
TRAFFIC FORECASTS FOR THE
TOLL SCENARIOS FOR
TIP PROJECT NO. U-4763,
TRIANGLE PARKWAY
WAKE COUNTY AND DURHAM COUNTY, NORTH CAROLINA

Prepared for

HNTB

for the



Prepared by



March, 2007

4000 WestChase Boulevard, Suite 530, Raleigh, North Carolina 27607

TOLL FORECASTS FOR TRIANGLE PARKWAY

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TOLL FORECASTS FOR TRIANGLE PARKWAY

INTRODUCTION

This memorandum details the methodology used to develop the toll forecasts for the Triangle Parkway Scenarios. This memorandum is accompanied with the documentation detailing the implementation of the tolling methodology by Elizabeth Harper (shown in Appendix A) of the Triangle Regional Model (TRM). The TRM was provided by the Capital Area Metropolitan Planning Organization (CAMPO).

Toll forecasts were developed for the Triangle Parkway and surrounding intersections for 2011 and 2030. Procedures for both No-Build and Build Alternatives for both years are summarized in this document. The study area intersections for which traffic forecasts were developed include:

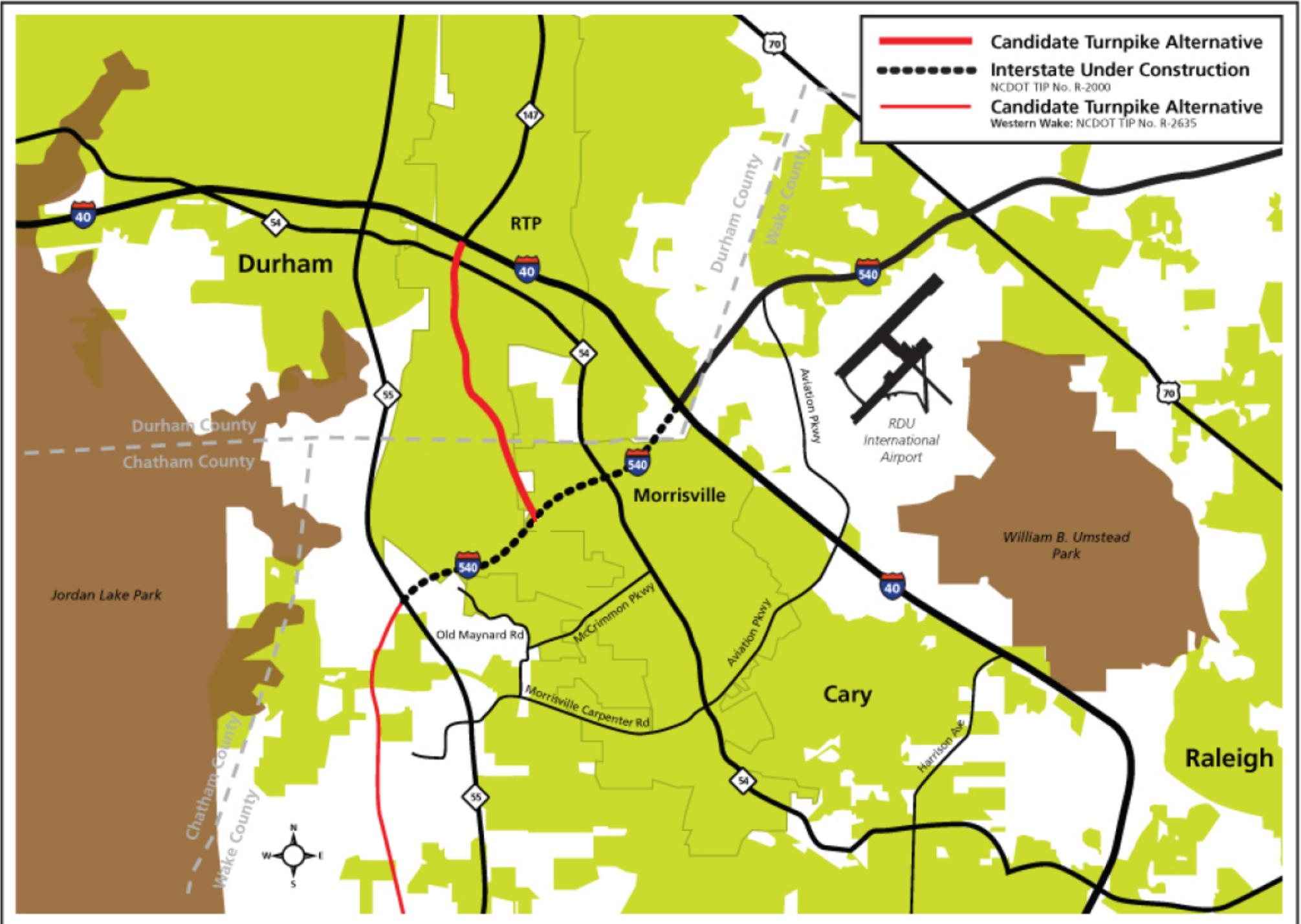
1. NC 147 (Durham Freeway) at Cornwallis Road;
2. Davis Drive at Cornwallis Road;
3. South Miami Boulevard at Cornwallis Road;
4. I-40 at NC 55;
5. I-40 at NC 147 (Durham Freeway) and Triangle Parkway;
6. I-40 at Davis Drive;
7. I-40 at South Miami Boulevard
8. I-40 at Page Road;
9. Page Road at Emperor Boulevard
10. I-40 at I-540;
11. I-40 at Airport Boulevard;
12. I-40 at Aviation Parkway;
13. Davis Drive at Park Drive;
14. NC 54 at NC 55;
15. NC 54 at Alston Avenue;
16. NC 54 at Alexander Drive;
17. NC 147 (Durham Freeway) at Alexander Drive;
18. NC 54 at Davis Drive;
19. NC 54 at South Miami Boulevard;
20. NC 55 at Alexander Drive;
21. Alston Avenue at Alexander Drive;
22. Alston Avenue at Hopson Road;
23. Triangle Parkway at Hopson Road;
24. Davis Drive at Hopson Road;
25. South Miami Boulevard at Hopson Road;
26. NC 55 at Alston Avenue;
27. NC 55 at Kit Creek Road;

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28. Davis Drive at Kit Creek Road;
29. Triangle Parkway at Davis Drive;
30. I-540 at NC 55;
31. I-540 at Triangle Parkway and Town Hall Drive;
32. I-540 at South Miami Boulevard;
33. Davis Drive at McCrimmon Parkway;
34. McCrimmon Parkway at Town Hall Drive;
35. NC 54 at McCrimmon Parkway;
36. NC 54 at Airport Boulevard;
37. Davis Drive at Morrisville-Carpenter Road; and
38. NC 54 at Morrisville-Carpenter Road.

Triangle Parkway, a 3.4-mile project, is a candidate North Carolina Turnpike Authority alternative that extends from I-40 at NC 147 in Durham County south to McCrimmon Parkway in Wake County. The project is also known as State Transportation Improvement Program Project No. U-4763. The project limits for the Triangle Parkway project are shown in Figure 1.

Figure 1: Triangle Parkway Project Limits



METHODOLOGY AND FORECAST DEVELOPMENT

For all scenarios, the terms No-Build and Build refer to the Triangle Parkway. Unless otherwise specified, I-540 (from NC 55 to I-40) and the Western Wake Parkway are assumed to be constructed. Descriptions of each facility included in each of the non-toll and toll alternatives are shown in Table 1.

DEVELOPMENT OF NON-TOLL AND TOLL FORECAST ALTERNATIVES

Forecast volumes for the Triangle Parkway toll alternatives were developed including:

- 2011 Build Toll without McCrimmon Parkway Connector (**Alternative C**);
- 2011 No-Build Toll without McCrimmon Parkway Connector (**Alternative C'**);
- 2030 Build Toll without McCrimmon Parkway Connector (**Alternative E**);
- 2030 Build Toll with McCrimmon Parkway Connector (**Alternative F**); and
- 2030 No-Build Toll with McCrimmon Parkway (**Alternative F'**).

Before the toll alternatives could be completed, base forecasts were developed assuming the Triangle Parkway as a non-toll facility. Several alternatives incorporating and not incorporating the McCrimmon Parkway Connector, I-540, Western Wake Parkway, and Triangle Parkway were developed to yield the appropriate non-toll alternatives.

These alternatives include:

- 2011 No-Build Non-Toll without I-540, Western Wake Parkway, and McCrimmon Parkway Connector (**Alternative A'**);
- 2011 No-Build Non-Toll with I-540, but without Western Wake Parkway and McCrimmon Parkway Connector (**Alternative A**);
- 2011 Build Non-Toll without McCrimmon Parkway Connector (**Alternative B**);
- 2011 No-Build Non-Toll without McCrimmon Parkway Connector (**Alternative B'**);
- 2030 Build Non-Toll without McCrimmon Parkway Connector (**Alternative D**);
- 2030 Build Non-Toll with McCrimmon Parkway Connector (**Alternative D+**); and
- 2030 No-Build Non-Toll with McCrimmon Parkway Connector (**Alternative D'**).

All non-toll and toll alternatives were developed using previous Triangle Parkway forecasts performed by HNTB Corporation (June, 2006). Shown in Appendix B, the HNTB forecasts used for interpolation and pivot procedures included:

- 2005 No-Build Non-Toll;
- 2030 No-Build Non-Toll; and
- 2030 Build Non-Toll.

The 2005 No-Build Non-Toll Alternative did not include forecasts for the McCrimmon Parkway Connector, I-540, Western Wake Parkway, or Triangle Parkway. The 2030 No-Build Non-Toll Alternative did not include forecasts for the McCrimmon Parkway Connector or Triangle Parkway.

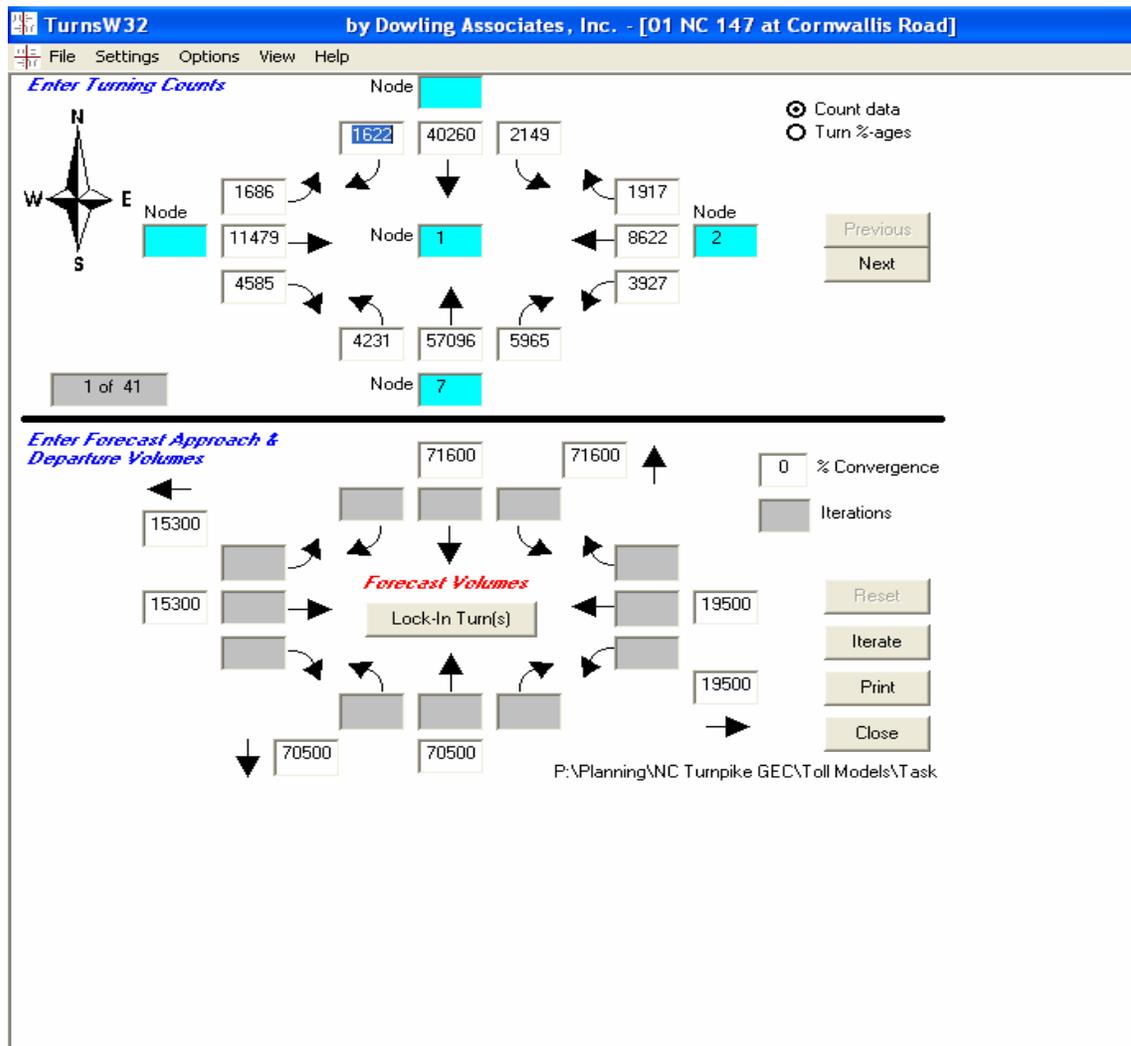
TOLL FORECASTS FOR TRIANGLE PARKWAY

The 2030 Build Non-Toll Alternative (referred to as **Alternative D+** in this document), however, did include all of these facilities.

GENERAL METHODOLOGY

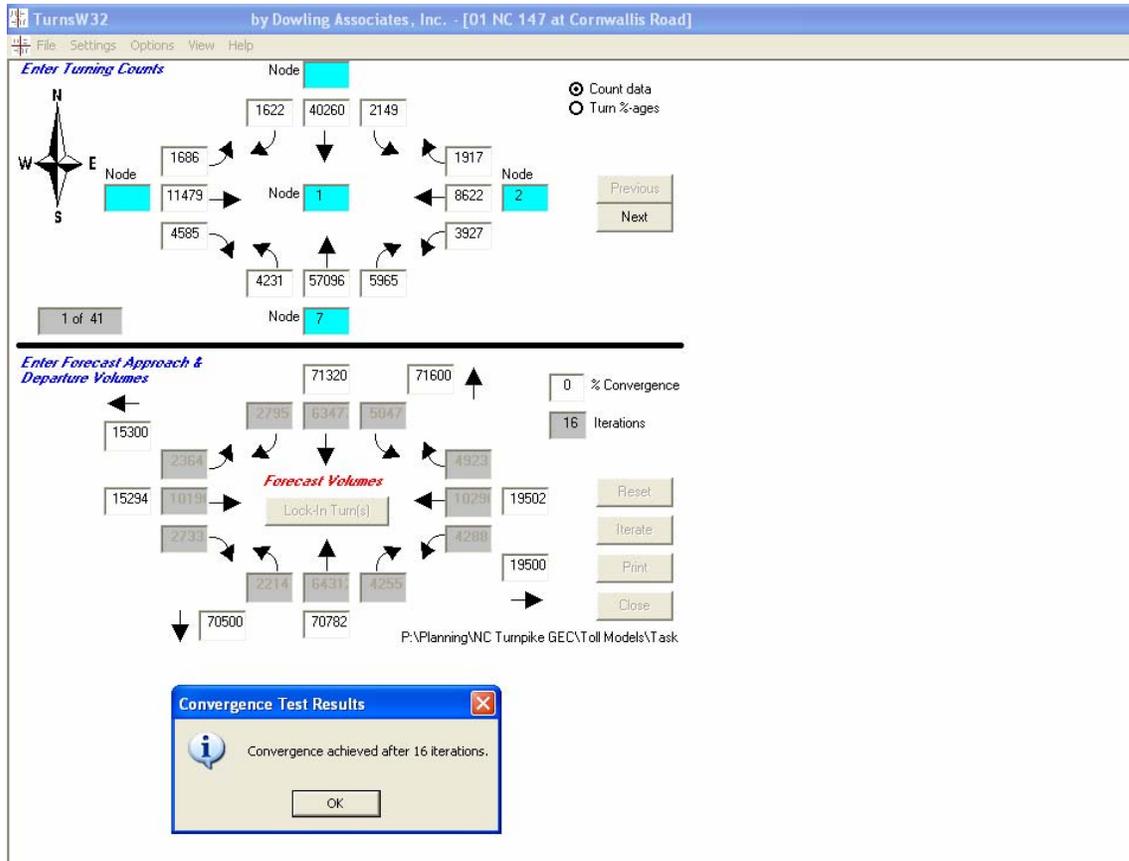
Forecast segment and turning movement volumes estimated for each alternative consisted of applying ratios of volumes extracted from model runs to the forecast volumes developed under a previous alternative. Upon completion of establishing the link and intersection turning movement volumes, each intersection was balanced. *TurnsW32*, a turning movement forecasting program, was used to facilitate this process. Examples of the input and output procedures of *TurnsW32* are shown in Figures 2 and 3.

Figure 2: NC 147 at Cornwallis Road *Input* Turning Movement Volumes *before* Iteration



TOLL FORECASTS FOR TRIANGLE PARKWAY

Figure 3: NC 147 at Cornwallis Road *Output* Turning Movement Volumes *after* Iteration



TurnsW32 employs techniques described in “National Cooperative Highway Research Program (NCHRP) Report 365: Travel Estimation Techniques for Urban Planning,” published by the Transportation Research Board National Research Council.

TurnsW32 derives forecast turning movements using an iterative approach that alternately balances the inflows and outflows until the results converge. The results converged within 100 iterations at each location. Simply, the estimated AADT volumes (inflows and outflows) at each intersection were used to estimate the turning movements. Once this process was completed, the turning movements were manually adjusted to complete the balancing procedure.

Table 1: Description of Alternatives Developed for the Triangle Parkway Toll Forecasts

Alternative	Forecast Year	Scenario				Major Facilities Included				Description
		No-Build	Build	Non-Toll	Toll	<i>McCrimmon Parkway Connector</i>	<i>I-540</i>	<i>Western Wake Parkway</i>	<i>Triangle Parkway</i>	
A'	2011	√		√						2011 No-Build Non-Toll without I-540, Western Wake Parkway, and McCrimmon Parkway Connector
A		√		√			√			2011 No-Build Non-Toll with I-540, but without Western Wake Parkway and McCrimmon Parkway Connector
B			√	√			√	√	√	2011 Build Non-Toll without McCrimmon Parkway Connector
C				√		√	√	√	√	2011 Build Toll without McCrimmon Parkway Connector
B'		√		√			√	√		2011 No-Build Non-Toll without McCrimmon Parkway Connector
C'		√				√	√	√		2011 No-Build Toll without McCrimmon Parkway Connector
D	2030		√	√			√	√	√	2030 Build Non-Toll without McCrimmon Parkway Connector
E			√		√		√	√	√	2030 Build Toll without McCrimmon Parkway Connector
D+			√	√		√	√	√	√	2030 Build Non-Toll with McCrimmon Parkway Connector
F			√			√	√	√	√	2030 Build Toll with McCrimmon Parkway Connector
D'		√		√		√	√	√		2030 No-Build Non-Toll with McCrimmon Parkway Connector
F'		√				√	√	√		2030 No-Build Toll with McCrimmon Parkway Connector

TOLL FORECASTS FOR TRIANGLE PARKWAY

2011 BUILD TOLL WITHOUT MCCRIMMON PARKWAY CONNECTOR (ALTERNATIVE C)

This toll alternative consisted of deriving three non-toll alternatives that could be applied to the link and turning movement volume ratios developed from the Triangle Regional Model. The three non-toll alternatives are:

1. 2011 No-Build Non-Toll without I-540, Western Wake Parkway, and McCrimmon Parkway Connector (**Alternative A'**);
2. 2011 No-Build Non-Toll with I-540, but without Western Wake Parkway and McCrimmon Parkway Connector (**Alternative A**); and
3. 2011 Build Non-Toll without McCrimmon Parkway Connector (**Alternative B**).

2011 No-Build Non-Toll without I-540, Western Wake Parkway, and McCrimmon Parkway Connector (Alternative A')

Alternative A' was derived by interpolation and applying growth rates of the link volumes between the 2005 and 2030 No-Build Alternatives documented by HNTB in June, 2006. Intersection turning movements were manually balanced and adjusted. Because I-540, Western Wake Parkway, and the McCrimmon Parkway Connector do not exist in the 2005 No-Build Alternative, there were no base volumes to grow on those facilities.

Appendix C-1 shows the forecast volumes for the **Alternative A'**. The design data (i.e., design hourly factors [K-Factors], directional distribution factors [D-Factors], and heavy vehicle percentages [single-unit trucks, tractor-trailer-semi-trailers]) for **Alternative A'** were adopted from HNTB's forecasts for the 2030 No-Build Non-Toll Alternative.

2011 No-Build Non-Toll with I-540, but without Western Wake Parkway and McCrimmon Parkway Connector (Alternative A)

Alternative A was estimated by applying ratios of model volumes developed from model runs of Alternative A' and Alternative A to the forecast volumes developed under **Alternative A'**. Except for the addition of I-540 between NC 55 and I-40, the roadway network is the same as **Alternative A'**. Link volumes on I-540 were estimated from the model volume run.

The forecasts for **Alternative A** were developed using the formula:

$$\text{Alternative A} = \frac{(\text{Alternative A}') * 2011 \text{ No-Build Non-Toll with I-540, w/o WWF, McC Pkwy Model Volume}}{2011 \text{ No-Build Non-Toll w/o I-540, WWF, McC Pkwy Model Volume}}$$

The forecast volumes for the **Alternative A** are shown in Appendix C-2. The design data for **Alternative A** were adopted from HNTB's forecasts for the 2030 No-Build Non-Toll Alternative.

2011 Build Non-Toll without McCrimmon Parkway Connector (Alternative B)

Forecasts for the 2011 Build Non-Toll without McCrimmon Parkway Connector (**Alternative B**) include I-540, Western Wake Parkway, and Triangle Parkway as constructed facilities. Once again,

TOLL FORECASTS FOR TRIANGLE PARKWAY

ratios of model volumes were calculated from the model runs. Link volumes on Triangle Parkway and Western Wake Parkway were estimated from the model runs.

The forecasts for **Alternative B** were developed using the formula:

$$\text{Alternative B} = \frac{(\text{Alternative A}) * 2011 \text{ Build Non-Toll without McCrimmon Parkway Model Volume}}{2011 \text{ No-Build Non-Toll with I-540, w/o WWF, McC Parkway Model Volume}}$$

The forecast volumes for the **Alternative B** are shown in Appendix C-3. The design data for **Alternative B** were adopted from HNTB's forecasts for the 2030 Build Non-Toll Alternative.

2011 Build Toll without McCrimmon Parkway Connector (Alternative C)

Upon developing the forecasts for **Alternative B**, the corresponding toll alternative (**Alternative C**) could be finalized. This alternative was developed by applying Triangle Regional Model volume ratios to forecasts previously developed for **Alternative B**. The model run volume ratios were developed from separate runs with Triangle Parkway and Western Wake Parkway as toll and non-toll facilities.

The forecasts for **Alternative C** were developed using the formula:

$$\text{Alternative C} = \frac{\text{Alternative B} * 2011 \text{ Build Toll without McCrimmon Parkway Model Volume}}{2011 \text{ Build Non-Toll without McCrimmon Parkway Model Volume}}$$

The forecast volumes for the **Alternative C** are shown in Diagram 1. The design data for **Alternative C** were adopted from HNTB's forecasts for the 2030 Build Non-Toll Alternative.

2011 NO-BUILD TOLL WITHOUT MCCRIMMON PARKWAY CONNECTOR (ALTERNATIVE C')

This toll alternative consisted of deriving a non-toll alternative known as 2011 No-Build Non-Toll without McCrimmon Parkway Connector (**Alternative B'**).

2011 No-Build Non-Toll without McCrimmon Parkway Connector (Alternative B')

Because **Alternative B'** is a No-Build Alternative, Triangle Parkway was removed from the model roadway network. Forecast volumes for **Alternative B'** were derived using the following equation:

$$\text{Alternative B}' = \frac{(\text{Alternative B}) * 2011 \text{ No-Build Non-Toll without McCrimmon Parkway Connector Model Volume}}{2011 \text{ Build Non-Toll without McCrimmon Parkway Connector Model Volume}}$$

The forecast volumes for the **Alternative B'** are shown in Appendix C-4. The design data for **Alternative B'** were adopted from HNTB's forecasts for the 2030 No-Build Non-Toll Alternative.

2011 No-Build Toll without McCrimmon Parkway Connector (Alternative C')

Upon developing the forecasts for **Alternative B'**, the corresponding toll alternative (**Alternative C'**) could be finalized. This alternative was developed by applying Triangle Regional Model link and turning movement volume ratios to forecasts developed for **Alternative B'**. The model ratios were developed from separate runs with Triangle Parkway and Western Wake Parkway as toll and non-toll facilities.

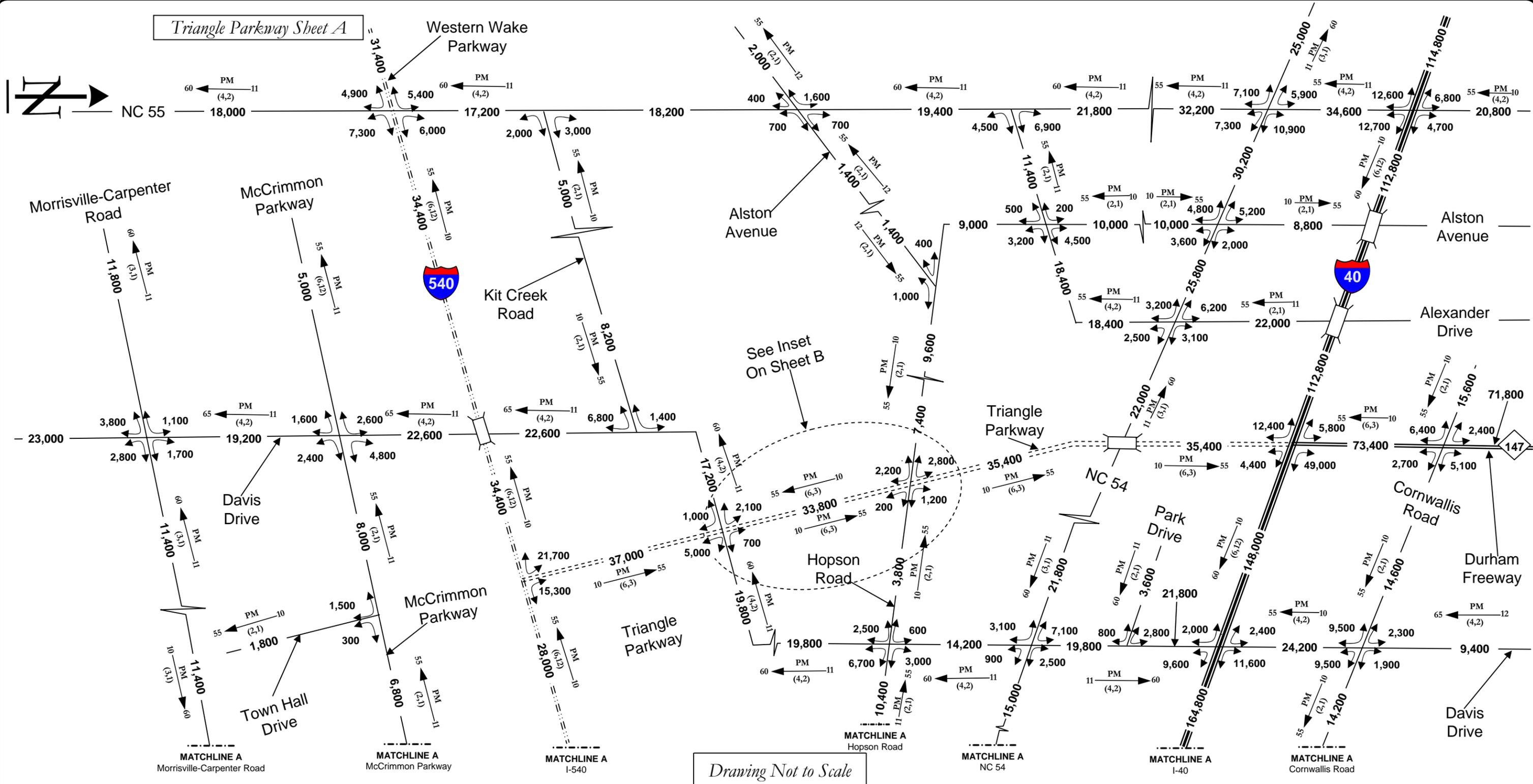
TOLL FORECASTS FOR TRIANGLE PARKWAY

The forecasts for **Alternative C** were developed using the formula:

$$\text{Alternative C} = \frac{\text{Alternative B} * \text{2011 No-Build Toll without McCrimmon Parkway Model Volume}}{\text{2011 Build Non-Toll without McCrimmon Parkway Model Volume}}$$

The forecast volumes for the **Alternative C'** are shown in Diagram 2. The design data for **Alternative C'** were adopted from HNTB's forecasts for the 2030 Build Non-Toll Alternative.

Triangle Parkway Sheet A



Drawing Not to Scale

Diagram 1:
2011 BUILD TOLL
 without McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
(Alternative C)

4000 WestChase Boulevard
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 Fax: 919-829-0329

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LEGEND

DHV — PM —> D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME

PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)

➔ INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

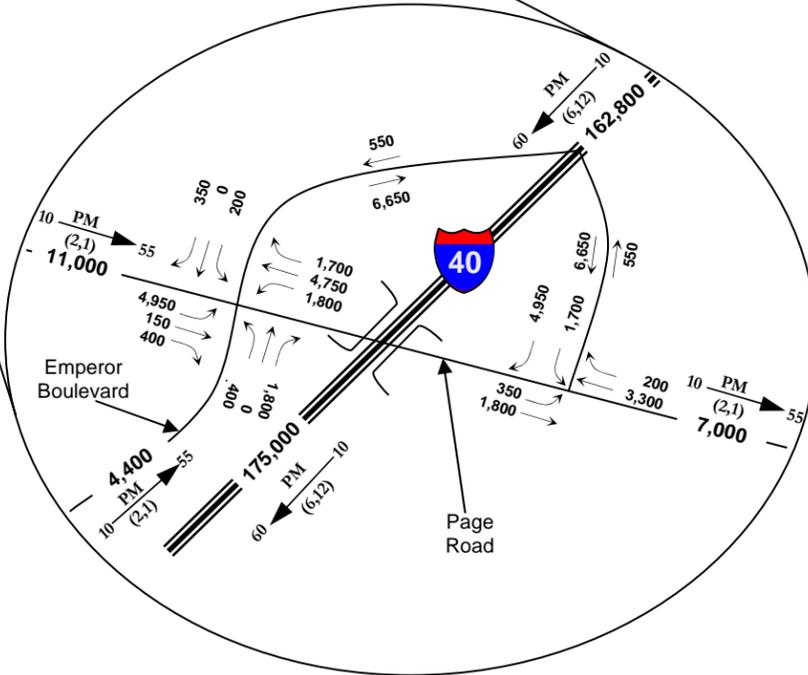
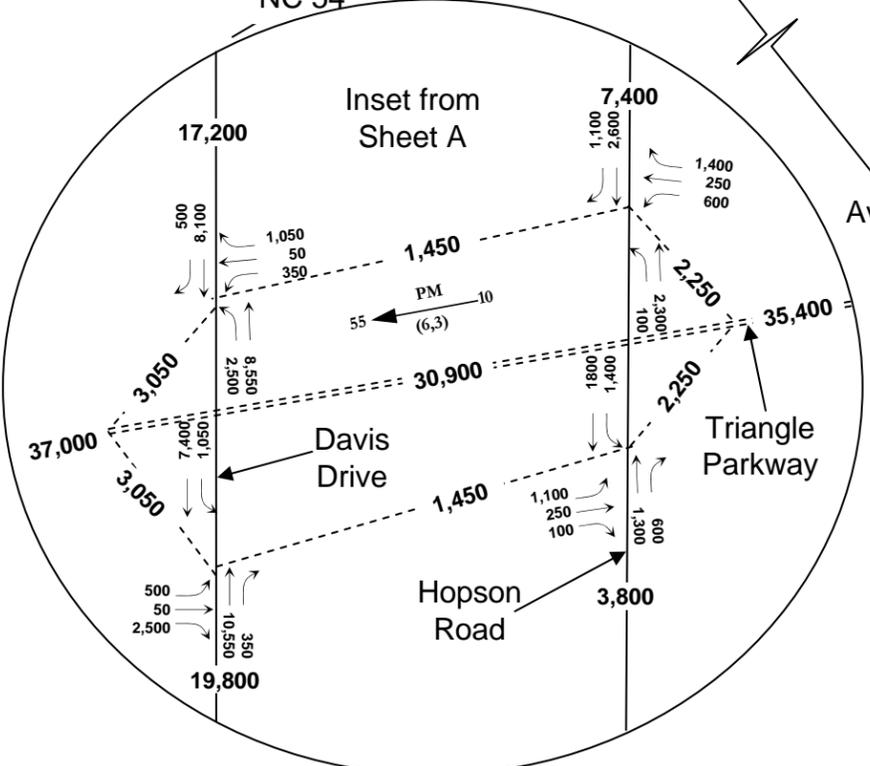
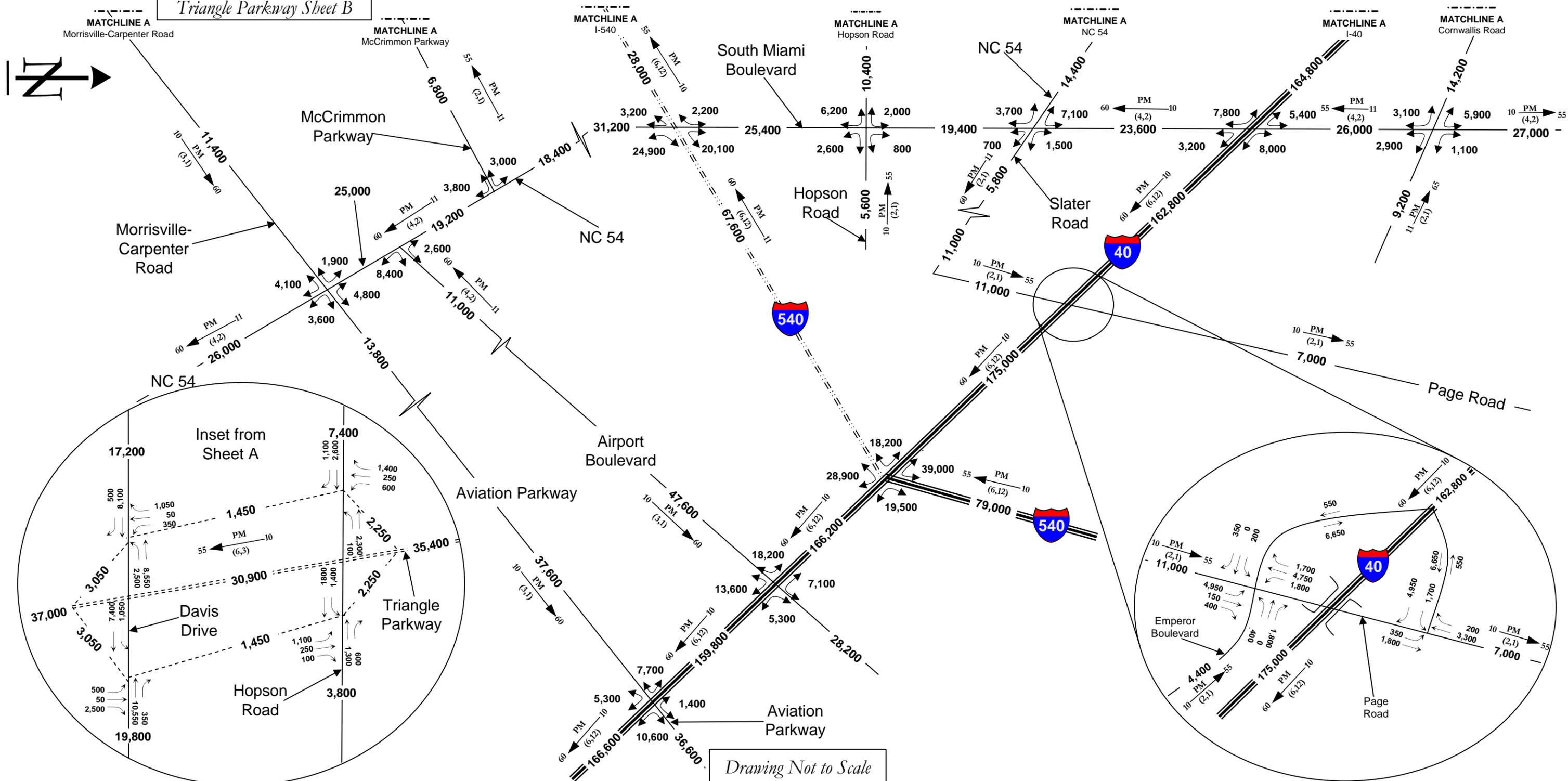
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Diagram 1:
2011 BUILD TOLL
 without McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
(Alternative C)

