APPENDIX Y
Travel Demand Forecasting

Tier 2 Environmental Impact Statement

I-69 Section 6

Martinsville to Indianapolis

August 9, 2017

Appendix Y - Travel Demand Forecasting

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CHAPTER 1 – INTRODUCTION

The I-69 Evansville to Indianapolis Tier 1 Environmental Impact Statement (EIS) chose a corridor to connect Evansville and Indianapolis by addressing broad planning issues. The Tier 1 Record of Decision (ROD) selected Alternative 3C as the preferred corridor that best satisfied transportation, economic development and national I-69 goals, while having an acceptable level of impacts. The Tier 1 ROD specified six sections for Tier 2 NEPA studies. An EIS has or will be prepared for each Tier 2 section. For each Tier 2 EIS, Lochmueller Group provided centralized traffic modeling and forecasting services. Although the preferred corridor is divided into six separate sections, traffic in one section can be influenced by design features of the alternative in other sections. To assure consistency, Lochmueller Group has used the Indiana Statewide Travel Demand Model (ISTDM) together with a subarea corridor model focused on the I-69 Evansville to Indianapolis corridor for traffic forecasting in Tier 2 sections.

This version of the corridor model for Tier 2 studies in I-69 Section 6 was developed in 2015 and validated against 2010 base year traffic counts, consistent with the base year for the ISTDM. For details of previous versions of the corridor model, see I-69 Tier 2 Section 4, Final EIS (FEIS), Appendix B, Traffic Modeling Technical Report and FHWA Review (regarding corridor model used for EISs in Sections 1 through 4) and I-69 Tier 2 Section 5, FEIS, Appendix GG, I-69 Corridor Model Documentation (regarding corridor model used for EIS in Section 5).

This technical memorandum documents the basic structure of the current corridor model and provides validation statistics against 2010 traffic counts for the final version of the I-69 Section 6 corridor model, which interfaced with ISTDM. It discusses the daily and peak hour traffic assignments, as well as traffic-related performance measures which inform the selection of a preferred alternative in Draft EIS (DEIS) and the refinement of the selected alternative in the FEIS.

CHAPTER 2 – OVERVIEW

2.1 Application to FEIS

The corridor model is used to develop forecasts and statistics for the four-county study area which are used support performance measures associated with purpose and need, and evaluation of alternatives in the FEIS. This evaluation corresponds to different chapters in the FEIS.

The highway user cost and benefits and economic impacts in **Chapter 5.5** are based on four-county study area metrics. The business and employment impacts are the result of economic forecasting performed in TREDIS, which utilities information from the corridor model. Operational analysis performed on the traffic forecasts from the corridor model is included in Chapter 5.6. The forecast results are summarized in Chapter 5.6 as well as in **Appendix E** of this document. Traffic forecasts from the corridor model are an input to air quality analysis (Chapter 5.9), highway noise analysis (**Chapter 5.10**), and energy impacts (**Chapter 5.25**).

2.2 Corridor Model Structure

The I-69 Section 6 corridor model utilizes the modeling methodology adopted in Section 5 corridor model. Necessary refinements were made to the model before using it for Section 6. The corridor model is a subarea model from the ISTDM. The external trips for the corridor model are extracted from the ISTDM. The traffic analysis zone (TAZ) information from the ISTDM is disaggregated for use in the corridor model. This memo describes the details of the roadway network, zone system, relationship to the statewide model, and component demand models.

CHAPTER 3 – ASSUMPTIONS AND COORDINATION

The following subsections describe major assumptions underlying the model development. They also describe the coordination among INDOT, FHWA, the Indianapolis MPO, and other regional stakeholders.

3.1 Forecast Year

Forecasts of future year traffic are used determine the capacity need for the project and other affected transportation facilities. Traffic forecasts help determine interchange locations, interchange types, the need for turning lanes and the number of mainline through lanes. The forecast year for the I-69 Section 6 corridor model is 2045.

The current ISTDM has a 2035 forecast year. The ISTDM will be updated to a 2045 forecast year, but the timing of this update does not fit with the I-69 Section 6 FEIS schedule. The consultant team developed a 2045 version of the ISTDM for use on this project. The 2045 TAZ economic and employment data was developed by straight-line extrapolations of 2010 to 2035 trends from ISTDM.

