520), but it is a low speed arterial that is not suitable for heavy truck traffic however could be utilized as an alternate route if necessary during a emergency situation. This was included in the Port Canaveral network definition for ITS applications.

The Port Canaveral road network was defined and modeled using VISSIM. The calibrated model was validated at the 95% confidence level using field data collected on the selected master links. The master links were all located on SR 528 however, they also capture the truck traffic on Interstate 95 generated by the port's freight activity. Of the total truck volumes generated by the port during the peak hour, on the average, 25% of the trucks generated by the port use I-95 and 18% use SR 528 for travel outside the defined network. Due to the local destinations on the network (US 1 rail terminal, Industry Road Rinker Cement facility), there are also a significant percent of local trips made in the area captured by the defined network as well. On the average, 11% of the total truck trips travel between US 1 (rail terminal) and the port and 22% of the total truck trips travel between Industry Road (Rinker Cement Distribution Facility) and the port.

In order to conduct the short term forecasting of the port generated heavy truck traffic on the network, a truck trip generation is required. This model was developed for Port Canaveral with the same methodology as in Phase II of this project (11). The model was successfully validated at the 95% confidence level with 45 days of field data collected at Port Canaveral's freight terminals. From historical vessel freight data, a short term (5-year) forecast was done using a time series modeling approach to obtain an estimate of the daily heavy trucks that the port would generate in years 2002 through 2006. The truck trip generation model has shown to be robust because it successfully captured seasonal truck traffic trends at the port as well.

Port Canaveral is projected to have a significant growth of its vessel freight activity. Using the results of year 2006, the truck volumes were used to determine the input for the Port Canaveral road network model. The growth factor based on the estimated future freight activity is significant at 38%. The distribution of trucks on the network however stays virtually unchanged. This is attributed to the simplicity of the network compared to Tampa. There is only one main access highway to the port that services heavy trucks (SR 528) and only two routes (SR 528 and I-95) are currently used for interstate and intrastate travel by the trucks generated from Port Canaveral's freight activity.

The methodology developed for modeling truck traffic generated by a Florida seaport's freight activity has been successfully tested for the Port of Tampa and applied in practice to Port Canaveral. Furthermore, the developed road network models utilize previously developed truck trip generation models for these two ports to determine short-term forecasts of truck volumes at the port. These forecasted truck volumes were used to determine the input data for the desired forecast year and the network was successfully modeled for that year. Due to the successful transferability testing, this methodology can be applied to any other Florida seaport.

The ANN trip generation model output is useful for determining the number of trucks expected to be generated by a facility with freight activity. The developed network methodology herein has proven the usefulness of this data. This model data can be utilized as input to other models such as the Florida Statewide Freight Model. Similarly, the developed network models can be utilized by local transportation and planning agencies to investigate the impacts of heavy trucks in areas with freight activity. These network models provide the agencies with a microscopic modeling approach for local traffic situations.

The developed road network models for Tampa and Cape Canaveral have application to any traffic study that would include the seaport in the network. The network models can be utilized to test the occurrence of new security measures for access to the port's freight terminal facilities. The network can be tested for alternate route choice. Intelligent Transportation System (ITS) applications can be tested on the network before deployment as well.

Scenarios based on estimated future port growth or changes to seasonal freight movements can also be tested to determine what impact these changes could have on the network in terms of travel time and delay. Local municipalities can determine if estimated growth will impact the network and if so, can test geometric improvement scenarios. These seaports are special generators of traffic and these models can be utilized to determine input for other broader computer models for planning and development purposes.

APPENDIX A
Trip Reports

TRUCK PROJECT REPORT

Date/Location:	November 5-6, 2000 / Tampa (phase 2I)
Travelers:	Anand Jujare, Ahmed Elhelw
Subject:	Meeting with City of Tampa Transportation Department
Objective:	Obtaining Volumes of traffic and signal timing for different nodes and links
Outcome:	Successful

Summary:

A meeting was held with City of Tampa Transportation Department. A brief summery of the project was provided to Mr. Mike Scanner (Head of traffic operations section). A map showing nodes and links of the proposed network was also provided. Traffic volumes at all the nodes that are west of 50^{th} street were obtained. Hillsborough County controls streets that are east of 50th street. Signal timing and turning movements' volumes were also obtained for the above mentioned nodes. Signal timing was obtained in two forms, namely basic and different patterns. Basic and all the different timing patterns for each signal (actuated ones) were also obtained. A sample of these data is shown in the attached sheet. All the data was obtained as hard copies. Another meeting should be held with City of Tampa TD to get any available data on the links for the same area. City of Tampa identified contact persons in Hillsborough County. Another meeting should be held with Mr. Greg Basset in Hillsborough County to get the same type of data for the rest of the network. People of City of Tampa were cooperative and helpful.

TRUCK PROJECT REPORT

Date/Location:	December 12th / Tampa
Subject:	Meeting with Ron Dickson (813-241-4080)
Objective:	Obtain information about their truck movements.
Outcome:	Successful

Summary:

Discussed the general operations of McKenzie tank lines. They operate out of 30 southeast distribution facilities. One of their main contracts in the Tampa/Orlando area are Mobile gas stations. The tankers travel in all directions to deliver fuel. They haul gasoline, diesel and some black oil (not considered high volume). The black oil mainly is delivered to power plants, citrus and sugar cane plants. The trucks are all 5-axle semi tractor-trailers. The distance between the truck cab rear axle and first trailer axle is less than 35 feet. The Orlando distribution site receives fuel from a GATX pipeline out of Tampa. All other locations are trucked out (i.e. Port Everglades). They also truck petroleum out of Port Manatee.

The Tampa locations average about 4 loads/day per truck. They are running about 20-23 trucks a day (24hr/7days/wk). Central dispatch (i.e. Mobile Gas) sends the requests to McKenzie dispatch that then sends their trucks to the gas stations for deliveries. The trucks are not scheduled depending on vessel petroleum products imported. These trucks run on a dispatch schedule based on the needs of the stations (retail sales driven). Out of

Tampa, the trucks mainly travel 22^{nd} st and Causeway blvd to Hwy 301 and 41. They also use I-75 and I-275 for longer distance trips.

Ft. Lauderdale (Port Everglades) McKenzie lines use the interstates for their trips. They are running about 35 to 40 trucks/day and also average about 4 loads/day.

The Terminal locations are:

Bucks, AL	Mobile, AL	Opelika, AL
Brooker, FL	Ft. Lauderdale, FL	Jacksonville, FL
Panama City, FL	Pensacola, FL	Port Manatee, FL
St. Marks, FL	Taft, FL	Tallahasse, FL
Tampa, FL	Albany, GA	Alma, GA
Bainbridge, GA	Jesup, GA	Milner, GA
Savannah, GA	Augusta, GA	Chicago, IL
Catlettsburg, KY	Hahnville, LA	St. Gabriel, LA
Charlotte, NC	Charleston, SC	Clarksville, TN
Beaumont, TX	Brownsville, TX	Houston, TX

Nodes #	Description	Link #	Description	Length	Speed limit	Notes	State Road
1	U.S. Highway 41 / Madison Avenue	1	Node 1 to Node 2	2.62	45 mph	2 Lane highway	
2	78th street / Madison Avenue	2	Node 2 to Node 3	2.69	35 mph	2 Lane highway	
3	Madison Avenue / U.S. Highway 301	3	Node 3 to Node 4	0.78	50 mph	2 Lane highway	SR 301
4	U.S. Highway 301 / I-75	4	Node 4 to Node 5	1.45	50 mph	6 Lane divided	SR 301
5	State road 676 / U.S. Highway 301	5	Node 5 to Node 6	0.6	50 mph	6 Lane divided	SR 301
6	Expressway 618 / U.S. Highway 301	6	Node 6 to Node 7	1.34	50 mph	6 Lane divided	SR 301
7	State Highway 60 / U.S. Highway 301	7	Node 7 to Node 8	2.3	50 mph	6 Lane divided	SR 301
8	State Highway 574 / U.S. Highway 301	8	Node 8 to Node 9	1.44	50 mph	4 Lane undivided	
9	State Highway 574 / I-4	9	Node 9 to Node 10	1.48	55 mph	6 Lane divided	I-4
10	22nd Street / I-4	10	Node 10 to Node 11	1.95	55 mph	4 Lane divided	I-4
11	I-4 / I-275	11	Node 11 to Node 12	1.16	55 mph	4 Lane divided	I-275
12	State Highway 92 / I-275	12	Node 12 to Node 13	3.85	45 mph	6 Lane divided	SR 92
13	State Highway 92 / State Highway 60	13	Node 13 to Node 14	0.68	45 mph	6 Lane divided	SR 92
14	State Highway 92 / State Highway 618	14	Node 14 to Node 15	3.35	65 mph	4 Lane undivided	SR 618
15	State Highway 60 / Expressway 618	15	Node 15 to Node 16	5.61	65 mph	4 Lane divided	SR 618
16	22nd Street / Expressway 618	16	Node 16 to Node 17	1.33	65 mph	4 Lane divided	SR 618
17	State Highway 41 / Expressway 618	17	Node 17 to Node 18	2.15	65 mph	6 Lane divided	SR 41
18	State road 676 / U.S. Highway 41	18	Node 18 to Node 1	1.87	55 mph	6 Lane divided	SR 41
19	State Highway 41 / State Highway 60	19	Node 19 to Node 17	1.49	55 mph	6 Lane divided	SR 41
20	22nd Street / State Highway 60	20	Node 21 to Node 5	1.12	45 mph	4 Lane divided	SR 676
21	State road 676 / 78th street	21	Node 2 to Node 21	1.6	45 mph	2 Lane highway	
		22	Node 21 to Node 18	3.85	45 mph	2 Lane highway	SR 676
		23	Node 6 to Node 17	2.91	55 mph	6 Lane divided	SR 618
		24	Node 19 to Node 7	0.15	35 mph	6 Lane divided	SR 60
		25	Node 10 to Node 20	1.05	55 mph	4 Lane divided	
		26	Node 20 to Node 16	2.07	55 mph	6 Lane divided	
		27	Node 19 to Node 20	3.42	55 mph	6 Lane divided	SR 60
		28	Node 15 to Node 20	0.64	35 mph	2 Lane highway	SR 60
		29	Node 13 to Node 15	3.42	55 mph	6 Lane divided	SR 60
		30	Node 9 to Node 19	3.42	55 mph	6 Lane divided	SR 41

Table A. 1: Data Gathered for the Links of Port of Tampa Road Network

TRUCK PROJECT REPORT

Date/Location:	April 16, 2002 / Canaveral
Subject:	vehicle classifier equipment maintenance
Objective:	download data, conduct routine maintenance on classifiers.
Outcome:	successful

Summary:

Routine maintenance of vehicle classifiers that are used to identify the number of heavy trucks entering and leaving the Port Canaveral facilities was conducted. Download of data from the classifiers was not accomplished for all locations (freight terminals and network locations). Several classifiers were repaired. One location was repaired. Another trip is required to test the viability of fiber optic sensor usage as an alternative to the tube counters for the dual lanes on SR528.

For Traffic Classifier Status, see Table 1.

To Do:

1. Test Fiber optic sensors.
2. Installation of new SR 528 locations.
3. Check geometric features from Brevard County with field observations.

Freight Terminal Location Details:

Location 1a,b:

(a). Inbound: 2-lane road, for south terminal facility. Metrocount Classifier # 19 locked to light in raised unpaved median. Data was downloaded successfully.
Lock # 2258

(b). Outbound: 1-lane road, south terminal facility. Metrocount Classifier # 21 locked to light in raised unpaved median. Data was downloaded successfully.
Lock # 2258

Location 2:

Very wide 2-lane bi-directional road for north terminals facilities. Security gate upstream of installation location. Diamond Classifier #10 was placed here for continuation of data collection. File name: <NT>. Only one classifier is necessary for both directions. Data was downloaded successfully.

Lock # 2258

Location 3a and 3b:

Cruise terminals: **INACTIVE DATA SITES**

Network Location Details:

Notes: Link #7 and Link #15 traffic volumes can be determined by adding or subtracting the I-95 ramp volumes from the through counts collected between the NB and SB I-95 off-ramps from SR528. This is the reason for the duplicate descriptions using the same classifier at these through lane data collection locations. Presently, only outbound (WB) through traffic counts are being collected due to the limited number of traffic classifiers. However, I-95 on-ramp traffic is being collected for the inbound (EB) through traffic and it may be possible to obtain traffic counts from the turnpike for SR528 eastbound.
Data was downloaded successfully from all classifiers.

Location L8W-SH:

Westbound SR528 through traffic (2-lane). Diamond Classifier #13 installed to collect shoulder lane traffic.
Lock #1122

Location L8W-ME:

Westbound SR528 through traffic (2-lane). Metrocount Classifier #22 installed to collect median lane traffic.
Lock #1122

Location L8E-SH:

Eastbound SR528 through traffic (2-lane). Diamond Classifier #17 installed to collect shoulder lane traffic. File name is <L8E-SHa>.
Lock #112

Location L8E-ME:

Eastbound SR528 through traffic (2-lane). Diamond Classifier #15 installed to collect median lane traffic. File name is <L8E-MEa>.
Lock #112

Location L1W-SH:

Westbound SR528 through traffic (2-lane). Diamond Classifier #07 removed. **INACTIVE DATA SITES**

Lock #465

Location L1W-ME:

Westbound SR528 through traffic (2-lane). Diamond Classifier #18 removed.
INACTIVE DATA SITES

Lock #465

Location N1-OF:

Westbound SR528 1 lane off-ramp to SR3. **INACTIVE DATA SITE**

Location N1-ON:

Westbound SR528 2 lane on-ramp from SR3. **INACTIVE DATA SITE**

Location N4-OF:

Westbound SR528 1 lane off-ramp to US1. **INACTIVE DATA SITE**

Location N4-ON:

Westbound SR528 1 lane on-ramp to US1. **INACTIVE DATA SITE**

Location N?-OF:

Westbound SR528 1 lane off-ramp to Industry Road. **INACTIVE DATA SITE**

Lock #489

SR524 is a two-lane undivided major arterial (55 mph) that travels through a residential area and has signalized intersections on it. It would not be a good selected route for truck drivers because of the side street traffic and signalized intersections that could create multiple deceleration and acceleration events for the trucks.

Location N6-OFa:

Westbound SR528 1 lane off-ramp to I-95 Northbound. Diamond Classifier #05 installed. Battery replaced.
Lock #A380

Location N6-OFb:

Westbound SR528 1 lane off-ramp to I-95 Southbound. Diamond Classifier #12 installed.

Lock #325

Location L7W-SH:

Westbound SR528 through traffic (2-lane). Diamond Classifier #09 installed for shoulder lane traffic counts. (traffic counts from Location N6-OFa need to be added to these counts to obtain a true through traffic count westbound to Orlando for Link #7).
Lock #A380

Location L15W-SH:

Westbound SR528 through traffic (2-lane). Diamond Classifier #09 installed for shoulder lane traffic counts. (traffic counts from Location N6-OFb need to be subtracted from these counts to obtain a true through traffic count westbound to Orlando for Link #15).
Lock #A380

Location L7W-ME:

Westbound SR528 through traffic (2-lane). Diamond Classifier #11 installed for shoulder lane traffic counts. (traffic counts from Location N6-OFa need to be added to these counts to obtain a true through traffic count westbound to Orlando for Link #7).
Lock #A380

Location L15W-ME:

Westbound SR528 through traffic (2-lane). Diamond Classifier #11 installed for shoulder lane traffic counts. (traffic counts from Location N6-OFb need to be subtracted from these counts to obtain a true through traffic count westbound to Orlando for Link #15).
Lock #A380

Location N6-ONa:

Eastbound SR528 1 lane on-ramp from I-95 Northbound. Metrocount Classifier #24 installed. Tube B was split and not collecting data. Tube was replaced.
Lock #1126

Location N6-ONb:

Eastbound SR528 1 lane on-ramp from I-95 Southbound. Metrocount Classifier #23 installed.
Lock #1126

Location L7E-SH:

Eastbound SR528 through traffic (2-lane). Diamond Classifier #18 installed for shoulder lane traffic counts. (traffic counts from Location N6-ONa need to be added to these counts to obtain a true through traffic count eastbound to the Port for Link #7).

