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Evaluation of contraflow lanes for hurricane evacuation

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Evaluation of Contraflow Lanes for Hurricane Evacuation

by

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NOTE TO READER

The original of this document contains color that is necessary for understanding the data. The original dissertation is on file with the USF library in Tampa, Florida.

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ABSTRACT

This dissertation evaluates contraflow during a hurricane evacuation for grade separated highways. Contraflow is the concept of reversing the typical direction of highway travel to provide more outbound roadway capacity. The State of Florida has spent more time and resources towards the planning and the designing of potential contraflow facilities than any other state in the country; however, contraflow has yet to be implemented (as of Summer 2008). This study determines if the additional capacity benefits of contraflow outweigh the logistical requirements of implementing contraflow. Five different alternatives of contraflow lane configurations were comparatively evaluated. The format of this study is unique due to the evaluation of both capacity and logistical measurements.

Each alternative was subject to evaluation of six different performance measures. The six different performance measures consisted of improved capacity, speed variation, logistics, required personnel, required infrastructure, and delay/congestion. Each performance measure was evaluated using a scaled scoring system. The alternative with the lowest average scoring among the different performance measures was considered the best alternative.

Contraflow should only be considered as a last resort. The loss of inbound access, safety concerns, logistical requirements, and the additional strain of public resources during an evacuation are negative aspects that should be considered when determining the capacity benefit.

If extenuating circumstances justify contraflow, then a full conversion of all inbound lanes to outbound lanes, known as Alternative D, should be considered. This alternative demonstrated the greatest capacity benefit while requiring the least amount of public resources.

However, instead of contraflow, it is suggested to divert public resources towards other, more practical alternatives. Real time traffic monitoring has been demonstrated to be quite useful. Publicly accessed web-pages on the internet and the recent installation of variable message signs all provide improved notification of traffic conditions and of the capability to use alternative "at-grade" evacuation routes in addition to using the grade separated highways. This driver notification and the ability to ensure the safe and efficient travel on these alternative routes may be worth further investment, as well as being a potential topic of future research.

INTRODUCTION

The event of an evacuation potentially contains the most demanding set of circumstances with regard to the transportation infrastructure. Millions of people from urban areas gather belongings and travel towards safety in a relatively short period of time, sometimes resulting in extreme congestion. The research topic of hurricane evacuation is continuously emerging, and new opportunities for improvement are identified after virtually each hurricane.

Figure 1
Florida Evacuation from Hurricane Charley in 2004

Problem Definition

As more vehicles crowd the roadways, the increase in density results in congestion and causes delay for the traveler, as represented in Figure 2. Roadways provide a finite amount of capacity. When the demand exceeds the available capacity, the overflow demand is held stationary, causing delay until the excess demand can be served.

Note: All values of Evacuation Time are in generic units.

Figure 2
Schematic Comparison for Evacuation Response Time

One countermeasure in providing more efficiency of the available roadway capacity is the use of contraflow lanes, which redirects inbound travel lanes toward the outbound direction of evacuation;

however, the use of contraflow has only been activated a few times in the United States and has not yet been activated on any grade separated highways in the State of Florida (as of 2007). The use of contraflow during an evacuation requires significant deployment of public resources during a time period when it is vital to have these resources available for other purposes.

A problem arises if public resources are deployed to implement contraflow when the absolute need for contraflow may not exist. While contraflow provides improved capacity, contraflow may not be an effective method of evacuation when one considers the number of security, law enforcement personnel, and resources that are required. Therefore, this dissertation study has been compiled for the purpose of addressing the necessity to implement contraflow in Florida. Additionally, the identification of which methods of contraflow are most effective is a question warranting analytical research.

Research Objective

The objective of this dissertation is to determine the necessity of contraflow for evacuation purposes. The focus is not only to improve capacity, but to also give consideration to the investment of public resources. If the determination is made that contraflow benefits outweigh the disadvantages, then the objective becomes determining which form of contraflow is most effective. The research begins with the evaluation of existing logistical procedures within the state of Florida, and then identifying improvements to the existing design plans and procedures. This dissertation is unique in that the Measures of Effectiveness (MOEs) are focused to evaluate both additional capacity benefits and logistical requirements.

While the study is directed towards hurricane evacuation procedures in Florida, several aspects of this study may be applied within other regions of the United States and contribute toward the advancement of the civil engineering and emergency planning professions. This dissertation may also be applied to other countries that experience mass evacuation of the general population. This research demonstrates that the use of contraflow lanes may not be needed to be the most effective evacuation plan on I-4 in Florida, but that other investments may be more effective when considering the access and logistical constraints associated with contraflow.

Dissertation Outline

This dissertation is a comprehensive examination of recommended evacuation procedures and is a quantitative evaluation between the advantages and disadvantages of contraflow. The result is the identification of suggested logistical methods toward enhancing the investment of public infrastructure and improved capacity.

The examination begins with detailed literature review of research dedicated to the advancement of evacuation planning and the compilation of knowledge from previous hurricane evacuation studies. Evacuation studies between Florida and other states are then compared. Previous studies also include evacuation demand and operations modeling. A summary of evacuation procedures in Florida is then presented.

The research methodology is then presented. The section begins with a description of each contraflow alternative. A description of the performance measures is defined in this section.

Administrative and logistical procedures are then evaluated. Development of how suggestions and conclusions are defined is also provided. The presentation of the comparative matrix between the contraflow alternatives and the performance measures concludes the research methodology.

Data sources are then presented defined, which are a foundation of the analysis. A description of how capacity and travel time analyses are performed is addressed. The data assumptions about driver behavior and evacuee tendencies address user characteristics. Data assumptions about roadways and traffic volumes address infrastructure characteristics.

Results of the analyses are then presented. The results of each performance measure between each contraflow alternative are provided in terms of:

- Improved Capacity
- Required Infrastructure
- Required Personnel
- Speed Variation
- Logistics
- Delay/Congestion

The comparative matrix then summarizes the performance measures in the Summary/Conclusions section of the dissertation. The determination of whether contraflow benefits outweigh disadvantages is concluded, as well as which contraflow alternative would be considered most effective.

The dissertation is completed with a discussion of future research that could be considered as a continuation of this research. A perspective of lessons learned during this process is then provided.

The dissertation then concludes with a bibliography of references and also with appendices that provide documentation of analytical results.

DEVELOPMENT OF HURRICANE PLANNING

Improvements for hurricane preparation and evacuation are constantly being identified. Something new is learned after each hurricane; therefore, much established research has evolved over the past fifty years. Particularly, the emphasis of transportation planning has advanced and has become a fundamental part of effective hurricane evacuation during the past 20 years. This section identifies some of the previous advancements that have been made in evacuation modeling and the implementation of contraflow lanes for evacuation.

Figure 3
Hurricane Katrina Evacuation in 2005

This section begins with a summary of existing databases and research centers that are established for research in hurricane planning. The topic of how hurricane evacuation studies have evolved for regional planning purposes is then addressed. A comparison of how hurricane evacuation studies are conducted between Florida and other regions in the country is performed. This comparison utilizes governmental authority structures and different adopted contraflow strategies. A review of how evacuation demand and traffic operations modeling have become incorporated into hurricane evacuation studies is then undertaken. A summary of existing hurricane evacuation procedures planned within the state of Florida then concludes the Literature Review.

Databases and Research Centers

Hurricane planning is a discipline that has significantly increased in recent history. This growing field of research is now recognized by both Federal Highway Administration (FHWA) and FEMA and is now represented as a Transportation Research Board subcommittee (A3B01(4) – Subcommittee on Emergency Evacuation) to help communicate new practices and data on this topic.

Specifically, the subcommittee addresses the following topics:

- To research and develop faster, more efficient, and more effective evacuation strategies
- Information exchange, Best-Practices documents, identify research needs
- Apply information for more “routine” conditions and for management of special event traffic
- Develop operational and safety guidelines for interstates and other major roadways during evacuations, including design standards for interstate and other major highways when operating them contra-flow for evacuations.

- Applications of ITS and remote sensing systems for evacuations, including the collection, processing, and communication of roadway and weather data to decision makers, evacuees, business and commercial carriers.
- Incorporate evacuation travel demand forecasting and operational planning.
- Evaluate human behavior/human factors issues in evacuations.
- Determine traffic enforcement issues for evacuations.

Research organizations have been developed to advance the field of hurricane planning. The International Hurricane Research Center (IHRC) at Florida International University (FIU) brought together the expertise of the public universities in Florida into an integrated multi-year, multidisciplinary cooperative research effort known as the Florida Hurricane Alliance. The Alliance is coordinated by the IHRC, drawing upon its mission as a center responsible for hurricane research, education and outreach. Individual Alliance members take the lead for specific research projects, on the basis of capabilities and relevant expertise, and working in partnership with other Alliance members. The members on the alliance focus primarily on the following types of research:

- Cost of Hurricane Warnings - FIU and Florida A&M University (FAMU)
- Weather Networks – University of North Florida (UNF), FAMU
- Coastal Vulnerability & Forecasting – FIU, Florida Atlantic University (FAU)
- Storm Surge - FIU
- LIDAR - FIU, University of Florida (UF)
- Simulation and Visualization - FIU, University of Central Florida (UCF)
- Surface Wind - UF, FIU
- Hurricane Structure and Prediction – Florida State University
- Ecological Impacts – University of South Florida

More recently, the Severe Storm Prediction, Education and Evacuation from Disaster Center, or SSPEED, was created. The center is an academic and public partnership. Inaugural members include seven Texas universities and the Louisiana State University Hurricane Center.

The SSPEED Center, which is housed in Houston, Texas, and based at Rice University, organizes universities, researchers, emergency managers and private and public entities to better address severe storm impacts from Texas to Louisiana in a zone that includes major cities along the Gulf of Mexico.

The SSPEED Center's research areas include:

- Severe storm and hurricane research and storm surge prediction
- Radar-based rainfall and flood warning systems for urban and coastal areas
- State-of-the-art educational programs for workforce training and public awareness
- Infrastructure risk assessment for sheltering and evacuation from disaster
- Evacuation plans linked to the best warning and transportation systems, and societal needs.

The SSPEED Center's expertise is applied through the different universities as described below.

Table 1
Speed Center Expertise

Research Center	Research Focus
Louisiana State University	Storm surge model prediction; evacuation and transportation planning
Rice University	Flood prediction and warning; urban hydrologic models; Web integration of real-time data; regional forecast test bed; public policy and response
University of Houston	Educational outreach for public and high schools; infrastructure risk assessment
University of Texas-Austin	Disaster planning; storm surge modeling; remotely sensed data; evacuation and transportation systems
Texas A&M and TAMU-Galveston	Coastal flood evacuation; storm surge impacts; community response, land planning in the coastal zone
Texas Southern University	Transportation systems and evacuation planning
University of Texas-Brownsville	Coastal flood response; regional forecast test bed; international border issues
Houston-Galveston Area Council	Evacuation planning and transportation management; lead governmental unit for operations and response

The Louisiana State University holds a hurricane research center that has special focus on transportation planning. The following list indicates a number of the areas of hurricane and hurricane-related expertise and ongoing research at the university. (Wilmont, 2001)

Table 2
Louisiana State University Research Areas

Hurricane Frequency/ Intensity	Hurricane climatology Paleotempestology Storm track prediction Effects of global climate change
Modeling	Storm surge flooding Wave modeling Riverine rainfall flooding Wind and wave fields Rain-induced landslides Evacuation traffic flow Wind effects on structures and wind tunnel modeling Coastal erosion/ land loss Coastal response/geology Impacts of coastal restoration Chemical releases in extreme weather Nuclear releases in extreme weather
Hurricane Impacts	Natural Environment: Coastal erosion/ wetland loss Barrier islands, estuarine environmental modifications, geomorphology Fish kills/ marsh kills Effects on agriculture Effects on aquaculture Effects on forestry resources Built Environment: Effects on infrastructure (roads, bridges, utilities, hospitals, schools, etc.) Effects on petroleum/chemical industries, onshore and/or offshore Effects on building stock Strength and stability of levees Human Environment: Effects on social organization Use of social networks to cope with hurricane impacts Effects of preexisting social networks on formal and informal aid and patterns of provision of informal support Effects on depressive symptomatology Effects on work disruption Epidemiology of floods Economic Impacts
Preparedness	Use of GIS for planning/ response activities Risk assessment Rainfall flood/ storm surge mapping Hurricane refuge/ shelter selection Evacuation planning Technology and emergency management Assessment/ evaluation of emergency management systems.
Response (Real-Time data analysis for landfalling hurricanes)	Remote sensing- satellite imagery acquisition and data analysis Offshore, coastal, and land-based sensing of wave, wind, sediment storm phenomena Storm surge flooding predictions Riverine rainfall flooding predictions Evacuation traffic monitoring management
Mitigation	Comprehensive community planning Floodplain management Coastal protection and restoration measures Design of wind resistant landscape Design of wind and flood resistant hurricane shelters Preparing historic buildings for hurricanes

History of Hurricane Evacuation Studies

The ability to inform the general public of an oncoming hurricane (and other forms of natural disasters) has historically been the key ingredient to avoid a catastrophe. Emerging technologies of storm forecasting and media outlets have been vital towards disseminating hurricane evacuation information. Given the fact that hurricane evacuation has the characteristics of non-recurring congestion, together with many variables in storm characteristics and behavior trends, the ability to plan for the necessary transportation infrastructure is quite challenging. Interestingly, the United States is one of only a few countries throughout the world that effectively use mass evacuations as a way of protecting the population along the coastline. (FHWA, 2005)

The primary tool for regional areas to determine their needed time for evacuation comes from Hurricane Evacuation Studies (HES). During the 1980's the Federal Emergency Management Agency (FEMA) began initiating HES around the country to identify the key factors towards a successful hurricane evacuation. A HES generally addresses the following five elements:

- Storm hazard analysis
- Vulnerability analysis
- Behavior analysis
- Sheltering analysis
- Transportation analysis

In March, 1994, FEMA, together with the National Oceanic and Atmospheric Agency (NOAA) and the U.S. Army Corps of Engineers (USACE), created the National Hurricane Evacuation Task Force to standardize guidelines for HES around the country. Federal, state, and local governments each

participate in these studies, which are updated every 4-5 years. Guidelines include a comprehensive scope and a multi-regional perspective. Some HES reach across state lines when necessary. In 1995, the NOAA published the Technical Guidelines for Hurricane Evacuation Studies as a reference so that the USACE can effectively develop information for translation to local officials. Guidelines were used to develop uniformity, terminology and content to a study process that was complex and constantly being refined. (Barret, 2000 and NOAA, 2006)

One of the most important components of the HES is the calculation of clearance times that identifies how much time would be required for all evacuating vehicles to leave the study area given the roadway infrastructure constraints within the area. The technical data produced in a HES is used toward creating or updating local hurricane evacuation plans. (Wolshon, 2001 and USACE, 2006) However, not until recently, did hurricane evacuation plans emphasize the need to incorporate effective traffic operations.

HES use travel demand models to calculate clearance times for evacuations. A combination of different evacuation scenarios is evaluated. The evacuation clearance times are based on different combinations of:

- Seasonal populations for evacuation
- Socioeconomic factors for what percentage of people evacuate
- Other populations of evacuees from other locations
- Evacuation destinations
- Different evacuation population based on storm intensity, direction, and evacuation zones
- Other behavioral assumptions

Previously, local emergency management personnel were required to develop evacuation plans and traffic operations began a greater involvement beginning in the mid-1980s. Since Hurricanes George and Frances in 1998 and Hurricane Floyd in 1999 transportation professionals have become more involved in the development of evacuation plans. This added transportation expertise has provided assistance forecasting evacuation travel demand, evacuation traffic operations analysis, and the application of Intelligent Transportation System (ITS) technologies.

Hurricane Evacuation Studies Between Different Regions

One traffic management tool used for hurricane evacuation is the use of contraflow lanes. Many HES throughout the country identify provisions to use contraflow lanes to reduce clearance times in the event of an evacuation. Florida is one state that has partaken in detailed activities for contraflow research.

Most states have a two level approach between local and state agencies. Generally, the local government is responsible for the planning, response, and recovery activities, while the state level emergency management agency coordinates with the local emergency management activities in the coordination of traffic and law enforcement. For example, the Texas State Emergency Plan has a general emergency plan, but the local coastal jurisdictions manage the evacuation planning. In Florida, the entire state is vulnerable to hurricanes; therefore, in Florida, the state emergency management agency assumes a greater managerial role in developing evacuation plans.

However, the evacuation order and management plan is the responsibility of the County law enforcement. The primary difference typically lies between the centralized versus decentralized decision making approach. Table 3 summarizes how the authority to give an evacuation order is provided throughout the hurricane prone states. (Wolshon, Urbina, and Levitan, 2001)

Table 3
Comparison of Authority Structure for Hurricane Evacuations

STATE	STATE AGENCIES				LOCAL AGENCIES					
	Governor	State Emergency Management Office	National Guard	State Police	Local Emergency Management Office	Mayor	Highest Local Elected Official	Local Law Enforcement	County Judge	County President
New Hampshire	X									
Massachusetts	X						X			
Rhode Island	X					X	X			
Connecticut	X			X		X		X		
New York							X			
New Jersey	X	X		X	X	X		X		
Delaware	X									
Maryland	X					X	X			
Virginia	X				X					
North Carolina	X									X
South Carolina	X									
Georgia	X					X				X
Florida	X		X*							X
Mississippi	X					X				X
Louisiana	X									X
Texas						X			X	

*Note: The State of Florida has since removed the planned deployment of the National Guard during the course of this research.

A comparison of hurricane traffic control plans throughout the Southeastern United States was undertaken during this research to learn how they compare to Florida. Florida, however, implements several different regional traffic control plans because of the possibility that several coastal areas in Florida may be evacuated for the same hurricane. For example, if a hurricane is approaching from the southwest of the state from the Gulf of Mexico, the evacuation of southwest Florida counties will greatly impact the evacuation clearance time within the Tampa Bay area because evacuees from south Florida will be using evacuation routes such as I-75 and I-4 to find shelter. This situation emphasizes the importance for regional communication between the different urban areas within Florida in creating an effective traffic control plan.

Many of the assumptions that are applied in HES are dependent upon evacuee behavior. This behavior creates many different scenarios of congestion for the road user, not just the characteristics of the roadway itself. Some of evacuees' behaviors and lifestyles toward evacuation and corresponding congestion include: (PBS&J, 2006)

- Participation Rates – What percent of the population in different areas will evacuate their dwelling units for future hurricane threats?
- Evacuation rapidity of response rates – How quickly will evacuees respond to what local officials are telling them to do?
- Vehicle usage – Of the vehicles available to the households, what percent of those vehicles will be used in an evacuation?

While FEMA originated the basic standardization of HES, the consistency regarding the authority structure and planning/design processes is relatively limited between different regions of the country. (Wolshon, Urbina, and Levitan, 2001 and Galvan, 2002) For example, the 2001 Hampton Roads, Virginia Traffic Control Plan identifies a criterion of a Category 4 or 5 hurricane needed to

implement contraflow lanes for evacuation. Other regions around the country do not use that criterion to implement contraflow. Each HES should reflect the evacuation needs for each particular region, so complete standardization may not be required.

For some areas in the country, such as Hampton Roads, Virginia, the use of contraflow is only part of the overall traffic control plan. Some other impacting factors are as follows: (Virginia DOT, 2001)

- Tolls are lifted for hurricane evacuations
- Traffic is metered onto the freeway for the I-64 Contraflow Plan
- Traffic signal timings on evacuation routes are modified from traffic management center
- Phases of implementation are based upon time periods upon the storm's arrival
- Closing of the Chesapeake Bay Bridge Tunnel
- Agency coordination and responsibilities are based upon location of evacuation
- Detailed maintenance of traffic (MOT) drawings are provided for each interchange and major intersection

In 2003, the arrival of Hurricane Isabel required an evacuation order for Hampton Roads, Virginia. This provided an opportunity to evaluate the effectiveness of the 2001 Traffic Control Plan. Hurricane Isabel made Virginia land fall in September, 2003, as a Category 2 hurricane. One recommendation identified that the study area for the Virginia HES should include communities further inland. Additionally, it was identified that more clear evacuation shutdown procedures were needed. The most notable recommendation from the Hurricane Isabel Post Assessment regarding traffic was the emphasis on integrating emergency management requirements into the Intelligent Transportation Systems (ITS) architecture at the federal and state level.

However, due to Isabel being a Category 2, many local governments reported that relatively few people actually evacuated, or, if they did evacuate, it occurred very late in the event timeline. Only isolated incidents of roadway blockage or traffic congestion were reported. (USACE, 2006 and PBS&J 2005)

The Texas Management & I-37 Conversion Plan also identifies a procedure for agency coordination to implement contraflow. There is detailed preparation and implementation for interstate contraflow. For example, there is a listed criterion needed to implement contraflow based upon the size/intensity of a storm, anticipated path, storm surge, and the number of citizens prepared for mobilization. Unlike the Hampton Roads plan, the I-37 Conversion Plan is expected for a Category 3 storm or greater. The contraflow is discouraged during hours of darkness. The length of contraflow laneage is already predetermined. Additionally, the number of police personnel required for contraflow is already predetermined. (Hamilton, 2002)

Hurricane Rita in October, 2005, was an example of how detailed contraflow planning may be difficult to implement under a real condition. This particular use of contraflow was a reactionary implementation, instead of a pre-planned event. The Hurricane Rita contraflow was implemented on I-45 outside of Houston, Texas and not on I-37 located outside the coastal city of Corpus Christi, Texas. The Hurricane Rita contraflow experienced extreme congestion at certain bottlenecks primarily for two reasons:

- The significant number of evacuating people from the major Houston, Texas metropolitan area occurred shortly after Hurricane Katrina
- Difficulty in the merge/diverge transition areas of contraflow lanes near major interchanges

In 1998, only Florida and Georgia DOTs had adopted plans to reverse the flow on their limited access highways to expedite evacuations. By 2005, 11 of the 18 mainland coastal states subject to the threat of a hurricane had some version of a contraflow plan. Contraflow was implemented for the first time in Georgia, in 1999, during Hurricane Floyd with mixed, but mostly positive, results. An ad hoc implementation (without previous adopted plans) of contraflow was also improvised in South Carolina during Hurricane Floyd, after a strong public outcry came from evacuees trapped in congestion on I-26 between Charleston and Columbia, SC. (Wolshon, 2001) To this date, Hurricane George and Floyd are still considered to be the largest hurricane evacuations in the history of the United States. It was estimated that over four million people evacuated for Hurricane Floyd between the coastal counties of Florida, Georgia, South Carolina, and North Carolina.

Figure 4
Hurricane Floyd

Shortly after Hurricane Floyd, in 1999, the state of Florida put in motion a detailed set of design plans for contraflow. However, these plans have yet to be implemented as of 2007. There is little debate that contraflow can significantly increase the outbound capacity for emergency evacuations. However, there are many other elements to consider in determining its effectiveness. The total costs of contraflow need also be determined in safety risks and manpower requirements, most of which are widely undetermined. Currently, there are no recognized standards or guidelines for the design, operation, and location of contraflow segments.

Along with the benefits that contraflow can provide, there are also inherent risks that are associated with the use of contraflow for evacuation purposes. These risks and uncertainties may include:

- Overwhelming congestion at end of route
- Uncertainty of the behavior of individuals
- Unique storm characteristics between each storm event
- Safety design for guardrails, signage, interchanges, and errant vehicles
- Labor and time investment during crisis
- Political consequences if contraflow not required

One consideration for contraflow planning is the inverse relationship between accessibility and capacity. The complete reversal of a highway would create the most amount of available outbound capacity. However, the complete reversal would remove all access for any vehicles traveling inbound, some of which may be emergency vehicles; and those vehicles would be required to use more localized alternative routes. This relationship should be considered during the development and updating of hurricane evacuation plans.

The amount of detail that is considered during contraflow planning also varies among the different states. Much of the variation may be related to the specific agency that prepared the plan. The Hampton Roads, Virginia plan which was developed by the Virginia DOT, includes great detail in the geometric design and traffic control aspects of the cross-over location. The Louisiana plan, which was developed primarily by the State Police, focuses more attention on law enforcement requirements in the contraflow area. Table 4 summarizes the planned Contraflow Routes among the 10 states which currently have them in effect. (Urbina, 2001)

Table 4
Planned Contraflow Evacuation Routes

State	Route(s)	Length (miles)	Origin Location	Termination Location
New Jersey	47/347 Atlantic City Expressway 72/70 35 138/I-195	19 44 29.5 3.5 26	Denis Twp Atlantic City Ship Bottom Boro Mantoloking Boro Wall Twp	Maurice River Twp Washington Twp Southhampton Pt. Pleasant Beach Upper Freehold
Maryland	MD-90	11	Ocean City	U.S. 50
Virginia	I-64	80	Hampton Road Bridge	Richmond
North Carolina	I-40	90	Wilmington	Benson (I-95)
South Carolina	I-26	95	Charleston	Columbia
Georgia	I-16	120	Savannah	Dublin
Florida*	I-10 Westbound I-10 Eastbound SR 528 (Beeline) I-4 Eastbound I-75 Northbound FL Turnpike I-75 (Alligator Alley)	180 180 20 110 85 75 100	Jacksonville Pensacola SR 520 Tampa Charlotte County Ft. Pierce Coast	Tallahassee Tallahassee SR 417 Orange County I-275 Orlando Coast
Alabama	I-65	135	Mobile	Montgomery
Louisiana	I-10 Westbound I-10/I-59 (East/North)	25 115	New Orleans New Orleans	I-55 Hattiesburg, MS
Texas	I-37	90	Corpus Christi	San Antonio

*Note: I-75 Contraflow between I-275 and I-10 currently under consideration for design in Florida.

In most states, including Florida, the authority to start contraflow operations resides with the Governor. Typically, the decision of when to initiate contraflow is made in close consultation with the Department of Transportation, law enforcement, and emergency management officials. Florida, like many other states, monitors real-time traffic conditions with "stand-by" alertness and will not implement contraflow until traffic volumes warrant their use.

All states that have contraflow are also looking towards ITS systems for hurricane operations. The most common use of ITS is for monitoring real-time traffic conditions. Florida DOT officials are able to retrieve traffic count information for hourly or 15-minute increments during evacuations. Recent enhancements allow data to be assembled and displayed in tables and graphs to monitor the progress of an evacuation. This traffic count data can also be used together with closed circuit

television (CCTV) cameras to provide direct visual confirmation of traffic conditions. In 2004, it was reported that the traffic count data was particularly useful in monitoring the evacuation and re-entry process. The count data was especially useful in coordinating with the state of Georgia in making a decision not to open a contraflow lane on I-75 in Georgia. (FHWA, 2006)

The Florida DOT also provides this real-time traffic information to the general public. The Florida DOT website provides access to its statewide network of real-time traffic volume and speed data recorders. This information helps traffic officials within the State of Florida decide when, if ever, is the appropriate time to start and end the use of contraflow. Other uses of ITS include highway advisory radio (HAR) and dynamic message signs (DMS). In the hurricane season of 2004, which witnessed four hurricanes travel through Florida, a combination of DMS, HAR, and *511 phone service was used. (FHWA, 2006) However, the difficultly with many ITS applications is that the majority of the infrastructure is located in urban areas, while the majority of evacuation route mileage is located in rural areas.

To initiate contraflow the general following procedure must be completed in sequential order:

- Install traffic control devices and barricades
- Clear inbound lanes of inbound vehicles
- Position law enforcement and DOT personnel at assigned locations

Most states anticipate that the above process requires four to 12 hours. The variation in the estimated time is dependent upon the length of the segment, number of interchanges, and number of ramps and merges points along the evacuation route. However, different authorities in Florida previously estimated that 49-96 hours were needed to prepare for contraflow operation. The time was so much longer than other states because Florida was required to activate the National Guard

forces (prior to 2005) to set up and patrol their locations (Collins, 2001). This special consideration in Florida had been the focal point of debate regarding the necessity to deploy the National Guard and the ability to effectively implement contraflow. The actual set up of contraflow has the ability to occur much faster in Florida if it were demanded by the local and state authority structure, which further questioned the necessary deployment of the National Guard. (PBS&J, 1993, 2008)

Other contraflow strategies have been reported to require only three hours to establish contraflow, such as the 2004 evacuation for Hurricane Charley in South Carolina (FHWA, 2005). However, it should be noted that a contraflow strategy for Florida is naturally more complex than most other hurricane prone states. Most other hurricane prone states are only bounded by the ocean from one side and also have highways that directly intersect the coastline, such as I-16 in Georgia, I-26 in South Carolina, and I-37 in Texas, which makes an evacuation route planning more straightforward. In the case of Florida, the major interstates of I-95 and I-75 run parallel to the coastline, with as little as 100 miles in between them. Florida is susceptible to hurricanes from either coast. That, together with the population density within the state, suggests a situation in which numerous evacuation scenarios exist with the capability of extreme congestion occurring towards the north end of the South Florida peninsula.

Florida officials have adopted a policy that contraflow operations will neither be initiated nor operated during night time. This policy has also been adopted by the Georgia DOT. One reason for this policy may include the fact that reflectors and pavement markings are designed to prevent “wrong way” driving, especially during nighttime hours. However, the same officials recognize that some situations may require flexibility depending upon the situation. (Wilmont, 2001)

Additionally, the topic of highway work zones was mostly ignored for previous hurricane evacuations. The problems of construction on hurricane evacuation routes were experienced throughout the southeast United States during the evacuations of Hurricane Opal in 1995, Hurricane George in 1998, and Hurricane Floyd in 1999. Today, most hurricane prone states have clauses that require a contractor to cease all construction activities once an evacuation order is given, clear all equipment, and open all lanes of traffic (including the lanes under construction).

At the onset of the study, it is expected the contraflow alternative with all outbound lanes *should* produce most capacity. But is it the most practical alternative? Previous efforts have shown that there is 70% additional outbound capacity with complete reversal of all inbound lanes when compared to normal operations. The increase of capacity is less than double due to reduced speed and also driver unfamiliarity on the contraflow lanes (Anderson, 2007).

Evacuation Demand and Operations Modeling

Since the 1970's travel demand modeling techniques have greatly improved, mostly because of the availability of faster computer processors capable of storing and compiling more data. Original travel demand models, such as MASSVAC, were developed in preparation for a nuclear disaster. These traditional models were designed to allow for long range planning in situations where origins and destinations were easily determined for only the peak hours of traffic flow. Today, the capability of hurricane modeling has helped create simulation programs which are used to model the characteristics of:

- Evacuation travel behavior

- Weather
- Flooding
- Traffic Flow

All evacuations, whether they are caused from hurricanes, floods, fires, or manmade disasters, should consider the following characteristics (Barret, 2000):

- Shape and size of energy source
- Shape and size of evacuation area
- Rate of growth of evacuation area
- Size and socioeconomic data of evacuation population
- Amount of warning time
- Level of disruption to the road network
- Level of danger of the emergency

The composition of the evacuating population will also be influenced by the time of day in which the emergency occurs. For example, if the emergency event occurs within an office or business district at 5:00 P.M., the resulting situation will differ considerably from what would result if the same emergency occurred in the same location at 5:00 A.M. (Ran, 2000). The same is true depending if the emergency occurs on a weekend or weekday.

What is unique about the ability to forecast a hurricane, as compared to other disasters, is that there is now much more information available about the storm's intensity, speed, direction, and approaching location. However, there are also special challenges associated with a hurricane evacuation. The difficulty occurs in being able to model the entire roadway network because of the large area of impact and the long period of impacted time. This type of situation is typically more appropriate to use for macroscopic models, instead of microscopic models. Additionally, due to the

ability of the oncoming storm to damage roadways and bridges, the actual road infrastructure cannot be assumed as constant. (Pillai, 2000 and PBS&J, 2005)

In creating a hurricane evacuation study there are a minimum of six important modeling steps. (PBS&J, 2000) The development of Evacuation Zones and Data first identify who is vulnerable and who is likely to evacuate. The trip generation step calculates how many evacuees will travel from a traffic analysis zone (or county, city, etc.) for a particular storm scenario. The trip distribution step then determines the destination and the direction that evacuees will travel. The development of the evacuation road network addresses which roads can accommodate an evacuation and the carrying capacity for each of those roads. The trip assignment determines which routes will be chosen by the evacuees to reach their particular destination. Finally, the step to calculate the expected clearance time determines how much time will be required to clear all evacuees past a chosen cordon line area within the evacuation area.

For hurricanes, the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model has been widely used to identify flood prone areas. This model was originally developed by the National Weather Service to predict storm surge. Since that time the model has been used to create a classification of hurricane evacuation areas and to identify evacuation routes and emergency shelters given possible flooding scenarios.

SLOSH assists in the development of evacuation zones, which are typically along the coastline due to their low elevation. Figure 5 shows the locations of the evacuation zones in Hillsborough County, Florida. Recent hurricane experiences have demonstrated that major hurricane damage does not occur only along the coastline, as shown in Figure 6 with Hurricane Charley in 2004, over central

Florida. Not surprisingly, there has also been an increase in the number of people who evacuate who do not live in an evacuation zone. These people are referred to as "shadow evacuees." Over the last 20 years, more hurricane related deaths have been attributed to inland flooding than coastal wind damage and storm surge.