3.2 Existing and Committed Projects

In the context of providing forecasts for a transportation project, a no-build network for the present or prior year reflects the existing transportation network in that year plus committed projects. All projects identified as funded for construction in a fiscally-constrained plan are considered to be committed and will be included in the 2045 no-build network. These are projects that that would be built would be constructed whether or not the project under consideration in the study is built. The build network for the future year includes the project under consideration (in this case, one of the I-69 Section 6 FEIS alternatives) in addition to the existing and committed projects included in the no-build network for that year. **Appendix B** of this report contains the list of projects added to the 2010 no-build network and the project included in the 2045 no-build network, and a memo that discusses the rationale for including projects in the 2045 no-build model network. A memo describing the sensitivity analysis performed for the I-69 Ohio River Bridge, which was not included in the 2045 horizon year model network, is included in **Appendix B** of this report.

3.3 Land Use and Demographic Forecasts

The model will forecast travel patterns for the year 2045 without and with Section 6 of I-69 complete.[1] These forecasts will be compared to year 2010 travel patterns. These 2045 no-build and build scenarios will assess future impacts of I-69 on regional traffic flows. Future no-build and build population and employment projections are key inputs to the model. No-build

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[1] *All 2045 forecasts assume Sections 1 to 5 of I-69 are completed and open to traffic.*

projections consider past development trends and assume that I-69 Section 6 is not be built. Build projections include added growth in population and employment along the I-69 corridor due to the completion of Section 6.

3.3.1 ISTDM Updates

For all counties except Marion, Morgan, Johnson and Hendricks, county-level control totals for 2045 were established for population using data from the Indiana Business Research Center, and for employment using Woods and Poole. Growth between the 2010 base year and 2045 forecast year were allocated according to the proportion of that TAZ's population or employment in 2010. Within the four counties mentioned earlier in the paragraph, the TAZ population and forecasts were based upon the corresponding forecasted increases in the corridor model (discussed in the section immediately following). Each ISTDM TAZ in these four counties is an aggregation of multiple corridor model TAZs. The 2045 forecasts in these four counties is the sum of the forecasts of the corresponding corridor model counties.

3.3.2 Corridor Model Updates

All corridor model TAZs are subdivisions of a single ISTDM TAZ. Outside of Morgan, Johnson, Marion and Hendricks counties, TAZ population and employment forecasts for 2045 were based upon the forecasted growth in the corresponding ISTDM TAZ.

A more detailed, focused effort was used to forecast growth in corridor model TAZs in Morgan, Johnson, Marion and Hendricks counties. In these counties, a land use allocation tool was deployed to spatially allocate the no-build future households and employment for the project's 2045 horizon year. CommunityViz, a land use modeling extension for ArcMap GIS software, automated the allocation of socioeconomic data to the I-69 corridor model's Traffic Analysis Zones (TAZs).[2] The I-69 corridor model has 1,524 TAZs in all of Hendricks, Johnson, Marion, and Morgan counties. The following methodology was used to develop and then allocate the future no-build household and employment growth.

3.3.2.1 Control Totals

The first step in forecasting future land use and demographic patterns was to identify the 2045 no-build total population and employment projections for each of the four study area counties. The growth in population and employment was calculated as the difference between these 2045 control totals and the 2010 totals from the U.S. Census. The 2045 control totals were obtained from the Indiana Business Research Center (IBRC) for population and Woods & Poole Economics, Inc. (W&P) for employment. The 2010 population and employment, and the 2045 control totals from these sources, are shown table below. CommunityViz allocated households (not population) to

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[2] *A Traffic Analysis Zone is a unit of geography utilized by the travel demand model to tabulate socioeconomic data and manage the assignment of trips to the model network.*

TAZs. Household size projections for the year 2045 were also obtained from Woods & Poole Economics, Inc. (W&P). The population control totals and the household projections for each county were used to calculate the number of households to allocate (see **Table 1**).