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 Fax: 919-829-0329

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LEGEND

DHV $\xrightarrow{\text{PM}}$ D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
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 \rightarrow INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

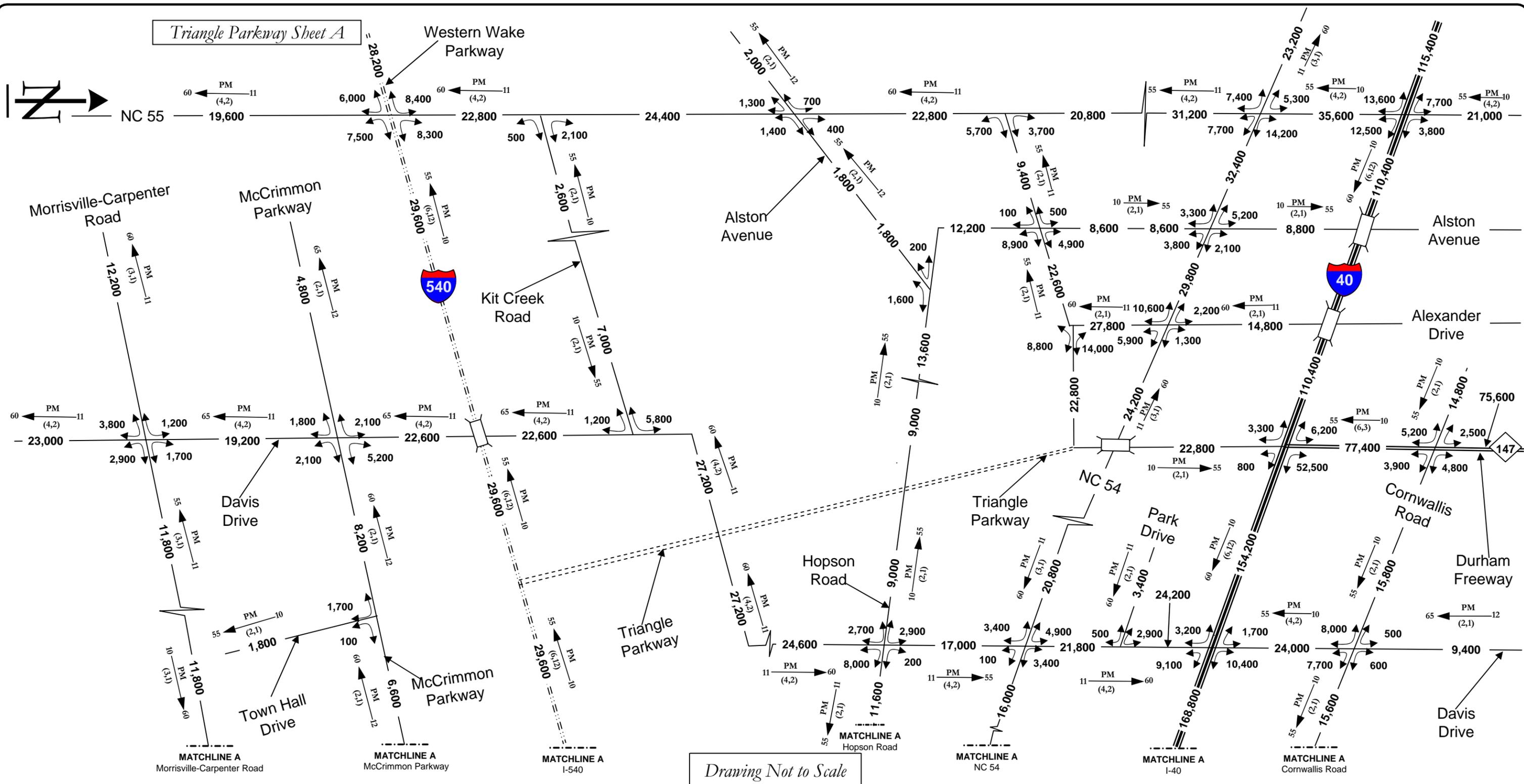
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet A



Drawing Not to Scale

Diagram 2:
2011 NO-BUILD TOLL
 without McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
(Alternative C')

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LEGEND

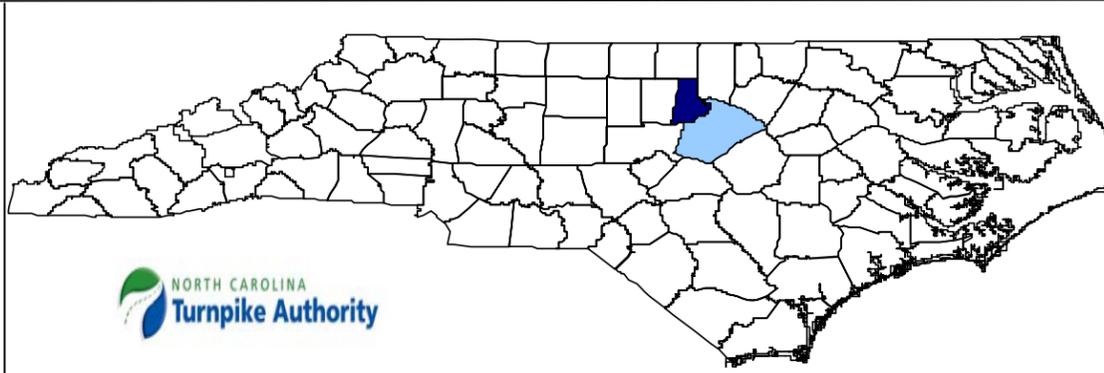
DHV — PM — D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
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PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)

→ INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

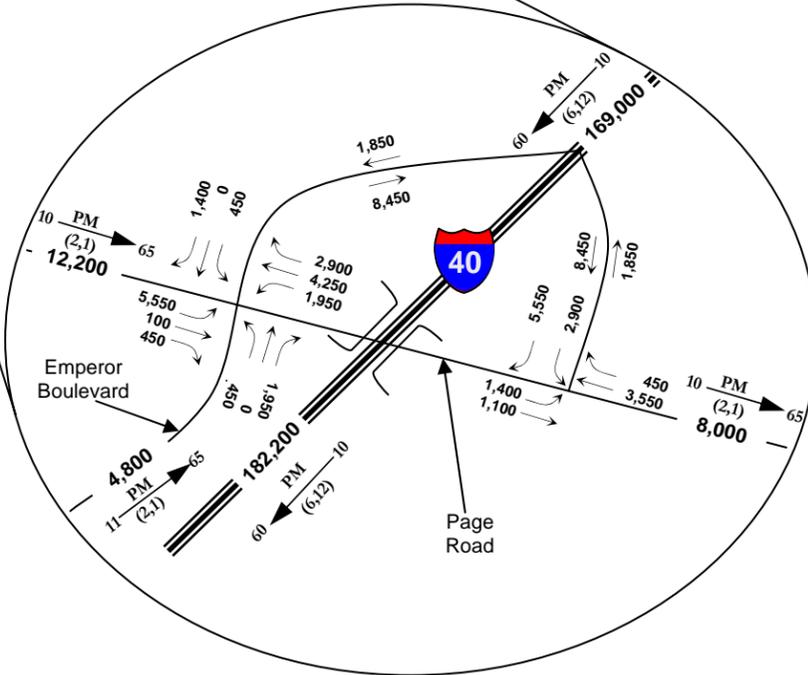
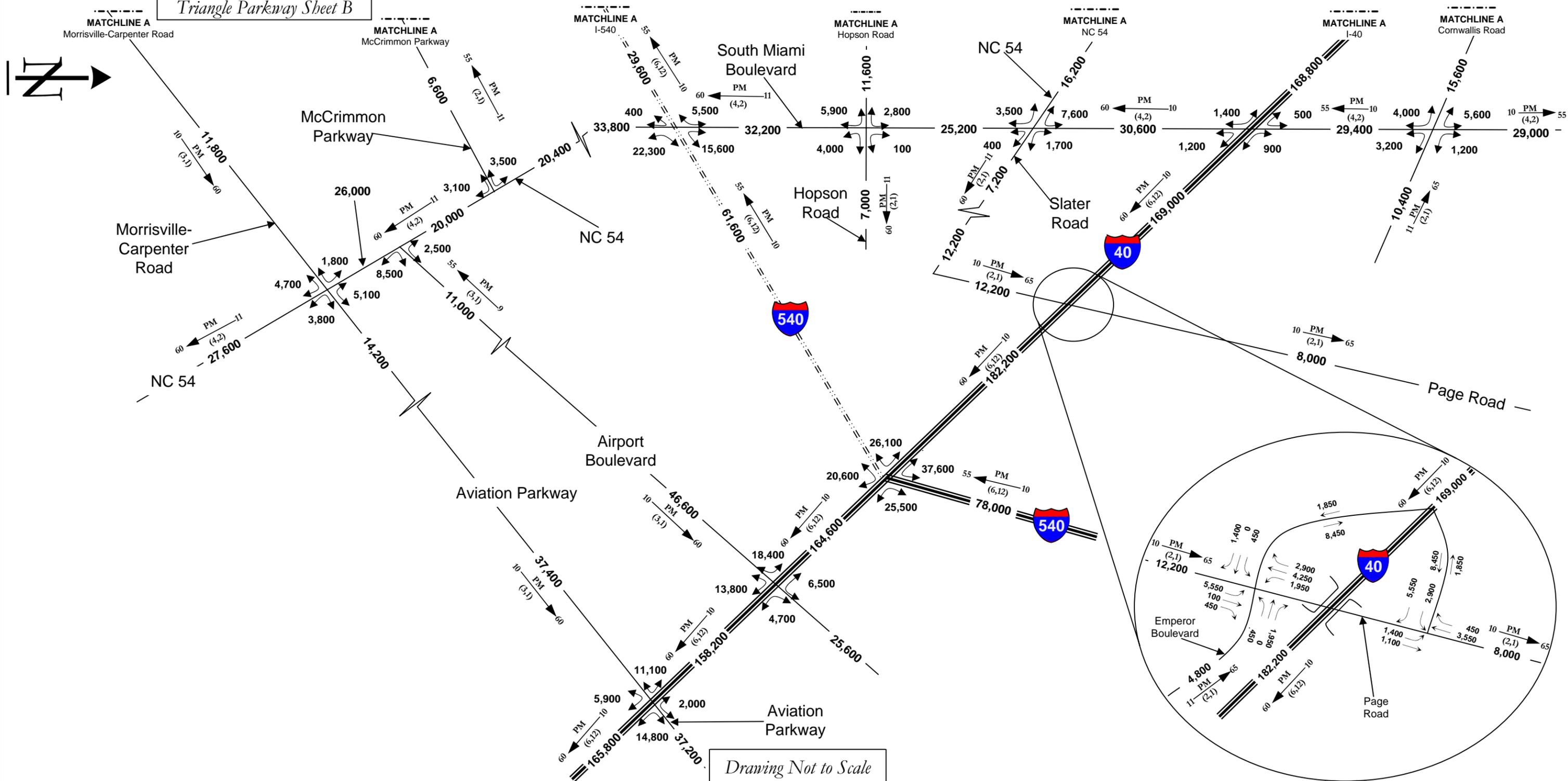
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Diagram 2:
2011 NO-BUILD TOLL
 without McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
 (Alternative C)

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LEGEND

DHV $\xrightarrow{\text{PM}}$ D
 (d, t)

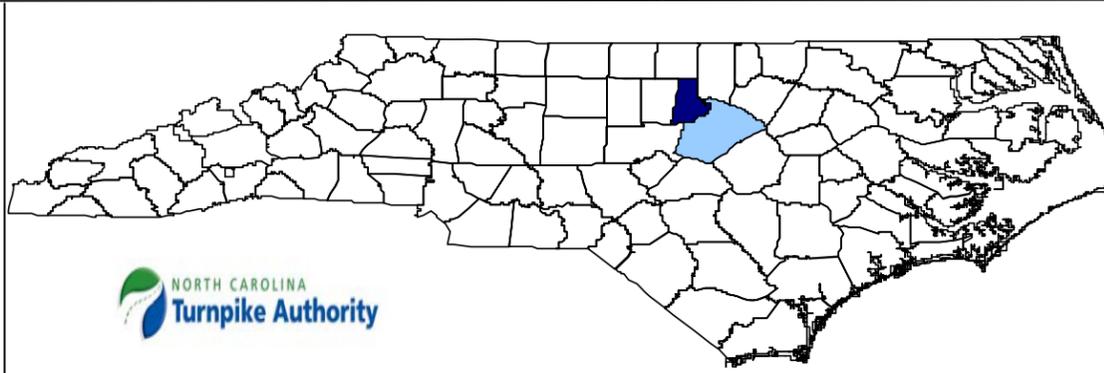
DHV = DESIGN HOURLY VOLUME (%) = K30
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D = DIRECTIONAL SPLIT (%)

\rightarrow INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK

(d,t) DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

TOLL FORECASTS FOR TRIANGLE PARKWAY

2030 BUILD TOLL WITHOUT MCCRIMMON PARKWAY CONNECTOR (ALTERNATIVE E)

Prior to developing toll forecasts for **Alternative E**, non-toll forecasts were developed and named **Alternative D**. This alternative was developed by applying Triangle Regional Model volume ratios to forecasts previously developed by HNTB (2030 Build Non-Toll Alternative). HNTB's forecasts are referred to as **Alternative D+** in this document.

A section of the Triangle Parkway identified as the McCrimmon Parkway Connector is eliminated and represents the difference between **Alternative D** and **Alternative D+**. This section extends from McCrimmon Parkway to I-540. I-540, Triangle Parkway and Western Wake Parkway were assumed to be constructed under **Alternative D+**.

2030 Build Non-Toll without McCrimmon Parkway Connector (Alternative D)

The 2030 Build Non-Toll with McCrimmon Parkway Connector Alternative was developed by obtaining link volumes from two independent model runs—one with the McCrimmon Parkway Connector and one without the McCrimmon Parkway Connector.

The forecasts for **Alternative D** were developed using the formula:

$$\text{Alternative D} = \frac{\text{Alternative D+} * 2030 \text{ Build Toll Model Volume w/o McCrimmon Parkway Connector}}{2030 \text{ Build Non Toll Model Volume with McCrimmon Parkway Connector}}$$

The forecast volumes for the **Alternative D** are shown in Appendix C-5. The design data for **Alternative D** were adopted from HNTB's forecasts for the 2030 Build Non-Toll Alternative.

2030 Build Toll without McCrimmon Parkway Connector (Alternative E)

Upon developing the non-toll alternative, the toll alternative could be finalized. This alternative was developed by applying Triangle Regional Model volume ratios to forecasts previously developed under **Alternative D**. Model volume ratios were developed from separate runs with Triangle Parkway and Western Wake Parkway as toll and non-toll facilities.

The forecasts for **Alternative E** were developed using the formula:

$$\text{Alternative E} = \frac{\text{Alternative D} * 2030 \text{ Build Toll without McCrimmon Parkway Connector Model Volume}}{2030 \text{ Build Non Toll without McCrimmon Parkway Connector Model Volume}}$$

The forecast volumes for the **Alternative E** are shown in Diagram 3. The design data for **Alternative E** were adopted from HNTB's forecasts for the 2030 Build Non-Toll Alternative.

2030 BUILD TOLL WITH MCCRIMMON PARKWAY CONNECTOR (ALTERNATIVE F)

This alternative was developed by applying Triangle Regional Model volume ratios to forecasts previously developed by HNTB. HNTB's forecasts assumed that the Triangle Parkway and Western Wake Parkway were non-toll facilities, and are referred to as **Alternative D+** in this document. A ratio of link volumes were developed from separate model runs with Triangle Parkway and Western Wake Parkway as non-toll and toll facilities.

The forecasts for **Alternative F** were developed using the formula:

TOLL FORECASTS FOR TRIANGLE PARKWAY

$$\text{Alternative F} = \frac{(\text{Alternative D+}) * 2030 \text{ Build Toll with McCrimmon Parkway Connector Model Volume}}{2030 \text{ Build Non Toll with McCrimmon Parkway Connector Model Volume}}$$

The forecast volumes for the **Alternative D+** are shown in Appendix C-6. The forecast volumes for the **Alternative F** are shown in Diagram 4. The design data for each interchange, intersection, and roadway segment in **Alternatives D+** and **F** were adopted HNTB's forecasts for the 2030 Build Non-Toll Alternative.

2030 NO-BUILD TOLL WITH MCCRIMMON PARKWAY CONNECTOR (ALTERNATIVE F')

This alternative consisted of deriving a non-toll alternative known as 2030 No-Build Non-Toll without McCrimmon Parkway Connector (**Alternative D'**). The design data for **Alternatives D'** and **E'** were adopted HNTB's forecasts for the 2030 Build Non-Toll Alternative.

2030 No-Build Non-Toll with McCrimmon Parkway Connector (Alternative D')

Because **Alternative D'** is a No-Build Alternative, Triangle Parkway was removed from the model roadway network. Forecast volumes for **Alternative D'** were derived using the following equation:

$$\text{Alternative D}' = \frac{(\text{Alternative D+}) * 2030 \text{ No-Build Toll with McCrimmon Parkway Connector Model Volume}}{2030 \text{ Build Non Toll with McCrimmon Parkway Connector Model Volume}}$$

The forecast volumes for the **Alternative D'** are shown in Appendix C-7. The design data for **Alternative D'** were adopted from HNTB's forecasts for the 2030 No-Build Non-Toll Alternative.

2030 No-Build Toll with McCrimmon Parkway Connector (Alternative F')

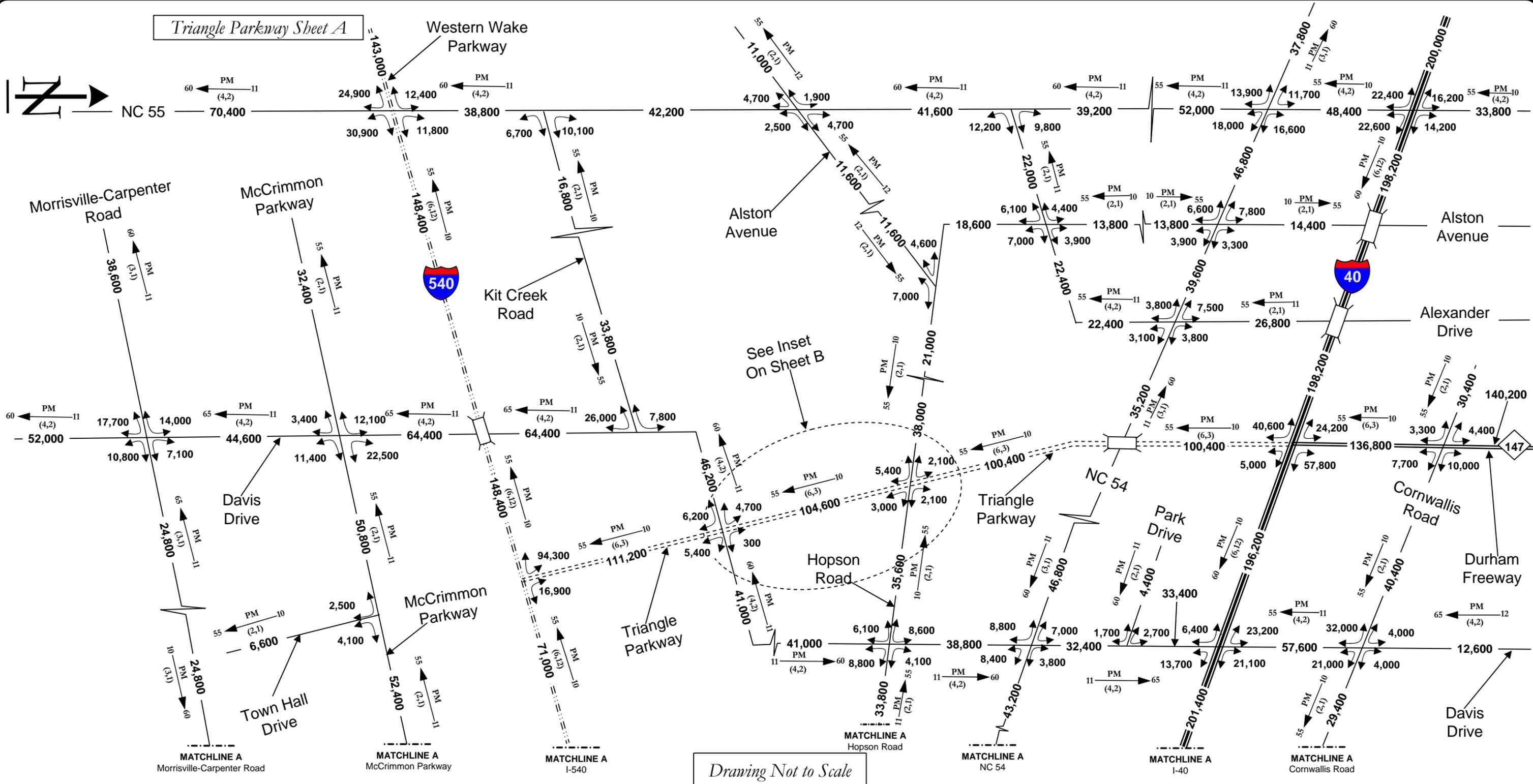
Upon developing the forecasts for **Alternative D'**, the corresponding toll alternative (**Alternative F'**) could be finalized. This alternative was developed by applying Triangle Regional Model volume ratios to forecasts developed for **Alternative D'**. The model ratios were developed from separate runs with Triangle Parkway and Western Wake Parkway as toll and non-toll facilities.

The forecasts for **Alternative F'** were developed using the formula:

$$\text{Alternative F}' = \frac{(\text{Alternative D}') * 2030 \text{ No-Build Toll with McCrimmon Parkway Connector Model Volume}}{2030 \text{ No-Build Non Toll with McCrimmon Parkway Connector Model Volume}}$$

The forecast volumes for the **Alternative F'** are shown in Diagram 5. The design data for each interchange, intersection, and roadway segment in **Alternative F'** were adopted HNTB's forecasts for the 2030 No-Build Non-Toll Alternative.

Triangle Parkway Sheet A



Drawing Not to Scale

Diagram 3:
2030 BUILD TOLL
 without McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
 (Alternative E)

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

MARTIN ALEXIOU BRYSON

Transportation Planning - Traffic Engineering

LEGEND

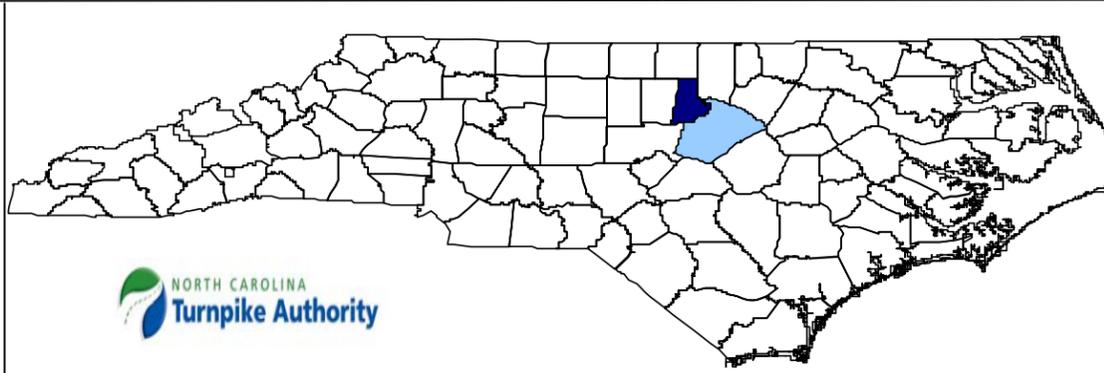
DHV — PM — D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME

PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)

→ INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

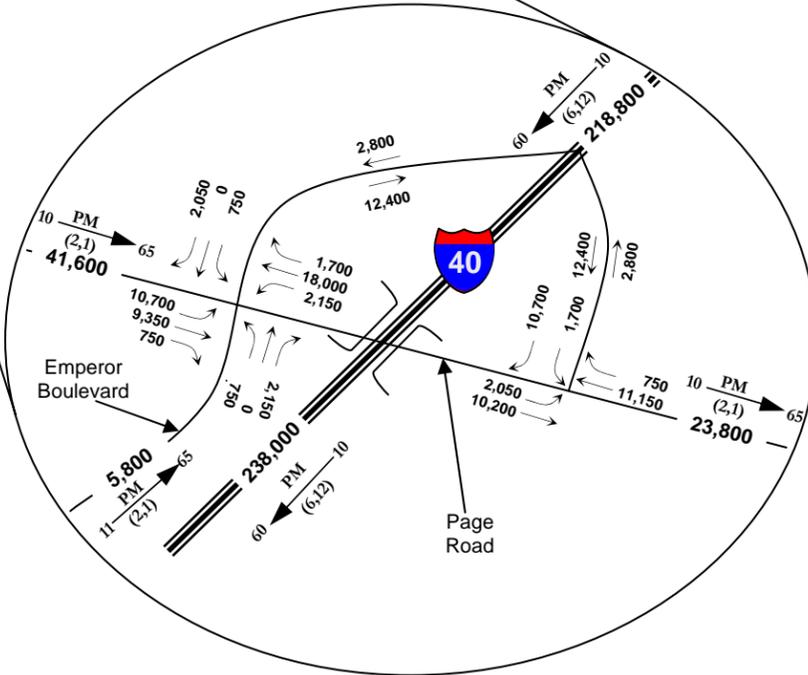
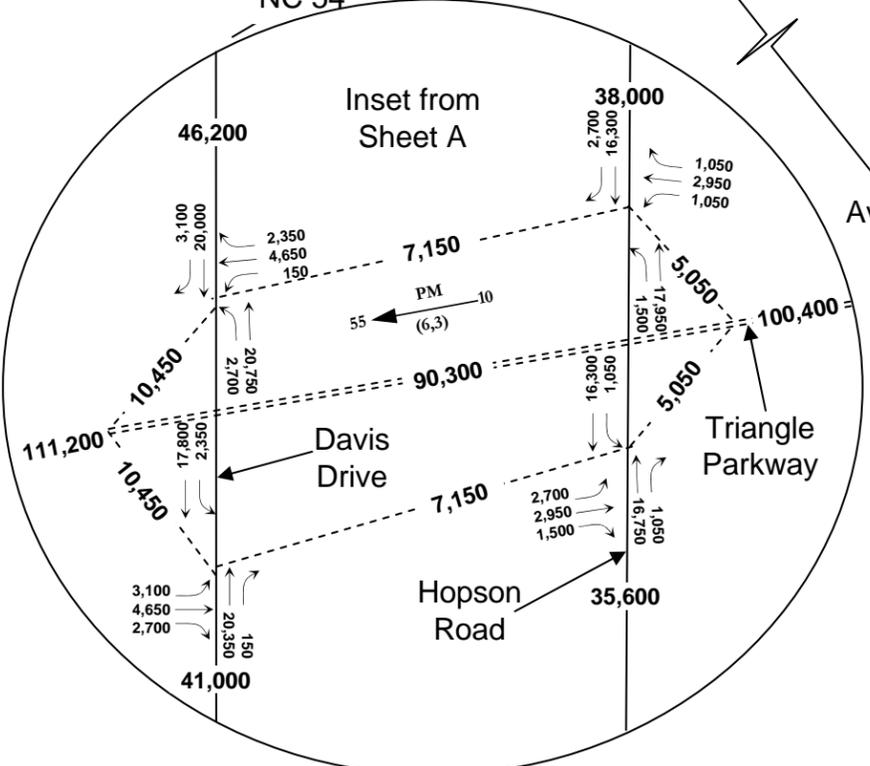
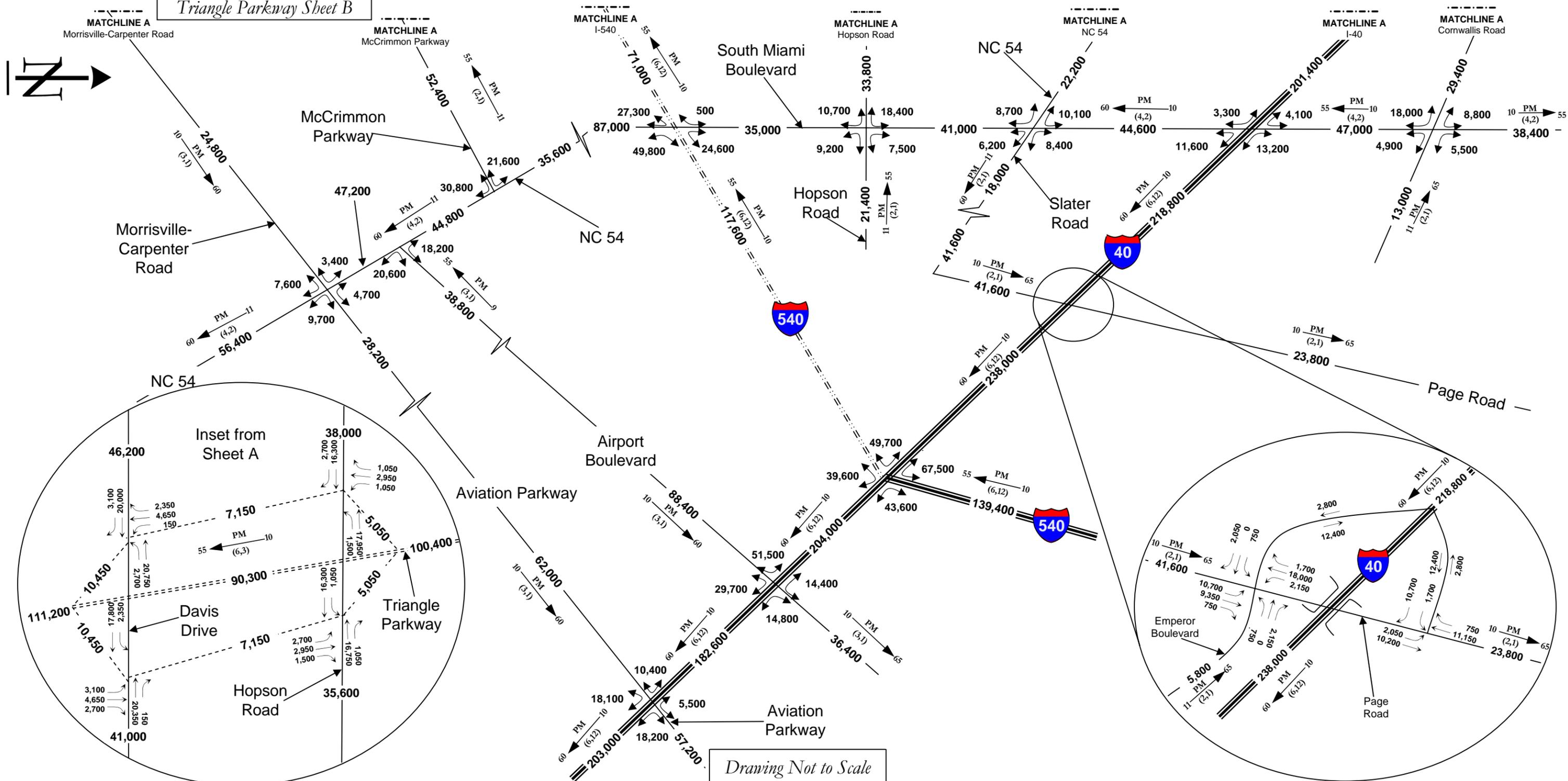
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Diagram 3:
2030 BUILD TOLL
 without McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
 (Alternative E)

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 Raleigh, North Carolina 27607
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LEGEND

DHV $\xrightarrow{\text{PM}}$ D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
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 \rightarrow INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

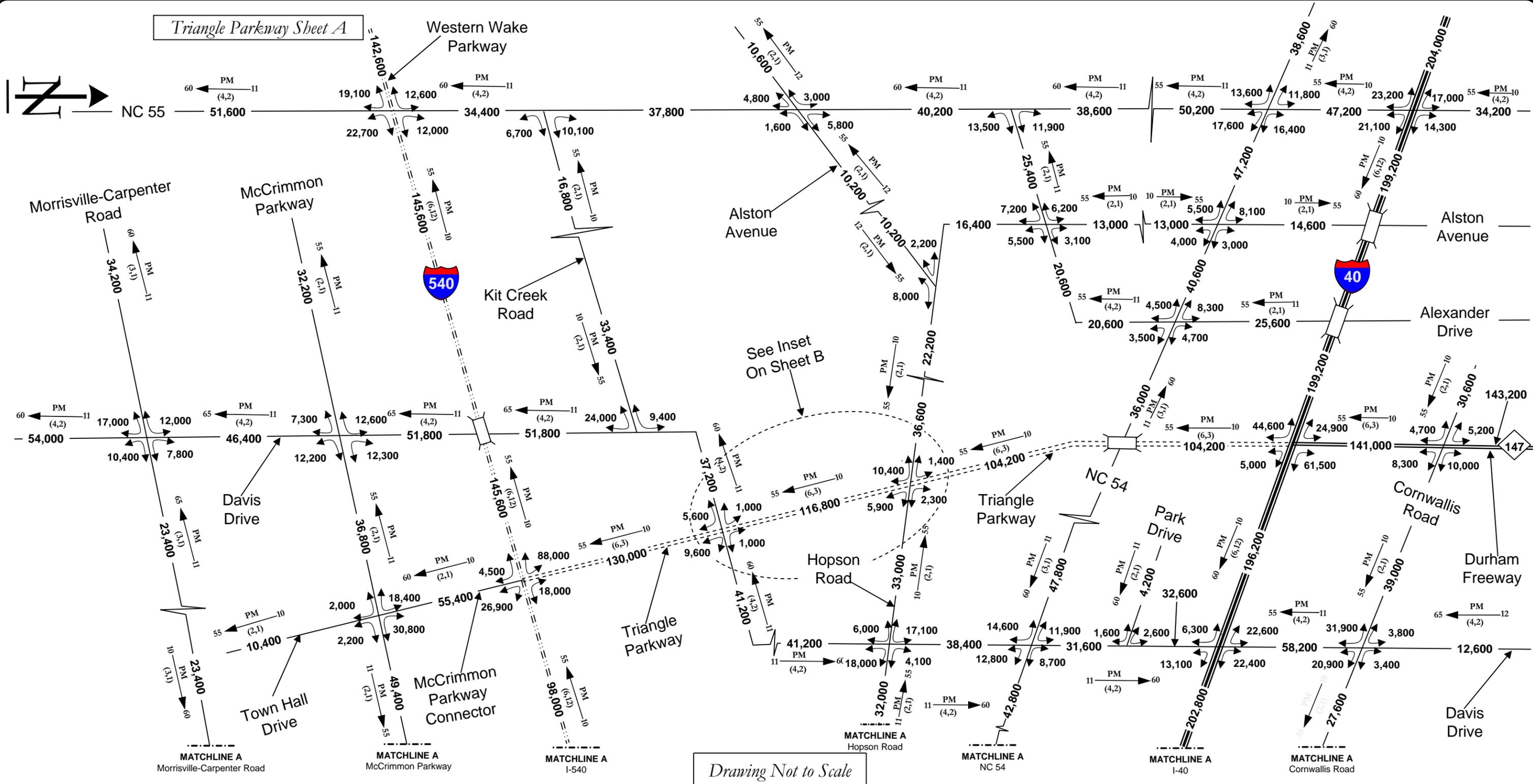
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet A



Drawing Not to Scale

Diagram 4:
2030 BUILD TOLL
 with McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
 (Alternative F)

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 Raleigh, North Carolina 27607
 Phone: 919-829-0328
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LEGEND

DHV — PM —> D
 (d, t)

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 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

