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Impact analysis of the Panama Canal expansion on Alabama

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IMPACT ANALYSIS OF THE PANAMA CANAL EXPANSION ON ALABAMA

by

JAEHOON KIM

A THESIS

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We, the undersigned members of the Graduate Faculty of The University of Alabama in Huntsville, certify that we have advised and/or supervised the candidate on the work described in this thesis. We further certify that we have reviewed the thesis manuscript and approve it in partial fulfillment of the requirements for the degree of Master of Science in Engineering.

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ABSTRACT

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Title Impact Analysis of the Panama Canal Expansion on Alabama

The Panama Canal expansion project begins in 2007 and is expected to be completed in 2014. The expansion project will have significant impact the international trade route, freight distribution and U.S maritime and intermodal system. The expected result from the expansion is amount of freight volume will be diverted from the West Coast ports to the East/Gulf Coast ports. The goal of this thesis is to analyze the impact of the Panama Canal expansion on the highway`s of Alabama. The analysis uses the Alabama Transportation Infrastructure Model (ATIM) and the Freight Analysis Framework database for computing volume/capacity ratio for several potential growth scenarios. The study concludes that Alabama statewide network does not have significant changing by increased freight volume and the port of Mobile can be attractive facility to new shipping clients.

Abstract Approval: Committee Chair Michael [signature]

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I love you, mom.

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CHAPTER I

INTRODUCTION

The Panama Canal expansion is a major issue in international trade and logistics because the canal expansion will have a significant impact on international trade routes, port facilities, freight distribution systems and the U.S maritime and intermodal system (Knight, 2008). Since its opening in 1914, the Panama Canal has been the most important link connecting the Pacific and Atlantic Oceans. Since opening, freight volume passing through the Panama Canal has continuously increased. Today, the Canal`s capacity is becoming strained. The Panama Canal Authority (ACP) estimated that the Panama Canal will reach its maximum capacity between 2009 and 2012 (ACP, 2006). After the Canal reaches capacity, it will not be able to efficiently handle freight demand, waiting time will be increased and service quality will decrease. The congestion will also reduce the Canal`s competitiveness as shipper will move away from the Panama Canal, using Suez Canal or another alternative routes. Therefore, the ACP decided to expand the Canal`s capacity, constructing a third set of locks. The expansion project began 2007 and is

expected to be completed in 2014 (ACP, 2006).

The expansion of the Panama Canal project will add one new lane and two lock facilities at each end of the Canal to the current two lock lanes. After construction, the Canal`s capacity will double as new container dry bulk vessels called Post-Panamax, will be able to pass through the Canal. This additional capacity is expected to shift cargo between Asia and the U.S from west coast ports to east coast and gulf coast ports (ACP, 2006). This shift is expected to reduce west coast port congestion (Rodrigue, 2010).

The goal of this research is to analyze the impact of the expansion of the Panama Canal on the highway`s of Alabama. The analysis uses the Alabama Transportation Infrastructure Model (ATIM) and the third generation of Freight Analysis Framework (FAF3) database. It is hypothesized that the added capacity will adversely impact the highway in highways in Alabama. This research performs a sensitivity analysis of traffic volumes. The models will examine volume/capacity ratios for several Alabama highways using various growth scenarios. The thesis presents a literature review related to the project, a study methodology, case study and results. The thesis concludes that the impact on Alabama highways will be limited, when using even high growth scenario.

CHAPTER II

LITERATURE REVIEW

A. Overview of the expansion of the Panama Canal

The Panama Canal expansion project is one of the most important current transportation projects in the world today. It will allow most Post-Panamax vessels to use the canal and will likely change transportation flow patterns between Asia and the U.S, as well as port utilization and transportation flows inland in the U.S (Sheffi, 2011).

The Panama Canal will reach its maximum capacity between the year 2009 and 2012 (ACP, 2006). When capacity is reach, it will be unable to handle the growing demand and maintain quality service. Traditionally, international trade volumes have continuously increased, but recent increases vessel in size has facilitated significant growth. However, since 2004 the cargo volumes growth has coincided with vessel volume growth (ACP, 2006). This growth has led to new containership sizes beyond the Panama Canal lock`s capacity (Rodrigue, 2010). To accommodate these larger vessels, an expansion project is expected to be completed in 2014.

The current Canal has two channels. The expansion of the Panama Canal will construct an additional lane with new lock facilities (See Figure 2.1). The third canal lane will double the Panama Canal capacity because it will increase operational efficiency and allow larger ships to pass the canal (ACP, 2006).

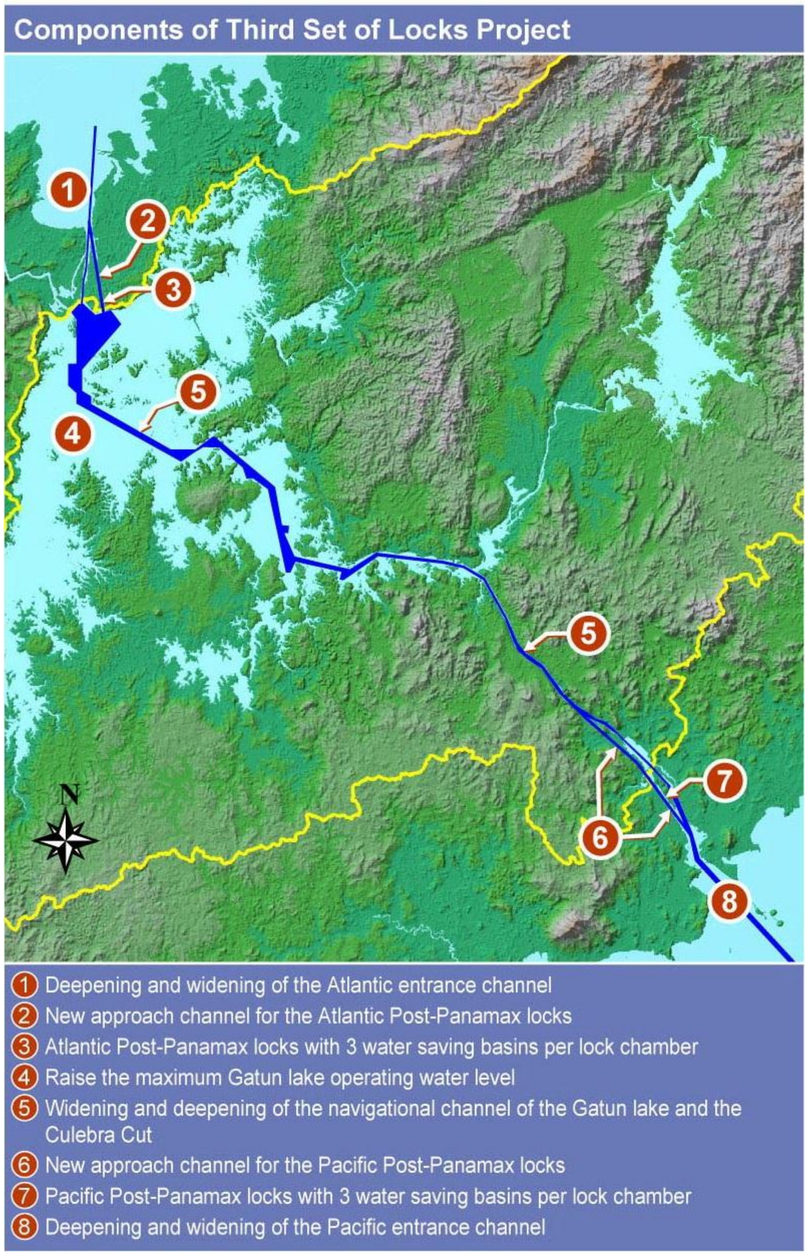

Figure 2.1 The Panama Canal Expansion outline (ACP, 2006)

Current mega-containerships are too large to use the Panama Canal. The new Panama Canal lock system will be able to handle larger containership named Post-Panamax (Knight, 2008). The Panamax vessel is 965 feet long and 106 feet wide, and has a maximum capacity if 4,500 twenty-foot equivalent units (TEU) (ACP, 2006). The Post-Panamax vessel is 1,200 feet long and 160 feet wide, and is capable of handling up to 12,000 TEU (ACP, 2006) (See Figure 2.2). The new lock and deepening the channel through the Canal will allow Post-Panamax vessels to be able to pass through the Canal. The proposed lock will also facilitate the Post-Panamax liquid vessels named Suezmax, dry bulk vessels named Capesize and other liquefied natural gas vessels (ACP, 2006).