Lock #710

Location L15E-SH:

Eastbound SR528 through traffic (2-lane). Diamond Classifier #18 installed for shoulder lane traffic counts. (traffic counts from Location N6-ONb need to be subtracted from these counts to obtain a true through traffic count eastbound to the Port for Link #15).

Location L7E-ME:

Eastbound SR528 through traffic (2-lane). Diamond Classifier #07 installed for shoulder lane traffic counts. (traffic counts from Location N6-ONa need to be added to these counts to obtain a true through traffic count eastbound to the Port for Link #7).
Lock #1057

Location L15E-ME:

Eastbound SR528 through traffic (2-lane). Diamond Classifier #07 installed for shoulder lane traffic counts. (traffic counts from Location N6-ONb need to be subtracted from these counts to obtain a true through traffic count eastbound to the Port for Link #15).

Location L5-WB:

SR520 Westbound 2-lane bi-directional road. Tubes still need to be removed from this location. **INACTIVE DATA SITE**

Lock #1126

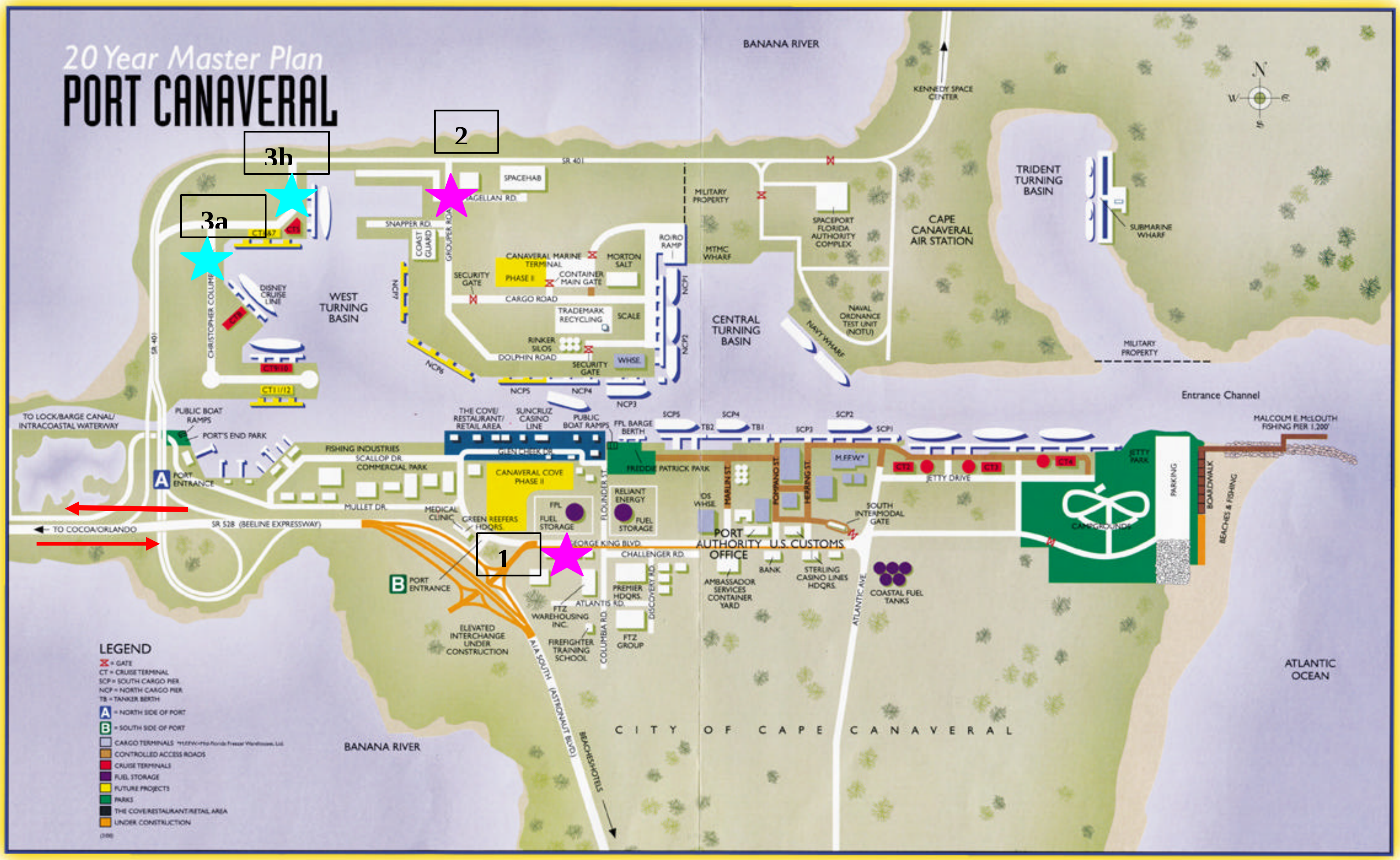
Bold indicates "ACTIVE SITES"

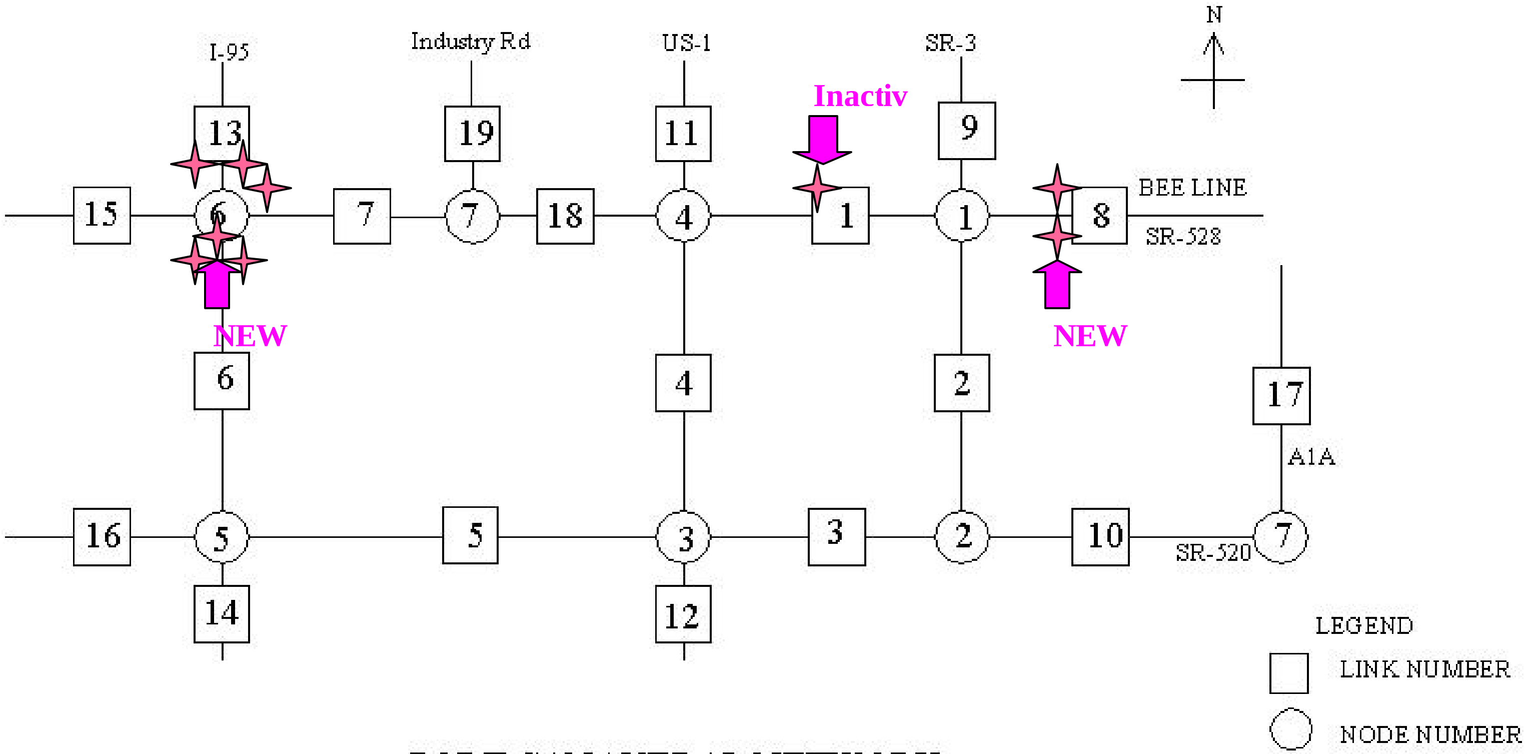
Number	Location	Charge	Notes
1			won't communicate w/ laptop
2		DEAD	
3	N1-OF (SR528 off-ramp to SR3)	terminated	
4		DEAD	
5	**N6-Ofa (SR528 WB off-ramp to I95 NB)**	**6.3**	
6		DEAD	
7	**L7E-ME (SR528 EB median lane)**	**6.2**	**power failure reading; batt rplc**
8		DEAD	power failure reading
9	**L7W-SH (SR528 WB shoulder lane)**	**6.2**	**power failure reading; batt rplc**
10	**2 (North Terminal; bi-directional)**	**6.4**	**power failure reading; batt rplc**
11	**L7W-ME (SR528 WB median lane)**	**6.2**	**power failure reading; batt rplc**
12	**N6-Ofb (SR528 WB off-ramp to I95 SB)**	**6.3**	
13	**L8W-SH (SR528 WB shoulder lane)**	**6.3**	
14		DEAD	
15	**L8E-ME (SR528 EB median lane)**		**power failure reading; batt rplc**
16		DEAD	
17	**L8E-SH (SR528 EB shoulder lane)**		**power fail; 0.0V off then on, 6.2V**
19	**1a (South Terminal; inbound)**		
20		DEAD	
21	**1b (South Terminal; outbound)**		
22	**L8W-ME (SR528 WB median lane)**		**spacing: 800mm**
23	**N6-Ona (SR528EB on-ramp from I95 SB**		**spacing: 800mm**
24	**N6-Onb (SR528EB on-ramp from I95 NB**		**spacing: 800mm**
18	**L7E-SH (SR528 EB shoulder lane)**	**6.2**	**power failure reading; batt rplco**

note: 1-18 are Diamond Phoenix, 19-24 are MetroCount

right justified #s are inoperable

TABLE 1: Traffic Classifier Status


20 Year Master Plan
PORT CANAVERAL
3b
3a
2
1
BANANA RIVER
KENNEDY SPACE CENTER
TRIDENT TURNING BASIN
SUBMARINE WHARF
CAPE CANAVERAL AIR STATION
MILITARY PROPERTY
WEST TURNING BASIN
CENTRAL TURNING BASIN
DISNEY CRUISE LINE
CANAVERAL MARINE TERMINAL
SPACEPORT FLORIDA AUTHORITY COMPLEX
NAVAL ORDNANCE TEST UNIT (NOTU)
Entrance Channel
MALCOLM E. McLOUTH FISHING PIER 1,200'
TO LOCK/BARGE CANAL/ INTRACOASTAL WATERWAY
PORT'S END PARK
PORT ENTRANCE
TO COCOA/ORLANDO
SR 528 (BEELINE EXPRESSWAY)
CANAVERAL COVE PHASE II
JETTY PARK
PORT AUTHORITY OFFICE
U.S. CUSTOMS
COASTAL FUEL TANKS
ELEVATED INTERCHANGE UNDER CONSTRUCTION
ATLANTIC OCEAN
CITY OF CAPE CANAVERAL
BANANA RIVER
LEGEND



