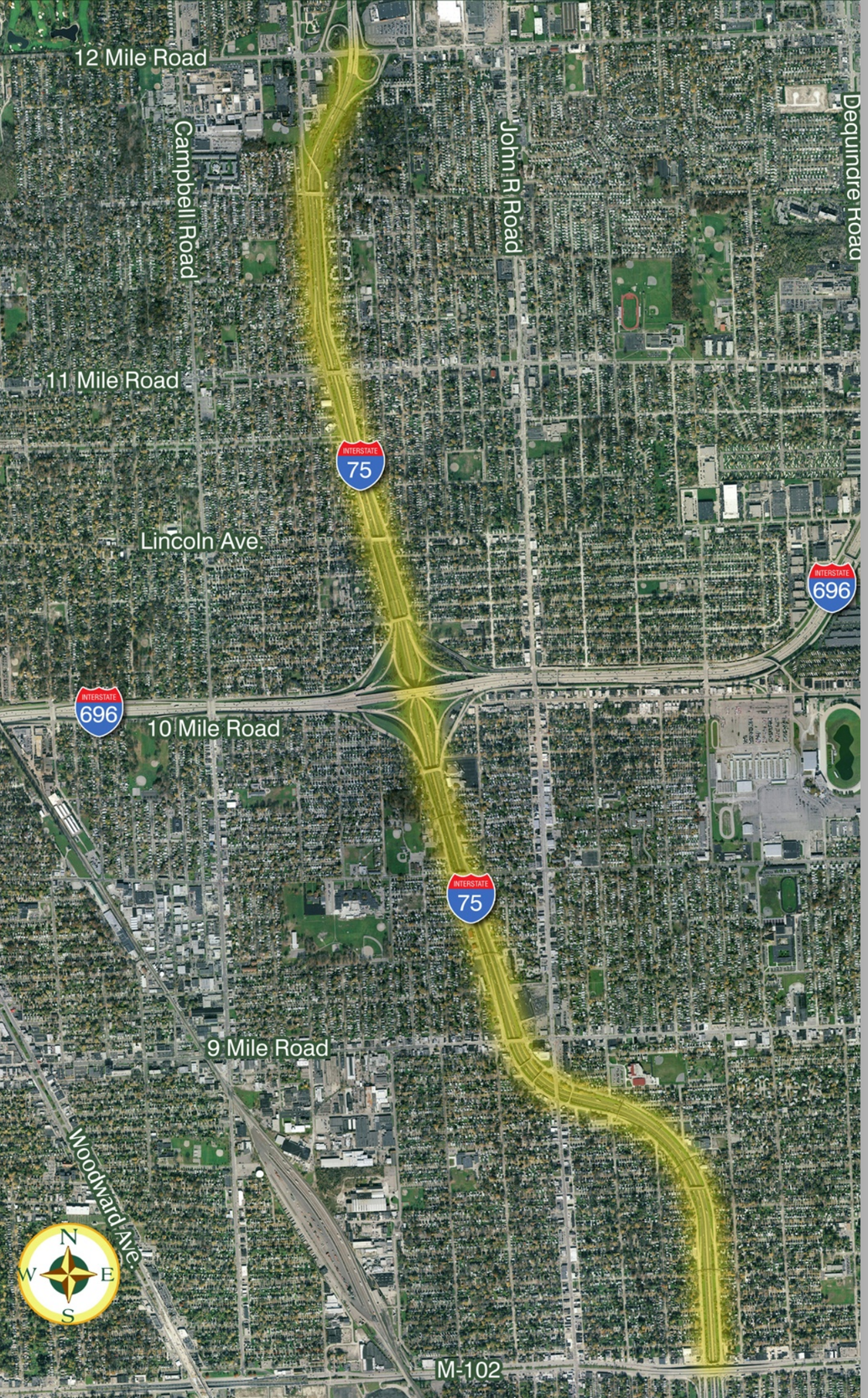


I-75 Engineering Report

M-102 to South of 12 Mile Rd

CS 63174 – JN 45700 and 100948

Appendix F
Stephenson Bridge

Submitted to:

MDOT
Michigan Department of Transportation

Michigan Department of Transportation

August, 2010

CORRADINO GROUP OF MICHIGAN, INC.