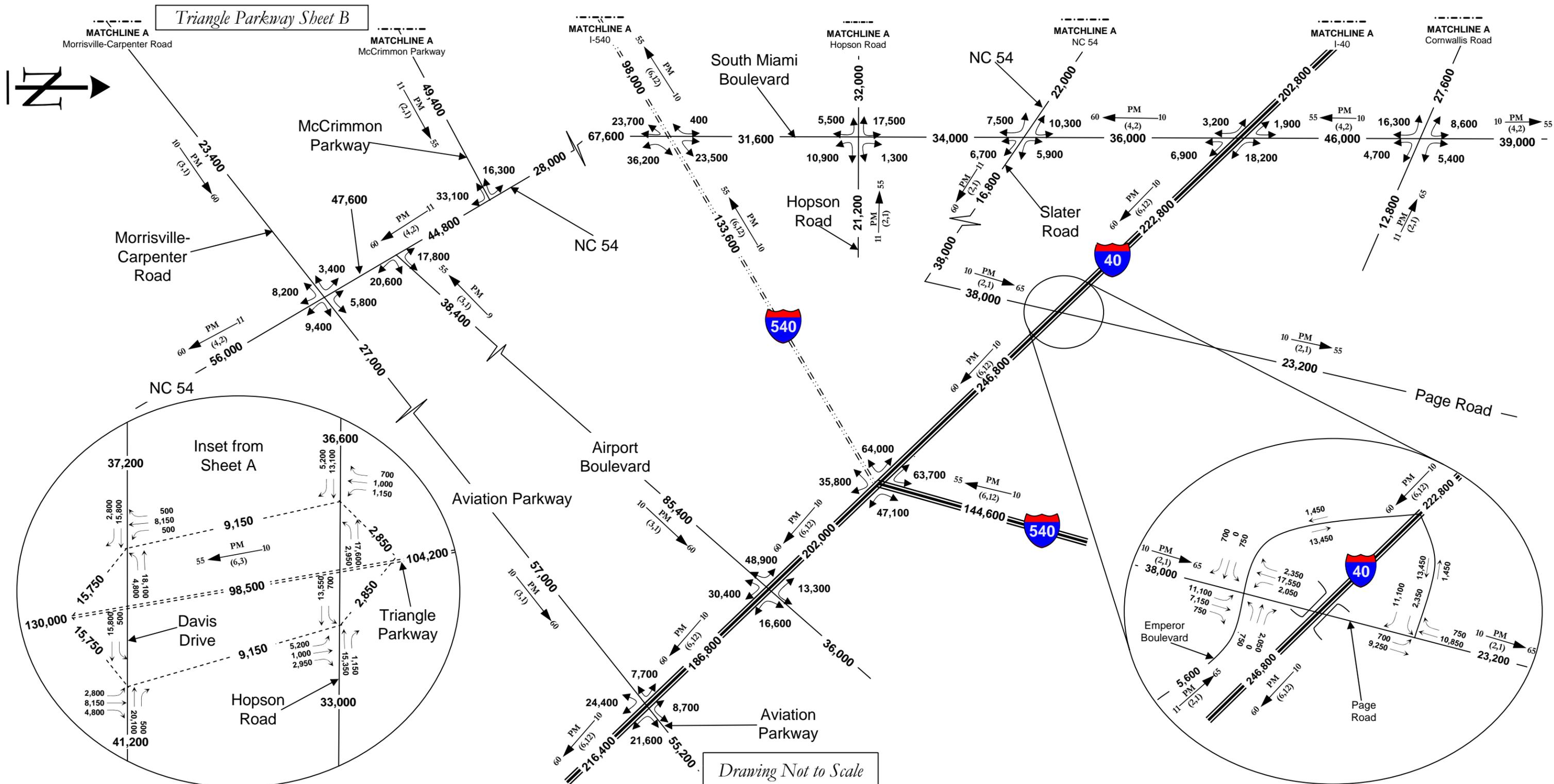
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Diagram 4:
2030 BUILD TOLL
 with McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
 (Alternative F)

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LEGEND

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\rightarrow INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK

(d,t) DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

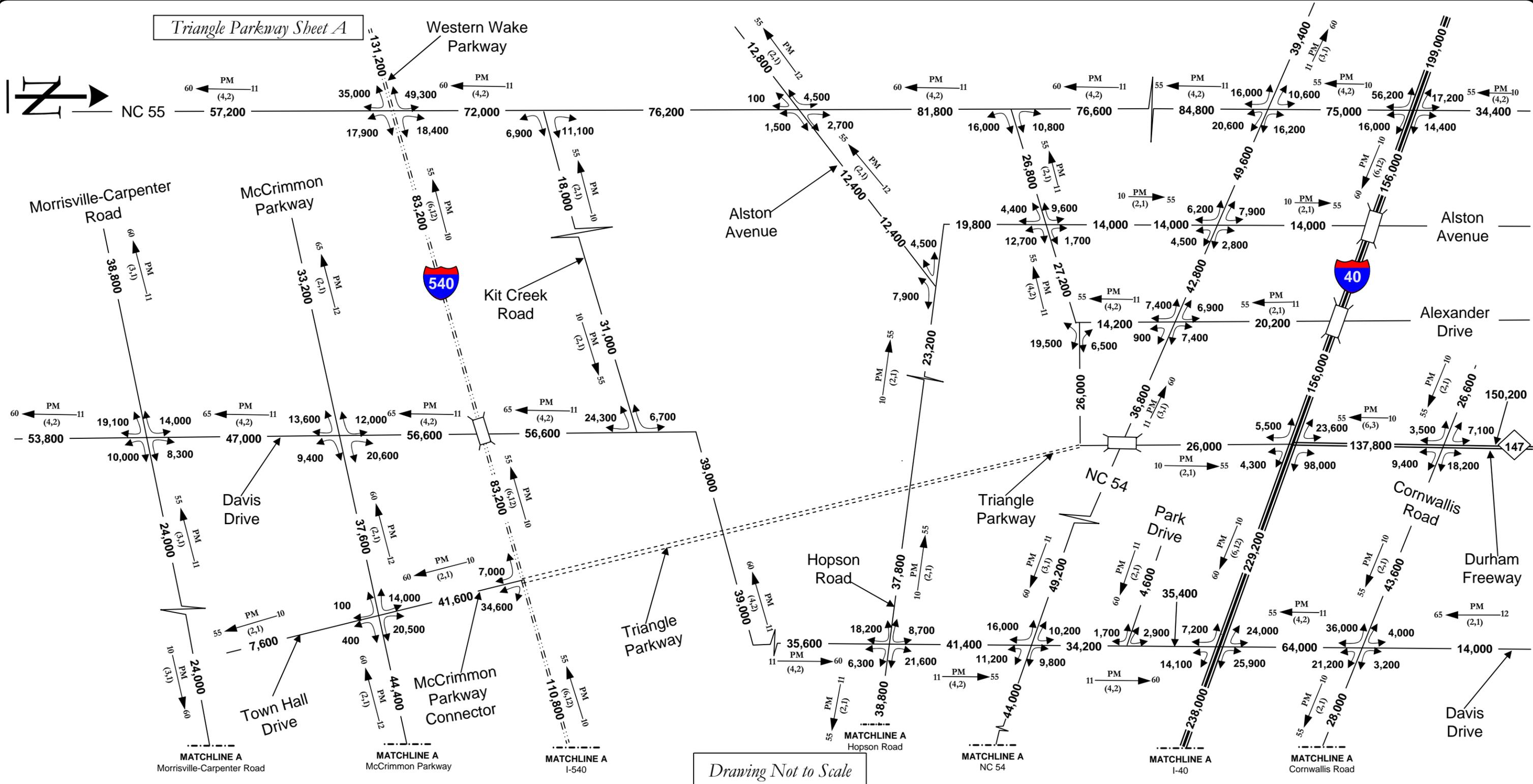
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet A



Drawing Not to Scale

Diagram 5:
2030 NO-BUILD TOLL
 with McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
 (Alternative F)

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➔ INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

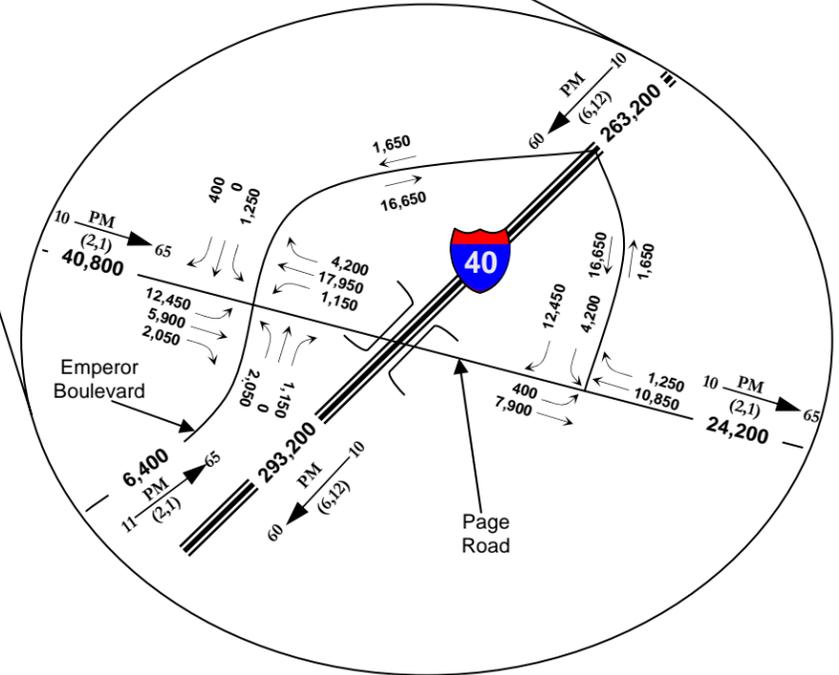
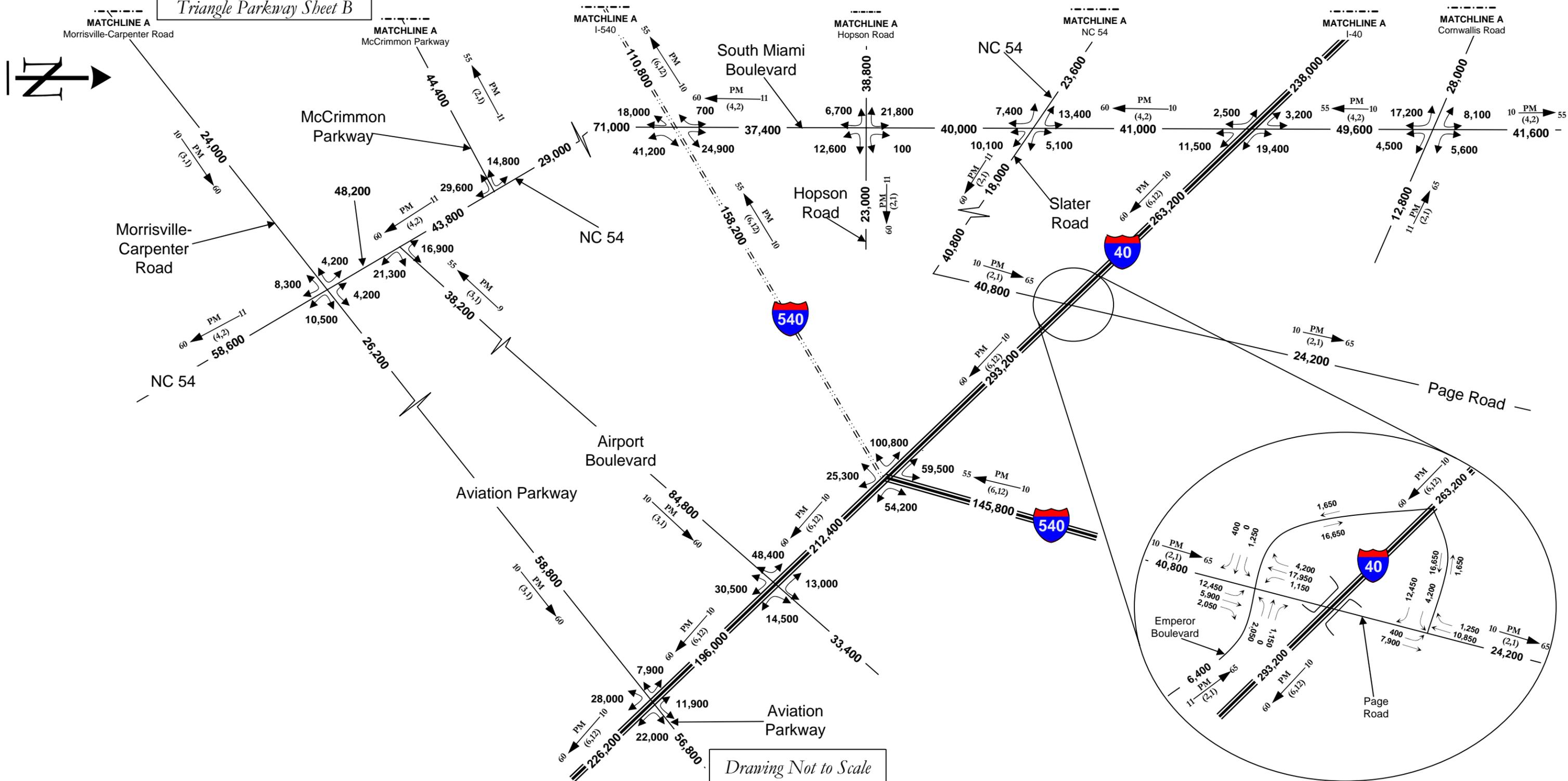
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Diagram 5:
 2030 NO-BUILD TOLL
 with McCrimmon Parkway Connector
 DAILY FORECAST VOLUMES
 (Alternative F')

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NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

APPENDICES

APPENDIX A: TRM TOLLING METHODOLOGY

Memorandum

To: Bill Martin, Martin/Alexiou/Bryson, Inc.
Taruna Tayal, Martin/Alexiou/Bryson, Inc.

From: Elizabeth A. Harper

Date: December 4, 2006

Re: Triangle Regional Model Tolling Application

This memo provides documentation of the implementation of the a tolling methodology within the Triangle Regional Model (TRM) for purposes of evaluation of the effect of tolling the Western Wake Parkway (WWP) and the Triangle Parkway (TP) on regional travel demand in 2030 and 2011. It is accompanied by a set of three CDs containing the official models as delivered by the Capital Area Metropolitan Planning Organization (CAMPO) and the model files used for the initial forecasts. The CD containing the model files used for the initial forecasts contains a workbook entitled 'Files on this CD.xls' describing the files required to run the various toll scenario analyses.

Installation and Verification of the TRM

The current official approved TRM for 2030 and for 2010 were provided by CAMPO via FTP, were installed at Martin/Alexiou/Bryson offices, and were tested to verify that the project installation produced the same results as those produced by CAMPO. Total vehicle miles traveled (VMT) for both the 2030 and the 2010 models were identical to that reported by CAMPO.

Modifications to the TRM for the Base Case (Non-toll)

The official TRM model was executed using version 9.1 of TranPlan. Subsequent testing has shown that some auto through trips may fail to be assigned using version 9.1 and that problems with the gravity model may also effect the vehicle loads. To assure the most accurate analysis of diversions due to tolls the consulting team choose to evaluate the use of version 9.2 of TranPlan. Tests showed a minor difference in total VMT and average speeds due to the use of TranPlan version 9.2 (see Table 1 below). Version 9.2 was chosen for this analysis.

Table 1: Changes in VMT and Speeds - V9.1 to V9.2*

	v9.1	v9.2	Difference
VMT	74,132,275	74,062,390	-0.09%
VHT	2,287,146	2,278,572	-0.37%
Speed	32.4	32.5	0.28%

*autos only, no trucks, commercial vehicles or through trips

Methodology for Modeling Tolls

There is little consensus in the travel demand modeling community on the appropriate methods for modeling travel demand under tolling conditions. The proceedings of an *Expert Forum on Road*

*Pricing and Travel Demand Modeling*¹ provides a good summary of the technical options evidenced in the current state of the practice, the benefits and drawbacks of each, and the directions in which the state of the art and current research are leading. A summary of the three² state of the practice approaches discussed at the Forum are listed and summarized relative to the TRM and this tolling analysis project in Table 2 on page 3.

Priorities for this analysis are for a capability to analyze tolls with minimum changes to the existing, approved TRM model structure and model stream. Time constraints prohibit data collection, model estimation and calibration. After testing and evaluation, the diversion model, using the default parameters provided in the TranPlan software³, was selected for the following reasons:

1. Estimation of a new mode choice model with a tolling capability is an extensive effort; and is beyond the scope and time constraints of this project.
2. The trip assignment approach provided erratic results due to highly congested facilities, short trip length frequencies, and undocumented but commonly recognized problems with the TRM distribution model. Building the trip assignment approach into the larger TRM model stream with full feedback might ameliorate this erratic behavior but would require a major change to the overall approved TRM model, and would not ameliorate potential issues related to the distribution model.
3. There is considerable precedence in the travel demand forecasting community for making use of calibrated model parameters from other regions where no local data exists for model estimation and calibration.
4. Making use of the diversion model allows the consulting team to remain as close as possible to the original, approved, TRM model structure.
5. Estimation of a single value of time for the entire region is difficult to defend and document but would not be necessary with the diversion model.
6. The toll diversion model can be easily implemented in a timely manner.

For more documentation on the algorithms and parameters of the TranPlan implementation of the toll diversion model please see the TranPlan Users' Guide.

Other Considerations

1. Because of the generous capacities coded on ramps in the 2030 TRM networks there are many locations in the corridor where traffic finds a shorter path by exiting and re-entering the expressway at an interchange, by-passing the mainline between the ramp gores. The consulting team coded turn prohibitors at the base of every interchange on the WWP and the TP to prohibit this unlikely movement from an exit ramp directly onto the subsequent entrance ramp. The locations where these turn prohibitors are added can be identified in the file included in the model setups and named "turnproh.prm".
2. Some ramps are incorrectly coded as two-way ramps and are receiving zero assigned volumes in the official TRM. However, these ramps became acceptable paths for some traffic being diverted by the tolls. These ramps were disabled with a combination of zero capacities and turn prohibitors. Ramps that are disabled can be seen in the file included in the model setups and named "disable.prm".

¹ Expert Forum on Road Pricing and Travel Demand Modeling Proceedings; November 14- 15, 2005; Hilton Alexandria Old Town; Sponsored the Office of Transportation Policy, U.S. Department of Transportation.

² A fourth approach, the Facilities Model, is documented in the TranPlan Users Guide, but is rarely used in current practice since GPS, video imagery, and electronic data capture technologies are making toll booths obsolete for future forecasts.

³ These parameters were developed for the Florida Department of Transportation based on considerable observed toll data.

Table 2: Approaches for Travel Demand Forecasting for Toll Facilities

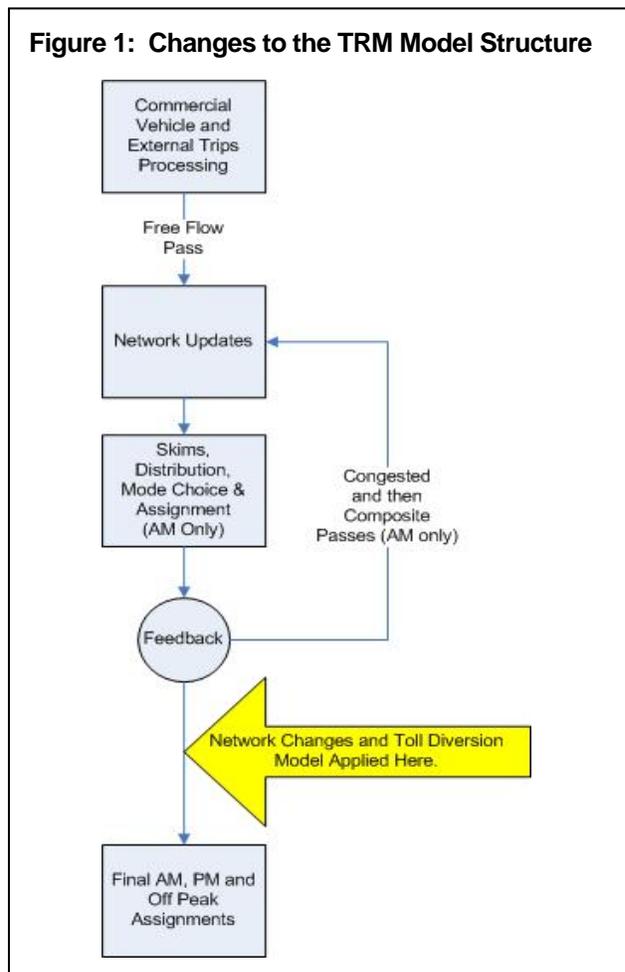
<i>Approach</i>	<i>Pros</i>	<i>Cons</i>
<p><u>Mode Choice Analysis</u> – Selection of a route that includes a toll is treated as a sub-mode choice in the auto nest of a nested-logit mode choice model. Variables that effect the choice may include cost, travel time savings, average income, purpose of trip, auto ownership, etc. Only those auto person trips that are identified as likely to choose the toll route are allowed to be assigned to the toll facility.</p>	<p>Use of 'generalized cost' functions in identifying toll choices resulting in a more realistic representation of choices made by drivers.</p> <p>Most defensible technically.</p>	<p>Requires full model feedback (mode choice through assignment) iteratively until convergence is reached – substantial change in TRM model structure.</p> <p>Requires estimation and calibration of a nested mode choice model and re-validation of the entire model stream – substantial level of effort.</p>
<p><u>Trip Assignment</u> – the cost of tolls are converted to an equivalent measure of time and added to the travel times on toll roads to compute a generalized time for calculating impedances and shortest paths. The choice to use a toll road or not is based on minimum generalized travel times only.</p>	<p>Provides ability to evaluate directly the influence of traffic congestion on demand for the toll facility.</p> <p>Easiest to implement.</p>	<p>Requires estimation of a single value of time for the entire population of the region (or complex multi class trip assignment with trip matrix stratification)</p> <p>Elimination of effect of other contributing factors such as income, trip purposes, and time of day.</p> <p>Should be applied within the full model feedback to account for changes in trip distribution – Requires major change to TRM model structure.</p> <p>Without incorporation into full model stream, results can be unpredictable in heavily congested networks with short trip length frequencies.</p>
<p><u>Diversion Models</u> – A probability that a vehicle will use the toll facility route rather than a free route is calculated for each origin-destination pair based on observed behavior, differences in travel times, and costs of the tolls.</p>	<p>Can be applied without modifying or recalibrating the existing four-step travel demand model structure.</p>	<p>Requires the estimation and calibration of model parameters based on observed data.</p>

3. The ramps on the TP between Hopson Road and Davis Drive are to be combined with a collector-distributor type configuration rather than the ramp coding currently included in the official TRM. Changes to the TRM network to implement this revised configuration can be seen in the file included with the model setups and named "addramp.prn".
4. It is assumed that electronic tolling capabilities will be sufficient by 2030 to effectively eliminate the need to model delays at service plazas.
5. Approximately eight percent of the total regional 2030 trips are represented by the trucks, external commercial vehicles, and through trips and are assigned separately from the autos and other internal trips in an all or nothing (AON) assignment. These trips load primarily on the freeways and constitute over 30% of freeway traffic volumes. They are not included in the impedance calculations for the auto and other internal trips assignment or for the toll probability calculations. This model structure was not modified because to do so would represent a major change in the adopted TRM, and would require re-validation of the highway model.

Toll Model Implementation

To minimize the changes between the official approved TRM and the Toll Model the consulting team choose to add the toll model changes to the end of the model stream after all congestion redistribution and skimming feedback loops. The toll model references output trip tables and networks generated by a run of the TRM, modifies the final networks to accommodate changes noted above, and then runs the final assignments with the toll diversion model implemented. (See Figure 1).

Traffic volumes on the WWP and the TP have already been estimated during long range planning efforts and early toll feasibility studies. The intention of this modeling exercise is to determine the extent of traffic diversion from these facilities due to the introduction of tolls. The strategy for implementing tolls, including locations of toll collection and price of the tolls, were initially determined by the Toll Authority and are documented under separate cover. A final determination of locations and amounts of tolls was still under consideration at the time of this analysis. To isolate the effects of the toll amounts from later decisions about locations of toll collections, this toll model applies a flat toll amount per mile to each link in the toll system. Toll amounts per mile are calculated based on an assumed \$2.00 toll on the Triangle Parkway and a \$4.00 toll on the Western Wake Parkway in 2030. All cost related parameters in the TRM are assumed to be 2002 dollars. A deflation factor of 0.44 (0.11/0.25) was documented in the *Preliminary Traffic and Revenue Study*⁴ and is used to derive the link level per mile toll rates as shown in Table 3.



⁴ "Proposed Western and Southern Wake Parkways Preliminary Traffic and Revenue Study Final Report", North Carolina Turnpike Authority, June 16, 2006.

Table 3: Calculation of Per Mile Toll Rates

<i>Total Tolls</i>	<i>Cost</i>	<i>Miles</i>	<i>Cost/mi (in 2030 \$)</i>	<i>Cost/mi (in 2002 \$)</i>
TP	2.00	3.69	0.5424	0.24
WWP	4.00	14.63	0.2734	0.12

Validation

The objective of this memo is to provide documentation of the methodology, but not to document the final toll scenario forecasts. However, to obtain a level of confidence that the toll modeling methodology is producing reasonable results a comparison of toll and non-toll baseline runs was prepared. All the changes described above were made to a base version of the model but with the tolling capability disabled. This created a base against which to compare the results from toll scenarios.

A comparison of screen-lines with and without tolls enabled shows insignificant differences (see Table 4). Table 5 shows the vehicle kilometers traveled (VKT) comparison by facility type and Table 6 shows the VKT comparison by volume-capacity ratio groupings. Shifts in VKT are consistent with what might be expected from the implementation of tolls.

Table 4: Comparison of Screenlines

<i>Screenline</i>	<i>No Toll</i>	<i>Toll</i>	<i>Percent Change</i>
Parallel to Fayetteville St., Durham	299,588	305,180	1.9%
Inside US-70 and I-85	74,345	675,387	0.2%
North of I-85	475,803	476,925	0.2%
Southeast of I-540	479,770	480,035	0.1%
External Cordon on West	72,057	72,364	0.4%
West of I-40	2,192,240	2,204,189	0.5%
North of I-440	613,492	621,126	1.2%
Between I-440 and I-540 cutting North-South	824,477	829,299	0.6%
South of US-64 west of I-440	683,574	680,355	-0.5%
Northeast-Southwest, South of Triangle Pkwy	1,211,518	1,205,374	-0.5%
Northeast of I-540 North	243,279	244,089	0.3%
Parallel to US-70 between I-540 and Miami Blvd	383,644	392,742	2.4%

Table 5: Comparison of VMTs by Facility Type

<i>Assignment Group</i>	<i>No Toll</i>	<i>Toll</i>	<i>Difference</i>	<i>Percent Change</i>
Access Controlled	51,016,416	49,614,738	(1,401,678)	-2.7%
Arterial Class 1	17,565,676	17,978,983	413,307	2.4%
Arterial Class 2	23,185,702	23,891,471	705,769	3.0%
Arterial Class 3	3,375,282	3,398,959	23,677	0.7%
Collector	16,180,853	16,662,827	481,974	3.0%
Local	10,242,292	10,620,983	378,692	3.7%
HOV Facility	1,090,590	1,163,296	72,706	6.7%
TOTAL	122,656,811	123,331,256	674,445	0.5%

Table 6: Comparison of VMTs by Volume Capacity Ratio Groupings

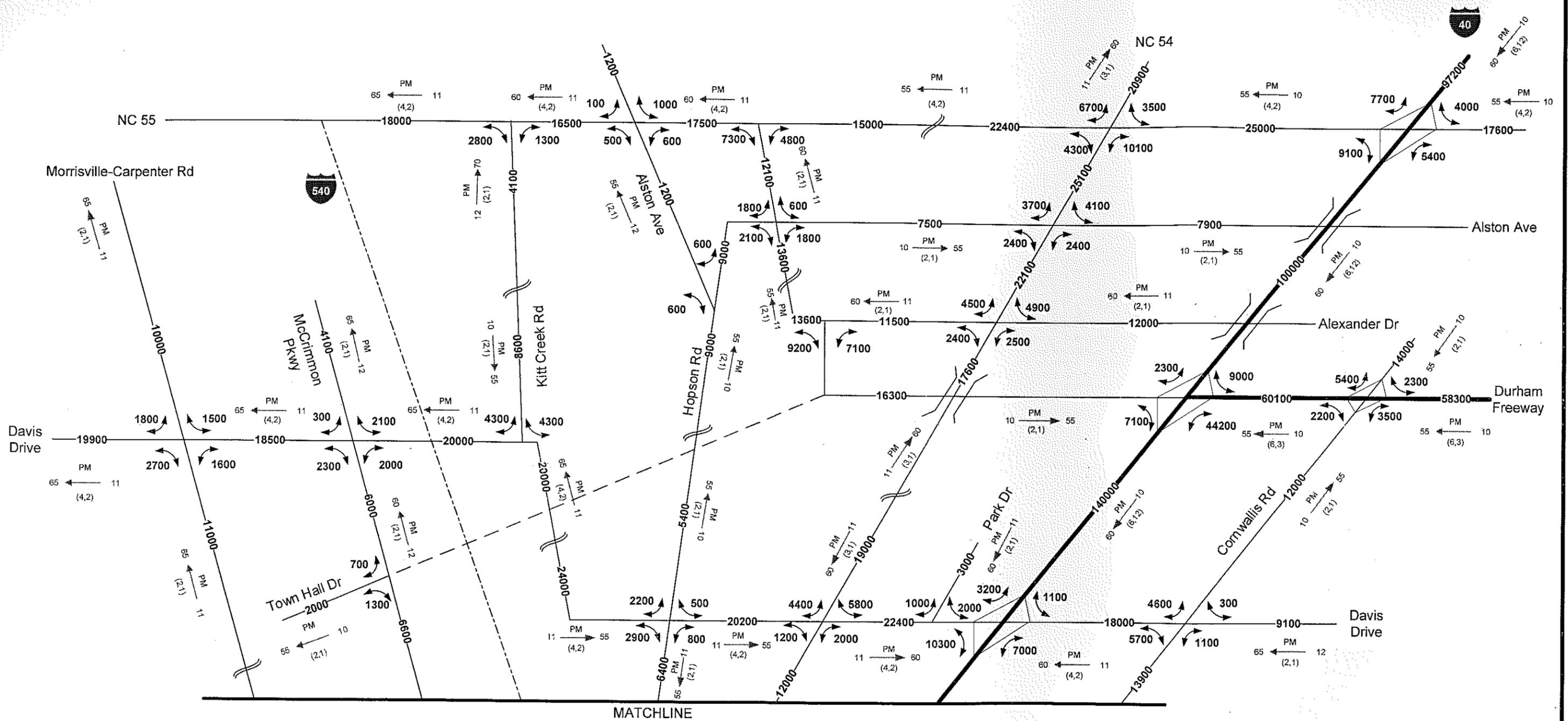
<i>V/C Ratio</i>	<i>No Toll</i>	<i>Toll</i>	<i>Difference</i>	<i>Percent Change</i>
0.2	8,823	7,842	(981)	-11.1%
0.4	40,844	42,253	1,409	3.4%
0.6	74,809	69,911	(4,899)	-6.5%
0.8	126,077	118,771	(7,306)	-5.8%
1.0	171,784	158,229	(13,555)	-7.9%
1.2	161,111	174,193	13,081	8.1%
>=1.4	122,073,362	122,760,057	686,696	0.6%
TOTAL	122,656,811	123,331,256	674,445	0.5%

Opening Year Model (2011)

For this analysis the opening year of 2011 was modeled by combining the official 2010 TRM model with a 2011 network. No changes were made to the socio-economic data. The 2011 network was provided by CAMPO. The consulting team added the coding for the WWP and TP as CAMPO had coded it in the 2017 network. The 2011 network coding is implemented outside the toll model stream and is provided in the accompanying CDs under the "RUN11\NETWORK EDITS" subdirectory.