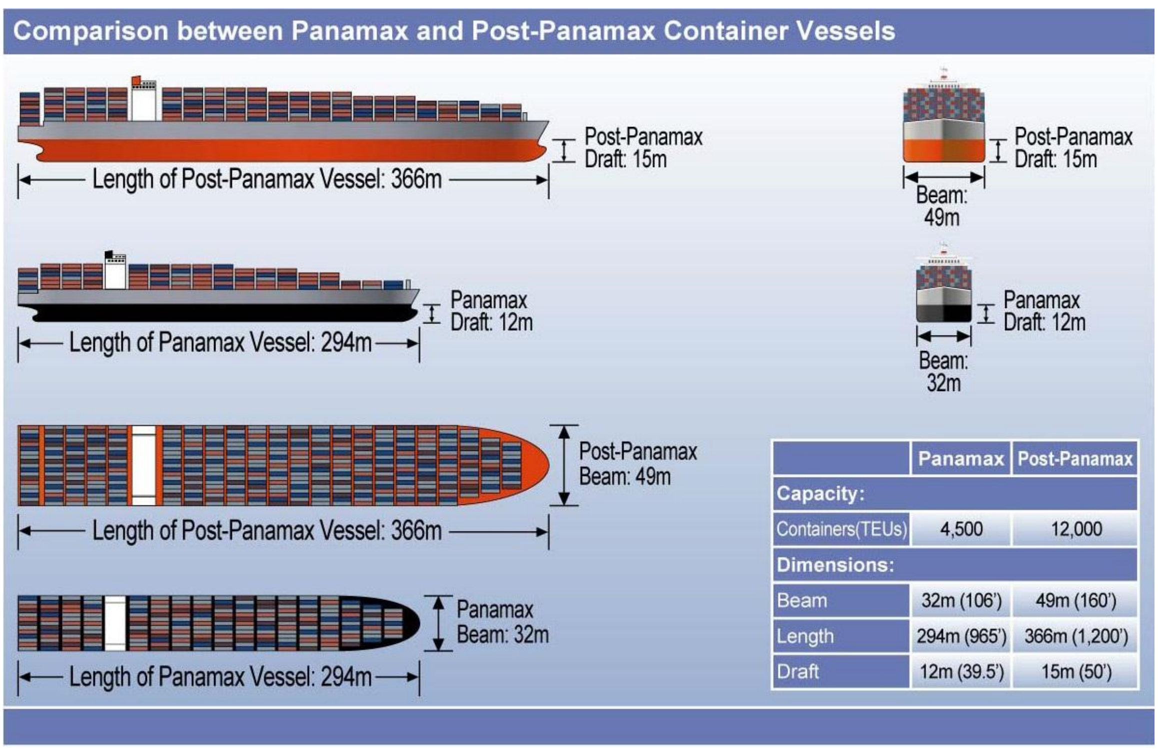

Figure 2.2 Comparison between Panamax and Post-Panamax (ACP, 2006)

The current lock system at the Panama Canal has annual capacity of 248,000 TEU using 4,800 TEU containerships, by contrast, the Suez Canal can handle 410,000 TEU shipping using the Post-Panamax. After 2014, the Panama Canal can accommodate 8,000 TEU containerships, allowing the Canal service over 410,000 TEU annually (ACP, 2006).

B. Expected Impact

One of the greatest impacts of the Panama Canal expansion will be changes in freight flow, specifically trade between Asia and the east/gulf coast of U.S. This volume has traditionally used west coast ports and travels overland on the road and/or rail network. But this freight switch to the East/Gulf Coasts ports (Knight, 2008). There are four routes for the trade between Asia and the U.S. The routes are through the Panama Canal, the Suez Canal, maritime routes around the Cape of Good Hope and Cape Horn (ACP, 2006). According to Rodrigue, there are two major trade routes which are the U.S intermodal routes with gateways along the West Coast and the all-water route. At present, the Panama Canal has a 38 percent market share of route between Pacific Asia and the U.S, west coast ports and the U.S intermodal system has 61 percent of the share, and the 1 percent remaining is shipped via the Suez Canal (ACP, 2006) (See Figure 2.3). The U.S intermodal system consists of large number of components such as the west coast ports, railroad and transcontinental road system. In the last decade, west coast ports cost have increased due to congestion and increased trade with Asia. Furthermore, cost for the intermodal system has been increasing due to fuel cost and regulation for protecting environment. As a result, the use of the Panama Canal has been largely increased for the decade (ACP, 2006).

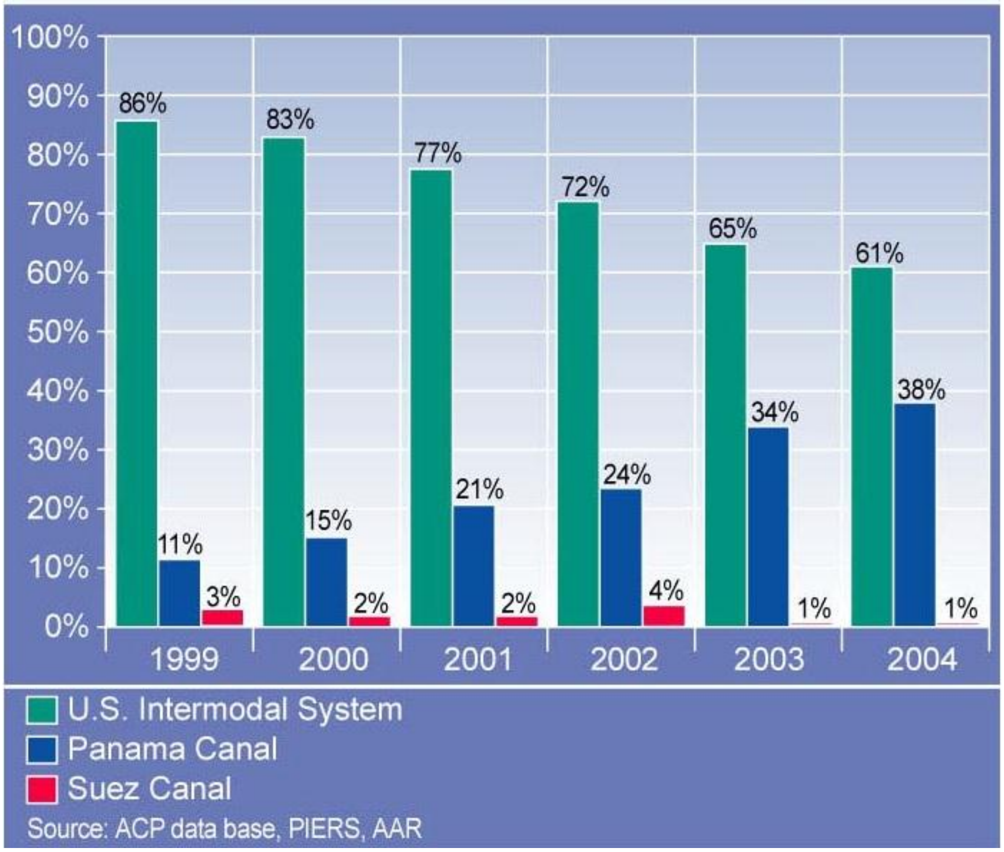

Figure 2.3 Market share of the container shipping Asia to U.S (ACP, 2006)

Freight volume from Asia to West Coast ports account for 75 percent of imports from Asia. The Panama Canal expansion will allow East/Gulf Coast ports to be competitive in the shipping market. Shippers generally consider three criteria in the routing of freight which are cost, time and reliability. A survey of the world largest shippers concluded that 38 percent of the respondents preferred cost, 12 percent preferred transit time and 43 percent preferred schedule reliability (Rodrigue, 2010).

The cost structure of freight transport is important in determining routing options. The expansion will affect cost of operating containership. A current Panamax shipping 4,000 TEU has annual operating expense of about $2,314/TEU (Rodrigue, 2010). Meanwhile, Post-Panamax vessels shipping 10,000 TEU have an expense of about

$1,450/TEU. The Post-Panamax vessels have approximately $860/TEU (Costa et al, 2011).

The expansion allows only capacity increases, not speed increases (ACP, 2006). Examining shipping time from Asia to the east coast, freight takes 13 days for transpacific crossing and 6 days of intermodal transport. Whereas freight travel time via the Panama Canal takes 22 days and the travel time via Suez Canal is 21 days (Rodrigue, 2010). Freight routed through the Panama Canal has the longest overall travel time.

U.S intermodal system moved 82 percent of U.S-Asia trade in 2000, however, the freight flow using the intermodal system has since decreased and now accounts for 55 percent in 2007 (Rodrigue, 2010). The reasons why freight shifted from intermodal along West Coast to East/Gulf Coast directly are caused by unreliability of the intermodal system and cost. The intermodal travel time has been affected by labor problem such as strikes, lack of expert labor, and congestion (Salin, 2010). Additionally, many major container ports in the U.S are reaching their capacity which will increase travel time. The ports of Los Angeles, Long Beach, New York, New Jersey, Seattle, Savannah and Oakland have 69 percent of the foreign trade container in 2008 (Salin, 2010). The new Panama Canal will have a role in reducing the West Coast congestion on routes and increase diverting shipments from the West Coast to the East/Gulf Coast (Costa et al, 2011).

The expansion of the Panama Canal will significantly affect port development. Due to the expansion, the East/Gulf Coast ports started increasing port capacity deepening channels to attract volume. Additionally, many port authorities along the

East/Gulf Coasts have signed memorandums of understanding (MOU) with ACP (Rodrigue, 2010). For example, the port of Miami has invested in intermodal rail service, rail and bridge project to improve competitiveness (Sheffi, 2011). Also, the port of New York and New Jersey are dredging their channels to 50 feet (Rodrigue, 2010). The Alabama State Port Authority completed improvements the port of Mobile to grow shipping volume (ASPA, 2011).

On the other hand, there are some opposite opinions to the impacts of the expansion of the Panama Canal. The expected diversion rate of freight flow is overestimated because the major West Coast ports including Los Angeles, Long Beach, Portland and Seattle have been improving their intermodal service in cooperation with Western railroads to guarantee competitiveness of cost and service (Sheffi, 2011). Also the West Coast ports will ameliorate road service to reduce congestions on network around the ports area (Sheffi, 2011).

C. Diverge Rate

The expansion of the Panama Canal is expected to increase cost differential between all-water route and inland intermodal system (Rodrigue, 2010). Current cost differential could save in range of \$75 to \$75, that matches maritime route for import from Asia of about 28 percent (Rodrigue, 2010). The expansion will allow the differential to increase in the range of in the range of \$25 to \$50 per TEU per day (Rodrigue, 2010). As a result, the market share of all-water route would be increased in the range of 40-50 percent (Rodrigue, 2010).

After expanding the Panama Canal, about 208,000 TEU of cargo traffic would be

diverted from West Coast ports to Gulf/East Coast ports via the Panama Canal (Lei Fan, 2009). Specifically, freight volume at port of Houston is the potential to increase 22 percent (Lei Fan, 2009) Also, other research estimates 25 percent of the West Coast cargo could be diverted to East/Gulf Coast ports via the Panama Canal (Wakeman, 2010).

Another study shows that the expansion of the Panama Canal is expected to reduce 28 percent maritime costs for world cotton trade (Costa et al, 2011). According to the research, only 15 percent of total U.S exports of cotton are transported via the West Coast ports (Costa et al, 2011). On the other hand, exports from Gulf/East Coast ports are estimated to be increase to 9,990 cotton bales from 5,119 bales (an increase of over 95 percent) (Costa et al, 2011).