CORRADINO

date: January 13, 2009

to: Bill Zipp, PE, Parsons Brinckerhoff

from: Jim Hartman, PE

project #: 3832

subject: Stephenson Bridge Operational Analysis

MEMORANDUM

Purpose

Due to the potential vertical and horizontal profile issues on mainline I-75, related to the new design and improvement of I-75 specifically from 12 Mile Road to 11 Mile Road, the Project Team has considered removal of the Stephenson Bridge over I-75 to eliminate its constraints on the new design alignment. A traffic operational analysis of existing and future traffic conditions was evaluated to determine the feasibility of rerouting traffic upon removal of the Stephenson Bridge.

Inadequate under clearance for 12 Mile Road under I-75 has pushed the proposed elevation of the mainline freeway vertically upward. This has now created a conflict on the freeway approximately one-half mile to the south near the Stephenson Bridge as the freeway transitions to the depressed (below ground) mainline section. The Stephenson Bridge crosses over I-75 just north of Gardenia Avenue in a northeasterly alignment skewed (not perpendicular) to the mainline freeway.
The Stephenson Bridge accommodates traffic as the last segment of the northbound I-75 service drive north of Gardenia. It currently is one-way operation (to the north) and ties it into southbound Stephenson Highway to create a five-lane two-way operation north and west of I-75.

Background

Stephenson Highway currently splits and becomes one way southbound just south of the Stephenson Bridge connection. It is the beginning of the continuous southbound I-75 service drive all the way into downtown Detroit. Figure 1 shows the area between Gardenia and 12 Mile Road as the focused study area for this analysis.

There are four signalized intersections within the study area. The 12 Mile Road and Stephenson Highway signal operates on a 100-second cycle length and is fully actuated. There is a pedestrian activated signal at Bellaire that only operates when the pedestrian pushbutton is actuated. Otherwise the signal stays green for northbound and southbound Stephenson Highway. Gardenia Avenue and the northbound and southbound service drives signalized intersections have 80-second cycle lengths and both operate in a simple two phase signal operation.

Figure 1
Study Area

20300 CIVIC CENTER DRIVE • SUITE 410
SOUTHFIELD, MI 48076
TEL 248.799.0140 • FAX 248.799.0146
WWW.CORRADINO.COM

Figure 1 highlights the convergence of the two one-way service drives north and west of I-75. They merge together to create a five-lane two-way operation called Stephenson Highway just north of the Stephenson Bridge which continues to 12 Mile Road in Royal Oak Township.

The solution that was examined as part of this technical memo was to eliminate the skewed Stephenson Bridge over I-75 and use the Gardenia Bridge over I-75 to accommodate the northbound service drive traffic across I-75. Then, new northbound lanes, next to the Stephenson Highway southbound lanes, would be required to accommodate the movement of traffic to the north (toward 12 Mile Road).

Under current conditions the northbound service drive traffic proceeds through the Gardenia Avenue signalized intersection to head across the Stephenson Bridge and over I-75 eventually merging into Stephenson Highway.

The northbound service drive traffic is proposed to be rerouted along with the other movements at the Gardenia Avenue and northbound service drive intersection. With the Stephenson Bridge removed, traffic wishing to head toward the north to 12 Mile Road would be forced westbound or to the left over the Gardenia Bridge over I-75. New northbound lanes on Stephenson Highway would be required to accommodate right turns at the corner of the existing southbound service drive and Gardenia Avenue.

This right turn or westbound to northbound traffic movement originating from the Gardenia Bridge was tested in a microsimulation model to see if it could accommodate this rerouted traffic from the removal of the Stephenson Bridge over I-75. This would make a new four-lane roadway section from Gardenia north to the old location of the Stephenson Bridge connection at Stephenson Highway. The new lanes would be on the outside of the two southbound lanes (toward the freeway) that are adjacent to the apartment complex at the northwest corner of Gardenia and the southbound service drive. A fifth lane would be difficult to fit within this section and was determined later to be unnecessary.

Figures 2 and 3 are detailed drawings of the future conditions with and without the Stephenson Bridge. These were the network scenarios tested in a SYNCHRO microsimulation model using proposed traffic volumes for Future Build conditions in 2025 for the AM and PM peak hour. Existing and Future No Build conditions were analyzed prior to the build scenarios.