PORT CANAVERAL NETWORK

APPENDIX B
Sample of Signal Timing and Intersection Data

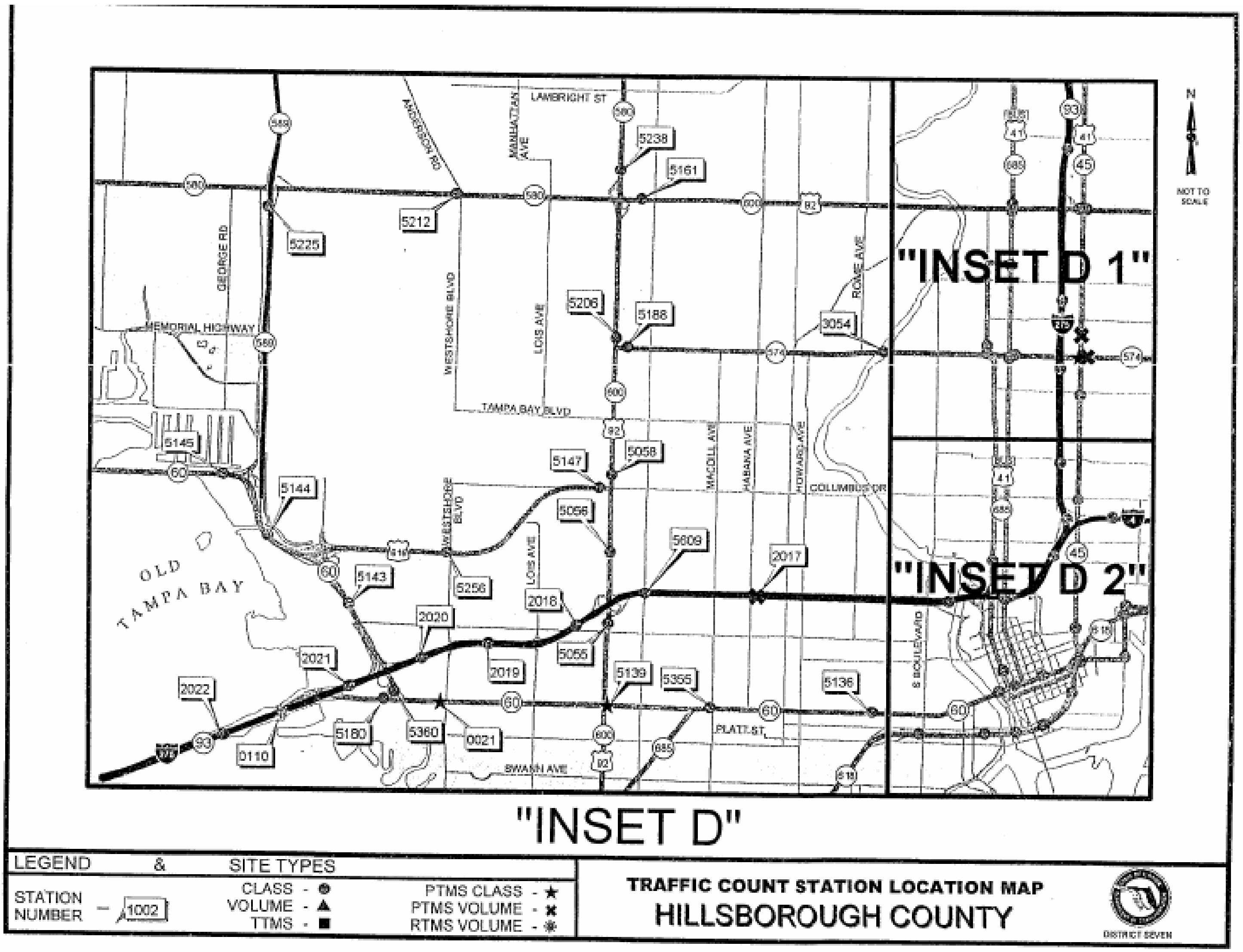


Figure B. 1: Key Map Obtained from Hillsborough County

Site Code : 19040000
N/S Street: DALE MABRY
E/W Street: G'MD.
Weather : CLEAR

Movements by: Primary

PAGE: 2
FILE: DALGAND6
DATE: 9/20/96

Time Begin	From North BIKES	From North RT	From North THRU	From North LT	From East BIKES	From East RT	From East THRU	From East LT	From South BIKES	From South RT	From South THRU	From South LT	From West BIKES	From West RT	From West THRU	From West LT	Vehicle Total	BIKES Total
3:00 PM	2	62	117	36	0	37	113	38	0	43	187	75	0	81	126	61	976	2
3:15	0	53	104	51	0	41	121	34	0	45	177	82	0	62	111	42	923	0
3:30	0	52	99	46	0	32	134	31	0	47	180	91	0	64	118	48	942	0
3:45	1	51	96	41	0	49	149	37	0	51	136	77	0	65	127	56	935	1
HR TOTAL	3	218	416	174	0	159	517	140	0	186	680	325	0	272	482	207	3776	3
4:00 PM	0	50	93	37	0	36	127	47	0	34	183	66	0	66	134	61	934	0
4:15	3	49	110	31	0	19	125	55	0	55	226	92	0	78	109	59	1028	3
4:30	2	48	93	55	0	42	123	62	0	76	259	118	0	80	151	64	1171	2
4:45	1	45	98	52	0	46	151	51	0	64	222	136	0	87	156	59	1167	1
HR TOTAL	6	192	394	175	0	163	526	215	0	229	890	412	0	311	550	243	4300	6
5:00 PM	0	49	100	43	0	41	141	54	0	46	233	98	0	107	171	51	1134	0
5:15	1	55	171	44	0	39	109	56	0	44	156	78	0	126	146	63	1167	1
5:30	0	54	117	57	0	43	144	58	0	44	183	71	0	100	198	59	1128	0
5:45	0	59	128	53	0	45	161	36	0	42	105	73	0	111	160	56	1029	0
HR TOTAL	1	217	516	197	0	168	635	204	0	176	677	320	0	444	675	229	4458	1
6:00 PM	0	34	130	41	0	44	123	45	0	27	141	58	0	101	143	61	956	0
6:15	3	55	110	44	0	42	142	52	0	40	110	49	0	98	183	34	967	3
6:30	0	43	116	44	0	41	137	37	0	38	111	51	0	104	147	62	931	0
6:45	2	48	89	26	0	41	135	29	0	37	110	53	0	89	119	48	824	2
HR TOTAL	5	180	461	155	0	168	537	163	0	142	472	211	0	392	592	205	3678	5
7:00 PM	3	40	121	31	0	40	132	21	0	35	111	55	0	68	113	50	817	3
7:15	0	43	82	30	0	27	103	35	0	39	107	35	0	66	107	26	700	0
7:30	0	45	85	30	0	30	85	36	0	32	108	47	0	64	104	30	696	0
7:45	0	46	88	31	0	35	89	34	0	23	95	42	0	62	101	33	679	0
HR TOTAL	3	174	376	122	0	132	409	126	0	129	421	179	0	260	425	139	2892	3
8:00 PM	1	47	90	30	0	20	80	34	0	28	82	39	0	59	90	36	643	1
8:15	1	36	90	28	0	25	81	30	0	24	75	41	0	68	77	23	598	1
8:30	0	43	75	26	0	14	71	17	0	14	66	28	0	54	84	32	524	0
8:45	0	44	77	27	0	15	69	14	0	12	63	24	0	56	82	33	516	0
HR TOTAL	2	170	332	111	0	74	301	95	0	78	286	132	0	237	341	124	2281	2
DAY TOTAL	63	2776	6025	1809	0	2172	6556	1874	0	2192	8479	3662	0	5354	6896	2826	50621	63

Figure B. 2: Sample of Turning Movements Counts

APPENDIX C
Scheffe's Statistical Test Results for Calibration Field Data of Master Links

		Link 13 (SR 92)		Link 17 (50th St.)		Link 22 (Causway)		Link 25	
		Northbound	Southbound	Northbound	Southbound	Eastbound	Westbound	22nd St.	21st St.
Sun	13-May	7,063	8,327		6,816		5,739	10,021	
Mon	14-May	10,807	13,867		10,258		4,702	15,872	
Tue	15-May	11,005	14,205		10,430		4,440	15,676	
Wed	16-May	11,148	14,283		10,538		7,618	14,967	
Thu	17-May	11,396	13,428		10,771		7,717	15,456	
Fri	18-May		14,118		10,658		7,883	15,733	
Sat	19-May		9,198		8,396		7,891	10,391	
Sun	20-May		7,829		7,238		6,116	9,622	
Mon	21-May		12,903				5,141	12,019	
Tue	22-May							15,851	
Wed	23-May							15,922	
Thu	24-May							15,584	
Fri	25-May					7,596			7,953
Sat	26-May	12,871		8,102	8,939	5,822		9,558	7,021
Sun	27-May	9,679		6,734	7,587	5,334		9,374	5,957
Mon	28-May	9,593		9,198	10,045	5,629		8,809	5,052
Tue	29-May	14,159		10,349	12,791	7,341		15,751	7,779
Wed	30-May	12,284		10,715	12,973	7,496		15,683	7,918
Thu	31-May	12,974		11,038	11,153	7,634		15,240	8,037
Fri	1-Jun	13,581		11,129	12,106	7,750			8,184
Sat	2-Jun	12,537		8,467	9,159	6,187			7,574
Sun	3-Jun	9,783		6,972	7,385	5,232			5,906
Mon	4-Jun	10,927		10,164	10,734				7,622
Tue	5-Jun	11,203		10,294	11,837				7,731
Wed	6-Jun			10,583	12,629				7,629
Thu	7-Jun			11,162	11,276				8,084
Fri	8-Jun			11,319					8,572
Sat	9-Jun			8,627					7,441
Sun	10-Jun			6,937					5,860
Mon	11-Jun			10,472					7,462
Tue	12-Jun								7,813
Wed	13-Jun								
Thu	14-Jun								
Fri	15-Jun								
Sat	16-Jun								
Sun	17-Jun								
Mon	18-Jun								
Tue	19-Jun								
Wed	20-Jun								
Thu	21-Jun								
Fri	22-Jun								
Sat	23-Jun	13,984	8,887	8,553		5,791	5,819		7,324
Sun	24-Jun	11,162	7,522	6,813		5,394	4,803		5,642
Mon	25-Jun	15,471	13,732	10,525		7,190	4,452	11,866	7,662
Tue	26-Jun	14,637	14,054	11,206		7,291	7,629	15,721	7,760
Wed	27-Jun	13,286	13,568	11,014		7,516	7,791	15,743	7,799
Thu	28-Jun	13,892	13,375	11,157		7,675	7,892	15,436	7,807
Fri	29-Jun	12,985	14,104			7,805	7,906	15,863	8,232
Sat	30-Jun		9,265			6,098	6,125		7,027
Sun	1-Jul		7,837			5,198	5,204		5,486
Mon	2-Jul		12,839			7,792	4,398		7,640
Tue	3-Jul						7,596		7,512
Average		**12,018**	**13,698**	**10,688**	**10,177**	**7,181**	**6,350**	**14,360**	**7,559**

Table C. 1: Inventory of Total Daily Counts for Calibration Data Set

Link 13 Northbound (SR 92)

Dependent Variable: I92NORTH
Scheffe

(I) DAYS	(J) DAYS	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
SUN	MON	-2277.75	1207.14	.731	-7173.41	2617.91
	TUE	-3329.25	1207.14	.326	-8224.91	1566.41
	WED	-2817.58	1303.86	.599	-8105.50	2470.34
	THU	-3332.25	1303.86	.410	-8620.17	1955.67
	FRI	-3861.25	1478.44	.386	-9857.19	2134.69
	SAT	-3708.92	1303.86	.293	-8996.84	1579.00
MON	SUN	2277.75	1207.14	.731	-2617.91	7173.41
	TUE	-1051.50	1207.14	.991	-5947.16	3844.16
	WED	-539.83	1303.86	1.000	-5827.75	4748.09
	THU	-1054.50	1303.86	.994	-6342.42	4233.42
	FRI	-1583.50	1478.44	.975	-7579.44	4412.44
	SAT	-1431.17	1303.86	.972	-6719.09	3856.75
TUE	SUN	3329.25	1207.14	.326	-1566.41	8224.91
	MON	1051.50	1207.14	.991	-3844.16	5947.16
	WED	511.67	1303.86	1.000	-4776.25	5799.59
	THU	-3.00	1303.86	1.000	-5290.92	5284.92
	FRI	-532.00	1478.44	1.000	-6527.94	5463.94
	SAT	-379.67	1303.86	1.000	-5667.59	4908.25
WED	SUN	2817.58	1303.86	.599	-2470.34	8105.50
	MON	539.83	1303.86	1.000	-4748.09	5827.75
	TUE	-511.67	1303.86	1.000	-5799.59	4776.25
	THU	-514.67	1393.88	1.000	-6167.69	5138.36
	FRI	-1043.67	1558.41	.998	-7363.94	5276.61
	SAT	-891.33	1393.88	.998	-6544.36	4761.69
THU	SUN	3332.25	1303.86	.410	-1955.67	8620.17
	MON	1054.50	1303.86	.994	-4233.42	6342.42
	TUE	3.00	1303.86	1.000	-5284.92	5290.92
	WED	514.67	1393.88	1.000	-5138.36	6167.69
	FRI	-529.00	1558.41	1.000	-6849.27	5791.27
	SAT	-376.67	1393.88	1.000	-6029.69	5276.36
FRI	SUN	3861.25	1478.44	.386	-2134.69	9857.19
	MON	1583.50	1478.44	.975	-4412.44	7579.44
	TUE	532.00	1478.44	1.000	-5463.94	6527.94
	WED	1043.67	1558.41	.998	-5276.61	7363.94
	THU	529.00	1558.41	1.000	-5791.27	6849.27
	SAT	152.33	1558.41	1.000	-6167.94	6472.61
SAT	SUN	3708.92	1303.86	.293	-1579.00	8996.84
	MON	1431.17	1303.86	.972	-3856.75	6719.09
	TUE	379.67	1303.86	1.000	-4908.25	5667.59
	WED	891.33	1393.88	.998	-4761.69	6544.36
	THU	376.67	1393.88	1.000	-5276.36	6029.69
	FRI	-152.33	1558.41	1.000	-6472.61	6167.94

Table C. 2: Confidence Interval for Difference between Weekdays

Link 13 Northbound

Scheffe[a,b]

DAYS	N	Subset for alpha = .05
		1
SUN	4	9421.75
MON	4	11699.50
WED	3	12239.33
TUE	4	12751.00
THU	3	12754.00
SAT	3	13130.67
FRI	2	13283.00
Sig.		.302

Means for groups in homogeneous subsets are displayed

a. Uses Harmonic Mean Sample Size = 3.111.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table C. 3: Subsets for Northbound Direction of Link 13

SR 92 Southbound

Scheffe[a,b]

DAYS	N	Subset for alpha = .05		
		1	2	3
SUN	4	7801.50		
SAT	3		9114.00	
MON	4			13348.00
THU	2			13409.50
WED	2			13925.50
FRI	2			14012.00
TUE	3			14096.67
Sig.		1.000	1.000	.481

Means for groups in homogeneous subsets are displayed

a. Uses Harmonic Mean Sample Size = 2.625.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table C. 4: Subsets for Southbound Direction of Link 13

50th Street Southbound

Scheffe[a,b]

DAYS	N	Subset for alpha = .05 1
SUN	5	8172.6000
SAT	4	9307.0000
THU	2	10962.00
MON	3	10977.33
FRI	2	11382.00
TUE	3	11499.00
WED	2	11755.50
Sig.		.326

Means for groups in homogeneous subsets are displayed

a. Uses Harmonic Mean Sample Size = 2.675.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table C. 5: Subsets for Southbound Direction of Link 17

50th Street Northbound

Scheffe[a,b]

DAYS	N	Subset for alpha = .05		
		1	2	3
SUN	4	6864.0000		
SAT	4		8437.2500	
MON	4			10089.75
TUE	3			10616.33
WED	3			10770.67
THU	3			11119.00
FRI	2			11224.00
Sig.		1.000	1.000	.053

Means for groups in homogeneous subsets are displayed

a. Uses Harmonic Mean Sample Size = 3.111.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table C. 6: Subsets for Northbound Direction of Link 17

Causeway Eastbound

Scheffe[a,b]

DAYS	N	Subset for alpha = .05 1	2
SUN	4	5371.0000	
SAT	4	6258.7500	6258.7500
MON	2	6803.5000	6803.5000
TUE	2		7107.5000
WED	3		7542.3333
THU	3		7642.0000
FRI	4		7837.2500
Sig.		.105	.060

Means for groups in homogeneous subsets are displayed

a. Uses Harmonic Mean Sample Size = 2.897.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table C. 7: Subsets for Eastbound Direction of Link 22

Causeway Westbound

Scheffe[a,b]

DAYS	N	Subset for alpha = .05 1
SUNDAY	3	4855.6667
WEDNESDAY	3	5532.6667
MONDAY	3	5819.0000
SATURDAY	4	5829.7500
TUESDAY	2	7469.0000
THURSDAY	3	7629.3333
FRIDAY	3	7850.0000
Sig.		.400

Means for groups in homogeneous subsets are displayed

a. Uses Harmonic Mean Sample Size = 2.897.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table C. 8: Subsets for Westbound Direction of Link 22

21st Street

Scheffe[a,b]

DAYS	N	Subset for alpha = .05	
		1	2
SUN	5	5770.2000	
MON	5	7087.6000	7087.6000
SAT	5		7277.4000
TUE	5		7719.0000
WED	3		7782.0000
THU	3		7976.0000
FRI	4		8235.2500
Sig.		.071	.159

Means for groups in homogeneous subsets are displayed

a. Uses Harmonic Mean Sample Size = 4.078.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table C. 9: Subsets for Southbound Direction of Link 25

I-4 on-Ramp

Scheffe[a,b]

DAYS	N	Subset for alpha = .05		
		1	2	3
SUN	2	1009.50		
SAT	2		1267.50	
TUE	2			1809.50
WED	2			1842.00
MON	2			1872.00
THU	3			1896.00
FRI	3			1954.33
Sig.		1.000	1.000	.121

Means for groups in homogeneous subsets are displayed

a. Uses Harmonic Mean Sample Size = 2.211.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table C. 10: Subsets for I-4 On-Ramp

SR 41

Scheffe[a,b]

DAYS	N	Subset for alpha = .05			
		1	2	3	4
SUN	2	6594.00			
SAT	2		8082.00		
WED	2			10374.00	
MON	2			10700.50	10700.50
THU	3			10731.33	10731.33
TUE	2			10736.00	10736.00
FRI	3				11029.00
Sig.		1.000	1.000	.274	.365

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 2.211.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table C. 11: Subsets for SR 41