The various rate of diversion have been estimated. Many estimates project between 20 percent to 35 percent of the West Coast cargo will be diverted to the East/Gulf Coast (Sheffi, 2011). However, the rate of diversion will depend on the toll imposed by ACP (Sheffi, 2011).

D. Modeling freight analysis

The Alabama Transportation Infrastructure Model (ATIM) is a discrete event simulation model to analyze the impact of changing freight patterns for accurate planning of transportation infrastructure (Anderson, 2007). The ATIM is able to generate performance measures that are average speed and average congestion level for road segment (Anderson, 2009). To run the simulation, an origin-destination (OD) table identify the locations where the cargo trips begin and end is required (Anderson, 2009). The table has to include the freight volumes for each OD pair.

CHAPTER III

Methodology

A. Data

For this research, the best available data is the Federal Highway Administration`s (FHWA) Freight Analysis Framework database. The third generation of Freight Analysis Framework (FAF3) is developed by FHWA to provide data and analytical capability to help various public needs. FAF3 integrates data from the 2007 Commodity Flow Survey (CFS) (See Table 3.1) and various sources to develop comprehensive representation of freight flow among states and major metropolitan area by a variety of transportation modes (FHWA website). The FAF3 provides a commodity flow Origin-Destination (OD) by type of commodity and mode of transportation (See Table 3.2) on all highways within the FAF3 network. FAF3 consists of total 123 CFS regions (See Figure 3.1). Also, the figure shows 8 world OP points for U.S trade partners. The 2002 values are the most recent estimates from 2007 CFS with various data sources. Estimates of forecasting are created for 2010 to 2040 in 5-year increment.

Table 3.1 Listing of commodities on FAF3 Database

SCTG*	Context	BTS/Census Full Commodity Name
01	Live animals/fish	Live animals and live fish
02	Cereal grains	Cereal grains
03	Other ag prods.	Other agricultural products
04	Animal feed	Animal feed and products of animal origin, n.e.c.1
05	Meat/seafood	Meat, fish, seafood, and their preparations
06	Milled grain prods.	Milled grain products and preparations, bakery products
07	Other foodstuffs	Other prepared foodstuffs and fats and oils
08	Alcoholic beverages	Alcoholic beverages
09	Tobacco prods.	Tobacco products
10	Building stone	Monumental or building stone
11	Natural sands	Natural sands
12	Gravel	Gravel and crushed stone
13	Nonmetallic minerals	Nonmetallic minerals n.e.c.1
14	Metallic ores	Metallic ores and concentrates
15	Coal	Coal
16	Crude petroleum	Crude Petroleum
17	Gasoline	Gasoline and aviation turbine fuel
18	Fuel oils	Fuel oils
19	Coal-n.e.c.1	Coal and petroleum products, n.e.c.1 (Note: primarily natural gas, selected coal products, and products of petroleum refining, excluding gasoline, aviation fuel, and fuel oil.)
20	Basic chemicals	Basic chemicals
21	Pharmaceuticals	Pharmaceutical products
22	Fertilizers	Fertilizers
23	Chemical prods.	Chemical products and preparations, n.e.c.1
24	Plastics/rubber	Plastics and rubber
25	Logs	Logs and other wood in the rough
26	Wood prods.	Wood products
27	Newsprint/paper	Pulp, newsprint, paper, and paperboard
28	Paper articles	Paper or paperboard articles
29	Printed prods.	Printed products
30	Textiles/leather	Textiles, leather, and articles of textiles or leather
31	Nonmetal min. prods.	Nonmetallic mineral products
32	Base metals	Base metal in primary or semi-finished forms and in finished basic shapes
33	Articles-base metal	Articles of base metal

34	Machinery	Machinery
35	Electronics	Electronic and other electrical equipment and components and office equipment
36	Motorized vehicles	Motorized and other vehicles (including parts)
37	Transport equip.	Transportation equipment, n.e.c.1
38	Precision instruments	Precision instruments and apparatus
39	Furniture	Furniture, mattresses and mattress supports, lamps, lighting fittings
40	Misc. mfg. prods.	Miscellaneous manufactured products
41	Waste/scrap	Waste and scrap
43	Mixed freight	Mixed freight
99	Unknown	Commodity unknown

* Standard Classification of Transported Goods (STCG)

* Source : FHWA, A description of the FAF3 Regional Database And How It Is Conducted, 2011

Table 3.2 Listing of Transportation Modes from FAF3

Mode ID	Mode Name	Mode Description
1	Truck	Includes private and for-hire truck. Private trucks are owned or operated by shippers, and exclude personal use vehicles hauling over-the-counter purchases from retail establishments.
2	Rail	Any common carrier or private railroad.
3	Water	Includes shallow draft, deep draft and Great Lakes shipments.
4	Air (includes truck-air)	Includes shipments typically weighing more than 100 pounds that move by air o r a combination of truck and air in commercial or private aircraft. Includes air freight and air express. Shipments typically weighing 100 pounds or less are classified with Multiple Modes and Mail.
5	Multiple Modes and Mail	Includes shipments by multiple modes and by parcel delivery services, U.S. Postal Service, or couriers. This category is not limited to containerized or trailer-on-flatcar shipments.
6	Pipeline	Includes flows from offshore wells to land, which are counted as water moves by the U.S. Army Corps of Engineers.
7	Other and Unknown	Includes flyaway aircraft, vessels, and vehicles moving under their own power from the manufacturer to a customer and not carrying any freight, unknown, and miscellaneous other modes of transport.
8	No Domestic Mode	A ‘No Domestic Mode’ category is used to capture petroleum imports that done to ensure a proper accounting when foreign and domestic flows are summed, while avoiding assigning flows to the domestic transportation network that do not use it.

* Source : FHWA, A description of the FAF3 Regional Database And How It Is Conducted, 2011

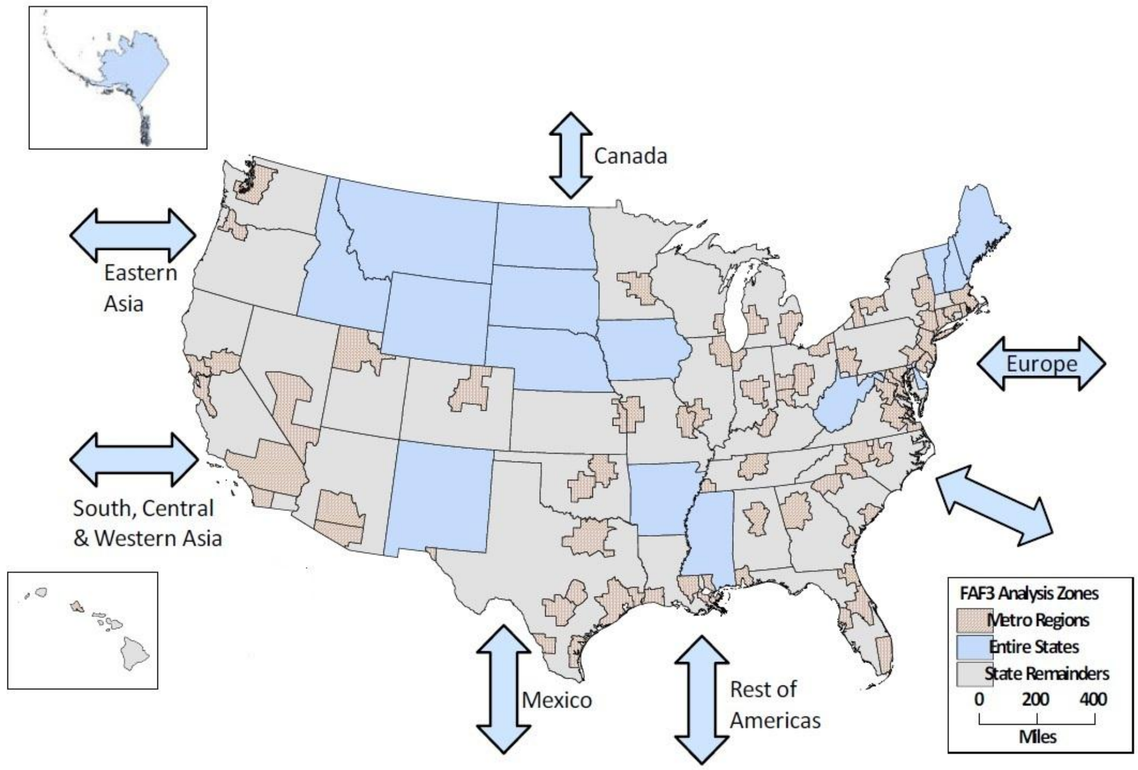

Figure 3.1 Geographic Location for FAF3 data (FHWA, 2010)

B. Database Preparation (FAF3 OD commodity flow table)

Using the FAF3 OD table, various queries were performed to select necessary OD pairs.

(1) Foreign Origin

This research focuses on imported freight volume from Asia to U.S. FAF3 database contains 8 international zones. Therefore, Asia (code 807) is selected to perform the analysis.

(2) Domestic Origin

FAF3 consists of 123 CFS zones. We need to select necessary OD pairs for this research. Table 3.3 shows major international trade ports in U.S with freight volume from Asia to the east of the Mississippi river area and CFS zone. According to the Figure 3.2, approximately 58 percent of the freight in 2007 (See Figure 3.2) and 59 percent of the freight in 2015 arrive from four major ports at the West Coast. The major ports at the West Coast are Los Angeles (061), Seattle (511), San Francisco (064) and Portland (411). The ports are selected to analyze freight flow from the West Coast ports to the East of the Mississippi river region.