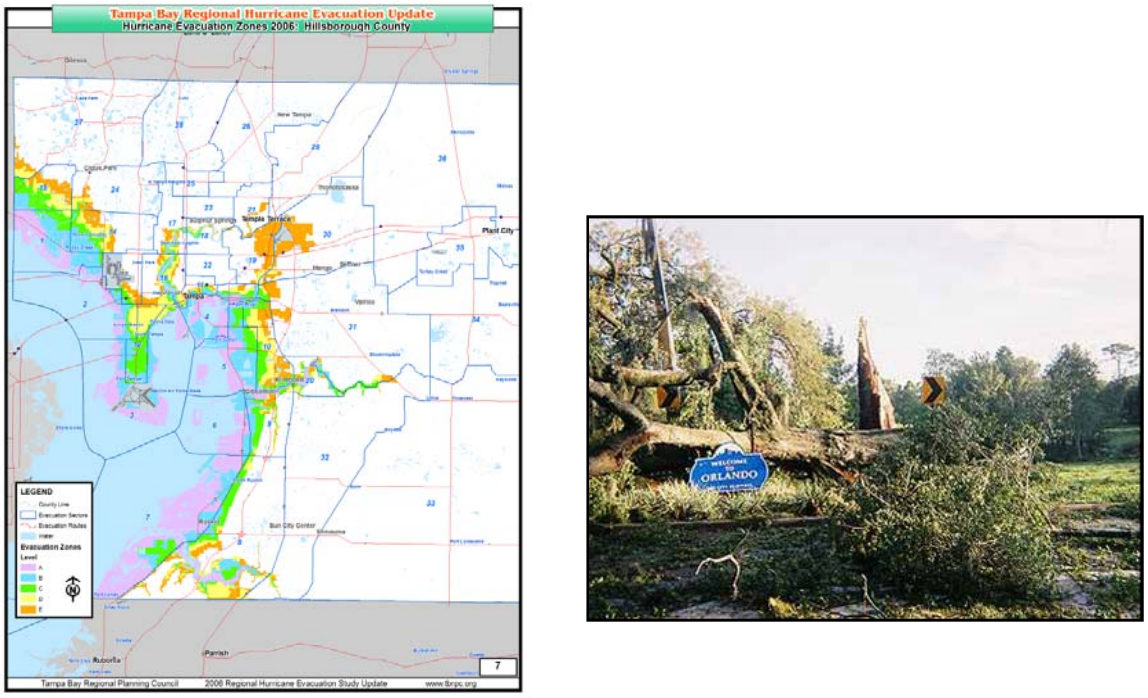


Figure 5
Coastal Hurricane Evacuation Zones and Inland Hurricane Damage

The hurricane evacuation zones based on the SLOSH model identify coastal flood prone areas from storm surge, but do not identify inland flood prone areas. Other at-risk areas located inland, such as mobile home parks, are also not identified in the SLOSH model. This current practice of determining hurricane evacuation zones does not identify these types of at-risk locations away from the shoreline. This information, together with traffic information, are two major components to consider towards effective hurricane planning.

One method of collecting traffic information is the Evacuation Traffic Information System (ETIS). Hurricane Floyd led to the development of ETIS to facilitate information sharing and planning across state boundaries in the southeast. Several features of the ETIS include integrating traffic count information across state lines, providing behavior study updates, and the ability to model partial and full evacuation options. The objective of ETIS is to estimate the necessary and available capacity on the public roadway system. However, ETIS primarily relies on historic traffic counts. (FHWA, 2006)

During an evacuation order within Florida, real time traffic conditions are used to determine traffic operation procedures, while historical traffic counts are referenced for the planning and preparation of hurricane evacuation plans. Real-time traffic counts are available via the Florida DOT webpage for the general public and are updated every fifteen minutes. The real-time traffic counts can be used for informational purposes to assist the general public with evacuation planning to avoid congestions. Also, the real-time counts are used by Florida DOT towards determining the necessity of when to deploy contraflow.

Another macroscopic model developed originally in the 1980's was the HURREVAC program. HURREVAC uses a Geographic Information System (GIS) to compare local demographic data with shelter locations and their proximity to evacuation routes to estimate the effect of strategic level evacuations. HURREVAC is not necessarily a traffic model, but is used as a tracking program for Hurricane Evacuation Studies in shelter planning.

Additionally, the continuous development of the Hurricane Evacuation Analysis and Decision Support Utility Program (HEADSUP) has been used in Florida to proactively manage traffic operations during an evacuation. (FHWA, 2006) HEADSUP integrates real time traffic data from 27 strategically located traffic counters placed on hurricane evacuation routes. The data provided from HEADSUP can help coordinate the timing of multi-regional evacuations, such as the Tampa Bay and Southwest Florida regions. Additionally the model can be used to identify bottlenecks and alternative evacuation routes. Some of the key functions include:

- Hourly dynamic travel demand forecasts
- Impact analyses of contra flow lanes
- Socio-economic statistics on evacuees
- Map-Based user interface system
- Travel demand modeling of evacuees on roadway network
- Archival capability of key events

One analysis tool developed for traffic operation performance was developed by the Oak Ridge National Laboratory and was called the Oak Ridge Evacuation Modeling System (OREMS). This program is based on a CORidor SIMulation (CORSIM) platform to simulate traffic flow during various emergency evacuations. CORSIM platforms have also been used by the Florida DOT to comparatively analyze traffic operations for different roadway enhancement projects. The model can be used to estimate clearance times and identify operational traffic characteristics. Table 5 summarizes a comparison of currently available evacuation programs that are applied to transportation networks.

By nature, the ability to model hurricane evacuation is a very dynamic process. Both the storm and the evacuating public have many variable characteristics which impact the evacuation process. A

dynamic hurricane evacuation model should allow for a continuous process, where information from traffic counters, law enforcement, and meteorological data can continuously update traffic conditions and optimize the system's overall performance. Several pieces of information are required to provide a dynamic modeling application (Barret, 2000 and NOAA, 2006):

- Evacuation route times and performance
- Predicted evacuation routes and departure times and the resulting evacuation time
- Monitoring of transportation infrastructure
- Impacts of different management strategies, whether they be operational or policy driven

Table 5
Comparison of Evacuation Modeling Programs

NAME	FEATURES	LOCATIONS	INPUTS	OUTPUTS
MASSVAC	• Macro level • Nuclear Power Plant Evacuations	• Inland Communities vulnerable to contamination	• Topographic data • Wind Conditions	• Direction • Area • Speed • Magnitude of contamination
Sea, Lake and Overland Surges from Hurricanes (SLOSH)	• Flooding model • Developed by National Weather Service	• All hurricane prone states	• Hurricane storm data • Topographic data • Tide data	• Predict hurricane storm surge • Identification of evacuation routes and shelter location
HURREVAC	• Macro level • GIS • Correlate demographic data to shelter locations and evacuation routes	• Hurricane prone coastal communities • Large urban areas	• Socioeconomic data • Shelter locations • Evacuation Route locations	• Sufficiency of shelter capacity and availability • Distance to shelters for population groups
Oak Ridge Evacuation Modeling System (OREMS)	• CORSIM platform • Micro level simulation • Compare alternative evacuation routes	• Hurricane evacuation routes • Florida	• Hurricane route locations, capacities, and speeds • Behavior data • Response rates • Destinations	• Clearance times • Simulate traffic flow • Forecast evacuee response rates • Comparison of alternative evacuation routes • Traffic control management techniques
Incident Management Decision Aid System (IMDAS)	• Identify high risk areas • Interaction of evacuation plans and traffic operations	• Florida	• Topographic data • Elevation • Behavior data • Land use data • Traffic volumes	• Risk prone areas • Alternative evacuation plans • Traffic operation strategies
Evacuation Travel Demand Forecasting System	• Macro level evacuation model • Customized inputs • Web-based interface	• Florida-Georgia • Georgia-South Carolina	• Behavior data • Evacuation routes • Traffic counters	• Level of congestion • Predicted volumes • Cross-state traffic impacts
Evacuation Traffic Information Systems (ETIS)	• Integrating historical traffic count information • Partial and full evacuation options	• Florida • South Carolina	• Historical traffic counts • Behavior data • Land use data	• Predicted volumes
Hurricane Evacuation Analysis and Decision Support Utility Program (HEASUP)	• More advanced than ETIS • Proactively manage traffic during evacuation • Ingest real time traffic data • Map based user interface • Archival capability	• Florida	• Real time traffic count data • Road capacities • Region specific behavior data	• Hourly dynamic travel demand forecasts • Impact analysis of contraflow • Traffic volume forecast

The development of a real-time evacuation model is critical to the demand side requirements because the behavior of individuals cannot be assumed to replicate from previous travel patterns. Therefore, the origin-destination matrices previously used for planning travel demand purposes would not be appropriate. Human behavior is not completely predictable under emergency and threatening conditions. Hurricane evacuation does not represent typical congestion.

Conversely, the supply side of evacuation modeling is also continuously changing. Evacuation traffic conditions are characteristically similar to non-recurring congestion, much like a crash incident on the roadway. Evacuating traffic volumes are much greater than typical peak hour (and peak directions) conditions, and this situation can result in significant variations in travel times due to congestion. Also, the peak period is more spread out than a typical PM peak hour, therefore resulting in a lower K value. A dynamic model should incorporate a regional network with complete information in link conditions for average speed, length, and capacity. The model should also incorporate changes in link conditions, such as reduction in capacity due to physical damage of the roadway or crash incidents, and then also simulate alternative traffic management strategies to change the network and recalculate levels of congestion once a new equilibrium has been established. (Ran, 2000)

Additionally, a dynamic model should identify the impacts on the transportation network from the hurricane itself. A hurricane has the ability to determine which evacuation routes are chosen because of the storm's ability to change trajectory and strength. This may be the most challenging input towards creating a dynamic hurricane evacuation model.

These combinations of demand, supply, and storm characteristics require unique model architecture for hurricane evacuation. Under ideal modeling conditions, the evacuee behavior would be completely controlled with optimized evacuation time. However, minimum evacuation times may underestimate the time actually required for complete evacuation since the road system is not in a state of equilibrium.

Therefore, a key component of a dynamic architecture is comparing the results from previous step to the difference between the actual and optimal evacuation times and determining that they are within an acceptable range. If they are not, the development of emergency management strategies would be required to improve the performance. If the model is used in real time, it can be used to gauge the success of management strategies. Therefore, the model would choose a rolling horizon approach where the Origin-Destination matrices and network data are updated and the time horizon is then rolled forward by a length equal to the roll period. (FHWA, 2006 and Barret, 2000)

Summary of Evacuation Procedures in Florida

As demonstrated in the previous sections, the State of Florida is considered to be quite progressive when preparing for evacuations from hurricanes. The State of Florida has invested more money toward the research and development of improved hurricane evacuation plans and analysis than any other state. This is not surprising considering the fact that Florida is also the most vulnerable state given its extensive ocean coastline and low elevation throughout the state.

The State of Florida is also a leader in the organization and management of hurricane preparation. As shown in Table 1, Florida is administratively structured so that the Governor serves as the lead coordinator between the different agencies, but the evacuation order is provided by the County law enforcement agencies. Therefore, the coordination between the Governor's office and local law enforcement is vital towards the success of hurricane preparation.

Florida has learned from other states that developing evacuation plans upon the eminent arrival of a hurricane is too late. Each year, the Florida Governor's office sponsors the annual Governor's Hurricane Conference. Local, regional, and state agencies attend this conference to review strategies from previous years and debate the ability to incorporate new and improved evacuation and hurricane preparation strategies. Administration procedures are also reviewed.

Recently, much of the coordination in Florida focuses with staff involvement at each County's Emergency Operations Center (EOC). The EOC is considered to be the focal point in determining an evacuation order. Local and state public agencies meet together at the EOC, such as law enforcement, public works directors, and the Department of Transportation. Adjacent EOCs communicate with each other and the state agencies upon their determination of evacuation.

Most EOCs in each county hold media press conferences in early summer to assist in the communication with the local public. The purpose of these press conferences is to inform the local public of evacuation schedules, shelter locations, road closures, standard operation procedures, etc.

Even outside hurricane season, the State of Florida is busy developing new strategies. For example, the contraflow design of I-4 has recently been reviewed for consistency with the new

widening construction and the ability to accommodate additional vehicles. However, it should be noted that the I-4 Contraflow design plans are being updated by Florida DOT to reflect recent capacity improvements. Additionally, preliminary plans have been developed to design I-75 as a contraflow route north of Tampa Bay. (Anderson, 2007)

In Florida, there have been four public agencies which are primarily responsible for hurricane evacuation:

- Florida DOT
- Florida Highway Patrol
- Florida National Guard*
- Local Law Enforcement and Emergency Operation Centers (EOC)

*However, the National Guard is no longer expected to be involved with contraflow evacuation. This was a result of a recent annual EOC meeting for State of Florida (Anderson, 2007), which coincidentally, is also during the same time period that this research has been conducted.

Since the National Guard is no longer part of the contraflow process, contraflow is now designed for a 6-hour setup. Coordination is primarily established between the FDOT and FHP. The call for contraflow originates from the Governor. All logistical operations originate at State EOC center. It is expected that the contraflow request originate upon congestion from a local official to the governor. Upon evacuation and contraflow activation, the District EOC Director assumes managerial control of FDOT operations, not the district secretary. All operations on the Interstate are managed by FDOT and FHP during contraflow activation. The local authorities then help provide law enforcement at the interchanges and local roadways leading to the contraflow routes.

The Florida DOT is responsible for developing any contraflow evacuation plans. Also, the FDOT furnishes the necessary resources for contraflow, such as cones, barricades, signs, etc. The Florida Highway Patrol implements and operates the contraflow plan when it is activated. The highway patrol provides monitoring personnel at locations such as interchanges, on-ramps, and other crossover locations during the evacuation.

The decision to call a hurricane evacuation in Florida now is determined at the local county level. Prior to Hurricane Opal in 1995, the State maintained primary responsibility, but has since modified that policy. The County Sheriff's department is responsible for coordinating local hurricane evacuation procedures with State agencies. Contraflow is implemented on state facilities and monitored by state agencies, while local law enforcement is responsible for monitoring local roads.

These procedures are constantly being updated within the State of Florida; however, there are still opportunities for improvement in being effectively prepared for an oncoming hurricane. This dissertation addresses that need to identify improvements toward hurricane evacuation, particularly towards identifying strategies for the use of contraflow lanes. Therefore, this research addresses the basic question, "Is Contraflow a real feasible alternative for hurricane evacuation in Florida?" The expected benefits associated with contraflow are examined together with the logistical requirements to answer this question.

RESEARCH METHODOLOGY

The methodology identified in this dissertation is to evaluate existing procedures and traffic management techniques in Florida. Special emphasis is placed towards the application of contraflow lanes within the state as an effective traffic management tool to increase available directional volume capacity. This study is unique in that the Measures of Effectiveness (MOEs) are evaluated for both a measure of available capacity for traffic operations and a measure of logistical feasibility.

The following checklist strategy summarizes the process that was undertaken for the dissertation:

- Define the problem to be evaluated
- Research development of hurricane planning process
- Identify current Florida evacuation procedures
- Develop performance measures for analysis
- Identify contraflow design alternatives
- Identify alternatives for contraflow logistical procedures
- Explain data assumptions and data variables
- Analyze results of performance measures
    - Improved Capacity
    - Required Infrastructure
    - Required Personnel
    - Speed Variation
    - Logistics
    - Delay/Congestion

- Development of suggestions/conclusions
- Identify opportunities of future research
- Describe observation of dissertation procedures

While the study is directed towards hurricane evacuation procedures in Florida, several aspects of this study may be applied within other regions of the United States. Also, this research may be applied towards other types of evacuation planning. The discussion of applicability of this dissertation is elaborated under a separate chapter following the results and the development of suggestions/conclusions.

It was hypothesized during the beginning of this research that the contraflow implementation process outlined in Florida required too much activation time to be an effective evacuation tool. Therefore, new techniques have been developed and analyzed to improve their anticipated effectiveness and possible implementation.

Development of Contraflow Alternatives

The development of contraflow alternatives began with a review of established contraflow procedures. This review was undertaken by a combination of methods. One method was by interviewing employees that represent the following emergency planning agencies and companies:

- Florida Department of Transportation
- Tampa Bay Regional Planning Council
- PBS&J
- Hillsborough County Emergency Operations Center
- Citrus County Emergency Operations Center

- State of Florida Emergency Operation Center
- State of Florida Governor's Office
- Florida Department of Community Affairs

The Director of each of the Emergency Operations Center was contacted for an interview. The Planning Director of the Tampa Bay Regional Planning Council was also interviewed as the local affiliate of the Department of Community Affairs. The Emergency Planning Coordinator was also interviewed and provided subsequent information representing the TBRPC. This information consisted of providing copies of the Tampa Bay Hurricane Evacuation Studies of 2006 and 1998.

The Emergency Operations Manager of Florida DOT – District Seven was interviewed to provide information regarding the policies and process standards currently adopted by the State of Florida. Information regarding the contraflow implementation process was also discussed in detail with Florida DOT staff. This information consisted of reviewing contraflow design plans, providing logistical and promotional videos and pamphlets for public information. Florida DOT staff also helped provide traffic count data.

Staff from PBS&J assisted with providing information regarding previous and current hurricane planning processes within Florida and around the Southeast United States. PBS&J has conducted numerous hurricane evacuation studies for local governments, and holds detailed information on how the profession of hurricane planning has emerged for the past 20 years.

Provided below is a sampling of questions that were asked between the different conducted interviews:

- Please summarize your current hurricane evacuation planning efforts.
- How have these planning efforts changed over the recent years?
- How does contraflow impact your evacuation planning efforts?
- If contraflow is implemented, what are the responsibilities of your agency; and how do you coordinate those responsibilities with the other emergency planning agencies?
- What has been learned from other regional planning efforts and contraflow operations from other regions of the country, and how has your agency responded to those lessons learned?
- What alternatives of contraflow have been considered during your evacuation planning?
- How are you involved with media campaigns or other methods of educating the general public towards contraflow and evacuation preparation?
- How frequently are your planning efforts updated?
- How is success defined within your agency regarding hurricane evacuation planning?
- What suggestions toward future planning efforts regarding hurricane evacuation and contraflow should be considered?

The answers from the questions above provided the information from the conducted interviews to establish the different performance measures and determine the measurements of effectiveness. Additionally, this information was collaborated between the different sources and determines the weighting system between the different performance measures, as described in the section labeled *Alternative Method of Weighting Performance Measures.* Much of the information received from Florida DOT was prioritized in the weighting system, since Florida DOT is considered to be the implementers, as well as the manager, of contraflow activities.

The annual Florida Governor's Hurricane Conference located in Ft. Lauderdale, Florida was also attended. The purpose of the technical sessions and the workshops from this conference is to provide new developments in the emergency planning practice throughout the State, as well as other hurricane prone states.

Currently, four different variations of contraflow have been identified. Table 6 summarizes the different strategies of contraflow between the different states. Previous studies have estimated that a full four-lane outbound contraflow may provide up to a 70 percent increase in capacity over a conventional two outbound lane configuration. Another strategy to improve capacity is to have a single inbound lane reversal, which is estimated to increase outbound lane capacity by about 30 percent on a four lane grade separated highway. Additionally, a strategy that uses the outbound left shoulder lane as an additional outbound lane is estimated to increase outbound capacity by eight percent (USACE, 2006). The capacity increase depends on the width and condition of the shoulder. The use of the shoulder lane also prohibits the exclusive use of emergency vehicles.

Table 6
State Comparison of Contraflow Strategies

Strategy	New Jersey	Maryland	Virginia	North Carolina	South Carolina	Georgia	Florida	Alabama	Louisiana	Texas
All lanes outbound		X	X	X	X	X	X	X	X	X
One lane reversed, one lane inbound for emergency/service vehicle entry only	X								X	
One lane reversed, one lane inbound for traffic only	X				X					
One lane reversed and use of outbound left shoulder lane									X	

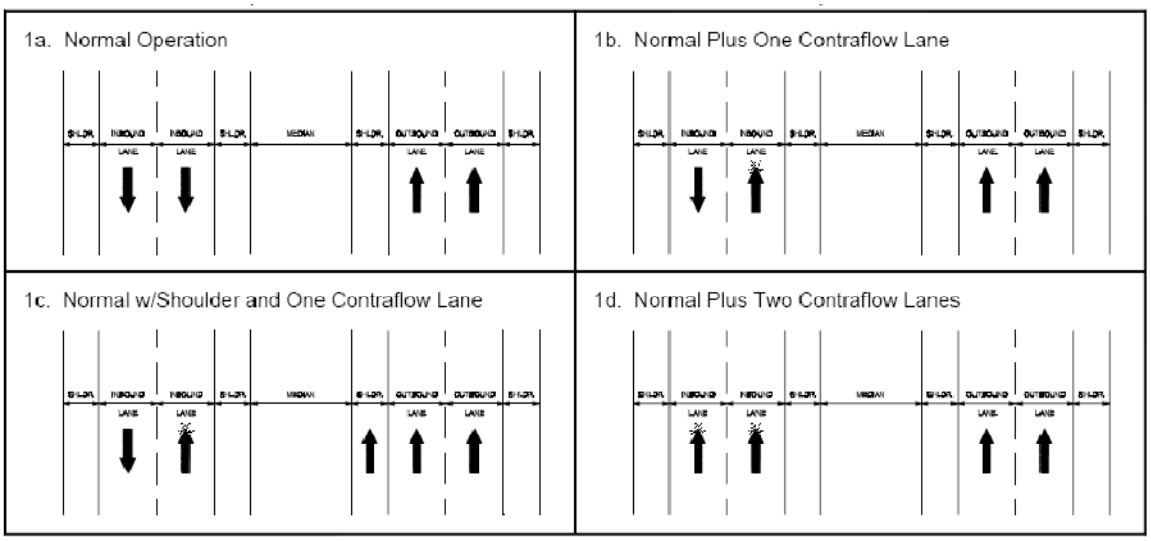


Figure 6
Typical Cross Section of Each Contraflow Strategy

Even though Florida has not yet implemented contraflow lanes, it has the most extensively planned use of contraflow operations, with seven identified sections. The first contraflow design plans in Florida were originally created for I-4 located between Tampa and Daytona Beach in February

2000. This section of I-4 has been previously considered to be the best candidate for contraflow to be activated. (Engerski, 2007) In total, approximately 750 miles are planned for possible contraflow use in Florida. An additional section is currently under design for I-75 between the North I-275 interchange and I-10. Additional contraflow plans were recently under development in Delaware, Virginia, Louisiana, and Mississippi.

This photo displays how a shoulder lane may not provide continuous capacity, and lead to merging congestion for hurricane evacuation.

Figure 7
Bridge Span Safety Consideration for Shoulder Lane

In summary, the primary contributors of technical data have been the Florida DOT and the Tampa Bay Regional Planning Council (RPC). This is in addition to the interviews conducted with the public agencies. The following sources of data were obtained for quantitative data necessary to measure the capacity analysis:

- Florida DOT Real-Time Traffic Information Website
- Tampa Bay RPC 2001 Hurricane Evacuation Study
- Tampa Bay RPC 2006 Hurricane Evacuation Study Update
- Florida Traffic Information Traffic Count CD (2006 FTI-CD)
- Florida Contraflow Design Plans

One of the tools that the Florida Department of Transportation uses to inform the traveling public of real time traffic conditions is their public website. The address for the web site is http://www3.dot.state.fl.us/trafficinformation/, and there is another web site available at www.511tampabay.com. This is a reliable source of data to obtain speed and traffic information for hurricane evacuation purposes. Drivers interested in knowing traffic congestion levels during an evacuation are able to access this website to identify which evacuation routes are experiencing congestion or incidents that would reduce the average travel speed.

Although the decision whether or not to evacuate may be predetermined by a local resident, drivers may use the information to help decide when they choose to evacuate, and/or which evacuation route to use. Congestion levels and average travel speeds are part of the information available on the web site in both graphical and tabular form. Figure 8 shows the information available provided to the traveling public on the website.

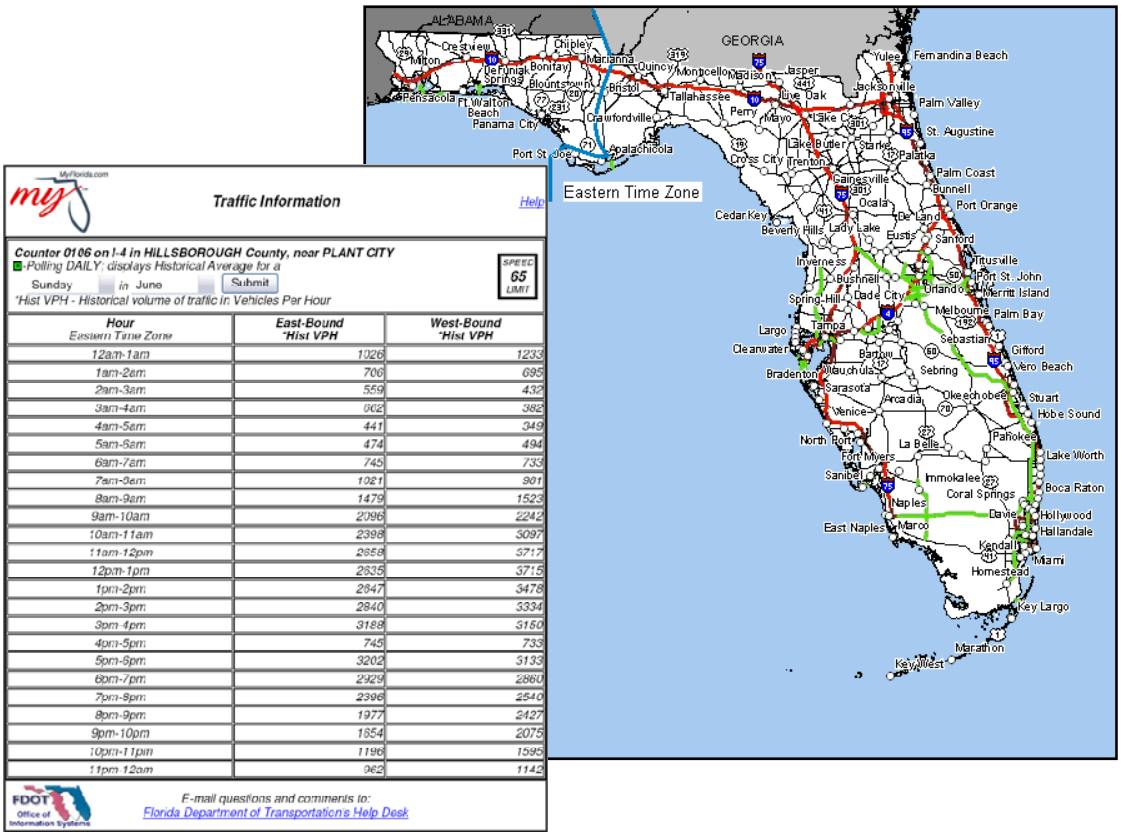


Figure 8
Florida Real Time Traveler Information Website

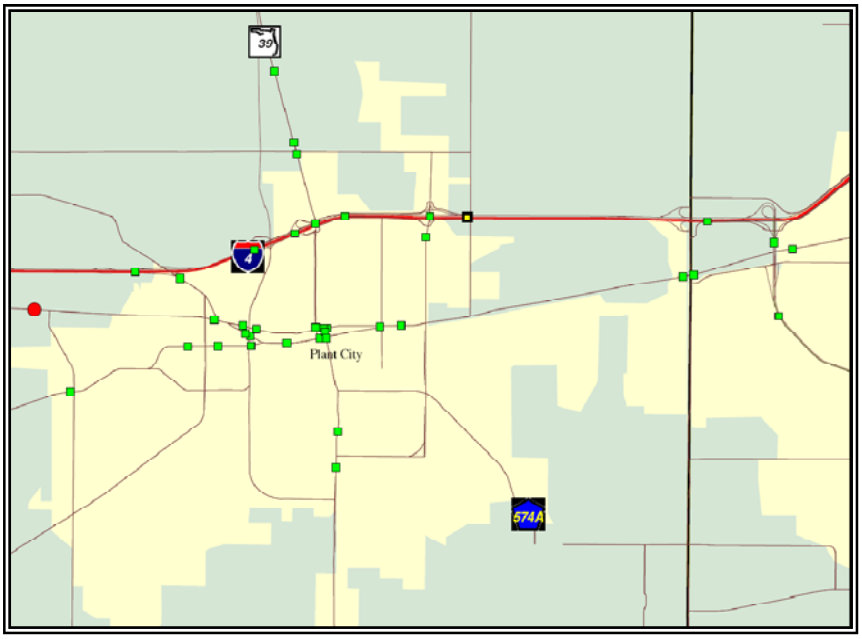
Other public websites have been as identified available to research Contraflow and hurricane evacuation procedures in Florida, such as:

- www.teachamerica.com
- www.onewayflorida.com
- www.fl511.com
- www.dot.state.fl.us
- www.tbrpc.org

One task that was undertaken was to evaluate the traffic volume growth that has been experienced on the study location of I-4 in eastern Hillsborough County. The purpose of this effort was to demonstrate how excess capacity that would have been previously available during an evacuation

has now been consumed for regular commuting traffic. The most recent edition of the Florida DOT Florida Traffic Information (FTI)-CD was obtained for data to identify the historical growth. This FTI-CD provides Annual Average Daily Traffic (AADT) volumes for each traffic count location in the state of Florida. For this particular count station on I-4, data has been available since 1970.

Data was obtained for the count location on I-4 just east of the Park Road Interchange, (count station 0084 located at mile marker 30.300). Figure 9 provides a map of the count station locations in east Hillsborough County.



Note: Count station used for analysis identified in yellow.

Figure 9
Florida DOT Traffic Count Location Map

The most recent data available identified an average daily volume of 104,500 vehicles per day. This is compared to an average daily volume of 17,000 vehicles per day in 1970. It should be noted that the capacity of study section of I-4 was increased from four lanes to a six lane typical cross

section in 2003 in eastern Hillsborough County. These data suggest that while I-4 has increased capacity, I-4 also experiences more congestion on a daily basis than it did 35 years ago, which then suggests that I-4 would be susceptible to extreme congestion during a hurricane evacuation. The peak hour of travel on the study section of I-4 currently represents 8.24% of the total daily volume. Figure 10 summarizes the historical growth of daily traffic volumes for the study area.

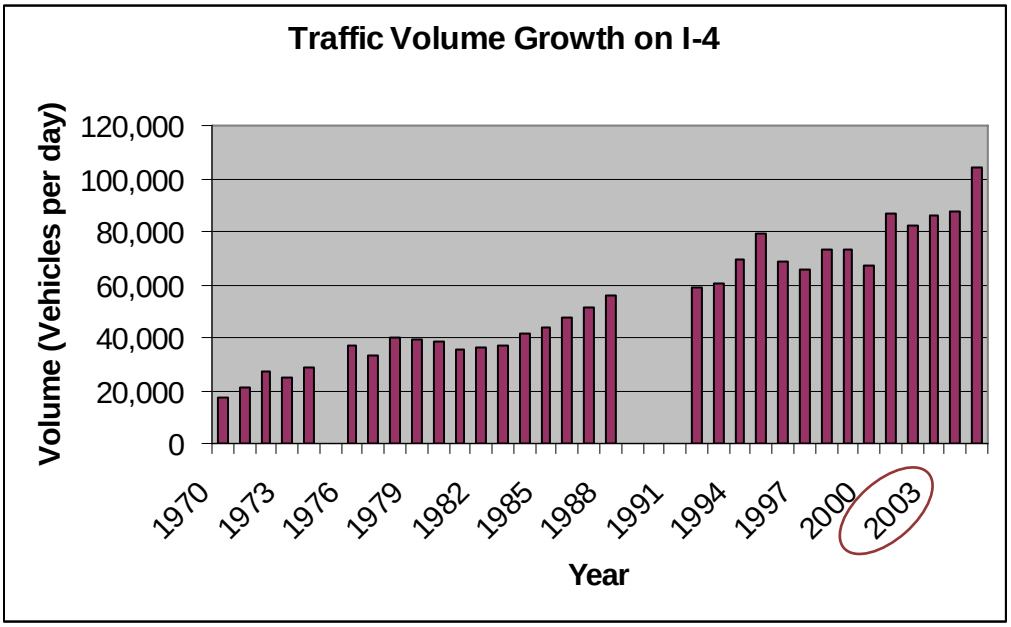


Figure 10
Daily Traffic Volume History

The researcher participated in the initial I-75 contraflow reviews. These meetings served as design workshops for the participating agencies of Highway Patrol, Department of Transportation, and local law enforcement. The attendance at these meetings assisted in understanding the development process of contraflow design plans. A design review of the I-4 Contraflow Design Plan for its anticipated effectiveness (if and when the contraflow is implemented) was also conducted. The I-4

Contraflow Design Plan was the first one developed in Florida and is considered to be the first likely roadway to be used for contraflow during an evacuation. (Anderson, 2007) Site visits of I-4 were performed during this research to demonstrate where the infrastructure is currently available to conduct a contraflow situation.

Note: When the median is not used as a crossover location, a movable concrete median is installed.

Figure 11
I-4 Crossover Locations for Contraflow

Development of Performance Measures

The six performance measures are as follows:

- Improved Capacity
- Required Infrastructure
- Required Personnel
- Speed Variation
- Logistics
- Delay/Congestion

Improved Capacity is a performance measure based upon the available vehicle throughput. Each contraflow alternative was evaluated on how much more capacity was created. This analysis evaluated improved capacity for two separate measurements:

- Evaluating average speed for each alternative assuming a standardized service volume
- Evaluating available capacity for each alternative assuming a standardized speed

For the first part of the *improved capacity* performance measure the LOS E service volume capacity was used to compare the average travel speeds. The 2002 Florida Quality/Level of Service Manual published by the Florida DOT was referenced to identify a generalized LOS E service volume. For a six-lane urban freeway, the peak-hour, peak-direction LOS E service volume is 6,150 vehicles per hour.

The total saturation flow was derived by adding the traffic volumes from the regular lanes together with the volumes from the contraflow lanes. The average speed from the total saturation flow was then evaluated and reported from Sychro/SimTraffic. The average speed was a weighted average

between the regular outbound lanes and the contraflow lanes. For the purpose of hurricane evacuation, the contraflow alternative which creates a greater average speed is considered to be more effective to quickly evacuate the general public.