APPENDIX D
Sample of CORSIM & VISSIM Traffic Assignment Output

```
8016-8015  250.0    23,     12,     17,     48,     41,     29
 (SEC):             .0,   27.0,   63.1,   90.1, 105.1, 122.1
             250  VPH

8017-8012   50.0    12,      9,     19,     25,     24,     18,      1,     61
 (SEC):             .0,   22.0,   58.0,   72.0,   92.0,  120.0,  148.6, 162.7
              50  VPH

8017-8009  150.0    12,      9,      8,      7
 (SEC):             .0,   22.0,   82.1,   99.1
             150  VPH

8017-8002  200.0    12,     23,     30,     31,     32
 (SEC):             .0,   27.3,   73.2, 108.3, 134.3
             200  VPH

8017-8014            12,     23,     30,     31,     32,     58,     33,     52,     14
 (SEC):             .0,   27.3,   73.2, 108.3, 134.9, 178.1, 227.3, 233.5, 236.6
8017-8014            12,     17,     48,     40,     35,     38,     37,     60,
33,     52,     14
 (SEC):             .0,   36.1,   63.1,   81.5,   88.5,   96.5, 116.5, 165.5, 226.0,
232.2, 235.3
             150  VPH
```

T

CORSIM External Nodes

CORSIM Internal Node

Volume

Figure D. 1: A Sample of CORSIM output

Network Node Number	CORSIM Node Number
1	8007
3	8004
4	8003
5	8011
6	8010
7	8009
8	8006
9	8005
10	8017
11	8016
12	8001
13	8002
14	8014
16	8015
18	8008

Table D. 1: Network and CORSIM External Node Number

	RIGHT TURN		THRU		LEFT TURN		DISCHARGE	ESTIMATED
LINK	VOL.	PCT.	VOL.	PCT.	VOL.	PCT.	VOLUME	SPEED
	VPH		VPH		VPH		VPH	MPH
(21, 5)	524	34	0	0	1000	66	1524	47.4
(5, 21)	0	0	838	100	0	0	838	48.6
(3, 2)	0	0	250	100	0	0	250	30.9
(2, 3)	0	0	500	87	76	13	576	30.1
(21, 2)	0	50	0	0	0	50	0	0
(2, 21)	0	50	0	0	0	50	0	0
(5, 4)	0	0	0	0	524	100	524	19.2
(4, 5)	0	0	0	0	300	100	300	56.7
(4, 3)	0	50	0	0	0	50	0	0
(3, 4)	76	100	0	0	0	0	76	21.3
(18, 21)	0	0	1524	100	0	0	1524	49.3
(21, 18)	0	0	338	40	500	60	838	49.9
(18, 1)	700	100	0	0	0	0	700	47.4
(1, 18)	924	38	1500	62	0	0	2424	46.5
(1, 2)	0	0	576	100	0	0	576	30.5
(2, 1)	0	0	250	100	0	0	250	44.1

Table D. 2: A sample of CORSIM output

Table	of	Delay

No.	1:00	Travel	time	section(s)	1	
No.	2:00	Travel	time	section(s)	2	
No.	3:00	Travel	time	section(s)	3	
No.	4:00	Travel	time	section(s)	4	
No.	5:00	Travel	time	section(s)	5	
No.	6:00	Travel	time	section(s)	6	
No.	7:00	Travel	time	section(s)	7,	8
No.	8:00	Travel	time	section(s)	9,	10
No.	11:00	Travel	time	section(s)	11	
No.	12:00	Travel	time	section(s)	12	
No.	13:00	Travel	time	section(s)	13	
No.	14:00	Travel	time	section(s)	14	

No.	1			
	Delay;	#Veh;	Pers.;	#Pers;
Average	34.8	91	34.8	91;

No.	2			
	Delay;	#Veh;	Pers.;	#Pers;
	18.3;	86;	18.3;	86;
Average	18.3	86	18.3	86

No.	14			
	Delay;	#Veh;	Pers.;	#Pers;
Average	124.8	897	124.8	897

Figure D. 2: A Sample of VISSIM output (*.VLZ)

APPENDIX E
CORSIM Calibration Tables Using FDOT Data

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150
6	40	0	0	0	0	0	0	250	100	0	400	0	0	350	0
7	0	0	0	0	0	0	0	500	**150**	0	1300	0	0	0	50
8	0	0	0	0	0	0	0	0	0	0	0	0	0	350	0
9	700	0	350	0	850	50	0	0	0	0	1000	0	50	150	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	300	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	250	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	0	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	120	0
14	0	0	0	0	0	0	0	500	200		400	0	0	200	0
16	0	0	0	0	0	0	100	100	250	200	50	100	350	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure E. 1: The 13th Iteration O-D Matrix

	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	540	5.62	488	675	27.78
L-20	493	574	14.20	578	607	4.70
L-23	928	810	14.58	1089	1219	10.63
L-24	1011	678	49.24	861	680	26.71
L-25	830	817	1.54	573	679	15.68
L-30	983	744	32.15	856	801	6.87

Table E. 1: FDOT and CORSIM Simulated Volumes for the Master Links (13th Iteration)

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	250
6	40	0	0	0	0	0	0	250	100	0	400	0	0	0	0
7	0	0	0	0	0	0	0	500	**300**	0	1300	0	0	0	350
8	0	0	0	0	0	0	0	0	0	0	0	0	0	250	100
9	700	0	350	0	850	50	0	0	0	0	1000	0	50	150	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	300	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	250	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	0	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	50	0
14	0	0	0	0	0	0	0	500	50	0	400	0	0	600	0
16	0	0	0	0	0	0	100	100	250	200	50	100	350	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure E. 2: The O-D Matrix of the 14th Iteration

	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	541	5.52	488	675	27.78
L-20	493	585	15.81	578	631	8.40
L-23	928	800	16.01	1089	1254	13.12
L-24	1011	755	34.01	861	734	17.38
L-25	830	850	2.40	573	685	16.42
L-30	983	1076	8.69	856	887	3.55

Table E. 2: FDOT and CORSIM Simulated Volumes for the Master Links (14th Iteration)

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	100	0	0	0	0	0	250
6	40	0	0	0	0	0	0	250	100	0	400	0	0	0	0
7	0	0	0	0	0	0	0	500	450	0	1300	0	0	0	350
8	0	0	0	0	0	0	0	0	0	0	0	0	0	250	100
9	700	0	350	0	850	50	0	0	0	0	1000	0	50	150	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	300	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	250	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	0	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	50	0
14	0	0	0	0	0	0	0	500	50	0	400	0	0	600	0
16	0	0	0	0	0	0	100	100	250	200	50	100	**350**	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure E. 3: The O-D Matrix of the 15th Iteration

	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	541	5.43	488	675	27.78
L-20	493	580	15.01	578	593	2.53
L-23	928	844	9.96	1089	1096	0.64
L-24	1011	930	8.72	861	734	17.30
L-25	830	857	3.20	573	685	16.42
L-30	983	1113	11.73	856	832	2.89

Table E. 3: FDOT and CORSIM Simulated Volumes for the Master Links (15th Iteration)

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	100	0	0	0	0	0	250
6	40	0	0	0	0	0	0	250	100	0	400	0	0	0	0
7	0	0	0	0	0	0	0	500	450	0	1300	0	0	0	350
8	0	0	0	0	0	0	0	0	0	0	0	0	0	250	100
9	700	0	350	0	850	50	0	0	0	0	1000	0	50	150	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	**300**	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	250	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	0	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	50	0
14	0	0	0	0	0	0	0	500	200	0	400	0	0	250	0
16	0	0	0	0	0	0	**120**	**120**	**300**	**240**	**50**	**120**	**200**	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure E. 4: The O-D Matrix of the 16th Iteration

	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	541	5.43	488	570	14.47
L-20	493	580	15.09	602	585	12.91
L-23	928	853	8.80	1089	1096	0.64
L-24	1011	1025	1.36	861	821	4.87
L-25	830	857	3.20	573	699	18.04
L-30	983	1113	11.73	856	970	11.80

Table E. 4: FDOT and CORSIM Simulated Volumes for the Master Links (16th Iteration)

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	100	0	0	0	0	0	250
6	40	0	0	0	0	0	0	250	450	0	400	0	0	0	0
7	0	0	0	0	0	0	0	500	0	0	1300	0	0	0	350
8	0	0	0	0	0	0	0	0	0	0	0	0	0	**290**	100
9	700	350	0	0	850	50	0	0	0	0	1000	0	50	**175**	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	**150**	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	**290**	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	**0**	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	**58**	0
14	0	0	0	0	0	0	0	500	200	0	400	0	0	**290**	0
16	0	0	0	0	0	0	120	120	300	240	50	120	200	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure E. 5: The O-D Matrix of the 17th Iteration

	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	541	5.43	488	570	14.47
L-20	537	470	14.26	602	653	7.74
L-23	928	810	14.51	1089	1003	8.57
L-24	1011	899	12.53	861	808	6.63
L-25	830	882	5.89	573	607	5.68
L-30	983	985	0.25	856	988	13.41

Table E. 5: FDOT and CORSIM Simulated Volumes for the Master Links (17th Iteration)

APPENDIX F
Output of the Truck Trip Generation ANN Model from Phase II for the Port of Tampa

Dates	Total	22nd-st Street	20th Street	Causeway Blvd	Sutton	Pendola point
05/28/2001	3925	1127	501	1756	328	213
05/29/2001	4034	1159	515	1805	337	219
05/30/2001	3984	1144	509	1782	333	216
05/31/2001	3975	1142	508	1778	332	215
06/01/2001	3865	1110	493	1729	323	209
06/25/2001	3632	1043	464	1625	303	197
06/26/2001	3971	1140	507	1776	332	215
06/27/2001	3999	1148	511	1789	334	217
06/28/2001	3714	1067	474	1662	310	201
06/29/2001	3971	1141	507	1777	332	215
07/11/2001	3182	1069	475	1125	311	202
07/12/2001	3355	1128	501	1185	328	213
07/13/2001	2987	1004	446	1056	292	189
07/14/2001	2233	750	334	789	218	142
07/15/2001	1455	489	218	514	142	92
07/16/2001	3275	1101	489	1157	320	208
07/17/2001	3122	1049	467	1103	305	198
07/18/2001	3039	1021	454	1074	297	193
07/19/2001	3094	1040	462	1094	302	196
07/20/2001	3283	1103	491	1160	321	208
07/21/2001	1727	580	258	610	169	110
07/22/2001	1339	450	200	473	131	85
07/23/2001	3172	1066	474	1121	310	201
07/24/2001	3506	1178	524	1239	343	222
07/25/2001	3615	1215	540	1278	353	229

Table F. 1: Daily Number of Trucks Entering the Port of Tampa Using the Phase II Truck Trip Generation ANN Model (Inbound Model)

Dates	Total	22nd-st Street	20th Street	Causeway Blvd	Sutton	Pendola point
05/28/2001	3588	840	532	1547	345	323
05/29/2001	3633	850	538	1567	349	327
05/30/2001	3627	849	538	1564	349	327
05/31/2001	3666	858	543	1581	353	330
06/01/2001	3064	717	454	1322	295	276
06/25/2001	3300	772	489	1423	317	297
06/26/2001	3676	860	545	1585	354	331
06/27/2001	3672	859	544	1584	353	331
06/28/2001	3688	863	547	1591	355	332
06/29/2001	3636	851	539	1568	350	328
07/11/2001	3819	1140	723	1471	250	234
07/12/2001	3751	1121	710	1445	245	230
07/13/2001	3835	1145	725	1479	251	235
07/14/2001	3043	909	576	1173	199	187
07/15/2001	788	235	150	303	51	49
07/16/2001	3896	1164	737	1502	255	239
07/17/2001	3874	1157	733	1492	254	238
07/18/2001	3868	1156	732	1491	253	237
07/19/2001	3853	1151	729	1484	252	236
07/20/2001	3902	1165	738	1503	256	239
07/21/2001	1871	559	354	721	123	115
07/22/2001	1405	420	265	541	92	86
07/23/2001	3362	1004	636	1296	220	206
07/24/2001	3372	1008	638	1299	220	207
07/25/2001	3947	1179	746	1522	259	242

Table F. 2: Daily Number of Trucks Leaving the Port of Tampa Using the Phase II Truck Trip Generation ANN Model (Outbound Model)

APPENDIX G
Final Calibration Tables for CORSIM and
Field Calibrated O-D Matrices

		Destination Nodes																
		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
Origin Nodes	**1 (Port)**	**0**	**0**	**40**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**53**
	1 south	**0**	0	0	50	0	0	20	0	50	10	0	0	0	0	**0**	**38**	
	3	**19**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
	4	**0**	0	100	0	0	0	0	0	35	0	0	0	0	0	**0**	**57**	
	5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**38**	
	6	**8**	0	0	0	0	0	0	0	51	60	0	70	0	0	**0**	**0**	
	7	**0**	0	0	0	0	0	0	0	25	80	0	260	0	0	**0**	**25**	
	8	**0**	0	100	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
	9	**0**	150	0	20	0	150	10	0	0	0	0	200	0	10	**22**	**0**	
	10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**13**	**0**	
	11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**41**	**0**	
	12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	220	**10**	**0**	
	13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**24**	**0**	
	14	**0**	0	0	0	0	0	0	0	30	40	0	80	0	0	**37**	**0**	
	16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**19**	**40**	**81**	**10**	**10**	**19**	**0**	**0**	**183**
	18 (Port)	**0**	**62**	**10**	**41**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**139**
	Sum.	**43**								**230**						**147**	**158**	

Figure G. 1: Field Data Calibrated O-D Matrix for May 28, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	Absolute % Error
SR-92	13	Northbound	170	167	1.76
	13	Southbound			
50th Street	17	Northbound	124	123	0.81
	17	Southbound	141	135	4.26
Causeway Blvd	22	Eastbound	110	105	4.55
	22	Westbound	91	88	3.30
22nd St	25	Northbound	158	155	1.90
21st St.	25	Southbound	117	112	4.27

Note: Shaded Cells Indicate No Available Field Data

Table G. 1: Final Field and CORSIM Simulated Volumes for the Master Links on May 28, 2001

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**41**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**54**
1 south	**0**	0	0	50	0	0	20	0	50	10	0	0	0	0	**0**	**39**	
3	**20**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	35	0	0	0	0	0	**0**	**59**	
5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**39**	
6	**8**	0	0	0	0	0	0	0	51	60	0	70	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	25	80	0	260	0	0	**0**	**25**	
8	**0**	0	100	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	130	0	20	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
10	**0**	17	0	0	0	100	30	0	0	0	0	0	40	30	**13**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**42**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	220	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**24**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	65	0	0	**38**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**19**	**41**	**82**	**10**	**10**	**19**	**0**	**0**	**185**
18 (Port)	**0**	**63**	**10**	**42**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**141**
Sum.	**44**								**230**						**151**	**162**	

Figure G. 2: Field Data Calibrated O-D Matrix for May 29, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	Absolute % Error
SR-92	13	Northbound	154	157	1.95
	13	Southbound			
50th Street	17	Northbound	120	124	3.33
	17	Southbound	115	114	0.87
Causeway Blvd	22	Eastbound	91	94	3.30
	22	Westbound	85	89	4.71
22nd St	25	Northbound	159	155	2.52
21st St.	25	Southbound	118	113	4.24

Note: Shaded Cells Indicate No Available Field Data

Table G. 2: Final Field and CORSIM Simulated Volumes for the Master Links on May 29, 2001