Table 3.3 Freight Volume from Asia to the East of the Mississippi river

Code	Zone	Tonnage 2007	Tonnage 2015
061	Los Angeles CA CSA	49,041.77	53,152.02
486	Houston TX CSA	9,705.03	9,985.96
531	Seattle WA CSA	9,582.52	10,321.05
341	New York NY-NJ-CT-PA CSA	7,923.30	8,715.43
064	San Francisco, CA CSA	5,610.93	6,051.74
132	Savannah, GA CSA	4,664.91	5,075.03
411	Portland, OR-WA MSA (OR Part)	3,235.00	3,462.64
223	New Orleans, LA CSA	2,968.62	2,197.87
512	Norfolk, VA-NC MSA (VA Part)	2,218.57	2,432.25
241	Baltimore, MD MSA	1,958.57	2,077.15
122	Miami, FL MSA	1,751.24	1,727.13
012	Mobile, AL CSA	1,012.89	1,179.15
124	Tampa, FL MSA	800.45	634.34
421	Philadelphia, PA-NJ-DE-MD CSA (PA Part)	391.82	333.96
251	Boston, MA-NH CSA (MA Part)	375.59	410.07
342	Philadelphia, PA-NJ-DE-MD CSA (NJ Part)	193.79	164.48
482	Beaumont, TX MSA	63.72	77.67
092	New York, NY-NJ-CT-PA CSA (CT Part)	10.88	9.39
	Others	15,400.17	14,806.32

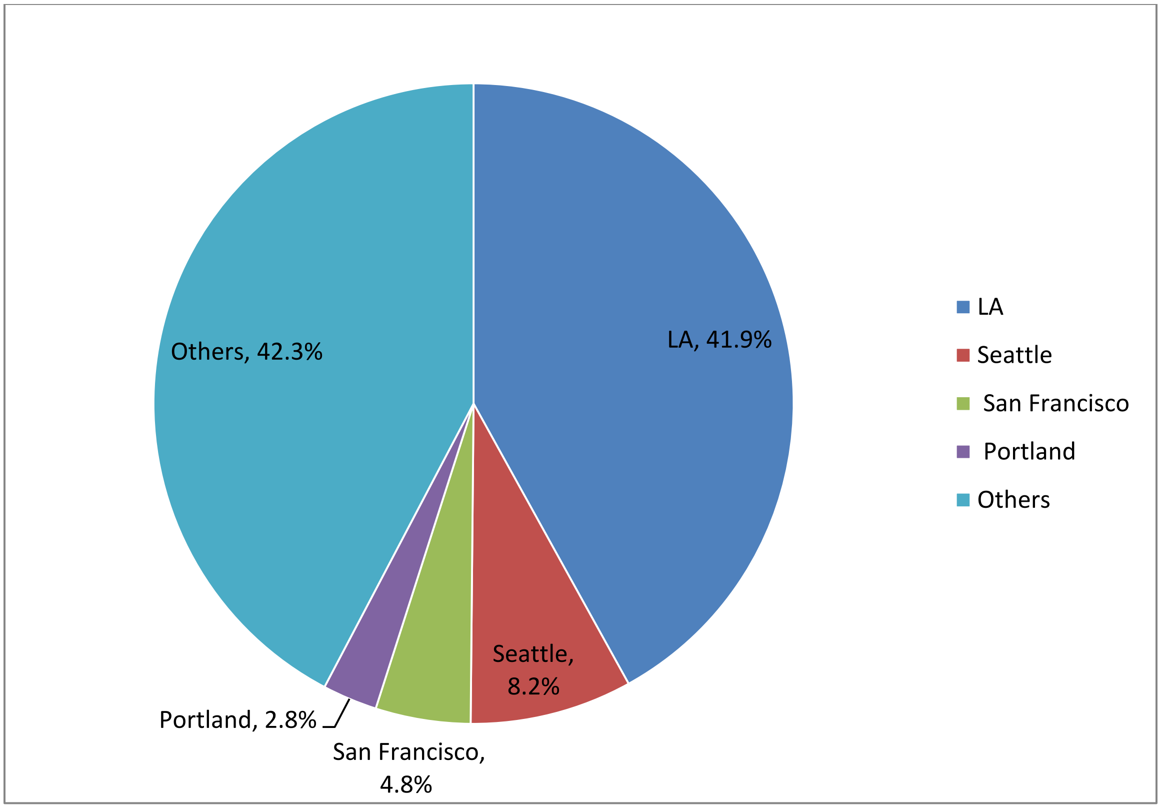

Figure 3.2 Freight Volume from Asia to the East of the Mississippi river in 2015

(3) Domestic destination

The area East of the Mississippi river regions comprise 74 zones in FAF3. In this research, 36 zones are selected to perform the analysis (See Table 3.3). According to ACP, the freight market share demarcation line would be shifted further west to connect Chicago and Dallas. For the reason, Wisconsin, Iowa and Missouri are additionally selected with the East of the Mississippi river regions.

Table 3.4 Selected zones from all of the East of Mississippi river regions

Zone No.	Zone Name	Zone No.	Zone Name
011	Birmingham, AL CSA	219	Remainder of Kentucky
012	Mobile, AL CSA	261	Detroit, MI CSA
019	Remainder of Alabama	262	Grand Rapids, MI CSA
121	Jacksonville, FL MSA	269	Remainder of Michigan
122	Miami, FL MSA	280	Mississippi
123	Orlando, FL CSA	291	Kansas City, MO-KS CSA (MO Part)
124	Tampa, FL MSA	292	St. Louis, MO-IL CSA (MO Part)
129	Remainder of Florida	299	Remainder of Missouri
131	Atlanta, GA-AL CSA (GA Part)	391	Cincinnati, OH-KY-IN CSA (OH Part)
132	Savannah, GA CSA	392	Cleveland, OH CSA
139	Remainder of Georgia	393	Columbus, OH CSA
171	Chicago, IL-IN-WI CSA (IL Part)	394	Dayton, OH CSA
172	St. Louis, MO-IL CSA (IL Part)	399	Remainder of Ohio
179	Remainder of Illinois	471	Memphis, TN-MS-AR MSA (TN Part)
181	Chicago, IL-IN-WI CSA (IN Part)	472	Nashville, TN CSA
182	Indianapolis, IN CSA	479	Remainder of Tennessee
189	Remainder of Indiana	551	Milwaukee, WI CSA
211	Louisville, KY-IN CSA (KY Part)	559	Remainder of Wisconsin

(4) Foreign Destination

The destination is not considered.

(5) Commodity

All commodities are selected to perform the query.

(6) Domestic mode

Domestic mode includes total seven modes such as truck, rail, air, multiple modes, pipeline and unknown modes. The truck mode is selected in this research.

(7) Inbound mode

There are several ways to ship commodities for trade. This research is to analyze the Panama Canal expansion, so only water way is considered to perform the research.

Approximately 50 percent of freight volume from Asia arrived at the selected East of the Mississippi river regions using major four of the West Coast ports. On the other hand, the freight volume from the port of Mobile is just 0.14 percent (See Table 3.5). However, the distance from LA to Chicago is more than 2,000 miles, but the distance from Mobile to Chicago is roughly 900 miles.

Table 3.5 Freight volume from Asia to the selected zones

Zone	Asia	LA		S.Fran		Portland		Seattle		Mobile	
121	195.33	36.509	18.7%	1.93	1.0%	0.20	0.1%	1.03	0.5%	1.99	1.0%
122	1539.80	156.877	10.2%	9.50	0.6%	0.91	0.1%	4.03	0.3%	0.70	0.0%
123	139.92	35.782	25.6%	0.53	0.4%	0.33	0.2%	0.69	0.5%	0.07	0.1%
124	279.22	42.981	15.4%	1.09	0.4%	0.01	0.0%	0.70	0.3%	0.10	0.0%
129	378.05	49.245	13.0%	0.70	0.2%	0.40	0.1%	1.02	0.3%	1.33	0.4%
131	1252.36	361.224	28.8%	10.71	0.9%	3.37	0.3%	30.50	2.4%	0.58	0.0%
132	136.73	8.575	6.3%	0.07	0.1%	-	0.0%	0.32	0.2%	0.10	0.1%
139	364.92	83.714	22.9%	5.14	1.4%	0.63	0.2%	5.80	1.6%	0.36	0.1%
171	3544.28	665.342	18.8%	75.64	2.1%	8.15	0.2%	496.33	14.0%	4.61	0.1%
172	43.51	27.668	63.6%	1.16	2.7%	-	0.0%	7.14	16.4%	-	0.0%
179	124.38	75.907	61.0%	3.00	2.4%	0.01	0.0%	10.36	8.3%	-	0.0%
181	10.78	6.282	58.3%	0.03	0.3%	-	0.0%	3.08	28.6%	-	0.0%
182	339.15	180.865	53.3%	1.65	0.5%	0.14	0.0%	72.79	21.5%	0.14	0.0%
189	277.30	200.194	72.2%	5.87	2.1%	0.45	0.2%	45.90	16.6%	-	0.0%
211	288.31	200.049	69.4%	1.75	0.6%	0.07	0.0%	50.92	17.7%	-	0.0%
219	393.52	136.575	34.7%	8.17	2.1%	0.06	0.0%	38.97	9.9%	-	0.0%
261	649.95	215.616	33.2%	38.87	6.0%	1.31	0.2%	111.85	17.2%	0.03	0.0%
262	139.22	81.643	58.6%	5.48	3.9%	0.03	0.0%	34.59	24.8%	-	0.0%
269	69.74	42.513	61.0%	1.13	1.6%	0.10	0.1%	20.07	28.8%	-	0.0%
280	254.85	116.861	45.9%	9.62	3.8%	0.37	0.1%	0.42	0.2%	10.21	4.0%
391	226.55	123.883	54.7%	2.69	1.2%	0.61	0.3%	57.20	25.2%	0.03	0.0%
392	551.14	248.086	45.0%	9.51	1.7%	0.17	0.0%	115.35	20.9%	-	0.0%