Figure 2
Future Conditions with Stephenson Bridge in Place

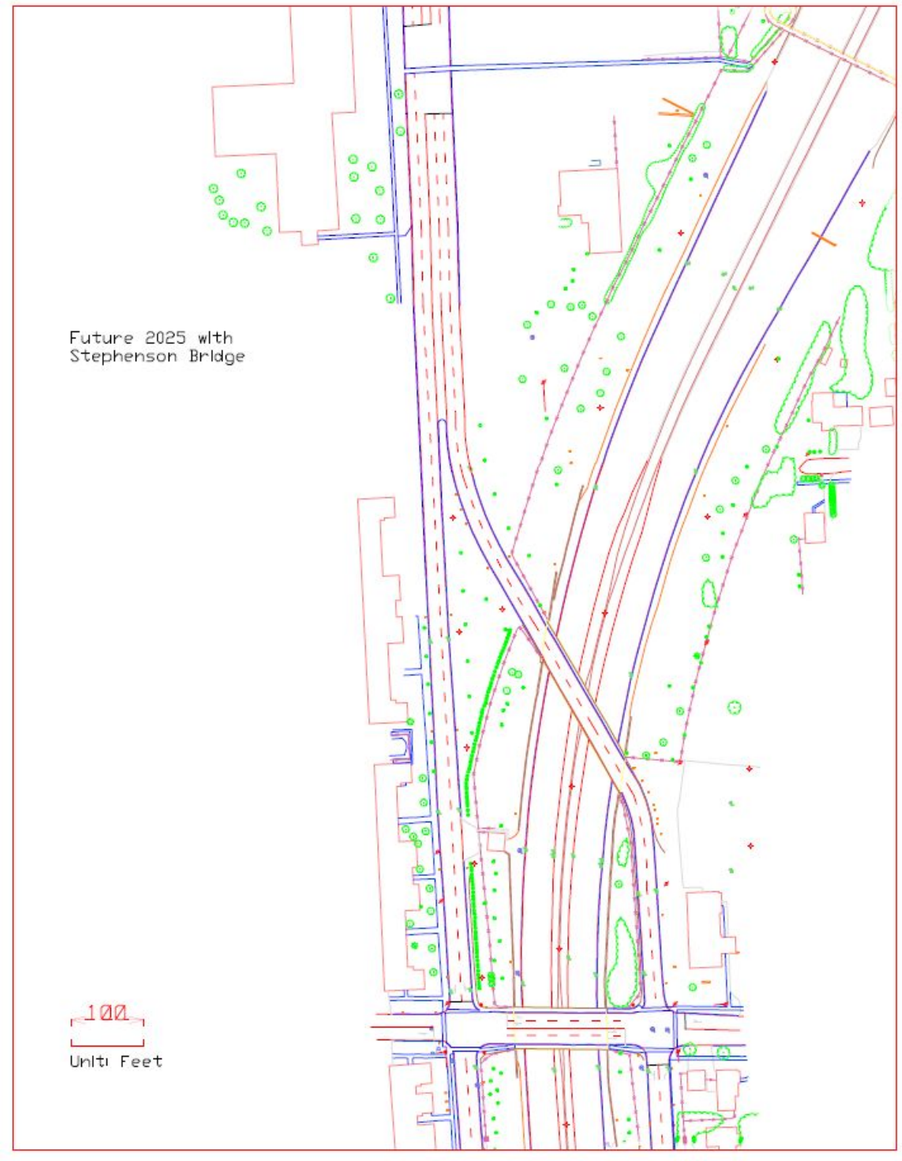
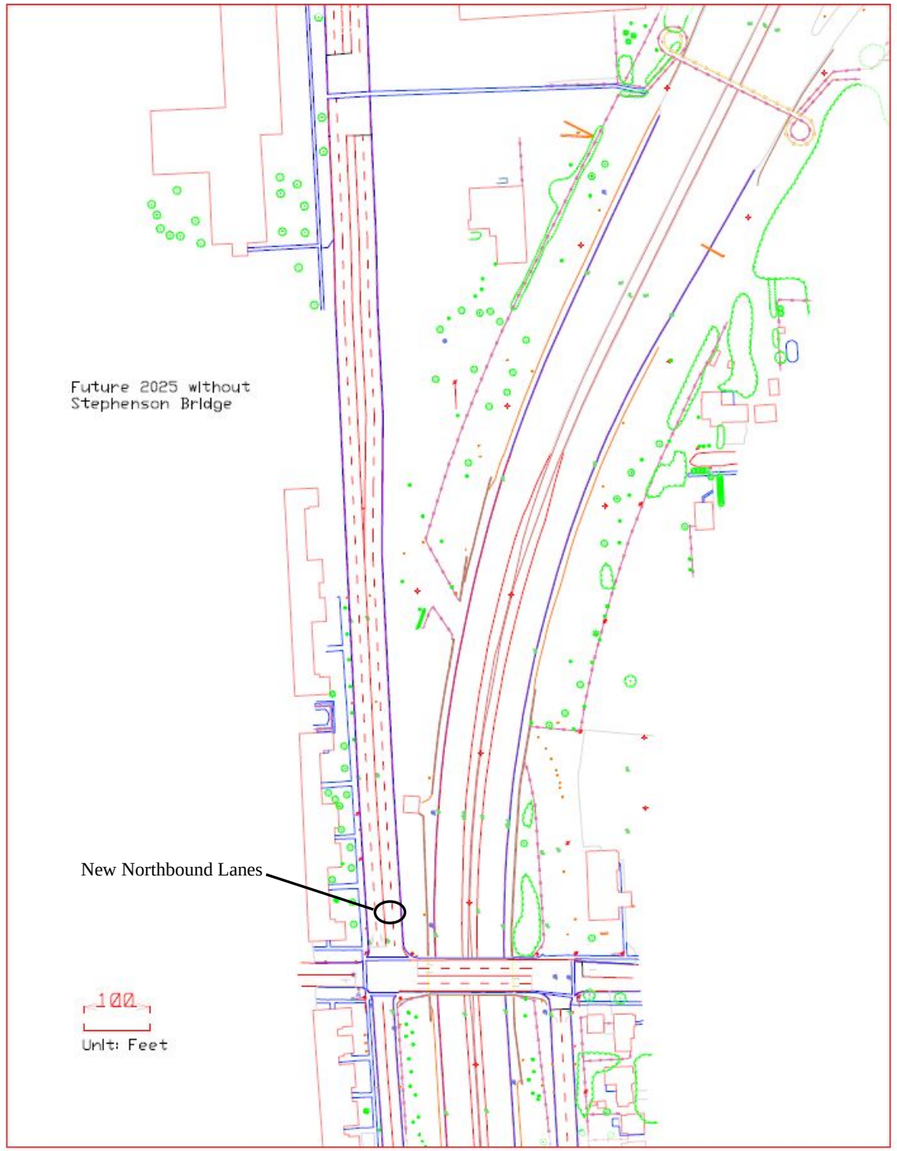