		Destination Nodes																
		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
Origin Nodes	**1 (Port)**	**0**	**0**	**41**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**54**
	1 south	**0**	0	0	50	0	0	20	0	50	10	0	0	0	0	**0**	**39**	
	3	**20**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
	4	**0**	0	100	0	0	0	0	0	35	0	0	0	0	0	**0**	**58**	
	5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**38**	
	6	**8**	0	0	0	0	0	0	0	51	60	0	80	0	0	**0**	**0**	
	7	**0**	0	0	0	0	0	0	0	25	170	0	260	0	0	**0**	**25**	
	8	**0**	0	70	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
	9	**0**	150	0	0	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
	10	**0**	17	0	0	0	100	30	0	0	0	0	0	40	30	**13**	**0**	
	11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**40**	**0**	
	12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	220	**10**	**0**	
	13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**24**	**0**	
	14	**0**	0	0	0	0	0	0	0	30	40	0	80	0	0	**38**	**0**	
	16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**19**	**41**	**82**	**10**	**10**	**19**	**0**	**0**	**185**
	18 (Port)	**0**	**63**	**10**	**42**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**141**
	Sum.	**44**								**230**						**149**	**160**	

Figure G. 3: Field Data Calibrated O-D Matrix for May 30, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	Absolute % Error
SR-92	13	Northbound	160	167	4.38
	13	Southbound			
50th Street	17	Northbound	129	123	4.65
	17	Southbound	143	136	4.90
Causeway Blvd	22	Eastbound	93	95	2.15
	22	Westbound	85	88	3.53
22nd St	25	Northbound	154	155	0.65
21st St.	25	Southbound	115	110	4.35

Note: Shaded Cells Indicate No Available Field Data

Table G. 3: Final Field and CORSIM Simulated Volumes for the Master Links on May 30, 2001

	Destination Nodes																
Origin Nodes	**1 (Port)**	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**42**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**55**
1 south	**0**	0	0	50	0	0	20	0	55	10	0	0	0	0	**0**	**39**	
3	**20**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	30	0	0	0	0	0	**0**	**58**	
5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**38**	
6	**8**	0	0	0	0	0	0	0	50	60	0	80	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	170	0	260	0	0	**0**	**25**	
8	**0**	0	70	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	145	0	0	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
10	**0**	10	0	0	0	100	30	0	0	0	0	0	40	30	**15**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**38**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	220	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**24**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	80	0	0	**38**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**19**	**42**	**83**	**10**	**10**	**19**	**0**	**0**	**187**
18 (Port)	**0**	**64**	**10**	**42**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**142**
Sum.	**44**								**230**						**149**	**160**	

Figure G. 4: The Field Data Calibrated O-D Matrix for May 31, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	% Error
SR-92	13	Northbound	169	167	1.18
	13	Southbound			
50th Street	17	Northbound	132	128	3.03
	17	Southbound	134	130	2.99
Causeway Blvd	22	Eastbound	95	95	0.00
	22	Westbound	87	88	1.15
22nd St	25	Northbound	150	155	3.33
21st St.	25	Southbound	119	114	4.20

Note: Shaded Cells Indicate No Available Field Data

Table G. 4: Final Field and CORSIM Simulated Volumes for the Master Links on May 31, 2001

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**34**	**0**	**0**	**12**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**46**
1 south	**0**	0	0	50	0	0	20	0	55	10	0	0	0	0	**0**	**38**	
3	**20**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	30	0	0	0	0	0	**0**	**56**	
5	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**37**	
6	**8**	0	0	0	0	0	0	0	50	60	0	80	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	29	170	0	260	0	0	**0**	**25**	
8	**0**	0	70	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	155	0	0	0	150	10	0	0	0	0	200	0	10	**26**	**0**	
10	**0**	17	0	0	0	100	30	0	0	0	0	0	40	30	**13**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**40**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	220	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**20**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	80	0	0	**35**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**16**	**34**	**70**	**8**	**8**	**14**	**0**	**0**	**156**
18 (Port)	**0**	**50**	**9**	**35**	**9**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**119**
Sum.	**43**								**230**						**144**	**156**	

Figure G. 5: Field Data Calibrated O-D Matrix for June 1, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	% Error
SR-92	13	Northbound	177	169	4.52
	13	Southbound			
50th Street	17	Northbound	134	128	4.83
	17	Southbound	145	138	4.04
Causeway Blvd	22	Eastbound	99	95	3.30
	22	Westbound	91	88	4.17
22nd St	25	Northbound			
21st St.	25	Southbound	120	115	4.17

Note: Shaded Cells Indicate No Available Field Data

Table G. 5: Final Field and CORSIM Simulated Volumes for the Master Links on June 1, 2001

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**36**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**49**
1 south	**0**	0	0	50	0	0	20	0	50	10	0	0	0	0	**0**	**35**	
3	**19**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	35	0	0	0	0	0	**0**	**53**	
5	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**35**	
6	**6**	0	0	0	0	0	0	0	52	60	0	80	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	25	170	0	260	0	0	**0**	**23**	
8	**0**	0	70	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	140	0	0	0	150	10	0	0	0	0	200	0	10	**21**	**0**	
10	**0**	18	0	0	0	100	30	0	0	0	0	0	40	30	**8**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**39**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	210	**8**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**22**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	85	0	0	**38**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**8**	**18**	**30**	**74**	**10**	**10**	**18**	**0**	**0**	**168**
18 (Port)	**0**	**56**	**9**	**38**	**9**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**128**
Sum.	**40**								**230**						**136**	**146**	

Figure G. 6: Field Data Calibrated O-D Matrix for June 25, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	% Error
SR-92	13	Northbound	179	172	3.91
	13	Southbound	165	169	2.42
50th Street	17	Northbound	126	123	2.38
	17	Southbound			
Causeway Blvd	22	Eastbound	93	95	2.15
	22	Westbound	87	88	1.15
22nd St	25	Northbound	142	148	4.23
21st St.	25	Southbound	112	108	3.57

Note: Shaded Cells Indicate No Available Field Data

Table G. 6: Final Field and CORSIM Simulated Volumes for the Master Links on June 25, 2001

		Destination Nodes																
		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
Origin Nodes	**1 (Port)**	**0**	**0**	**42**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	55
	1 south	**0**	0	0	50	0	0	20	0	55	10	0	0	0	0	**0**	**40**	
	3	**20**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
	4	**0**	0	100	0	0	0	0	0	30	0	0	0	0	0	**0**	**60**	
	5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**35**	
	6	**8**	0	0	0	0	0	0	0	51	60	0	80	0	0	**0**	**0**	
	7	**0**	0	0	0	0	0	0	0	25	170	0	260	0	0	**0**	**25**	
	8	**0**	0	70	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
	9	**0**	140	0	0	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
	10	**0**	13	0	0	0	100	30	0	0	0	0	0	40	30	**17**	**0**	
	11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**36**	**0**	
	12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	220	**10**	**0**	
	13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**24**	**0**	
	14	**0**	0	0	0	0	0	0	0	30	40	0	80	0	0	**37**	**0**	
	16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**19**	**42**	**83**	**10**	**10**	**19**	**0**	**0**	**187**
	18 (Port)	**0**	**65**	**10**	**42**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**143**
	Sum.	**44**								**230**						**148**	**160**	

Figure G. 7: Field Data Calibrated O-D Matrix for June 26, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	Absolute % Error
SR-92	13	Northbound	174	167	4.02
	13	Southbound	169	179	5.92
50th Street	17	Northbound	134	128	4.48
	17	Southbound			
Causeway Blvd	22	Eastbound	93	95	2.15
	22	Westbound	83	86	3.61
22nd St	25	Northbound	156	155	0.64
21st St.	25	Southbound	113	108	4.42

Note: Shaded Cells indicate No Available Field Data

Table G. 7: Final Field and CORSIM Simulated Volumes for the Master Links on June 26, 2001

	Destination Nodes																
Origin Nodes	**1 (Port)**	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**42**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**55**
1 south	**0**	0	0	50	0	0	20	0	55	10	0	0	0	0	**0**	**40**	
3	**20**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	30	0	0	0	0	0	**0**	**61**	
5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**35**	
6	**8**	0	0	0	0	0	0	0	51	60	0	80	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	25	170	0	260	0	0	**0**	**25**	
8	**0**	0	70	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	140	0	0	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
10	**0**	13	0	0	0	100	30	0	0	0	0	0	40	30	**20**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**37**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	210	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**23**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	80	0	0	**35**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**19**	**42**	**83**	**10**	**10**	**19**	**0**	**0**	**187**
18 (Port)	**0**	**65**	**10**	**42**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**143**
Sum.	**44**								**230**						**149**	**161**	

Figure G. 8: Field Data Calibrated O-D Matrix for June 27, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	Absolute % Error
SR-92	13	Northbound	159	166	4.40
	13	Southbound	163	170	4.29
50th Street	17	Northbound	132	128	3.03
	17	Southbound			
Causeway Blvd	22	Eastbound	94	95	1.06
	22	Westbound	89	88	1.12
22nd St	25	Northbound	158	155	1.90
21st St.	25	Southbound	114	109	4.39

Note: Shaded Cells Indicate No Available Field Data

Table G. 8: Final Field and CORSIM Simulated Volumes for the Master Links on June 27, 2001

	Destination Nodes																
Origin Nodes	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	16 (Port)	18 (Port)	Sum.
1 (Port)	0	0	42	0	0	13	0	0	0	0	0	0	0	0	0	0	55
1 south	0	0	0	50	0	0	20	0	55	10	0	0	0	0	0	36	
3	20	0	0	100	0	0	0	100	0	0	0	0	0	0	0	0	
4	0	0	100	0	0	0	0	0	30	0	0	0	0	0	0	54	
5	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	
6	6	0	0	0	0	0	0	0	51	60	0	80	0	0	0	0	
7	0	0	0	0	0	0	0	0	25	170	0	260	0	0	0	24	
8	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	140	0	0	0	150	10	0	0	0	0	200	0	10	24	0	
10	0	13	0	0	0	100	30	0	0	0	0	0	40	30	24	0	
11	0	0	0	0	0	0	0	0	0	0	0	60	0	0	36	0	
12	0	0	0	0	0	80	120	0	20	0	60	0	0	210	10	0	
13	0	0	0	0	0	0	0	0	0	10	0	0	0	0	23	0	
14	0	0	0	0	0	0	0	0	30	40	0	80	0	0	32	0	
16 (Port)	0	0	0	0	0	0	0	4	19	42	84	10	10	19	0	0	188
18 (Port)	0	65	10	42	10	0	8	8	0	0	0	0	0	0	0	0	143
Sum.	41								230						149	150	

Figure G. 9: Field Data Calibrated O-D Matrix for June 28, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	Absolute % Error
SR-92	13	Northbound	167	165	1.20
	13	Southbound	161	169	4.97
50th Street	17	Northbound	134	128	4.48
	17	Southbound			
Causeway Blvd	22	Eastbound	98	95	3.06
	22	Westbound	90	88	2.22
22nd St	25	Northbound	153	155	1.31
21st St.	25	Southbound	114	109	4.39

Note: Shaded Cells Indicate No Available Field Data

Table G. 9: Final Field and CORSIM Simulated Volumes for the Master Links on June 28, 2001

	Destination Nodes																
Origin Nodes	**1 (Port)**	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**41**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**54**
1 south	**0**	0	0	50	0	0	20	0	55	10	0	0	0	0	**0**	**41**	
3	**20**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	30	0	0	0	0	0	**0**	**62**	
5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**32**	
6	**8**	0	0	0	0	0	0	0	51	60	0	80	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	25	170	0	260	0	0	**0**	**25**	
8	**0**	0	70	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	140	0	0	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**27**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**34**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	210	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**23**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	80	0	0	**30**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**19**	**42**	**81**	**10**	**10**	**19**	**0**	**0**	**185**
18 (Port)	**0**	**64**	**10**	**41**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**141**
Sum.	**44**								**230**						**148**	**160**	

Figure G. 10: Field Data Calibrated O-D Matrix for June 29, 2001

Road Name	Link	Direction	Average Field Trucks Volumes	CORSIM Simulated Trucks Volumes	Absolute % Error
SR-92	13	Northbound	167	168	0.60
	13	Southbound	161	169	4.97
50th Street	17	Northbound	134	128	4.48
	17	Southbound			
Causeway Blvd	22	Eastbound	99	95	4.04
	22	Westbound	80	84	5.00
22nd St	25	Northbound	159	155	2.52
21st St.	25	Southbound	120	115	4.17

Note: Shaded Cells Indicate No Available Field Data

Table G. 10: Table G.10 Final Field and CORSIM Simulated Volumes for the Master Links on June 29, 2001

APPENDIX H
C.I. Method for CORSIM Models Calibration

SR-92 (N)				SR-92 (S)			
Field	**CORSIM**	**Difference**		**Field**	**CORSIM**	**Difference**	
170	167	-3	6	165	169	4	0
154	157	3	13	169	179	10	44
160	167	7	58	163	170	7	13
169	167	-2	2	161	169	8	21
177	169	-8	54	161	169	8	21
179	172	-7	40				
174	167	-7	40				
159	166	7	58				
167	169	2	7				
167	168	1	3				
	SUM	-7	40		SUM	37	1131
Z*	-0.6363636		323	Z*	3.3636364		1232
VAR Z*	2.9330579			VAR Z*	11.200601		
sqrt	1.7126173			sqrt	3.3467299		
lower	**-5.140547**			**lower**	**-5.4382633**		
upper	**7.0775785**			**upper**	**32.821217**		

Figure H. 1: CORSIM C.I. calculations of SR -92

For SR-92 (N)

Z* = Average of Z values

Z* = -7 / 11 = -0.6363

VAR Z* = S $(Z-Z^*)^2$ /10(10-1)

VAR Z* = 323/90 = 2.9330

Lower boundary = Z* - t $_{10,0.975}$ * Square Root of (VAR Z*)

Lower boundary = -0.6363-2.63 * 1.7126 = -5.1405

Upper boundary = Z* + t $_{10,0.975}$ * Square Root of (VAR Z*)

Lower boundary = -0.6363+2.63 * 1.7126 = 7.0775

50th Street (N)				50th Street (S)			
Field	**CORSIM**	**Difference**		**Field**	**CORSIM**	**Difference**	
124	129	5	67	141	135	-6	14
120	124	4	52	115	114	-1	2
129	123	-6	8	143	136	-7	22
132	127	-5	3	134	130	-4	3
134	128	-6	8	145	138	-7	22
126	123	-3	0				
134	128	-6	8				
132	126	-6	8				
134	128	-6	8				
134	128	-6	8				
	SUM	-35	1012		SUM	-25	517
Z*	-3.1818182		1182	Z*	-2.2727273		580
VAR Z*	10.744628			VAR Z*	5.2701728		
sqrt	3.2779			sqrt	2.2956857		
lower	**-11.802695**			**lower**	**-8.3103806**		
upper	**25.076554**			**upper**	**11.587827**		

Figure H. 2: CORSIM C.I. calculations of 50th Street

Causway E				Causway W			
Field	**CORSIM**	**Difference**		**Field**	**CORSIM**	**Difference**	
110	105	-5	22	91	88	-3	15
91	94	3	11	85	89	4	10
93	95	2	5	85	88	3	5
95	94	-1	1	87	90	3	5
99	96	-3	7	91	88	-3	15
93	95	2	5	87	88	1	0
93	97	4	18	83	86	3	5
94	95	1	2	89	88	-1	3
98	95	-3	7	90	88	-2	8
99	96	-3	7	80	84	4	10
	SUM	-3	7		SUM	9	67
Z*	-0.2727273		94	Z*	0.8181818		142
VAR Z*	0.8504132			VAR Z*	1.2900826		
sqrt	0.9221785			sqrt	1.1358181		
lower	**-2.6980568**			**lower**	**-2.1690197**		
upper	**1.9638595**			**upper**	**4.2110992**		