393	511.07	272.221	53.3%	3.56	0.7%	0.13	0.0%	66.25	13.0%	-	0.0%
394	61.10	43.931	71.9%	0.45	0.7%	-	0.0%	2.38	3.9%	-	0.0%
399	347.17	235.822	67.9%	17.44	5.0%	5.32	1.5%	41.04	11.8%	0.18	0.1%
471	558.60	452.126	80.9%	15.47	2.8%	0.97	0.2%	5.11	0.9%	-	0.0%
472	723.66	412.877	57.1%	2.37	0.3%	0.14	0.0%	58.37	8.1%	-	0.0%
479	319.54	167.328	52.4%	4.68	1.5%	1.22	0.4%	2.63	0.8%	0.26	0.1%
551	245.89	145.631	59.2%	6.24	2.5%	0.03	0.0%	46.20	18.8%	-	0.0%
559	435.63	236.834	54.4%	55.08	12.6%	1.02	0.2%	123.65	28.4%	-	0.0%
Total	14401.65	5063.16	35.2%	299.53	2.1%	26.13	0.2%	1454.68	10.1%	20.70	0.1%
		35.16%		2.08%		0.18%		10.10%		0.14%	

Table 3.6 shows travel time of freight volume spend from Shanghai, China to Chicago, U.S. 18.8 percent of Chicago from Asia arrives via LA port. It would take roughly 21 days to arrive. On the other hand, the travel time would be 26 days if the freight uses the port of Mobile. The inland intermodal system spends less time, but the shipping price is very expensive. For these reasons, the port of Mobile has competitiveness to be a gateway for trade from Asia to the East of the Mississippi river regions. According to Rodrigue, there are three options to choose the route: cost, time and reliability. If cost is the dominant factor to choose, all water routes will be preferred. On the other hand, if time is the predominant factor, the intermodal system will be selected by shipping owners (Rodrigue, 2010). According to a survey by Vickerman (2006), 38 percent of repondents prefer shipping rates, and 43 percent of the respondents prefer reliability. Only 12 percent of the respondents prefer shipping time. The Panama Canal route is less costly and high reliable, but it has a longer time to ship cargoes (Salin, 2010). Therefore, it is expected that large amount of the freight volume using the West Coast ports will be diverted to the all-water route via the Panama Canal.

Table 3.6 Expected shipping time between Shanghai and Chicago

Zone	Port Name	Travel Time From Shanghai to Chicago							Total
		Maritime				Inland			
		Mile	Days	Hours	Delay	Mile	Hours	Days	Days
012	Mobile AL CSA	9,728	23	20	-	900	12.9	2	26
061	Los Angeles CA CSA	5,724	14	1	2.2	2,014	28.8	4	21
064	San Francisco CA CSA	5,407	13	6	-	2,137	30.5	4	18
092	New York NY-NJ-CT-PA CSA	10,343	25	8	-	786	11.2	2	28
411	Portland OR-WA MSA	5,135	12	4	-	2,120	30.3	4	17
531	Seattle WA CSA	5,071	12	10	0.6	2,070	29.6	4	17

* Truck can move during only 8 hours per day

* Average waiting time at LA is roughly 2 days more

* Maritime travel time is calculated by port distance calculator at Sea-Rates.com

C. Scenarios

A sensitivity analysis is performed in this research. According to some researches, trade freight volume using the West Coast from Asia would be diverted to the East/Gulf Coast. The estimated rates vary. Although several researches indicate the diverge rate, there is no research to clearly present the rate between the West Coast and the port of Mobile. Therefore, we assume the increased freight volume using expected containership arrival and expected port of Mobile capacity.

In this research, we assume that the increased freight volume is related expected containership arrival at the port of Mobile. Also, there will be no effect to affect changing trade volume. For example, free trade agreement would cause significant trade volume increases. Therefore, we assume there is no event to affect total trade volume.

The first scenario is a base scenario and to forecast to the year 2015 developed

within FAF3 database without any adjustments. This scenario is the criteria to analyze what would happen if freight volumes grow under the normal conditions and the Panama Canal is not included in the analysis.

Six additional scenarios are prepared to analyze the impact. Each scenario involves increasing freight volume from Asia using the FAF3 database (See Table 3.7).

Table 3.7 Developed scenarios for simulation

Scenario	**Increased volume**	**Year**
Base (1)	-	2015
2	8,000 TEUs Post-Panamax vessel per two month	2015
3	8,000 TEUs Post-Panamax vessel per a month	2015
4	Two 8,000 TEUs Post-Panamax vessel per a month	2015
5	12,000 TEUs Post-Panamax vessel per two month	2015
6	12,000 TEUs Post-Panamax vessel per a month	2015
7	Two 12,000 TEUs Post-Panamax vessel per a month	2015

The second scenario is added expected traffic volume when a 8,000 TEU containership arrives once per two months. The third scenario obtains expected truck trips when the same vessel arrives once per a month. The fourth scenario has two of the vessel arrival per a month. The fifth, sixth and seventh scenario have same conditions except the vessel`s capacity. The capacity is 12,000 TEU in these scenarios.

There are more assumptions for this simulation. As a single TEU can be carried by one truck. It means 8,000 TEU containership product 8,000 truck trips. Also, a month has 22 work days excluding weekend. So, if a 8,000 TEU Post-Panamax arrives at the port of Mobile, the total roughly 364 outbound average daily truck trips will be added to the base scenario. We also consider outbound trips. We assume inbound trips are same with the outbound trips. Using the truck trips, we perform OD tables and add the OD tables to the base scenario for performing other scenarios.

The following tables show OD matrices of the expected traffic volume. Table 3.8 is the OD matrix of 8,000 TEU containership arrival and Table 3.9 is the OD matrix of 12,000 TEU containership arrival. The zone numbers are different with FAF3 zone numbers because it was necessary to change the numbers to apply to ATIM. These matrices are added to base scenario with proper adjustment.

Table 3.8 OD matrix of 8,000 TEU containership arrival

Outbound truck volume from Mobile			Inbound truck volume to Mobile		
Origin	Destination	Volume	Origin	Destination	Volume
710	386	5	386	710	5
710	854	2	753	710	2
710	753	4	854	710	4
710	1121	2	1097	710	0
710	1121	8	1097	710	4
710	1121	2	1097	710	103
710	1121	2	1121	710	8
710	1121	2	1121	710	2
710	1097	24	1121	710	2
710	1097	0	1121	710	2
710	1097	4	1121	710	24
710	1151	103	1127	710	6
710	1151	1	1151	710	1
710	1151	3	1151	710	3
710	1151	0	1151	710	0
710	1151	12	1151	710	12
710	1151	9	1151	710	9
710	1151	9	1151	710	9
710	1151	7	1151	710	7
710	1151	15	1151	710	15
710	1151	4	1151	710	4
710	1151	2	1151	710	2
710	1127	7	1151	710	7
710	1151	6	1151	710	9
710	1151	9	1151	710	4
710	1151	4	1151	710	7
710	1151	7	1151	710	14
710	1151	14	1151	710	17
710	1151	17	1151	710	2
710	1151	2	1151	710	11
710	1151	11	1151	710	21
710	1151	21	1151	710	21
710	1151	21	1151	710	7
710	1151	7	1151	710	7
710	1151	7	1151	710	11
710	1151	11			

Table 3.9 OD matrix of 12,000 TEU containership arrival

Inbound truck volume from Mobile			Outbound truck volume to Mobile		
Origin	Destination	Volume	Origin	Destination	Volume
710	386	8	386	710	8
710	854	2	753	710	3
710	753	6	854	710	6
710	1121	3	1097	710	1
710	1121	12	1097	710	6
710	1121	3	1097	710	155
710	1121	3	1121	710	12
710	1121	3	1121	710	3
710	1097	36	1121	710	3
710	1097	1	1121	710	3
710	1097	6	1121	710	36
710	1151	155	1127	710	9
710	1151	2	1151	710	2
710	1151	5	1151	710	5
710	1151	1	1151	710	1
710	1151	17	1151	710	17
710	1151	13	1151	710	13
710	1151	14	1151	710	14
710	1151	10	1151	710	10
710	1151	23	1151	710	23
710	1151	7	1151	710	7
710	1151	3	1151	710	3
710	1127	10	1151	710	10
710	1151	9	1151	710	14
710	1151	14	1151	710	7
710	1151	7	1151	710	11
710	1151	11	1151	710	22
710	1151	22	1151	710	25
710	1151	25	1151	710	3
710	1151	3	1151	710	17
710	1151	17	1151	710	31
710	1151	31	1151	710	31
710	1151	31	1151	710	10
710	1151	10	1151	710	11
710	1151	11	1151	710	16
710	1151	16			

CHAPTER IV

CASE STUDY

A. Analysis

The scenarios developed in Chapter III are simulated in this chapter using ATIM. Volume/Capacity ratio (V/C ratio) is developed to analyze the impact of the expansion of the Panama Canal with a focus on the V/C ratio on the interstate highways and major arterials for each scenario.

B. Result 1

This research identifies network segments where the V/C ratio exceeds 1.0. V/C ratio is one of the most important measures to analyze level of service or capacity of network facilities. Therefore, we verify V/C ratio for each scenario and compare base scenario and other scenarios.

Table 4.1 shows distance of overflow network segments for each scenario. The total centerline miles in Alabama are 3,514.1 miles of interstate highway and major arterials connected with adjacent states. The total network centerline miles in Alabama with V/C ratio > 1.0 are 1,912.13 miles in the base scenario. However, in the scenarios, the total mileage of road with V/C ratio > 1.0 is not significantly increased. The increasing congested network distance in scenario 4 is 3.74 mile and the distance is 3.52 mile in scenario 6. The maximum increase is just 6.03 miles for the worst case scenario.