The second method of the *improved capacity* performance measure was based upon identifying which alternative could produce the greatest throughput of vehicles, or the greatest volume during a hurricane evacuation. This evaluation would identify the greatest density prior to creating excessive congestion where vehicle speeds would be slow. Therefore, the average speed was assumed at approximately 30 mph to evaluate the maximum throughput for each alternative during an evacuation.

The *required infrastructure* performance measure is based upon the amount of materials and infrastructure required to implement a contraflow operation during hurricane evacuation. The primary type of additional infrastructure is the orange cones needed to delineate traffic from their desired lanes and routes. It is assumed that the best contraflow alternative for this performance measure will require the least amount of additional infrastructure.

The *required personnel* performance measure is also based upon the quantity to effectively implement the contraflow operation. Similar to the required infrastructure, the fewer number of *required personnel* that are required to operate a contraflow operation, the more favorable it is scored.

However, it is difficult to obtain a firm cost of the different alternatives, and the cost associated with additional personnel. For example, how does one measure the cost/benefit ratio when an analysis

would require the cost of FDOT/FHP overtime pay cost versus the benefit cost of evacuation? That is why this analysis is not an economical benefit/cost emphasis.

Speed variation is considered a performance measure primarily due to safety. The more variation in speed during an evacuation can create a safety risk, mostly due to side swiping and/or rear end collisions. The concern is magnified during an evacuation, because the roadway is operating at capacity; and when there is a crash, the resulting congestion delay is much greater during a time when throughput is most important. Therefore, this performance measure is rewarded by the consistency, or the lack of speed variation.

Additionally, the *speed variation* was evaluated for each lane group. However, only the outbound evacuation direction was evaluated for speed variation (not the inbound direction).

The *logistics* performance measured is measured by how much set up is required to implement contraflow. Also, part of the *logistics* is the amount of effort required to convert the contraflow lanes back to regular operation. This performance measure is related to the required personnel and the required infrastructure performance measures. The amount of cooperation and time for set up is a key component of this performance measurement.

The amount of set up and breakdown time is considered one of the most straight forward measurements of *logistics*. This is because it assumes the coordination of evacuation personnel and *logistics* to prepare for each contraflow alternative. Other logistical considerations, such as operating Highway Advisory Radio (HAR), Variable Message Signs (VMS), road rangers, etc. are expected to be relatively constant between each alternative.

The *delay/congestion* performance measure is directly related to the effectiveness of an evacuation. The amount of *delay* inhibits the free flow of vehicles. It is a quantitative measure that can be evaluated by seconds delayed, speed differentiation from free flow conditions, and/or the number of vehicles unable to be served by the highway during peak conditions. The *delay/congestion* performance measure can be evaluated using Synchro/SimTraffic modeling software.

Evaluate Contraflow Logistics

The ability for contraflow to serve as an effective evacuation tool in Florida may currently be most limited by some of the originally identified logistical procedures. The following is to be accomplished while evaluating the logistics to implement contraflow:

- Determine the Need of the Florida National Guard
- Identify the Time Needed to Activate Contraflow
- Compare Logistics to Other States
- Evaluate Authority Structure

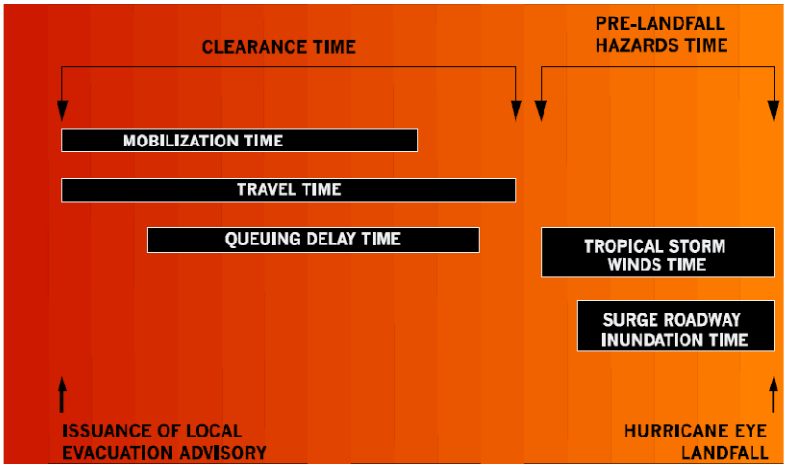
Unlike any other state that has adopted contraflow lanes, the State of Florida previously required the activation of the National Guard. The purpose of the National Guard was to assist local law enforcement officials. Their responsibilities would include monitoring travel conditions at locations such as interchanges and helping remove disabled vehicles from the travel lanes. However, it had been reported that the National Guard may require up to 96 hours to be completely activated and deployed to the evacuation routes. (PBS&J, 2000)

Ninety six hours is the equivalent of four days, and is too long of a time to initiate an effective evacuation. Typically, an evacuation order is given two to three days prior to the expected arrival of a hurricane; therefore, the National Guard would likely arrive too late to be effective. Thus, an evacuation order would need to be called approximately six days prior to the hurricane making landfall. Six days is currently beyond the capability to accurately forecast a hurricane's trajectory.

This research evaluated the necessary logistics for contraflow deployment. The procedures used by other neighboring states were reviewed for their effectiveness and applicability to Florida. Other states, such as Texas and Georgia, have the ability to activate contraflow within a 7-15 hour time frame. Alternatives to improve Florida's ability to quickly activate contraflow, such as removing the dependence of the National Guard, have been identified. Some of these recommendations also may include modifying the authority structure in Florida summarized in Table 1. The improved measurement of time to activate contraflow would be considered as one measure of effectiveness.

Perform Capacity and Travel Time Analyses

The researcher started the contraflow analysis by reviewing existing Hurricane Evacuation Studies. The assumptions and methodology were reviewed for appropriateness in determining the anticipated traffic volumes for particular evacuation scenarios. The Tampa Bay Region Hurricane Evacuation Study is periodically updated for the Tampa Bay Regional Planning Council and the Florida Department of Community Affairs.



Source: 2006 Tampa Bay Hurricane Evacuation Study

Figure 12
Components of Evacuation Time

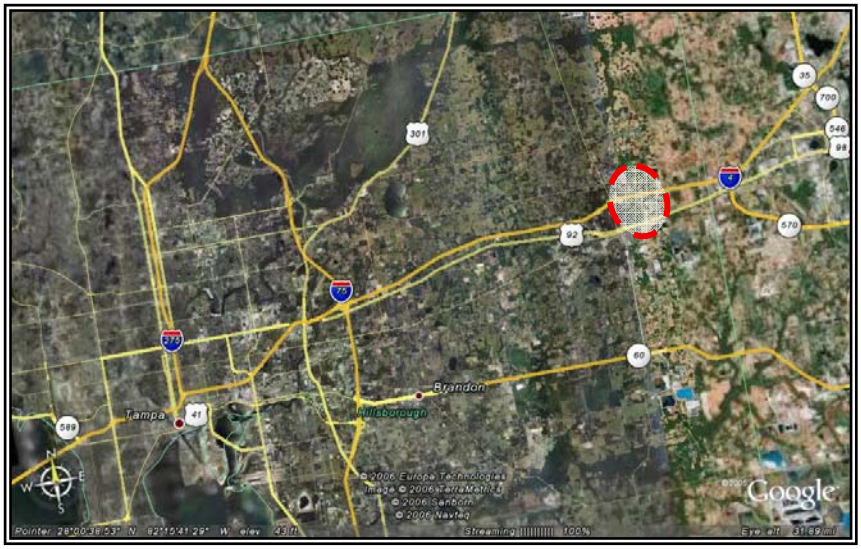
The regional population is factored into the evacuation clearance times. Some scenarios also incorporate evacuees from Southwest Florida. The referenced population assumptions for Hillsborough County are provided below (PBS&J, 2006):

- Year 2006 Permanent Population – 1,176,781
- Permanent occupied dwelling units – 509, 553

- Mobile homes – 34,041
- Tourist/seasonal units – 29,677
- Year 2011 Population – 1,301,648
- People per permanent unit – 2.31
- Vehicles per permanent unit – 1.64

Level of Service "E" traffic volumes were used as a constant variable in creating a comparative format of analysis for the different contraflow design plan alternatives. Expected variations between the time of day and variations between different days of the week that influence demand of the roadway were not analyzed separately. Instead, the analysis was undertaken to evaluate the available supply, or capacity, of the roadway. This was done so that the impacts from the different contraflow could be evaluated in a more straightforward approach.

A typical cross-section of grade separated highway in Central Florida was used as a demonstration facility to comparatively analyze the alternatives. Interstate 4 between Tampa, Florida and Polk County, Florida was used as the demonstration facility. The study area location was located in East Hillsborough County, just west of the Hillsborough/Polk County line. The study area location is shown in Figure 13.



Note: Cross-section study location identified by dashed red circle.

Figure 13
Study Area Location

This typical cross-section study area can help this research study in its application to other regions in the Country. The four different versions of contraflow previously identified have been analyzed comparatively for their effectiveness.

This research study incorporates incident management techniques that impact the capacity of a highway. These incidents include friction factors such as broken down vehicles within and outside the travel lanes. Other friction factors may include narrow travel lanes, narrow shoulder lanes, poor pavement conditions, etc.

The capacity analysis for the different contraflow alternatives was undertaken using the most recent released version of *Synchro, version 7*. This format allows the direct benefit analysis for the alternatives. Additionally, simulation analyses were undertaken for each of the different contraflow

alternatives using the most recent version of *SimTraffic.* Graphical illustrations of *SimTraffic* were overlaid recent available aerial photography for the study area.

Development of Suggestions/Conclusions

The *Synchro/SimTraffic* capacity software was used to calculate the capacity Measure of Effectiveness (MOE) for the different contraflow alternatives. The different MOE considered are as follows:

- Average Travel Speed
- Total Throughput
- Speed Variation
- Level of Service
- Volume
- Saturation Flow Rate

Other measures of effectiveness were measured in terms different from the above, but were also considered in the development of conclusions. These measures include:

- Implementation time to construct
- Required manpower and equipment
- Safety risks
- Implementation time to de-construct back to normal operations
- Number of personnel required

The data for the MOEs described above were from a combination of interviews and the review of state/county administrative procedures. These aforementioned MOEs have been grouped together to create a matrix of alternatives. A sample matrix comparing the MOEs is provided in Table 7.

The matrix is summarized between the six different performance measures. The improved capacity is measured on a basis of volume, most typically in terms of vehicles per hour. The alternative, which accommodates the most vehicles per hour, received the highest score. Required Infrastructure consists of items such as cones, barriers, signage, safety enhancements, etc. that are required to modify the travel lanes into a contraflow format. The alternative which requires the least amount of additional infrastructure was rated the highest score. Required personnel are a measurement needed to monitor and manage each contraflow alternative. This column is also measured in terms of the number of different public agencies requiring activation and how many non-local personnel require activation. The alternative which requires the fewest number of personnel and least number of public agencies requiring activation will receive the best score.

Speed variation is considered to be an indicator of safety and is measured in terms of speeds (miles per hour) which deviate from the average speed. The output reports from the Synchro/SimTraffic modeling platform was the basis for evaluation. Each performance measure that was evaluated with Synchro/SimTraffic was completed using methodologies consistent with the most recent edition of the Highway Capacity Manual (HCM). The alternative with the most consistent speed received the best score.

Logistics was predominantly measured from conducting interviews during the study. The alternative with the most simplistic logistics received the best score. Factors such as accessibility, emergency vehicles, etc. are considered into the analysis.

Each performance measure, or criterion, was scaled. This method allows an alternative to be scored accordingly by how dominant, or inferior, it compared to the other alternatives for each performance measure.

Initially, each performance measure had equal weight. This assumes that each performance measure has a uniform importance. The conclusions were identified based upon this assumption. However, an alternate approach was also undertaken where different performance measures were assigned different weights. This approach is addressed under a separate chapter later in the report.

Table 7
Matrix Format Summary

Contraflow Alternative	A – Normal Operation	B – Normal Outbound +1 Contraflow	C1 – Normal Outbound +1 Shoulder +1 Contraflow	C2 – Normal Outbound +2 Contraflow	D – Normal Outbound +Complete Contraflow
Improved Capacity	--	--	--	--	--
Required Infrastructure	--	--	--	--	--
Required Personnel	--	--	--	--	--
Speed Variation	--	--	--	--	--
Logistics	--	--	--	--	--
Delay/Congestion	--	--	--	--	--
Average Score	--	--	--	--	--

Each considered factor identified for each column has been presented in various charts and graphics to compare the analysis for each alternative. Each column has then been comparatively summarized. The result of each alternative is summarized in the matrix format to determine the most appropriate form of contraflow for hurricane evacuation. The contraflow design alternative with the highest average scoring between the columns will be considered as the best alternative. Suggested modifications (if any) to the implementation procedures were developed to help improve the ability of contraflow lanes to serve as an effective hurricane evacuation strategy. This research also facilitates the development of preliminary design guidelines for contraflow lanes within the state of Florida.

DATA ASSUMPTIONS

The calculated 2006 and projected 2011 clearance times from the TBRPC Hurricane Evacuation Study are based on the current and projected evacuation roadway network, storm intensity, evacuation population, and the behavioral response rate, which were adopted into the contraflow analysis. Other data assumptions more pertinent to the effectiveness of contraflow evacuation are described below:

- Driver behavior and evacuee assumptions
- Roadway characteristic assumptions
- Traffic Volume Assumptions

Sources of Data

This dissertation collected data from several different sources. The data were collected from local, state, national, and international resources. The Florida DOT, Tampa Bay Regional Planning Council, Literature Sources, and Emergency Operation Centers represented the four primary sources of data. Each of the four sources provided different types of data, as described below:

Table 8
Sources of Data

- Florida Department of Transportation
  - Contraflow designs and logistics
  - Level of Service methodologies
- Tampa Bay Regional Planning Council
  - Hurricane Evacuation Studies
  - Development of traffic volumes
  - Behavioral Survey
- Literature Reviews
  - Contraflow alternatives
  - Examples from other states
- State and Local Emergency Operation Centers
  - Evacuation procedures
  - Contraflow determination

Driver Behavior and Evacuee Assumptions

The clearance time is considered as the necessary time to clear the roadways of all evacuating vehicles from the region during an approaching hurricane. The clearance time should not be confused for the time required for one vehicle to evacuate. The time begins when the first vehicle begins evacuation and ends when the last evacuating vehicle arrives at a predetermined point of safety. The 2006 HES assumes the point of safety at I-75 and Florida's Turnpike interchange near Wildwood, Florida for northbound evacuees. Orlando is determined as the eastbound point of safety. No safety location was assumed for vehicles evacuating to the south.

The Tampa Bay HES evaluates several different scenarios. For the purposes of this study, the scenario which includes a full scale evacuation associated with an oncoming Category 5 storm was

used. Standard assumptions, such as typical seasonal populations, auto ownership, trailers, and heavy vehicle percentages were used.

Traffic volumes and the distribution patterns of evacuees were adopted from the existing Florida Standard Urban Transportation Modeling Structure (FSUTMS) and Cube/Voyager protocol travel demand modeling software that is used for the Tampa Bay HES. Adopted socioeconomic data and land use intensities for the traffic analysis zones from the HES were used. Therefore, the travel demand modeling structure was adopted and applied for the following parameters:

- Anticipated traffic volumes on the evacuation routes
- Anticipated clearance times

A time distribution for evacuation was not assumed, such as hours of the day and days of the weeks. These assumptions, and other assumptions that would affect the travel demand for the highway, would be the largest source of uncertainties. Rather, the analysis is based upon a supply-side evaluation of available capacity. This provides a more straight forward ability to evaluate the different alternatives and minimize the influence of demand uncertainties.

Previous HES documentation assumed 100% evacuation for locations within the SLOSH storm surge area. All mobile homes in both coastal and inland zones are assumed to evacuate. However, most people know their intentions of evacuation and their intended refuge. 70-80% of vehicle usage was assumed for household, depending upon specific risk area. 55% of evacuees plan to go to homes of friends and relatives. Recent behavior surveys document a greater tendency of “local” evacuations, or evacuations of shorter distances. The behavioral assumptions and the

precise parameters used for each county and zone for the selected hurricane scenario was referenced from Appendix C of the 2006 Tampa Bay HES Transportation Model Support Document.

The use of clearance time is mostly used for determining the requirements and logistics of public shelters. The clearance times from the HES is not referenced by the FDOT in preparing hurricane evacuation contraflow logistical planning and setup (Hibbard, 2006). However, the information does provide helpful insight into the travel demand characteristics and driver behavior during an evacuation.

Roadway Characteristic Assumptions

Law enforcement personnel were assumed to assist at bottleneck locations. The evacuation network includes facilities with sufficient elevations, minimal tree coverage, sufficient shoulder widths, and roads along existing hurricane evacuation plans. A link-node system was developed where links are the roadway segments and a node was identified at a location where two roadways change in characteristics. Directional traffic service volumes of a Level of Service E were established for each link. This was the volume used to compare each of the contraflow alternatives. The LOS E peak hour, peak direction volume for an urban, six-lane divided freeway is 6,150 vehicles per hour.

LOS E conditions are rarely reached during evacuations. Actual flow rates are typically lower. However, there can be temporary variations of traffic volumes from demand variations. To ensure a

more straight forward evaluation of the alternatives to minimize the impact of demand fluctuation, a supply-side evaluation of the available capacity was undertaken.

Other important roadway network assumptions include:

- All vehicles will evacuate prior to sustained tropical force winds (39 mph).
- Traffic signal timings will be actuated to provide the most green time for northbound and eastbound movements away from the coast.
- Vehicles in distress on the network will be removed quickly through aggressive traveler incident management.
- Drawbridges will be locked down at least 12 hours prior to the arrival of hazardous conditions by the U.S. Coast Guard.

It has been observed that during an evacuation, the rate of traffic volume growth observes a relatively minor peak. For example, the K factor observed during the peak hour of a 24 hour evacuation period may be 0.05-0.07. The typical K factor for the afternoon peak hour is approximately 0.09-0.10. The reason for this situation is because of an evacuation period being anywhere between one to two-and-one-half days, depending upon the characteristics of the hurricane.

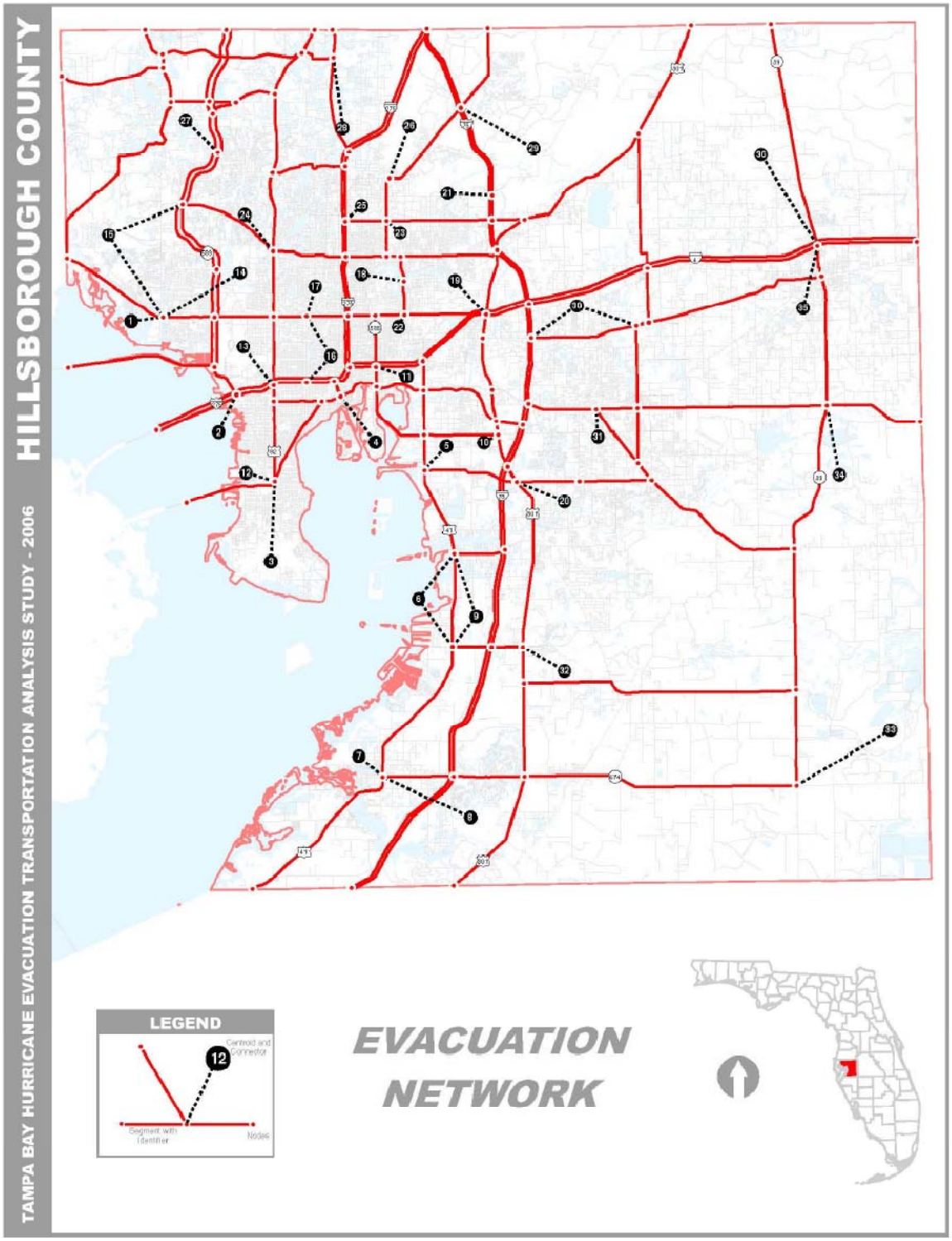


Figure 14
Evacuation Network

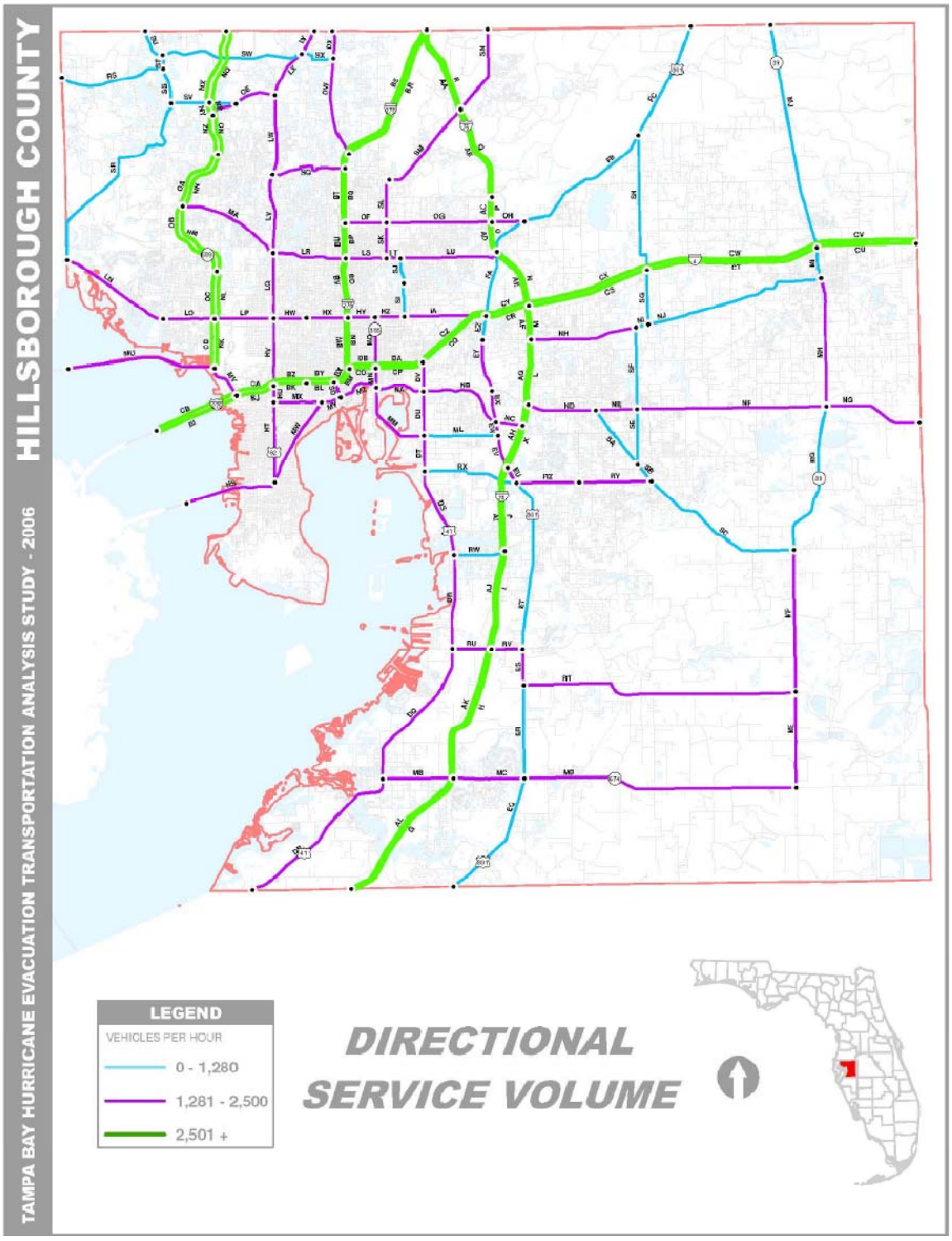


Figure 15
Directional Service Volume

Within the regional area, the majority of the critical locations are located in Tampa. Two of the six most congested locations expected during an evacuation are located along I-4. The most Critical Roadway Sections/Interchanges in Hillsborough County were previously identified to be:

- I-275/1-75 interchange
- I-275/I-4 interchange
- I-275 northbound on ramps
- I-4 eastbound on ramps
- SR580/Veterans Expressway interchange
- Gandy Boulevard Crosstown Expressway Interchange

Interstate-4 has been considered to be the most likely candidate for contraflow. The adopted I-4 contraflow design plans identified a typical cross section changeover. Recently, I-4 was widened as a typical six-lane rural cross section between Tampa and Orlando. The primary crossover location is planned at the major interchanges, such as I-4 & I-75. Also, the recent effort to install median guardrails along Florida interstates has impeded the ability for the contraflow design and implementation plans. The six-lane widening of I-4 was not designed to accommodate shoulder riding. (Anderson, 2007) Previous contraflow design plans from when I-4 was still a four lane cross-section is provided below (Yik Lim, 2003).

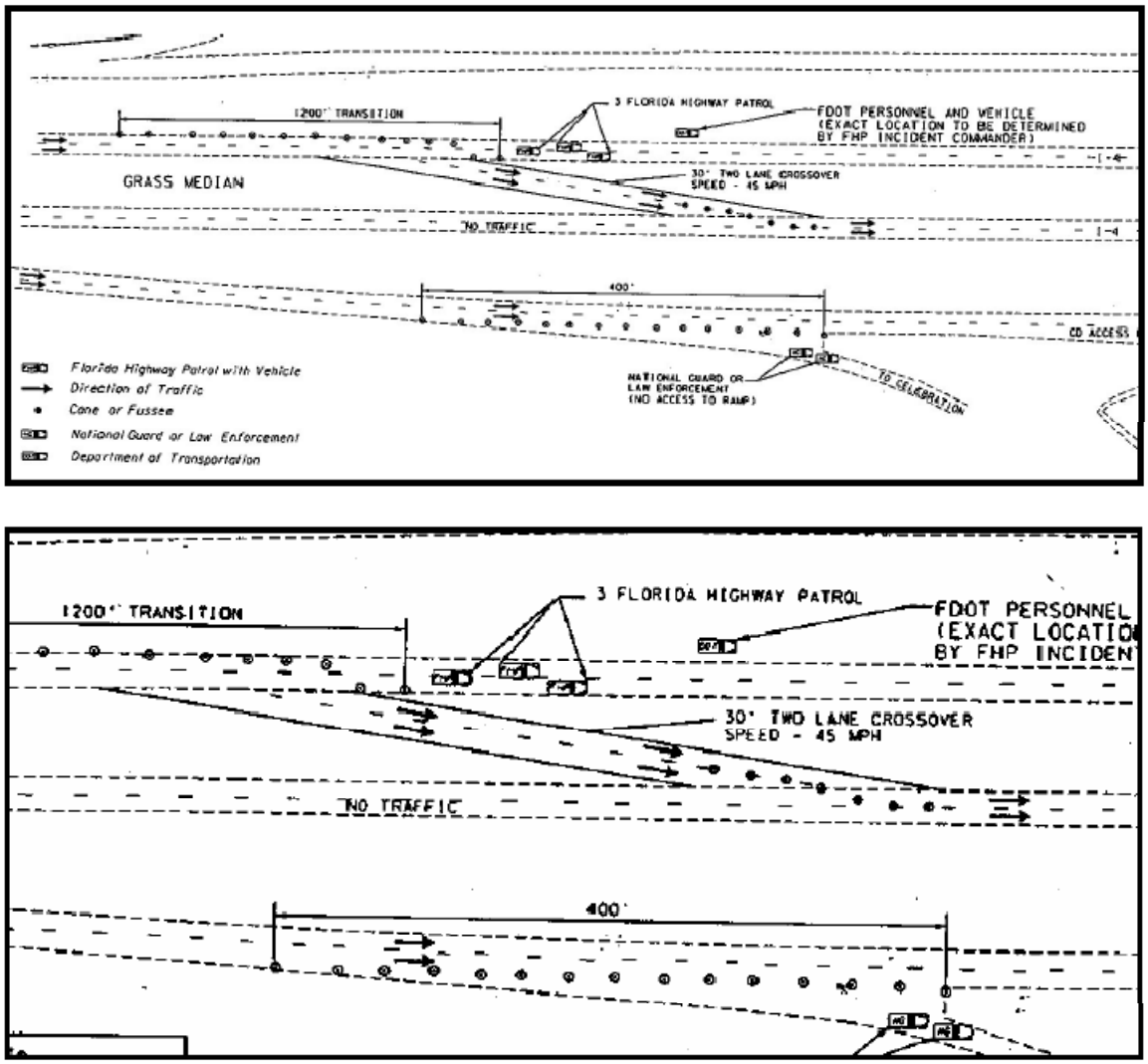


Figure 16
Previous I-4 Contraflow Design Plans at SR 417

Traffic Volume Assumptions

This research has been completed with two basic assumptions regarding traffic volumes. The previous subsection describes how the traffic volumes were adopted from a Generalized PM Peak Hour Level of Service "E" service volume for the basic three lanes in the outbound direction.

Therefore, the measures of effectiveness were evaluated from an adopted traffic volume and corresponding saturation flow rate of vehicles for each evaluated contraflow alternative. For example, consistent volumes were assumed for both non-contraflow and contraflow conditions. The same volumes were assumed for each contraflow alternative, so that the different MOEs, like average travel speed, could be evaluated under a constant baseline comparison. Then the simulation of traffic operations was run using *Synchro/SimTraffic*, version 7.

The second part of the capacity analysis was evaluated differently, in which each contraflow was evaluated to identify the maximum volumes that could be serviced. Therefore, MOE for this scenario changed so that the service volume was used to comparatively evaluate each alternative.

The capacity analysis using Synchro/SimTraffic, version 7 was completed using methodologies consistent with the most recent edition of the Highway Capacity Manual (HCM). A lane utilization factor of 1.0 was assumed when the volume/capacity (v/c) ratio for each lane group approached 1.0.

The traffic volume assumptions were most influential for the *Improved Capacity* and the *Delay/Congestion* performance measures. Other influencing factors are discussed in the following chapter.

RESULTS

As previously discussed in the research methodology, the evaluation of the different contraflow alternatives was determined upon the usage of six different performance measures. Each contraflow alternative is comparatively scored for each performance measure, and each performance measure has initially been provided an equal scale. The lowest scored alternative is considered to be the best and most feasible alternative for implementation. The six performance measures are as follows:

- Improved Capacity
- Required Infrastructure
- Required Personnel
- Speed Variation
- Logistics
- Delay/Congestion

Improved Capacity

Improved Capacity is a performance measure based upon the available vehicle throughput. Each contraflow alternative was evaluated on how much more capacity was created. As earlier described, the analysis evaluated improved capacity for two separate measurements:

- Evaluating average speed for each alternative assuming a standardized service volume
- Evaluating available capacity for each alternative assuming a standardized speed

For the first part of the capacity performance measure the LOS E service volume capacity was used to compare the average travel speeds. The 2002 Florida Quality/Level of Service Manual published by the Florida DOT was referenced to identify a generalized LOS E service volume. For a six-lane urban freeway, the peak-hour, peak-direction LOS E service volume is 6,150 vehicles per hour.

Therefore, each contraflow alternative for this first series of evaluation was held to a constant total hourly volume of 6,150. The ideal saturation flow per lane was then identified for the regular outbound lanes. For Alternative C1, which uses the shoulder lane for outbound direction, the ideal saturation flow per lane was reduced to reflect a reduced lane width of 10 feet, and other friction factors of road debris, different pavement type, and rumble strips located along the shoulder lane.

The ideal saturation flow per lane for the contraflow lanes was also referenced from the 2002 Florida DOT Q/LOS Manual. However, traffic service volumes for an uninterrupted, undivided highway were assumed for the alternatives which experienced opposing traffic, such as for

Alternatives B, C1, and C2. A five percent capacity reduction was applied to account for the lack of a median within the contraflow lanes (to reflect the influence of oncoming traffic).

A constant opposing volume of 400 vehicles per hour was assumed for the inbound direction during the evacuation. This volume was assumed for each alternative, except for Alternative D, which consists of complete reversal. Therefore, the assumed 400 vehicles would need to access other local, parallel facilities for Alternative D.