Figure H. 3: CORSIM C.I. Calculations of Causeway Boulevard

22nd ST				21st ST			
Field	**CORSIM**	**Difference**		**Field**	**CORSIM**	**Difference**	
158	155	-3	9	117	124	7	107
159	156	-3	9	118	113	-5	3
154	155	1	1	115	110	-5	3
150	155	5	25	119	114	-5	3
142	148	6	36	120	115	-5	3
156	155	-1	1	112	108	-4	0
158	156	-2	4	113	108	-5	3
153	155	2	4	114	109	-5	3
159	154	-5	25	114	109	-5	3
	SUM	0	0	120	115	-5	3
Z*	0		114		SUM	-37	1131
				Z*	-3.3636364		1261
VAR Z*	1.0363636						
sqrt	1.0180195			VAR Z*	11.460331		
lower	**-2.6773912**			sqrt	3.385311		
upper	**2.7256364**			**lower**	**-12.267004**		
				upper	**26.777033**		

Figure H. 4: CORSIM C.I. Calculations of 22^{nd} and 21^{st} Streets

APPENDIX I
VISSIM Calibration Tables Using FDOT Data

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150
6	40	0	0	0	0	0	0	250	100	0	400	0	0	350	0
7	0	0	0	0	0	0	0	500	**150**	0	1300	0	0	0	50
8	0	0	0	0	0	0	0	0	0	0	0	0	0	350	0
9	700	0	350	0	850	50	0	0	0	0	1000	0	50	150	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	300	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	250	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	0	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	120	0
14	0	0	0	0	0	0	0	500	200		400	0	0	200	0
16	0	0	0	0	0	0	100	100	250	200	50	100	350	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure I. 1: O-D Matrix of the 13th iteration

Link Number	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	550	3.70	488	664	**26.58**
L-20	493	546	9.80	578	593	2.53
L-23	928	840	10.42	1089	1219	10.63
L-24	1011	686	**47.39**	861	710	**21.27**
L-25	830	755	9.88	573	691	**17.15**
L-30	983	717	**37.03**	856	804	6.41

Table I. 1: FDOT and VISSIM Simulated Volumes for the Master Links (13th Iteration)

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	250
6	40	0	0	0	0	0	0	250	100	0	400	0	0	0	0
7	0	0	0	0	0	0	0	500	**300**	0	1300	0	0	0	350
8	0	0	0	0	0	0	0	0	0	0	0	0	0	250	100
9	700	0	350	0	850	50	0	0	0	0	1000	0	50	150	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	300	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	250	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	0	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	50	0
14	0	0	0	0	0	0	0	500	50	0	400	0	0	600	0
16	0	0	0	0	0	0	100	100	250	200	50	100	350	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure I. 2: O-D Matrix of 14th Iteration

Link Number	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	550	3.70	488	664	26.58
L-20	493	546	9.80	578	593	2.53
L-23	928	840	10.42	1089	1219	10.63
L-24	1011	770	31.31	861	742	16.04
L-25	830	755	9.88	573	691	17.15
L-30	983	1076	8.69	856	804	6.41

Table I. 2: FDOT and VISSIM Simulated Volumes for the Master Links (14th Iteration)

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	100	0	0	0	0	0	250
6	40	0	0	0	0	0	0	250	100	0	400	0	0	0	0
7	0	0	0	0	0	0	0	500	**450**	0	1300	0	0	0	350
8	0	0	0	0	0	0	0	0	0	0	0	0	0	250	100
9	700	0	350	0	850	50	0	0	0	0	1000	0	50	150	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	300	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	250	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	0	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	50	0
14	0	0	0	0	0	0	0	500	50	0	400	0	0	600	0
16	0	0	0	0	0	0	100	100	250	200	50	100	**350**	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure I. 3: O-D Matrix of 15th Iteration

	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	550	3.70	488	664	26.58
L-20	493	546	9.80	578	593	2.53
L-23	928	840	10.42	1089	1219	10.63
L-24	1011	940	7.56	861	742	16.04
L-25	830	755	9.88	573	691	17.15
L-30	983	1076	8.69	856	804	6.41

Table I. 3: FDOT and VISSIM Simulated Volumes for the Master Links (15th Iteration)

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	100	0	0	0	0	0	250
6	40	0	0	0	0	0	0	250	100	0	400	0	0	0	0
7	0	0	0	0	0	0	0	500	450	0	1300	0	0	0	350
8	0	0	0	0	0	0	0	0	0	0	0	0	0	250	100
9	700	0	350	0	850	50	0	0	0	0	1000	0	50	150	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	**300**	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	250	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	0	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	50	0
14	0	0	0	0	0	0	0	500	200	0	400	0	0	250	0
16	0	0	0	0	0	0	**120**	**120**	**300**	**240**	**50**	**120**	**200**	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure I. 4: O-D Matrix of the 16th Iteration

	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	550	3.70	488	558	12.63
L-20	493	546	9.80	578	593	2.53
L-23	928	840	10.42	1089	1219	10.63
L-24	1011	940	7.56	861	809	6.43
L-25	830	755	9.88	573	653	15.93
L-30	983	1076	8.69	856	930	8.01

Table I. 4: FDOT and VISSIM Simulated Volumes for the Master Links (16th Iteration)

	1	3	4	5	6	7	8	9	10	11	12	13	14	16	18
1	0	100	250	0	25	100	0	600	0	0	0	0	0	0	150
3	100	0	500	0	0	0	500	250	0	0	0	0	0	0	0
4	0	500	0	0	0	0	0	0	0	0	0	0	0	0	200
5	0	0	0	0	0	0	0	0	100	0	0	0	0	0	250
6	40	0	0	0	0	0	0	250	450	0	400	0	0	0	0
7	0	0	0	0	0	0	0	500	0	0	1300	0	0	0	350
8	0	0	0	0	0	0	0	0	0	0	0	0	0	**290**	100
9	700	350	0	0	850	50	0	0	0	0	1000	0	50	**175**	0
10	50	0	0	0	500	150	0	0	0	0	0	100	100	**150**	0
11	0	0	0	0	0	0	0	0	0	0	300	0	0	**290**	0
12	0	0	0	0	300	500	0	100	0	150	0	0	450	**0**	0
13	0	0	0	0	0	0	0	0	50	0	0	0	0	**58**	0
14	0	0	0	0	0	0	0	500	200	0	400	0	0	**290**	0
16	0	0	0	0	0	0	120	120	300	240	50	120	200	0	0
18	350	100	250	100	0	50	50	150	0	0	0	0	0	0	0

Figure I. 5: O-D Matrix of the 17th Iteration

	Inbound			Outbound		
	FDOT Data	Simulated Data	% error	FDOT Data	Simulated Data	% error
L-14	570	550	3.70	488	558	12.63
L-20	493	546	9.80	578	593	2.53
L-23	928	840	10.42	1089	1219	10.63
L-24	1011	940	7.56	861	809	6.43
L-25	830	755	9.88	573	615	6.91
L-30	983	1076	8.69	856	930	8.01

Table I. 5: FDOT and CORSIM Simulated Volumes for the Master Links (17th Iteration)

APPENDIX J
Final Calibration Tables for VISSIM Field Calibrated O-D Matrices

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	Absolute % Error
SR-92	13	Northbound	170	168	1.18
	13	Southbound			
50th Street	17	Northbound	124	126	1.61
	17	Southbound	141	137	2.84
Causeway Blvd	22	Eastbound	110	107	2.73
	22	Westbound	91	89	2.20
22nd St	25	Northbound	158	160	1.27
21st St.	25	Southbound	117	119	1.71

Note: Dashed Cells Indicate No Available Field Data

Table J. 1: Final Field and VISSIM Simulated Volumes for the Master Links on May 28, 2001

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	% Error
SR-92	13	Northbound	154	156	1.30
	13	Southbound			
50th Street	17	Northbound	120	123	2.50
	17	Southbound	115	113	1.74
Causeway Blvd	22	Eastbound	91	93	2.20
	22	Westbound	85	87	2.35
22nd St	25	Northbound	159	155	2.52
21st St.	25	Southbound	118	116	1.69

Note: Dashed Cells Indicate No Available Field Data

Table J. 2: Final Field and VISSIM Simulated Volumes for the Master Links on May 29, 2001

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	% Error
SR-92	13	Northbound	160	165	3.13
	13	Southbound			
50th Street	17	Northbound	129	131	1.55
	17	Southbound	143	138	3.50
Causeway Blvd	22	Eastbound	93	94	1.08
	22	Westbound	85	86	1.18
22nd St	25	Northbound	154	155	0.65
21st St.	25	Southbound	115	112	2.61

Note: Dashed Cells Indicate No Available Field Data

Table J. 3: Final Field and VISSIM Simulated Volumes for the Master Links on May 30, 2001

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	% Error
SR-92	13	Northbound	169	166	1.78
	13	Southbound			
50th Street	17	Northbound	132	130	1.52
	17	Southbound	134	131	2.24
Causeway Blvd	22	Eastbound	95	96	1.05
	22	Westbound	87	89	2.30
22nd St	25	Northbound	150	154	2.67
21st St.	25	Southbound	119	115	3.36

Note: Dashed Cells Indicate No Available Field Data

Table J. 4: Final Field and VISSIM Simulated Volumes for the Master Links on May 31, 2001

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	% Error
SR-92	13	Northbound	177	172	2.82
	13	Southbound			
50th Street	17	Northbound	134	130	2.99
	17	Southbound	145	139	4.14
Causeway Blvd	22	Eastbound	99	97	2.02
	22	Westbound	91	89	2.20
22nd St	25	Northbound			
21st St.	25	Southbound	120	117	2.50

Note: Dashed Cells Indicate No Available Field Data

Table J. 5: Final Field and VISSIM Simulated Volumes for the Master Links on June 1, 2001

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	% Error
SR-92	13	Northbound	179	174	2.79
	13	Southbound	165	168	1.82
50th Street	17	Northbound	126	129	2.38
	17	Southbound			
Causeway Blvd	22	Eastbound	93	95	2.15
	22	Westbound	87	89	2.30
22nd St	25	Northbound	142	147	3.52
21st St.	25	Southbound	112	113	0.89

Note: Dashed Cells Indicate No Available Field Data

Table J. 6: Final Field and VISSIM Simulated Volumes for the Master Links on June 25, 2001

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	% Error
SR-92	13	Northbound	174	169	2.87
	13	Southbound	169	175	3.55
50th Street	17	Northbound	134	131	2.24
	17	Southbound			
Causeway Blvd	22	Eastbound	93	95	2.15
	22	Westbound	83	87	4.82
22nd St	25	Northbound	156	153	1.92
21st St.	25	Southbound	113	111	1.77

Note: Dashed Cells Indicate No Available Field Data

Table J. 7: Final Field and VISSIM Simulated Volumes for the Master Links on June 26, 2001

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	% Error
SR-92	13	Northbound	159	163	2.52
	13	Southbound	163	168	3.07
50th Street	17	Northbound	132	128	3.03
	17	Southbound			
Causeway Blvd	22	Eastbound	94	96	2.13
	22	Westbound	89	88	1.12
22nd St	25	Northbound	158	157	0.63
21st St.	25	Southbound	114	117	2.63

Note: Dashed Cells Indicate No Available Field Data

Table J. 8: Final Field and VISSIM Simulated Volumes for the Master Links on June 27, 2001

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	% Error
SR-92	13	Northbound	167	170	1.80
	13	Southbound	161	165	2.48
50th Street	17	Northbound	134	136	1.49
	17	Southbound			
Causeway Blvd	22	Eastbound	98	97	1.02
	22	Westbound	90	87	3.33
22nd St	25	Northbound	153	155	1.31
21st St.	25	Southbound	114	118	3.51

Note: Dashed Cells Indicate No Available Field Data

Table J. 9: Final Field and VISSIM Simulated Volumes for the Master Links on June 28, 2001

Road Name	Link	Direction	Field Truck Volumes	VISSIM Simulated Truck Volumes	% Error
SR-92	13	Northbound	167	168	0.60
	13	Southbound	161	166	3.11
50th Street	17	Northbound	134	130	2.99
	17	Southbound			
Causeway Blvd	22	Eastbound	99	97	2.02
	22	Westbound	80	83	3.75
22nd St	25	Northbound	159	155	2.52
21st St.	25	Southbound	120	117	2.50

Note: Dashed Cells Indicate No Available Field Data

Table J. 10: Final Field and VISSIM Simulated Volumes for the Master Links on June 29, 2001

APPENDIX K
C.I. Method for VISSIM Model Calibration

SR-92 (N)				SR-92 (S)			
Field	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**
208	212	3	20	242	243	1	1
234	209	-25	556	211	225	15	165
222	217	-5	16	233	239	6	15
223	220	-3	5	253	246	-7	77
217	226	9	100	227	235	7	30
230	234	4	27	220	211	-9	112
219	217	-2	1	231	237	6	16
216	214	-3	2	228	231	3	2
214	212	-2	1	241	240	-1	10
242	244	3	15	230	234	4	6
230	238	8	85	221	216	-5	46
	SUM	-13	148		SUM	22	386
Z*	-1.21818182		975	Z*	1.963636		864
VAR Z*	8.86284598			VAR Z*	7.851384		
sqrt	2.977053238			sqrt	2.802032		
lower	**-9.04783183**			**lower**	**-5.40571**		
upper	**6.611468197**			**upper**	**9.332981**		

Figure K. 1: VISSIM C.I. calculations of SR -92

50th Street (N)				50th Street (S)			
Field	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**
168	182	14	130	161	165	4	80
168	181	13	112	154	155	1	35
153	149	-3	32	153	148	-5	0
154	153	-1	12	191	170	-21	264
147	146	-2	16	175	168	-7	5
182	186	3	1	173	159	-14	86
186	187	1	1	170	177	7	143
188	192	4	2	171	164	-7	5
174	170	-5	52	161	158	-4	1
150	153	3	0	167	164	-3	2
155	154	-1	10	161	157	-4	1
	SUM	27	585		SUM	-50	2066
Z*	2.418181818		952	Z*	-4.54545		2688
VAR Z*	8.658879038			VAR Z*	24.44039		
sqrt	2.942597329			sqrt	4.943722		
lower	**-5.32084916**			**lower**	**-17.5474**		
upper	**10.15721279**			**upper**	**8.456535**		

Figure K. 2: VISSIM C.I. calculations of 50th Street

Causway E				Causway W			
Field	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**
140	124	-16	106	130	112	-18	353
127	116	-11	26	124	123	-1	3
130	122	-8	6	120	120	0	1
124	118	-6	0	124	123	-1	3
124	121	-3	6	136	137	1	0
148	148	0	26	124	136	12	139
119	112	-7	4	118	125	7	38
101	107	6	137	108	113	5	23
122	118	-4	1	91	93	2	1
121	118	-2	11	125	126	1	0
124	115	-9	12	123	122	-1	3
	SUM	-60	3015		SUM	7	36
Z*	-5.49090909		3351	Z*	0.6		602
VAR Z*	30.45961232			VAR Z*	5.474182		
sqrt	5.519022769			sqrt	2.339697		
lower	**-20.005939**			**lower**	**-5.5534**		
upper	**9.024120791**			**upper**	**6.753403**		

Figure K. 3: VISSIM C.I. Calculations of Causeway Boulevard

22nd St.				21st St			
Field	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**
184	179	-5	1	127	130	3	7
196	192	-4	6	137	135	-1	2
184	176	-8	4	142	137	-5	29
182	179	-3	14	123	125	2	3
164	167	3	91	120	132	11	130
197	182	-14	61	126	126	1	0
192	174	-18	145	150	154	4	16
186	178	-8	3	133	128	-5	25
184	178	-6	1	157	156	-1	2
178	181	3	84	136	127	-9	74
198	189	-9	9	121	123	2	3
	SUM	-70	4050		SUM	0	0
Z*	-6.36363636		4470	Z*	1.29E-15		290
VAR Z*	40.63392938			VAR Z*	2.638545		
sqrt	6.374474831			sqrt	1.62436		
lower	**-23.1285052**			**lower**	**-4.27207**		
upper	**10.40123244**			**upper**	**4.272067**		