Table 4.1 Distance of segments with V/C ratio exceeds 1.0

Scenario	**Distance (mile)**	**Variation (mile)**
Scenario 1 (Base)	1,912.13	-
Scenario 2 (8k per two month)	1,912.13	0
Scenario 3 (8k per a month)	1,912.13	0
Scenario 4 (Two 8k per a month)	1,915.87	3.74
Scenario 5 (12k per two month)	1,912.13	0
Scenario 6 (12 per a month)	1,915.65	3.52
Scenario 7 (Two 12k per a month)	1,918.16	6.03

Figure 4.1 to 4.7 show overflow network centerline in Alabama. Figure 4.1 is the result of base scenario, and Figure 4.2 to 4.7 are the results of other scenarios. V/C ratio is presented by line weight in these figures. The boldest lines mean congested network. The result shows congestions occur around major cities such as Birmingham, Mobile, Montgomery and Huntsville. The congestion is mainly detected on I-65. For these results, we can conclude current statewide network facilities would be able to handle the increased freight volume.

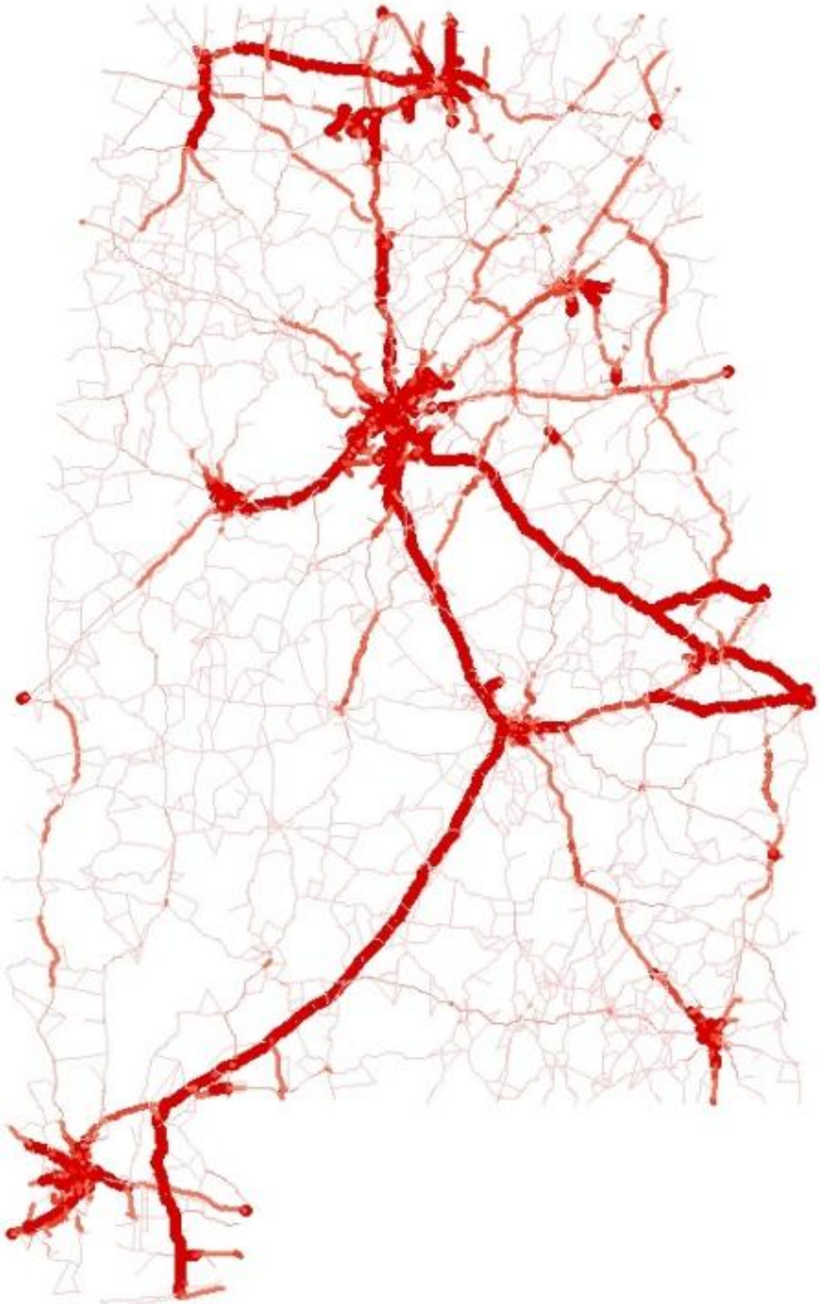

Figure 4.1 Overflow network in the scenario 1

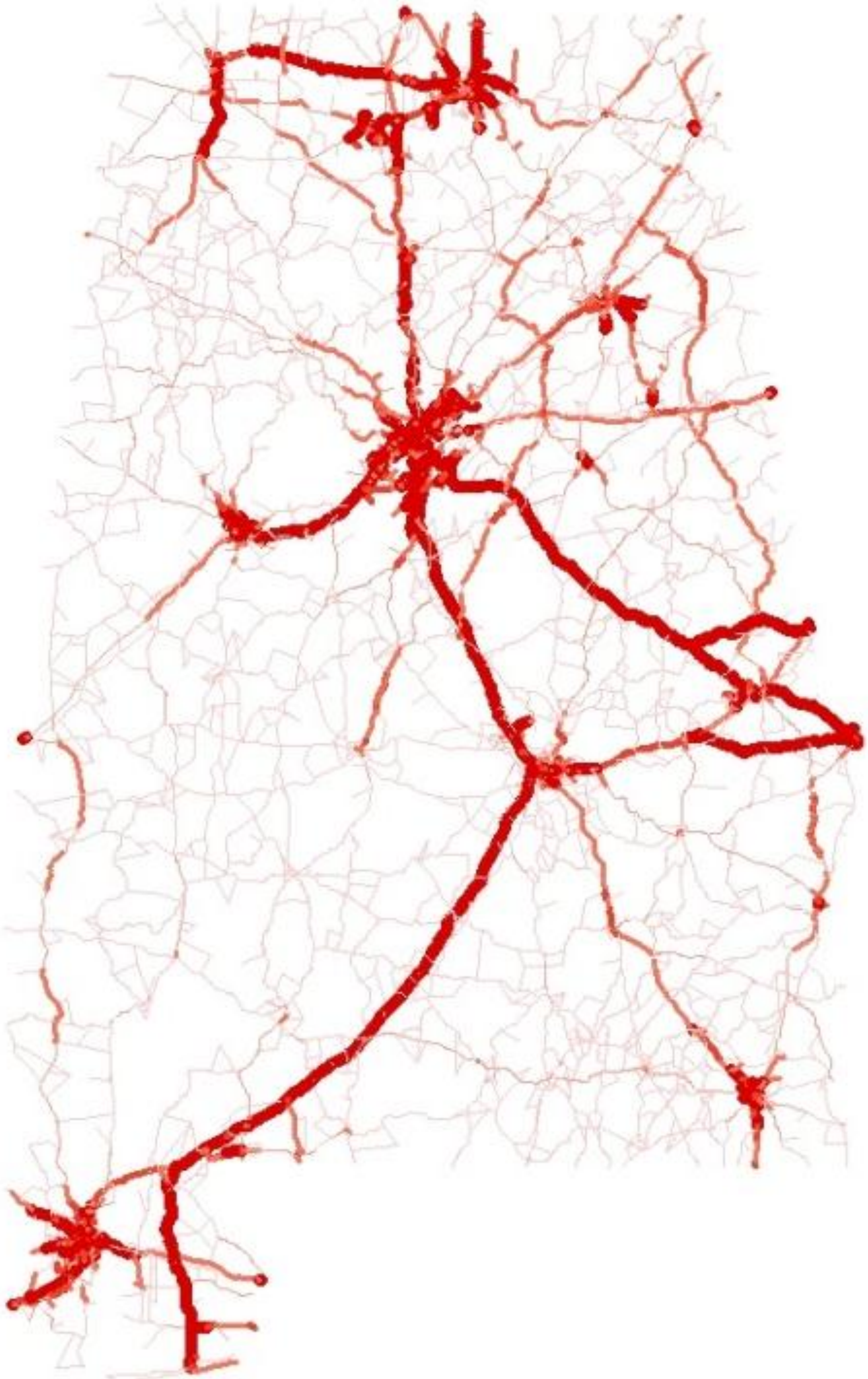

Figure 4.2 Overflow network in the scenario 2

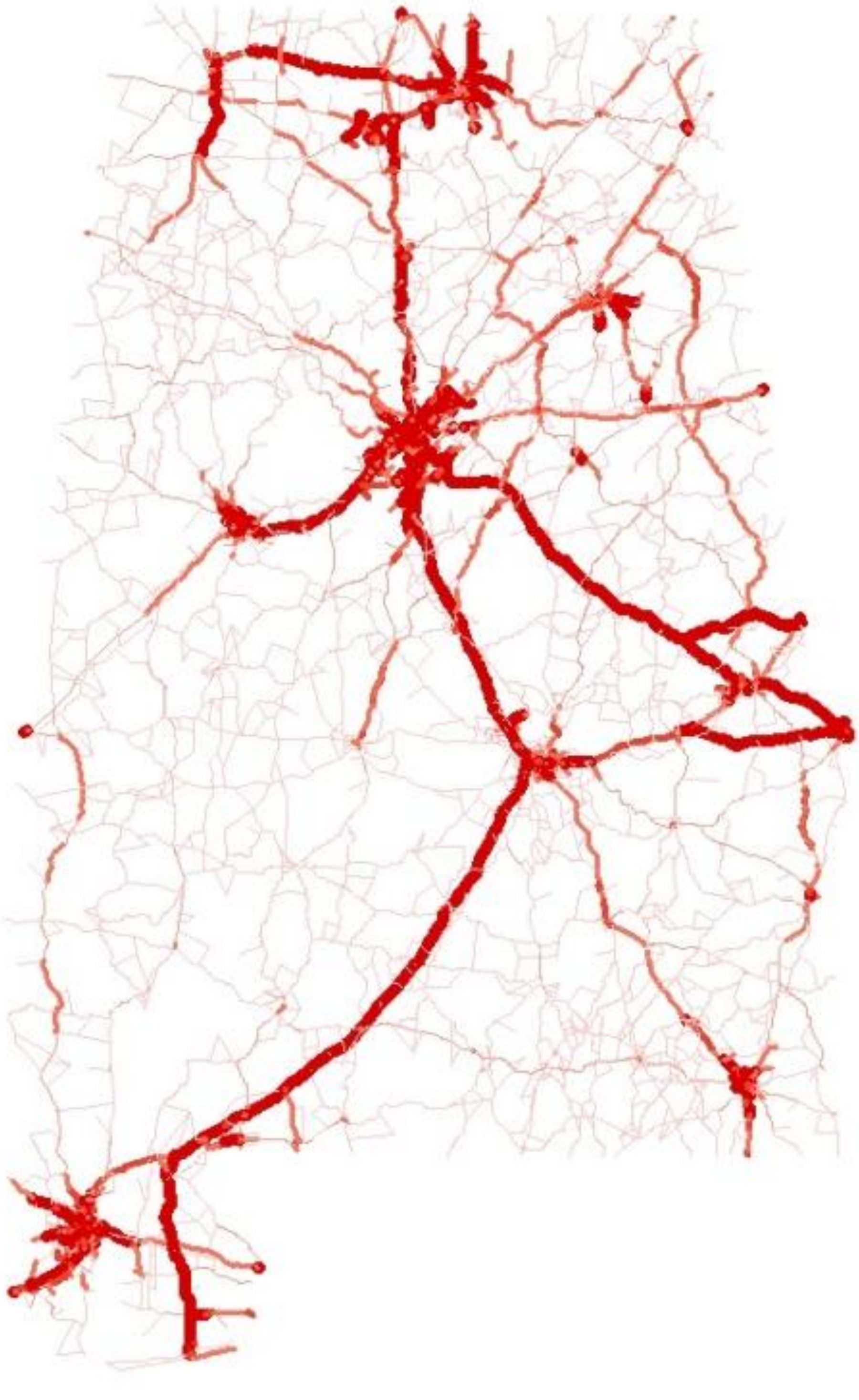

Figure 4.3 Overflow network in the scenario 3

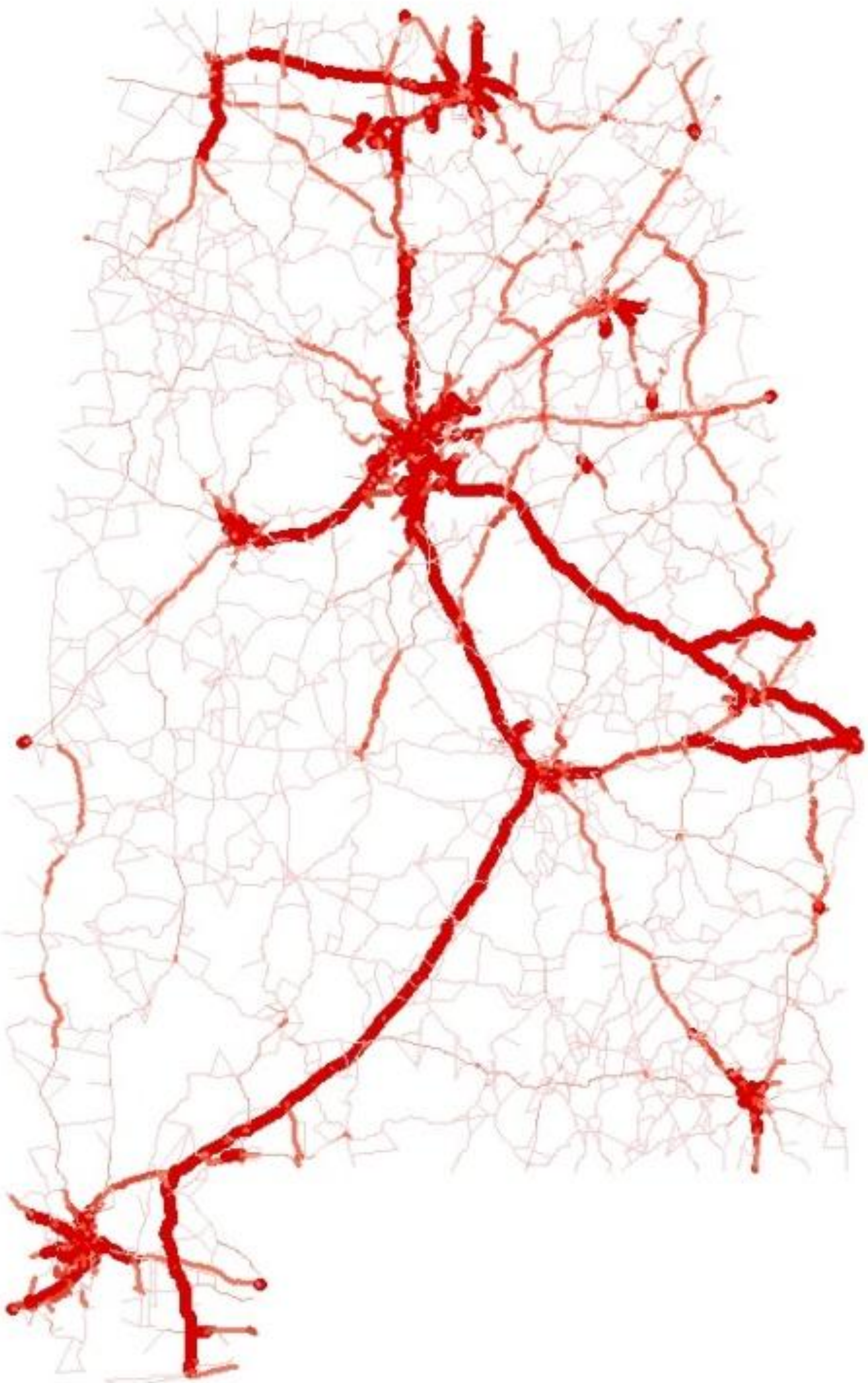

Figure 4.4 Overflow network in the scenario 4

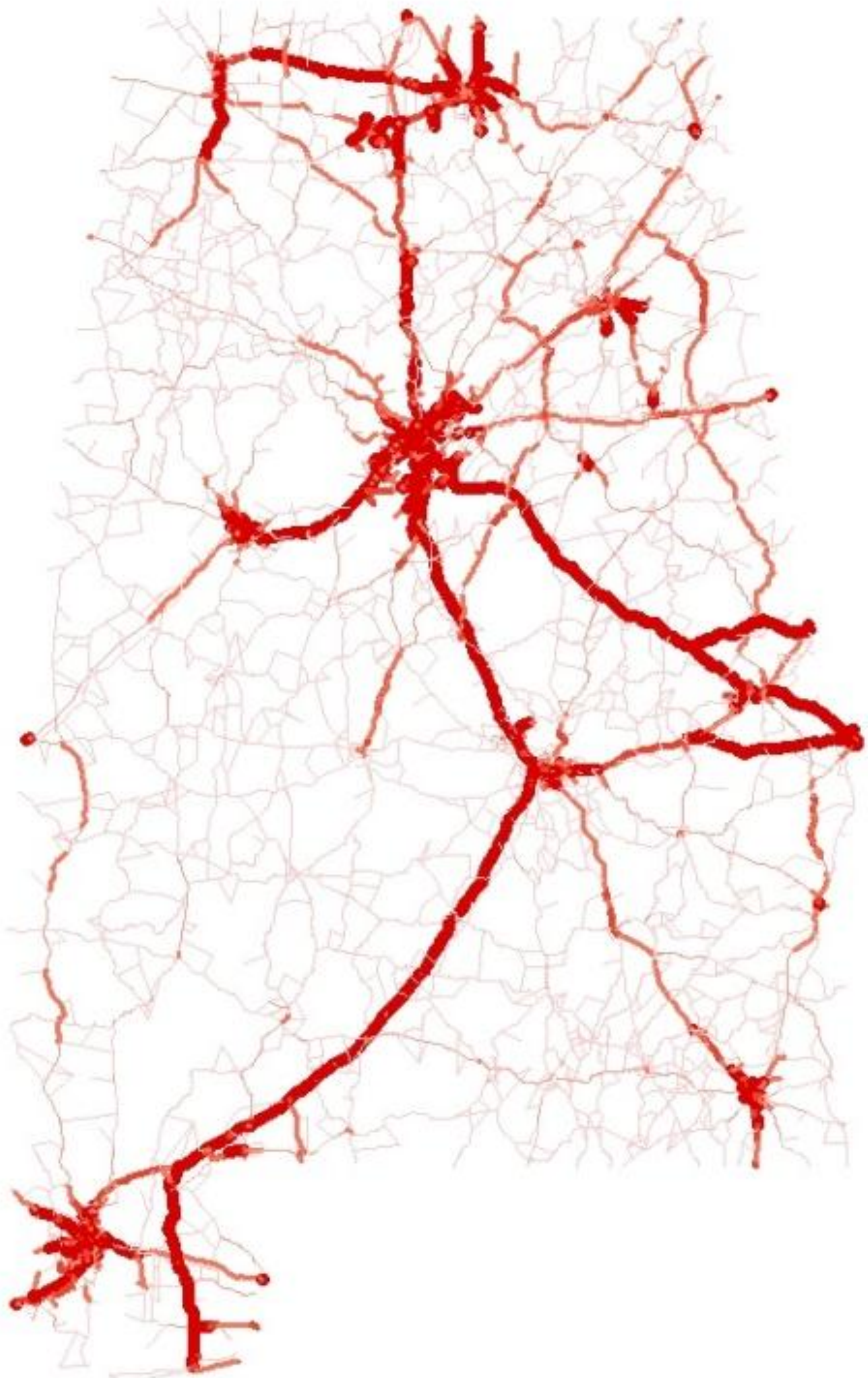

Figure 4.5 Overflow network in the scenario 5

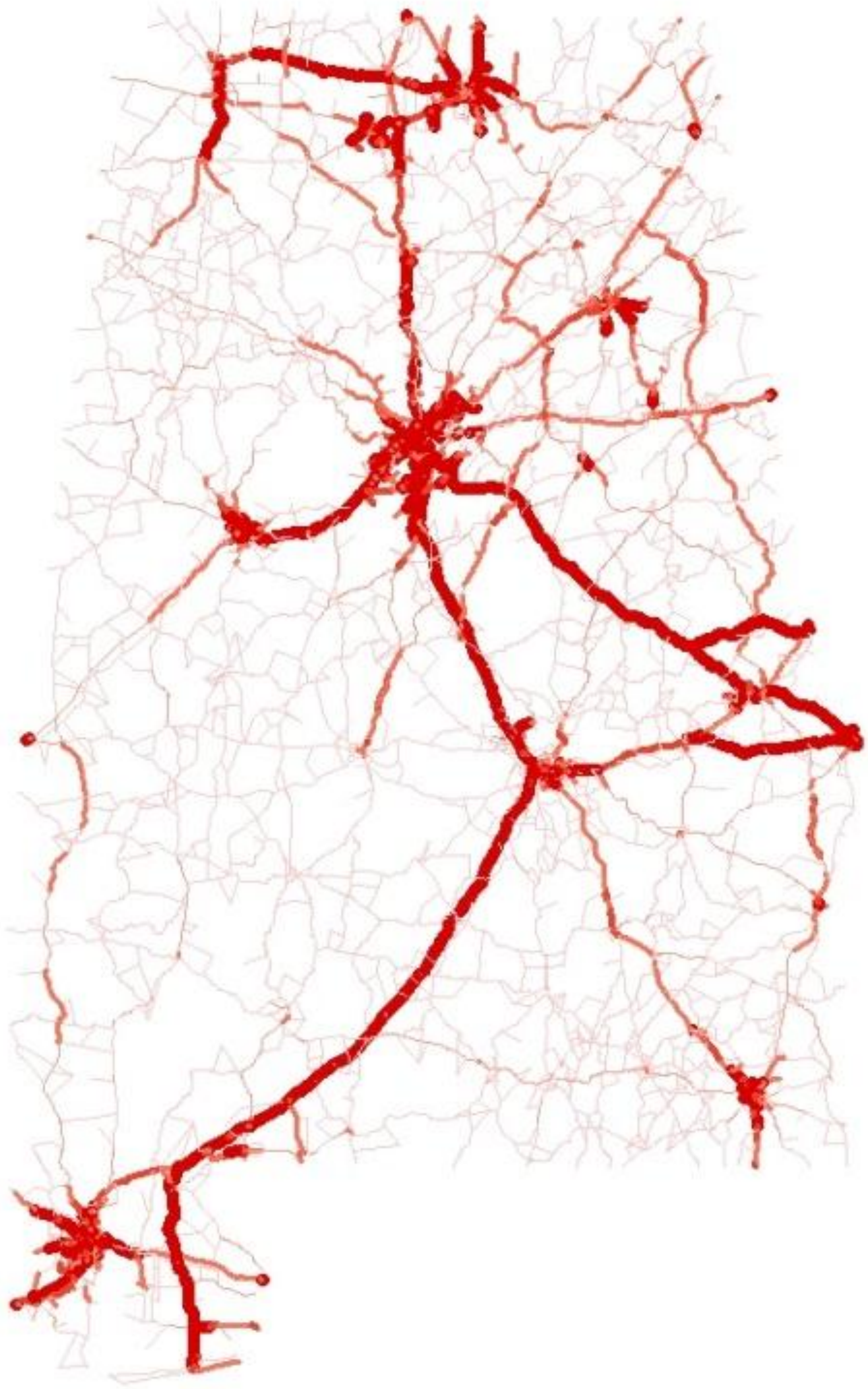

Figure 4.6 Overflow network in the scenario 6