Table 1: Control Total by County

County	Population		Employment	
	2010	2045 (IBRC)	2010	2045 (W&P)
Hendricks	145,447	256,407	74,959	146,520
Johnson	139,654	198,076	65,149	135,372
Marion	903,393	1,048,383	642,525	818,562
Morgan	68,894	74,441	18,923	25,829

3.3.2.2 Geographical Information Systems (GIS) Analysis

A variety of GIS data were gathered for CommunityViz to allocate household and employment growth. First, several files representing constraints to future development were merged into a single GIS layer. These data included wetlands, floodways, parks/managed lands/golf courses, landfills, schools, cemeteries, quarries, airports, and Section 5 mitigation sites.[3] CommunityViz uses these GIS layers to identify where future development should not occur.

Next, a parcel layer[4] for each of the four counties was added to the CommunityViz model to calculate existing household and employment densities and the potential for future development. There are over 500,000 parcels total in the four counties, representing every residential, commercial, industrial, and government property in each county. The parcel layer includes a land classification identifier that places every parcel into one of seven major categories:

- Agricultural
- Severed Mineral Rights
- Industrial
- Commercial
- Residential
- Exempt Property

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[3] *Section 5 runs along existing SR 37 from Bloomington to Martinsville. Mitigation sites for Section 5 are located in both Monroe and Morgan counties. These mitigation sites were used in the constraints layer because they will not be developed in the future.*

[4] *The parcel layers were obtained from the IndianaMap Data Sharing Initiative between IGIC, Indiana Office of Technology (IOT), Indiana Geographic Information Office (GIO), Indiana Department of Homeland Security (IDHS), Indiana Geological Survey (IGS), Department of Local Government Finance, and Indiana Department of Natural Resources.*

- Taxable Land
- Improvements Owned by a Public Utility Company

The county parcel layers include information that can help identify whether each parcel already includes a structure or if it has space for new development. These parcel layers provide very detailed data for the current development densities and the potential area available for future development. By aggregating the 500,000 plus parcels into the 1,524 TAZs, CommunityViz can determine the amount of available space to allocate households and employment.

3.3.2.3 Future Land Use Maps

Finally, the Future Land Use Maps obtained from the Comprehensive Plans of each of the four counties were used to identify where future development is most likely to occur. These Future Land Use Maps show the planned allocation of development by land use type based on available infrastructure, available land, past trends, and other factors deemed relevant by that particular jurisdiction. A development suitability score was determined from the future land use maps and incorporated into the automated process used by CommunityViz. For example, areas identified for future high density residential development on the Future Land Use Maps received a high score for household allocation, whereas areas identified for future commercial development received a high score for employment allocation. CommunityViz then distributed new households and new employment to the TAZs based on the development suitability score and the amount of land available for development.

3.3.2.4 Land Use Panel Meetings

Land use panels (LUP) were convened for I-69 Section 6. There were four land use panels, one each for Marion, Morgan, Johnson and Hendricks County. The panel is composed of local economic development, land use planners and development professionals. The purpose of the land use panel is to assist the project team with allocating future household and employment growth into specific TAZs. CommunityViz allocates growth based on a variety of criteria. However, engaging local land use experts to review and ultimately validate the growth allocations has proven to be an effective step in the process.

The I-69 Section 6 project area has denser concentrations of population and employment than other areas of the I-69 project. In particular, it has areas where infrastructure already is in place or is reasonably certain to be provided to support increases in employment (and to a lesser extent, housing) within specifically targeted areas. Some of the larger reallocations of growth in employment and population reflect the land use panels' knowledge of these locations.

Summaries of the two land use panel meetings (held on September 29, 2015 and February 29, 2016) are provided in **Appendix G** of this document.

Land Use Panel Meeting #1 - September 29th, 2015

The first land use panel meeting focused on employment and household growth for the 2045 no-build scenario. In the no-build scenario I-69 Section 6 would not be constructed, while Sections 1 through 5 are completed and open to traffic.

During and after the land use panel meeting, the initial no-build allocation of households and employment was reviewed and shifted using the LUP's feedback. The LUP provided this feedback based on its members' understanding of current and future growth. As described above, the initial allocation was based on a Land Use Model that used parcel data which indicated the households and employment that could potentially be added to each TAZ. The model also determined the most suitable locations for future development based on the Future Land Use maps of each county. Because the households and employment totals for 2045 were based on countywide control totals, the LUP was asked to shift households and employment growth between TAZs only within counties. Adding households or employees to the county control totals was not part of this exercise. Any amount subtracted from one TAZ was offset by amounts added to other TAZs, signifying a shift between TAZs within counties. As noted, county control totals for households and employees were not changed. The LUP was asked to shift growth in households, industrial employment, and commercial (non-industrial/non-government) employment for the no-build scenario. The information gathered from this meeting was used to re-allocate 2045 no-build TAZ employment and household forecasts.