APPENDIX B: HNTB FORECASTS

2005 Balanced "No-Build" AADT Volumes



MATCHLINE



HNTB

HNTB, North Carolina, PC
343 East Six Forks Rd Suite 200
Raleigh, North Carolina 27609

LEGEND

- = Breakline
- = Proposed Triangle Parkway
- = Proposed Other Freeway
- ### = VPD - # of Vehicles per Day
- DHV = Design Hourly Volume = K30
- K30 = 30th Highest Hourly Volume
- PM = PM Peak Period
- D = Directional Split (%)
- = Indicates Direction of D
- = Reverse Flow for AM Peak
- (d,t) = Duals, TT-ST's (%)
- = Daily Turn Movements



LOCATION: TRIANGLE PARKWAY

2005 Balanced "No-Build" AADT Volumes

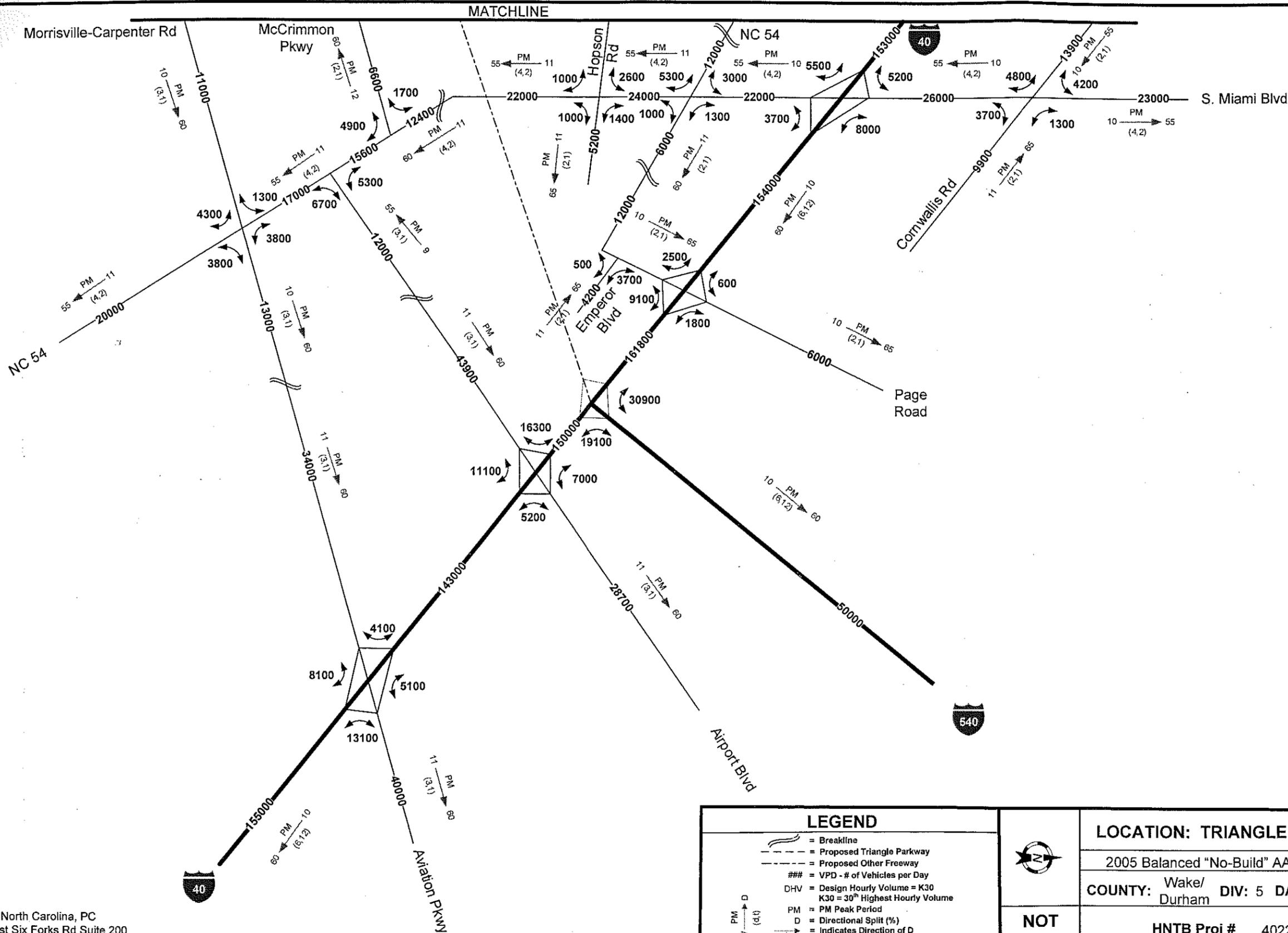
COUNTY: Wake/Durham DIV: 5 DATE: December 2005

NOT TO SCALE

HNTB Proj # 40225

FIGURE 4

2005 Balanced "No-Build" AADT Volumes



LEGEND	
	= Breakline
	= Proposed Triangle Parkway
	= Proposed Other Freeway
###	= VPD - # of Vehicles per Day
DHV	= Design Hourly Volume = K30
K30	= 30 th Highest Hourly Volume
PM	= PM Peak Period
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	= Indicates Direction of D
	= Reverse Flow for AM Peak
(d,t)	= Duals, TT-ST's (%)
	= Daily Turn Movements

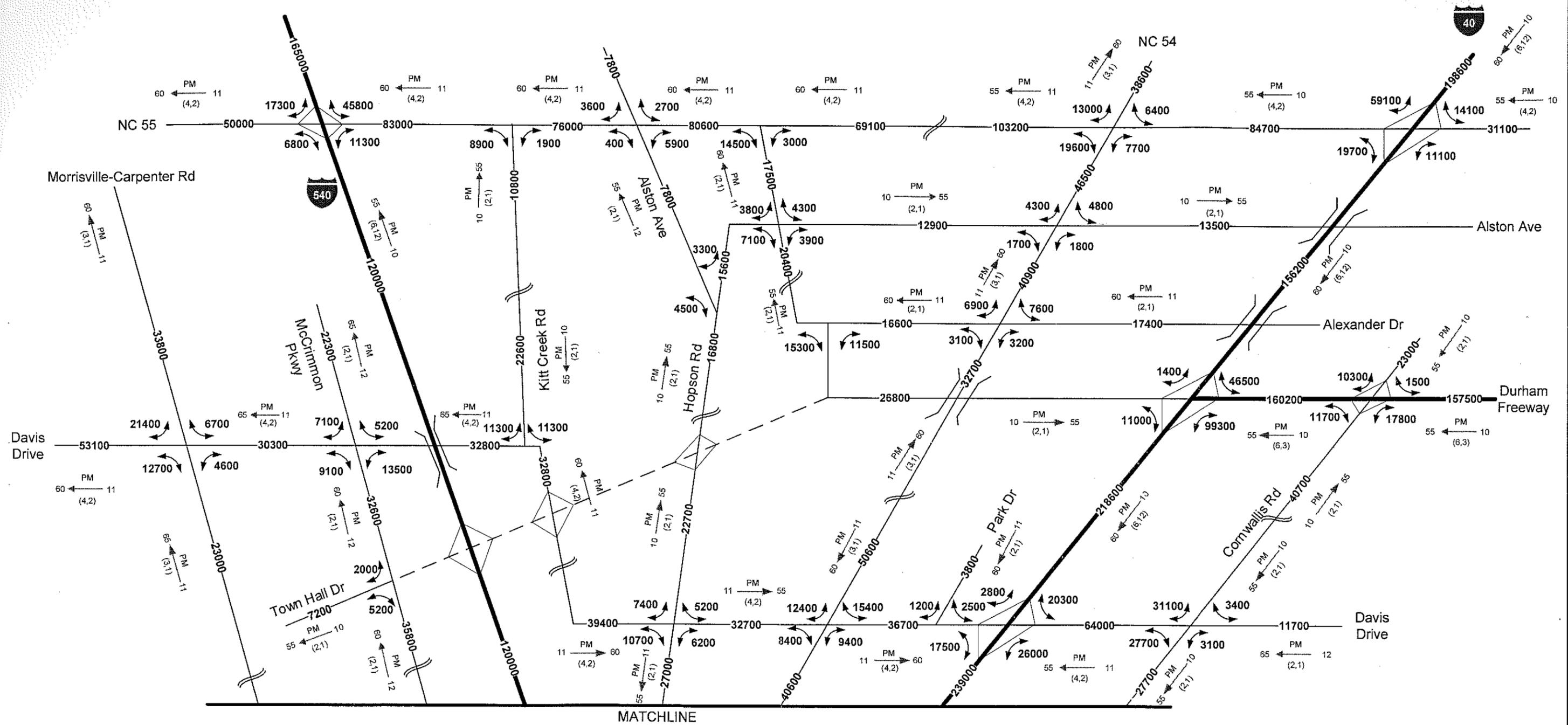
 NOT TO SCALE	LOCATION: TRIANGLE PARKWAY	
	2005 Balanced "No-Build" AADT Volumes	
	COUNTY: Wake/ Durham	DIV: 5
	DATE: December 2005	
	HNTB Proj # 40225	
	FIGURE 5	



HNTB

HNTB, North Carolina, PC
343 East Six Forks Rd Suite 200
Raleigh, North Carolina 27609

2030 Balanced "No-Build" AADT Volumes

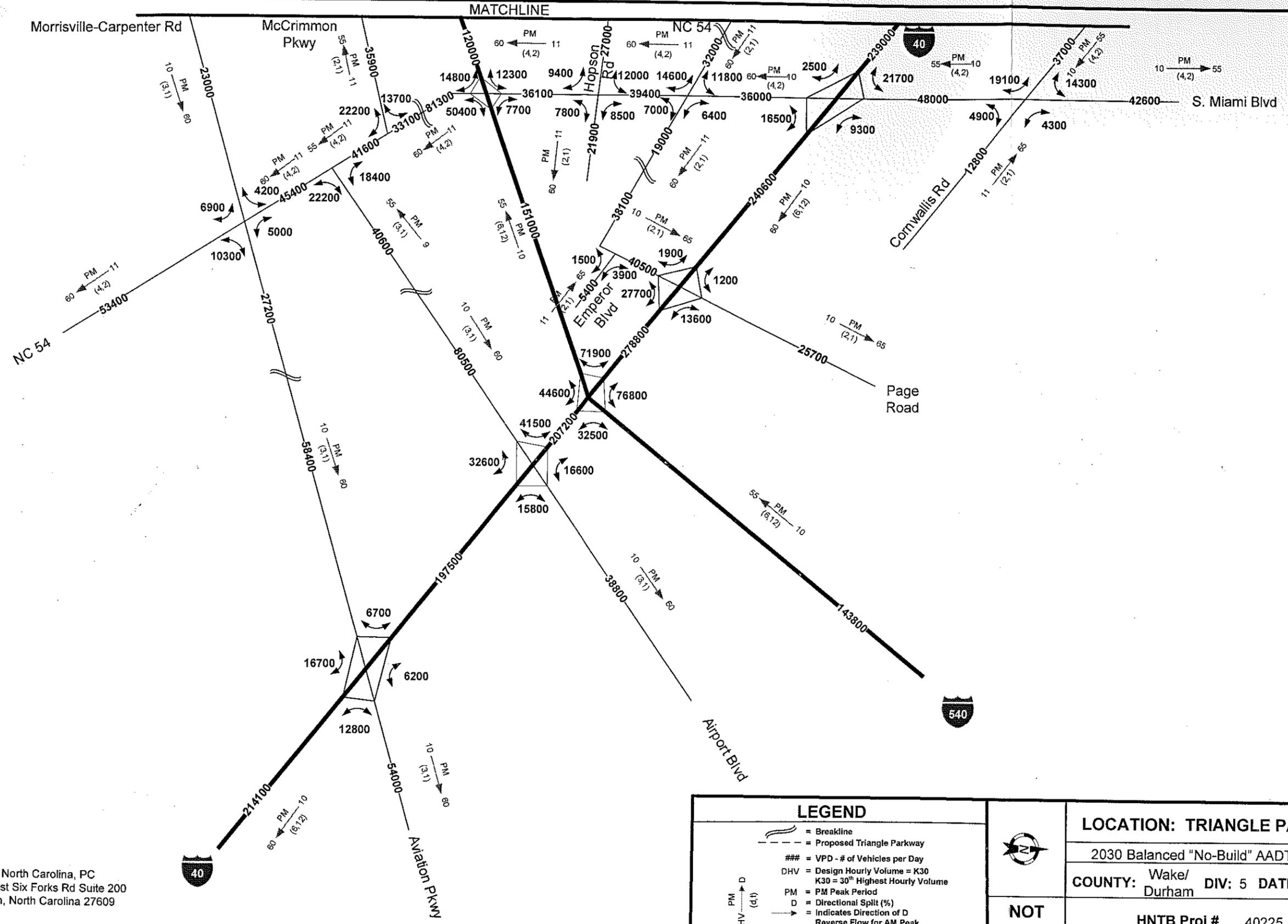


HNTB HNTB, North Carolina, PC
343 East Six Forks Rd Suite 200
Raleigh, North Carolina 27609

LEGEND	
	= Breakline
	= Proposed Triangle Parkway
###	= VPD - # of Vehicles per Day
DHV	= Design Hourly Volume = K30 K30 = 30 th Highest Hourly Volume
PM	= PM Peak Period
D	= Directional Split (%)
	= Indicates Direction of D
	= Reverse Flow for AM Peak
(d,t)	= Duals, TT-ST's (%)
	= Daily Turn Movements

 NOT TO SCALE	LOCATION: TRIANGLE PARKWAY	
	2030 Balanced "No-Build" AADT Volumes	
	COUNTY: Wake/ Durham	DIV: 5
	HNTB Proj # 40225	
	FIGURE 8	

2030 Balanced "No-Build" AADT Volumes



HNTB

HNTB, North Carolina, PC
343 East Six Forks Rd Suite 200
Raleigh, North Carolina 27609

LEGEND

- = Breakline
- = Proposed Triangle Parkway
- ### = VPD - # of Vehicles per Day
- DHV = Design Hourly Volume = K30
K30 = 30th Highest Hourly Volume
- PM = PM Peak Period
- D = Directional Split (%)
- = Indicates Direction of D
- = Reverse Flow for AM Peak
- (d,t) = Duals, TT-ST's (%)
- = Daily Turn Movements



LOCATION: TRIANGLE PARKWAY

2030 Balanced "No-Build" AADT Volumes

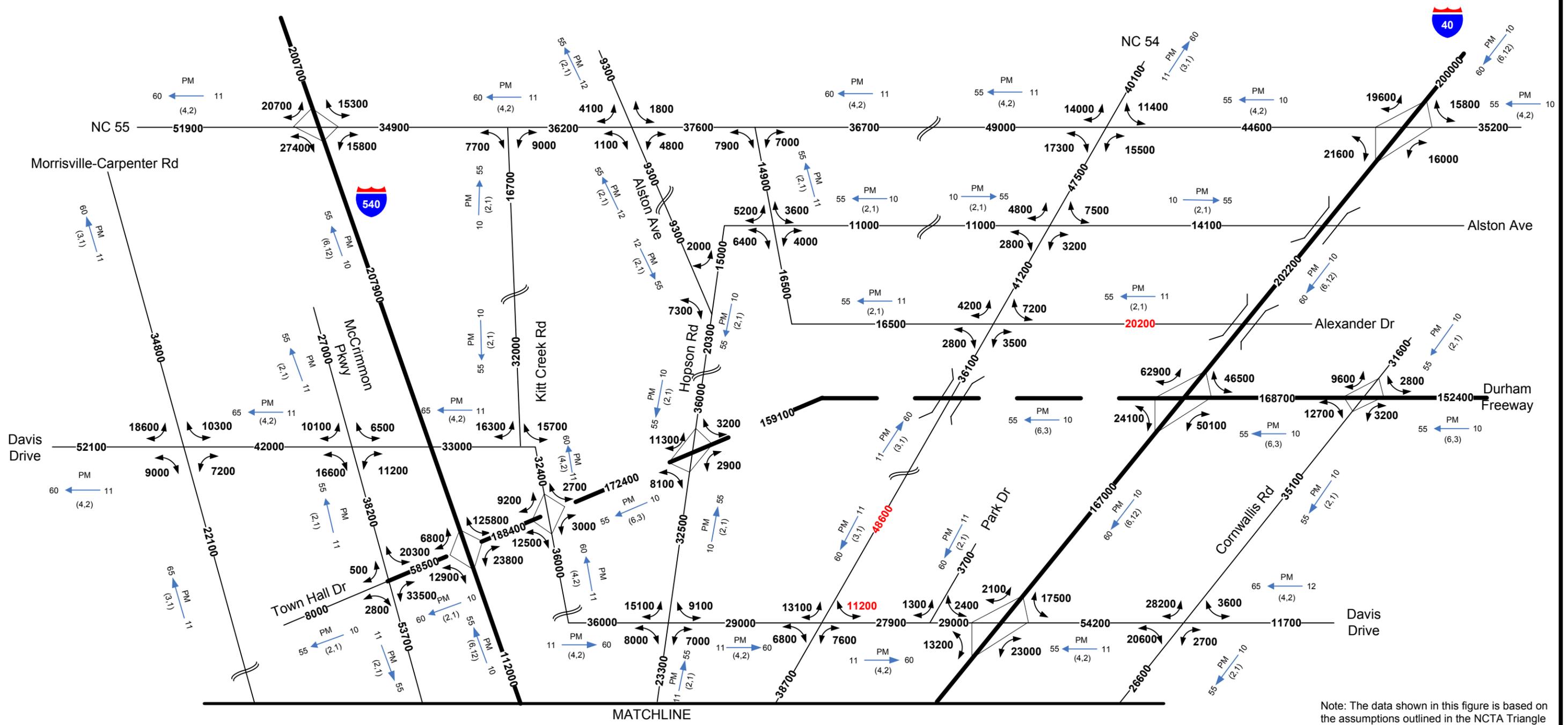
COUNTY: Wake/ Durham DIV: 5 DATE: December 2005

NOT TO SCALE

HNTB Proj # 40225

FIGURE 9

2030 Balanced "Build" AADT Volumes



Note: The data shown in this figure is based on the assumptions outlined in the NCTA Triangle Parkway Traffic Forecast.

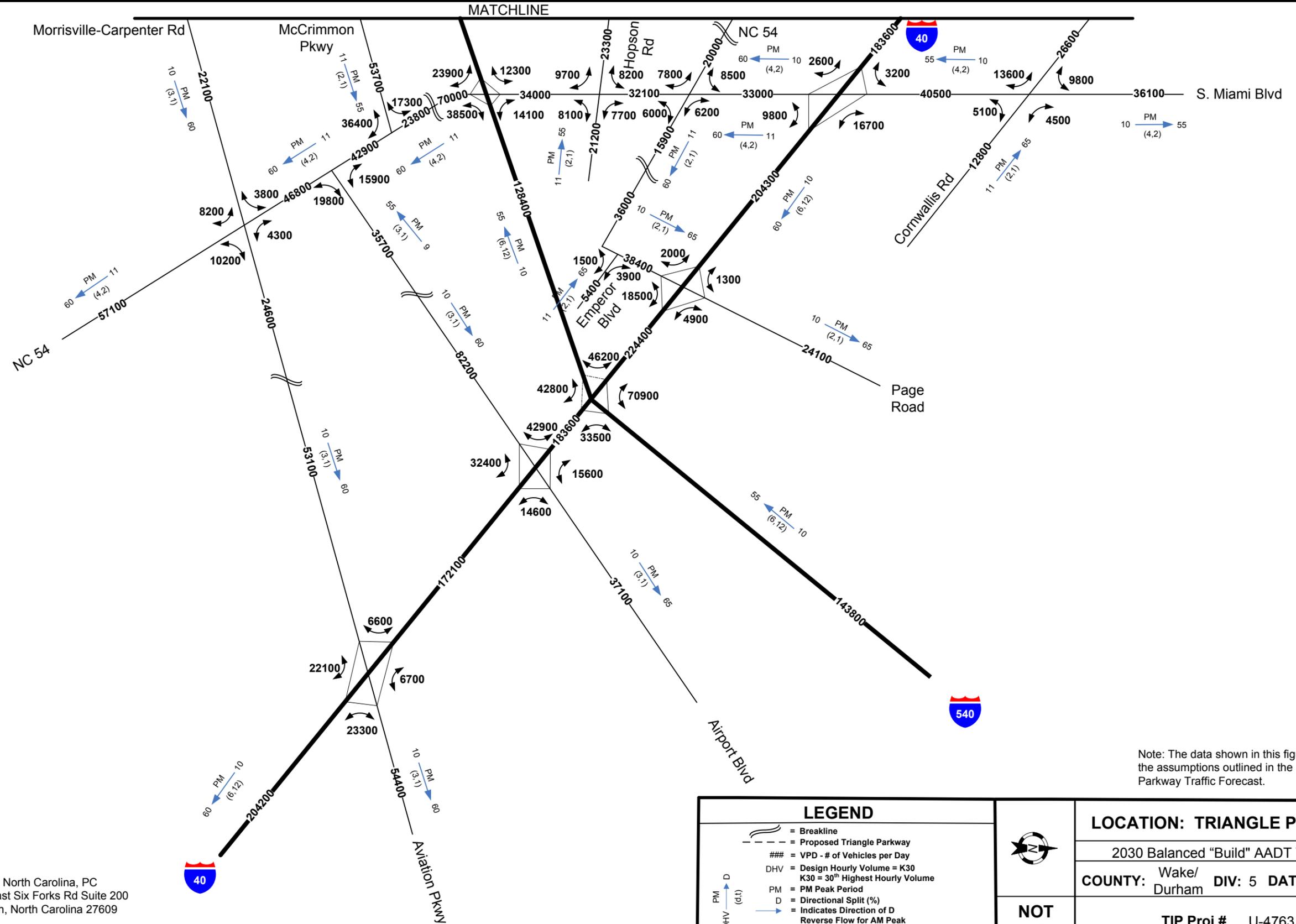


HNTB HNTB, North Carolina, PC
343 East Six Forks Rd Suite 200
Raleigh, North Carolina 27609

LEGEND	
	= Breakline
	= Proposed Triangle Parkway
	= VPD - # of Vehicles per Day
	= Design Hourly Volume = K30 K30 = 30 th Highest Hourly Volume
	= PM Peak Period
	= Directional Split (%)
	= Indicates Direction of D
	= Reverse Flow for AM Peak
	= Duals, TT-ST's (%)
	= Daily Turn Movements

 NOT TO SCALE	LOCATION: TRIANGLE PARKWAY	
	2030 Balanced "Build" AADT Volumes	
	COUNTY: Wake/Durham	DIV: 5 DATE: June 2006
	TIP Proj # U-4763	
FIGURE 10		

2030 Balanced "Build" AADT Volumes



Note: The data shown in this figure is based on the assumptions outlined in the NCTA Triangle Parkway Traffic Forecast.



HNTB HNTB, North Carolina, PC
343 East Six Forks Rd Suite 200
Raleigh, North Carolina 27609

LEGEND	
	= Breakline
	= Proposed Triangle Parkway
###	= VPD - # of Vehicles per Day
DHV	= Design Hourly Volume = K30 K30 = 30 th Highest Hourly Volume
PM	= PM Peak Period
D	= Directional Split (%)
	= Indicates Direction of D
	= Reverse Flow for AM Peak
(d,t)	= Duals, TT-ST's (%)
	= Daily Turn Movements



LOCATION: TRIANGLE PARKWAY

2030 Balanced "Build" AADT Volumes

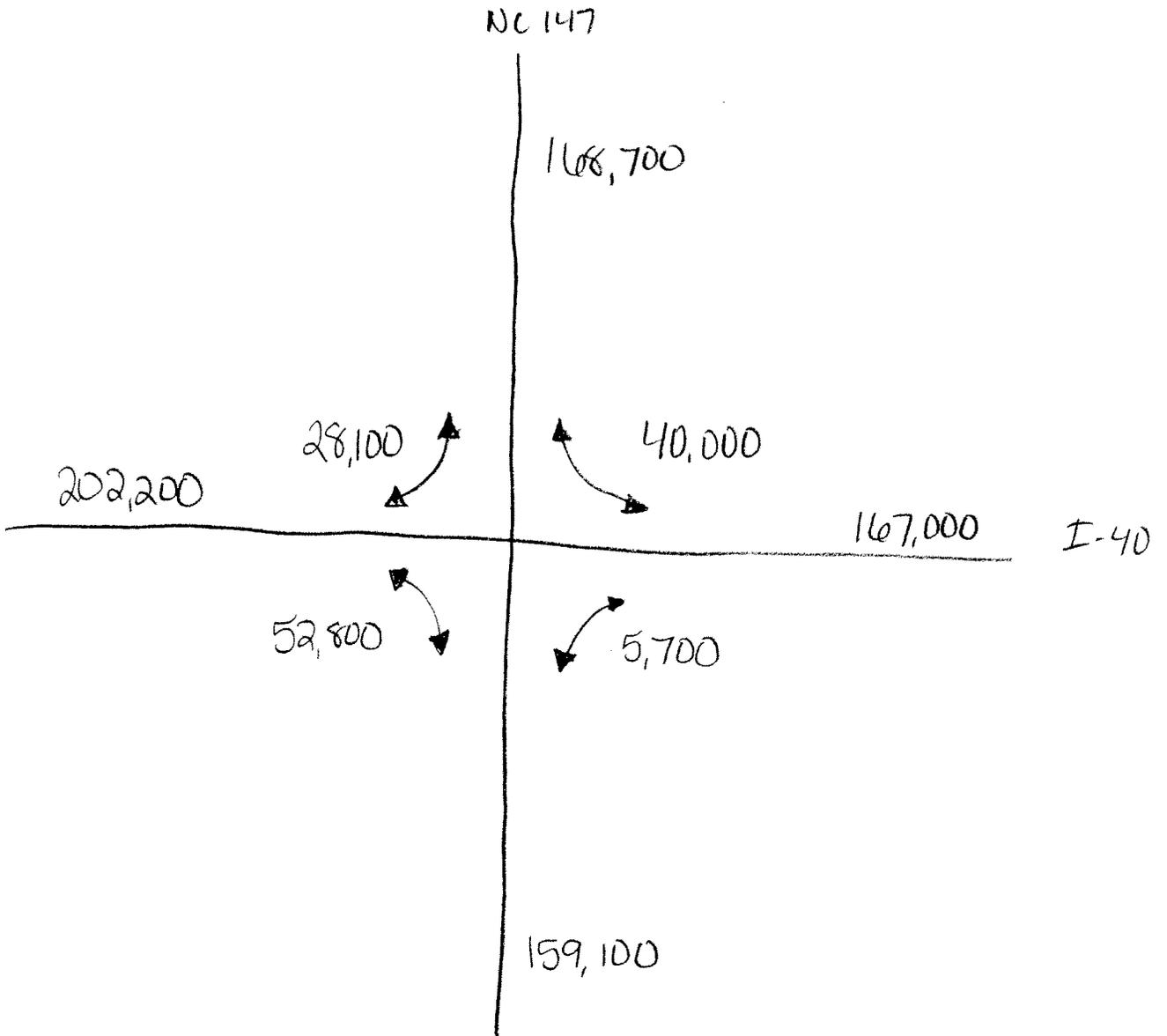
COUNTY: Wake/Durham DIV: 5 DATE: June 2006

NOT TO SCALE

TIP Proj # U-4763

FIGURE 11

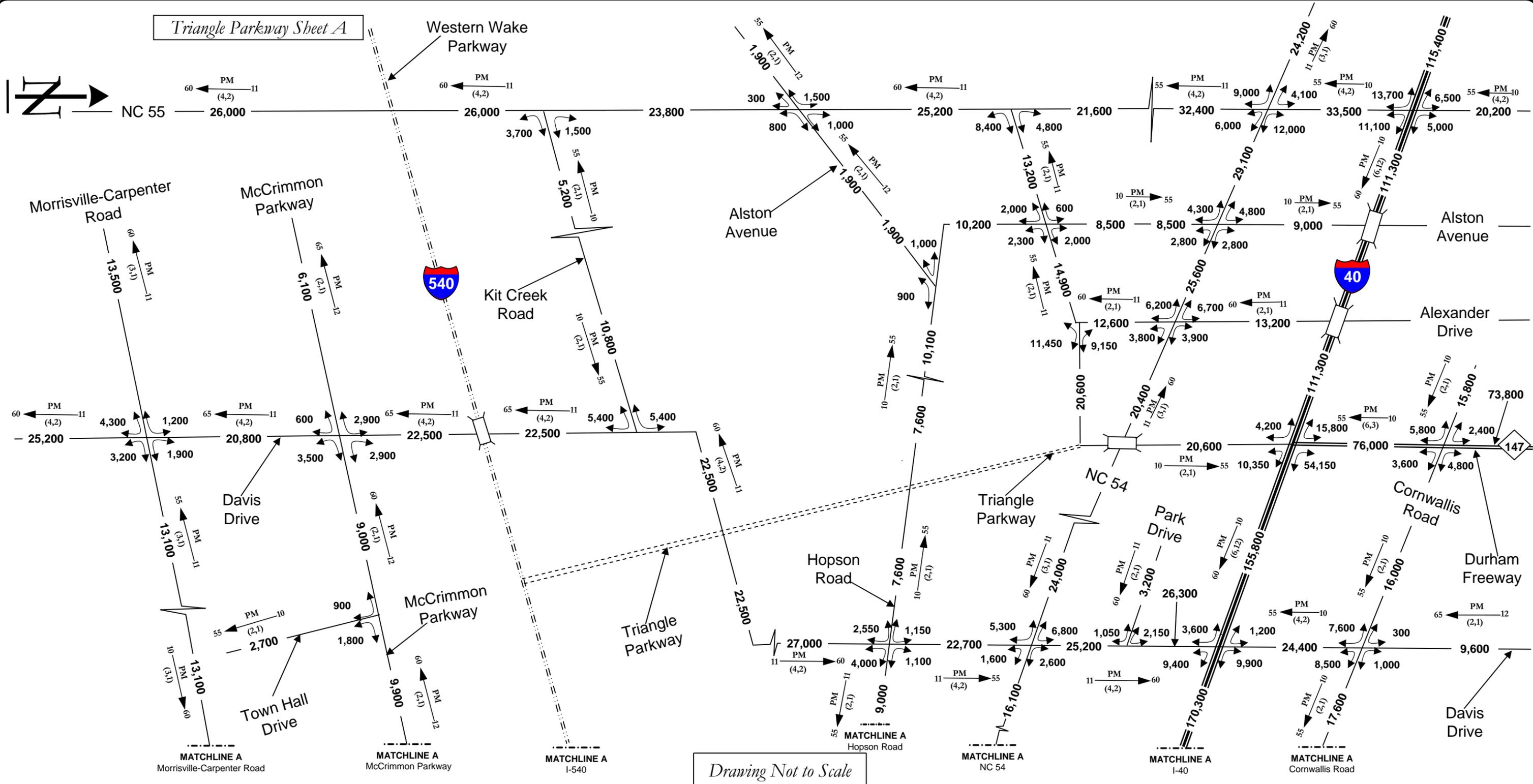
Metric Calculations For	Job No.	Sheet No.
Made by	Date	
Checked by	Date	
Backchecked by	Date	



Triangle Parkway
2030 Build Non-Toll

APPENDIX C: BASE NON-TOLL FORECAST SHEETS

Triangle Parkway Sheet A



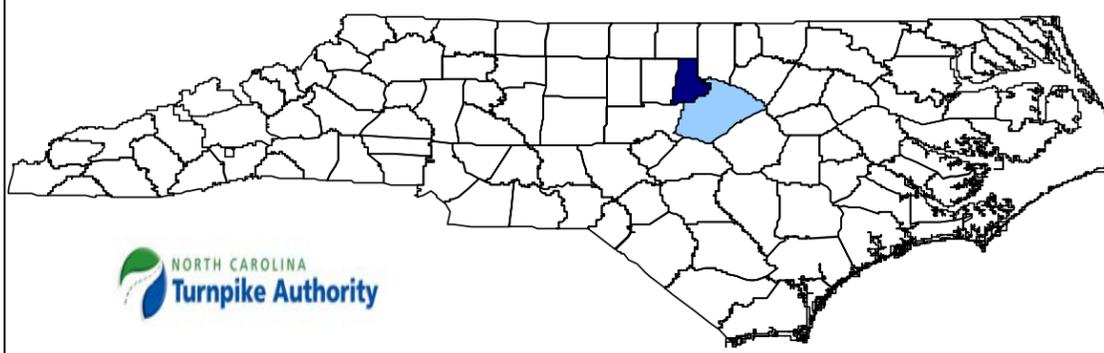
Drawing Not to Scale

Appendix C-1:
2011 NO-BUILD NON-TOLL without I-540, Western Wake Parkway, and McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
(Alternative A')

4000 WestChase Boulevard
Suite 530
Raleigh, North Carolina 27607
Phone: 919-829-0328
Fax: 919-829-0329

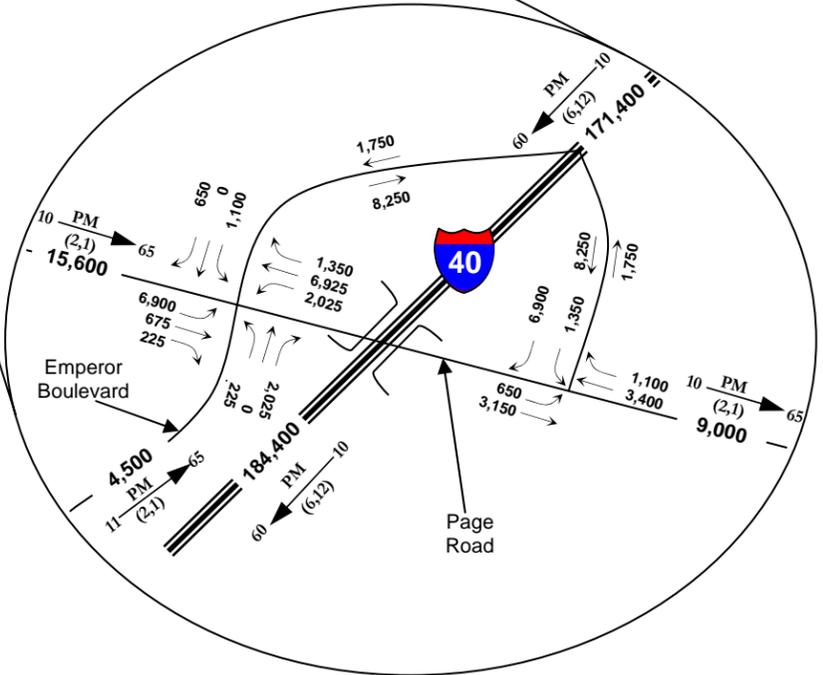
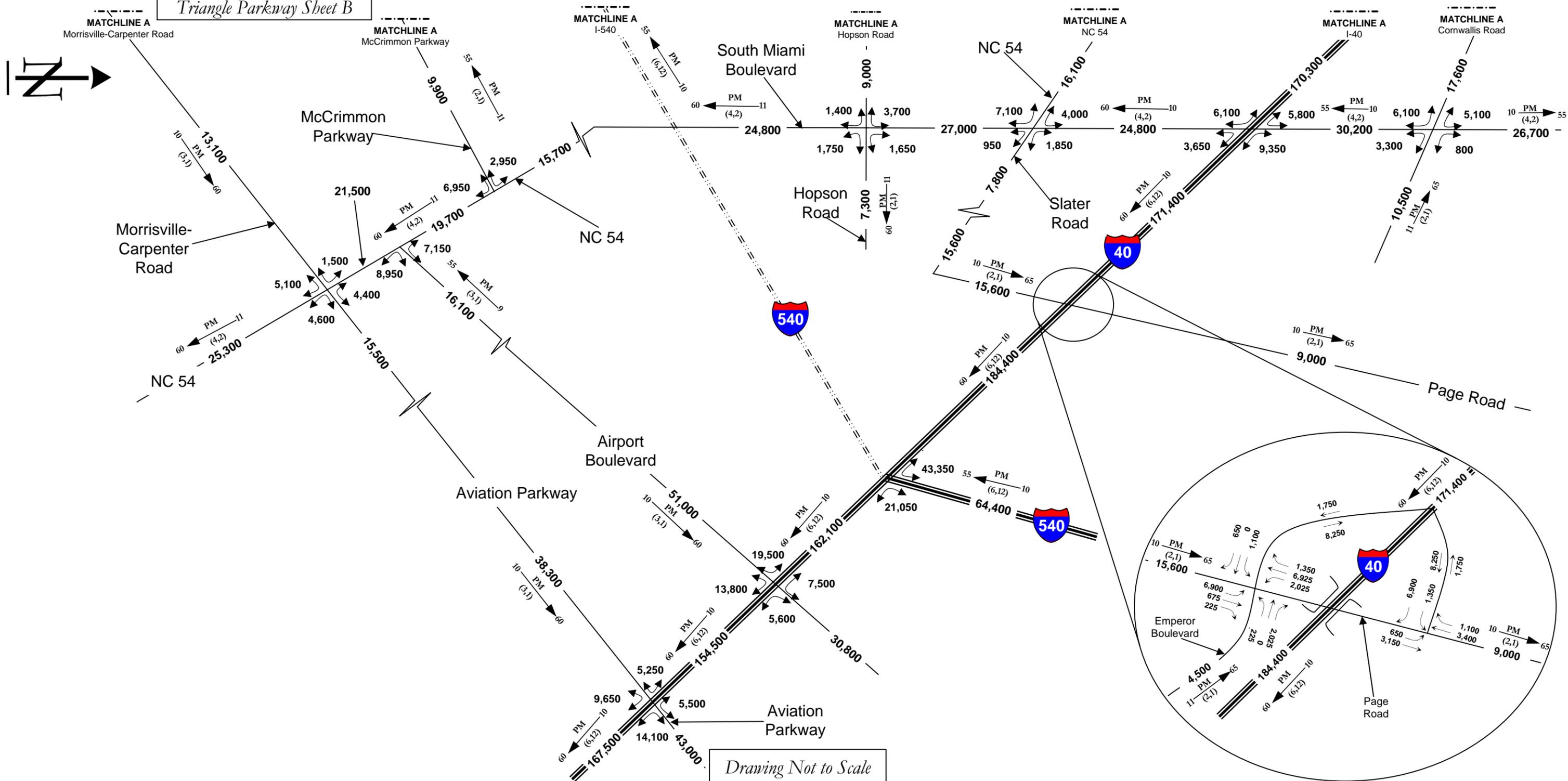
Transportation Planning - Traffic Engineering

LEGEND
 DHV — PM —> D
 (d, t)
 DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME
 PM = PM PEAK PERIOD
 D = DIRECTIONAL SPLIT (%)
 —> INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540
PROJECT: Triangle Parkway
COUNTIES: WAKE and DURHAM
DIVISION: 5 **DATE:** March, 2007
TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Appendix C-1:
 2011 NO-BUILD NON-TOLL without I-540, Western Wake Parkway, and McCrimmon Parkway Connector
 DAILY FORECAST VOLUMES
 (Alternative A)

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

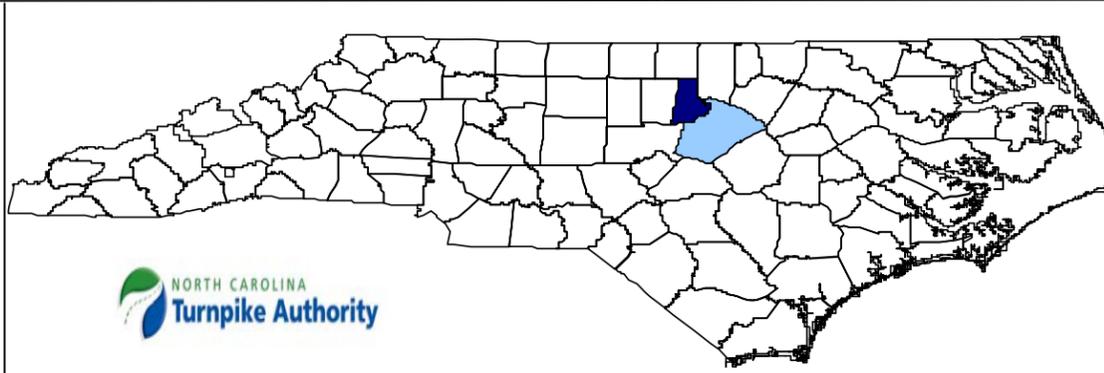
MARTIN ALEXIOU BRYSON

Transportation Planning - Traffic Engineering

LEGEND

DHV $\xrightarrow{\text{PM}}$ D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME
 PM = PM PEAK PERIOD
 D = DIRECTIONAL SPLIT (%)
 \rightarrow INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