Figure 3
Future Conditions without the Stephenson Bridge



Currently there is no access provided to any businesses or residences between Gardenia Avenue and the northbound I-75 service drive intersection to the convergence of northbound lanes with Stephenson Highway to the north 800 feet.

Also there is no vehicular access to any residence or business between Gardenia Avenue and the southbound service drive intersection to the north.

Introduction

This new operational analysis was based off a previous model and analysis completed in October 2005 called Technical Memorandum No. 4 where different local road scenarios were examined in and around Lincoln Avenue near I-75 just one-half mile south of the Stephenson Bridge over I-75. That full report is included on CD as Appendix A.

This Lincoln Road analysis model was amended and updated to 2009 conditions to include 12 Mile Road and Stephenson Highway as part of the transportation network. The microsimulation network is shown in Figure 4.

Figure 4
Microsimulation Network

Network conditions along with new traffic volumes were used in the analysis to examine, address, and understand the potential implications and pitfalls, benefits and impacts of the proposed removal of the Stephenson Bridge.

The traffic at 12 Mile Road and Stephenson Highway was assumed to be the same regardless of the future build scenario analyzed. The traffic assignment is different whether Stephenson Bridge is assumed to be in or out of the network. The impacts for the operations on the two signalized intersections at the northbound and southbound service drive with Gardenia Avenue are the key. Again they where studied with and without the proposed solution and are the only place that traffic was redistributed. Other adjacent intersections where reported on but should be no different than earlier 2005 analyses. They are included again in the appendix and part of the comprehensive model.

Traffic counts collected in 2005 along with existing conditions modeling from 2005 were used and updated to represent January 2009 conditions.