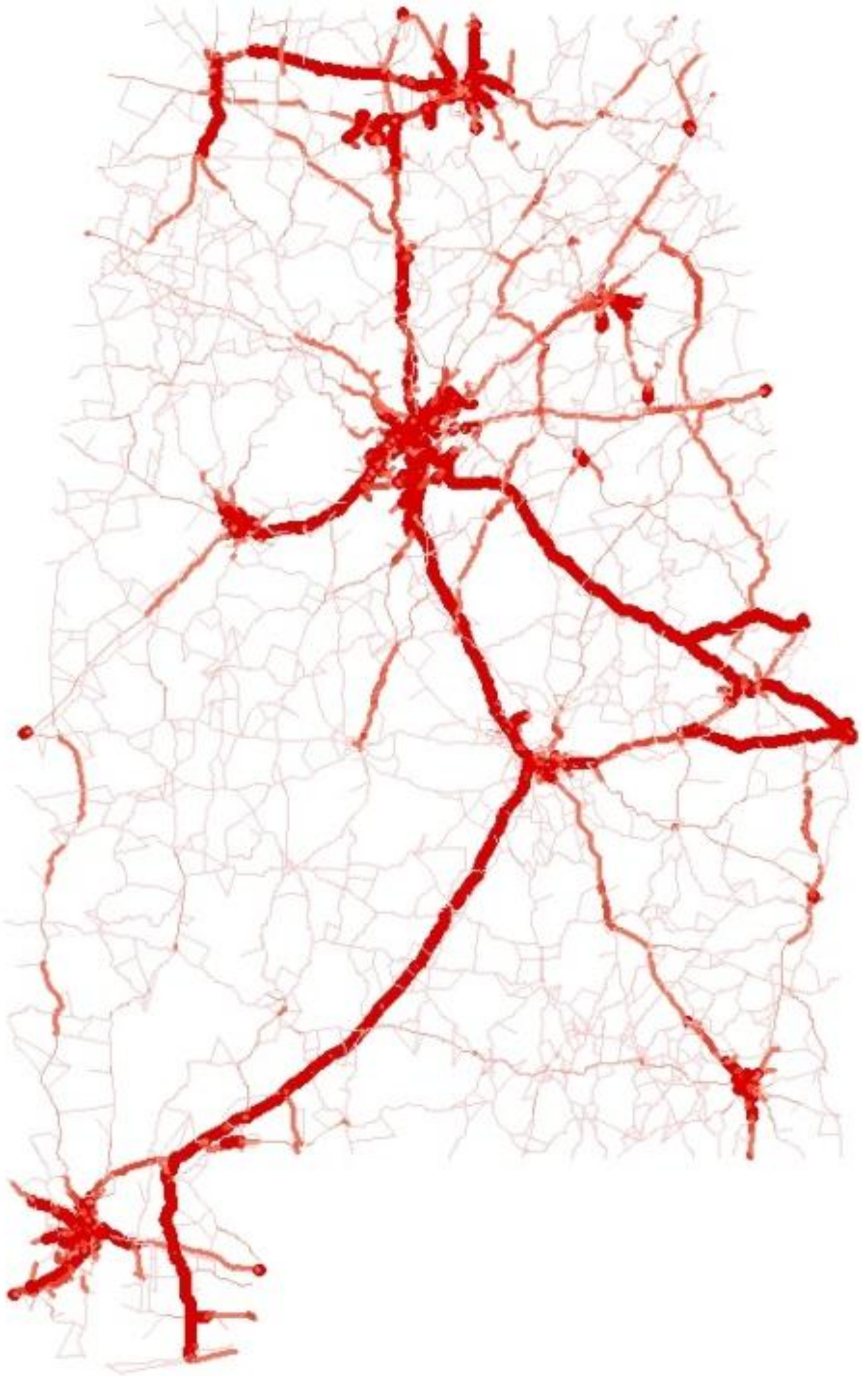

Figure 4.7 Overflow network in the scenario 7

C. Result 2

This analysis identifies network segments where difference of V/C ratio between base scenario and other scenarios exceed zero. Table 4.2 shows the centerline miles in Alabama when its V/C ratio is increased compared with normal condition. Generally, V/C ratio is increased on the I-65 and I-10. In the worst case the distance of network segments with the difference exceed zero is 721.34 miles. 20.38 percent of the networks V/C ratio is changed compared with base scenario. However, V/C ratio is increased below 0.05 in roughly 99 percent of the segments. The network which contains most increased V/C ratio is the US 90 connected between the port of Mobile and I-165. Its V/C ratio in worst case is 1.02. V/C ratio is also heavily increased on the networks around Mobile, specifically, junction connected between I-165 and I-65. Its V/C ratio is 0.82. However, it is difficult to conclude that the level of service is significantly decreased in the network.

Table 4.2 Distance of segments with level of changed V/C ratio

Level of Change (V/C ratio)	**Unit**	**Scenario**					
		1	**2**	**3**	**4**	**5**	**6**
> 0.1	Mile	-	-	-	-	-	0.76
	Percent	-	-	-	-	-	0.02%
0.05 ~ 0.1	Mile	-	-	0.76	-	0.76	4.25
	Percent	-	-	0.02%	-	0.02%	0.12%
< 0.05	Mile	4.23	6.32	670.69	5.71	476.63	716.33
	Percent	0.12%	0.18%	19.09%	0.16%	13.56%	20.38%

CHAPTER V

CONCLUSION

This project analyzed the impact of the Panama Canal expansion. ATIM was used to perform measurements to examine the impact of the expansion. Seven scenarios were simulated to analyze the impact of the effect of project.

The expanded Canal will significantly affect freight flow between Asia and East/Gulf Coast. It is expected freight volume will be increased to use East/Gulf Coast because the canal`s capacity will be doubled and shipping rate will be decreased. However, there is limited information about diverge rate of freight after expansion. So, a sensitivity analysis was performed to obtained results.

It can be concluded that the Alabama statewide network will not experience significant change due to increased truck trips resulting from the expansion project. The distance of the overflow network is increased 6 mile and level of congestion is not significantly grown. It is possible to conclude that current highway facilities can handle increased freight volume by the Panama Canal expansion. In conclusion, the port of

Mobile has the potential to attract new clients to use the port of Mobile to ship from Asia to regions East of the Mississippi river. However, some of networks in the City of Mobile will have the possibility to have severe congestion affected by the expansion. It will be necessary to study for improving the network and attraction of the port of Mobile.

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