The total saturation flow was derived by adding the traffic volumes from the regular lanes together with the volumes from the contraflow lanes. The average speed from the total saturation flow was then evaluated and reported from Sychro/SimTraffic. The average speed was a weighted average between the regular outbound lanes and the contraflow lanes.

The capacity analysis was also based upon referencing several different empirical formulas from the most recently published edition of the *Highway Capacity Manual* (HCM), version 2000. Specifically, the referenced chapters and formulas for this analysis were derived from Chapter 22 – Freeway Facilities, Chapter 23 – Basic Freeway Segments, and Time-Space domains.

The flow rate of a basic freeway segment was referenced toward evaluating the improved capacity and the delay/congestion performance measures. The Highway Capacity Manual was referenced toward determining the flow rate. The flow rate was based upon the formula, in which:

$$v(p) = V / (PHF * N * f(hv) * f(p))$$

Where:

v(p) = 15-min passenger car equivalent flow rate (passenger cars/hour/lane)

V = hourly volume

PHF = peak-hour factor

N = number of lanes

f(hv) = heavy vehicle adjustment factor

f(p) = driver population factor

For the purpose of hurricane evacuation, the contraflow alternative which creates a greater average speed and the greatest flow rate is considered to be more effective for quickly evacuating the general public.

It should be noted that the Florida DOT has operational policies about contraflow (when and if it were to be enacted). For example, trucks are unable to travel on shoulder lanes, as provided on Alternative C1. Also, trucks are not permitted to use the contraflow lanes in Florida (Anderson, 2007). Typically, trucks reduce the number of vehicles able to travel on the roadway because they require more space, starting distance, and stopping distance. These policies were incorporated into the analysis for evaluating the improved capacity performance measure.

Alternative C1 identifies the use of the shoulder lane for outbound travel. However, this additional capacity is minimal when compared to the additional capacity achieved from Alternative C2 (when Alternative C2 is compared to Alternative C1).

However, when the average speed is lowered to obtain a greater throughput, a cross-sectional capacity analysis demonstrates that the contraflow lanes may obtain equal throughput as the regular outbound lanes.

In summary, Alternative D demonstrated the greatest average speed for the first part of the capacity analysis and did demonstrate the greatest throughput for the second part of the analysis. Alternative D experienced an average speed of 61 mph for the equal volume conditions.

Alternatively, Alternative A experienced the lowest average speed of 35 mph for the equal volume conditions. Each of the other three alternatives experienced an average speed range between 43-57 mph. Tables and graphs summarizing the capacity analysis results are provided below. Detailed report printout reports are provided in Appendix A.

Table 9
Average Speed Comparison with Constant Volume

Alternative	Outbound Direction Volume = 6,150 vehicles per hour										
	Normal Outbound Lanes					Contraflow Lanes					Weighted Average Speed
	Lanes	Volume	Ideal Sat. Flow Rate per Lane	Total Sat. Flow	Avg Speed	Lanes	Volume	Ideal Sat. Flow Rate per Lane	Total Sat. Flow	Avg Speed	
A	3	6,150	2,091	6,150	35	--	0	--	0	--	35
B	3	5,077	2,091	6,150	40	1	1,073	1,300	1,300	59	43
C1	3+1	5,181	1,773	6,950	51	1	969	1,300	1,300	61	53
C2	3	3,925	2,091	6,150	56	2	2,225	1,744	3,487	58	57
D	3	3,075	2,091	6,150	61	3	3,075	2,050	6,150	61	61

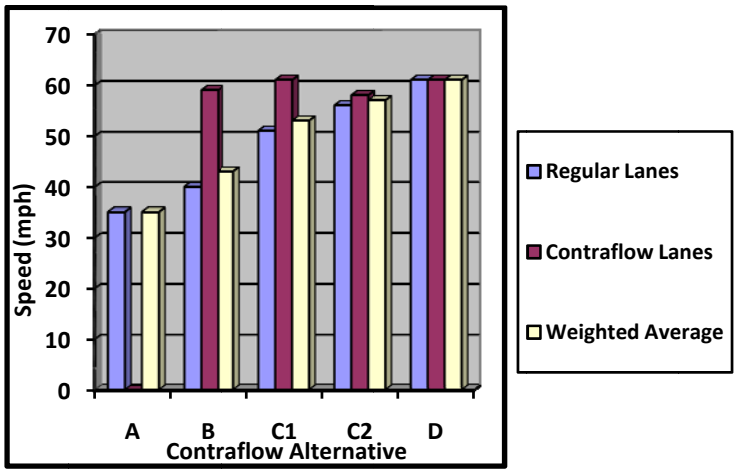


Figure 17
Contraflow Average Speed Comparisons Using LOS E Service Volumes

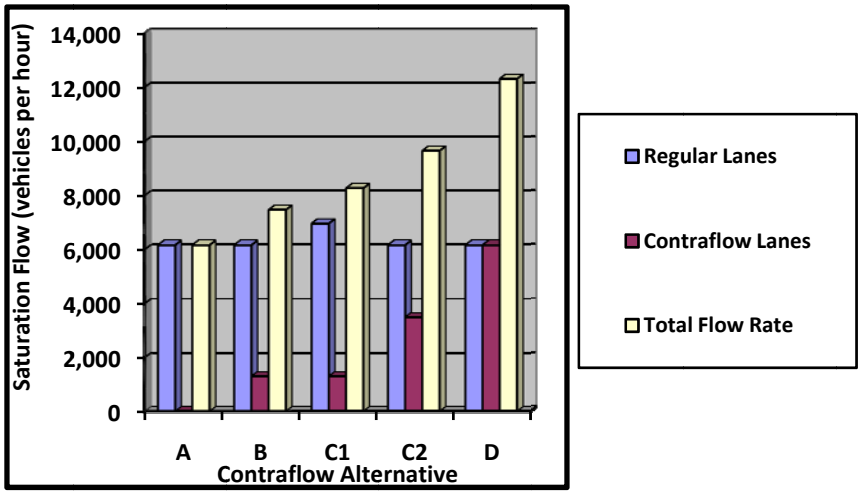


Figure 18
Total Saturation Flow vs. Contraflow Alternative for LOS E Service Volume

The second method of the improved capacity performance measure was based upon identifying which alternative could produce the greatest throughput of vehicles, or the greatest volume during a hurricane evacuation. This evaluation would identify the greatest density prior to creating excessive congestion where vehicle speeds would be slow. Therefore, the average speed was assumed at approximately 30 mph to evaluate the maximum throughput for each alternative during an evacuation.

In summary, Alternative D demonstrated the greatest average speed for the first part of the capacity analysis and did demonstrate the greatest throughput for the second part of the analysis. Alternative D experienced the greatest throughput of 10,442 vehicles per hour.

Alternatively, Alternative A experienced the throughput at 5,208 vehicles per hour (vph). Each of the other three alternatives experienced a total throughput between the range of 7,083 and 8,846 vph. Tables and graphs summarizing the capacity analysis results are provided below. Detailed report printout reports are provided in Appendix B.

Table 10
Total Throughput Comparison by Alternative

Alternative	Eastbound Volume per Hour Average Speed 30 mph				
	Free Flow (Regular Outbound)		Contraflow		Total Volume
	Lanes	Volume	Lanes	Volume	
A	3	5,208	--	0	5,208
B	3	5,208	1	1,875	7,083
C1	3+1	6,775	1	1,875	8,650
C2	3	5,208	2	3,638	8,846
D	3	5,208	3	5,233	10,442

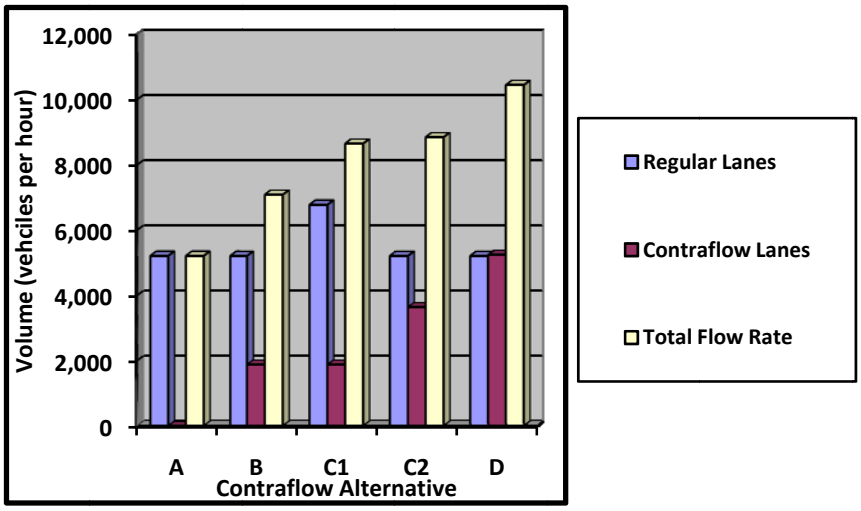
Several iterations were completed for each simulation alternative. Three or four iterations of similar, but varying, volumes were run to identify the total average throughput and the average running speed for each alternative. The average speed between the different iterations was resulted at a constant speed of approximately 30 mph. Provided below is a summary table of the Synchro/SimTraffic simulation modeling results. Also, provided is a graphical summary of the total throughput comparison summary for each contraflow alternative for a constant speed of 30 mph.

Table 11
Simulation Modeling Results for Analyzing Total Throughput

Iteration	Freeflow Eastbound (Saturation Flow Per Lane – 2500) To Park Road Ramp Lanes	Volume	Average Speed	
1	3	5,300	23	
2	3	5,200	31	
3	3	5,250	25	5208

Iteration	Contraflow Eastbound (Saturation Flow Per Lane – 2500) Free Flow Lanes	Volume	Average Speed	
1	1	1,800	37	
2	1	1,900	25	
3	1	1,850	35	1875
1	2	3,700	27	
2	2	3,600	33	
3	2	3,650	29	3638
1	3	5,300	26	
2	3	5,200	32	
3	3	5,250	29	5233

Iteration	Freeflow Eastbound (Saturation Flow Per Lane = 2200) To Park Road Ramp Lanes	Volume	Average Speed	
1	3+shoulder	7,000	26	
2	3+shoulder	6,500	35	
3	3+shoulder	6,800	29	
4	3+shoulder	6,750	31	8775



Note: Assumed at a constant speed of 30 mph..

Figure 19
Total Throughput vs. Contraflow Alternative

Provided below is a summary of the scorings for each measurement of improved capacity:

Table 12
Cumulative Evaluation of Improved Capacity

	Alternative A	Alternative B	Alternative C1	Alternative C2	Alternative D
Average Speed with Constant Volume	5	3.5	1.5	0.8	0
Total Saturation Flow Rate	5	4.0	3.2	2.2	0
Total Throughput	5	3.2	1.8	1.6	0
Average Scaled Score (0-5)	5	3.6	2.2	1.5	0

In summary, Alternative D, which utilizes the full contraflow operation of the inbound lanes, was identified as the best alternative for the improved capacity performance measure.

Table 13
Improved Capacity Performance Measure Summary

Score	Alternative
1	D
2	C2
3	C1
4	B
5	A

Required Infrastructure

This required infrastructure performance measure is based upon materials and infrastructure needed to implement a contraflow operation during hurricane evacuation. The primary type of additional infrastructure is the orange cones needed to delineate traffic from their desired lanes and routes. Other infrastructure includes gates and signage. The most effective contraflow alternative for this performance measure requires the least amount of additional infrastructure.

The more infrastructure that was required, the more increase there would be in the amount of time and human resources needed for activation. In addition the more infrastructure required, the more it would add to the complexity of implementation, and to the likelihood of something going wrong that could jeopardize an effective evacuation.

It was determined that Alternative D would require approximately 3,000 orange cones to implement contraflow for a distance of 63 miles. (Anderson, 2007) The number of cones required for

Alternatives B and C would be much greater because of the need to separate outbound traffic from any inbound traffic for the same 63 miles. Also, the maintenance of extra cones for Alternatives B and C would be very high because of travelers driving over and knocking over the cones.

The recent reconstruction of I-4 to six-lanes of general traffic was recently completed; however, the reconstruction does not permit shoulder riding across bridges. (Anderson, 2007) Therefore, Alternative C1 would be difficult, if not impossible to realistically implement. Thus, the required infrastructure to operate Alternative C1 would require the reconstruction of the bridge spans, which would be an extremely costly measure. This eliminates the feasibility of Alternative C1 for the purposes of this research.

However, for the purpose of this research study, Alternative C1 was evaluated. For Alternatives B, C1, and C2 cones were assumed to be placed approximately every 50 feet.

Other equipment may consist of typical costs that are part of an existing infrastructure, such as electronic signage, while other costs are representative only for contraflow, such as gates to control accessibility between inbound lanes and outbound lanes. Resources necessary to implement contraflow may include the following:

- Manual gates to provide traffic control at interchange ramps and other entry points
- Variable Message Signs (VMS)
- Highway Advisory Radio (HAR)
- Fold-down signs
- Dedicated media outlets
- Typical media outlets
- Automated Gates

The availability of resources and equipment is difficult to measure and rely upon during the times of an oncoming hurricane. (Hibbard, 2006) Each storm has its own unique characteristics, and the manner in which the general public reacts to a storm can be unique for each hurricane. For example, the news media may cover a hurricane evacuation in more detail for the first storm of the season, rather than the tenth storm of the season.

More simplistic methods of contraflow are good for dependability and quick implementation. Easy and cost effective strategies are preferred. A summary of the cost considerations is provided below:

Table 14
Equipment Cost Comparison

Equipment	Comparative Cost
Manual Gates	$
Variable Message Signs (VMS)	$ (Able to use for other purposes)
Highway Advisory Radio (HAR)	$ (Able to use for other purposes)
Fold Down Signs	$
Dedicated Media Outlets	$$
Typical Media Outlets	$
Automated Gates	$$$

Note: The number of $-symbols indicates relative cost. More $ indicates more cost.

It is anticipated that different contraflow alternatives require different amounts of necessary equipment that would be required to notify the general public and to direct traffic. Alternative A would require little or no additional equipment to operate under regular operations. After Alternative A, Alternative D is considered to require the least amount of equipment for operation. This is

because the reversal of all inbound lanes to operate as outbound lanes is a more straight forward operation than Alternatives B and C. More notification and equipment would be required to effectively separate the direction of the inbound lanes.

Table 15
Required Number of Orange Cones for Operation

	Alternative A	Alternative B	Alternative C1	Alternative C2	Alternative D
Number of Cones	0	9,650	>10,000	9,650	3,000
Scaled Score (0-5)	0	4.8	5	4.8	1.5

Table 16
Alternative Comparison of Required Equipment

	Alternative A	Alternative B	Alternative C1	Alternative C2	Alternative D
Equipment Score	1.0	3.0	3.0	3.0	2.0

Georgia uses an automated system for gates, which is very expensive. This cost would be several times greater in Florida considering the length of contraflow is 63 miles for I-4 while distances on other evacuation routes are even longer.

A summary of required infrastructure performance measure is provided below. The scorings are compiled between the required number of orange cones and the required equipment.

Table 17
Summary of Required Infrastructure Performance Measure

	Alternative A	Alternative B	Alternative C1	Alternative C2	Alternative D
Cones	0	4.8	5.0	4.8	1.5
Other Equipment	1.0	3.0	3.0	3.0	2.0
Scaled Score (0-5)	0.5	3.9	4.0	3.9	1.75

Required Personnel

Similar to the previous required infrastructure, this performance measure of required personnel is based upon the number of safety and law enforcement personnel to effectively implement the contraflow operation. The fewer number of personnel required for contraflow operation, the more favorably it is scored.

During the time of a hurricane evacuation, government resources are strained to ensure the public welfare and public safety. Local Emergency Operation Centers (EOCs) are running on full

activation to coordinate evacuation procedures between the different governmental agencies and media reports. Roadway emergency crews are on full alert to ensure the roadways are operating safely, free from debris, stalled vehicles, etc.

The primary personnel to operate a safe and efficient contraflow operation are law enforcement and FDOT personnel. Law enforcement personnel help regulate the direction of traffic and monitor key intersections and key interchanges operating through contraflow. FDOT personnel monitor traffic operations through Closed Circuit Television (CCTV) and continuous traffic count stations.

Interstate-4 contraflow was most recently designed in June, 2006. Contraflow design plans have been updated for the six-laning capacity improvement. The design plans are considered to be classified documents for security/terrorist reasons. Therefore, the researcher is not able to incorporate the design plans into the report; however, contraflow design plans are updated every year. New plans are incorporating gate locations and flip sign locations. (Anderson, 2007)

The Florida evacuations for the hurricanes in 2004 and 2005 worked successfully without contraflow lanes. It should be noted that those hurricanes experienced limited evacuation, and are not a fair example of how to demonstrate the need for contraflow. Contraflow is considered as the last alternative only when regular operations are insufficient as individual drivers will become more aware of other major available routes besides the interstate. Interstate-4 was designed for 63 miles of contraflow. *This design of I-4 contraflow requires more monitoring personnel than any other contraflow plan in the state of Florida.* (Hibbard, 2006) This requirement may be because of I-4 containing the most number of interchanges within an urban environment along the contraflow route.

The current I-4 contraflow design plan (Alternative D) requires the activation of 105 FDOT personnel. Road rangers are provided on every evacuation route to assist, not just on the interstate. Approximately 89 repairmen, 109 trucks, and 53 vans are required to ensure timely arrivals, timely repairs to stalled vehicles, and necessary towing if the stalled vehicle cannot be fixed. (Anderson, 2007)

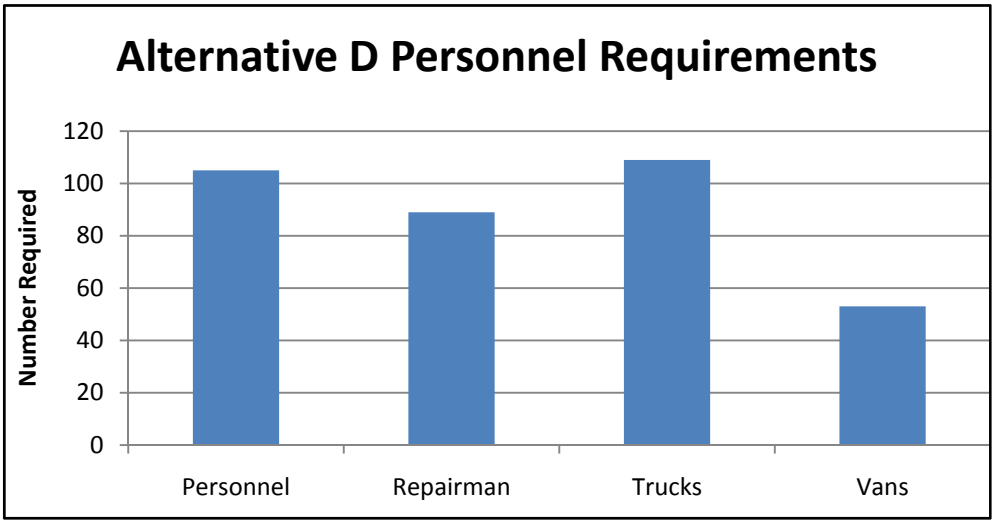


Figure 20
Alternative D Personnel Requirements

Because of the fact that Alternative A operates under regular conditions, it is anticipated that no additional personnel are required for operation. Therefore, since Alternative A does not require any additional personnel, it received the best score for this performance measure. Additional personnel to monitor an evacuation are expected when the evacuation order is given; however, they are not required since the amount of capacity is the same as it is for normal operations.

As previously stated, Alternatives B and C require more infrastructure, mostly because of the additional cones. Additional cones require additional manpower for installation and then, subsequently, require more personnel to maintain the cones. Mainline conditions need to be monitored for delineation so that vehicles do not accidentally wander into oncoming traffic. During an evacuation, it can be expected that several vehicles will accidentally drive over the cones requiring additional personnel to replace the cones.

It can be expected that Alternative C1 requires the most number of personnel because of using the shoulder lane for additional capacity. The ability to maintain a free flow operation of the shoulder lane (instead of being used for stalled vehicles) is essential. A stalled vehicle stored on the shoulder lane would eliminate the additional capacity and actually create an upstream bottleneck due to vehicles attempting to merge over. Therefore, additional personnel would be required to quickly remove the stalled vehicles, in addition to those personnel required to monitor the utilization of cones on the contraflow lane.

Alternatives B and C2 require the same amount of additional personnel. That is because the same number of cones would be utilized to create one contraflow lane as would be necessary to create two contraflow lanes.

Table 18
Summary of Required Personnel Performance Measure

	Alternative A	Alternative B	Alternative C1	Alternative C2	Alternative D
Scaled Score (0-5)	0.0	3.5	4.0	3.5	2.5

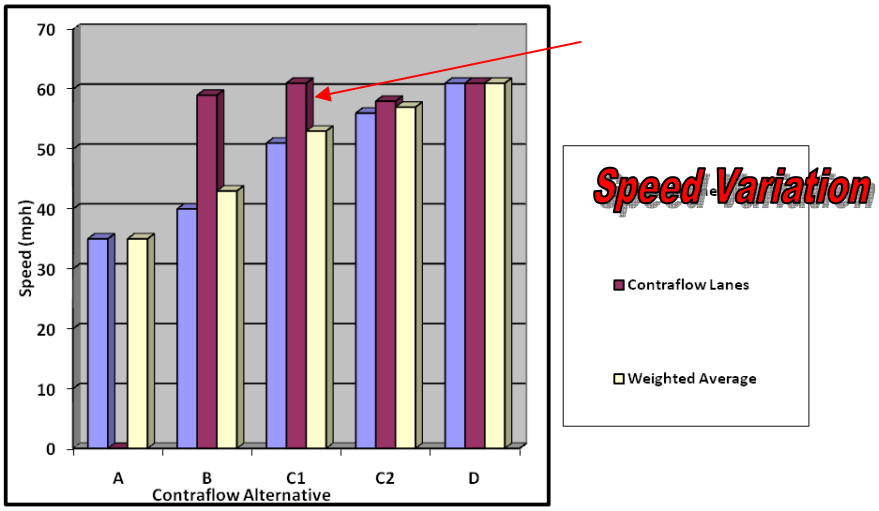
Speed Variation

Speed variation is considered a performance measure primarily because of safety issues. The more variation in speed during an evacuation the more likelihood there is of a safety risk, mostly because of side swiping and/or rear end collisions. The concern is magnified during an evacuation because the roadway is operating at capacity. When a crash occurs, the resulting congestion delay has much greater significance during a time when throughput is most important.

Therefore, this performance measure is rewarded by the consistency or the lack of speed variation. Synchro/SimTraffic was used to evaluate the speed variation. The difference of speed between the contraflow lanes and the regular outbound lanes was considered.

Drivers may become distracted when they see other vehicles on the other lane group traveling the same direction at a different speed. This may especially be distracting for drivers that see the other lane group traveling faster and wanting to find ways to travel faster themselves.

Anxiety is elevated for drivers during an evacuation because of the need to travel long distances and the need to arrive at the secure destination prior to the hurricane making landfall. Noticing a different lane group moving faster during congestion may add to drivers' anxiety in the slower lane group and ultimately increase the frequency of risk maneuvers by drivers desiring to speed ahead. Risks, such as traveling on emergency lanes, shoulders, and in opposite travel lanes were documented during the Hurricane Rita evacuation. This increase in risk maneuvers and speed variation eventually leads to additional safety risks.



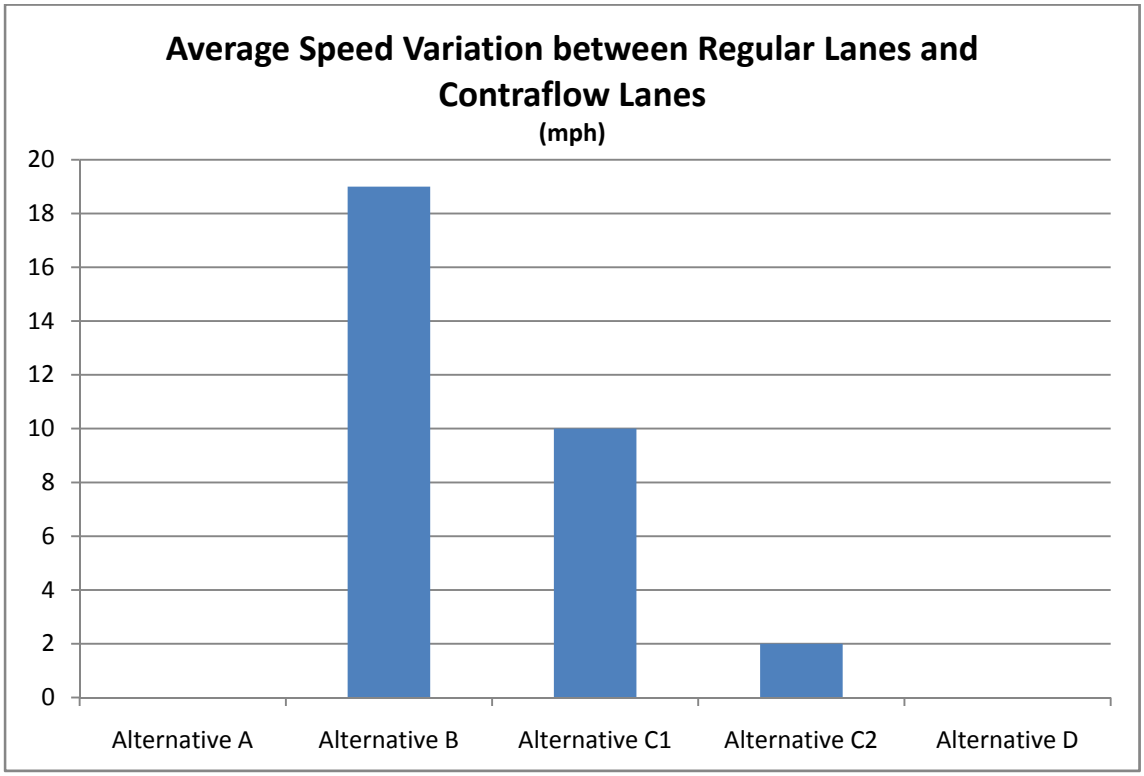


Figure 21
Average Speed Variation Between Regular Lanes and Contraflow Lanes

Table 19
Summary of Speed Variation Performance Measure

	Alternative A	Alternative B	Alternative C1	Alternative C2	Alternative D
Scaled Score (0-5)	0.0	5.0	2.6	0.5	0.0

The speed variation was measured upon using a consistent of LOS E generalized service volume of 6,150 vehicles per hour. It was identified that the contraflow lanes generally travelled at a faster speed than the regular lanes. This is because fewer vehicles are anticipated to travel on the contraflow lanes. The only alternative where the contraflow lanes traveled slower than the regular lanes was Alternative D.

Additionally, the speed variation was evaluated for each lane group. However, only the outbound evacuation direction was evaluated for speed variation (not the inbound direction). It was identified that Alternative C1 contained the greatest speed variation. This is mostly because of C1 utilizing the shoulder lanes. This is because the shoulder lanes are expected to travel slower than other mainline outbound lanes as the shoulder lane will create a side friction factor causing reduced speeds.

This is primarily because of the shoulder lanes are designed to be 10 feet wide, as opposed to the regular travel lanes having a width of 12 feet. Also, the shoulder lanes have inferior pavement and

debris, which can disrupt free flow speed. Shoulder lanes typically also have rumble strips, which can disrupt drivers by the induced noise and, as a result, create a safety concern.

Drivers unfamiliar with driving in the opposite direction may lead to greater speed variation. Different drivers may travel slower on the contraflow lanes. The corresponding free flow speed on the contraflow lanes would witness more variation depending on driver roadway and driver characteristics. Drivers in the contraflow lanes are likely traveling under those conditions for the first time. They would experience typical signage in the opposite direction, a reverse median, and interchange lane assignments in the opposite direction. If cones are knocked over during the evacuation (such as Alternative B, C1, and C2), this situation would result in greater speed variation, adding to a greater safety concern.

Speed variation is one of the major contributing factors to crashes on grade separated highways. Previous research has demonstrated that crash frequency significantly increases when drivers are unsure of the safe driving speed for different driving conditions. (Collins, 2000)

Logistics

The logistics performance measure is determined by how much required set up time and the set of circumstances there is to potentially implement contraflow. Also, the logistics performance measure incorporates the amount of effort required to convert the contraflow lanes back to regular operation. This performance measure is different than the other performance measures because it measures the effort required establishing each alternative, as opposed to the other performance measures

which only evaluate the benefit of each alternative upon set up. The amount of cooperation and time for set up is a key component of this performance measurement.

When this dissertation began, the deployment of the National Guard was part of the evacuation policy to establish and manage contraflow operation. The National Guard would require approximately 96-104 hours to fully deploy at the contraflow route, specifically I-4. This time sequence of three to four days would have been prohibitive during an oncoming hurricane. The purpose for deploying the National Guard would be primarily to manage traffic control at crossing locations and interchanges and to securely monitor evacuation.

By the time the National Guard would have been fully deployed, the ability to effectively evacuate the general population would have passed. During the time period while this dissertation was performed, the policy to deploy the National Guard was removed. Their responsibility was delegated to local and state law enforcement, and FDOT personnel, who could effectively deploy on scene much quickly and efficiently.

The updated hurricane evacuation plan now identifies a full contraflow (Alternative D) in much less time without the National Guard. Alternative D is currently identified for a six (6) hour set up before contraflow operations and a four (4) hour breakdown after contraflow operations. A handout describing how Alternative D may operate is provided below.

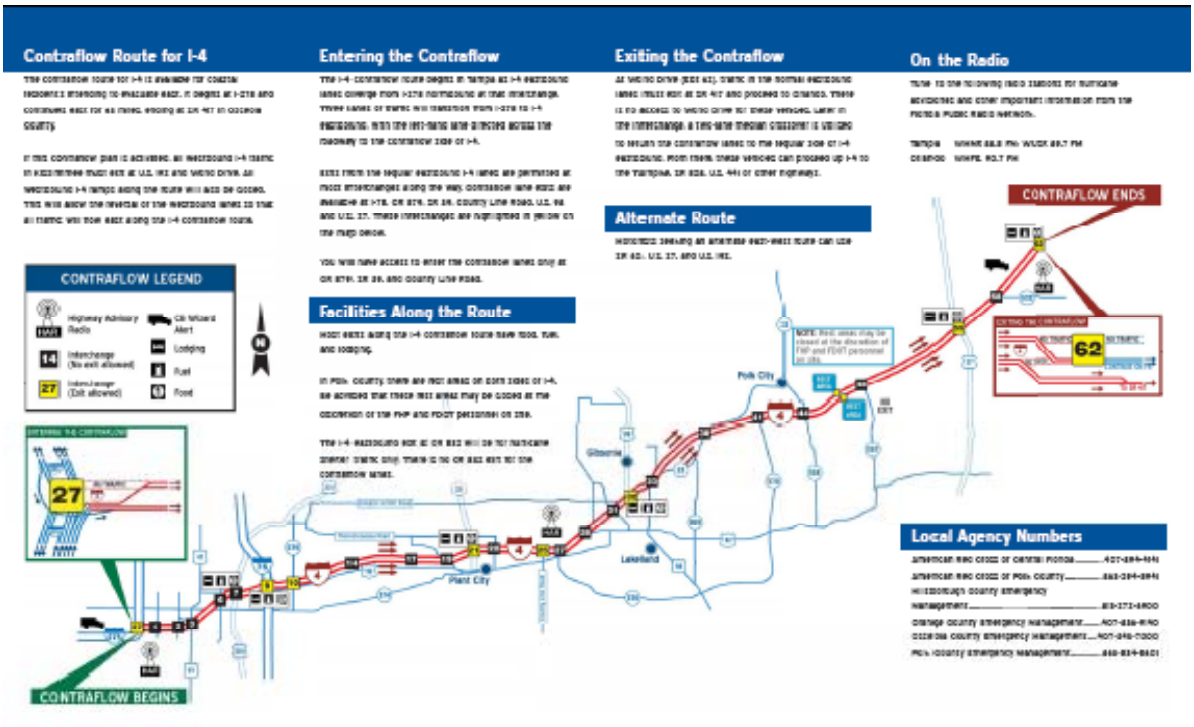


Figure 22
FDOT Contraflow Logistical Handout

Since Alternative A operates under regular operations, Alternative A would require less logistical coordination than the other alternatives during an evacuation. For this performance measure, Alternative A is logically considered the best Alternative for the easiest logistical operations.

An evaluation was undertaken to consider the time line of events and circumstances likely required to determine the need for contraflow operation, implement contraflow, and to resume back to normal operations. The process begins with the developing hurricane in the open sea. The storm event is then forecasted upon a projected route with an anticipated landfall location. When a storm event transforms from a tropical storm to a hurricane the local Emergency Operation Center (EOC)

becomes activated for the counties affected near the projected landfall location. (Anderson, 2007) The following graphic summarizes the process of events to implement contraflow.