Traffic counts were factored up 25 percent from existing conditions analyses to obtain future No Build analyses for 2025, as well as volumes for future build scenarios with and without the Stephenson Bridge.

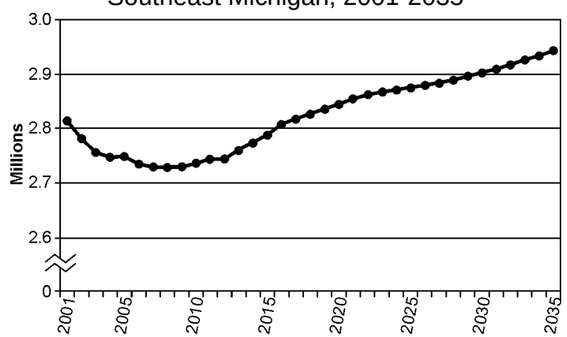
The base model used 26 traffic counts from 2004 and 2005 for the AM and PM peak periods. These counts were collected in Royal Oak and Madison Heights in and around the 11 Mile Road study area as part of the local road analysis at Lincoln Avenue and I-75.

The peak hours of the analysis in 2005 suggested the AM peak hour was from 7:30 a.m. to 8:30 a.m. and from 4 p.m. to 5 p.m. in the afternoon peak hour. These volumes were the basis for the Lincoln Avenue alternative analysis and assumed to be a worse case analysis for this study of the potential removal of the Stephenson Bridge.

The 2005 study in its entirely is provide in the Appendix A as are all of the backup data including counts, OD studies and the respective SYNCHRO and HCS reports for that study.

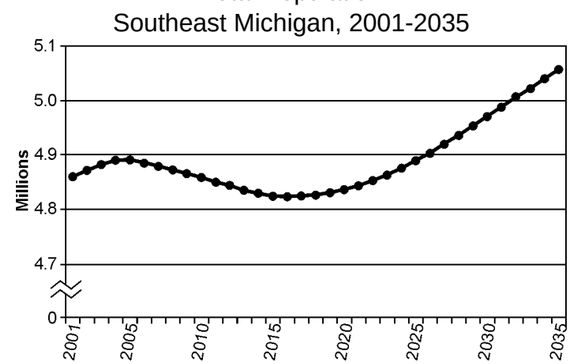
New appendices in Appendix B include the new model, new counts and the new reports of the Stephenson Bridge scenarios analyzed. They will be discussed in detail in the following sections.

Figure 5
Total Employment
Southeast Michigan, 2001-2035



Source: SEMCOG

Figure 6
Total Population
Southeast Michigan, 2001-2035



Source: SEMCOG

Recent Traffic Developments

In September 2008 the Southeast Michigan Council of Governments (SEMCOG) released a press release titled *Traffic Down in Southeast Michigan*. It indicated from 2002-2007, the seven-county Southeast Michigan region has seen a 4.5-6.5 percent decrease in weekday traffic volumes. These results were based on an analysis of about 3,000 locations regionwide, through SEMCOG's traffic count program. Weekend or discretionary travel is down another two percent. Although some areas in the region have seen an increase in traffic, the magnitude of decrease is greater. Factors contributed to the decrease in travel include the economy, high gas prices, and changes in travel choice.

SEMCOG also mentioned that analyses by national agencies (Federal Highway Administration) and state agencies (Michigan Department of Transportation) have also show a decrease in travel at both the national and state levels.

In addition, SEMCOG issued a report in April 2007 titled *A Region in Turbulence and Transition*, which states the following:

"Southeast Michigan's economy is in the midst of a fundamental restructuring that has serious consequences for the region's long-term future. This turbulence and transition is due to the shrinkage of the domestic auto industry, where the Big Three have seen their share of U.S. light-vehicle sales (cars, SUVs, vans, pickup trucks) decline from 73 percent in 1995 to 53 percent in 2006.

"The consequences of the changes in the auto industry are profound. Losses of jobs in the region's core industry are rippling through the economy and will be felt across many sectors, from retail to construction.

"Southeast Michigan has lost 128,000 jobs since 2000 and will not begin to gain total jobs until 2010. By 2035, the region's employment will have grown seven percent over 2005 levels (Figure 5).