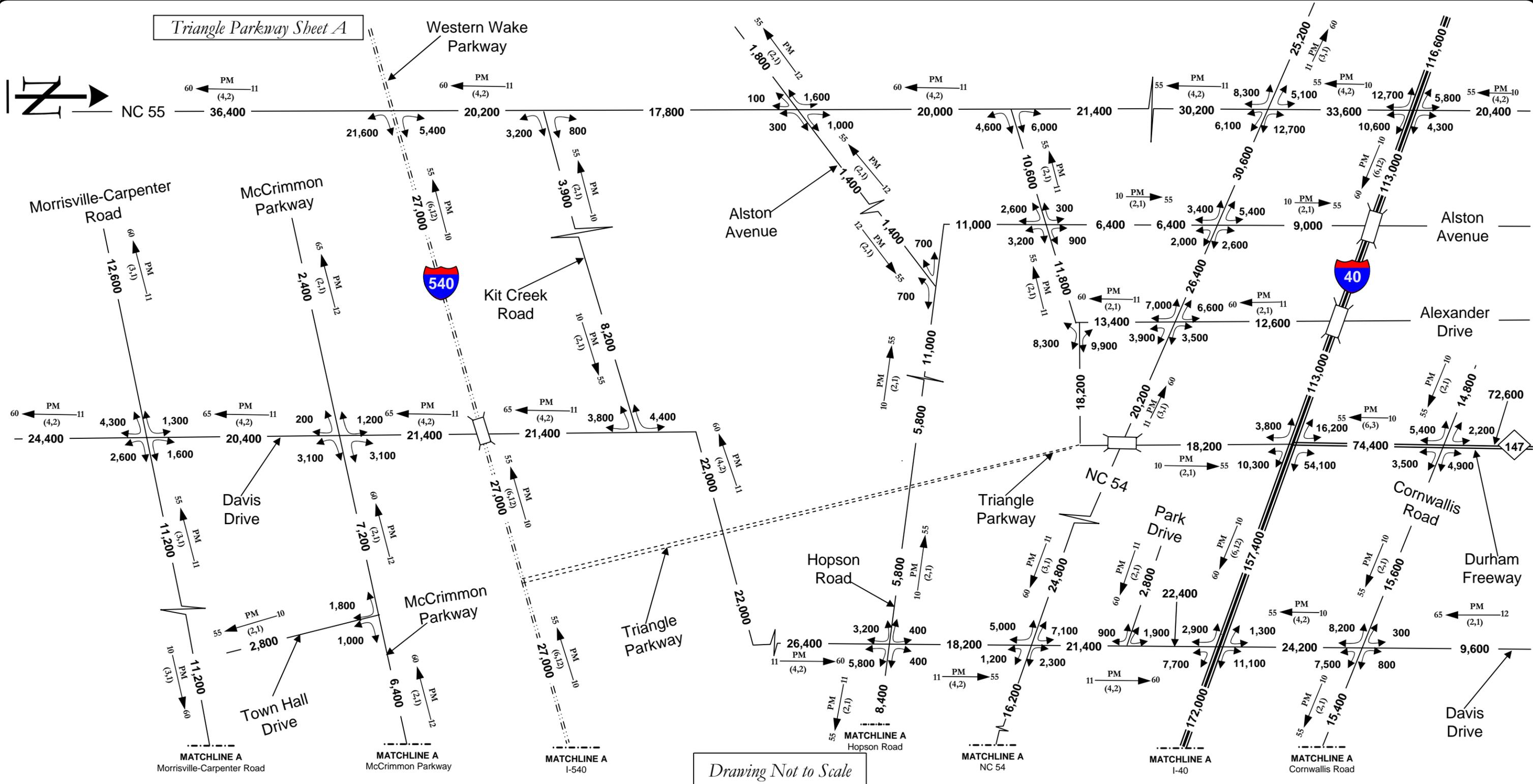
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet A



Drawing Not to Scale

Appendix C-2:
2011 NO-BUILD NON-TOLL with I-540, but without
Western Wake Parkway and McCrimmon Connector
DAILY FORECAST VOLUMES
(Alternative A)

4000 WestChase Boulevard
Suite 530
Raleigh, North Carolina 27607
Phone: 919-829-0328
Fax: 919-829-0329

Transportation Planning - Traffic Engineering

LEGEND

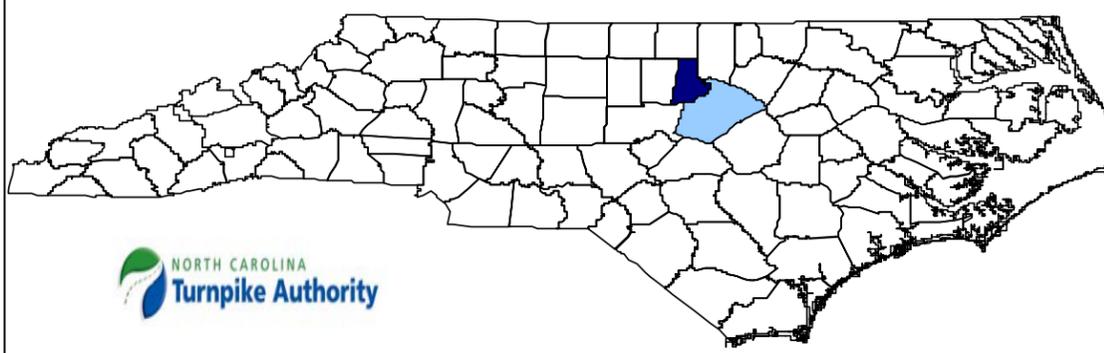
DHV — PM —> D
(d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
K30 = 30th HIGHEST HOURLY VOLUME

PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)

—> INDICATES DIRECTION OF D
REVERSE FOR AM PEAK
DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

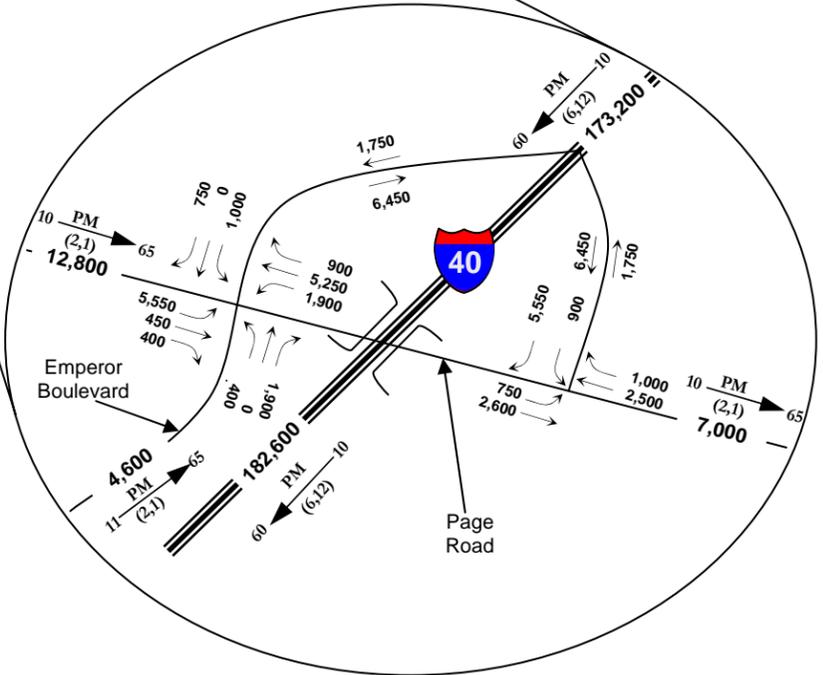
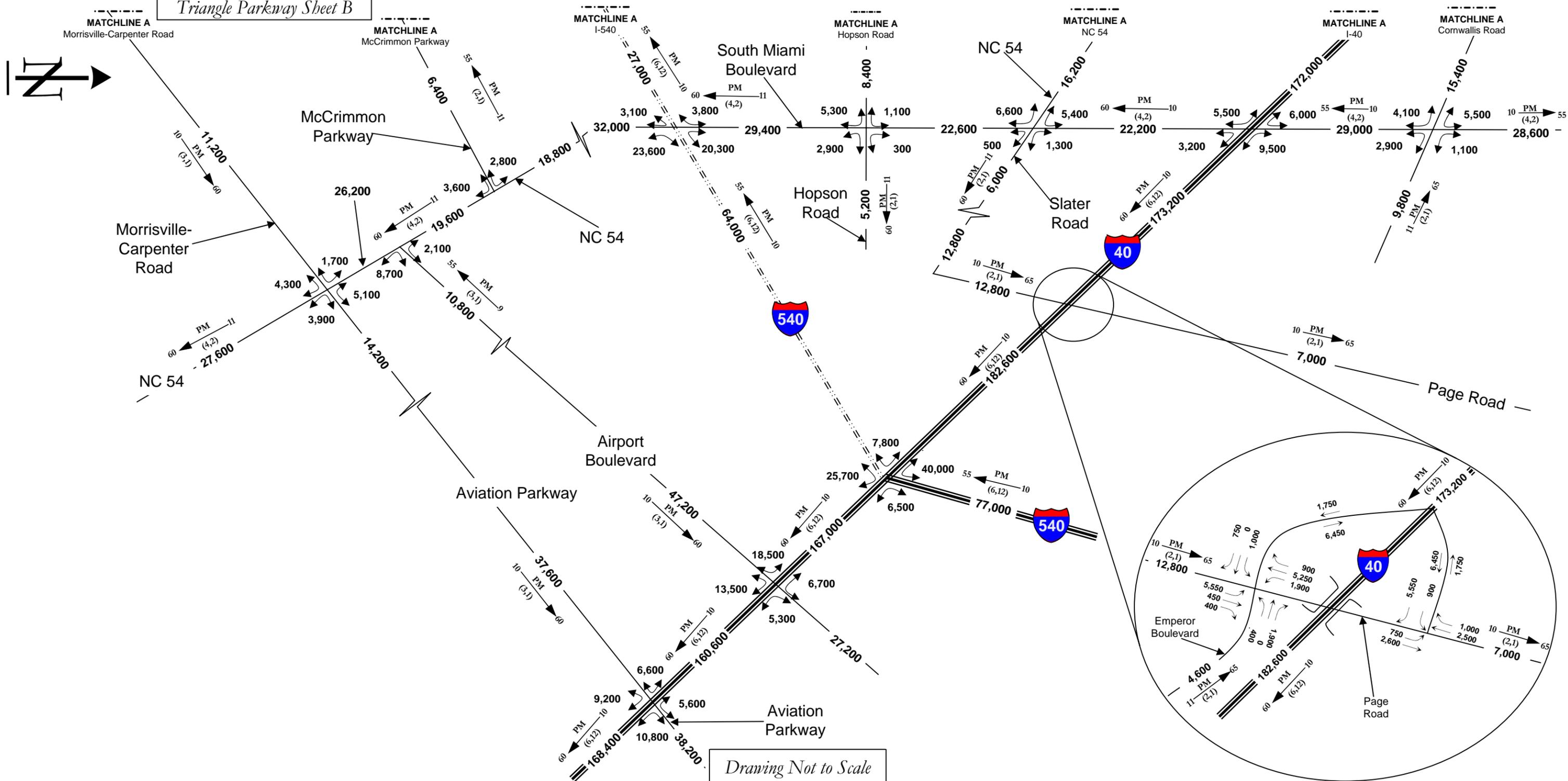
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

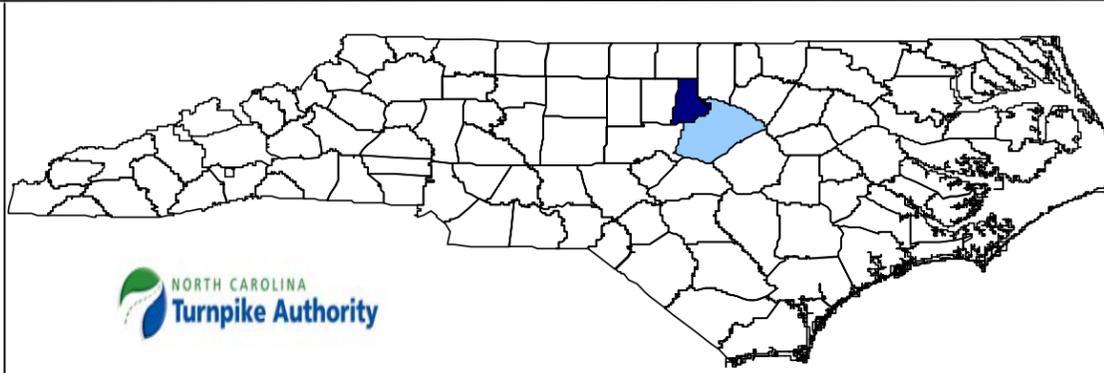
Triangle Parkway Sheet B



Appendix C-2:
 2011 NO-BUILD NON-TOLL with I-540, but without
 Western Wake Parkway and McCrimmon Connector
 DAILY FORECAST VOLUMES
 (Alternative A)

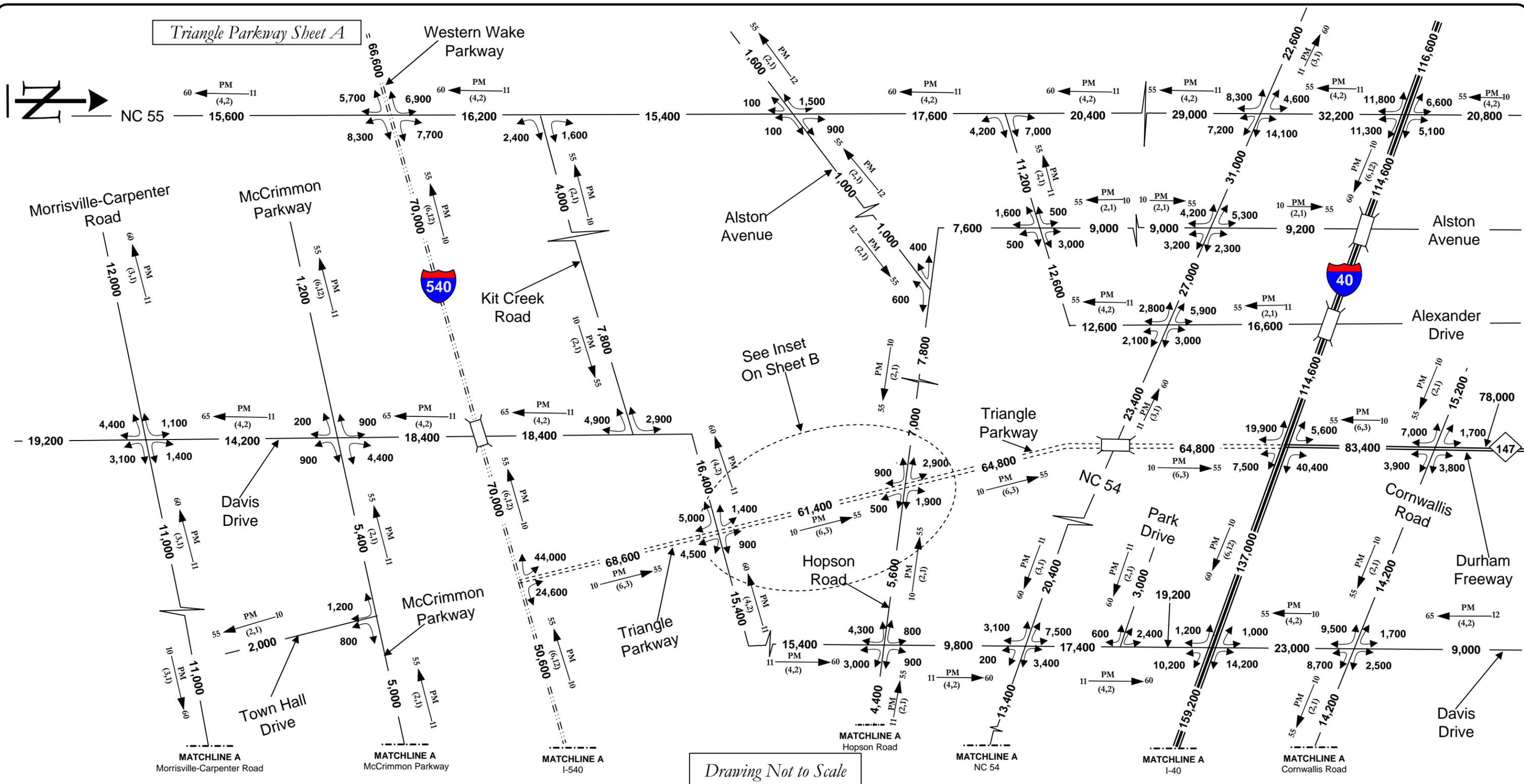
MARTIN ALEXIOU BRYSON
 4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329
 Transportation Planning - Traffic Engineering

LEGEND
 DHV $\xrightarrow{\text{PM}}$ D
 (d, t)
 DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME
 PM = PM PEAK PERIOD
 D = DIRECTIONAL SPLIT (%)
 \rightarrow INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540
PROJECT: Triangle Parkway
COUNTIES: WAKE and DURHAM
DIVISION: 5 **DATE:** March, 2007
TIP Project No. U-4763

Triangle Parkway Sheet A



Drawing Not to Scale

Appendix C-3:
 2011 BUILD NON-TOLL
 without McCrimmon Parkway Connector
 DAILY FORECAST VOLUMES
 (Alternative B)

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

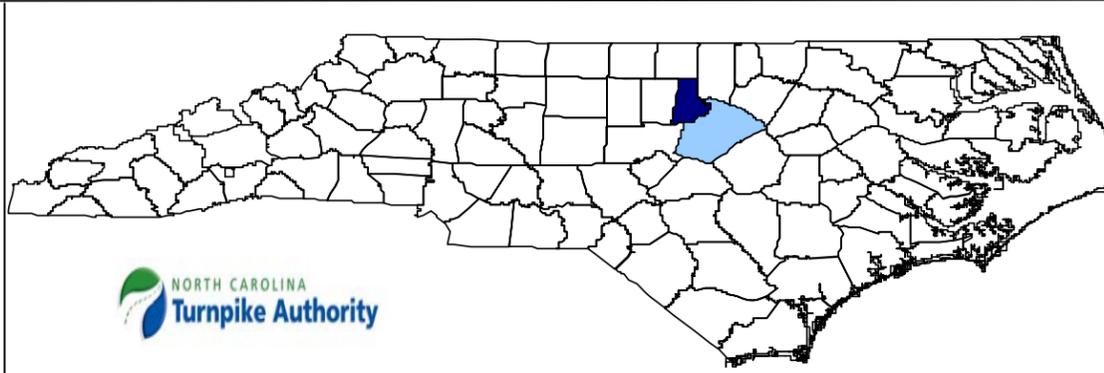
MARTIN ALEXIOU BRYSON

Transportation Planning - Traffic Engineering

LEGEND

DHV — PM —> D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME
 PM = PM PEAK PERIOD
 D = DIRECTIONAL SPLIT (%)
 —> INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

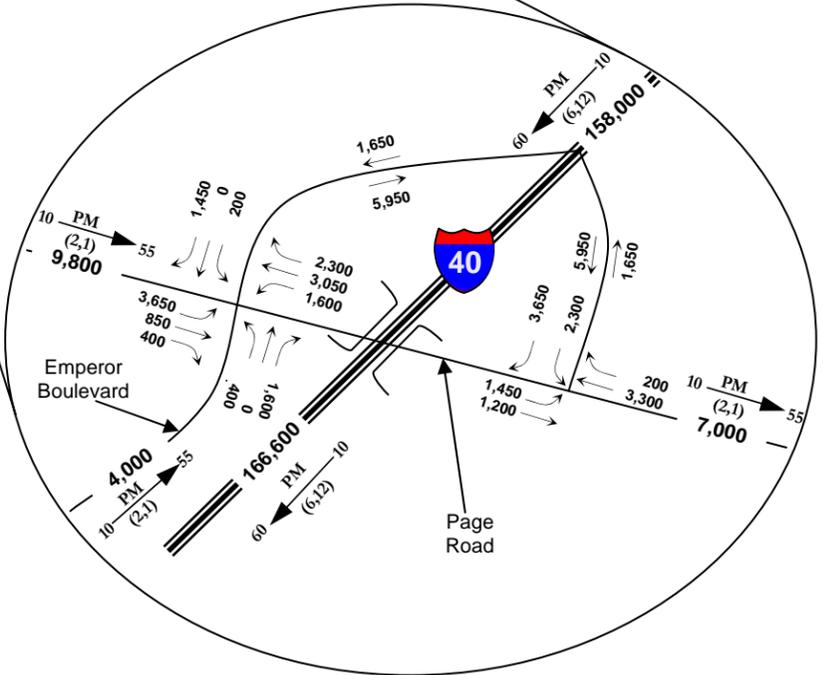
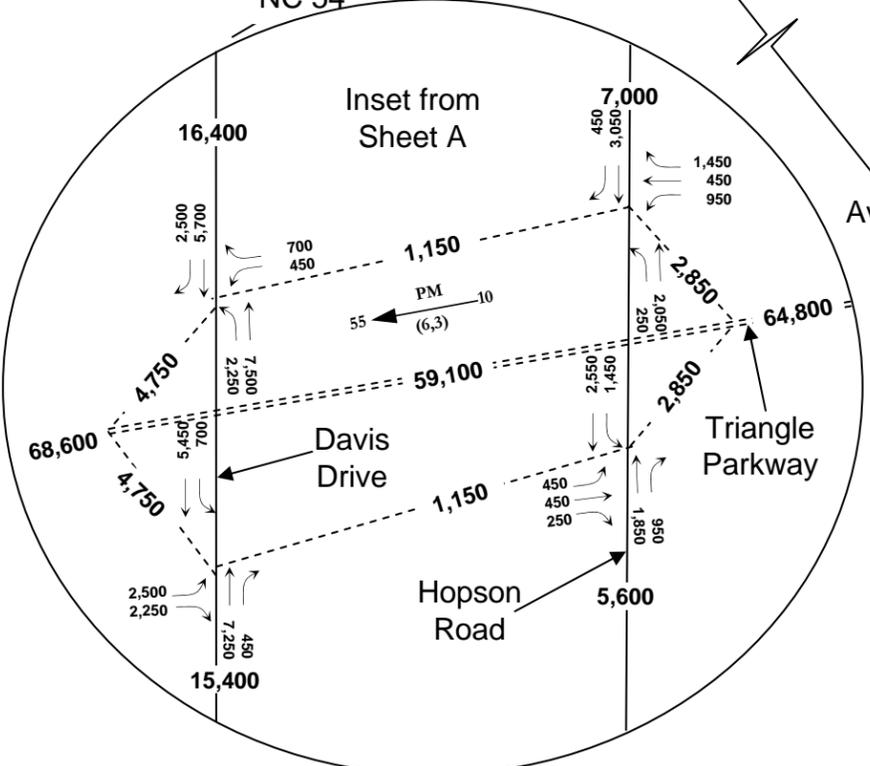
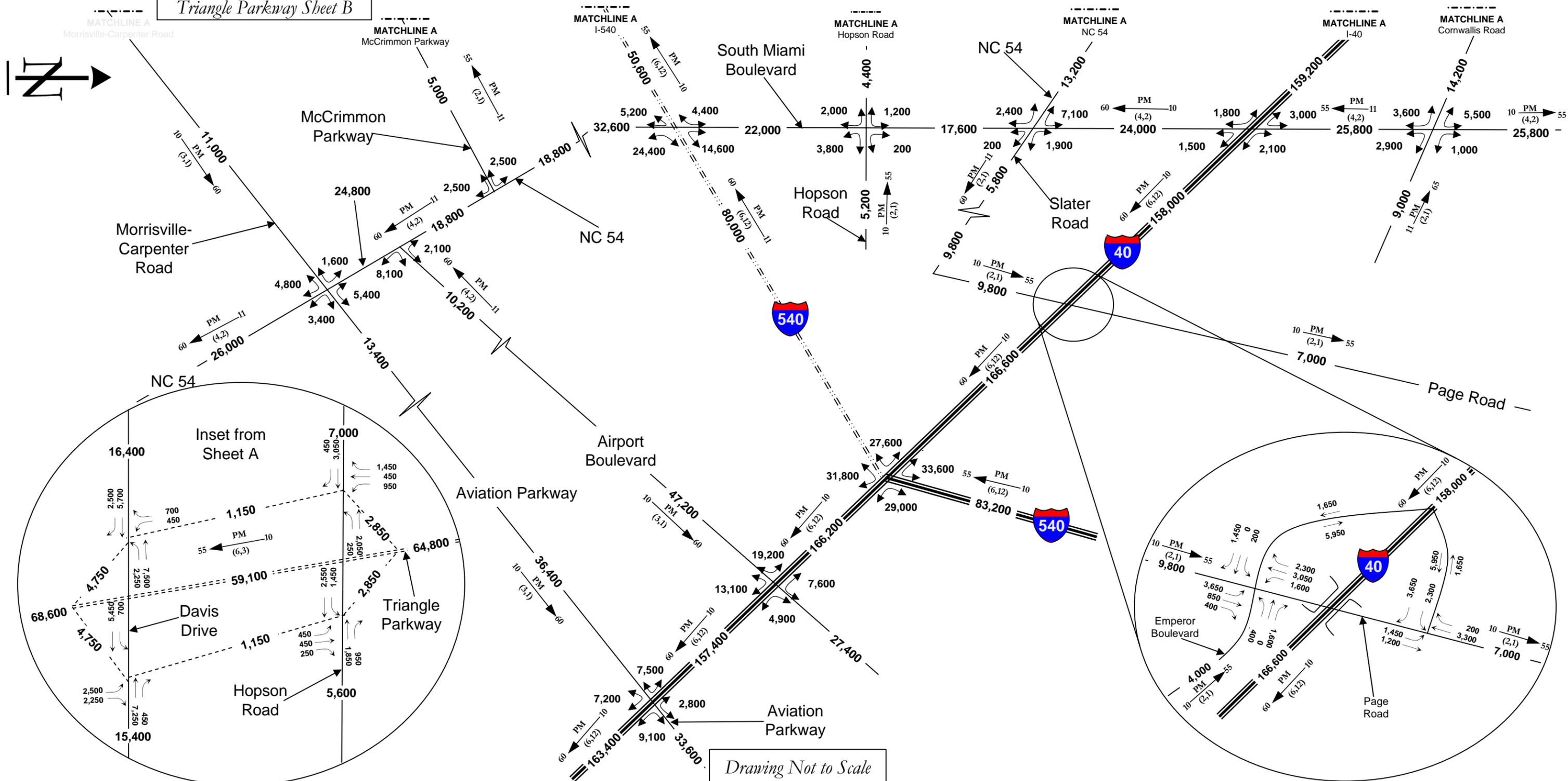
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Appendix C-3:
2011 BUILD NON-TOLL
 without McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
 (Alternative B)

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

MARTIN ALEXIOU BRYSON

Transportation Planning - Traffic Engineering

LEGEND

DHV $\xrightarrow{\text{PM}}$ D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME

PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)
 INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

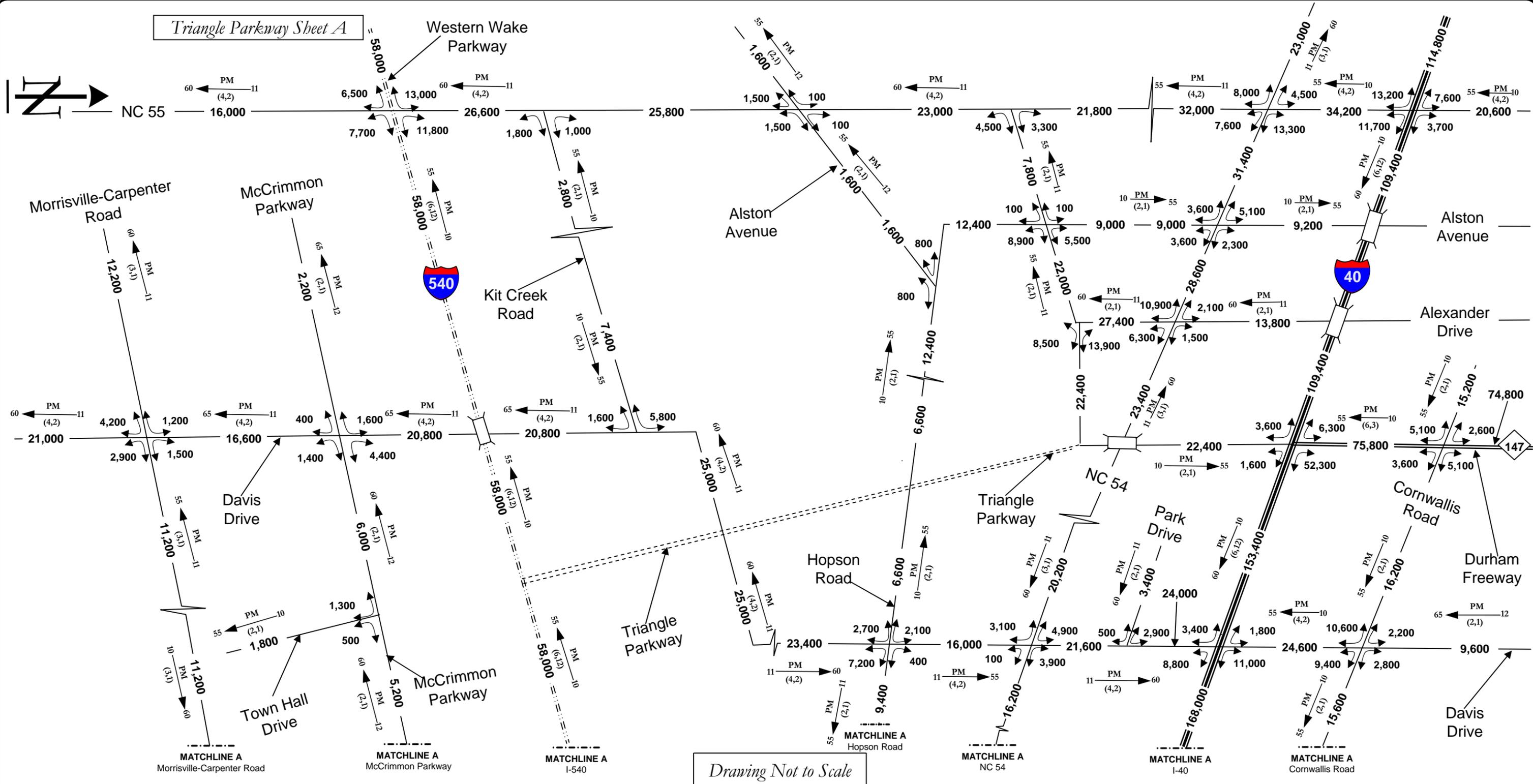
LOCATION: Triangle Parkway—From I-40 to I-540

PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763



Drawing Not to Scale

Appendix C-4:
 2011 NO-BUILD NON-TOLL
 without McCrimmon Parkway Connector
 DAILY FORECAST VOLUMES
 (Alternative B')

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

MARTIN ALEXIOU BRYSON

Transportation Planning - Traffic Engineering

LEGEND

DHV — PM — D
 (d, t)

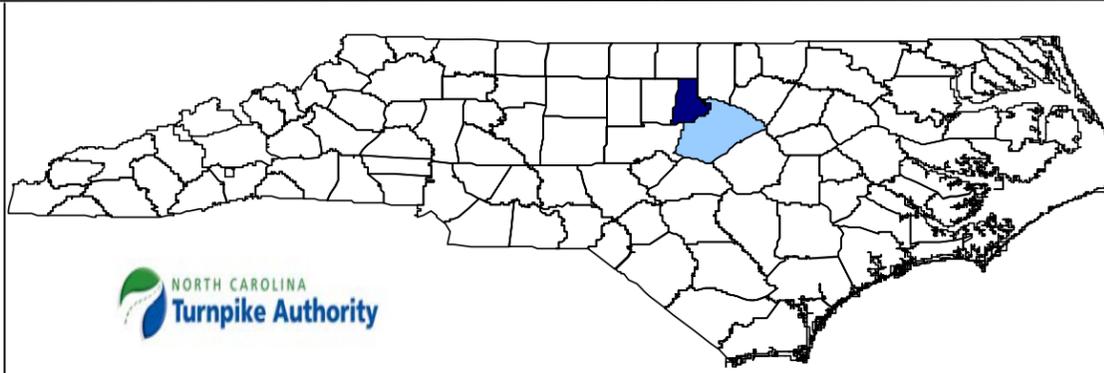
DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME

PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)

→ INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK

(d,t) DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

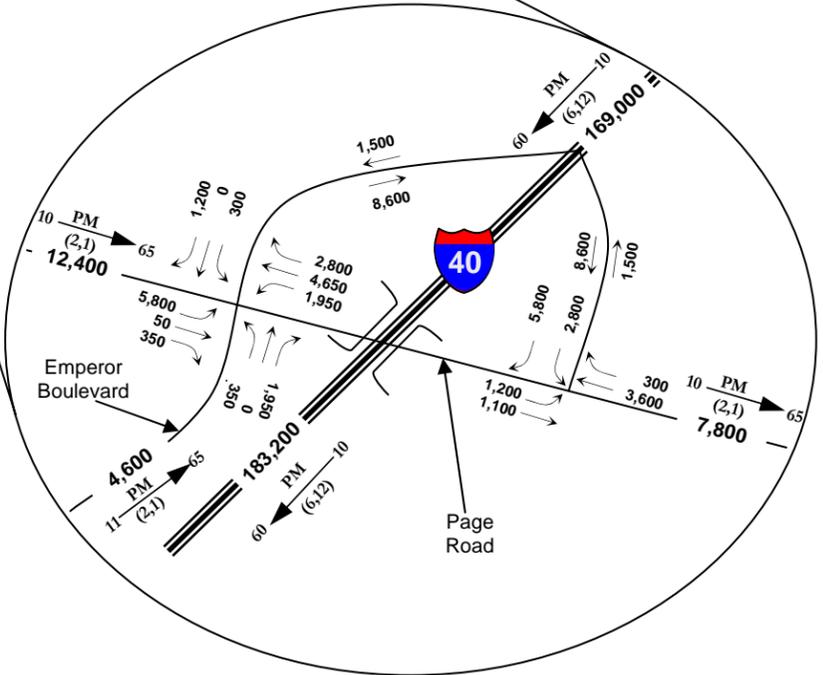
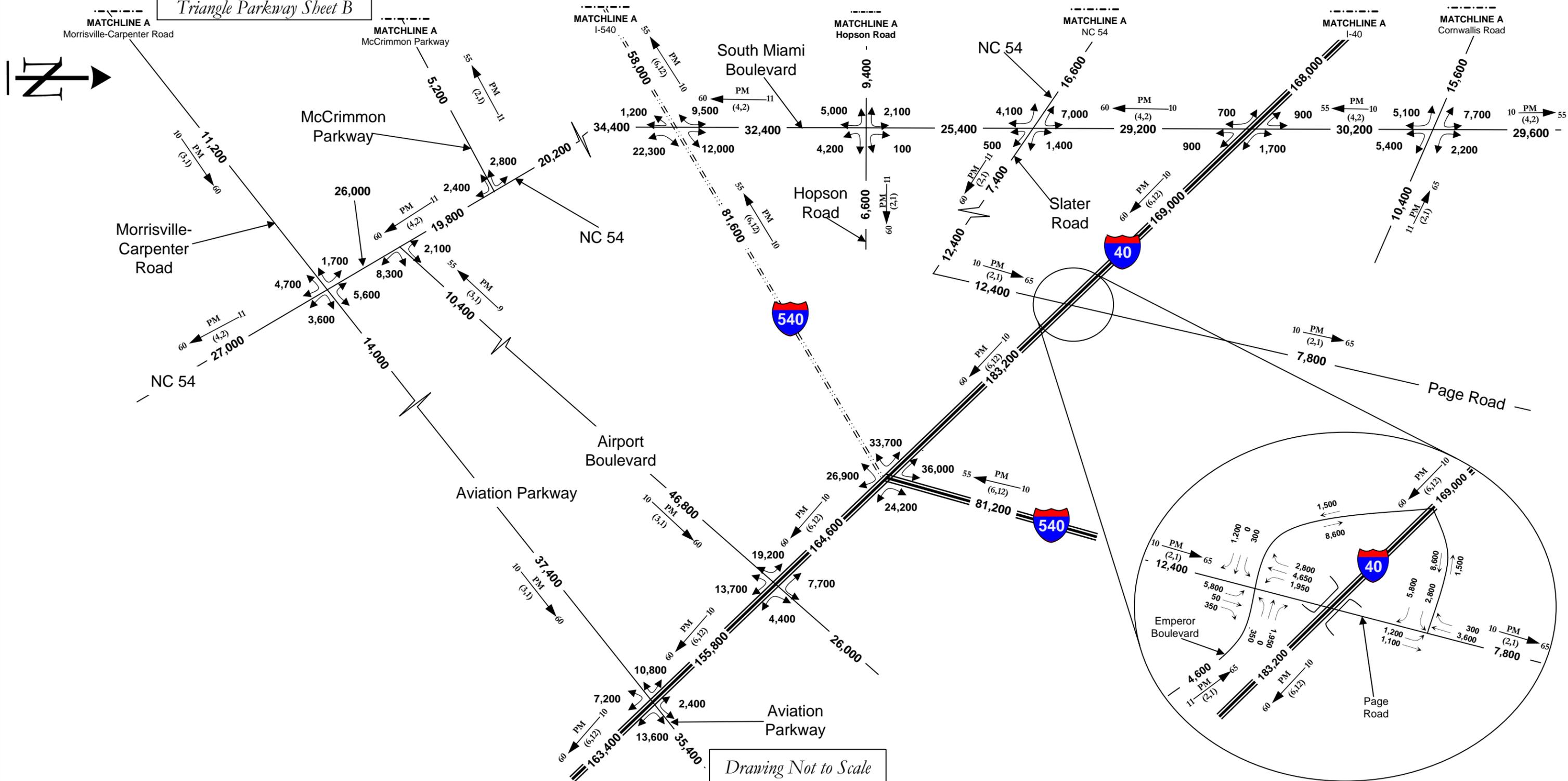
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Appendix C-4:
 2011 NO-BUILD NON-TOLL
 without McCrimmon Parkway Connector
 DAILY FORECAST VOLUMES
 (Alternative B')