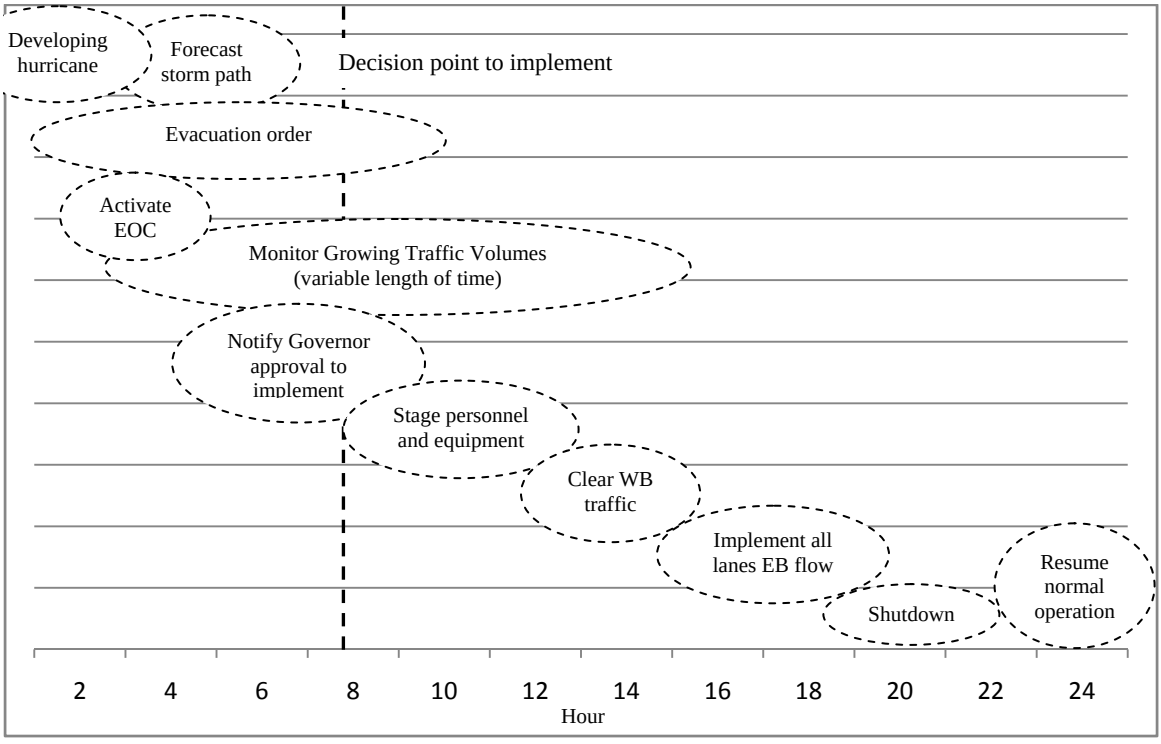


Figure 23
Conceptual Time Line of Events to Implement Contraflow

The next step in the process is the evacuation order, followed by the monitoring of traffic volumes on the evacuation route (which in this dissertation is I-4 in Central Florida). Permanent traffic counters installed into the highway pavement and CCTV provide continuous traffic count data and visual for monitoring congestion levels. One of the special considerations with contraflow is determining what level of congestion is required to warrant contraflow, and when the decision should be made. As approximately six hours is needed to implement contraflow, that means

whenever the decision is made to implement contraflow, congestion is likely to keep building for the six hours until contraflow becomes operational. Therefore, the ability to anticipate the need for contraflow six hours before it is needed may greatly alleviate congestion during an evacuation. This aspect alone may justify a topic of future study.

When traffic volumes exceed acceptable congestion, the order to implement is then given from the Governor's office following a local request. The process to stage the personnel and equipment, and then to clear the westbound (inbound) traffic, is undertaken to implement contraflow for all outbound lanes. The contraflow is activated for the necessary period of time until the evacuees are served and traffic volumes decline. Then, following the evacuation, the next step in the process is to shutdown the operation and then resume back to normal operations.

Certain circumstances are anticipated around the hurricane event to potentially warrant contraflow implementation. The first circumstance is that the hurricane would be a Category 4 or 5 storm. As described in previous sections, other states that have hurricane plans have a policy to implement contraflow only for a Category 4 or 5. Although this is not official policy in Florida, it may be assumed during an evacuation.

The next circumstance may be that the hurricane is that the hurricane is traveling quickly toward the coast, perhaps at 25-35 mph. The fast moving hurricane likely results in a evacuation where many evacuees depart in a short amount of time, which would result in many evacuees arriving to travel on the highway in a relatively short amount of time. This circumstance would result in greater congestion, which may warrant contraflow evacuation.

Thirdly, prior to contraflow being implemented, a review of the time of day when congestion arrives to warrant contraflow would be undertaken. The state of Georgia and the state of Florida currently have a policy not to operate contraflow during nighttime hours. This is because specific safety concerns arise with contraflow operated in the dark, as discussed in previous sections. If congestion reaches levels to warrant contraflow during evening hours or late in the afternoon, the decision to implement contraflow may still not be made. With six hours needed to implement contraflow, the decision may need to be made in the morning, or the early afternoon hours of the day.

Alternatives with partial contraflow implementation, Alternatives B, C1, and C2 require more logistical coordination. Set up time and cost would be increased for these alternatives that require cones along a typical cross section. For I-4, that typical cross section is a distance of 63 miles. These alternatives also require constant maintenance and monitoring. These considerations make Alternatives B, C1, and C2 less successful for the logistical performance measure.

The amount of time to logistically operate Alternative C1 and C2 is greater than for Alternative A and Alternative D. The number of people needed to deploy is also greater. Approximately nine (9) hours may be needed to deploy Alternative C1 and eight (8) hours to deploy C2. (Engerski, 2007) Alternative C1 may require more time because of the need to ensure that the shoulder lane is cleared for travel.

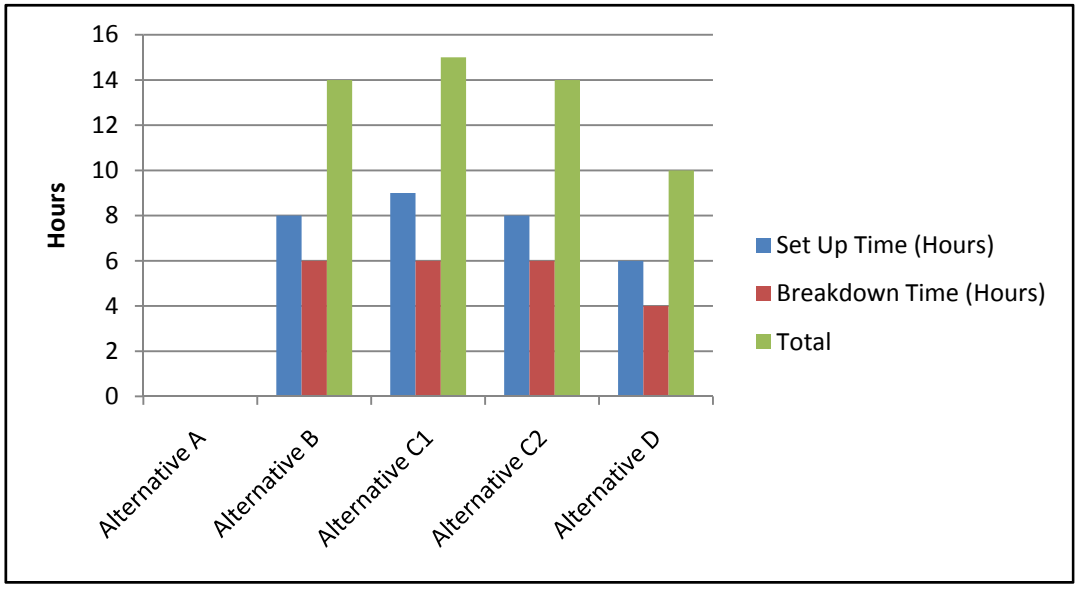


Figure 24
Summary of Set Up and Breakdown Time

The amount of set up and breakdown time is considered one of the most straight forward measurements of logistics. This is because it assumes the coordination of evacuation personnel and logistics needed to prepare for each contraflow alternative. Other logistical considerations, such as operating Highway Advisory Radio (HAR), Variable Message Signs (VMS), road rangers, etc. are expected to be relatively constant among each alternative.

In summary, Alternative A is considered the easiest logistically (primarily because it operates under normal conditions). For the contraflow alternatives, Alternative D is considered to be the most straightforward to implement. Alternatives B, C1, and C2 are considered to be relatively similar.

Table 20
Summary of Logistics Performance Measure

	Alternative A	Alternative B	Alternative C1	Alternative C2	Alternative D
Set Up Time	0	8 hours	9 hours	8 hours	6 hours
Break Down Time	0	6 hours	6 hours	6 hours	4 hours
Total	0	14 hours	15 hours	14 hours	10 hours
Scaled Score (0-5)	0.0	4.7	5.0	4.7	3.3

Delay/Congestion

The Delay/Congestion performance measure evaluates the traffic operation effects of the different contraflow alternatives. The delay and congestion are a result of how traffic is able to respond to the roadway capacity. It is measured in terms of seconds (or minutes) of delay between each contraflow alternative.

The Delay/Congestion performance measure has an inverse relationship to the Additional Capacity performance measure. At the onset of evaluation, it was assumed the alternative that resulted with

the most amount of capacity would also result in the least amount of delay/congestion. The alternative with the least amount of delay or congestion is considered to be the best alternative.

Average delay was measured using a total constant volume of 6,150 vehicles per hour on the facility. The delay was measured as a total weighted average of volume between the regular outbound lanes and the contraflow lanes. Table 21 and Figure 24 illustrate the results of the analysis.

Table 21
Average Delay Comparison with Constant Total Volume

Scenario	Outbound (Eastbound) Average Delay Per Vehicle with Constant Volume						
	Regular Outbound Lanes			Contraflow Lanes			Weighted Average Delay (s/veh)
	Lanes	Volume	Delay (s/veh)	Lanes	Volume	Delay (s/veh)	
A	3	6,150	619.8	--	--	0.0	619.8
B	3	5,077	121.9	1	1,073	24.4	104.9
C1	3+1	5,181	52.1	1	969	16.5	46.5
C2	3	3,925	34.4	2	2,225	23.9	30.6
D	3	3,075	19.3	3	3,075	19.0	19.2

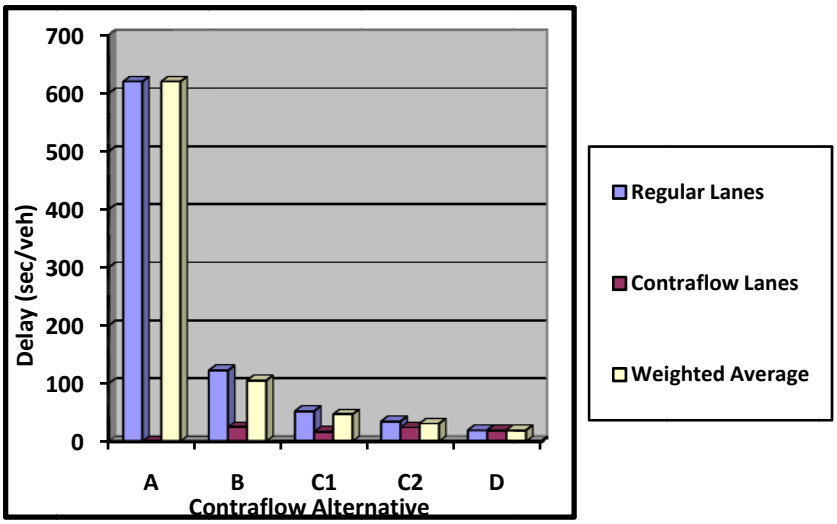


Figure 25
Average Delay Comparison with Constant Total Volume

In summary, Alternative D demonstrated the best results with the lowest amount of average delay per vehicle. Alternative D had an average delay of 19.2 seconds per vehicle from the free flow speed. Each alternative that used contraflow demonstrated significant improvements toward reducing delay. The comparative delay between Alternatives C1, C2, and D were relatively similar.

Alternative A, which operates under regular conditions and does not implement contraflow, demonstrated a significant increase of delay. The average delay per vehicle for Alternative A was 619.8 seconds. Table 22 summarizes the results of the Delay/Congestion performance measure.

Table 22
Summary of Delay/Congestion Performance Measure

	Alternative A	Alternative B	Alternative C1	Alternative C2	Alternative D
Delay/Congestion (sec/vehicle)	618.9	104.9	46.5	30.6	19.2
Scaled Score (0-5)	5.0	0.9	0.4	0.25	0

SUMMARY/CONCLUSIONS

The Florida evacuations for the hurricanes in 2004 and 2005 worked successfully without contraflow lanes. As of 2007, contraflow has never been implemented on a grade separated highway in Florida. Several factors contribute to this. One factor is that Florida's topography is unique with two coastal regions. Also, Florida has generally more than one evacuation route. For example, the Tampa Bay region may use I-75, I-4, or the Suncoast Parkway to evacuate in the north direction.

Contraflow is considered to be an effort of last resort. Currently, real time traffic monitoring has been considered effective via CCTV and via continuous traffic count stations that were used in previous evacuations. Thus far, evacuations from West Central and Southwest Florida have not created enough congestion to necessitate contraflow. There are several reasons for this. For example, it has been reported that fewer people in recent history are evacuating longer distances. Also, it has been reported that people are becoming more knowledgeable of alternate evacuation routes besides the interstate.

Alternative D, which is the alternative that operates with full contraflow implementation, was determined to be most effective. This conclusion was based primarily upon the influence of the improved capacity and the delay/congestion performance measures. If contraflow is to be implemented, Alternative D is considered the best.

Alternative D was scored best, but only by a narrow margin above Alternative A. Alternative A scored the best in the performance measures related to the implementation and safety. The fewest number of resources are required for Alternative A, resources that are strained during the time of an evacuation. The Alternative A scored best in the following performance measures:

- Required personnel
- Required infrastructure
- Speed Variation
- Logistics

Each performance measure was evaluated using a weighted scoring system. The alternative with the lowest score was considered the best alternative. Alternative D was considered the best alternative with an average score of 1.3. In summary, the conclusion can be made that the improved traffic operations of contraflow narrowly provide more benefit than that negative investment required to implement contraflow. Table 23 summarizes the results of each performance measure for each contraflow alternative.

Table 23
Summary of Performance Measure Evaluation

Contraflow Alternative	A – Normal Operation	B – Normal Outbound +1 Contraflow	C1 – Normal Outbound +1 Shoulder +1 Contraflow	C2 – Normal Outbound +2 Contraflow	D – Normal Outbound +Complete Contraflow
Improved Capacity	5.0	3.6	2.2	1.5	0
Required Infrastructure	0.5	3.9	4.0	3.9	1.75
Required Personnel	0	3.5	4.0	3.5	2.5
Speed Variation	0	5.0	2.6	0.5	0
Logistics	0	4.7	5.0	4.7	3.3
Delay/Congestion	5.0	0.9	0.4	0.25	0
Average Score	1.75	3.6	3.0	2.4	1.3

Note: Lowest scored alternative is considered the best alternative.

In the event that congestion amounts to a level that unsatisfactorily serves traffic during an evacuation, and contraflow is ultimately required, then it is suggested that Alternative D is implemented. This alternative uses all of the regular inbound lanes during an evacuation as an outbound lane. Alternative D demonstrated to provide the most improved capacity, while also demonstrating to be the most "implementable" contraflow alternative. If contraflow is implemented, this alternative was demonstrated to be the most efficient, requiring the fewest amount of personnel and resources, while also being the most effective. This is primarily because of removing the deployment of the National Guard during evacuation. The removal of this requirement took place

during the same time period that this research was undertaken. Alternative A was scored second behind Alternative D for required infrastructure, required personnel, and logistics. The average scoring of all the performance measures for Alternative A was 1.75.

The contraflow alternative with the worst score was alternative B. The average score for Alternative B was 3.6. This alternative was scored in the bottom half of each performance measure. This occurred because Alternative B demonstrated the greatest speed variation. Much of this poor performance was caused by the amount of additional infrastructure that would need to be installed, and the number of personnel needed to monitor the operation for the lanes to be properly and safely delineated within the normal inbound lane group.

So what suggestions should be made from the results and observations derived from this dissertation? It is suggested to reduce the significant investment that has been made with regard to contraflow. The need to implement contraflow appears unlikely on I-4 when considering the investment required along with the other mentioned disadvantages, and should only be considered as a last resort. However, it is always challenging to predict the future when considering the dynamic socioeconomic and changing infrastructure within Florida. Therefore, it should be stressed that these suggestions are provided for the present existing conditions. More importantly, there are other alternatives for reducing the need of contraflow that should be considered.

One alternative is to increase awareness of other evacuation routes besides the interstate. At times, the other local surface routes, such as U.S. 92 in Hillsborough County, are parallel to the interstate evacuation route. During periods of congestion, these local surface routes may more quickly serve the evacuating public.

Observations and Uncertainties

This dissertation, to evaluate performance measures identified the different aspects that should be considered for contraflow. The performance measures were selected for the purposes of identifying the traffic operational impacts, as well as the personnel, infrastructure, and logistical requirements. It was observed that the traffic operations of capacity, speed variation, and delay/congestion were more easily to quantify. Conversely, it was also learned that the other performance measures represented a greater challenge to comparatively evaluate.

The performance measures of required personnel, infrastructure, and logistical requirements were more challenging to quantify. The ability to compare the value of additional personnel is difficult. How should one perform a benefit/cost analysis of paying law enforcement personnel overtime pay if they are a significant factor towards an effective evacuation? However, the type of measurement undertaken still is reflective of how important these factors are and how they may comparatively differ between alternative contraflow strategies.

One challenge was to determine if certain performance measures were more important than others. This dissertation initially assumed that each performance measure was weighted equally. However, a separate evaluation was undertaken that provides more weight to the traffic operational performance measures, and is discussed in the next section.

There are several uncertainties attributed toward evaluating the potential effectiveness. Most of the uncertainties are attributed towards the travel demand and anticipated traffic volumes during an evacuation, such as:

- Size, development, and intensity of hurricane
- Speed and direction of hurricane
- Arrival time of hurricane
    - Beginning or end of season
    - Time of day
    - Day of week
- Percentage of people that evacuate
    - Shadow evacuations
    - Amount of manufactured homes
- Distance of evacuation

Because of these uncertainties, it was observed than an evaluation based upon the supply, or capacity, represented a more straightforward approach. This would help determine how many evacuees could be adequately served during an evacuation.

As stated above, the majority of uncertainties for hurricane and evacuation planning is related to the travel demand aspects onto the transportation infrastructure. Each hurricane event is, and will be, unique. Therefore, the greatest uncertainty is the challenge to prepare hurricane evacuation plans that depend upon previous events.

Alternative Method of Weighting Performance Measures

The initial evaluation assumed that each performance measure contained the same amount of influence towards evaluating the overall effectiveness. However, one may successfully debate that the ability to provide enough capacity for evacuees may be of more importance than the investment of additional personnel and temporary infrastructure.

The Delay/Congestion performance measure was developed later during the research process to more effectively account for the importance of providing adequate service. The Improved Capacity performance measure and the Delay/Congestion performance measure are similar in determining effective service with their inverse relationship.

Therefore, an effort was undertaken to consider how each of the different performance measures may be weighted differently. Initially, the ability to weigh the differences may be considered somewhat of a subjective evaluation. However, this effort to weigh the performance measures was a result of several methods of input and research.

Interviews were conducted with Florida DOT staff regarding which performance measures were considered more important. FDOT staff provided impact that it is inherently difficult to measure the cost/benefit difference between the benefit of safely evacuating the general public versus the cost of paying overtime personnel costs (Anderson, 2007). It was inherently determined that improved capacity and the reduction of delay/congestion with contraflow would be at least double the importance of the required infrastructure of orange cones (especially when considering that the

orange cones are not required for Alternative D). More so, the benefit of reduced delay/congestion was considered to be slightly more important than improved capacity. That is because the delay/congestion is a resulting performance measure, and the results may be considered to be more important than the contributing factors.

Similar discussions were undertaken with staff from the Tampa Bay Regional Planning Council regarding the importance to weigh the different performance measures. Similarly, it was determined that delay/congestion was considered to be the most important performance measure.

In addition to interviews, literature reviews were undertaken for evaluating the performance measure weighting system. Previous reports published by the Texas Department of Highway Safety identified the importance of efficient logistics, and how personnel requirements and infrastructure requirements may change over time to create a more efficient process (Galvin, 2002). Speed variation between the contraflow lanes and the regular outbound lanes was previously identified to not be as significant of a contributable factor towards a successful evacuation.

Each performance measure was then listed by order of priority as a result of the conducted interviews and literature review. It was determined the weighting of the performance measures would be provided in the following priority:

- Delay/Congestion
- Improved Capacity
- Logistics (tie)
- Required Personnel (tie)
- Speed Variation
- Required Infrastructure

The weighting of each performance measure was considered against the baseline of the lowest weighted performance measure of Required Infrastructure, weighted at 1.0. The Delay/Congestion performance measure was considered to be of the greatest importance with a scaled weight of 2.25. This is because delay and congestion are probably the most significant factors that can inhibit a successful evacuation. Following the Delay/Congestion performance measure was the Improved Capacity performance measure with a scaled weight of 2.0.

The performance measure with the lowest scaled weight was Required Infrastructure. This is because the primary measure of additional infrastructure consisted of the additional orange cones needed to delineate traffic. This does not directly influence the performance of an evacuation, but is merely a measurement of one component of investment to help supply the contraflow.

An alternative method of weighting the performance measures was introduced to provide more significance of evacuation capacity. The process of evaluation was similar, but for this alternative analysis, each of the different performance measures was assigned an assumed weight of significance.

Provided below is a summary of the evaluation results using the alternative weighting method. The performance measures related to capacity and serving the evacuation public were provided a greater weight.

Table 24
Summary Matrix Using Weighted Scaling Alternative

Contraflow Alternative	*Scaled Weight*	A – Normal Operation	B – Normal Outbound +1 Contraflow	C1 – Normal Outbound +1 Shoulder +1 Contraflow	C2 – Normal Outbound +2 Contraflow	D – Normal Outbound +Complete Contraflow
Improved Capacity	*2.0*	10.0	7.2	4.4	3.0	0
Required Infrastructure	*1.0*	0.5	3.9	4.0	3.9	1.75
Required Personnel	*1.5*	0	5.25	6.0	5.25	3.75
Speed Variation	*1.25*	0	6.25	3.25	0.6	0
Logistics	*1.5*	0	7.05	7.5	7.05	4.95
Delay/Congestion	*2.25*	11.25	2.0	0.9	0.6	0
Average Score	n/a	3.6	5.3	4.3	3.4	1.7

In summary, after applying the scaled weights, the performance measures of improved capacity and delay/congestion benefited greatly. The contraflow alternative that benefited the most from the scaled weighting of those two performance measures was Alternative D (Complete Contraflow).

The results of the scaled weighted performance measures demonstrated a greater differential between Alternative D and Alternative A. Alternative C2 benefitted with the scaled weighting, and scored second, while Alternative A was scored lower as the third best alternative.

In summary, both the scaled weighted analysis and the original analysis demonstrated one major observation; that if contraflow is implemented, a full contraflow has consistently more benefit than the partial contraflow alternatives, and a slightly greater benefit than normal operations during a hurricane evacuation.

Future Research

This research has been directed towards evaluating the hurricane evacuation of I-4 in the West Central Florida region; however, many aspects of the research apply to wherever hurricane evacuation occurs. Some aspects of contraflow also relate to the evacuation of the general public. The United States still uses mass evacuation as the predominant method of safely preparing for a hurricane. However, recent evacuation surveys have demonstrated that many people are starting to modify their plans for evacuation.

Recent trends have shown more "local" evacuations within the same region and using alternate routes besides the interstate. Additionally, the public is becoming more informed of real time traffic conditions to monitor their evacuation routes and plan for their evacuation accordingly. This may become a topic to consider for future research. Ultimately, the combination of continual population increase in Florida growing faster than the rate of typical roadway capacity will necessitate the increasing efficiency of the existing transportation infrastructure to safely serve the evacuating public.

This dissertation can be applied to:

- Other types of evacuation planning and modeling
    - Floods
    - Fires
    - Manmade disasters
- Operation planning of potential reverse lane facilities with significant peak hour directionality

While this dissertation can be applied to several different types of mass evacuations, such as floods, fires, or manmade disasters, each type of evacuation planning should consider the following:

- Shape and size of energy source
- Shape and size of evacuation area
- Rate of growth of evacuation area
- Size and socioeconomic data of evacuation population
- Amount of warning time
- Level of disruption to the road network
- Level of danger of the emergency

The side-by-side analysis of different laneage configurations and alternatives presented in this dissertation can be used as a framework toward future research. The reality of travel demand uncertainties is addressed in this research and may be referenced for future study. Future research can also reference the constantly changing behavioral tendencies of evacuees.

It is suggested that future research focus on these behavioral trends. Something new is learned after each hurricane. Future research may address the changing characteristics of evacuees.

One characteristic of evacuees that may be researched is the route assignment. Are evacuees dependent upon using only interstate and grade separated highways for evacuation, or are other

parallel local facilities determined to be as beneficial? Would the advertisement of other parallel facilities be an effective method of avoiding the need of contraflow?

Future research may also address the relationship between hurricane evacuation zones and land elevation. It has been documented that the majority of hurricane damage and human deaths is caused from inland flooding, not coastal flooding or wind damage. Therefore, the identification of damage-prone locations and hurricane evacuation zones should extend beyond coastal locations.

The ability to anticipate the need for contraflow prior to congestion may also be a topic of future research. Currently, 6-8 hours is anticipated to be needed to implement contraflow. Therefore, the ability to predict the need for contraflow approximately 6-8 hours in advance would further facilitate successful hurricane evacuations.

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APPENDICES

I-4 Contraflow Evaluation
Freeflow - 6150 Cars - Alternative A

No Contraflow Lanes
12/3/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	5256	5223	5245	5241
Vehs Exited	4995	5142	5009	5049
Starting Vehs	370	389	338	366
Ending Vehs	631	470	574	558
Denied Entry Before	221	189	256	222
Denied Entry After	1036	1092	1167	1098
Travel Distance (mi)	15354	15382	15303	15346
Travel Time (hr)	1094.3	1043.5	1191.5	1109.8
Total Delay (hr)	869.9	819.2	968.2	885.8
Total Stops	740	342	604	562
Fuel Used (gal)	6425.0	6424.9	6698.5	6516.2

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	5256	5223	5245	5241
Vehs Exited	4995	5142	5009	5049
Starting Vehs	370	389	338	366
Ending Vehs	631	470	574	558
Denied Entry Before	221	189	256	222
Denied Entry After	1036	1092	1167	1098
Travel Distance (mi)	15354	15382	15303	15346
Travel Time (hr)	1094.3	1043.5	1191.5	1109.8
Total Delay (hr)	869.9	819.2	968.2	885.8
Total Stops	740	342	604	562
Fuel Used (gal)	6425.0	6424.9	6698.5	6516.2

JSC

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Appendix A (Continued)

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	716.6	716.6
Delay / Veh (s)	492.6	492.6
Total Stops	243	243
Travel Dist (mi)	2554.5	2554.5
Travel Time (hr)	756.2	756.2
Avg Speed (mph)	32	32
Fuel Used (gal)	2593.2	2593.2
HC Emissions (g)	178	178
CO Emissions (g)	66812	66812
NOx Emissions (g)	576	576
Vehicles Entered	5241	5241
Vehicles Exited	5233	5233
Hourly Exit Rate	5233	5233
Input Volume	6150	6150
% of Volume	85	85
Denied Entry Before	222	222
Denied Entry After	1098	1098

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	147.8	147.8
Delay / Veh (s)	103.4	103.4
Total Stops	317	317
Travel Dist (mi)	11473.5	11473.5
Travel Time (hr)	313.2	313.2
Avg Speed (mph)	37	37
Fuel Used (gal)	3311.7	3311.7
HC Emissions (g)	447	447
CO Emissions (g)	167891	167891
NOx Emissions (g)	1730	1730
Vehicles Entered	5233	5233
Vehicles Exited	5055	5055
Hourly Exit Rate	5055	5055
Input Volume	6150	6150
% of Volume	82	82
Denied Entry Before	0	0
Denied Entry After	0	0

Appendix A (Continued)

Total Network Performance

Total Delay (hr)	885.8
Delay / Veh (s)	619.8
Total Stops	562
Travel Dist (mi)	15346.2
Travel Time (hr)	1109.8
Avg Speed (mph)	35
Fuel Used (gal)	6516.2
HC Emissions (g)	707
CO Emissions (g)	272465
NOx Emissions (g)	2622
Vehicles Entered	5241
Vehicles Exited	5049
Hourly Exit Rate	5049
Input Volume	18450
% of Volume	27
Denied Entry Before	222
Denied Entry After	1098

I-4 Contraflow Evaluation
Freeflow - 6150 Cars

No Contraflow Lanes
12/3/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	492.6	519.8	0.5	33	32	457.7
Cty Line Off Ramp	6	103.4	219.2	2.2	36	33	124.7
Total		596.0	739.0	2.7	35	33	582.4

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	33	478.2	34	541.9
Cty Line Off Ramp	42	74.4	35	111.4
Total	40	552.6	34	653.3

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB
Directions Served	T	T	T
Maximum Queue (ft)	2582	2581	2590
Average Queue (ft)	172	201	201
95th Queue (ft)	1235	1341	1344
Link Distance (ft)	2573	2573	2573
Upstream Blk Time (%)	0	0	0
Queuing Penalty (veh)	0	0	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB
Directions Served	T	T	TR
Maximum Queue (ft)	92	174	159
Average Queue (ft)	12	24	26
95th Queue (ft)	52	96	97
Link Distance (ft)	11494	11494	11494
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt B — One Contraflow Lane
Contraflow - 1073 Cars 12/3/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	1461	1491	1500	1484
Vehs Exited	1465	1475	1492	1478
Starting Vehs	73	58	56	62
Ending Vehs	69	74	64	68
Denied Entry Before	0	0	0	0
Denied Entry After	3	5	2	3
Travel Distance (mi)	4302	4372	4394	4356
Travel Time (hr)	72.2	73.8	73.6	73.2
Total Delay (hr)	9.7	10.4	10.0	10.0
Total Stops	0	0	0	0
Fuel Used (gal)	1355.4	1357.7	1378.3	1363.8

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	1461	1491	1500	1484
Vehs Exited	1465	1475	1492	1478
Starting Vehs	73	58	56	62
Ending Vehs	69	74	64	68
Denied Entry Before	0	0	0	0
Denied Entry After	3	5	2	3
Travel Distance (mi)	4302	4372	4394	4356
Travel Time (hr)	72.2	73.8	73.6	73.2
Total Delay (hr)	9.7	10.4	10.0	10.0
Total Stops	0	0	0	0
Fuel Used (gal)	1355.4	1357.7	1378.3	1363.8

Contraflow
JSC

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Appendix A (Continued)

12: I-4 C & Park Road On Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	3.7	0.3	4.0
Delay / Veh (s)	12.5	2.2	9.6
Total Stops	0	0	0
Travel Dist (mi)	524.5	903.1	1427.6
Travel Time (hr)	11.4	13.3	24.7
Avg Speed (mph)	55	68	63
Fuel Used (gal)	158.8	308.9	467.6
HC Emissions (g)	10	49	60
CO Emissions (g)	5765	23807	29573
NOx Emissions (g)	79	196	275
Vehicles Entered	1072	413	1485
Vehicles Exited	1068	409	1477
Hourly Exit Rate	1068	409	1477
Input Volume	1073	400	1473
% of Volume	100	102	100
Denied Entry Before	0	0	0
Denied Entry After	3	0	3

14: I-4 C & County Line Off Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	5.6	0.0	5.6
Delay / Veh (s)	18.9	0.2	13.7
Total Stops	0	0	0
Travel Dist (mi)	2350.8	100.3	2451.0
Travel Time (hr)	39.6	1.5	41.1
Avg Speed (mph)	59	67	60
Fuel Used (gal)	676.9	37.9	714.8
HC Emissions (g)	44	7	51
CO Emissions (g)	24496	3868	28365
NOx Emissions (g)	386	23	409
Vehicles Entered	1068	412	1480
Vehicles Exited	1072	413	1485
Hourly Exit Rate	1072	413	1485
Input Volume	1073	400	1473
% of Volume	100	103	101
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

Appendix A (Continued)

Total Network Performance

Total Delay (hr)	10.0
Delay / Veh (s)	24.4
Total Stops	0
Travel Dist (mi)	4356.1
Travel Time (hr)	73.2
Avg Speed (mph)	61
Fuel Used (gal)	1363.8
HC Emissions (g)	134
CO Emissions (g)	73391
NOx Emissions (g)	776
Vehicles Entered	1484
Vehicles Exited	1478
Hourly Exit Rate	1478
Input Volume	4419
% of Volume	33
Denied Entry Before	0
Denied Entry After	3

I-4 Contraflow Evaluation
Contraflow - 1073 Cars

One Contraflow Lane
12/3/2007

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Road On Ramp	12	12.5	38.5	0.5	56	56	12.4
County Line Off Ramp	14	18.9	133.3	2.2	59	59	18.6
Total		31.4	171.8	2.7	59	59	31.0

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Road On Ramp	56	13.2	57	11.7
County Line Off Ramp	59	18.9	59	19.2
Total	59	32.1	59	30.9

Arterial Level of Service: WB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
County Line Off Ramp	14	0.2	13.2	0.2	69	69	0.2
Park Road On Ramp	12	2.2	116.5	2.2	68	68	2.0
Total		2.4	129.7	2.4	68	68	2.2

Arterial Level of Service: WB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
County Line Off Ramp	68	0.2	69	0.2
Park Road On Ramp	68	2.3	68	2.3
Total	68	2.5	68	2.5

Intersection: 12: I-4 C & Park Road On Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 14: I-4 C & County Line Off Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation
Freeflow - 5077 Cars

Alt B – One Contraflow Lanes
12/3/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	5034	5045	5131	5070
Vehs Exited	4994	5017	4923	4978
Starting Vehs	301	319	323	314
Ending Vehs	341	347	531	406
Denied Entry Before	2	0	15	6
Denied Entry After	7	18	9	11
Travel Distance (mi)	14822	14888	14970	14893
Travel Time (hr)	358.5	360.3	447.9	388.9
Total Delay (hr)	140.3	141.7	228.2	170.1
Total Stops	147	210	552	303
Fuel Used (gal)	4813.1	4859.4	4947.4	4873.3