A brief summary of the meeting's findings is presented below:

- Morgan County – Panel members suggests that the employment and household forecasts should be re-allocated. They noted employment forecasts were too high in Martinsville and along SR 37 and too low in Mooresville.
- Johnson County – Only minor revisions were recommended for these forecasts. Johnson County is also in the process of re-doing its Future Land Use Map for its Comprehensive Plan. The group focused on re-allocating employment growth near Greenwood and Franklin. The panel members suggested the residential growth near Bargersville is too low.
- Marion County – Employment growth is more likely to occur in downtown Indianapolis, while residential growth will likely occur outside the core of downtown.
- Hendricks County – The allocation from the model is fairly accurate. A suggestion was made to split the TAZ that includes the outdoor mall into two zones. The group also focused employment growth around the airport due to avoiding growth which would affect Indiana bat hibernacula.

Land Use Panel Meeting #2 - February 29th, 2016

The purpose of the second land use meeting was to allocate the forecasted "induced growth". The induced growth is the further increase in households and employment between 2010 and 2045 that occurs due to additional economic development triggered by the completion of I-69 Section 6.

A key technical tool used to forecast induced population and employment (as well as to compute economic development benefits) is TREDIS. TREDIS documentation and results are discussed in detail in **Appendix D** of this report. TREDIS forecasted induced population and employment for Johnson, Morgan, Marion and Hendricks counties. TREDIS provided two forecasts of induced population and employment, which included and excluded an Ohio Street interchange in Martinsville.

Appendix D of this report details how induced growth was allocated to the four study area counties. Each LUP was asked to allocate the total countywide growth within its respective county. Panel members from Morgan County were asked to perform two induced growth allocations – one assuming an interchange is provided at Ohio Street in Martinsville, and one assuming that interchange is not provided. In addition to allocating induced growth, the panel members also had an opportunity to redistribute no-build growth (already allocated during the first land use panel meeting) due to the completion of I-69 Section 6.

A brief summary of the meeting’s findings is presented below:

- Hendricks County – Panel members allocated all of the induced growth to the southeastern portion of the county, noting that the areas around the airport and I-70 would benefit most from the completion of I-69 Section 6. It was determined that a re-allocation of no-build growth would not be appropriate due to the completion of I-69 Section 6.
- Johnson County –The induced growth was allocated either along I-69, between Smith Valley Road and County Line Road, or along County Road 144, east of I-69. It was determined that a re-allocation of no-build growth would not be appropriate due to the completion of I-69 Section 6.
- Marion County – All of the induced growth was allocated to TAZs in the southwestern portion of the county, close to I-69. The panel members assumed that Southport Road would be upgraded west of the I-69 corridor and would attract the majority of the induced growth. It was determined that a re-allocation of no-build growth would not be appropriate due to the completion of I-69 Section 6.
- Morgan County – The induced growth was generally split 50/50 between Martinsville and the area around I-69 and SR 144. If an interchange is included at Ohio Street, the City of Martinsville will get a larger proportion of the induced growth than the northern portion of Morgan County. No-build growth was re-allocated from the area around Mooresville and I-70 to Martinsville and near interchanges along I-69.

3.4 INDOT, FHWA and MPO Coordination

As of December 21, 2016, a total of eleven meetings have been held between the HNTB team and INDOT, FHWA and the Indianapolis MPO. These meetings were held to coordinate I-69 modeling efforts with the Indianapolis MPO and its ongoing travel forecasting. These meetings also were held so that FHWA Indiana Division and technical staff from the FHWA Resource Center could provide input to model development. Both managerial and technical staff have been involved in these meetings.

Appendix A of this report contains the detailed summary for each meeting. Following is a short summary of each meeting. The header for each meeting indicates the entities participating.