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

MARTIN ALEXIOU BRYSON

Transportation Planning - Traffic Engineering

LEGEND

DHV $\xrightarrow{\text{PM}}$ D
 (d, t)

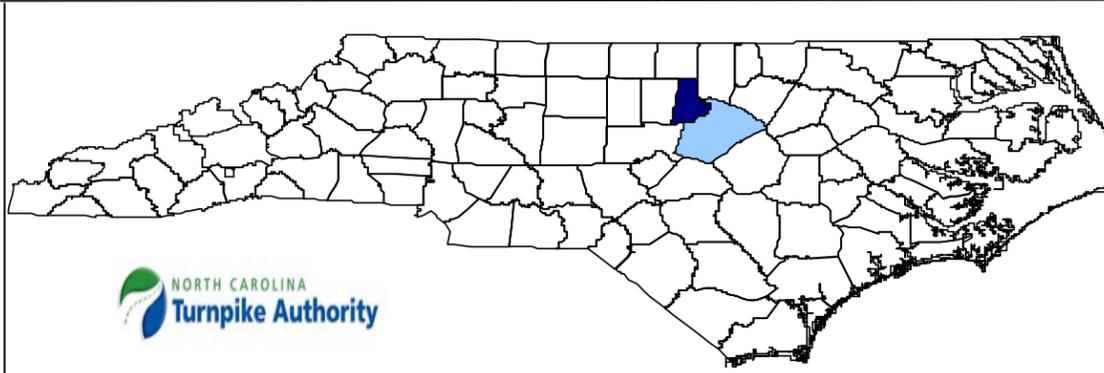
DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME

PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)

\rightarrow INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK

(d,t) DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

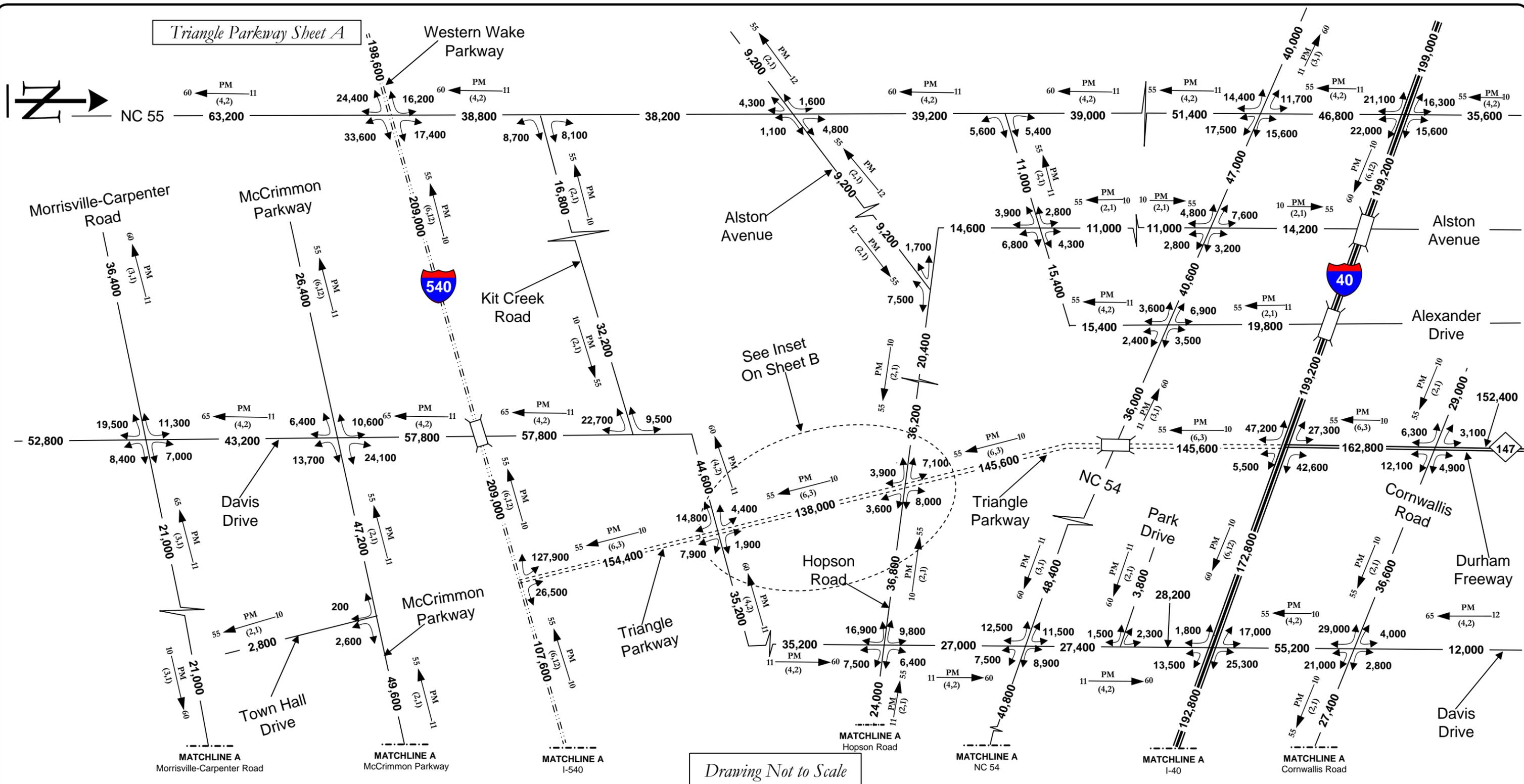
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet A



Drawing Not to Scale

Appendix C-5:
 2030 BUILD NON-TOLL
 without McCrimmon Parkway Connector
 DAILY FORECAST VOLUMES
 (Alternative D)

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

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LEGEND

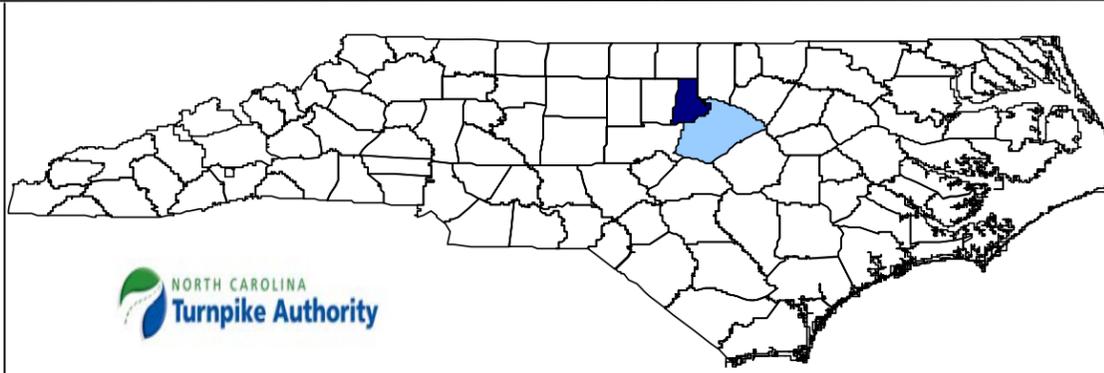
DHV — PM — D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME

PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)

→ INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

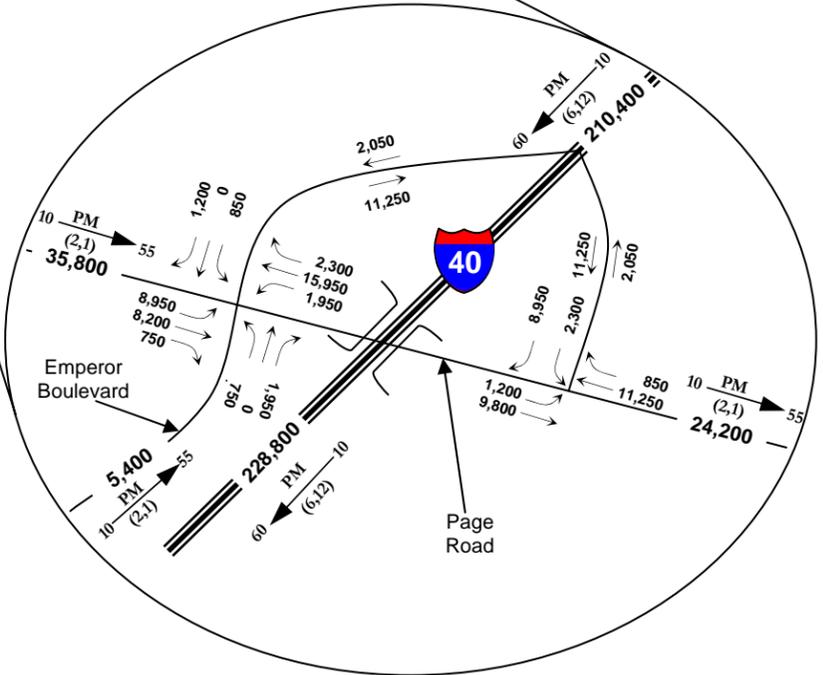
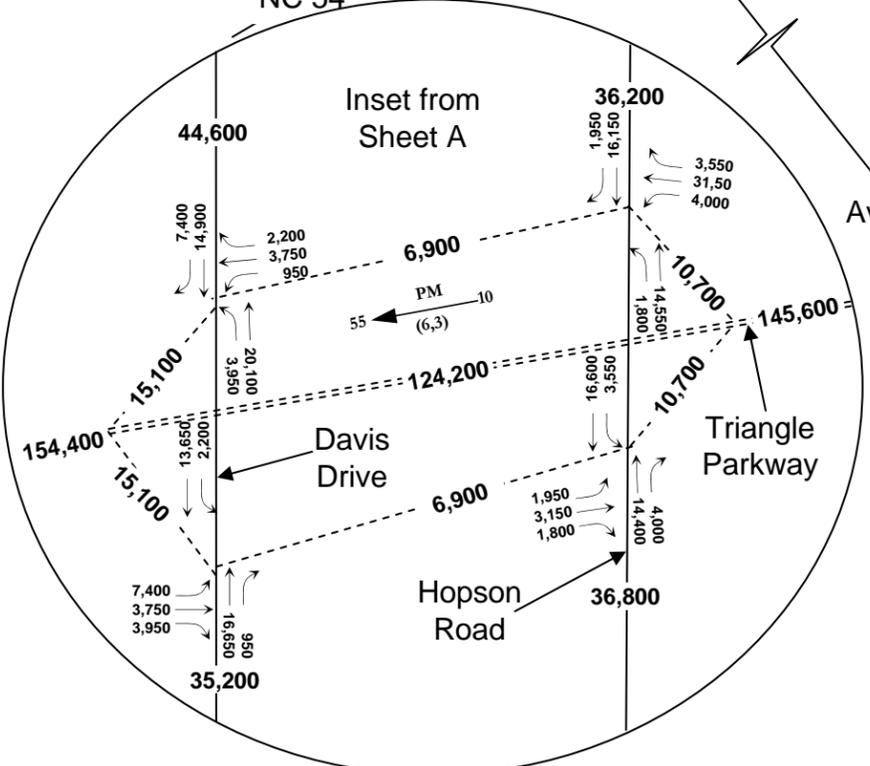
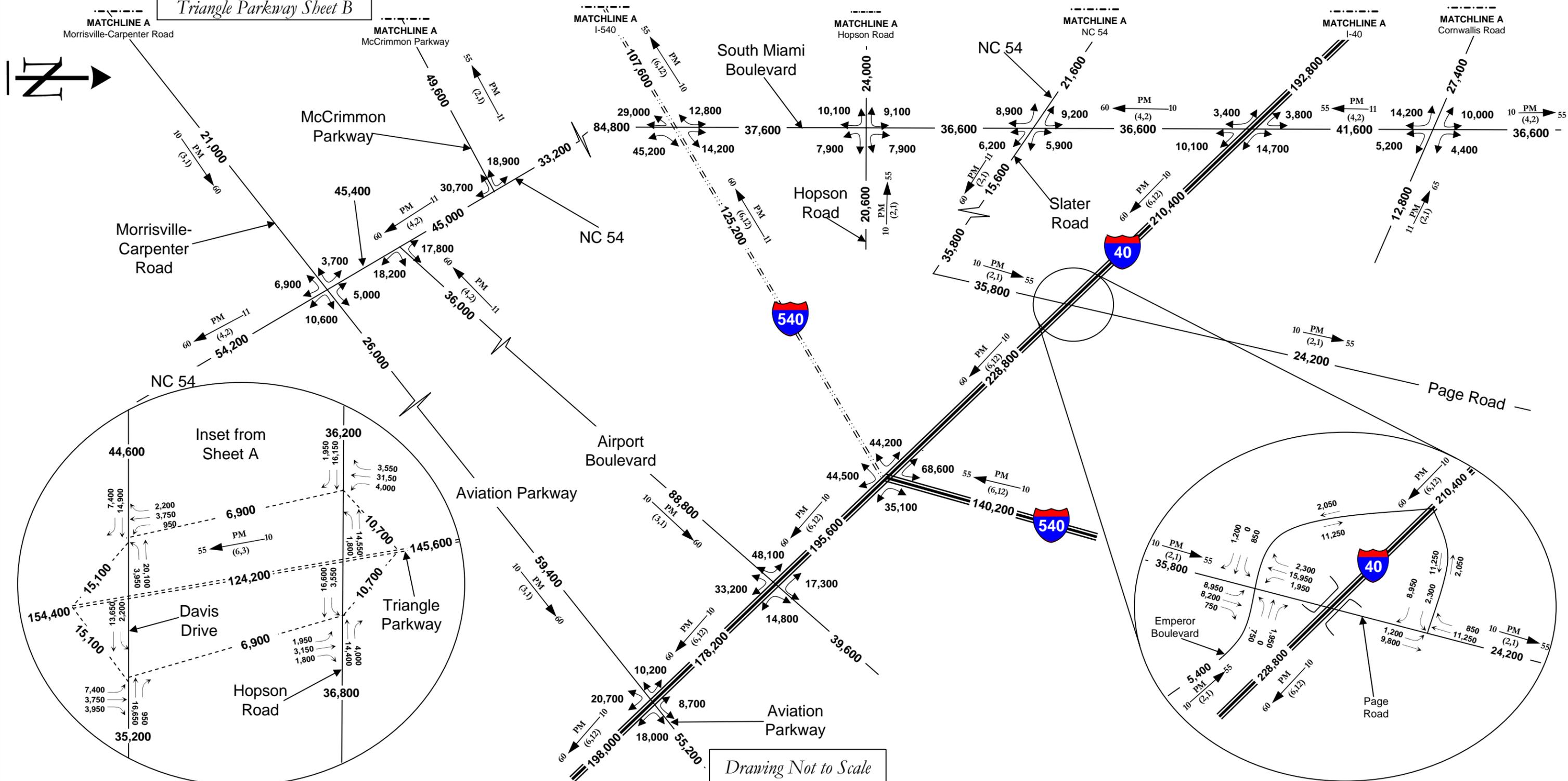
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Appendix C-5:
2030 BUILD NON-TOLL
without McCrimmon Parkway Connector
DAILY FORECAST VOLUMES
(Alternative D)

4000 WestChase Boulevard
Suite 530
Raleigh, North Carolina 27607
Phone: 919-829-0328
Fax: 919-829-0329

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Transportation Planning - Traffic Engineering

LEGEND

DHV $\xrightarrow{\text{PM}}$ D
(d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
K30 = 30th HIGHEST HOURLY VOLUME

PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)

\rightarrow INDICATES DIRECTION OF D
REVERSE FOR AM PEAK
DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

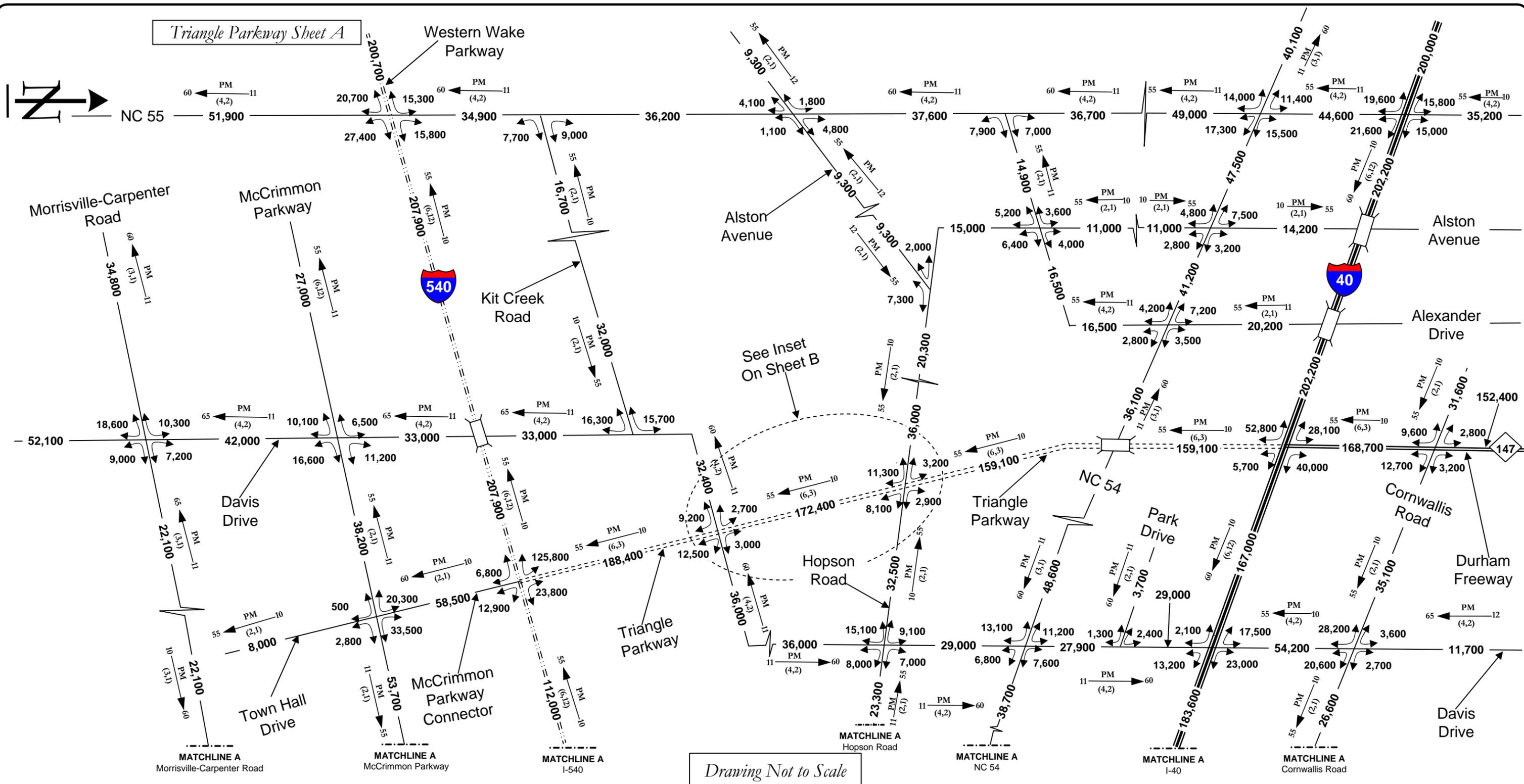
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet A



Drawing Not to Scale

Appendix C-6
 2030 BUILD NON-TOLL
 with McCrimmon Parkway Connector
 DAILY FORECAST VOLUMES
 (Alternative D+)

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

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Transportation Planning - Traffic Engineering

LEGEND

DHV — PM — D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME
 PM = PM PEAK PERIOD
 D = DIRECTIONAL SPLIT (%)
 —> INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

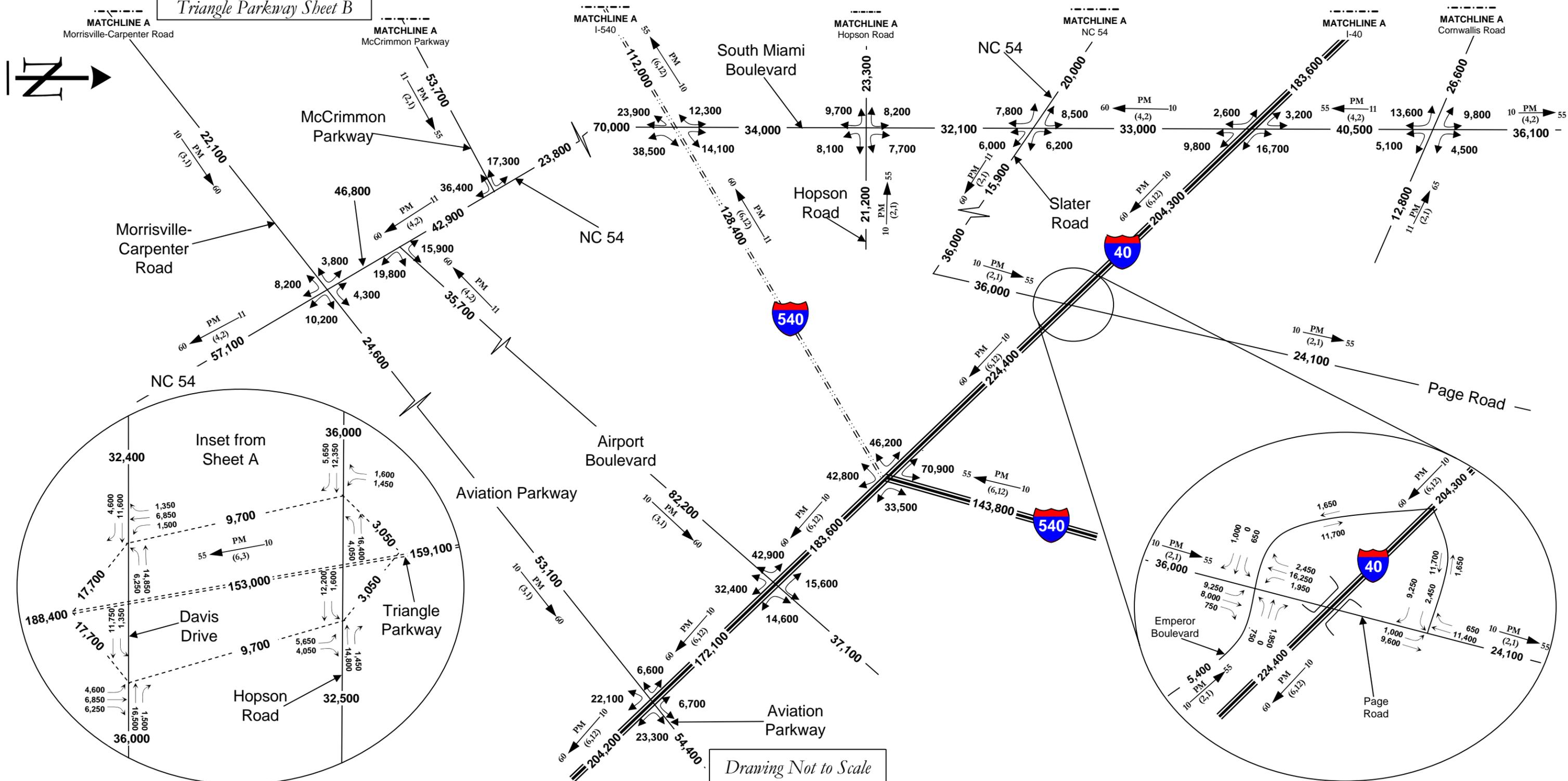
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet B



Drawing Not to Scale

Appendix C-6
 2030 BUILD NON-TOLL
 with McCrimmon Parkway Connector
 DAILY FORECAST VOLUMES
 (Alternative D+)

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

MARTIN ALEXIOU BRYSON

Transportation Planning - Traffic Engineering

LEGEND

DHV $\xrightarrow{\text{PM}}$ D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME
 PM = PM PEAK PERIOD
 D = DIRECTIONAL SPLIT (%)
 \rightarrow INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 (d,t) DUALS, TT-ST'S (%)

NORTH CAROLINA Turnpike Authority

LOCATION: Triangle Parkway—From I-40 to I-540

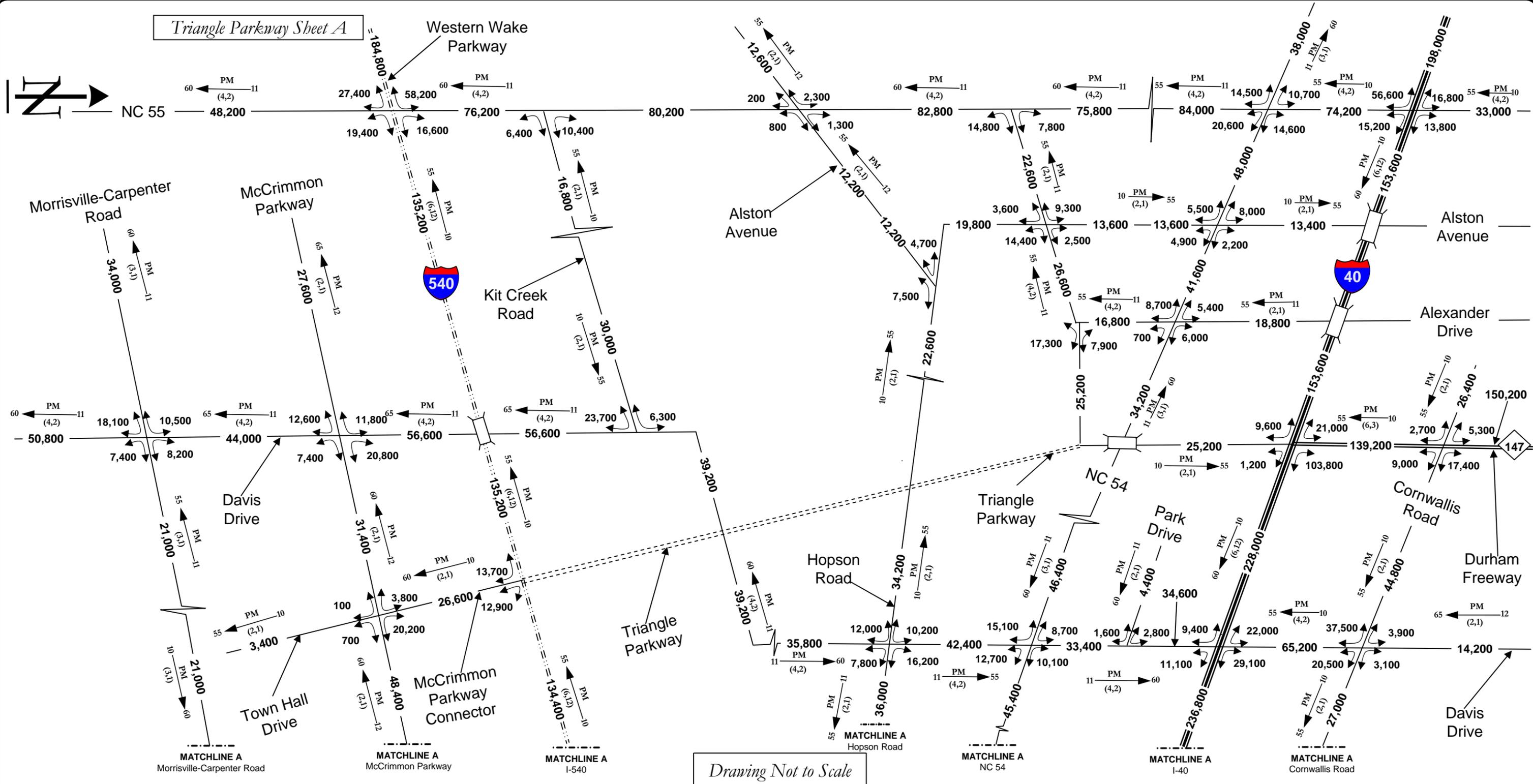
PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

Triangle Parkway Sheet A



Drawing Not to Scale

Appendix C-7:
 2030 NO-BUILD NON-TOLL
 with McCrimmon Parkway Connector
 DAILY FORECAST VOLUMES
 (Alternative D')

4000 WestChase Boulevard
 Suite 530
 Raleigh, North Carolina 27607
 Phone: 919-829-0328
 Fax: 919-829-0329

MARTIN ALEXIOU BRYSON

Transportation Planning - Traffic Engineering

LEGEND

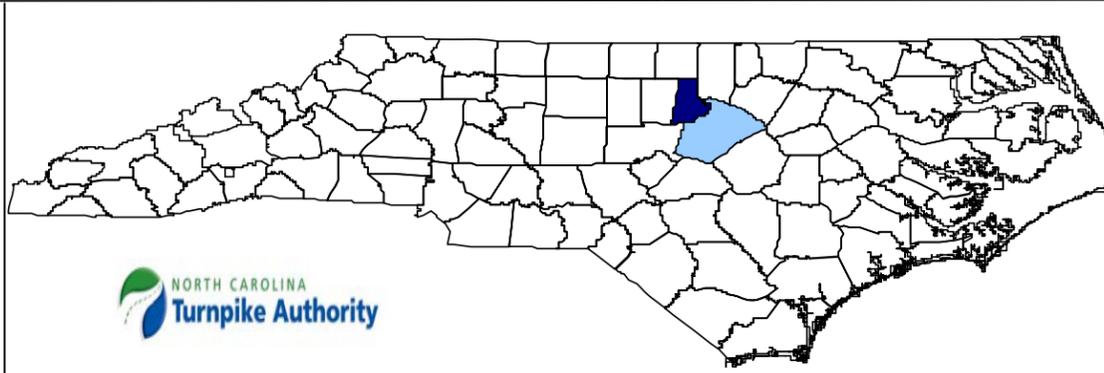
DHV — PM — D
 (d, t)

DHV = DESIGN HOURLY VOLUME (%) = K30
 K30 = 30th HIGHEST HOURLY VOLUME

PM = PM PEAK PERIOD

D = DIRECTIONAL SPLIT (%)

→ INDICATES DIRECTION OF D
 REVERSE FOR AM PEAK
 DUALS, TT-ST'S (%)