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	5034	5045	5131	5070
Vehs Exited	4994	5017	4923	4978
Starting Vehs	301	319	323	314
Ending Vehs	341	347	531	406
Denied Entry Before	2	0	15	6
Denied Entry After	7	18	9	11
Travel Distance (mi)	14822	14888	14970	14893
Travel Time (hr)	358.5	360.3	447.9	388.9
Total Delay (hr)	140.3	141.7	228.2	170.1
Total Stops	147	210	552	303
Fuel Used (gal)	4813.1	4859.4	4947.4	4873.3

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	41.6	41.6
Delay / Veh (s)	29.6	29.6
Total Stops	191	191
Travel Dist (mi)	2468.5	2468.5
Travel Time (hr)	80.9	80.9
Avg Speed (mph)	36	36
Fuel Used (gal)	1068.4	1068.4
HC Emissions (g)	144	144
CO Emissions (g)	65584	65584
NOx Emissions (g)	558	558
Vehicles Entered	5070	5070
Vehicles Exited	5058	5058
Hourly Exit Rate	5058	5058
Input Volume	5077	5077
% of Volume	100	100
Denied Entry Before	6	6
Denied Entry After	11	11

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	110.0	110.0
Delay / Veh (s)	78.9	78.9
Total Stops	112	112
Travel Dist (mi)	11124.7	11124.7
Travel Time (hr)	270.8	270.8
Avg Speed (mph)	41	41
Fuel Used (gal)	3246.1	3246.1
HC Emissions (g)	450	450
CO Emissions (g)	182533	182533
NOx Emissions (g)	1746	1746
Vehicles Entered	5058	5058
Vehicles Exited	4990	4990
Hourly Exit Rate	4990	4990
Input Volume	5077	5077
% of Volume	98	98
Denied Entry Before	0	0
Denied Entry After	0	0

I-4 Contraflow Evaluation
Freeflow - 5077 Cars

One Contraflow Lanes
12/3/2007

Total Network Performance

Total Delay (hr)	170.1
Delay / Veh (s)	121.9
Total Stops	303
Travel Dist (mi)	14893.4
Travel Time (hr)	388.9
Avg Speed (mph)	39
Fuel Used (gal)	4873.3
HC Emissions (g)	668
CO Emissions (g)	283128
NOx Emissions (g)	2586
Vehicles Entered	5070
Vehicles Exited	4978
Hourly Exit Rate	4978
Input Volume	15231
% of Volume	33
Denied Entry Before	6
Denied Entry After	11

I-4 Contraflow Evaluation
Freeflow - 5077 Cars

One Contraflow Lanes
12/3/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	29.6	57.5	0.5	37	39	23.8
Cty Line Off Ramp	6	78.9	194.1	2.2	41	44	64.9
Total		108.4	251.5	2.7	40	43	88.8

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	37	28.8	35	36.0
Cty Line Off Ramp	45	60.2	35	111.5
Total	43	89.0	35	147.4

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB
Directions Served	T	T	T
Maximum Queue (ft)	2597	2585	2587
Average Queue (ft)	373	430	230
95th Queue (ft)	1873	2017	1443
Link Distance (ft)	2573	2573	2573
Upstream Blk Time (%)	0	0	0
Queuing Penalty (veh)	0	0	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB
Directions Served	T	T	TR
Maximum Queue (ft)	36	39	56
Average Queue (ft)	7	7	11
95th Queue (ft)	44	41	53
Link Distance (ft)	11494	11494	11494
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt C 1 – One Contraflow Lane Plus Shoulder Lane on EB
Contraflow - 969 Cars — 12/3/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	1357	1392	1305	1351
Vehs Exited	1359	1387	1278	1342
Starting Vehs	59	59	46	53
Ending Vehs	57	64	73	65
Denied Entry Before	1	0	0	0
Denied Entry After	1	0	1	1
Travel Distance (mi)	4013	4073	3797	3961
Travel Time (hr)	63.8	66.4	60.4	63.6
Total Delay (hr)	5.9	7.2	5.5	6.2
Total Stops	0	0	0	0
Fuel Used (gal)	1256.7	1269.3	1184.8	1236.9

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	1357	1392	1305	1351
Vehs Exited	1359	1387	1278	1342
Starting Vehs	59	59	46	53
Ending Vehs	57	64	73	65
Denied Entry Before	1	0	0	0
Denied Entry After	1	0	1	1
Travel Distance (mi)	4013	4073	3797	3961
Travel Time (hr)	63.8	66.4	60.4	63.6
Total Delay (hr)	5.9	7.2	5.5	6.2
Total Stops	0	0	0	0
Fuel Used (gal)	1256.7	1269.3	1184.8	1236.9

Contraflow
JSC

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12: I-4 C & Park Road On Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	1.6	0.2	1.9
Delay / Veh (s)	6.2	2.0	5.0
Total Stops	0	0	0
Travel Dist (mi)	463.3	884.7	1348.0
Travel Time (hr)	8.5	13.0	21.5
Avg Speed (mph)	61	68	65
Fuel Used (gal)	143.6	299.9	443.5
HC Emissions (g)	11	54	64
CO Emissions (g)	6939	24381	31320
NOx Emissions (g)	76	201	276
Vehicles Entered	947	403	1350
Vehicles Exited	944	402	1346
Hourly Exit Rate	944	402	1346
Input Volume	969	400	1369
% of Volume	97	100	98
Denied Entry Before	0	0	0
Denied Entry After	1	0	1

14: I-4 C & County Line Off Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	3.9	0.0	4.0
Delay / Veh (s)	15.0	0.2	10.6
Total Stops	0	0	0
Travel Dist (mi)	2073.8	98.1	2171.9
Travel Time (hr)	33.9	1.5	35.4
Avg Speed (mph)	61	67	61
Fuel Used (gal)	592.6	36.9	629.6
HC Emissions (g)	40	7	47
CO Emissions (g)	22716	3876	26592
NOx Emissions (g)	343	23	366
Vehicles Entered	944	404	1348
Vehicles Exited	940	403	1343
Hourly Exit Rate	940	403	1343
Input Volume	969	400	1369
% of Volume	97	101	98
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

Appendix A (Continued)

Total Network Performance

Total Delay (hr)	6.2
Delay / Veh (s)	16.5
Total Stops	0
Travel Dist (mi)	3961.0
Travel Time (hr)	63.6
Avg Speed (mph)	63
Fuel Used (gal)	1236.9
HC Emissions (g)	134
CO Emissions (g)	72036
NOx Emissions (g)	731
Vehicles Entered	1351
Vehicles Exited	1342
Hourly Exit Rate	1342
Input Volume	4107
% of Volume	33
Denied Entry Before	0
Denied Entry After	1

I-4 Contraflow Evaluation — One Contraflow Lane Plus Shoulder Lane on EB
Contraflow - 969 Cars — 12/3/2007

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Road On Ramp	12	6.2	32.3	0.5	62	63	5.1
County Line Off Ramp	14	15.0	129.5	2.2	61	61	15.0
Total		21.3	161.7	2.7	61	61	20.1

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Road On Ramp	60	8.3	63	5.1
County Line Off Ramp	61	15.5	62	14.6
Total	61	23.8	62	19.6

Arterial Level of Service: WB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
County Line Off Ramp	14	0.2	13.1	0.2	69	70	0.2
Park Road On Ramp	12	2.0	116.2	2.2	68	68	2.0
Total		2.2	129.4	2.4	68	69	2.2

Arterial Level of Service: WB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
County Line Off Ramp	69	0.2	69	0.2
Park Road On Ramp	68	2.1	68	2.1
Total	68	2.3	68	2.3

Contraflow
JSC

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Intersection: 12: I-4 C & Park Road On Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 14: I-4 C & County Line Off Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt C1 - No Contraflow Plus Shoulder Lane on EB
Freeflow - 5181 Cars — 12/3/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	5057	5116	5208	5127
Vehs Exited	5089	5145	5197	5144
Starting Vehs	294	320	287	301
Ending Vehs	262	291	298	284
Denied Entry Before	0	2	0	1
Denied Entry After	0	1	7	3
Travel Distance (mi)	14987	15141	15319	15149
Travel Time (hr)	294.9	297.9	305.4	299.4
Total Delay (hr)	72.0	73.0	78.1	74.3
Total Stops	30	8	25	21
Fuel Used (gal)	5145.7	5212.4	5232.7	5196.9

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Run Number	10	11	12	Avg
Vehs Entered	5057	5116	5208	5127
Vehs Exited	5089	5145	5197	5144
Starting Vehs	294	320	287	301
Ending Vehs	262	291	298	284
Denied Entry Before	0	2	0	1
Denied Entry After	0	1	7	3
Travel Distance (mi)	14987	15141	15319	15149
Travel Time (hr)	294.9	297.9	305.4	299.4
Total Delay (hr)	72.0	73.0	78.1	74.3
Total Stops	30	8	25	21
Fuel Used (gal)	5145.7	5212.4	5232.7	5196.9

Freeflow
JSC

SimTraffic Report
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4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	12.1	12.1
Delay / Veh (s)	8.5	8.5
Total Stops	21	21
Travel Dist (mi)	2478.5	2478.5
Travel Time (hr)	53.9	53.9
Avg Speed (mph)	47	47
Fuel Used (gal)	997.4	997.4
HC Emissions (g)	163	163
CO Emissions (g)	85675	85675
NOx Emissions (g)	561	561
Vehicles Entered	5127	5127
Vehicles Exited	5120	5120
Hourly Exit Rate	5120	5120
Input Volume	5181	5181
% of Volume	99	99
Denied Entry Before	1	1
Denied Entry After	3	3

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	57.1	57.1
Delay / Veh (s)	40.1	40.1
Total Stops	0	0
Travel Dist (mi)	11326.3	11326.3
Travel Time (hr)	221.0	221.0
Avg Speed (mph)	51	51
Fuel Used (gal)	3633.9	3633.9
HC Emissions (g)	594	594
CO Emissions (g)	267431	267431
NOx Emissions (g)	2202	2202
Vehicles Entered	5120	5120
Vehicles Exited	5140	5140
Hourly Exit Rate	5140	5140
Input Volume	5181	5181
% of Volume	99	99
Denied Entry Before	0	0
Denied Entry After	0	0

Total Network Performance

Total Delay (hr)	74.3
Delay / Veh (s)	52.1
Total Stops	21
Travel Dist (mi)	15149.2
Travel Time (hr)	299.4
Avg Speed (mph)	51
Fuel Used (gal)	5196.9
HC Emissions (g)	858
CO Emissions (g)	409234
NOx Emissions (g)	3093
Vehicles Entered	5127
Vehicles Exited	5144
Hourly Exit Rate	5144
Input Volume	15543
% of Volume	33
Denied Entry Before	1
Denied Entry After	3

I-4 Contraflow Evaluation
Freeflow - 5181 Cars

No Contraflow Plus Shoulder Lane on EB
12/3/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	8.5	37.9	0.5	49	49	8.4
Cty Line Off Ramp	6	40.1	155.1	2.2	51	51	39.3
Total		48.6	192.9	2.7	51	51	47.6

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	50	7.9	48	9.3
Cty Line Off Ramp	51	39.8	51	41.1
Total	51	47.7	50	50.4

I-4 Contraflow Evaluation — No Contraflow Plus Shoulder Lane on EB
Freeflow - 5181 Cars — 12/3/2007

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	854	852
Average Queue (ft)	28	28
95th Queue (ft)	472	471
Link Distance (ft)	2551	2551
Upstream Blk Time (%)	0	0
Queuing Penalty (veh)	0	0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation
Contraflow - 2225 Cars

Alt C2 – Two Contraflow Lanes
12/3/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	2546	2624	2662	2611
Vehs Exited	2536	2613	2651	2600
Starting Vehs	115	112	135	119
Ending Vehs	125	123	146	131
Denied Entry Before	0	0	0	0
Denied Entry After	0	0	6	2
Travel Distance (mi)	7495	7699	7800	7665
Travel Time (hr)	125.9	129.7	132.2	129.3
Total Delay (hr)	16.3	17.3	18.3	17.3
Total Stops	3	1	2	2
Fuel Used (gal)	2495.0	2597.3	2602.5	2564.9

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Run Number	10	11	12	Avg
Vehs Entered	2546	2624	2662	2611
Vehs Exited	2536	2613	2651	2600
Starting Vehs	115	112	135	119
Ending Vehs	125	123	146	131
Denied Entry Before	0	0	0	0
Denied Entry After	0	0	6	2
Travel Distance (mi)	7495	7699	7800	7665
Travel Time (hr)	125.9	129.7	132.2	129.3
Total Delay (hr)	16.3	17.3	18.3	17.3
Total Stops	3	1	2	2
Fuel Used (gal)	2495.0	2597.3	2602.5	2564.9

12: I-4 C & Park Road On Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	2.9	0.8	3.6
Delay / Veh (s)	4.7	6.8	5.0
Total Stops	2	0	2
Travel Dist (mi)	1070.9	895.9	1966.8
Travel Time (hr)	19.7	13.7	33.4
Avg Speed (mph)	56	65	60
Fuel Used (gal)	410.8	287.6	698.4
HC Emissions (g)	42	51	93
CO Emissions (g)	32928	21002	53930
NOx Emissions (g)	179	205	384
Vehicles Entered	2206	404	2610
Vehicles Exited	2200	409	2609
Hourly Exit Rate	2200	409	2609
Input Volume	2225	400	2625
% of Volume	99	102	99
Denied Entry Before	0	0	0
Denied Entry After	2	0	2

14: I-4 C & County Line Off Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	12.4	0.1	12.5
Delay / Veh (s)	20.3	0.9	17.3
Total Stops	0	0	0
Travel Dist (mi)	4837.8	96.3	4934.1
Travel Time (hr)	82.1	1.5	83.7
Avg Speed (mph)	59	66	59
Fuel Used (gal)	1537.7	35.5	1573.2
HC Emissions (g)	129	6	135
CO Emissions (g)	89312	3330	92642
NOx Emissions (g)	753	22	775
Vehicles Entered	2200	405	2605
Vehicles Exited	2193	404	2597
Hourly Exit Rate	2193	404	2597
Input Volume	2225	400	2625
% of Volume	99	101	99
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

Appendix A (Continued)

Total Network Performance

Total Delay (hr)	17.3
Delay / Veh (s)	23.9
Total Stops	2
Travel Dist (mi)	7664.6
Travel Time (hr)	129.3
Avg Speed (mph)	60
Fuel Used (gal)	2564.9
HC Emissions (g)	264
CO Emissions (g)	171800
NOx Emissions (g)	1305
Vehicles Entered	2611
Vehicles Exited	2600
Hourly Exit Rate	2600
Input Volume	7875
% of Volume	33
Denied Entry Before	0
Denied Entry After	2

I-4 Contraflow Evaluation
Contraflow - 2225 Cars

Two Contraflow Lanes
12/3/2007

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Road On Ramp	12	4.7	32.2	0.5	57	57	4.6
County Line Off Ramp	14	20.3	134.6	2.2	59	59	19.4
Total		24.9	166.8	2.7	58	59	24.0

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Road On Ramp	57	4.5	57	4.9
County Line Off Ramp	59	20.2	59	21.1
Total	59	24.7	58	26.0

Arterial Level of Service: WB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
County Line Off Ramp	14	0.9	13.7	0.2	69	68	0.9
Park Road On Ramp	12	6.8	121.2	2.2	65	65	6.8
Total		7.7	134.9	2.4	66	65	7.7

Arterial Level of Service: WB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
County Line Off Ramp	69	1.1	69	0.8
Park Road On Ramp	65	7.0	65	6.5
Total	66	8.0	66	7.4

Intersection: 12: I-4 C & Park Road On Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 14: I-4 C & County Line Off Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt c2 - Two Contraflow Lanes
Freeflow - 3925 Cars — 12/3/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	4008	3800	3993	3934
Vehs Exited	4018	3850	3944	3937
Starting Vehs	207	260	174	213
Ending Vehs	197	210	223	210
Denied Entry Before	0	0	1	0
Denied Entry After	0	0	2	1
Travel Distance (mi)	11849	11265	11706	11607
Travel Time (hr)	217.4	199.3	210.5	209.1
Total Delay (hr)	42.2	33.0	37.7	37.6
Total Stops	15	5	2	7
Fuel Used (gal)	4035.3	3867.3	3974.1	3958.9

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	4008	3800	3993	3934
Vehs Exited	4018	3850	3944	3937
Starting Vehs	207	260	174	213
Ending Vehs	197	210	223	210
Denied Entry Before	0	0	1	0
Denied Entry After	0	0	2	1
Travel Distance (mi)	11849	11265	11706	11607
Travel Time (hr)	217.4	199.3	210.5	209.1
Total Delay (hr)	42.2	33.0	37.7	37.6
Total Stops	15	5	2	7
Fuel Used (gal)	4035.3	3867.3	3974.1	3958.9

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	5.2	5.2
Delay / Veh (s)	4.8	4.8
Total Stops	7	7
Travel Dist (mi)	1919.6	1919.6
Travel Time (hr)	36.6	36.6
Avg Speed (mph)	53	53
Fuel Used (gal)	774.4	774.4
HC Emissions (g)	133	133
CO Emissions (g)	76501	76501
NOx Emissions (g)	431	431
Vehicles Entered	3934	3934
Vehicles Exited	3933	3933
Hourly Exit Rate	3933	3933
Input Volume	3925	3925
% of Volume	100	100
Denied Entry Before	0	0
Denied Entry After	1	1

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	27.8	27.8
Delay / Veh (s)	25.5	25.5
Total Stops	0	0
Travel Dist (mi)	8660.3	8660.3
Travel Time (hr)	153.1	153.1
Avg Speed (mph)	57	57
Fuel Used (gal)	2810.2	2810.2
HC Emissions (g)	480	480
CO Emissions (g)	225422	225422
NOx Emissions (g)	1764	1764
Vehicles Entered	3933	3933
Vehicles Exited	3932	3932
Hourly Exit Rate	3932	3932
Input Volume	3925	3925
% of Volume	100	100
Denied Entry Before	0	0
Denied Entry After	0	0

I-4 Contraflow Evaluation
Freeflow - 3925 Cars

Two Contraflow Lanes
12/3/2007

Total Network Performance

Total Delay (hr)	37.6
Delay / Veh (s)	34.4
Total Stops	7
Travel Dist (ml)	11606.7
Travel Time (hr)	209.1
Avg Speed (mph)	56
Fuel Used (gal)	3958.9
HC Emissions (g)	676
CO Emissions (g)	333670
NOx Emissions (g)	2417
Vehicles Entered	3934
Vehicles Exited	3937
Hourly Exit Rate	3937
Input Volume	11775
% of Volume	33
Denied Entry Before	0
Denied Entry After	1

I-4 Contraflow Evaluation
Freeflow - 3925 Cars

Two Contraflow Lanes
12/3/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	4.8	33.5	0.5	55	55	5.1
Cty Line Off Ramp	6	25.5	140.2	2.2	56	55	28.0
Total		30.3	173.7	2.7	56	55	33.1

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	56	4.4	55	4.8
Cty Line Off Ramp	57	22.9	56	25.5
Total	57	27.3	56	30.3

Intersection: 4: I-4 F & Park Rd On Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation
Contraflow - 3075 Cars

A1+ D

Three Contraflow Lanes
12/3/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	3017	3155	3099	3090
Vehs Exited	3033	3145	3106	3095
Starting Vehs	169	148	148	154
Ending Vehs	153	158	141	150
Denied Entry Before	1	0	0	0
Denied Entry After	0	1	0	0
Travel Distance (mi)	8943	9319	9168	9143
Travel Time (hr)	146.6	154.4	150.5	150.5
Total Delay (hr)	15.4	17.4	16.2	16.3
Total Stops	0	1	0	0
Fuel Used (gal)	3081.0	3217.6	3184.3	3160.9

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	3017	3155	3099	3090
Vehs Exited	3033	3145	3106	3095
Starting Vehs	169	148	148	154
Ending Vehs	153	158	141	150
Denied Entry Before	1	0	0	0
Denied Entry After	0	1	0	0
Travel Distance (mi)	8943	9319	9168	9143
Travel Time (hr)	146.6	154.4	150.5	150.5
Total Delay (hr)	15.4	17.4	16.2	16.3
Total Stops	0	1	0	0
Fuel Used (gal)	3081.0	3217.6	3184.3	3160.9

4: I-4 C & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	1.7	1.7
Delay / Veh (s)	2.0	2.0
Total Stops	0	0
Travel Dist (mi)	1510.0	1510.0
Travel Time (hr)	25.6	25.6
Avg Speed (mph)	60	60
Fuel Used (gal)	599.5	599.5
HC Emissions (g)	68	68
CO Emissions (g)	55235	55235
NOx Emissions (g)	256	256
Vehicles Entered	3090	3090
Vehicles Exited	3095	3095
Hourly Exit Rate	3095	3095
Input Volume	3075	3075
% of Volume	101	101
Denied Entry Before	0	0
Denied Entry After	0	0

6: I-4 C & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	12.7	12.7
Delay / Veh (s)	14.8	14.8
Total Stops	0	0
Travel Dist (ml)	6825.8	6825.8
Travel Time (hr)	111.4	111.4
Avg Speed (mph)	61	61
Fuel Used (gal)	2276.3	2276.3
HC Emissions (g)	210	210
CO Emissions (g)	152683	152683
NOx Emissions (g)	1076	1076
Vehicles Entered	3095	3095
Vehicles Exited	3096	3096
Hourly Exit Rate	3096	3096
Input Volume	3075	3075
% of Volume	101	101
Denied Entry Before	0	0
Denied Entry After	0	0

I-4 Contraflow Evaluation
Contraflow - 3075 Cars

Three Contraflow Lanes
12/3/2007

Total Network Performance

Total Delay (hr)	16.3
Delay / Veh (s)	19.0
Total Stops	0
Travel Dist (mi)	9143.4
Travel Time (hr)	150.5
Avg Speed (mph)	61
Fuel Used (gal)	3160.9
HC Emissions (g)	305
CO Emissions (g)	227947
NOx Emissions (g)	1462
Vehicles Entered	3090
Vehicles Exited	3095
Hourly Exit Rate	3095
Input Volume	9225
% of Volume	34
Denied Entry Before	0
Denied Entry After	0

I-4 Contraflow Evaluation
Contraflow - 3075 Cars

Three Contraflow Lanes
12/3/2007

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	2.0	29.8	0.5	62	62	2.0
Cty Line Off Ramp	6	14.8	129.5	2.2	61	61	14.2
Total		16.8	159.3	2.7	61	61	16.2

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	61	2.0	62	2.0
Cty Line Off Ramp	61	15.5	61	14.6
Total	61	17.5	61	16.6

Intersection: 4: I-4 C & Park Rd On Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: I-4 C & Cty Line Off Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Network Summary

Network wide Queuing Penalty: 0

Appendix A (Continued)

I-4 Contraflow Evaluation
Freeflow - 3075 Cars

Alt D – Three Contraflow Lanes
12/3/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	3081	3138	2976	3065
Vehs Exited	3083	3088	2950	3040
Starting Vehs	154	127	109	130
Ending Vehs	152	177	135	155
Denied Entry Before	0	0	0	0
Denied Entry After	0	0	0	0
Travel Distance (mi)	9110	9199	8750	9020
Travel Time (hr)	150.5	152.4	144.0	149.0
Total Delay (hr)	16.5	17.3	15.4	16.4
Total Stops	0	0	0	0
Fuel Used (gal)	3135.3	3174.1	3026.1	3111.8

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	3081	3138	2976	3065
Vehs Exited	3083	3088	2950	3040
Starting Vehs	154	127	109	130
Ending Vehs	152	177	135	155
Denied Entry Before	0	0	0	0
Denied Entry After	0	0	0	0
Travel Distance (mi)	9110	9199	8750	9020
Travel Time (hr)	150.5	152.4	144.0	149.0
Total Delay (hr)	16.5	17.3	15.4	16.4
Total Stops	0	0	0	0
Fuel Used (gal)	3135.3	3174.1	3026.1	3111.8

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	1.7	1.7
Delay / Veh (s)	2.0	2.0
Total Stops	0	0
Travel Dist (mi)	1496.6	1496.6
Travel Time (hr)	25.4	25.4
Avg Speed (mph)	60	60
Fuel Used (gal)	589.9	589.9
HC Emissions (g)	108	108
CO Emissions (g)	61703	61703
NOx Emissions (g)	342	342
Vehicles Entered	3065	3065
Vehicles Exited	3067	3067
Hourly Exit Rate	3067	3067
Input Volume	3075	3075
% of Volume	100	100
Denied Entry Before	0	0
Denied Entry After	0	0

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	12.7	12.7
Delay / Veh (s)	14.9	14.9
Total Stops	0	0
Travel Dist (mi)	6729.9	6729.9
Travel Time (hr)	110.1	110.1
Avg Speed (mph)	61	61
Fuel Used (gal)	2240.6	2240.6
HC Emissions (g)	424	424
CO Emissions (g)	190882	190882
NOx Emissions (g)	1519	1519
Vehicles Entered	3067	3067
Vehicles Exited	3039	3039
Hourly Exit Rate	3039	3039
Input Volume	3075	3075
% of Volume	99	99
Denied Entry Before	0	0
Denied Entry After	0	0

I-4 Contraflow Evaluation
Freeflow - 3075 Cars

Three Contraflow Lanes
12/3/2007

Total Network Performance

Total Delay (hr)	16.4
Delay / Veh (s)	19.3
Total Stops	0
Travel Dist (mi)	9019.6
Travel Time (hr)	149.0
Avg Speed (mph)	61
Fuel Used (gal)	3111.8
HC Emissions (g)	584
CO Emissions (g)	277249
NOx Emissions (g)	2042
Vehicles Entered	3065
Vehicles Exited	3040
Hourly Exit Rate	3040
Input Volume	9225
% of Volume	33
Denied Entry Before	0
Denied Entry After	0

I-4 Contraflow Evaluation
Freeflow - 3075 Cars

Three Contraflow Lanes
12/3/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	2.0	29.8	0.5	62	62	2.0
Cty Line Off Ramp	6	14.9	129.8	2.2	61	61	14.9
Total		16.9	159.6	2.7	61	61	16.8

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	61	2.1	62	1.8
Cty Line Off Ramp	61	15.4	61	14.6
Total	61	17.5	61	16.3

Intersection: 4: I-4 F & Park Rd On Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation
Baseline

Alt A – No Contraflow Lanes
Simulation #1
11/30/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	5132	5108	5212	5151
Vehs Exited	4877	4885	4866	4876
Starting Vehs	331	327	337	332
Ending Vehs	586	550	683	606
Denied Entry Before	0	0	2	1
Denied Entry After	5	4	10	6
Travel Distance (mi)	14930	14927	15086	14981
Travel Time (hr)	448.2	452.9	522.7	474.6
Total Delay (hr)	226.8	231.6	298.9	252.4
Total Stops	2286	2430	3294	2670
Fuel Used (gal)	5304.1	5288.9	5448.1	5347.0

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	5132	5108	5212	5151
Vehs Exited	4877	4885	4866	4876
Starting Vehs	331	327	337	332
Ending Vehs	586	550	683	606
Denied Entry Before	0	0	2	1
Denied Entry After	5	4	10	6
Travel Distance (mi)	14930	14927	15086	14981
Travel Time (hr)	448.2	452.9	522.7	474.6
Total Delay (hr)	226.8	231.6	298.9	252.4
Total Stops	2286	2430	3294	2670
Fuel Used (gal)	5304.1	5288.9	5448.1	5347.0

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Appendix B (Continued)

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	13.2	13.2
Delay / Veh (s)	9.2	9.2
Total Stops	60	60
Travel Dist (mi)	2509.0	2509.0
Travel Time (hr)	55.0	55.0
Avg Speed (mph)	47	47
Fuel Used (gal)	1097.0	1097.0
HC Emissions (g)	179	179
CO Emissions (g)	105467	105467
NOx Emissions (g)	581	581
Vehicles Entered	5151	5151
Vehicles Exited	5133	5133
Hourly Exit Rate	5133	5133
Input Volume	5200	5200
% of Volume	99	99
Denied Entry Before	1	1
Denied Entry After	6	6

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	215.3	215.3
Delay / Veh (s)	154.7	154.7
Total Stops	2599	2599
Travel Dist (mi)	11197.5	11197.5
Travel Time (hr)	377.3	377.3
Avg Speed (mph)	30	30
Fuel Used (gal)	3538.8	3538.8
HC Emissions (g)	468	468
CO Emissions (g)	217774	217774
NOx Emissions (g)	1641	1641
Vehicles Entered	5133	5133
Vehicles Exited	4885	4885
Hourly Exit Rate	4885	4885
Input Volume	5200	5200
% of Volume	94	94
Denied Entry Before	0	0
Denied Entry After	0	0

Appendix B (Continued)

Total Network Performance

Total Delay (hr)	252.4
Delay / Veh (s)	181.3
Total Stops	2670
Travel Dist (mi)	14981.0
Travel Time (hr)	474.6
Avg Speed (mph)	32
Fuel Used (gal)	5347.0
HC Emissions (g)	738
CO Emissions (g)	369005
NOx Emissions (g)	2585
Vehicles Entered	5151
Vehicles Exited	4876
Hourly Exit Rate	4876
Input Volume	15600
% of Volume	31
Denied Entry Before	1
Denied Entry After	6

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	9.2	38.5	0.5	48	49	8.2
Cty Line Off Ramp	6	154.7	271.1	2.2	29	31	137.8
Total		164.0	309.6	2.7	31	33	146.0

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	49	8.9	47	10.5
Cty Line Off Ramp	31	140.6	26	185.5
Total	33	149.5	28	196.0

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB
Directions Served	T	T	T
Maximum Queue (ft)	860	861	860
Average Queue (ft)	29	29	29
95th Queue (ft)	475	475	475
Link Distance (ft)	2573	2573	2573
Upstream Blk Time (%)	0	0	0
Queuing Penalty (veh)	0	0	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB
Directions Served	T	T	TR
Maximum Queue (ft)	1846	3615	3537
Average Queue (ft)	160	414	504
95th Queue (ft)	933	1745	1836
Link Distance (ft)	11494	11494	11494
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt A - No Contraflow Lanes
Baseline — Simulation #2 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	5248	5244	5446	5313
Vehs Exited	4889	4885	4834	4869
Starting Vehs	322	373	436	377
Ending Vehs	681	732	1048	820
Denied Entry Before	1	0	7	3
Denied Entry After	1	0	1	1
Travel Distance (mi)	15230	15155	15392	15259
Travel Time (hr)	531.5	536.9	732.8	600.4
Total Delay (hr)	305.7	311.8	505.1	374.2
Total Stops	2882	3322	5463	3890
Fuel Used (gal)	5529.8	5441.9	5881.7	5617.8

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	5248	5244	5446	5313
Vehs Exited	4889	4885	4834	4869
Starting Vehs	322	373	436	377
Ending Vehs	681	732	1048	820
Denied Entry Before	1	0	7	3
Denied Entry After	1	0	1	1
Travel Distance (mi)	15230	15155	15392	15259
Travel Time (hr)	531.5	536.9	732.8	600.4
Total Delay (hr)	305.7	311.8	505.1	374.2
Total Stops	2882	3322	5463	3890
Fuel Used (gal)	5529.8	5441.9	5881.7	5617.8

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Appendix B (Continued)

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	18.7	18.7
Delay / Veh (s)	12.7	12.7
Total Stops	106	106
Travel Dist (mi)	2594.5	2594.5
Travel Time (hr)	61.6	61.6
Avg Speed (mph)	44	44
Fuel Used (gal)	1145.1	1145.1
HC Emissions (g)	196	196
CO Emissions (g)	106128	106128
NOx Emissions (g)	643	643
Vehicles Entered	5313	5313
Vehicles Exited	5316	5316
Hourly Exit Rate	5316	5316
Input Volume	5250	5250
% of Volume	101	101
Denied Entry Before	3	3
Denied Entry After	1	1

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	331.1	331.1
Delay / Veh (s)	234.0	234.0
Total Stops	3774	3774
Travel Dist (mi)	11393.2	11393.2
Travel Time (hr)	496.0	496.0
Avg Speed (mph)	23	23
Fuel Used (gal)	3765.4	3765.4
HC Emissions (g)	489	489
CO Emissions (g)	200438	200438
NOx Emissions (g)	1633	1633
Vehicles Entered	5316	5316
Vehicles Exited	4870	4870
Hourly Exit Rate	4870	4870
Input Volume	5250	5250
% of Volume	93	93
Denied Entry Before	0	0
Denied Entry After	0	0

I-4 Contraflow Evaluation
Baseline

No Contraflow Lanes
11/30/2007

Total Network Performance

Total Delay (hr)	374.2
Delay / Veh (s)	264.7
Total Stops	3890
Travel Dist (mi)	15259.1
Travel Time (hr)	600.4
Avg Speed (mph)	26
Fuel Used (gal)	5617.8
HC Emissions (g)	785
CO Emissions (g)	352959
NOx Emissions (g)	2661
Vehicles Entered	5313
Vehicles Exited	4869
Hourly Exit Rate	4869
Input Volume	15750
% of Volume	31
Denied Entry Before	3
Denied Entry After	1

I-4 Contraflow Evaluation
Baseline

No Contraflow Lanes
11/30/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	12.7	41.7	0.5	45	47	11.1
Cty Line Off Ramp	6	234.0	350.6	2.2	23	26	188.7
Total		246.7	392.3	2.7	25	28	199.8

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	47	10.2	43	16.6
Cty Line Off Ramp	25	193.8	18	318.2
Total	28	204.0	20	334.8