March 16, 2015 (INDOT, Indianapolis MPO, HNTB, Lochmueller Group)

This meeting discussed interim forecasts for conceptual alternatives of the I-69 Section 6 project. TAZ forecasts for 2045 were made using straight-line extrapolations of 2010 to 2035 trends from ISTDM. Similarities and differences of 2035 forecasts between ISTDM and Indianapolis MPO models were discussed. INDOT noted that it was at least six to eight months from beginning work to update ISTDM to a 2045 forecast year. HNTB team was tasked with providing proposed methodology to update ISTDM and I-69 corridor model to 2045 forecast year prior to INDOT work. Indiana Business Research Center and Woods & Poole were identified as sources for control totals. Also discussed was use of TREDIS to forecast growth, along with use of land use panels to allocate growth forecasts.

April 22, 2015 (INDOT, Indianapolis MPO, FHWA, HNTB, Lochmueller Group)

The 2010 base year validation for the I-69 corridor model was discussed. It also was determined that neither the Indianapolis MPO nor INDOT would be updating their models in a timeframe to meet the schedule of the I-69 Section 6 project. Accordingly, the HNTB team was designated to provide 2045 TAZ forecasts for this project. Various assumptions regarding added capacity projects for a 2045 forecast year were discussed.

May 26, 2015 (INDOT, Indianapolis MPO, FHWA, HNTB, Lochmueller Group)

INDOT and FHWA decided to evaluate alternatives outside of the Tier 1 selected SR 37 corridor. The approaches to modeling a range of conceptual alternatives and preliminary modeling results for representative conceptual alternatives were discussed. Assumptions for the 2045 no-build network were reviewed. Validation statistics for the 2010 base year corridor model were reviewed. Also reviewed were sensitivity analyses for assumptions regarding I-465 widening and the I-69 Ohio River Bridge. Preliminary assumptions regarding year 2045 population and employment forecasts were reviewed.

December 16, 2015 (INDOT, Indianapolis MPO, FHWA, HNTB, Lochmueller Group)

This meeting reviewed the 2045 no-build demographic forecasts prepared by Lochmueller Group. The roles of the land use panels and the CommunityViz tool were discussed. The MPO and INDOT stated that the proposed 2045 no-build demographic forecasts were acceptable and did not require modification.

March 17, 2016 (INDOT, Indianapolis MPO, FHWA, HNTB, Lochmueller Group)

In addition to staff from the FHWA Indiana Division, staff from the FHWA Resource Center participated in this meeting. The allocation of induced population and employment due to the I-69 project was discussed. The MPO and INDOT stated that the proposed 2045 demographic forecasts including induced population and employment were acceptable and did not require modification. FHWA staff discussed the importance of reasonable consistency between MPO and INDOT/I-69 forecasts.

March 22, 2016 (INDOT, Indianapolis MPO, FHWA, HNTB, Lochmueller Group)

The purpose of this meeting was to address questions from FHWA Resource Center related to the model structure and development. The discussion topics included how the corridor model differs from a classic four-step model, integration with ISTDM, validation, truck assignments, and time-of day forecasting.

May 31, 2016 (INDOT, Indianapolis MPO, FHWA, HNTB, Lochmueller Group)

This meeting reviewed specific facilities where forecasts are particularly important. This included I-465 between I-70 and I-65, as well as freeways and arterial roads intersecting this portion of I-465. Maps showing traffic volumes and recent counts were provided and reviewed. Significant construction activities at several locations over a multi-year period resulted in significant year-to-year variability in traffic counts. Several follow up actions, such as select link analyses and comparison of passenger car equivalents, were recommended to the project team. INDOT identified specific links whose forecasted volumes should be further evaluated.

July 25, 2016 (INDOT, HNTB, Lochmueller Group)

This meeting addressed specific questions posed by INDOT in e-mail correspondence earlier in July. Key items reviewed included daily truck volumes at external stations, daily truck volumes at key interstate locations, traffic volumes on US 31, and factors used to calculate passenger car equivalents. The meeting concluded with agreements that forecasts which were reviewed were appropriate for use in the FEIS.