Figure K. 4: VISSIM C.I. Calculations of 22nd and 21st Streets

APPENDIX L
Validation O-D Matrices for CORSIM and VISSIM

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**30**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**40**
1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**26**	
3	**20**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**42**	
5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**27**	
6	**8**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**15**	
8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**44**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**24**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**40**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**22**	**44**	**88**	**10**	**10**	**20**	**0**	**0**	**198**
18 (Port)	**0**	**60**	**10**	**40**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**136**
Sum.	**44**														**152**	**110**	

Figure L. 1: The Truck O-D Matrix for the Peak Hour on 5th of July 2001

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**33**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**43**
1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**25**	
3	**19**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**40**	
5	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**25**	
6	**6**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**15**	
8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**44**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**24**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**40**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**22**	**44**	**88**	**10**	**10**	**20**	**0**	**0**	**198**
18 (Port)	**0**	**60**	**10**	**40**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**136**
Sum.	**40**														**152**	**105**	

Figure L. 2: The Truck O-D Matrix for the Peak Hour on 6th of July 2001

		Destination Nodes																
		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
Origin Nodes	**1 (Port)**	**0**	**0**	**30**	**0**	**0**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**39**
	1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**25**	
	3	**19**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
	4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**40**	
	5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**25**	
	6	**6**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
	7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**11**	
	8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
	9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
	10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
	11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**40**	**0**	
	12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
	13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**20**	**0**	
	14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**35**	**0**	
	16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**17**	**44**	**90**	**10**	**10**	**20**	**0**	**0**	**196**
	18 (Port)	**0**	**59**	**10**	**40**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**135**
	Sum.	**41**														**139**	**101**	

Figure L. 3: The Truck O-D Matrix for the Peak Hour on 9th of July 2001

		Destination Nodes																
		1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
Origin Nodes	**1 (Port)**	**0**	**0**	**30**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**40**
	1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**24**	
	3	**17**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
	4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**39**	
	5	**14**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**25**	
	6	**8**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
	7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**10**	
	8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
	9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**21**	**0**	
	10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
	11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**40**	**0**	
	12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
	13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**20**	**0**	
	14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**34**	**0**	
	16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**17**	**44**	**90**	**10**	**10**	**18**	**0**	**0**	**195**
	18 (Port)	**0**	**59**	**10**	**39**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**134**
	Sum.	**39**														**135**	**98**	

Figure L. 4: The Truck O-D Matrix for the Peak Hour on 10th of July 2001

	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
Origin Nodes																	
1 (Port)	**0**	**0**	**30**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**40**
1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**24**	
3	**19**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**40**	
5	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**25**	
6	**8**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**10**	
8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**26**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**42**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**20**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**35**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**18**	**45**	**90**	**10**	**10**	**18**	**0**	**0**	**197**
18 (Port)	**0**	**60**	**10**	**39**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**135**
Sum.	**42**														**143**	**99**	

Figure L. 5: The Truck O-D Matrix for the Peak Hour on 16th of July 2001

	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
Origin Nodes																	
1 (Port)	**0**	**0**	**30**	**0**	**0**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**39**
1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**24**	
3	**19**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**40**	
5	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**25**	
6	**6**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**10**	
8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**21**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**8**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**39**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**8**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**22**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**38**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**17**	**44**	**90**	**10**	**10**	**20**	**0**	**0**	**196**
18 (Port)	**0**	**58**	**10**	**40**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**134**
Sum.	**40**														**136**	**99**	

Figure L. 6: The Truck O-D Matrix for the Peak Hour on 17th of July 2001

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**30**	**0**	**0**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**39**
1 south	**17**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**24**	
3	**0**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**14**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**38**	
5	**8**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**25**	
6	**0**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**10**	
8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**20**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**40**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**20**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**33**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**17**	**44**	**90**	**10**	**10**	**20**	**0**	**0**	**196**
18 (Port)	**0**	**58**	**10**	**40**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**134**
Sum.	**39**														**133**	**97**	

Figure L. 7: The Truck O-D Matrix for the Peak Hour on 18th of July 2001

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**30**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**40**
1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**24**	
3	**19**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**39**	
5	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**25**	
6	**6**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**10**	
8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**21**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**40**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**20**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**34**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**17**	**44**	**90**	**10**	**10**	**18**	**0**	**0**	**195**
18 (Port)	**0**	**58**	**10**	**40**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**134**
Sum.	**40**														**135**	**98**	

Figure L. 8: The Truck O-D Matrix for the Peak Hour on 19th of July 2001

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**32**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**42**
1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**25**	
3	**19**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**39**	
5	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**25**	
6	**6**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**15**	
8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**26**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**42**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**20**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**35**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**18**	**45**	**90**	**10**	**10**	**18**	**0**	**0**	**197**
18 (Port)	**0**	**59**	**10**	**40**	**10**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**135**
Sum.	**40**														**143**	**104**	

Figure L. 9: The Truck O-D Matrix for the Peak Hour on 20th of July 2001

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**28**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**34**
1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**25**	
3	**19**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**40**	
5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**25**	
6	**6**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**11**	
8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**40**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**20**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**35**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**16**	**38**	**79**	**8**	**8**	**15**	**0**	**0**	**170**
18 (Port)	**0**	**53**	**8**	**32**	**8**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**117**
Sum.	**41**														**139**	**101**	

Figure L. 10: The Truck O-D Matrix for the Peak Hour on 23rd of July 2001

Origin Nodes	Destination Nodes																
	1 (Port)	1 south	3	4	5	6	7	8	9	10	11	12	13	14	**16 (Port)**	**18 (Port)**	**Sum.**
1 (Port)	**0**	**0**	**28**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**34**
1 south	**0**	0	0	50	0	0	20	0	53	10	0	0	0	0	**0**	**26**	
3	**21**	0	0	100	0	0	0	100	0	0	0	0	0	0	**0**	**0**	
4	**0**	0	100	0	0	0	0	0	32	0	0	0	0	0	**0**	**43**	
5	**16**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**28**	
6	**8**	0	0	0	0	0	0	0	51	60	0	78	0	0	**0**	**0**	
7	**0**	0	0	0	0	0	0	0	26	152	0	260	0	0	**0**	**15**	
8	**0**	0	76	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	
9	**0**	143	0	4	0	150	10	0	0	0	0	200	0	10	**24**	**0**	
10	**0**	15	0	0	0	100	30	0	0	0	0	0	40	30	**10**	**0**	
11	**0**	0	0	0	0	0	0	0	0	0	0	60	0	0	**45**	**0**	
12	**0**	0	0	0	0	80	120	0	20	0	60	0	0	216	**10**	**0**	
13	**0**	0	0	0	0	0	0	0	0	10	0	0	0	0	**24**	**0**	
14	**0**	0	0	0	0	0	0	0	30	40	0	79	0	0	**40**	**0**	
16 (Port)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**16**	**38**	**80**	**8**	**8**	**15**	**0**	**0**	**171**
18 (Port)	**0**	**53**	**8**	**32**	**8**	**0**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**117**
Sum.	**45**														**153**	**112**	

Figure L. 11: The Truck O-D Matrix for the Peak Hour on 24th of July 2001

APPENDIX M
C.I. Method for CORSIM and VISSIM Models Validation

SR-92 (N)				SR-92 (S)			
Field	**CORSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**CORSIM**	**Difference (Z)**	**(Z-Z*)2**
208	220	12	179	242	237	-5	81
234	222	-12	109	211	233	22	323
222	220	-2	0	233	236	3	1
223	219	-4	7	253	239	-13	303
217	220	3	23	227	233	5	2
230	224	-6	18	220	234	15	112
219	220	1	8	231	234	4	0
216	220	3	27	228	236	8	16
214	220	6	57	241	234	-7	121
242	230	-12	97	230	236	6	4
230	222	-8	39	221	228	7	8
	SUM	-19	311		SUM	44	1615
Z*	-1.7636364		873	Z*	4.0181818		2586
VAR Z*	7.9395162			VAR Z*	23.511772		
sqrt	2.8177147			sqrt	4.8488939		
lower	**-9.174226**			**lower**	**-8.734409**		
upper	**5.6469533**			**upper**	**16.770773**		

Figure M. 1: CORSIM C.I. calculations of SR -92

For SR-92 (N)

Z* = Average of Z values

Z* = -19 / 11 = -1.7636

VAR Z* = S $(Z-Z^*)^2$ /11(11-1)

VAR Z* = 873/110 = 7.9395

Lower boundary = Z* - $t_{10,0.975}$ * Square Root of (VAR Z*)

Lower boundary = -1.763-2.63 * 2.818 = -9.174

Upper boundary = Z* + $t_{10,0.975}$ * Square Root of (VAR Z*)

Lower boundary = -1.763+2.63 * 2.818 = 5.646

50th Street (N)				50th Street (S)			
Field	**CORSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**CORSIM**	**Difference (Z)**	**(Z-Z*)2**
168	158	-10	10	161	160	-1	10
168	156	-12	29	154	156	2	43
153	155	2	89	153	160	7	121
154	156	2	81	191	175	-16	135
147	156	9	250	175	163	-12	58
182	167	-15	70	173	166	-7	7
186	168	-18	121	170	166	-4	0
188	165	-23	268	171	161	-10	32
174	156	-18	130	161	163	2	33
150	155	5	149	167	160	-7	8
155	157	2	85	161	160	-1	13
	SUM	-77	4925		SUM	-46	1749
Z*	-7.0181818		6208	Z*	-4.1818182		2208
VAR Z*	56.434945			VAR Z*	20.077061		
sqrt	7.5123196			sqrt	4.4807433		
lower	**-26.775582**			**lower**	**-15.966173**		
upper	**12.739219**			**upper**	**7.6025368**		

Figure M. 2: CORSIM C.I. calculations of 50th Street

Causeway E				Causeway W			
Field	**CORSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**CORSIM**	**Difference (Z)**	**(Z-Z*)2**
140	121	-19	153	130	114	-16	85
127	121	-6	1	124	116	-8	1
130	121	-9	8	120	104	-16	85
124	114	-10	10	124	119	-5	3
124	120	-4	6	136	108	-28	441
148	121	-27	431	124	114	-10	10
119	121	2	68	118	108	-10	10
101	121	20	699	108	114	6	169
122	123	1	52	91	108	17	566
121	113	-8	1	125	118	-7	0
124	113	-12	25	123	125	2	71
	SUM	-73	4404		SUM	-75	4624
Z*	-6.6363636		5857	Z*	-6.8		6065
VAR Z*	53.249797			VAR Z*	55.134545		
sqrt	7.2972459			sqrt	7.425264		
lower	**-25.82812**			**lower**	**-26.328444**		
upper	**12.555393**			**upper**	**12.728444**		

Figure M. 3: CORSIM C.I. Calculations of Causeway Boulevard

22nd St.				21st St			
Field	**CORSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**CORSIM**	**Difference (Z)**	**(Z-Z*)2**
184	178	-6	4	127	126	-2	18
196	190	-6	4	137	132	-5	1
184	178	-6	4	142	129	-13	58
182	178	-4	0	123	127	4	96
164	190	26	907	120	130	9	225
197	179	-18	182	126	122	-4	3
192	170	-22	320	150	128	-23	289
186	181	-5	0	133	127	-6	0
184	190	6	102	157	131	-27	433
178	184	6	102	136	128	-8	6
198	181	-17	171	121	132	11	269
	SUM	-45	1688		SUM	-64	3364
Z*	-4.1090909		3484	Z*	-5.8		4761
VAR Z*	31.675745			VAR Z*	43.279273		
sqrt	5.6281209			sqrt	6.5786984		
lower	**-18.911049**			**lower**	**-23.101977**		
upper	**10.692867**			**upper**	**11.501977**		

Figure M. 4: CORSIM C.I. Calculations of 22nd and 21st Streets

SR-92 (N)				SR-92 (S)			
Field	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**
208	212	3	20	242	243	1	1
234	209	-25	556	211	225	15	165
222	217	-5	16	233	239	6	15
223	220	-3	5	253	246	-7	77
217	226	9	100	227	235	7	30
230	234	4	27	220	211	-9	112
219	217	-2	1	231	237	6	16
216	214	-3	2	228	231	3	2
214	212	-2	1	241	240	-1	10
242	244	3	15	230	234	4	6
230	238	8	85	221	216	-5	46
	SUM	-13	148		SUM	22	386
Z*	-1.21818182		975	Z*	1.963636		864
VAR Z*	8.86284598			VAR Z*	7.851384		
sqrt	2.977053238			sqrt	2.802032		
lower	**-9.04783183**			**lower**	**-5.40571**		
upper	**6.611468197**			**upper**	**9.332981**		

Figure M. 5: VISSIM C.I. Calculations of SR -92

50th Street (N)				50th Street (S)			
Field	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**
168	182	14	130	161	165	4	80
168	181	13	112	154	155	1	35
153	149	-3	32	153	148	-5	0
154	153	-1	12	191	170	-21	264
147	146	-2	16	175	168	-7	5
182	186	3	1	173	159	-14	86
186	187	1	1	170	177	7	143
188	192	4	2	171	164	-7	5
174	170	-5	52	161	158	-4	1
150	153	3	0	167	164	-3	2
155	154	-1	10	161	157	-4	1
	SUM	27	585		SUM	-50	2066
Z*	2.418181818		952	Z*	-4.54545		2688
VAR Z*	8.658879038			VAR Z*	24.44039		
sqrt	2.942597329			sqrt	4.943722		
lower	**-5.32084916**			**lower**	**-17.5474**		
upper	**10.15721279**			**upper**	**8.456535**		

Figure M. 6: VISSIM C.I. Calculations of 50th Street

Causway E				**Causway W**			
Field	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**
140	124	-16	106	130	112	-18	353
127	116	-11	26	124	123	-1	3
130	122	-8	6	120	120	0	1
124	118	-6	0	124	123	-1	3
124	121	-3	6	136	137	1	0
148	148	0	26	124	136	12	139
119	112	-7	4	118	125	7	38
101	107	6	137	108	113	5	23
122	118	-4	1	91	93	2	1
121	118	-2	11	125	126	1	0
124	115	-9	12	123	122	-1	3
	SUM	-60	3015		SUM	7	36
Z*	-5.49090909		3351	Z*	0.6		602
VAR Z*	30.45961232			VAR Z*	5.474182		
sqrt	5.519022769			sqrt	2.339697		
lower	**-20.005939**			**lower**	**-5.5534**		
upper	**9.024120791**			**upper**	**6.753403**		

Figure M. 7: VISSIM C.I. Calculations of Causeway Boulevard

22nd St.				21st St			
Field	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**	**Field**	**VISSIM**	**Difference (Z)**	**(Z-Z*)2**
184	179	-5	1	127	130	3	7
196	192	-4	6	137	135	-1	2
184	176	-8	4	142	137	-5	29
182	179	-3	14	123	125	2	3
164	167	3	91	120	132	11	130
197	182	-14	61	126	126	1	0
192	174	-18	145	150	154	4	16
186	178	-8	3	133	128	-5	25
184	178	-6	1	157	156	-1	2
178	181	3	84	136	127	-9	74
198	189	-9	9	121	123	2	3
	SUM	-70	4050		SUM	0	0
Z*	-6.36363636		4470	Z*	1.29E-15		290
VAR Z*	40.63392938			VAR Z*	2.638545		
sqrt	6.374474831			sqrt	1.62436		
lower	**-23.1285052**			**lower**	**-4.27207**		
upper	**10.40123244**			**upper**	**4.272067**		