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB
Directions Served	T	T	T
Maximum Queue (ft)	1720	1722	1725
Average Queue (ft)	86	115	115
95th Queue (ft)	850	993	993
Link Distance (ft)	2573	2573	2573
Upstream Blk Time (%)	0	0	0
Queuing Penalty (veh)	0	0	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB
Directions Served	T	T	TR
Maximum Queue (ft)	1103	1664	1692
Average Queue (ft)	151	319	410
95th Queue (ft)	605	1054	1210
Link Distance (ft)	11494	11494	11494
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt A - No Contraflow Lanes
Baseline — Simulation #3 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	5376	5332	5358	5355
Vehs Exited	4864	4889	4895	4883
Starting Vehs	400	412	421	411
Ending Vehs	912	855	884	884
Denied Entry Before	2	1	4	2
Denied Entry After	1	0	1	1
Travel Distance (mi)	15347	15343	15361	15351
Travel Time (hr)	595.4	639.5	676.5	637.1
Total Delay (hr)	367.4	412.4	448.5	409.4
Total Stops	4313	5514	5186	5004
Fuel Used (gal)	5651.0	5775.7	5819.9	5748.8

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	Avg
Vehs Entered	5376	5332	5358	5355
Vehs Exited	4864	4889	4895	4883
Starting Vehs	400	412	421	411
Ending Vehs	912	855	884	884
Denied Entry Before	2	1	4	2
Denied Entry After	1	0	1	1
Travel Distance (mi)	15347	15343	15361	15351
Travel Time (hr)	595.4	639.5	676.5	637.1
Total Delay (hr)	367.4	412.4	448.5	409.4
Total Stops	4313	5514	5186	5004
Fuel Used (gal)	5651.0	5775.7	5819.9	5748.8

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Appendix B (Continued)

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	19.0	19.0
Delay / Veh (s)	12.7	12.7
Total Stops	103	103
Travel Dist (mi)	2616.0	2616.0
Travel Time (hr)	62.3	62.3
Avg Speed (mph)	43	43
Fuel Used (gal)	1170.7	1170.7
HC Emissions (g)	187	187
CO Emissions (g)	106058	106058
NOx Emissions (g)	627	627
Vehicles Entered	5355	5355
Vehicles Exited	5362	5362
Hourly Exit Rate	5362	5362
Input Volume	5300	5300
% of Volume	101	101
Denied Entry Before	2	2
Denied Entry After	1	1

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	365.8	365.8
Delay / Veh (s)	257.1	257.1
Total Stops	4889	4889
Travel Dist (mi)	11459.2	11459.2
Travel Time (hr)	531.7	531.7
Avg Speed (mph)	22	22
Fuel Used (gal)	3862.9	3862.9
HC Emissions (g)	443	443
CO Emissions (g)	190298	190298
NOx Emissions (g)	1519	1519
Vehicles Entered	5362	5362
Vehicles Exited	4883	4883
Hourly Exit Rate	4883	4883
Input Volume	5300	5300
% of Volume	92	92
Denied Entry Before	0	0
Denied Entry After	0	0

Total Network Performance

Total Delay (hr)	409.4
Delay / Veh (s)	287.9
Total Stops	5004
Travel Dist (mi)	15350.6
Travel Time (hr)	637.1
Avg Speed (mph)	24
Fuel Used (gal)	5748.8
HC Emissions (g)	723
CO Emissions (g)	341858
NOx Emissions (g)	2516
Vehicles Entered	5355
Vehicles Exited	4883
Hourly Exit Rate	4883
Input Volume	15900
% of Volume	31
Denied Entry Before	2
Denied Entry After	1

I-4 Contraflow Evaluation
Baseline

No Contraflow Lanes
11/30/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	12.7	41.8	0.5	45	44	13.5
Cty Line Off Ramp	6	257.1	373.7	2.2	21	23	227.2
Total		269.8	415.5	2.7	23	25	240.7

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	46	11.5	45	13.1
Cty Line Off Ramp	21	260.7	20	283.3
Total	23	272.2	22	296.4

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB
Directions Served	T	T	T
Maximum Queue (ft)	1721	2582	1722
Average Queue (ft)	115	229	86
95th Queue (ft)	991	1440	851
Link Distance (ft)	2573	2573	2573
Upstream Blk Time (%)	0	0	0
Queuing Penalty (veh)	0	0	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB
Directions Served	T	T	TR
Maximum Queue (ft)	2010	4045	4488
Average Queue (ft)	238	436	536
95th Queue (ft)	1199	1789	2155
Link Distance (ft)	11494	11494	11494
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt B - One Contraflow Lane
Baseline — Simulation #1 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	13	14	Avg
Start Time	4:45	4:45	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intvls	1	1	1	1	1	1
Vehs Entered	2190	2197	2199	2188	2140	2182
Vehs Exited	2076	2140	2086	2123	2103	2106
Starting Vehs	110	114	140	96	140	119
Ending Vehs	224	171	253	161	177	197
Denied Entry Before	0	0	0	1	0	0
Denied Entry After	1	0	0	0	1	0
Travel Distance (mi)	6374	6446	6366	6399	6278	6373
Travel Time (hr)	165.5	135.1	198.1	129.3	167.7	159.2
Total Delay (hr)	72.9	41.2	105.6	36.2	76.6	66.5
Total Stops	3	0	0	2	0	1
Fuel Used (gal)	2014.9	1963.6	2088.9	1930.5	2002.4	2000.1

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	13	14	Avg
Vehs Entered	2190	2197	2199	2188	2140	2182
Vehs Exited	2076	2140	2086	2123	2103	2106
Starting Vehs	110	114	140	96	140	119
Ending Vehs	224	171	253	161	177	197
Denied Entry Before	0	0	0	1	0	0
Denied Entry After	1	0	0	0	1	0
Travel Distance (mi)	6374	6446	6366	6399	6278	6373
Travel Time (hr)	165.5	135.1	198.1	129.3	167.7	159.2
Total Delay (hr)	72.9	41.2	105.6	36.2	76.6	66.5
Total Stops	3	0	0	2	0	1
Fuel Used (gal)	2014.9	1963.6	2088.9	1930.5	2002.4	2000.1

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Appendix B (Continued)

12: I-4 C & Park Road On Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	3.1	0.2	3.3
Delay / Veh (s)	6.1	1.9	5.4
Total Stops	0	0	0
Travel Dist (mi)	875.7	871.2	1746.9
Travel Time (hr)	16.3	12.8	29.0
Avg Speed (mph)	56	68	61
Fuel Used (gal)	270.4	294.6	565.0
HC Emissions (g)	25	54	79
CO Emissions (g)	18663	24241	42904
NOx Emissions (g)	120	201	321
Vehicles Entered	1789	394	2183
Vehicles Exited	1785	398	2183
Hourly Exit Rate	1785	398	2183
Input Volume	1800	400	2200
% of Volume	99	100	99
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

14: I-4 C & County Line Off Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	55.1	0.0	55.1
Delay / Veh (s)	113.7	0.2	92.8
Total Stops	1	0	1
Travel Dist (mi)	3895.5	95.6	3991.1
Travel Time (hr)	111.4	1.4	112.9
Avg Speed (mph)	35	68	35
Fuel Used (gal)	1092.3	35.9	1128.2
HC Emissions (g)	62	7	68
CO Emissions (g)	38680	3822	42502
NOx Emissions (g)	465	23	487
Vehicles Entered	1785	393	2178
Vehicles Exited	1708	394	2102
Hourly Exit Rate	1708	394	2102
Input Volume	1800	400	2200
% of Volume	95	98	96
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

Appendix B (Continued)

Total Network Performance

Total Delay (hr)	66.5
Delay / Veh (s)	111.6
Total Stops	1
Travel Dist (mi)	6372.5
Travel Time (hr)	159.2
Avg Speed (mph)	40
Fuel Used (gal)	2000.1
HC Emissions (g)	176
CO Emissions (g)	101765
NOx Emissions (g)	951
Vehicles Entered	2182
Vehicles Exited	2106
Hourly Exit Rate	2106
Input Volume	6600
% of Volume	32
Denied Entry Before	0
Denied Entry After	0

I-4 Contraflow Evaluation
Baseline

One Contraflow Lane
11/30/2007

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Road On Ramp	12	6.1	32.8	0.5	57	56	6.4
County Line Off Ramp	14	113.7	229.8	2.2	34	33	124.4
Total		119.8	262.5	2.7	37	36	130.8

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
Park Road On Ramp	56	6.6	57	5.9	56	6.5	58
County Line Off Ramp	44	61.5	26	193.6	47	52.1	31
Total	46	68.1	28	199.5	49	58.6	34

Arterial Level of Service: WB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
County Line Off Ramp	14	0.2	13.1	0.2	69	70	0.2
Park Road On Ramp	12	1.9	116.2	2.2	68	68	1.6
Total		2.1	129.3	2.4	68	68	1.8

Arterial Level of Service: WB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
County Line Off Ramp	69	0.2	69	0.1	69	0.2	69
Park Road On Ramp	68	2.3	68	1.8	68	1.9	68
Total	68	2.5	68	2.0	68	2.1	68

Intersection: 12: I-4 C & Park Road On Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 14: I-4 C & County Line Off Ramp

Movement	EB
Directions Served	T
Maximum Queue (ft)	12
Average Queue (ft)	1
95th Queue (ft)	10
Link Distance (ft)	11547
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt B -- One Contraflow Lane
Baseline — Simulation #2 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	13	14	Avg
Start Time	4:45	4:45	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intvls	1	1	1	1	1	1
Vehs Entered	2251	2208	2178	2213	2261	2222
Vehs Exited	2126	2160	2102	2132	2132	2130
Starting Vehs	135	112	137	115	90	118
Ending Vehs	260	160	213	196	219	210
Denied Entry Before	4	0	1	0	0	1
Denied Entry After	1	0	2	1	0	1
Travel Distance (mi)	6517	6469	6374	6464	6571	6479
Travel Time (hr)	197.2	128.8	186.7	156.7	171.1	168.1
Total Delay (hr)	102.8	34.6	93.9	62.6	75.8	73.9
Total Stops	2	0	1	0	2	1
Fuel Used (gal)	2136.6	1944.7	2076.4	2022.7	2084.4	2053.0

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	13	14	Avg
Vehs Entered	2251	2208	2178	2213	2261	2222
Vehs Exited	2126	2160	2102	2132	2132	2130
Starting Vehs	135	112	137	115	90	118
Ending Vehs	260	160	213	196	219	210
Denied Entry Before	4	0	1	0	0	1
Denied Entry After	1	0	2	1	0	1
Travel Distance (mi)	6517	6469	6374	6464	6571	6479
Travel Time (hr)	197.2	128.8	186.7	156.7	171.1	168.1
Total Delay (hr)	102.8	34.6	93.9	62.6	75.8	73.9
Total Stops	2	0	1	0	2	1
Fuel Used (gal)	2136.6	1944.7	2076.4	2022.7	2084.4	2053.0

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Appendix B (Continued)

12: I-4 C & Park Road On Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	3.2	0.2	3.4
Delay / Veh (s)	6.3	2.1	5.6
Total Stops	0	0	0
Travel Dist (mi)	885.9	909.6	1795.5
Travel Time (hr)	16.5	13.5	30.0
Avg Speed (mph)	56	68	61
Fuel Used (gal)	272.3	307.9	580.2
HC Emissions (g)	25	66	92
CO Emissions (g)	18699	26931	45630
NOx Emissions (g)	120	231	351
Vehicles Entered	1809	413	2222
Vehicles Exited	1808	415	2223
Hourly Exit Rate	1808	415	2223
Input Volume	1850	400	2250
% of Volume	98	104	99
Denied Entry Before	1	0	1
Denied Entry After	1	0	1

14: I-4 C & County Line Off Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	62.3	0.0	62.3
Delay / Veh (s)	127.3	0.2	103.1
Total Stops	1	0	1
Travel Dist (mi)	3937.6	100.5	4038.1
Travel Time (hr)	119.1	1.5	120.6
Avg Speed (mph)	33	67	33
Fuel Used (gal)	1119.1	37.8	1156.9
HC Emissions (g)	61	8	69
CO Emissions (g)	38892	4127	43018
NOx Emissions (g)	456	26	483
Vehicles Entered	1808	413	2221
Vehicles Exited	1716	413	2129
Hourly Exit Rate	1716	413	2129
Input Volume	1850	400	2250
% of Volume	93	103	95
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

Appendix B (Continued)

Total Network Performance

Total Delay (hr)	73.9
Delay / Veh (s)	122.3
Total Stops	1
Travel Dist (mi)	6479.1
Travel Time (hr)	168.1
Avg Speed (mph)	39
Fuel Used (gal)	2053.0
HC Emissions (g)	192
CO Emissions (g)	105906
NOx Emissions (g)	985
Vehicles Entered	2222
Vehicles Exited	2130
Hourly Exit Rate	2130
Input Volume	6750
% of Volume	32
Denied Entry Before	1
Denied Entry After	1

Appendix B (Continued)

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Road On Ramp	12	6.3	32.9	0.5	56	55	7.1
County Line Off Ramp	14	127.3	243.4	2.2	33	26	184.2
Total		133.6	276.3	2.7	35	29	191.3

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
Park Road On Ramp	57	6.1	58	5.7	57	5.6	55
County Line Off Ramp	49	47.1	28	170.6	36	105.1	32
Total	50	53.2	31	176.2	38	110.7	35

Arterial Level of Service: WB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
County Line Off Ramp	14	0.2	13.2	0.2	69	69	0.2
Park Road On Ramp	12	2.1	117.0	2.2	68	68	1.7
Total		2.3	130.2	2.4	68	68	1.9

Arterial Level of Service: WB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
County Line Off Ramp	68	0.2	69	0.2	69	0.2	69
Park Road On Ramp	67	2.3	68	2.2	68	2.2	68
Total	67	2.5	68	2.3	68	2.4	68

Intersection: 12: I-4 C & Park Road On Ramp

Movement	
Directions Served	
Maximum Queue (ft)	
Average Queue (ft)	
95th Queue (ft)	
Link Distance (ft)	
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 14: I-4 C & County Line Off Ramp

Movement	EB
Directions Served	T
Maximum Queue (ft)	19
Average Queue (ft)	1
95th Queue (ft)	10
Link Distance (ft)	11547
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt B - One Contraflow Lane
Baseline — Simulation #3 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	13	14	Avg
Start Time	4:45	4:45	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intvls	1	1	1	1	1	1
Vehs Entered	2271	2308	2435	2240	2312	2313
Vehs Exited	2075	2109	2176	2079	2099	2108
Starting Vehs	145	135	119	125	127	131
Ending Vehs	341	334	378	286	340	336
Denied Entry Before	0	2	0	0	0	0
Denied Entry After	0	0	0	0	0	0
Travel Distance (mi)	6456	6593	6888	6436	6584	6591
Travel Time (hr)	234.7	219.7	249.3	202.2	223.2	225.8
Total Delay (hr)	140.8	123.9	149.3	108.4	127.4	130.0
Total Stops	1	0	1	4	3	2
Fuel Used (gal)	2182.0	2166.5	2315.1	2084.7	2183.3	2186.3

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	13	14	Avg
Vehs Entered	2271	2308	2435	2240	2312	2313
Vehs Exited	2075	2109	2176	2079	2099	2108
Starting Vehs	145	135	119	125	127	131
Ending Vehs	341	334	378	286	340	336
Denied Entry Before	0	2	0	0	0	0
Denied Entry After	0	0	0	0	0	0
Travel Distance (mi)	6456	6593	6888	6436	6584	6591
Travel Time (hr)	234.7	219.7	249.3	202.2	223.2	225.8
Total Delay (hr)	140.8	123.9	149.3	108.4	127.4	130.0
Total Stops	1	0	1	4	3	2
Fuel Used (gal)	2182.0	2166.5	2315.1	2084.7	2183.3	2186.3

Appendix B (Continued)

12: I-4 C & Park Road On Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	4.3	0.2	4.6
Delay / Veh (s)	8.2	2.1	7.1
Total Stops	0	0	0
Travel Dist (mi)	937.5	882.0	1819.5
Travel Time (hr)	18.5	13.0	31.5
Avg Speed (mph)	53	68	59
Fuel Used (gal)	274.7	300.5	575.1
HC Emissions (g)	24	74	98
CO Emissions (g)	17568	28292	45860
NOx Emissions (g)	115	243	359
Vehicles Entered	1913	400	2313
Vehicles Exited	1912	402	2314
Hourly Exit Rate	1912	402	2314
Input Volume	1900	400	2300
% of Volume	101	100	101
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

14: I-4 C & County Line Off Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	116.7	0.0	116.7
Delay / Veh (s)	232.4	0.2	190.3
Total Stops	2	0	2
Travel Dist (mi)	4038.5	97.3	4135.8
Travel Time (hr)	175.0	1.5	176.5
Avg Speed (mph)	23	67	23
Fuel Used (gal)	1249.2	36.7	1286.0
HC Emissions (g)	51	9	60
CO Emissions (g)	36549	4246	40795
NOx Emissions (g)	376	27	404
Vehicles Entered	1912	400	2312
Vehicles Exited	1705	400	2105
Hourly Exit Rate	1705	400	2105
Input Volume	1900	400	2300
% of Volume	90	100	92
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

I-4 Contraflow Evaluation
Baseline

One Contraflow Lane
11/30/2007

Total Network Performance

Total Delay (hr)	130.0
Delay / Veh (s)	211.7
Total Stops	2
Travel Dist (mi)	6591.3
Travel Time (hr)	225.8
Avg Speed (mph)	29
Fuel Used (gal)	2186.3
HC Emissions (g)	192
CO Emissions (g)	104629
NOx Emissions (g)	922
Vehicles Entered	2313
Vehicles Exited	2108
Hourly Exit Rate	2108
Input Volume	6900
% of Volume	31
Denied Entry Before	0
Denied Entry After	0

I-4 Contraflow Evaluation
Baseline

One Contraflow Lane
11/30/2007

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Road On Ramp	12	8.2	34.8	0.5	54	55	7.4
County Line Off Ramp	14	232.4	348.5	2.2	23	21	258.0
Total		240.6	383.3	2.7	25	24	265.4

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
Park Road On Ramp	54	7.6	52	9.7	54	7.9	54
County Line Off Ramp	23	220.9	21	263.0	26	192.2	23
Total	26	228.5	23	272.7	28	200.1	26

Arterial Level of Service: WB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
County Line Off Ramp	14	0.2	13.2	0.2	69	69	0.2
Park Road On Ramp	12	2.1	116.7	2.2	68	68	1.9
Total		2.2	129.9	2.4	68	68	2.1

Arterial Level of Service: WB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
County Line Off Ramp	69	0.2	68	0.2	69	0.2	69
Park Road On Ramp	68	2.1	67	2.5	68	1.9	68
Total	68	2.3	67	2.7	68	2.1	68

Intersection: 12: I-4 C & Park Road On Ramp

Movement	
Directions Served	
Maximum Queue (ft)	
Average Queue (ft)	
95th Queue (ft)	
Link Distance (ft)	
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 14: I-4 C & County Line Off Ramp

Movement	EB
Directions Served	T
Maximum Queue (ft)	25
Average Queue (ft)	2
95th Queue (ft)	13
Link Distance (ft)	11547
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt C1 - Three EB Through Plus Shoulder Lane
Baseline — Simulation #1 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	6451	6530	6651	6544
Vehs Exited	6310	6392	6401	6368
Starting Vehs	397	424	438	419
Ending Vehs	538	562	688	596
Denied Entry Before	4	0	8	4
Denied Entry After	4	0	0	1
Travel Distance (mi)	18967	19172	19479	19206
Travel Time (hr)	522.0	509.8	620.8	550.9
Total Delay (hr)	239.6	224.8	332.1	265.5
Total Stops	1443	1052	2412	1636
Fuel Used (gal)	6515.1	6591.7	6817.0	6641.3

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Run Number	10	11	12	Avg
Vehs Entered	6451	6530	6651	6544
Vehs Exited	6310	6392	6401	6368
Starting Vehs	397	424	438	419
Ending Vehs	538	562	688	596
Denied Entry Before	4	0	8	4
Denied Entry After	4	0	0	1
Travel Distance (mi)	18967	19172	19479	19206
Travel Time (hr)	522.0	509.8	620.8	550.9
Total Delay (hr)	239.6	224.8	332.1	265.5
Total Stops	1443	1052	2412	1636
Fuel Used (gal)	6515.1	6591.7	6817.0	6641.3

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4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	27.0	27.0
Delay / Veh (s)	14.8	14.8
Total Stops	190	190
Travel Dist (mi)	3166.7	3166.7
Travel Time (hr)	80.3	80.3
Avg Speed (mph)	41	41
Fuel Used (gal)	1403.5	1403.5
HC Emissions (g)	214	214
CO Emissions (g)	114168	114168
NOx Emissions (g)	758	758
Vehicles Entered	6544	6544
Vehicles Exited	6539	6539
Hourly Exit Rate	6539	6539
Input Volume	6600	6600
% of Volume	99	99
Denied Entry Before	4	4
Denied Entry After	1	1

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	210.6	210.6
Delay / Veh (s)	117.4	117.4
Total Stops	1436	1436
Travel Dist (mi)	14373.4	14373.4
Travel Time (hr)	418.6	418.6
Avg Speed (mph)	34	34
Fuel Used (gal)	4326.2	4326.2
HC Emissions (g)	596	596
CO Emissions (g)	259332	259332
NOx Emissions (g)	2157	2157
Vehicles Entered	6539	6539
Vehicles Exited	6377	6377
Hourly Exit Rate	6377	6377
Input Volume	6600	6600
% of Volume	97	97
Denied Entry Before	0	0
Denied Entry After	0	0

Total Network Performance

Total Delay (hr)	265.5
Delay / Veh (s)	148.0
Total Stops	1636
Travel Dist (mi)	19206.4
Travel Time (hr)	550.9
Avg Speed (mph)	35
Fuel Used (gal)	6641.3
HC Emissions (g)	936
CO Emissions (g)	436150
NOx Emissions (g)	3398
Vehicles Entered	6544
Vehicles Exited	6368
Hourly Exit Rate	6368
Input Volume	19800
% of Volume	32
Denied Entry Before	4
Denied Entry After	1

I-4 Contraflow Evaluation
Baseline

Three EB Through Plus Shoulder Lane
11/30/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	14.8	44.2	0.5	43	44	12.8
Cty Line Off Ramp	6	117.4	233.4	2.2	34	35	106.7
Total		132.3	277.5	2.7	35	37	119.5

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	44	14.0	41	17.7
Cty Line Off Ramp	37	95.9	30	149.2
Total	38	109.8	31	166.8

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB	EB
Directions Served	T	T	T	T
Maximum Queue (ft)	2561	2562	2556	1707
Average Queue (ft)	284	284	142	114
95th Queue (ft)	1610	1611	1109	984
Link Distance (ft)	2551	2551	2551	2551
Upstream Blk Time (%)	0	0	0	0
Queuing Penalty (veh)	0	0	0	0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB	EB
Directions Served	T	T	T	TR
Maximum Queue (ft)	994	1265	257	357
Average Queue (ft)	103	148	88	132
95th Queue (ft)	792	862	216	293
Link Distance (ft)	11483	11483	11483	11483
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt C1 – Three EB Through Plus Shoulder Lane
Baseline — Simulation #2 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	6620	6680	6819	6706
Vehs Exited	6360	6407	6424	6397
Starting Vehs	411	467	478	453
Ending Vehs	671	740	873	761
Denied Entry Before	8	2	5	5
Denied Entry After	0	4	0	1
Travel Distance (mi)	19400	19548	19869	19606
Travel Time (hr)	587.4	612.2	716.5	638.7
Total Delay (hr)	298.9	322.1	422.6	347.9
Total Stops	2082	2191	2820	2364
Fuel Used (gal)	6737.8	6835.8	7048.3	6874.0

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Run Number	10	11	12	Avg
Vehs Entered	6620	6680	6819	6706
Vehs Exited	6360	6407	6424	6397
Starting Vehs	411	467	478	453
Ending Vehs	671	740	873	761
Denied Entry Before	8	2	5	5
Denied Entry After	0	4	0	1
Travel Distance (mi)	19400	19548	19869	19606
Travel Time (hr)	587.4	612.2	716.5	638.7
Total Delay (hr)	298.9	322.1	422.6	347.9
Total Stops	2082	2191	2820	2364
Fuel Used (gal)	6737.8	6835.8	7048.3	6874.0

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4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	34.6	34.6
Delay / Veh (s)	18.6	18.6
Total Stops	208	208
Travel Dist (mi)	3246.5	3246.5
Travel Time (hr)	88.8	88.8
Avg Speed (mph)	39	39
Fuel Used (gal)	1437.5	1437.5
HC Emissions (g)	213	213
CO Emissions (g)	109419	109419
NOx Emissions (g)	771	771
Vehicles Entered	6706	6706
Vehicles Exited	6713	6713
Hourly Exit Rate	6713	6713
Input Volume	6750	6750
% of Volume	99	99
Denied Entry Before	5	5
Denied Entry After	1	1

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	284.8	284.8
Delay / Veh (s)	156.4	156.4
Total Stops	2147	2147
Travel Dist (mi)	14685.7	14685.7
Travel Time (hr)	497.2	497.2
Avg Speed (mph)	30	30
Fuel Used (gal)	4516.0	4516.0
HC Emissions (g)	579	579
CO Emissions (g)	242151	242151
NOx Emissions (g)	2095	2095
Vehicles Entered	6713	6713
Vehicles Exited	6402	6402
Hourly Exit Rate	6402	6402
Input Volume	6750	6750
% of Volume	95	95
Denied Entry Before	0	0
Denied Entry After	0	0

I-4 Contraflow Evaluation
Baseline

Three EB Through Plus Shoulder Lane
11/30/2007

Total Network Performance

Total Delay (hr)	347.9
Delay / Veh (s)	191.2
Total Stops	2364
Travel Dist (mi)	19605.6
Travel Time (hr)	638.7
Avg Speed (mph)	31
Fuel Used (gal)	6874.0
HC Emissions (g)	918
CO Emissions (g)	414193
NOx Emissions (g)	3353
Vehicles Entered	6706
Vehicles Exited	6397
Hourly Exit Rate	6397
Input Volume	20250
% of Volume	32
Denied Entry Before	5
Denied Entry After	1

I-4 Contraflow Evaluation
Baseline

Three EB Through Plus Shoulder Lane
11/30/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	18.6	47.6	0.5	41	42	15.5
Cty Line Off Ramp	6	156.4	273.0	2.2	29	31	134.4
Total		174.9	320.6	2.7	31	33	149.9

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	42	16.9	39	23.1
Cty Line Off Ramp	30	143.9	26	190.2
Total	32	160.8	27	213.3

I-4 Contraflow Evaluation — Three EB Through Plus Shoulder Lane
Baseline — 11/30/2007

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB	EB
Directions Served	T	T	T	T
Maximum Queue (ft)	2564	2563	2562	2562
Average Queue (ft)	284	256	256	199
95th Queue (ft)	1612	1523	1523	1330
Link Distance (ft)	2551	2551	2551	2551
Upstream Blk Time (%)	0	0	0	0
Queuing Penalty (veh)	0	0	0	0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB	EB
Directions Served	T	T	T	TR
Maximum Queue (ft)	290	502	533	630
Average Queue (ft)	46	90	115	137
95th Queue (ft)	174	277	324	379
Link Distance (ft)	11483	11483	11483	11483
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt C1 - Three EB Through Plus Shoulder Lane
Baseline — Simulation #3 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	6666	6719	6882	6756
Vehs Exited	6367	6417	6405	6396
Starting Vehs	424	452	504	460
Ending Vehs	723	754	981	819
Denied Entry Before	5	4	10	6
Denied Entry After	0	6	2	3
Travel Distance (mi)	19514	19621	19936	19690
Travel Time (hr)	598.8	610.5	788.3	665.9
Total Delay (hr)	308.7	319.5	493.7	373.9
Total Stops	2349	2230	3993	2857
Fuel Used (gal)	6753.8	6839.1	7192.9	6928.6

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Run Number	10	11	12	Avg
Vehs Entered	6666	6719	6882	6756
Vehs Exited	6367	6417	6405	6396
Starting Vehs	424	452	504	460
Ending Vehs	723	754	981	819
Denied Entry Before	5	4	10	6
Denied Entry After	0	6	2	3
Travel Distance (mi)	19514	19621	19936	19690
Travel Time (hr)	598.8	610.5	788.3	665.9
Total Delay (hr)	308.7	319.5	493.7	373.9
Total Stops	2349	2230	3993	2857
Fuel Used (gal)	6753.8	6839.1	7192.9	6928.6

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Appendix B (Continued)

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	38.9	38.9
Delay / Veh (s)	20.7	20.7
Total Stops	240	240
Travel Dist (mi)	3269.4	3269.4
Travel Time (hr)	93.2	93.2
Avg Speed (mph)	38	38
Fuel Used (gal)	1433.2	1433.2
HC Emissions (g)	208	208
CO Emissions (g)	104775	104775
NOx Emissions (g)	763	763
Vehicles Entered	6756	6756
Vehicles Exited	6758	6758
Hourly Exit Rate	6758	6758
Input Volume	6800	6800
% of Volume	99	99
Denied Entry Before	6	6
Denied Entry After	3	3

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	306.7	306.7
Delay / Veh (s)	167.8	167.8
Total Stops	2610	2610
Travel Dist (mi)	14747.2	14747.2
Travel Time (hr)	520.1	520.1
Avg Speed (mph)	28	28
Fuel Used (gal)	4565.8	4565.8
HC Emissions (g)	575	575
CO Emissions (g)	236963	236963
NOx Emissions (g)	2082	2082
Vehicles Entered	6758	6758
Vehicles Exited	6404	6404
Hourly Exit Rate	6404	6404
Input Volume	6800	6800
% of Volume	94	94
Denied Entry Before	0	0
Denied Entry After	0	0

Appendix B (Continued)

Total Network Performance

Total Delay (hr)	373.9
Delay / Veh (s)	204.7
Total Stops	2857
Travel Dist (mi)	19690.5
Travel Time (hr)	665.9
Avg Speed (mph)	30
Fuel Used (gal)	6928.6
HC Emissions (g)	911
CO Emissions (g)	405983
NOx Emissions (g)	3339
Vehicles Entered	6756
Vehicles Exited	6396
Hourly Exit Rate	6396
Input Volume	20400
% of Volume	31
Denied Entry Before	6
Denied Entry After	3

I-4 Contraflow Evaluation
Baseline

Three EB Through Plus Shoulder Lane
11/30/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	20.7	49.7	0.5	40	42	16.4
Cty Line Off Ramp	6	167.8	284.6	2.2	28	31	138.6
Total		188.5	334.2	2.7	29	32	155.0

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	41	17.9	38	27.6
Cty Line Off Ramp	31	140.9	23	223.0
Total	32	158.9	25	250.6

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB	EB
Directions Served	T	T	T	T
Maximum Queue (ft)	2561	2563	2559	2563
Average Queue (ft)	199	171	171	171
95th Queue (ft)	1330	1224	1224	1224
Link Distance (ft)	2551	2551	2551	2551
Upstream Blk Time (%)	0	0	0	0
Queuing Penalty (veh)	0	0	0	0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB	EB
Directions Served	T	T	T	TR
Maximum Queue (ft)	909	1106	1305	1207
Average Queue (ft)	78	176	197	204
95th Queue (ft)	541	719	670	630
Link Distance (ft)	11483	11483	11483	11483
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt C1 - Three EB Through Plus Shoulder Lane
SimTraffic Simulation Summary — Simulation #4 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	Avg
Start Time	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75
Time Recorded (min)	60	60	60	60
# of Intervals	2	2	2	2
# of Recorded Intvls	1	1	1	1
Vehs Entered	6885	6862	7090	6946
Vehs Exited	6377	6404	6403	6395
Starting Vehs	448	477	514	480
Ending Vehs	956	935	1201	1030
Denied Entry Before	4	6	19	10
Denied Entry After	14	36	6	19
Travel Distance (mi)	19919	19909	20251	20027
Travel Time (hr)	714.8	717.5	905.7	779.3
Total Delay (hr)	420.0	423.0	607.4	483.5
Total Stops	3368	3142	4450	3653
Fuel Used (gal)	7051.3	7074.8	7493.1	7206.4

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Run Number	10	11	12	Avg
Vehs Entered	6885	6862	7090	6946
Vehs Exited	6377	6404	6403	6395
Starting Vehs	448	477	514	480
Ending Vehs	956	935	1201	1030
Denied Entry Before	4	6	19	10
Denied Entry After	14	36	6	19
Travel Distance (mi)	19919	19909	20251	20027
Travel Time (hr)	714.8	717.5	905.7	779.3
Total Delay (hr)	420.0	423.0	607.4	483.5
Total Stops	3368	3142	4450	3653
Fuel Used (gal)	7051.3	7074.8	7493.1	7206.4

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Appendix B (Continued)

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	61.7	61.7
Delay / Veh (s)	32.0	32.0
Total Stops	297	297
Travel Dist (mi)	3360.3	3360.3
Travel Time (hr)	116.6	116.6
Avg Speed (mph)	36	36
Fuel Used (gal)	1513.1	1513.1
HC Emissions (g)	208	208
CO Emissions (g)	99713	99713
NOx Emissions (g)	784	784
Vehicles Entered	6946	6946
Vehicles Exited	6946	6946
Hourly Exit Rate	6946	6946
Input Volume	7000	7000
% of Volume	99	99
Denied Entry Before	10	10
Denied Entry After	19	19

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	392.9	392.9
Delay / Veh (s)	211.9	211.9
Total Stops	3346	3346
Travel Dist (mi)	14993.4	14993.4
Travel Time (hr)	609.6	609.6
Avg Speed (mph)	25	25
Fuel Used (gal)	4765.7	4765.7
HC Emissions (g)	547	547
CO Emissions (g)	214318	214318
NOx Emissions (g)	2001	2001
Vehicles Entered	6946	6946
Vehicles Exited	6401	6401
Hourly Exit Rate	6401	6401
Input Volume	7000	7000
% of Volume	91	91
Denied Entry Before	0	0
Denied Entry After	0	0