LOCATION: Triangle Parkway—From I-40 to I-540

PROJECT: Triangle Parkway

COUNTIES: WAKE and DURHAM

DIVISION: 5 **DATE:** March, 2007

TIP Project No. U-4763

APPENDIX D: TRIANGLE REGIONAL MODEL FACTORS AND VOLUMES

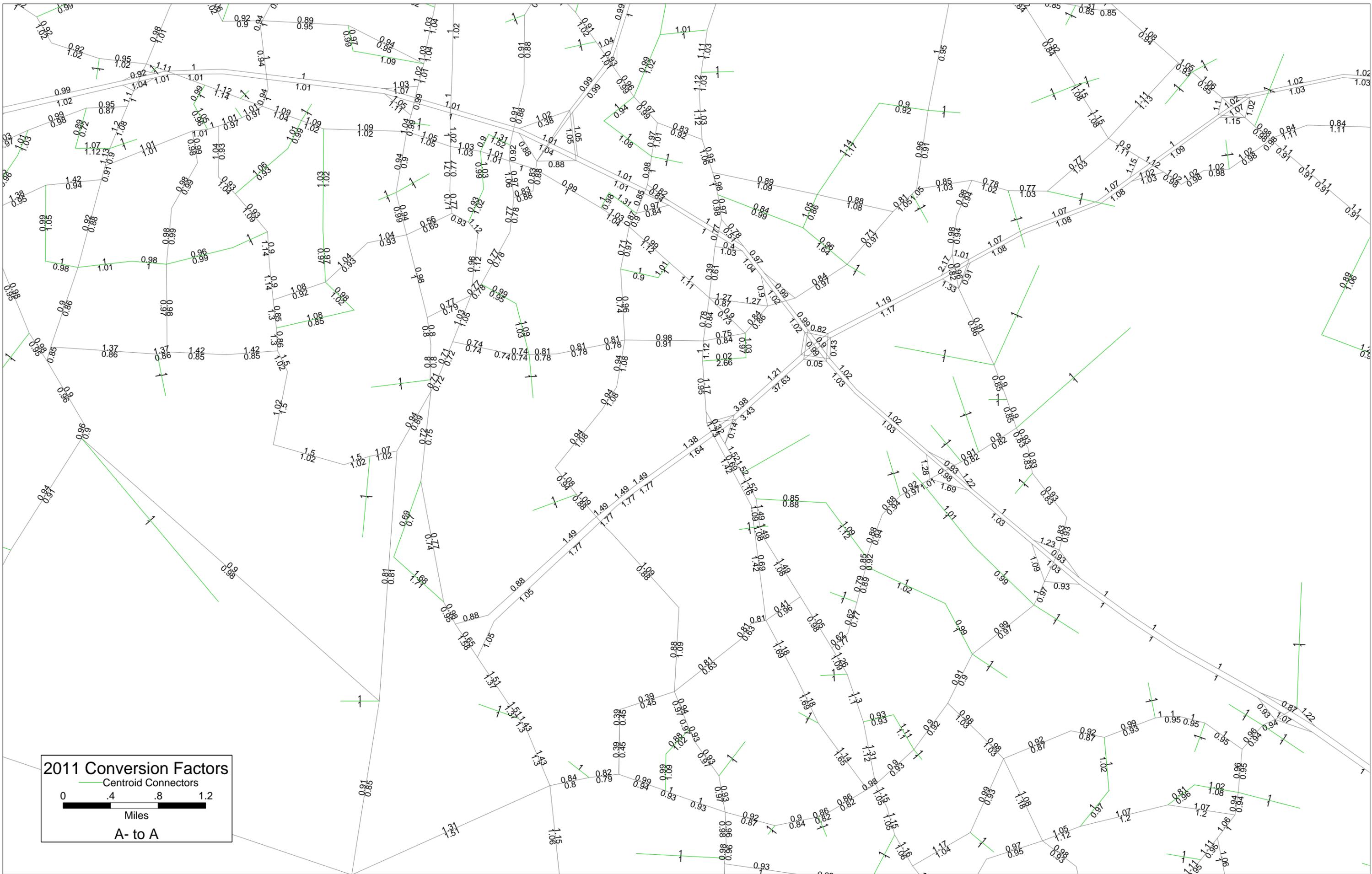
2011 Conversion Factors

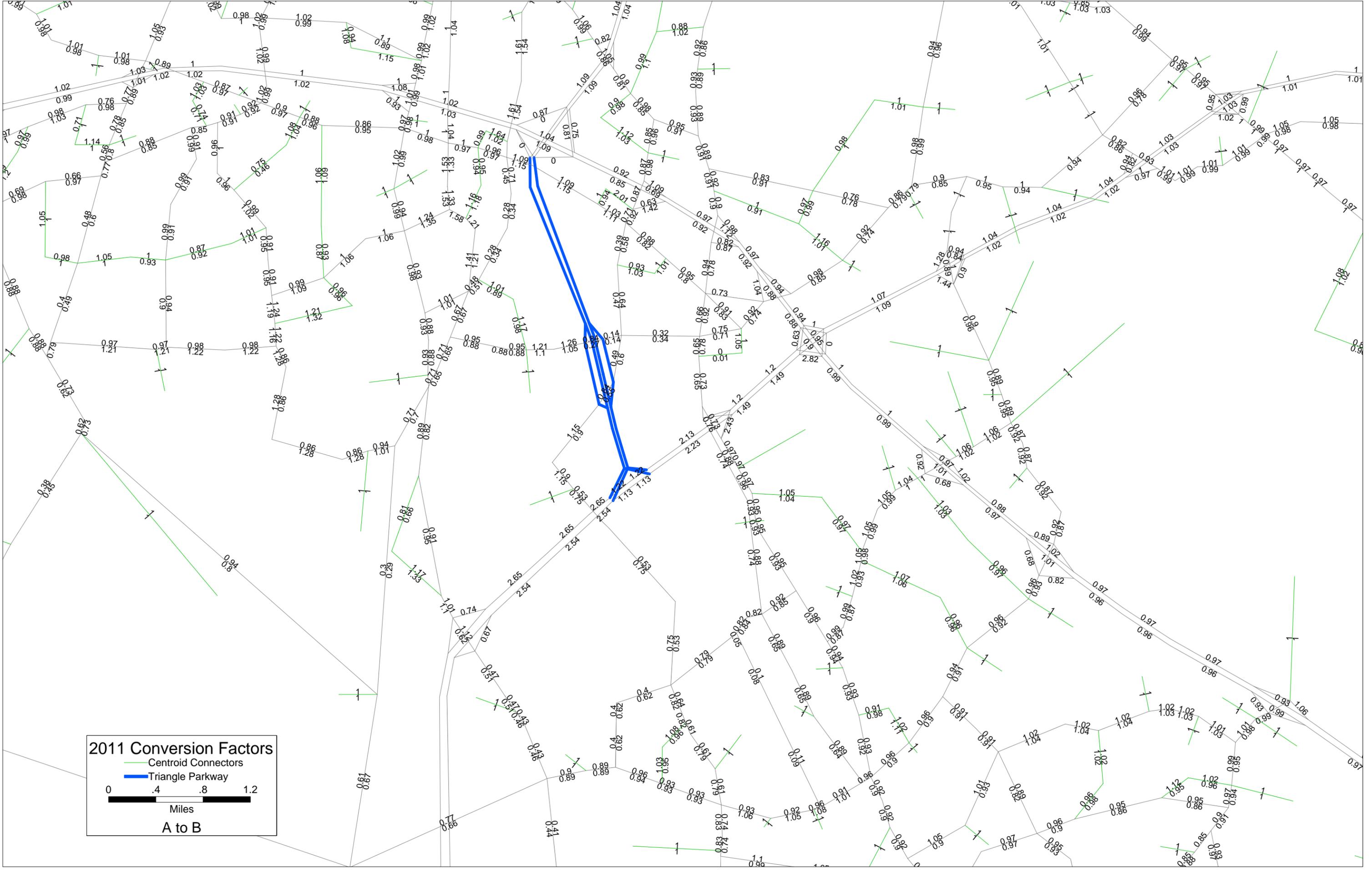
Centroid Connectors



Miles

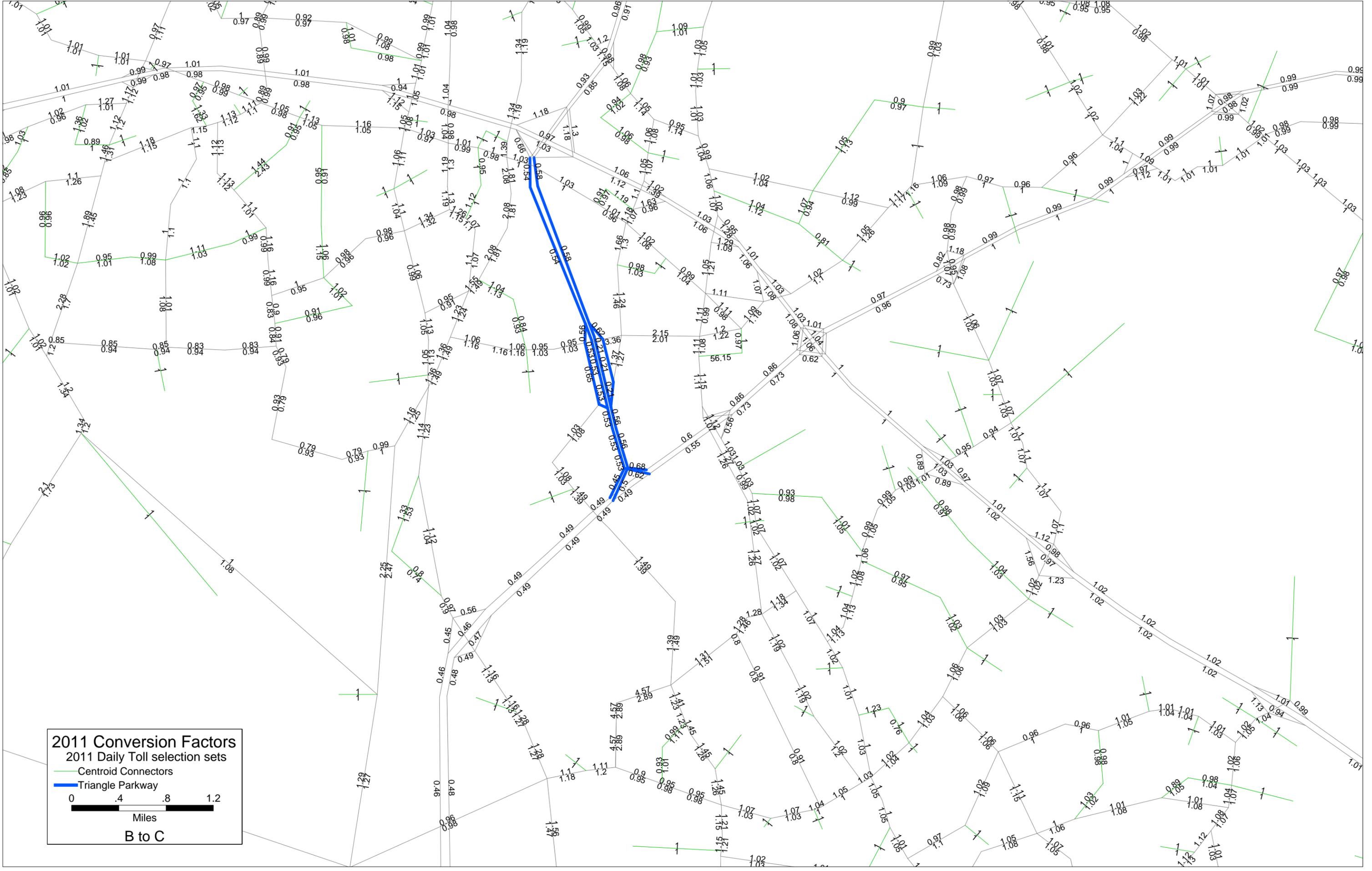
A- to A





2011 Conversion Factors
— Centroid Connectors
— Triangle Parkway

0 .4 .8 1.2
Miles
A to B



2011 Conversion Factors

2011 Daily Toll selection sets

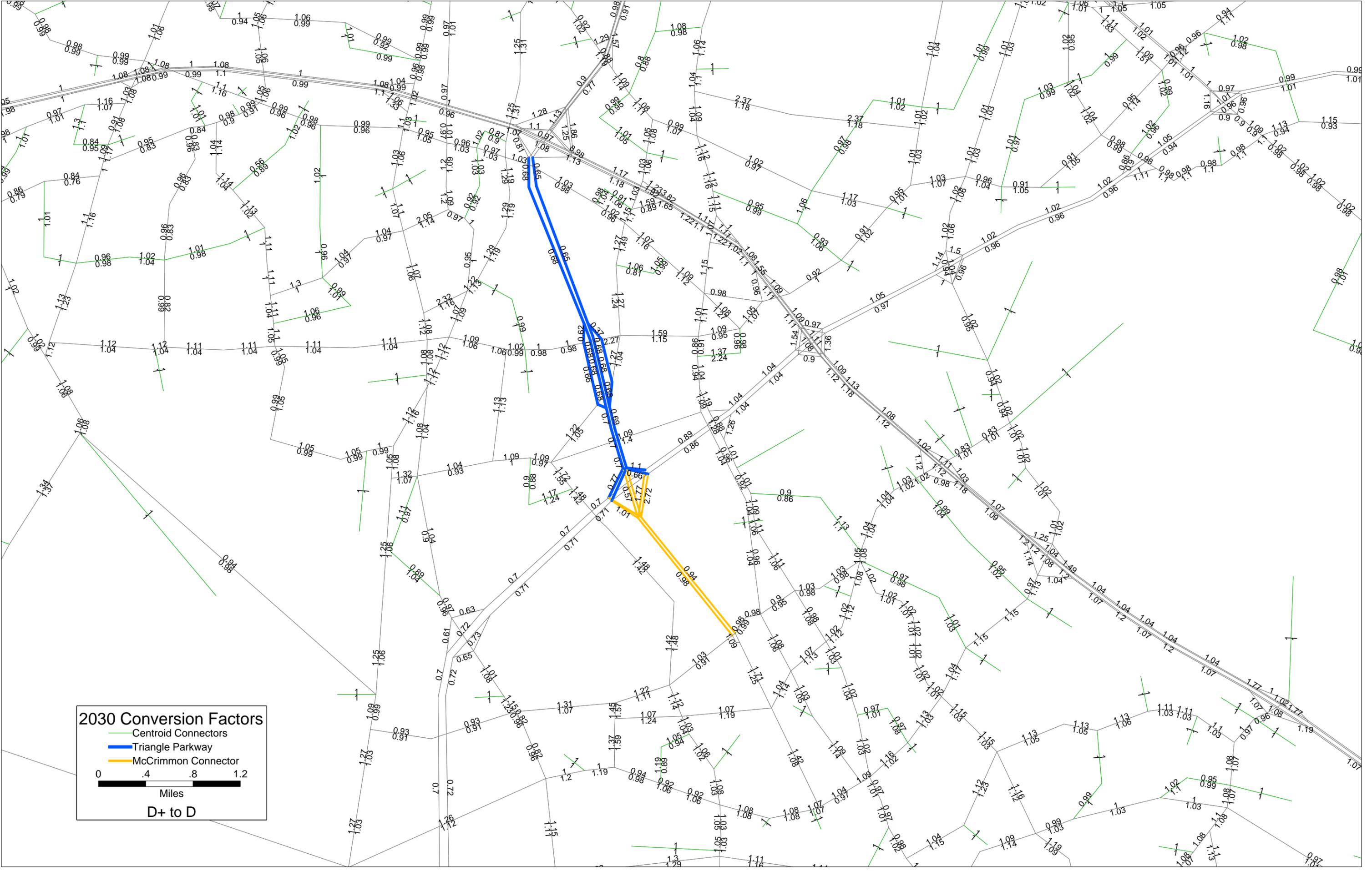
Centroid Connectors

Triangle Parkway

0 .4 .8 1.2

Miles

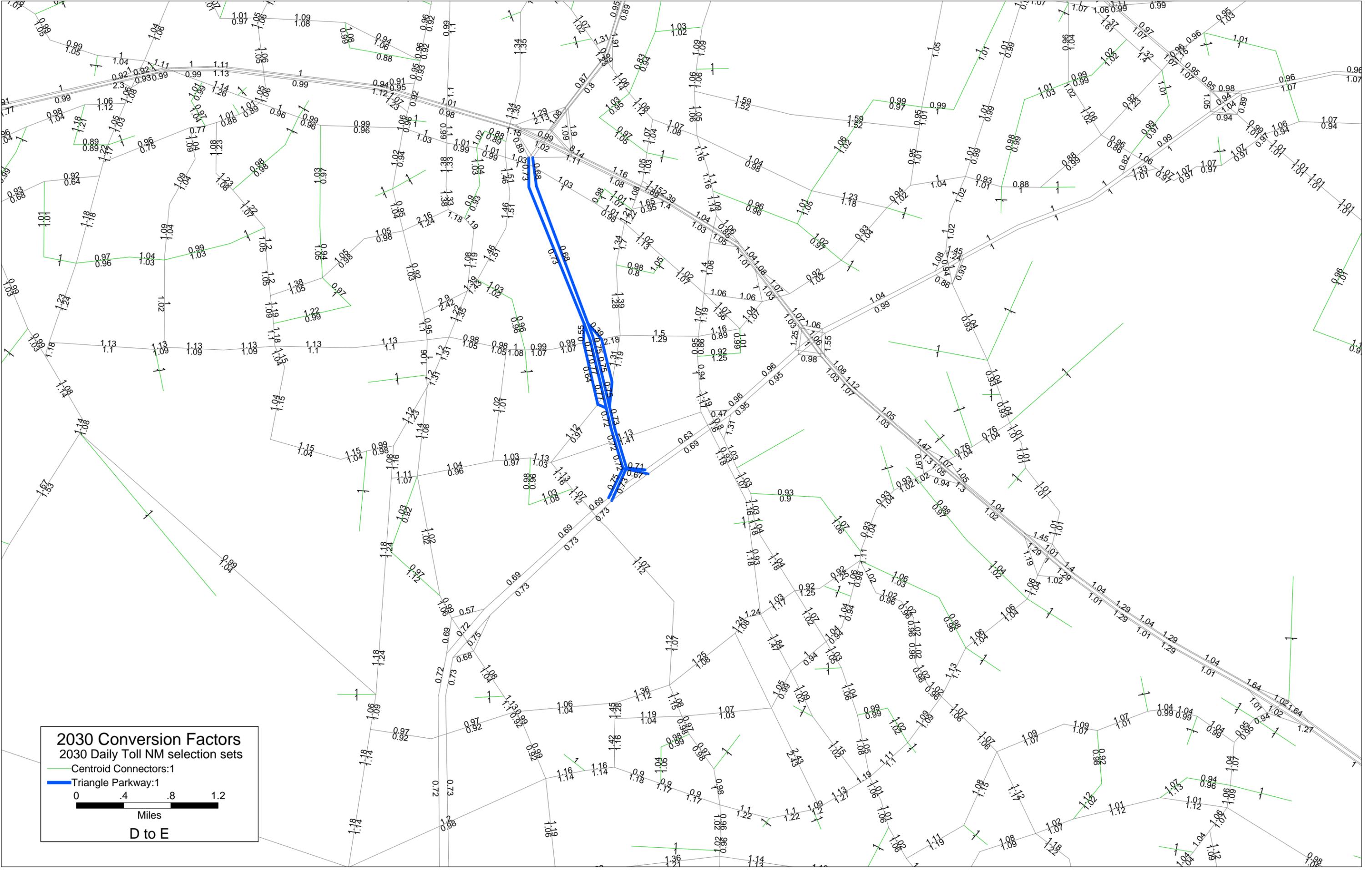
B to C



2030 Conversion Factors

- Centroid Connectors
- Triangle Parkway
- McCrimmon Connector

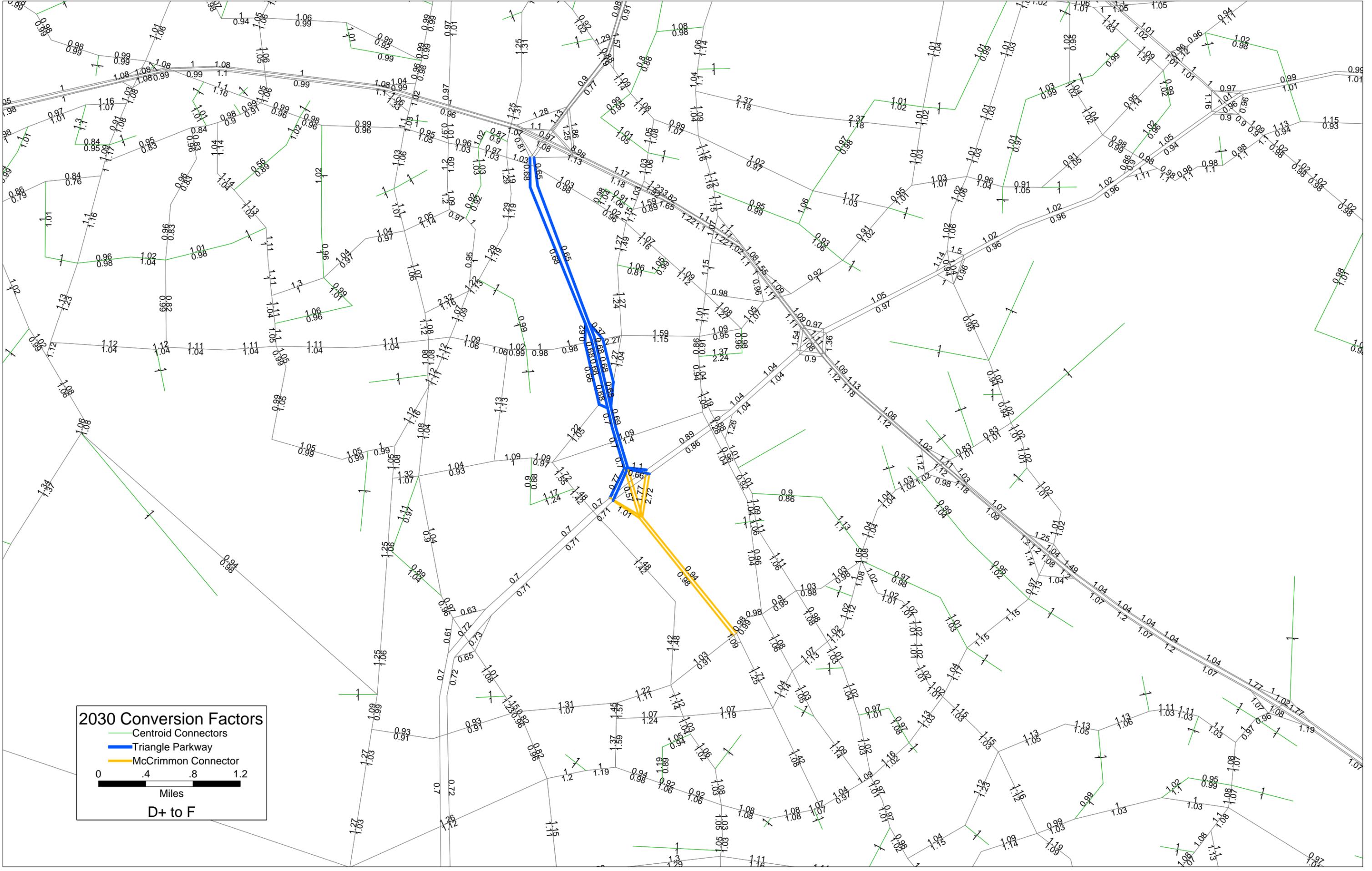
0 .4 .8 1.2
Miles
D+ to D



2030 Conversion Factors
2030 Daily Toll NM selection sets

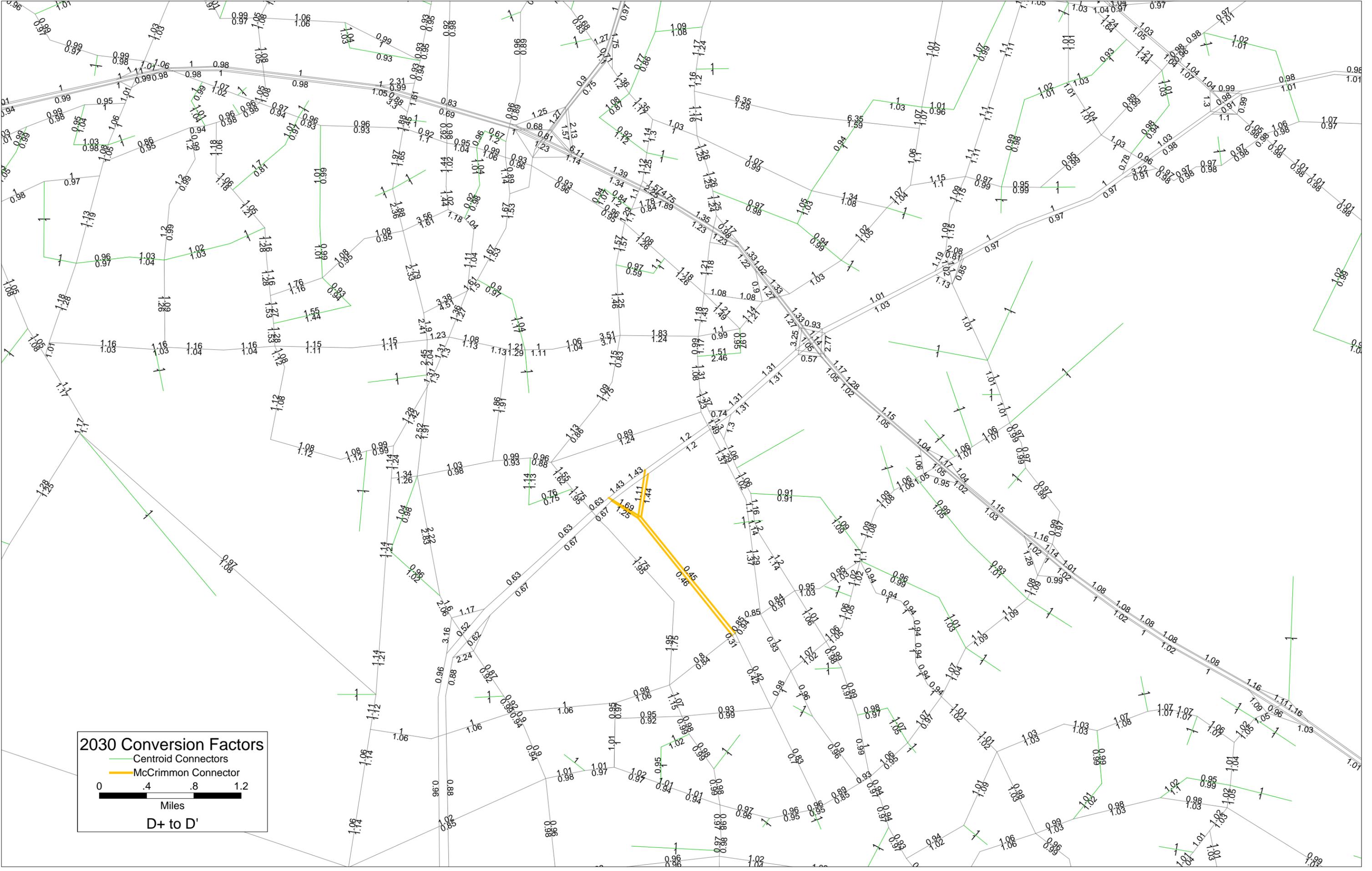
- Centroid Connectors:1
- Triangle Parkway:1

0 .4 .8 1.2
Miles
D to E



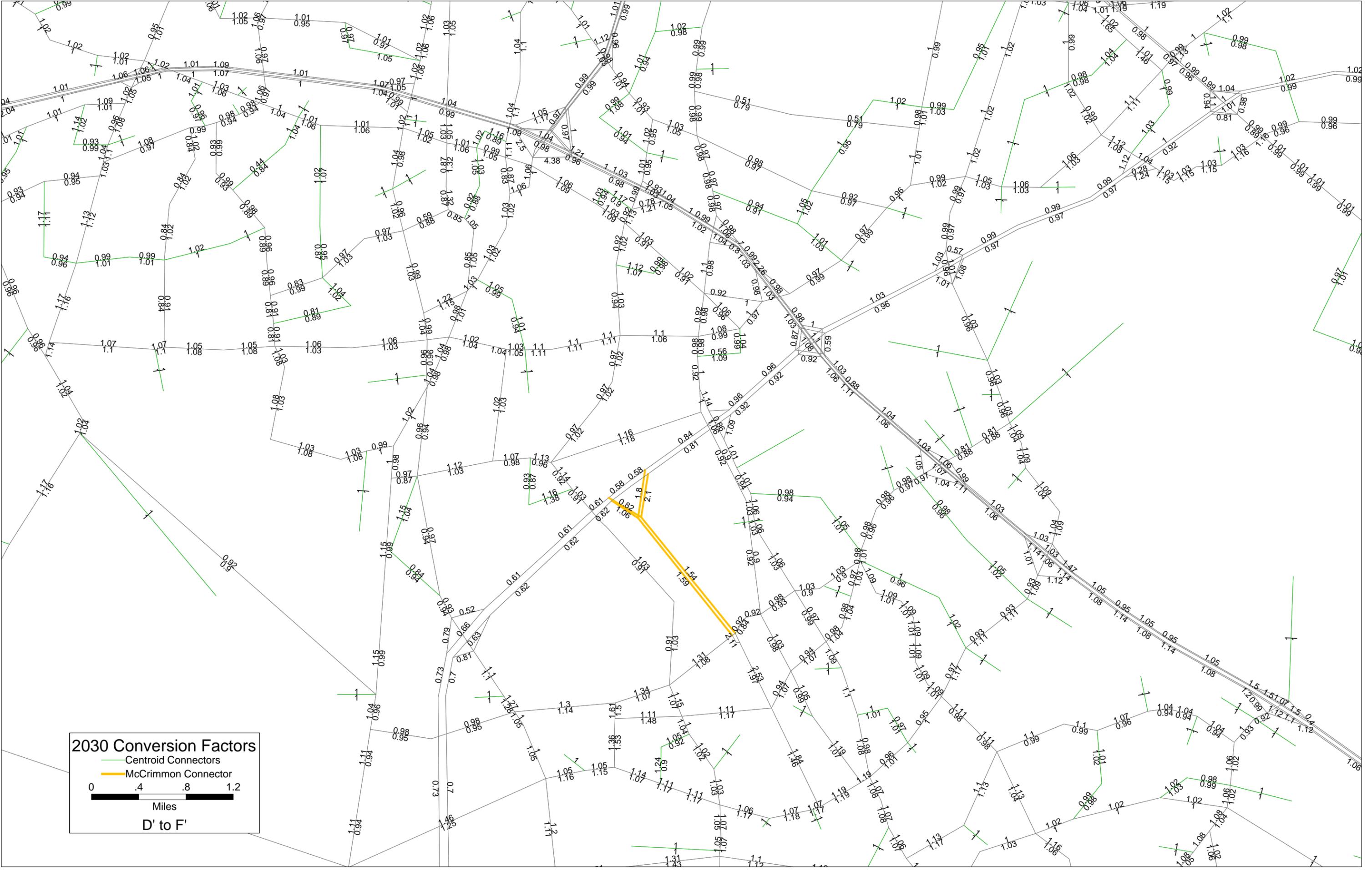
2030 Conversion Factors
— Centroid Connectors
— Triangle Parkway
— McCrimmon Connector

0 .4 .8 1.2
Miles
D+ to F



2030 Conversion Factors
— Centroid Connectors
— McCrimmon Connector

0 .4 .8 1.2
Miles
D+ to D'



2030 Conversion Factors

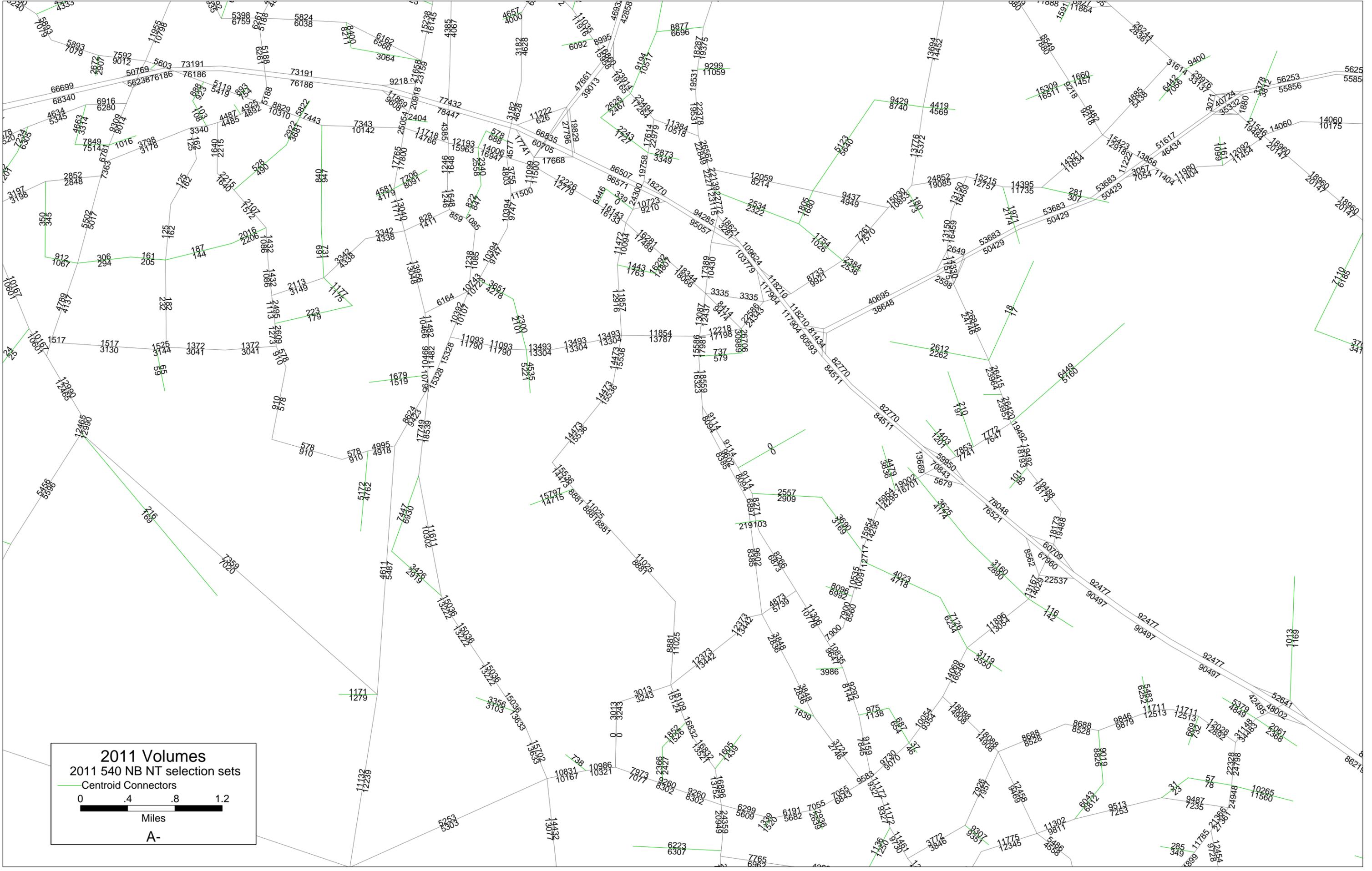
— Centroid Connectors

— McCrimmon Connector

0 .4 .8 1.2

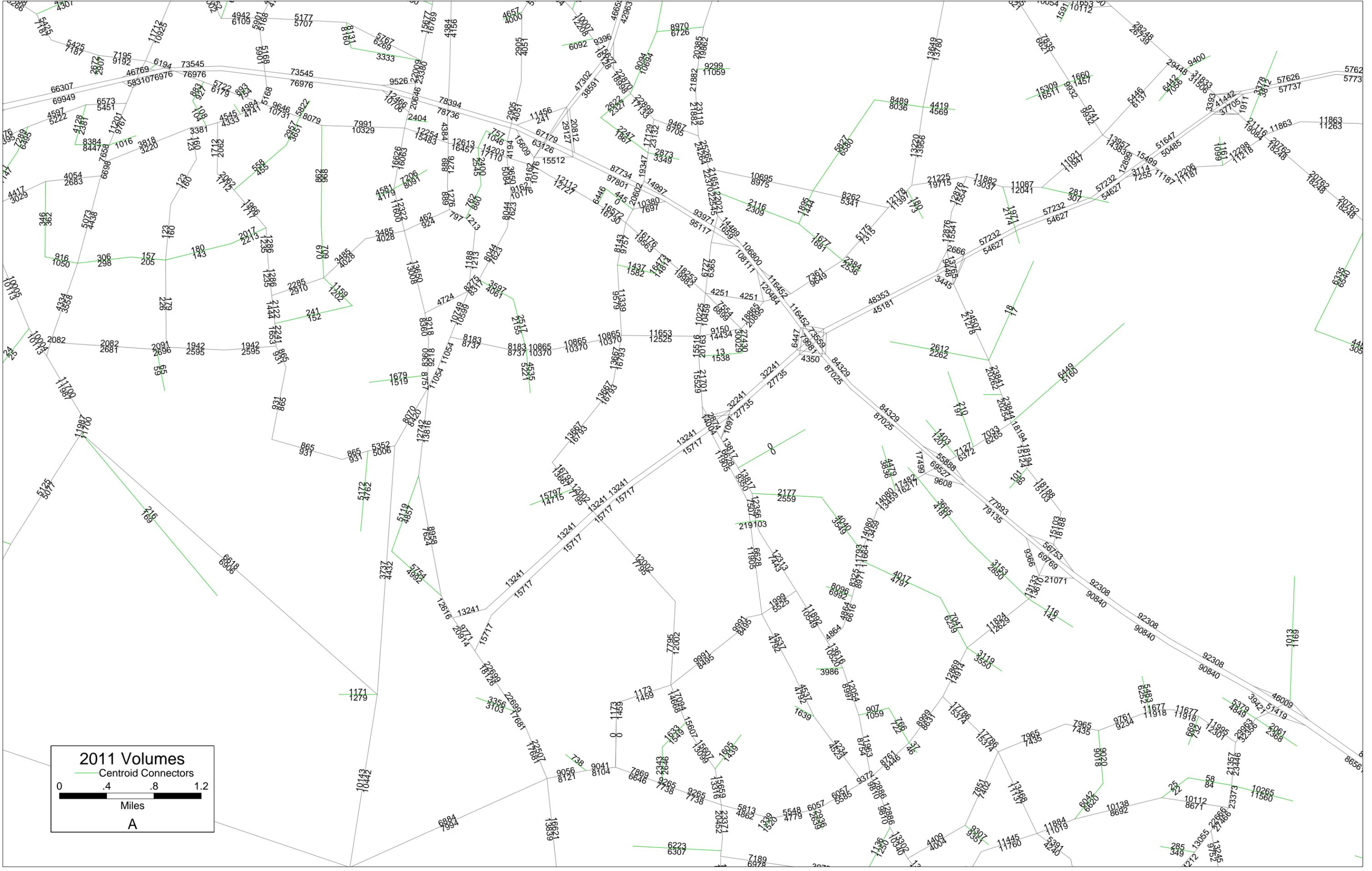
Miles

D' to F'



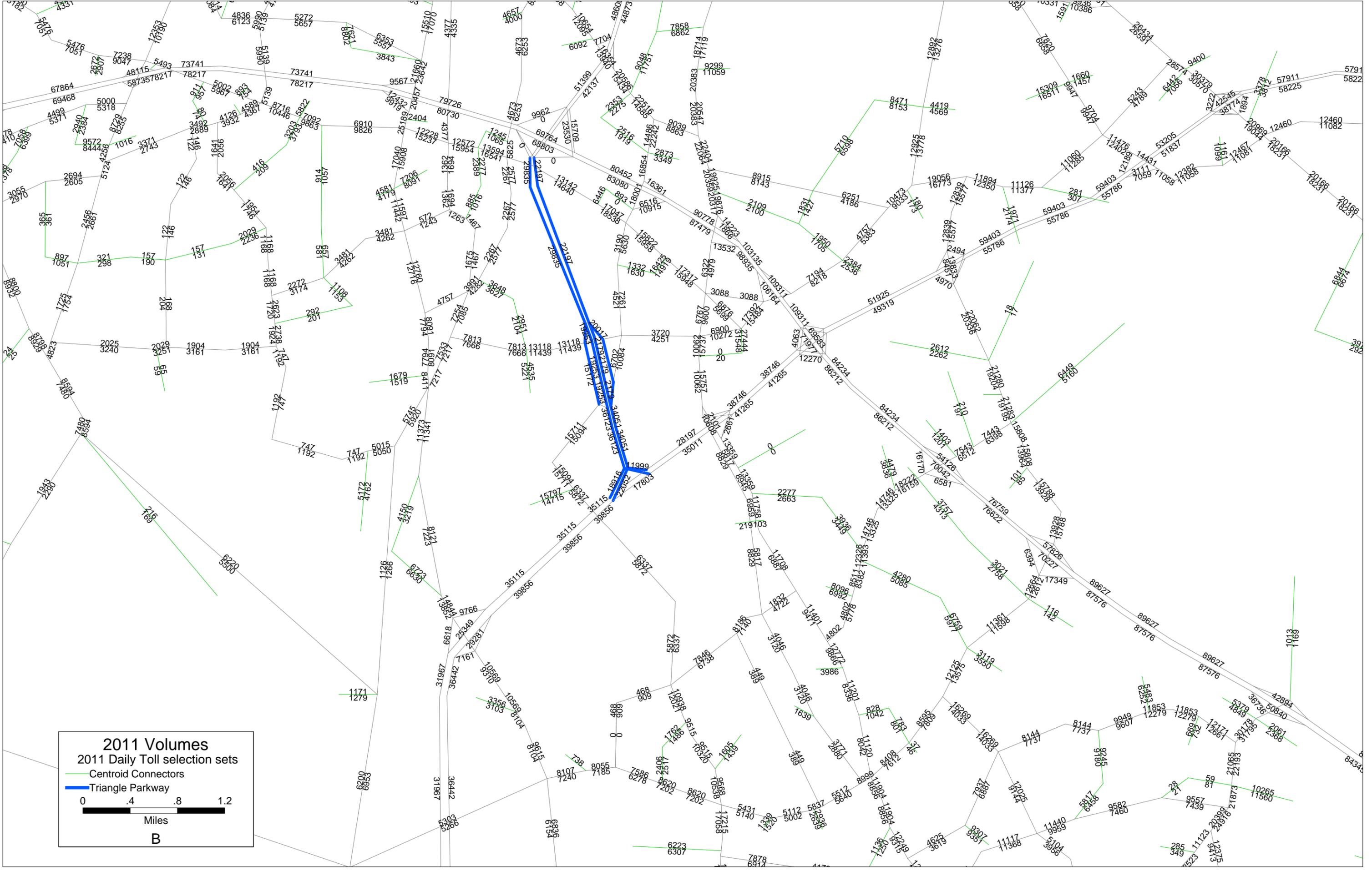
2011 Volumes
 2011 540 NB NT selection sets
 Centroid Connectors