"The other major factor that will affect the region in the long-term is the aging of the population. By 2035 Southeast Michigan will have 651,000 more people 65 or older and 296,000 fewer people of prime working age 25-64. This is a trend that will also be felt in the U.S. as a whole where, as in Southeast Michigan, the percentage of population 65 or older will increase dramatically. For the region, the percentage 65 or older will increase from 12 to 24 percent by 2035, and for the U.S. it will go from 12 to 20 percent.

"Combined with more deaths in an aging population, increased out-migration is now causing Southeast Michigan's population to decline. The region will only recover enough, beginning after 2015, to add about three percent to the population over 30 years (Figure 6). Southeast Michigan's population will be 5.1 million in 2035."

With these observations as background, SEMCOG reduced its 2005-2030 forecasts of growth in employment and population by approximately 50 percent and 75 percent, respectively.[1] The changes still reflect positive, albeit, small growth. These changes have been distributed to the county level, but not to a smaller geographical unit.

The county-level changes in growth provide an understanding of the dynamics of the region. From a population perspective (Table 1), Macomb County is expected to continue to grow at almost the same pace in the new forecast as in the previous SEMCOG forecast that it replaces. The outer-ring counties – Livingston, Monroe and Washtenaw – are projected to experience lower population growth than previously forecast. Wayne County is expected to experience an even greater population loss by 2030, compared to the earlier SEMCOG forecast. It is likely the Wayne County loss will be especially felt in Detroit, based on past trends.

Table 1
Changes in Forecast Growth in Employment by SEMCOG

County	Employment			
	Year 2000	Previous[a] Forecast 2030	Current[b] Forecast 2030	Change in Forecast Growth
Livingston	59,186	102,378	95,274	-16.4%
Macomb	383,308	441,126	427,658	-23.3%
Monroe	54,375	74,268	63,278	-55.5%
Oakland	910,441	1,100,545	1,001,198	-52.3%
St. Clair	64,531	80,857	78,780	-12.7%
Washtenaw	230,212	285,543	289,059	+6.4%
Wayne	971,127	1,024,905	943,826	-150.8%
Total	2,673,180	3,109,622	2,899,073	-48.2%

[a]Based on Bureau of Labor Statistics definition.
[b]Based on Bureau of Economic Analysis definition.
Source: SEMCOG

The two SEMCOG employment forecasts are not directly comparable because the new forecast uses the employment definition of the Bureau of Economic Analysis and the previous forecast used the Bureau of Labor Statistics database. Nonetheless, trends can be observed. The new projections of employment growth by 2030 in the SEMCOG region are down by about 50 percent compared to the earlier forecast. The greatest impact will be felt in Wayne County and, by implication, Detroit, where continued job losses are forecast. All other counties are still projected to experience employment growth by 2030, albeit lower than projected earlier (Table 2).

[1] SEMCOG's planning horizon is 2030.

Table 2
Changes in Forecast Growth in Population by SEMCOG

County	Population			
	Year 2000	Previous Forecast 2030	Current Forecast 2030	Change in Forecast Growth
Livingston	156,951	282,405	210,359	-42.6%
Macomb	788,149	926,347	914,685	-8.4%
Monroe	145,945	191,500	159,797	-69.6%
Oakland	1,194,156	1,346,185	1,303,674	-28.0%
St. Clair	164,235	203,552	189,274	-36.3%
Washtenaw	322,895	433,205	369,474	-57.8%
Wayne	2,061,162	2,018,091	1,824,112	-118.2%
Total	4,833,493	5,401,285	4,971,375	-75.7%

Source: SEMCOG

These regional reports from SEMCOG were issued after the initial Lincoln Avenue Local Road Analysis and after the I-75 FEIS and Record of Decision. For this analysis it was necessary to determine how traffic demand has changed at this specific part of the overall transportation system.

New traffic counts were collected on Stephenson Highway South of 12 Mile Road just north of the Stephenson Bridge over I-75 on Wednesday, January 7, 2009, in the AM and PM peak hours. They are provided in Table 3, along with the original 2005 data and other traffic count data received from SEMCOG.

Table 3
Recent Traffic Count Data

Traffic Count Date	AM Peak Hour (7:30-8:30 AM)		PM Peak Hour (4:00-5:00 PM)	
	Southbound Stephenson Highway (vph)	Northbound Stephenson Highway (vph)	Southbound Stephenson Highway (vph)	Northbound Stephenson Highway (vph)
January 7, 2009	163	198	359	261
September 11, 2007	NA	417	NA	378
May 20, 2005*	586	750	974	756
July 20, 2004	NA	558	NA	462

Traffic counts collected on Stephenson Highway in the study area peaked in 2005 according to this data. Overall the traffic volumes at this location have been decreasing since 2005. This further confirms the results mentioned in SEMCOG's publications and analyses discussed earlier.