I-4 Contraflow Evaluation
SimTraffic Performance Report

Three EB Through Plus Shoulder Lane
11/30/2007

Total Network Performance

Total Delay (hr)	483.5
Delay / Veh (s)	260.9
Total Stops	3653
Travel Dist (mi)	20026.6
Travel Time (hr)	779.3
Avg Speed (mph)	27
Fuel Used (gal)	7206.4
HC Emissions (g)	882
CO Emissions (g)	376821
NOx Emissions (g)	3277
Vehicles Entered	6946
Vehicles Exited	6395
Hourly Exit Rate	6395
Input Volume	21000
% of Volume	30
Denied Entry Before	10
Denied Entry After	19

I-4 Contraflow Evaluation
Arterial Level of Service

Three EB Through Plus Shoulder Lane
11/30/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	32.0	60.4	0.5	38	39	22.0
Cty Line Off Ramp	6	211.9	328.9	2.2	24	26	189.9
Total		243.9	389.3	2.7	26	27	211.9

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay
Park Rd On Ramp	39	22.9	36	50.5
Cty Line Off Ramp	26	190.0	21	255.2
Total	27	212.8	23	305.7

I-4 Contraflow Evaluation — Three EB Through Plus Shoulder Lane
Queuing and Blocking Report — 11/30/2007

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB	EB
Directions Served	T	T	T	T
Maximum Queue (ft)	2573	2565	2563	2554
Average Queue (ft)	455	512	398	142
95th Queue (ft)	2071	2202	1927	1108
Link Distance (ft)	2551	2551	2551	2551
Upstream Blk Time (%)	0	0	0	0
Queuing Penalty (veh)	0	0	0	0
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB	EB
Directions Served	T	T	T	TR
Maximum Queue (ft)	216	474	652	770
Average Queue (ft)	42	108	168	184
95th Queue (ft)	129	314	437	485
Link Distance (ft)	11483	11483	11483	11483
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 0

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I-4 Contraflow Evaluation — Alt C2 – Two Contraflow Lanes
Baseline — Simulation #1 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	13	14	Avg
Start Time	4:45	4:45	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intvls	1	1	1	1	1	1
Vehs Entered	3911	3999	4055	3943	3983	3978
Vehs Exited	3809	3813	3833	3830	3846	3826
Starting Vehs	229	263	271	244	263	254
Ending Vehs	331	449	493	357	400	406
Denied Entry Before	1	0	1	0	0	0
Denied Entry After	3	0	1	0	2	1
Travel Distance (mi)	11426	11660	11735	11528	11685	11607
Travel Time (hr)	297.1	364.1	373.4	326.4	365.5	345.3
Total Delay (hr)	128.9	192.8	201.1	156.6	194.0	174.7
Total Stops	750	1496	1652	952	1533	1277
Fuel Used (gal)	3836.0	4071.5	4083.8	3935.2	4085.3	4002.3

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Run Number	10	11	12	13	14	Avg
Vehs Entered	3911	3999	4055	3943	3983	3978
Vehs Exited	3809	3813	3833	3830	3846	3826
Starting Vehs	229	263	271	244	263	254
Ending Vehs	331	449	493	357	400	406
Denied Entry Before	1	0	1	0	0	0
Denied Entry After	3	0	1	0	2	1
Travel Distance (mi)	11426	11660	11735	11528	11685	11607
Travel Time (hr)	297.1	364.1	373.4	326.4	365.5	345.3
Total Delay (hr)	128.9	192.8	201.1	156.6	194.0	174.7
Total Stops	750	1496	1652	952	1533	1277
Fuel Used (gal)	3836.0	4071.5	4083.8	3935.2	4085.3	4002.3

12: I-4 C & Park Road On Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	11.0	0.7	11.7
Delay / Veh (s)	11.1	6.1	10.6
Total Stops	43	0	43
Travel Dist (ml)	1733.4	902.1	2635.5
Travel Time (hr)	38.9	13.8	52.7
Avg Speed (mph)	47	65	52
Fuel Used (gal)	759.1	290.5	1049.6
HC Emissions (g)	81	51	133
CO Emissions (g)	65147	21234	86380
NOx Emissions (g)	307	207	514
Vehicles Entered	3570	409	3979
Vehicles Exited	3567	411	3978
Hourly Exit Rate	3567	411	3978
Input Volume	3600	400	4000
% of Volume	99	103	99
Denied Entry Before	0	0	0
Denied Entry After	1	0	1

14: I-4 C & County Line Off Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	137.2	0.0	137.2
Delay / Veh (s)	141.4	0.3	126.6
Total Stops	1219	0	1219
Travel Dist (mi)	7795.9	97.5	7893.4
Travel Time (hr)	249.9	1.5	251.4
Avg Speed (mph)	31	66	31
Fuel Used (gal)	2412.8	36.9	2449.7
HC Emissions (g)	163	7	169
CO Emissions (g)	119558	3649	123208
NOx Emissions (g)	819	23	842
Vehicles Entered	3567	408	3975
Vehicles Exited	3420	409	3829
Hourly Exit Rate	3420	409	3829
Input Volume	3600	400	4000
% of Volume	95	102	96
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

Total Network Performance

Total Delay (hr)	174.7
Delay / Veh (s)	161.1
Total Stops	1277
Travel Dist (mi)	11606.9
Travel Time (hr)	345.3
Avg Speed (mph)	34
Fuel Used (gal)	4002.3
HC Emissions (g)	338
CO Emissions (g)	231719
NOx Emissions (g)	1526
Vehicles Entered	3978
Vehicles Exited	3826
Hourly Exit Rate	3826
Input Volume	12000
% of Volume	32
Denied Entry Before	0
Denied Entry After	1

I-4 Contraflow Evaluation
Baseline

Two Contraflow Lanes
11/30/2007

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Road On Ramp	12	11.1	39.2	0.5	48	49	9.8
County Line Off Ramp	14	141.4	257.5	2.2	31	37	95.5
Total		152.6	296.8	2.7	33	39	105.3

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
Park Road On Ramp	48	9.9	46	12.3	49	10.5	46
County Line Off Ramp	29	160.1	28	166.1	33	125.2	29
Total	31	169.9	30	178.4	35	135.7	31

Arterial Level of Service: WB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
County Line Off Ramp	14	0.3	13.2	0.2	69	69	0.3
Park Road On Ramp	12	6.1	121.1	2.2	65	66	5.6
Total		6.5	134.3	2.4	66	66	6.0

Arterial Level of Service: WB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
County Line Off Ramp	70	0.3	70	0.3	68	0.4	69
Park Road On Ramp	66	5.8	66	5.6	64	7.0	65
Total	67	6.2	66	5.9	64	7.4	65

Intersection: 12: I-4 C & Park Road On Ramp

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	1543	1541
Average Queue (ft)	86	51
95th Queue (ft)	847	645
Link Distance (ft)	2561	2561
Upstream Blk Time (%)	0	0
Queuing Penalty (veh)	0	0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 14: I-4 C & County Line Off Ramp

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	397	388
Average Queue (ft)	64	108
95th Queue (ft)	210	265
Link Distance (ft)	11536	11536
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation
Baseline

Alt c2 - Two Contraflow Lanes
Simulation #2 11/30/2007

Summary of All Intervals

Run Number	10	11	12	13	14	Avg
Start Time	4:45	4:45	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intvls	1	1	1	1	1	1
Vehs Entered	3947	4061	4111	3996	4024	4028
Vehs Exited	3805	3820	3829	3822	3830	3821
Starting Vehs	243	267	286	249	282	265
Ending Vehs	385	508	568	423	476	472
Denied Entry Before	0	3	1	1	1	1
Denied Entry After	1	1	0	0	1	1
Travel Distance (mi)	11500	11773	11820	11641	11744	11696
Travel Time (hr)	321.6	394.8	419.3	359.4	413.2	381.6
Total Delay (hr)	152.4	222.1	246.1	187.9	240.6	209.8
Total Stops	941	1666	1839	1391	1844	1537
Fuel Used (gal)	3928.1	4182.9	4215.6	4023.4	4194.3	4108.9

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Run Number	10	11	12	13	14	Avg
Vehs Entered	3947	4061	4111	3996	4024	4028
Vehs Exited	3805	3820	3829	3822	3830	3821
Starting Vehs	243	267	286	249	282	265
Ending Vehs	385	508	568	423	476	472
Denied Entry Before	0	3	1	1	1	1
Denied Entry After	1	1	0	0	1	1
Travel Distance (mi)	11500	11773	11820	11641	11744	11696
Travel Time (hr)	321.6	394.8	419.3	359.4	413.2	381.6
Total Delay (hr)	152.4	222.1	246.1	187.9	240.6	209.8
Total Stops	941	1666	1839	1391	1844	1537
Fuel Used (gal)	3928.1	4182.9	4215.6	4023.4	4194.3	4108.9

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SimTraffic Report
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12: I-4 C & Park Road On Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	12.6	0.7	13.3
Delay / Veh (s)	12.6	6.1	11.9
Total Stops	63	0	63
Travel Dist (mi)	1757.8	900.4	2658.2
Travel Time (hr)	40.8	13.8	54.5
Avg Speed (mph)	46	65	51
Fuel Used (gal)	785.9	289.8	1075.8
HC Emissions (g)	83	51	135
CO Emissions (g)	66729	21216	87946
NOx Emissions (g)	317	206	524
Vehicles Entered	3620	409	4029
Vehicles Exited	3615	409	4024
Hourly Exit Rate	3615	409	4024
Input Volume	3650	400	4050
% of Volume	99	102	99
Denied Entry Before	1	0	1
Denied Entry After	1	0	1

14: I-4 C & County Line Off Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	171.0	0.0	171.0
Delay / Veh (s)	175.2	0.3	156.9
Total Stops	1457	0	1457
Travel Dist (mi)	7863.4	97.3	7960.7
Travel Time (hr)	284.6	1.5	286.1
Avg Speed (mph)	28	66	28
Fuel Used (gal)	2489.1	36.8	2525.9
HC Emissions (g)	152	7	159
CO Emissions (g)	113360	3648	117008
NOx Emissions (g)	778	23	801
Vehicles Entered	3615	408	4023
Vehicles Exited	3414	409	3823
Hourly Exit Rate	3414	409	3823
Input Volume	3650	400	4050
% of Volume	94	102	94
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

Total Network Performance

Total Delay (hr)	209.8
Delay / Veh (s)	192.5
Total Stops	1537
Travel Dist (mi)	11695.6
Travel Time (hr)	381.6
Avg Speed (mph)	31
Fuel Used (gal)	4108.9
HC Emissions (g)	330
CO Emissions (g)	227476
NOx Emissions (g)	1499
Vehicles Entered	4028
Vehicles Exited	3821
Hourly Exit Rate	3821
Input Volume	12150
% of Volume	31
Denied Entry Before	1
Denied Entry After	1

I-4 Contraflow Evaluation
Baseline

Two Contraflow Lanes
11/30/2007

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Road On Ramp	12	12.6	40.6	0.5	47	48	11.5
County Line Off Ramp	14	175.2	291.6	2.2	27	34	119.8
Total		187.7	332.1	2.7	29	36	131.2

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
Park Road On Ramp	46	12.7	45	14.4	49	10.7	46
County Line Off Ramp	26	185.1	24	208.6	29	156.6	25
Total	28	197.9	27	223.0	31	167.4	27

Arterial Level of Service: WB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
County Line Off Ramp	14	0.3	13.2	0.2	69	69	0.3
Park Road On Ramp	12	6.1	121.2	2.2	65	66	5.7
Total		6.5	134.4	2.4	66	66	6.0

Arterial Level of Service: WB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
County Line Off Ramp	70	0.3	70	0.3	68	0.4	69
Park Road On Ramp	66	5.8	66	5.6	64	7.0	65
Total	67	6.1	66	6.0	64	7.3	65

Intersection: 12: I-4 C & Park Road On Ramp

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	2059	2056
Average Queue (ft)	137	86
95th Queue (ft)	1091	847
Link Distance (ft)	2561	2561
Upstream Blk Time (%)	0	0
Queuing Penalty (veh)	0	0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 14: I-4 C & County Line Off Ramp

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	276	511
Average Queue (ft)	59	119
95th Queue (ft)	165	318
Link Distance (ft)	11536	11536
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation
Baseline

Alt C2- Two Contraflow Lanes
Simulation #3 11/30/2007

Summary of All Intervals

Run Number	10	11	12	13	14	Avg
Start Time	4:45	4:45	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intvls	1	1	1	1	1	1
Vehs Entered	3995	4114	4151	4030	4090	4076
Vehs Exited	3812	3832	3816	3840	3831	3826
Starting Vehs	247	279	302	268	292	278
Ending Vehs	430	561	637	458	551	528
Denied Entry Before	1	0	1	0	1	1
Denied Entry After	0	2	0	5	2	2
Travel Distance (mi)	11597	11873	11853	11705	11841	11774
Travel Time (hr)	345.3	423.3	466.3	386.7	458.0	415.9
Total Delay (hr)	174.7	249.5	292.4	214.3	284.2	243.0
Total Stops	1272	1627	2608	1909	2248	1933
Fuel Used (gal)	3985.1	4235.5	4290.4	4097.4	4277.1	4177.1

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Run Number	10	11	12	13	14	Avg
Vehs Entered	3995	4114	4151	4030	4090	4076
Vehs Exited	3812	3832	3816	3840	3831	3826
Starting Vehs	247	279	302	268	292	278
Ending Vehs	430	561	637	458	551	528
Denied Entry Before	1	0	1	0	1	1
Denied Entry After	0	2	0	5	2	2
Travel Distance (mi)	11597	11873	11853	11705	11841	11774
Travel Time (hr)	345.3	423.3	466.3	386.7	458.0	415.9
Total Delay (hr)	174.7	249.5	292.4	214.3	284.2	243.0
Total Stops	1272	1627	2608	1909	2248	1933
Fuel Used (gal)	3985.1	4235.5	4290.4	4097.4	4277.1	4177.1

12: I-4 C & Park Road On Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	14.0	0.7	14.7
Delay / Veh (s)	13.8	6.1	13.0
Total Stops	75	0	75
Travel Dist (mi)	1780.9	899.3	2680.1
Travel Time (hr)	42.4	13.8	56.2
Avg Speed (mph)	45	65	50
Fuel Used (gal)	794.0	289.4	1083.4
HC Emissions (g)	82	51	134
CO Emissions (g)	65594	21191	86786
NOx Emissions (g)	319	206	526
Vehicles Entered	3669	408	4077
Vehicles Exited	3664	408	4072
Hourly Exit Rate	3664	408	4072
Input Volume	3700	400	4100
% of Volume	99	102	99
Denied Entry Before	1	0	1
Denied Entry After	2	0	2

14: I-4 C & County Line Off Ramp Performance by movement

Movement	EBT	WBT	All
Total Delay (hr)	202.2	0.0	202.3
Delay / Veh (s)	205.8	0.3	184.6
Total Stops	1842	0	1842
Travel Dist (mi)	7920.0	97.1	8017.1
Travel Time (hr)	316.7	1.5	318.2
Avg Speed (mph)	25	66	25
Fuel Used (gal)	2555.2	36.8	2591.9
HC Emissions (g)	141	7	148
CO Emissions (g)	106373	3639	110012
NOx Emissions (g)	742	23	764
Vehicles Entered	3664	407	4071
Vehicles Exited	3412	408	3820
Hourly Exit Rate	3412	408	3820
Input Volume	3700	400	4100
% of Volume	92	102	93
Denied Entry Before	0	0	0
Denied Entry After	0	0	0

I-4 Contraflow Evaluation
Baseline

Two Contraflow Lanes
11/30/2007

Total Network Performance

Total Delay (hr)	243.0
Delay / Veh (s)	221.4
Total Stops	1933
Travel Dist (mi)	11773.7
Travel Time (hr)	415.9
Avg Speed (mph)	28
Fuel Used (gal)	4177.1
HC Emissions (g)	317
CO Emissions (g)	218700
NOx Emissions (g)	1459
Vehicles Entered	4076
Vehicles Exited	3826
Hourly Exit Rate	3826
Input Volume	12300
% of Volume	31
Denied Entry Before	1
Denied Entry After	2

I-4 Contraflow Evaluation
Baseline

Two Contraflow Lanes
11/30/2007

Arterial Level of Service: EB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Road On Ramp	12	13.8	41.7	0.5	46	47	12.2
County Line Off Ramp	14	205.8	322.2	2.2	25	31	139.1
Total		219.5	363.9	2.7	27	33	151.3

Arterial Level of Service: EB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
Park Road On Ramp	44	14.8	45	14.8	47	12.8	45
County Line Off Ramp	24	209.4	21	252.5	27	180.2	22
Total	26	224.1	24	267.3	29	192.9	24

Arterial Level of Service: WB I-4 C

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
County Line Off Ramp	14	0.3	13.2	0.2	69	69	0.3
Park Road On Ramp	12	6.1	121.4	2.2	65	65	5.7
Total		6.5	134.6	2.4	66	66	6.0

Arterial Level of Service: WB I-4 C

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
County Line Off Ramp	70	0.3	69	0.3	68	0.4	69
Park Road On Ramp	66	5.8	66	5.6	64	7.0	65
Total	67	6.2	66	6.0	64	7.4	65

Intersection: 12: I-4 C & Park Road On Ramp

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	2059	1028
Average Queue (ft)	86	34
95th Queue (ft)	848	520
Link Distance (ft)	2561	2561
Upstream Blk Time (%)	0	0
Queuing Penalty (veh)	0	0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 14: I-4 C & County Line Off Ramp

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	386	580
Average Queue (ft)	77	136
95th Queue (ft)	230	376
Link Distance (ft)	11536	11536
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt D — Three Contraflow Lanes
Baseline — Simulation #1 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	13	14	Avg
Start Time	4:45	4:45	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intvls	1	1	1	1	1	1
Vehs Entered	5215	5245	5129	5192	5221	5200
Vehs Exited	4947	4953	4921	4946	4938	4941
Starting Vehs	310	358	344	358	348	343
Ending Vehs	578	650	552	604	631	603
Denied Entry Before	0	0	3	1	0	1
Denied Entry After	0	3	4	0	0	1
Travel Distance (mi)	15163	15262	15035	15124	15273	15171
Travel Time (hr)	464.1	531.6	407.8	476.2	518.8	479.7
Total Delay (hr)	239.9	306.0	185.0	252.4	292.4	255.1
Total Stops	2666	3157	1725	2467	3445	2693
Fuel Used (gal)	5417.4	5563.0	5250.8	5413.1	5531.3	5435.1

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	13	14	Avg
Vehs Entered	5215	5245	5129	5192	5221	5200
Vehs Exited	4947	4953	4921	4946	4938	4941
Starting Vehs	310	358	344	358	348	343
Ending Vehs	578	650	552	604	631	603
Denied Entry Before	0	0	3	1	0	1
Denied Entry After	0	3	4	0	0	1
Travel Distance (mi)	15163	15262	15035	15124	15273	15171
Travel Time (hr)	464.1	531.6	407.8	476.2	518.8	479.7
Total Delay (hr)	239.9	306.0	185.0	252.4	292.4	255.1
Total Stops	2666	3157	1725	2467	3445	2693
Fuel Used (gal)	5417.4	5563.0	5250.8	5413.1	5531.3	5435.1

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4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	14.1	14.1
Delay / Veh (s)	9.7	9.7
Total Stops	78	78
Travel Dist (mi)	2535.0	2535.0
Travel Time (hr)	56.1	56.1
Avg Speed (mph)	47	47
Fuel Used (gal)	1131.2	1131.2
HC Emissions (g)	123	123
CO Emissions (g)	99295	99295
NOx Emissions (g)	458	458
Vehicles Entered	5200	5200
Vehicles Exited	5192	5192
Hourly Exit Rate	5192	5192
Input Volume	5200	5200
% of Volume	100	100
Denied Entry Before	1	1
Denied Entry After	1	1

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	216.3	216.3
Delay / Veh (s)	153.6	153.6
Total Stops	2605	2605
Travel Dist (mi)	11344.9	11344.9
Travel Time (hr)	380.2	380.2
Avg Speed (mph)	30	30
Fuel Used (gal)	3588.1	3588.1
HC Emissions (g)	247	247
CO Emissions (g)	187345	187345
NOx Emissions (g)	1167	1167
Vehicles Entered	5192	5192
Vehicles Exited	4948	4948
Hourly Exit Rate	4948	4948
Input Volume	5200	5200
% of Volume	95	95
Denied Entry Before	0	0
Denied Entry After	0	0

I-4 Contraflow Evaluation
Baseline

Three Contraflow Lanes
11/30/2007

Total Network Performance

Total Delay (hr)	255.1
Delay / Veh (s)	181.1
Total Stops	2693
Travel Dist (mi)	15171.3
Travel Time (hr)	479.7
Avg Speed (mph)	32
Fuel Used (gal)	5435.1
HC Emissions (g)	426
CO Emissions (g)	326185
NOx Emissions (g)	1898
Vehicles Entered	5200
Vehicles Exited	4941
Hourly Exit Rate	4941
Input Volume	15600
% of Volume	32
Denied Entry Before	1
Denied Entry After	1

I-4 Contraflow Evaluation
Baseline

Three Contraflow Lanes
11/30/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed	Run 10 Speed	Run 10 Delay
Park Rd On Ramp	4	9.7	38.9	0.5	48	49	9.0
Cty Line Off Ramp	6	153.6	270.0	2.2	29	30	143.2
Total		163.3	308.8	2.7	32	33	152.2

Arterial Level of Service: EB I-4 F

Cross Street	Run 11 Speed	Run 11 Delay	Run 12 Speed	Run 12 Delay	Run 13 Speed	Run 13 Delay	Run 14 Speed
Park Rd On Ramp	48	10.6	49	8.5	48	10.2	47
Cty Line Off Ramp	26	188.0	35	106.6	30	151.2	27
Total	28	198.6	37	115.1	32	161.4	29

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB
Directions Served	T	T
Maximum Queue (ft)	2064	2067
Average Queue (ft)	120	138
95th Queue (ft)	1018	1095
Link Distance (ft)	2573	2573
Upstream Blk Time (%)	0	0
Queuing Penalty (veh)	0	0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB
Directions Served	T	T	TR
Maximum Queue (ft)	784	1584	2000
Average Queue (ft)	112	248	403
95th Queue (ft)	425	840	1361
Link Distance (ft)	11494	11494	11494
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt D - Three Contraflow Lanes
Baseline — Simulation #2 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	13	14	Avg
Start Time	4:45	4:45	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intvls	1	1	1	1	1	1
Vehs Entered	5224	5259	5412	5272	5237	5281
Vehs Exited	4978	4980	4954	4914	4966	4958
Starting Vehs	337	371	364	330	414	363
Ending Vehs	583	650	822	688	685	686
Denied Entry Before	0	0	0	0	0	0
Denied Entry After	8	0	4	0	0	2
Travel Distance (mi)	15251	15329	15555	15272	15258	15333
Travel Time (hr)	460.0	504.9	604.1	508.0	571.4	529.7
Total Delay (hr)	234.3	278.2	374.5	282.1	345.5	302.9
Total Stops	2261	2430	5026	3463	3529	3341
Fuel Used (gal)	5407.7	5518.1	5778.0	5535.6	5633.0	5574.5

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	13	14	Avg
Vehs Entered	5224	5259	5412	5272	5237	5281
Vehs Exited	4978	4980	4954	4914	4966	4958
Starting Vehs	337	371	364	330	414	363
Ending Vehs	583	650	822	688	685	686
Denied Entry Before	0	0	0	0	0	0
Denied Entry After	8	0	4	0	0	2
Travel Distance (mi)	15251	15329	15555	15272	15258	15333
Travel Time (hr)	460.0	504.9	604.1	508.0	571.4	529.7
Total Delay (hr)	234.3	278.2	374.5	282.1	345.5	302.9
Total Stops	2261	2430	5026	3463	3529	3341
Fuel Used (gal)	5407.7	5518.1	5778.0	5535.6	5633.0	5574.5

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4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	16.2	16.2
Delay / Veh (s)	11.1	11.1
Total Stops	104	104
Travel Dist (mi)	2575.5	2575.5
Travel Time (hr)	58.9	58.9
Avg Speed (mph)	46	46
Fuel Used (gal)	1165.7	1165.7
HC Emissions (g)	126	126
CO Emissions (g)	101320	101320
NOx Emissions (g)	471	471
Vehicles Entered	5281	5281
Vehicles Exited	5277	5277
Hourly Exit Rate	5277	5277
Input Volume	5250	5250
% of Volume	101	101
Denied Entry Before	0	0
Denied Entry After	2	2

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	261.8	261.8
Delay / Veh (s)	184.1	184.1
Total Stops	3229	3229
Travel Dist (mi)	11462.1	11462.1
Travel Time (hr)	427.2	427.2
Avg Speed (mph)	27	27
Fuel Used (gal)	3689.7	3689.7
HC Emissions (g)	234	234
CO Emissions (g)	178480	178480
NOx Emissions (g)	1124	1124
Vehicles Entered	5277	5277
Vehicles Exited	4960	4960
Hourly Exit Rate	4960	4960
Input Volume	5250	5250
% of Volume	94	94
Denied Entry Before	0	0
Denied Entry After	0	0

Total Network Performance

Total Delay (hr)	302.9
Delay / Veh (s)	213.0
Total Stops	3341
Travel Dist (mi)	15333.0
Travel Time (hr)	529.7
Avg Speed (mph)	29
Fuel Used (gal)	5574.5
HC Emissions (g)	415
CO Emissions (g)	319687
NOx Emissions (g)	1869
Vehicles Entered	5281
Vehicles Exited	4958
Hourly Exit Rate	4958
Input Volume	15750
% of Volume	31
Denied Entry Before	0
Denied Entry After	2

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	16.2	16.2
Delay / Veh (s)	11.1	11.1
Total Stops	104	104
Travel Dist (mi)	2575.5	2575.5
Travel Time (hr)	58.9	58.9
Avg Speed (mph)	46	46
Fuel Used (gal)	1165.7	1165.7
HC Emissions (g)	126	126
CO Emissions (g)	101320	101320
NOx Emissions (g)	471	471
Vehicles Entered	5281	5281
Vehicles Exited	5277	5277
Hourly Exit Rate	5277	5277
Input Volume	5250	5250
% of Volume	101	101
Denied Entry Before	0	0
Denied Entry After	2	2

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	261.8	261.8
Delay / Veh (s)	184.1	184.1
Total Stops	3229	3229
Travel Dist (mi)	11462.1	11462.1
Travel Time (hr)	427.2	427.2
Avg Speed (mph)	27	27
Fuel Used (gal)	3689.7	3689.7
HC Emissions (g)	234	234
CO Emissions (g)	178480	178480
NOx Emissions (g)	1124	1124
Vehicles Entered	5277	5277
Vehicles Exited	4960	4960
Hourly Exit Rate	4960	4960
Input Volume	5250	5250
% of Volume	94	94
Denied Entry Before	0	0
Denied Entry After	0	0

I-4 Contraflow Evaluation
Baseline

Three Contraflow Lanes
11/30/2007

Total Network Performance

Total Delay (hr)	302.9
Delay / Veh (s)	213.0
Total Stops	3341
Travel Dist (mi)	15333.0
Travel Time (hr)	529.7
Avg Speed (mph)	29
Fuel Used (gal)	5574.5
HC Emissions (g)	415
CO Emissions (g)	319687
NOx Emissions (g)	1869
Vehicles Entered	5281
Vehicles Exited	4958
Hourly Exit Rate	4958
Input Volume	15750
% of Volume	31
Denied Entry Before	0
Denied Entry After	2

I-4 Contraflow Evaluation
Baseline

Three Contraflow Lanes
11/30/2007

Arterial Level of Service: EB I-4 F

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Park Rd On Ramp	4	11.1	40.2	0.5	47
Cty Line Off Ramp	6	184.1	300.5	2.2	26
Total		195.2	340.7	2.7	29

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB
Directions Served	T	T	T
Maximum Queue (ft)	2582	2066	1549
Average Queue (ft)	172	138	86
95th Queue (ft)	1234	1095	851
Link Distance (ft)	2573	2573	2573
Upstream Blk Time (%)	0	0	0
Queuing Penalty (veh)	0	0	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB
Directions Served	T	T	TR
Maximum Queue (ft)	2568	3121	3356
Average Queue (ft)	317	456	533
95th Queue (ft)	2050	2231	2335
Link Distance (ft)	11494	11494	11494
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

I-4 Contraflow Evaluation — Alt D – Three Contraflow Lanes
Baseline — Simulation #3 — 11/30/2007

Summary of All Intervals

Run Number	10	11	12	13	14	Avg
Start Time	4:45	4:45	4:45	4:45	4:45	4:45
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	75	75	75	75	75	75
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intvls	1	1	1	1	1	1
Vehs Entered	5334	5308	5424	5377	5272	5343
Vehs Exited	4969	4940	4967	4952	4898	4945
Starting Vehs	388	387	422	345	327	373
Ending Vehs	753	755	879	770	701	771
Denied Entry Before	1	0	2	0	0	1
Denied Entry After	0	0	0	0	0	0
Travel Distance (mi)	15462	15385	15583	15491	15274	15439
Travel Time (hr)	587.0	586.5	656.5	569.8	520.2	584.0
Total Delay (hr)	358.4	358.4	426.4	340.8	293.9	355.6
Total Stops	4550	3643	4961	3495	3490	4028
Fuel Used (gal)	5656.6	5639.2	5854.1	5695.7	5551.4	5679.4

Interval #0 Information Seeding

Start Time	4:45
End Time	5:00
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60

Volumes adjusted by Growth Factors.

Run Number	10	11	12	13	14	Avg
Vehs Entered	5334	5308	5424	5377	5272	5343
Vehs Exited	4969	4940	4967	4952	4898	4945
Starting Vehs	388	387	422	345	327	373
Ending Vehs	753	755	879	770	701	771
Denied Entry Before	1	0	2	0	0	1
Denied Entry After	0	0	0	0	0	0
Travel Distance (mi)	15462	15385	15583	15491	15274	15439
Travel Time (hr)	587.0	586.5	656.5	569.8	520.2	584.0
Total Delay (hr)	358.4	358.4	426.4	340.8	293.9	355.6
Total Stops	4550	3643	4961	3495	3490	4028
Fuel Used (gal)	5656.6	5639.2	5854.1	5695.7	5551.4	5679.4

4: I-4 F & Park Rd On Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	17.4	17.4
Delay / Veh (s)	11.7	11.7
Total Stops	98	98
Travel Dist (mi)	2607.4	2607.4
Travel Time (hr)	60.5	60.5
Avg Speed (mph)	45	45
Fuel Used (gal)	1165.5	1165.5
HC Emissions (g)	123	123
CO Emissions (g)	98065	98065
NOx Emissions (g)	470	470
Vehicles Entered	5343	5343
Vehicles Exited	5343	5343
Hourly Exit Rate	5343	5343
Input Volume	5300	5300
% of Volume	101	101
Denied Entry Before	1	1
Denied Entry After	0	0

6: I-4 F & Cty Line Off Ramp Performance by movement

Movement	EBT	All
Total Delay (hr)	313.6	313.6
Delay / Veh (s)	219.4	219.4
Total Stops	3921	3921
Travel Dist (mi)	11539.7	11539.7
Travel Time (hr)	480.2	480.2
Avg Speed (mph)	24	24
Fuel Used (gal)	3791.8	3791.8
HC Emissions (g)	216	216
CO Emissions (g)	166092	166092
NOx Emissions (g)	1066	1066
Vehicles Entered	5343	5343
Vehicles Exited	4947	4947
Hourly Exit Rate	4947	4947
Input Volume	5300	5300
% of Volume	93	93
Denied Entry Before	0	0
Denied Entry After	0	0

Appendix B (Continued)

Total Network Performance

Total Delay (hr)	355.6
Delay / Veh (s)	248.8
Total Stops	4028
Travel Dist (mi)	15438.9
Travel Time (hr)	584.0
Avg Speed (mph)	27
Fuel Used (gal)	5679.4
HC Emissions (g)	394
CO Emissions (g)	304186
NOx Emissions (g)	1813
Vehicles Entered	5343
Vehicles Exited	4945
Hourly Exit Rate	4945
Input Volume	15900
% of Volume	31
Denied Entry Before	1
Denied Entry After	0

Intersection: 4: I-4 F & Park Rd On Ramp

Movement	EB	EB	EB
Directions Served	T	T	T
Maximum Queue (ft)	2581	2585	516
Average Queue (ft)	138	189	17
95th Queue (ft)	1094	1300	364
Link Distance (ft)	2573	2573	2573
Upstream Blk Time (%)	0	0	0
Queuing Penalty (veh)	0	0	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 6: I-4 F & Cty Line Off Ramp

Movement	EB	EB	EB
Directions Served	T	T	TR
Maximum Queue (ft)	2602	3012	2885
Average Queue (ft)	287	445	541
95th Queue (ft)	1826	2047	2461
Link Distance (ft)	11494	11494	11494
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 0

ABOUT THE AUTHOR

Jason Scott Collins, Ph.D, P.E., AICP was originally born and raised in Milwaukee, Wisconsin. Building from his personal hobbies of geography and automobiles, he attended Vanderbilt University where he obtained is Bachelor of Engineering degree with a focus on transportation. Then shortly after, Jason attended University of South Florida where he received his Master's degree in Civil Engineering through the University's Interdisciplinary Program of Public Administration and Economics.

Transforming his personal hobbies into his career, Jason has since worked for consulting engineering firms managing transportation planning, traffic operations, permitting, and design projects. He is currently the Florida Manager of Trans Associates Engineering Consultants, Inc. Jason lives in Tampa, Florida with his wife Carly.