Figure M. 8: VISSIM C.I. Calculations of 22nd and 21st Streets

APPENDIX N
Forecasted Truck Volumes on Network Links for the Port of Tampa

Day	Dates	Total	22nd-st Street	20th Street	Causeway Blvd	Sutton	Pendola point
Friday	7/1/05	4333	1244	553	1288	362	235
Monday	7/4/05	4329	1233	548	1275	358	233
Tuesday	7/5/05	4041	1254	557	1297	365	237
Wednesday	7/6/05	4292	1243	553	1287	361	235
Thursday	7/7/05	4385	1160	516	1201	337	219

Table N. 1: Forecast of Daily Number of Trucks Coming to the Port of Tampa in the First Week of July 2005

Day	Dates	Total	22nd-st Street	20th Street	Causeway Blvd	Sutton	Pendola point
Friday	7/1/05	3689	863	547	1591	355	332
Monday	7/4/05	3929	779	494	1436	320	300
Tuesday	7/5/05	3337	944	598	1740	388	363
Wednesday	7/6/05	3330	919	582	1694	378	354
Thursday	7/7/05	4034	781	495	1439	321	301

Table N. 2: Forecast of Daily Number of Trucks Leaving the Port of Tampa in the First Week of July 2005

APPENDIX O
VISSIM Runs Results for Sensitivity Analysis:
Average Travel Time and Average Delay of Network Links

Nodes #	Description	Link #	Description	Avearge Travel Time	Average Delay	State Road
1	U.S. Highway 41 / Madison Avenue	1	Node 1 to Node 2	115	10	
2	78th street / Madison Avenue	2	Node 2 to Node 3	95	12	
3	Madison Avenue / U.S. Highway 301	3	Node 3 to Node 4	92	15	SR 301
4	U.S. Highway 301 / I-75	4	Node 4 to Node 5	196	35	SR 301
5	State road 676 / U.S. Highway 301	5	Node 5 to Node 6	39	8	SR 301
6	Expressway 618 / U.S. Highway 301	6	Node 6 to Node 7	73	26	SR 301
7	State Highway 60 / U.S. Highway 301	7	Node 7 to Node 8	95	29	SR 301
8	State Highway 574 / U.S. Highway 301	8	Node 8 to Node 9	183	11	
9	State Highway 574 / I-4	9	Node 9 to Node 10	125	10	I-4
10	22nd Street / I-4	10	Node 10 to Node 11	165	13	I-4
11	I-4 / I-275	11	Node 11 to Node 12	176	15	I-275
12	State Highway 92 / I-275	12	Node 12 to Node 13	34	9	SR 92
13	State Highway 92 / State Highway 60	13	Node 13 to Node 14	345	95	SR 92
14	State Highway 92 / State Highway 618	14	Node 14 to Node 15	234	15	SR 618
15	State Highway 60 / Expressway 618	15	Node 15 to Node 16	135	12	SR 618
16	22nd Street / Expressway 618	16	Node 16 to Node 17	127	10	SR 618
17	State Highway 41 / Expressway 618	17	Node 17 to Node 18	89	24	SR 41
18	State road 676 / U.S. Highway 41	18	Node 18 to Node 1	65	26	SR 41
19	State Highway 41 / State Highway 60	19	Node 19 to Node 17	25	6	SR 41
20	22nd Street / State Highway 60	20	Node 21 to Node 5	93	43	SR 676
21	State road 676 / 78th street	21	Node 2 to Node 21	73	28	
		22	Node 21 to Node 18	132	52	SR 676
		23	Node 6 to Node 17	145	15	SR 618
		24	Node 19 to Node 7	198	61	SR 60
		25	Node 10 to Node 20	138	25	
		26	Node 20 to Node 16	43	13	
		27	Node 19 to Node 20	216	73	SR 60
		28	Node 15 to Node 20	183	29	SR 60
		29	Node 13 to Node 15	354	203	SR 60
		30	Node 9 to Node 19	113	27	SR 41

Table O. 1: Scenario 1 (Base Scenario)

Nodes #	Description	Link #	Description	Avearge Travel Time	% Change	Average Delay	% Change	State Road
1	U.S. Highway 41 / Madison Avenue	1	Node 1 to Node 2	113	-1.74%	9	-10.00%	
2	78th street / Madison Avenue	2	Node 2 to Node 3	92	-3.16%	13	8.33%	
3	Madison Avenue / U.S. Highway 301	3	Node 3 to Node 4	93	1.09%	14	-6.67%	SR 301
4	U.S. Highway 301 / I-75	4	Node 4 to Node 5	191	-2.55%	32	-8.57%	SR 301
5	State road 676 / U.S. Highway 301	5	Node 5 to Node 6	37	-5.13%	9	12.50%	SR 301
6	Expressway 618 / U.S. Highway 301	6	Node 6 to Node 7	72	-1.37%	24	-7.69%	SR 301
7	State Highway 60 / U.S. Highway 301	7	Node 7 to Node 8	90	-5.26%	28	-3.45%	SR 301
8	State Highway 574 / U.S. Highway 30	8	Node 8 to Node 9	176	-3.83%	13	18.18%	
9	State Highway 574 / I-4	9	Node 9 to Node 10	124	-0.80%	9	-10.00%	I-4
10	22nd Street / I-4	10	Node 10 to Node 11	160	-3.03%	12	-7.69%	I-4
11	I-4 / I-275	11	Node 11 to Node 12	162	-7.95%	16	6.67%	I-275
12	State Highway 92 / I-275	12	Node 12 to Node 13	34	0.00%	10	11.11%	SR 92
13	State Highway 92 / State Highway 60	13	Node 13 to Node 14	344	-0.29%	96	1.05%	SR 92
14	State Highway 92 / State Highway 618	14	Node 14 to Node 15	215	-8.12%	14	-6.67%	SR 618
15	State Highway 60 / Expressway 618	15	Node 15 to Node 16	123	-8.89%	16	33.33%	SR 618
16	22nd Street / Expressway 618	16	Node 16 to Node 17	116	-8.66%	11	10.00%	SR 618
17	State Highway 41 / Expressway 618	17	Node 17 to Node 18	83	-6.74%	22	-8.33%	SR 41
18	State road 676 / U.S. Highway 41	18	Node 18 to Node 1	64	-1.54%	25	-3.85%	SR 41
19	State Highway 41 / State Highway 60	19	Node 19 to Node 17	26	4.00%	7	16.67%	SR 41
20	22nd Street / State Highway 60	20	Node 21 to Node 5	94	1.08%	44	2.33%	SR 676
21	State road 676 / 78th street	21	Node 2 to Node 21	74	1.37%	29	3.57%	
		22	Node 21 to Node 18	131	-0.76%	51	-1.92%	SR 676
		23	Node 6 to Node 17	142	-2.07%	14	-6.67%	SR 618
		24	Node 19 to Node 7	181	-8.59%	59	-3.28%	SR 60
		25	Node 10 to Node 20	73	-47.10%	10	-60.00%	
		26	Node 20 to Node 16	26	-39.53%	11	-15.38%	
		27	Node 19 to Node 20	215	-0.46%	72	-1.37%	SR 60
		28	Node 15 to Node 20	174	-4.92%	28	-3.45%	SR 60
		29	Node 13 to Node 15	346	-2.26%	194	-4.43%	SR 60
		30	Node 9 to Node 19	109	-3.54%	25	-7.41%	SR 41

Table O. 2: Scenario 2

Nodes #	Description	Link #	Description	Avearge Travel Time	% Change	Average Delay	% Change	State Road
1	U.S. Highway 41 / Madison Avenue	1	Node 1 to Node 2	117	1.74%	11	10.00%	
2	78th street / Madison Avenue	2	Node 2 to Node 3	97	2.11%	13	8.33%	
3	Madison Avenue / U.S. Highway 301	3	Node 3 to Node 4	93	1.09%	16	6.67%	SR 301
4	U.S. Highway 301 / I-75	4	Node 4 to Node 5	198	1.02%	37	5.71%	SR 301
5	State road 676 / U.S. Highway 301	5	Node 5 to Node 6	41	5.13%	10	25.00%	SR 301
6	Expressway 618 / U.S. Highway 301	6	Node 6 to Node 7	89	21.92%	38	46.15%	SR 301
7	State Highway 60 / U.S. Highway 301	7	Node 7 to Node 8	112	17.89%	31	6.90%	SR 301
8	State Highway 574 / U.S. Highway 30	8	Node 8 to Node 9	198	8.20%	15	36.36%	
9	State Highway 574 / I-4	9	Node 9 to Node 10	123	-1.60%	11	10.00%	I-4
10	22nd Street / I-4	10	Node 10 to Node 11	162	-1.82%	12	-7.69%	I-4
11	I-4 / I-275	11	Node 11 to Node 12	178	1.14%	16	6.67%	I-275
12	State Highway 92 / I-275	12	Node 12 to Node 13	35	2.94%	9	0.00%	SR 92
13	State Highway 92 / State Highway 60	13	Node 13 to Node 14	359	4.06%	103	8.42%	SR 92
14	State Highway 92 / State Highway 61	14	Node 14 to Node 15	243	3.85%	20	33.33%	SR 618
15	State Highway 60 / Expressway 618	15	Node 15 to Node 16	137	1.48%	12	0.00%	SR 618
16	22nd Street / Expressway 618	16	Node 16 to Node 17	135	6.30%	13	30.00%	SR 618
17	State Highway 41 / Expressway 618	17	Node 17 to Node 18	92	3.37%	27	12.50%	SR 41
18	State road 676 / U.S. Highway 41	18	Node 18 to Node 1	67	3.08%	27	3.85%	SR 41
19	State Highway 41 / State Highway 60	19	Node 19 to Node 17	27	8.00%	8	33.33%	SR 41
20	22nd Street / State Highway 60	20	Node 21 to Node 5	96	3.23%	45	4.65%	SR 676
21	State road 676 / 78th street	21	Node 2 to Node 21	72	-1.37%	27	-3.57%	
		22	Node 21 to Node 18	134	1.52%	57	9.62%	SR 676
		23	Node 6 to Node 17	159	9.66%	24	60.00%	SR 618
		24	Node 19 to Node 7	218	10.10%	73	19.67%	SR 60

Table O. 3: Scenario 3

Nodes #	Description	Link #	Description	Avearge Travel Time	% Change	Average Delay	% Change	State Road
1	U.S. Highway 41 / Madison Avenue	1	Node 1 to Node 2	114	-0.87%	11	10.00%	
2	78th street / Madison Avenue	2	Node 2 to Node 3	97	2.11%	13	8.33%	
3	Madison Avenue / U.S. Highway 301	3	Node 3 to Node 4	95	3.26%	17	13.33%	SR 301
4	U.S. Highway 301 / I-75	4	Node 4 to Node 5	205	4.59%	37	5.71%	SR 301
5	State road 676 / U.S. Highway 301	5	Node 5 to Node 6	46	17.95%	10	25.00%	SR 301
6	Expressway 618 / U.S. Highway 301	6	Node 6 to Node 7	78	6.85%	29	11.54%	SR 301
7	State Highway 60 / U.S. Highway 301	7	Node 7 to Node 8	102	7.37%	32	10.34%	SR 301
8	State Highway 574 / U.S. Highway 30	8	Node 8 to Node 9	194	6.01%	12	9.09%	
9	State Highway 574 / I-4	9	Node 9 to Node 10	108	-13.60%	8	-20.00%	I-4
10	22nd Street / I-4	10	Node 10 to Node 11	148	-10.30%	11	-15.38%	I-4
11	I-4 / I-275	11	Node 11 to Node 12	158	-10.23%	13	-13.33%	I-275
12	State Highway 92 / I-275	12	Node 12 to Node 13	42	23.53%	12	33.33%	SR 92
13	State Highway 92 / State Highway 60	13	Node 13 to Node 14	359	4.06%	105	10.53%	SR 92
14	State Highway 92 / State Highway 61	14	Node 14 to Node 15	259	10.68%	17	13.33%	SR 618
15	State Highway 60 / Expressway 618	15	Node 15 to Node 16	154	14.07%	14	16.67%	SR 618
16	22nd Street / Expressway 618	16	Node 16 to Node 17	152	19.69%	13	30.00%	SR 618
17	State Highway 41 / Expressway 618	17	Node 17 to Node 18	96	7.87%	25	4.17%	SR 41
18	State road 676 / U.S. Highway 41	18	Node 18 to Node 1	61	-6.15%	24	-7.69%	SR 41
19	State Highway 41 / State Highway 60	19	Node 19 to Node 17	28	12.00%	7	16.67%	SR 41
20	22nd Street / State Highway 60	20	Node 21 to Node 5	96	3.23%	48	11.63%	SR 676
21	State road 676 / 78th street	21	Node 2 to Node 21	75	2.74%	29	3.57%	
		22	Node 21 to Node 18	137	3.79%	56	7.69%	SR 676
		23	Node 6 to Node 17	166	14.48%	18	20.00%	SR 618
		24	Node 19 to Node 7	229	15.66%	75	22.95%	SR 60
		25	Node 10 to Node 20	278	101.45%	49	96.00%	
		26	Node 20 to Node 16	49	13.95%	14	7.69%	
		27	Node 19 to Node 20	216	0.00%	75	2.74%	SR 60
		28	Node 15 to Node 20	187	2.19%	33	13.79%	SR 60
		29	Node 13 to Node 15	357	0.85%	207	1.97%	SR 60
		30	Node 9 to Node 19	114	0.88%	31	14.81%	SR 41

Table O. 4: Scenario 4

APPENDIX P
Scheffe's Test for Port Canaveral Freight Terminal Daily Truck Volumes

South-in

Scheffe [a,b]

DAY	N	Subset for alpha = .05	
		1	2
SUNDAY	14	71.79	
SATURDAY	16	114.88	
MONDAY	14		225.43
TUESDAY	15		246.67
WEDNESDAY	17		251.82
FRIDAY	18		255.44
THURSDAY	17		266.47
Sig.		.220	.275

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 15.722.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Figure P. 1: South Terminal (Inbound)

North-in

Scheffe [a,b]

DAY	N	Subset for alpha = .05	
		1	2
SUNDAY	14	1.86	
SATURDAY	16	14.25	
MONDAY	14		96.29
FRIDAY	18		103.17
TUESDAY	15		108.73
THURSDAY	17		115.82
WEDNESDAY	17		120.06
Sig.		.823	.115

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 15.722.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Figure P. 2: North Terminal (Inbound)

South-out

Scheffe[a,b]

DAY	N	Subset for alpha = .05	
		1	2
SUNDAY	13	57.69	
SATURDAY	15	88.80	
MONDAY	11		186.27
FRIDAY	13		199.54
THURSDAY	12		207.08
WEDNESDAY	15		208.67
TUESDAY	13		213.85
Sig.		.804	.880

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 13.003.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Figure P. 3: South Terminal (Outbound)

North-out

Scheffe[a,b]

DAY	N	Subset for alpha = .05	
		1	2
SUNDAY	13	3.46	
SATURDAY	15	14.47	
MONDAY	11		110.00
FRIDAY	13		110.54
THURSDAY	12		120.33
TUESDAY	13		121.46
WEDNESDAY	16		133.69
Sig.		.916	.169

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 13.104.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Figure P. 4: North Terminal (Outbound)

APPENDIX Q
Statistical Results for Port Canaveral ANN Validation Data

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	ACTUAL - MODEL	-7.8333	42.3871	8.6522	-25.7318	10.0652	-.905	23	.375

Table Q. 1: Total Inbound Trucks

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	ACTUAL - MODEL	-10.1429	39.0337	8.5178	-27.9108	7.6251	-1.191	20	.248

Table Q. 2: Total Outbound Trucks

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