Table 4 shows a percentage of the 2005 or baseline counts.

Table 4
Recent Traffic Counts Compared to 2005 Counts Totals

Traffic Count Date	Percentage of 2005 Base Year Traffic			
	SB Stephenson Highway AM Peak Hour	NB Stephenson Highway AM Peak Hour	SB Stephenson Highway PM Peak Hour	NB Stephenson Highway PM Peak Hour
January 7, 2009	28%	26%	37%	35%
September 11, 2007	NA	56%	NA	50%
May 20, 2005*	0	0	0	0
July 20, 2004	NA	74%	NA	61%

With the baseline as 2005, existing traffic volumes observed recently are approximately 1/3 of 4 years ago. Because of the timing of this request, January 7 was the only opportunity to collect new traffic data. Additional counts in mid January or February should also be compared to historic counts as holiday traffic normalizes back to typical weekday trends.

For the operational analysis it was decided to run both a worse case scenario (2005 volumes) and an analysis that represents existing (2009) traffic conditions which was assumed to be only 50 percent of 2005 volumes.

Traffic Conditions Summary

In order to analyze the capacity of the transportation system, the existing volumes for the AM and PM peak hours were used in the microsimulation model called SYNCHRO. The model uses the volumes along with geometric data and traffic control device information to calculate measures of performance. It allows a comparison of the performance of the entire transportation network, as well as individual intersections.

The methods of the 2000 Highway Capacity Manual (HCM) and SYNCHRO were used to perform a baseline capacity analysis of the relevant freeway and local road systems, consistent with the accepted practice of MDOT and FHWA. For signalized intersections, the analysis method defines Level of Service (LOS) in terms of "control delay" which includes all delay caused by a traffic signal. Delay is a measure of driver and/or passenger discomfort, frustration, fuel consumption and lost travel time. The LOS Criteria defined by the HCM are illustrated in Table 5. Volume-to-capacity ratios are another Measure of Effectiveness (MOE) used to determine performance of the system.

Table 5
Correspondence Between Levels of Service and Delays (seconds per vehicle) For Signalized Intersections

Level of Service	Delays	Level of Service	Delays
LOS A	≤ 10	LOS D	> 35 and ≤ 55
LOS B	> 10 and ≤ 20	LOS E	> 55 and ≤ 80
LOS C	> 20 and ≤ 35	LOS F	> 80

Source: 2000 Highway Capacity Manual

The volume-to-capacity ratio is an indication of how much of the intersection capacity is being used by the traffic volumes. It is a measure of effectiveness distinct from delay. In fact, under certain conditions, low volume-to-capacity ratios could be observed even in high delay conditions. This situation is generally linked to long traffic signal cycle lengths.

The results are shown in Tables 6 through 9 for the existing conditions, future No Build and two Build scenarios with and without the Stephenson Bridge in place for both the worse case (2005 traffic) and with current 2009 traffic.

All the intersections in the model are available in the Appendix. The focus is on the two Gardenia Avenue signalized intersections which would be the only intersections impacted by the removal of the Stephenson Bridge.

Table 6
Worse Case 2005 AM Peak Hour Traffic Analysis

AM Peak Hour		Existing 2005 Conditions			Future 2025 No Build			Future 2025 Build with Stephenson			Future 2025 Build without Stephenson		
INTERSECTION DESCRIPTION	INT ID	LOS	DELAY	V/C	LOS	DELAY	V/C	LOS	DELAY	V/C	LOS	DELAY	V/C
Gardenia and NB I-75 Service Drive	**396**	B	15.4	0.52	B	17.8	0.66	B	15.1	0.66	B	14.8	0.64
Gardenia and SB I-75 Service Drive	**397**	B	11.9	0.26	B	13.4	0.39	B	13.3	0.32	C	26.7	0.88
12 Mile and Stephenson Hwy	**152**	D	36.0	0.81	D	47.0	0.95	D	36.0	0.78	D	36.0	0.78