0 .4 .8 1.2
 Miles
 A-



2011 Volumes
— Centroid Connectors

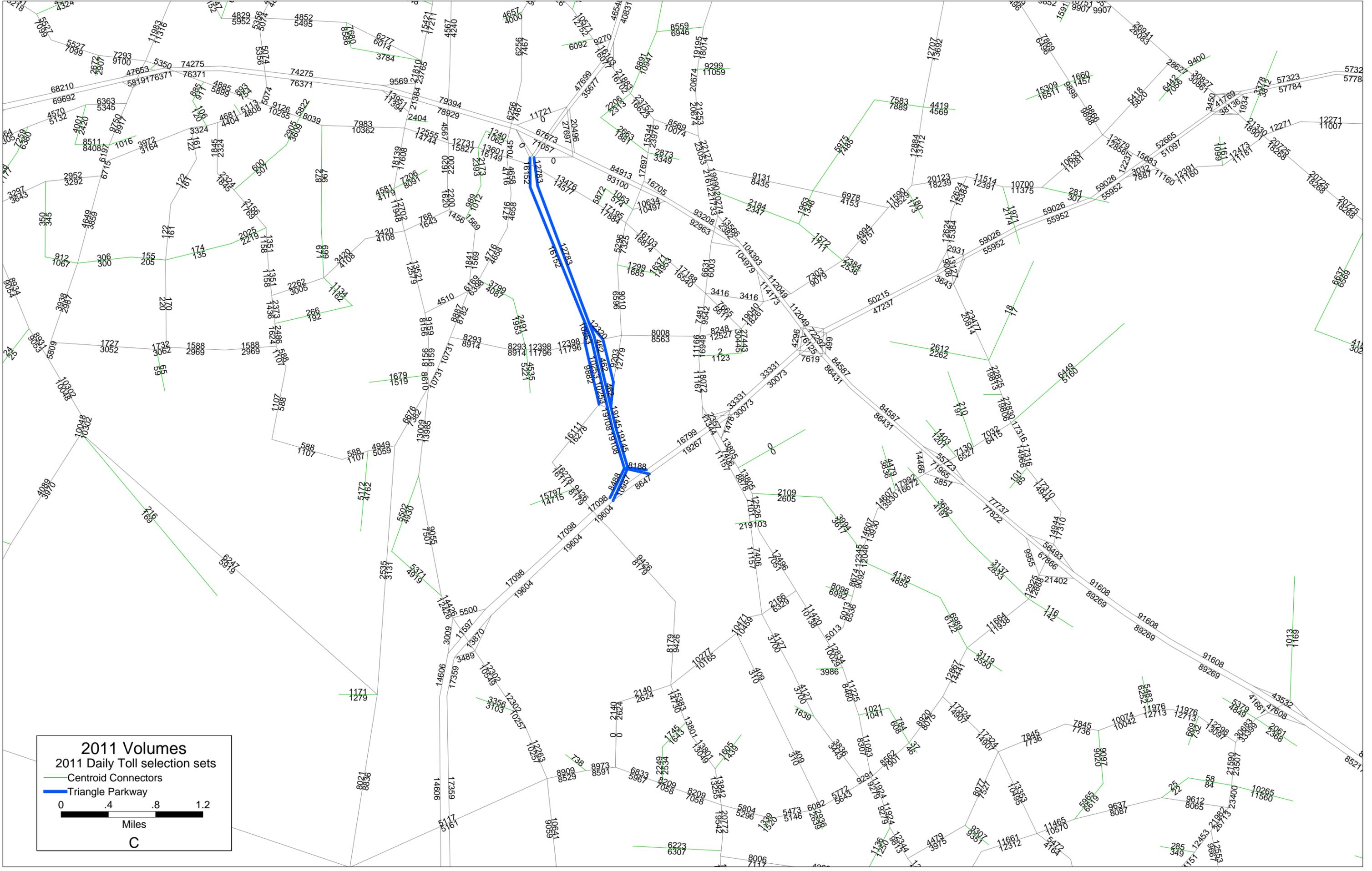
0 .4 .8 1.2
Miles
A



2011 Volumes
 2011 Daily Toll selection sets

- Centroid Connectors
- Triangle Parkway

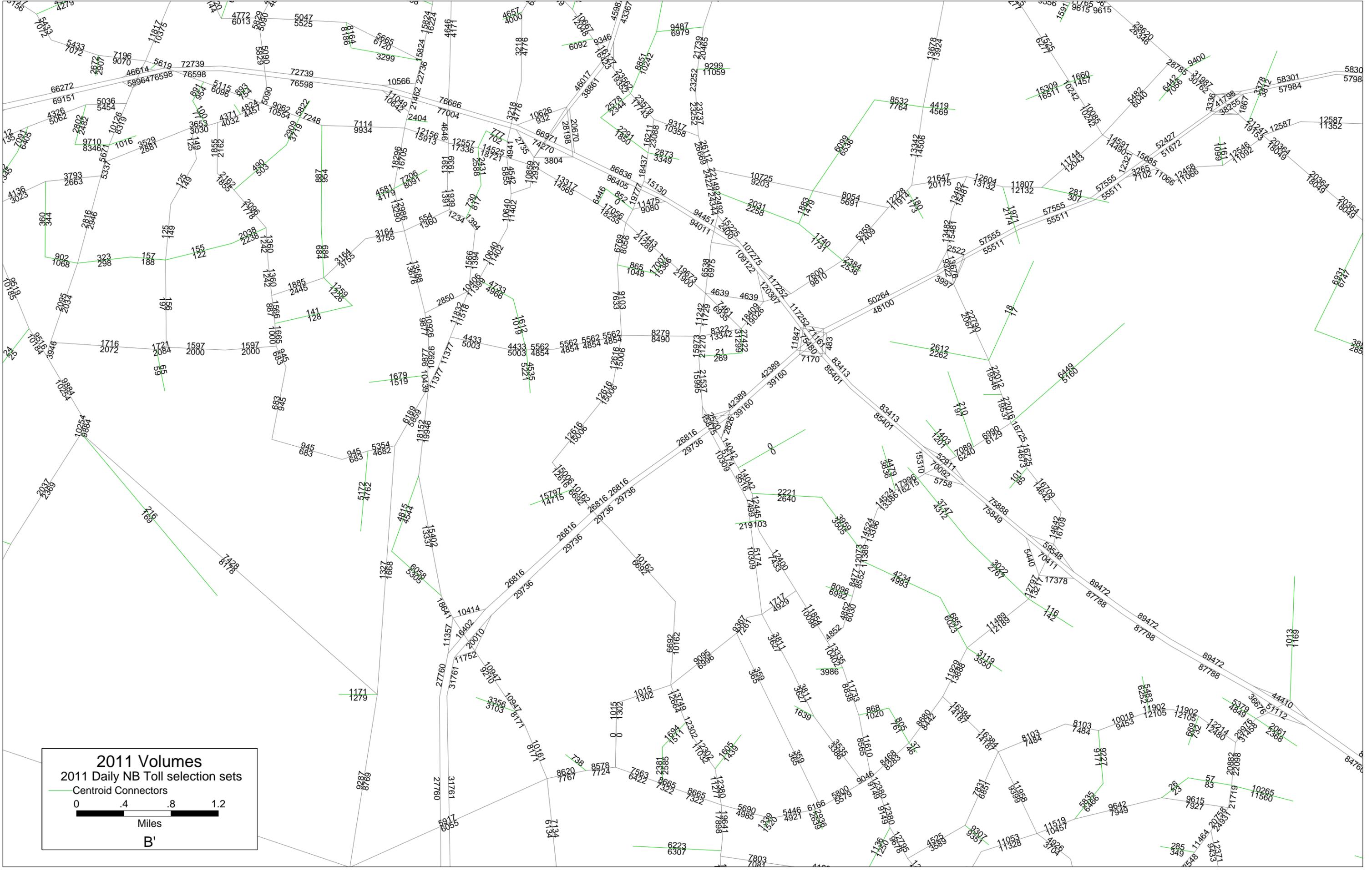
0 .4 .8 1.2
 Miles
 B



2011 Volumes
2011 Daily Toll selection sets

- Centroid Connectors
- Triangle Parkway

0 .4 .8 1.2
Miles
C

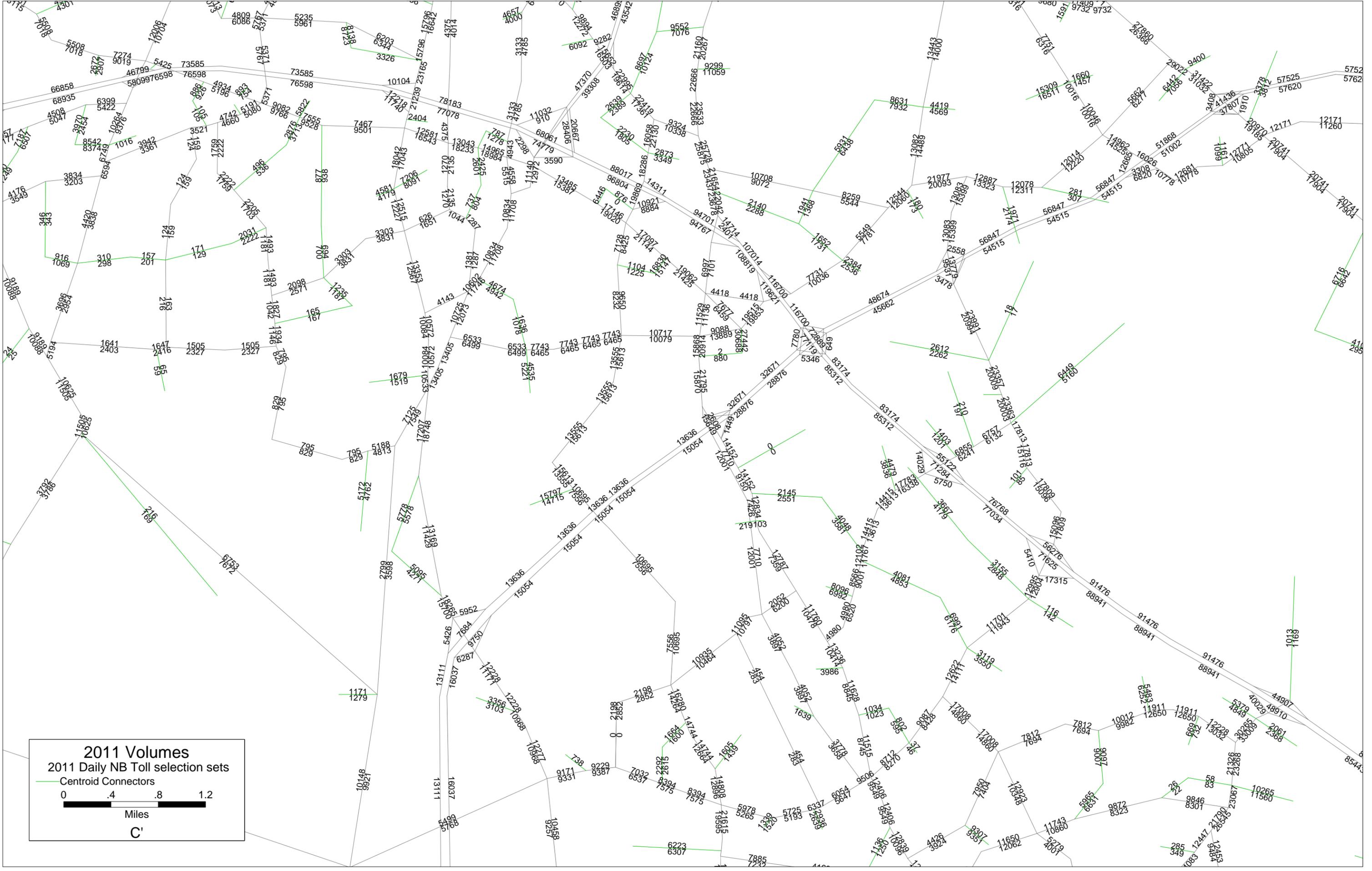


2011 Volumes
2011 Daily NB Toll selection sets

Centroid Connectors

0 .4 .8 1.2
Miles

B'

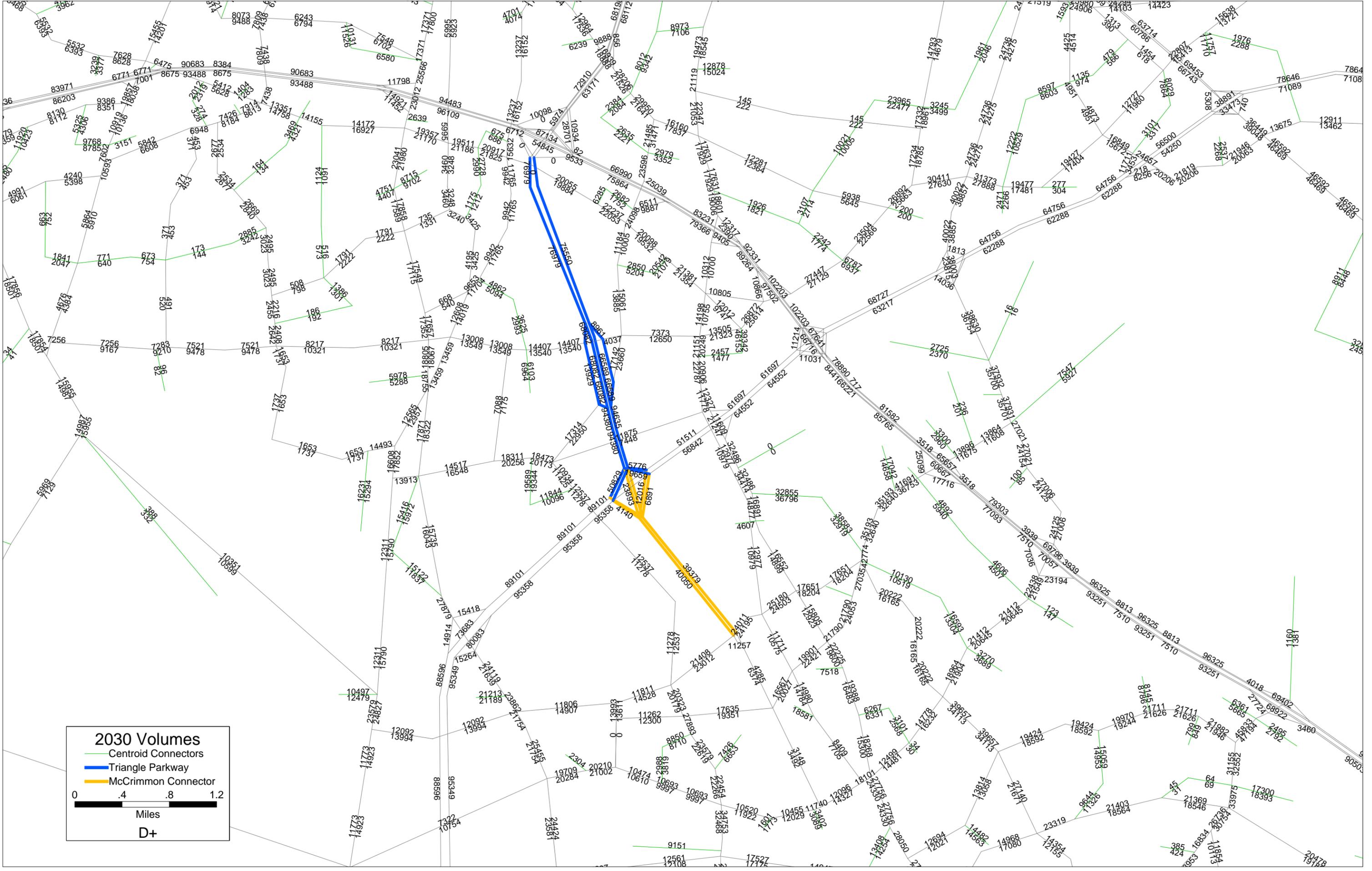


2011 Volumes
2011 Daily NB Toll selection sets

Centroid Connectors

0 .4 .8 1.2
Miles

C'



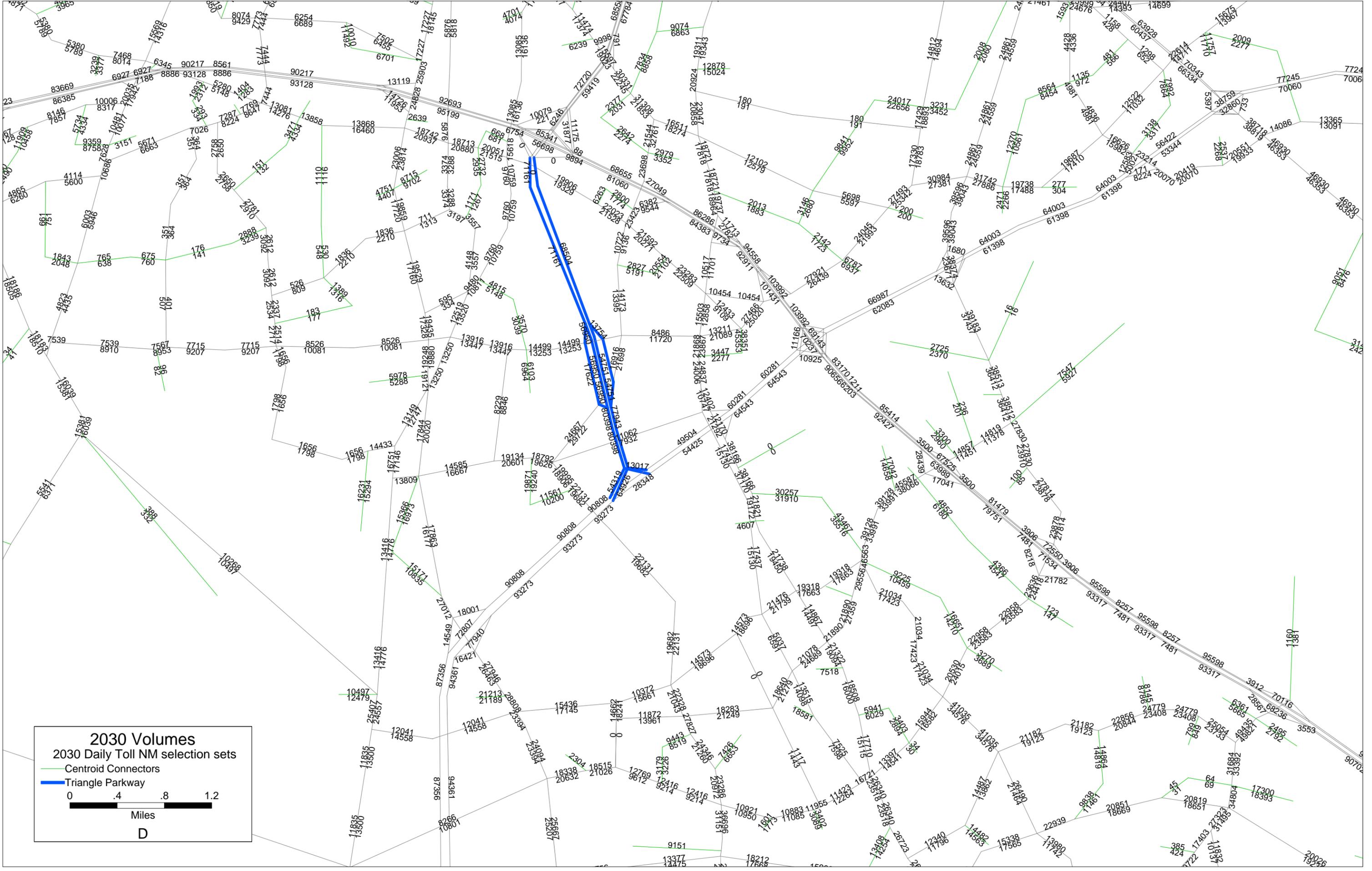
2030 Volumes

- Centroid Connectors
- Triangle Parkway
- McCrimmon Connector

0 .4 .8 1.2

Miles

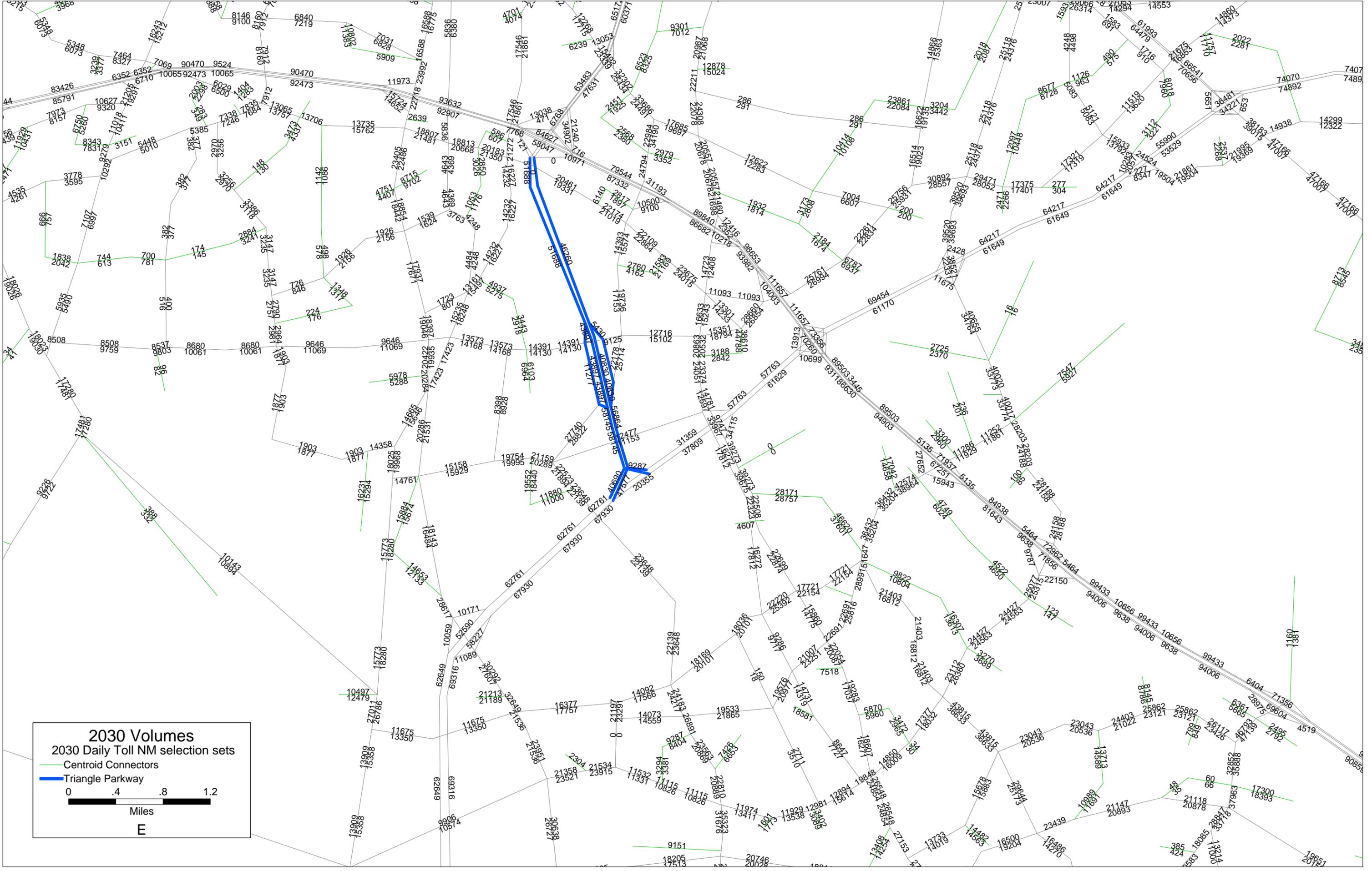
D+



2030 Volumes
 2030 Daily Toll NM selection sets

- Centroid Connectors
- Triangle Parkway

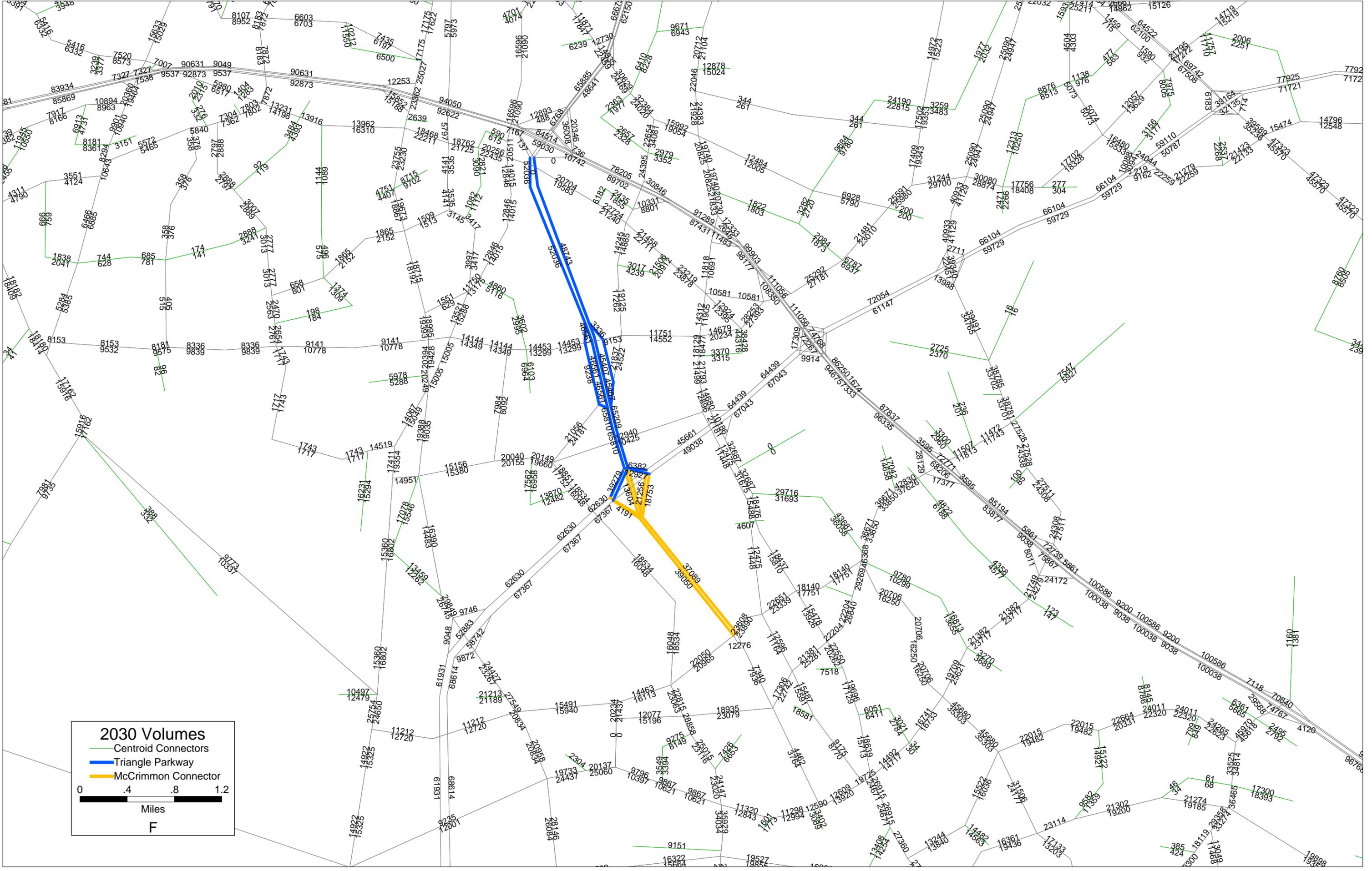
0 .4 .8 1.2
 Miles
 D



2030 Volumes
2030 Daily Toll NM selection sets

- Centroid Connectors
- Triangle Parkway

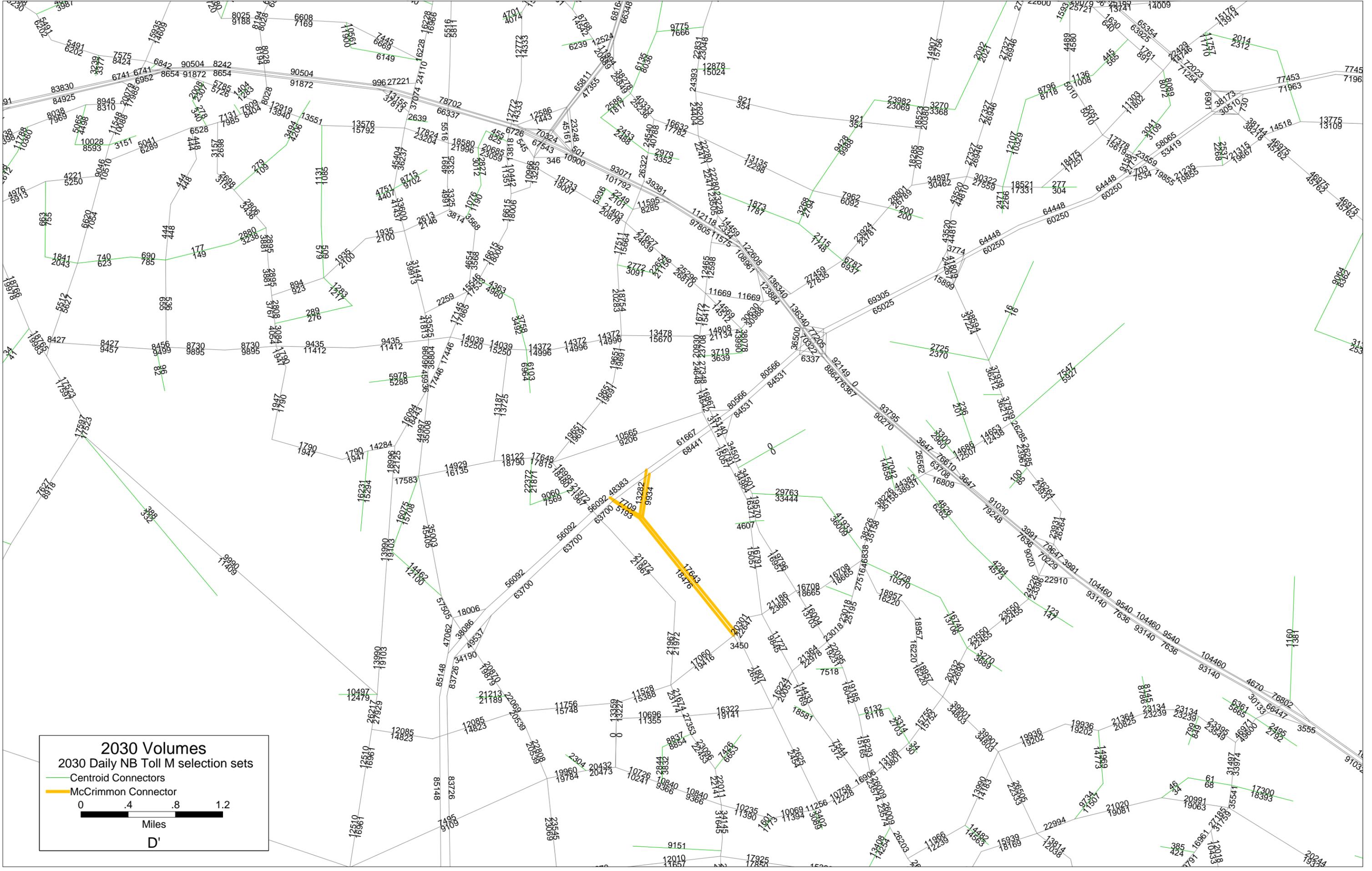
0 .4 .8 1.2
Miles
E



2030 Volumes

- Centroid Connectors
- Triangle Parkway
- McCrimmon Connector

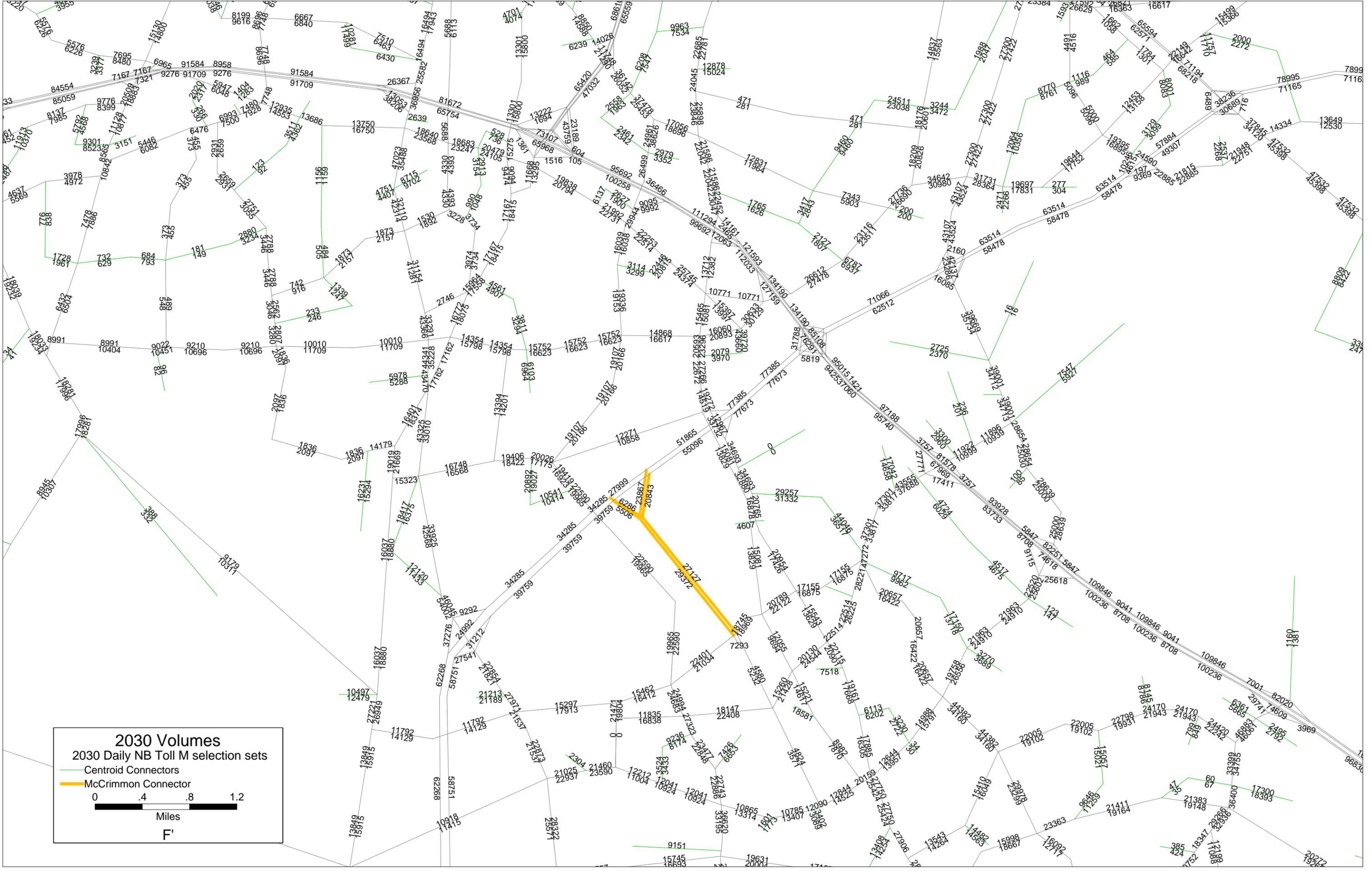
0 .4 .8 1.2
Miles
F



2030 Volumes
 2030 Daily NB Toll M selection sets

— Centroid Connectors
 — McCrimmon Connector

0 .4 .8 1.2
 Miles
 D'



2030 Volumes
2030 Daily NB Toll M selection sets

- Centroid Connectors
- McCrimmon Connector

0 .4 .8 1.2
Miles
F'