Table 7
Worse Case 2005 PM Peak Hour Traffic Analysis

PM Peak Hour		Existing 2005 Conditions			Future 2025 No Build			Future 2025 Build with Stephenson			Future 2025 Build without Stephenson		
INTERSECTION DESCRIPTION	INT ID	LOS	DELAY	V/C	LOS	DELAY	V/C	LOS	DELAY	V/C	LOS	DELAY	V/C
Gardenia and NB I-75 Service Drive	**396**	B	16.7	0.66	C	24.7	0.87	C	23.4	0.87	C	23.3	0.85
Gardenia and SB I-75 Service Drive	**397**	B	15.7	0.48	B	19.5	0.60	B	13.8	0.60	F	102.1	1.20
12 Mile and Stephenson Hwy	**152**	F	126.9	1.12	F	96.0	1.13	E	66.5	1.00	E	66.5	1.00

Overall the traffic conditions operate acceptably at LOS D or better under these worse case conditions that represent traffic volumes two to three times what they are today. Locations with volume-to-capacity (v/c) ratios approaching 1.0 or poor LOS are highlighted in the table.

Overall the PM peak hour does not operate worse under Build conditions when compared to future No Build conditions. The only exception is that the westbound approach to Gardenia and the southbound I-75 service drive

intersection which was overwhelmed with more than 900 right-turn vehicles through the intersection. Queues from the microsimulation model extended beyond the limits of the adjacent Gardenia and northbound service drive intersection and cause the southbound service drive intersection to break down at LOS F.

Table 8
Existing Traffic Conditions (2009) AM Peak Hour

AM Peak Hour		Existing 2009 Conditions (0.5 factor of 2005 Volumes)			Future 2025 No Build			Future 2025 Build with Stephenson			Future 2025 Build without Stephenson		
INTERSECTION DESCRIPTION	INT ID	LOS	DELAY	V/C	LOS	DELAY	V/C	LOS	DELAY	V/C	LOS	DELAY	V/C
Gardenia and NB I-75 Service Drive	**396**	B	13.0	0.26	B	13.7	0.32	B	11.7	0.32	B	12.5	0.32
Gardenia and SB I-75 Service Drive	**397**	B	11.5	0.15	B	12.1	0.19	B	12.3	0.16	C	20.7	0.38
12 Mile and Stephenson Hwy	**152**	C	24.7	0.34	C	26.8	0.45	C	27.4	0.49	C	27.4	0.49

With or without, the Stephenson Bridge in the future scenario under existing (2009) conditions, operations are acceptable at both Gardenia Avenue intersections. This includes rerouting all the traffic in the without Stephenson Bridge scenario west and then to the north. Queuing reports from the model also suggest there is no problem with average or 95 percent queues at either location.

Table 9
Existing Traffic Conditions (2009) PM Peak Hour

PM Peak Hour		Existing 2009 Conditions (0.5 factor of 2005 Volumes)			Future 2025 No Build			Future 2025 Build with Stephenson			Future 2025 Build without Stephenson		
INTERSECTION DESCRIPTION	INT ID	LOS	DELAY	V/C	LOS	DELAY	V/C	LOS	DELAY	V/C	LOS	DELAY	V/C
Gardenia and NB I-75 Service Drive	**396**	B	12.8	0.33	B	12.8	0.43	B	12.8	0.43	B	14.4	0.42
Gardenia and SB I-75 Service Drive	**397**	B	12.4	0.24	B	11.2	0.30	B	11.2	0.30	C	28.5	0.51
12 Mile and Stephenson Hwy	**152**	C	28.4	0.45	C	30.3	0.56	C	31.3	0.62	C	31.3	0.62

The PM peak hour analysis for current conditions also suggests operations are LOS C or better throughout all the signalized intersections analyzed as part of the microsimulation modeling.

Summary

The removal of the Stephenson Bridge and the rerouting of traffic through the two Gardenia Avenue intersections works acceptably based on existing conditions analysis for both the AM and PM peak hour. It also operates acceptably in the AM peak hour of the worse case analysis. Only in the PM peak hour worse case analysis does the Gardenia and southbound I-75 service drive intersection break down. This breakdown occurs after the existing traffic is grown by a factor of 2.9 or an additional 190 percent of today's volume on the northbound I-75 service drive. This would equate to a four percent compounded growth rate for the next 16 years, which is highly unlikely at this point in time.

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