July 26, 2016 (Indianapolis MPO, HNTB, Lochmueller Group)

The meeting addressed specific questions posed by the Indianapolis MPO in e-mail correspondence earlier in July. The discussions centered on corridor model truck volumes and factors used to calculate passenger car equivalents. Truck forecasts between the ISTDM and corridor model generally were similar except in the vicinity of Indianapolis International Airport. It was agreed that zones and traffic loading in the vicinity of Indianapolis International Airport will be revisited.

October 5, 2016 (INDOT, FHWA, HNTB, Lochmueller Group)

The meeting reviewed several topics. Lochmueller Group discussed the coordination history with the Indianapolis MPO and INDOT. This discussion focused on the relationship between the ISTDM and the I-69 corridor model, year 2045 household and employment forecasts, and generation of peak hour forecasts. The team is addressing variability in counts used for model validation, especially along I-465, by using an appropriate level of engineering judgment to address significant year-to-year variations in traffic counts. There was significant construction on freeways and arterials in Indianapolis. Traffic patterns were impacted to such an extent that there is not a clear “normal” year for traffic.

December 21, 2016 (INDOT, FHWA, HNTB, Lochmueller Group)

FHWA Resource Center commented that overall the model documentation was thorough and captured important details of the modeling process. Its staff also suggested additional analyses and documentation which could be provided in the FEIS. It also suggested the documentation (this appendix) include tables and maps summarizing the forecast results. This suggestion was accommodating by adding **Appendix E** (Travel Forecast Results) to this documentation. There also was a discussion of how best to characterize LOS congestion measures when comparing the no build and built networks in several parts of the project area.

CHAPTER 4 – CORRIDOR MODEL STRUCTURE

4.1 Roadway Network

The updated corridor model's study area focuses only on the areas for which traffic is most significantly influenced by I-69 Section 6 (see **Figure 1**). This focused study area includes the four-county region; Hendricks, Marion, Morgan, Johnson counties. The model area also includes all or portions of Boone, Brown, Greene, Hamilton, Hancock, Lawrence, Monroe, Owen, and Putnam counties.

The model's roadway network in the subarea study area was developed from the Section 5 corridor model network. The I-69 Section 6 corridor model network includes over 4,000 miles of roadway, with increasing network detail closer to the I-69 corridor. The model network was updated for 2010 based on a thorough review of local transportation plans and aerial photography.

The network also includes over 1,400 traffic signals, which were verified from recent aerial photography and Google Street View (if needed). Updated free flow speed and capacity calculation routines were also implemented which include logic to impute the locations of stop signs and link capacity calculations based on the produces recommended in the Highway Capacity Manual (HCM) 2010.[5] INDOT and local agencies transportation plans were reviewed to develop the 2045 model network.

4.2 Zone System

The I-69 Section 6 corridor model contains socioeconomic data in a system of 2,109 TAZs covering over 2,520 square miles, as shown in **Figure 2**. The zones contain demographic information aggregated from 2010 Census blocks and block group data from the American Community Survey. Demographic variables include information on the total, household and group quarters population, the number of households and average household size, number of workers, number of vehicles, number of students, and percentage of households with seniors. Estimates of employment in seven industry groups (Agriculture, Mining and Construction; Manufacturing, Transportation, Warehousing and Utilities; Retail Trade; Food and Lodging; Finance, Insurance, Real Estate, Information, Medical and other Professional Services; Other Services; and Government) were developed by disaggregating U.S. Bureau of Economic Analysis county employment totals by industry based on the locations of employment by industry from a proprietary database purchased from InfoGroup[6] for 2010 conditions. The zones also contain an estimate of sidewalk coverage, and of other variables related to urban form, such as the density

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[5] *HCM 2010 is a publication of the Transportation Research Board of the National Academies of Science in the United States. It is the standard reference for transportation and traffic engineering practitioners for computing capacity and quality of service on highways.*

[6] *InfoGroup collects information on people and businesses worldwide using a variety of sources. Its database contains information on 15.5 million businesses, and 210 million consumers.*

and connectivity of the full street network, based primarily on available GIS layers. The location and enrollment for K-12 schools was updated based on information from the state department of education, and information on the enrollment and parking locations for post-secondary institutions was developed through available online information and contacting those institutions directly when necessary.

Details of populating the zone system are provided in the Land Use and Demographics section.

Figure 1: I-69 Subarea Corridor Model within the Indiana Statewide Travel Demand Model

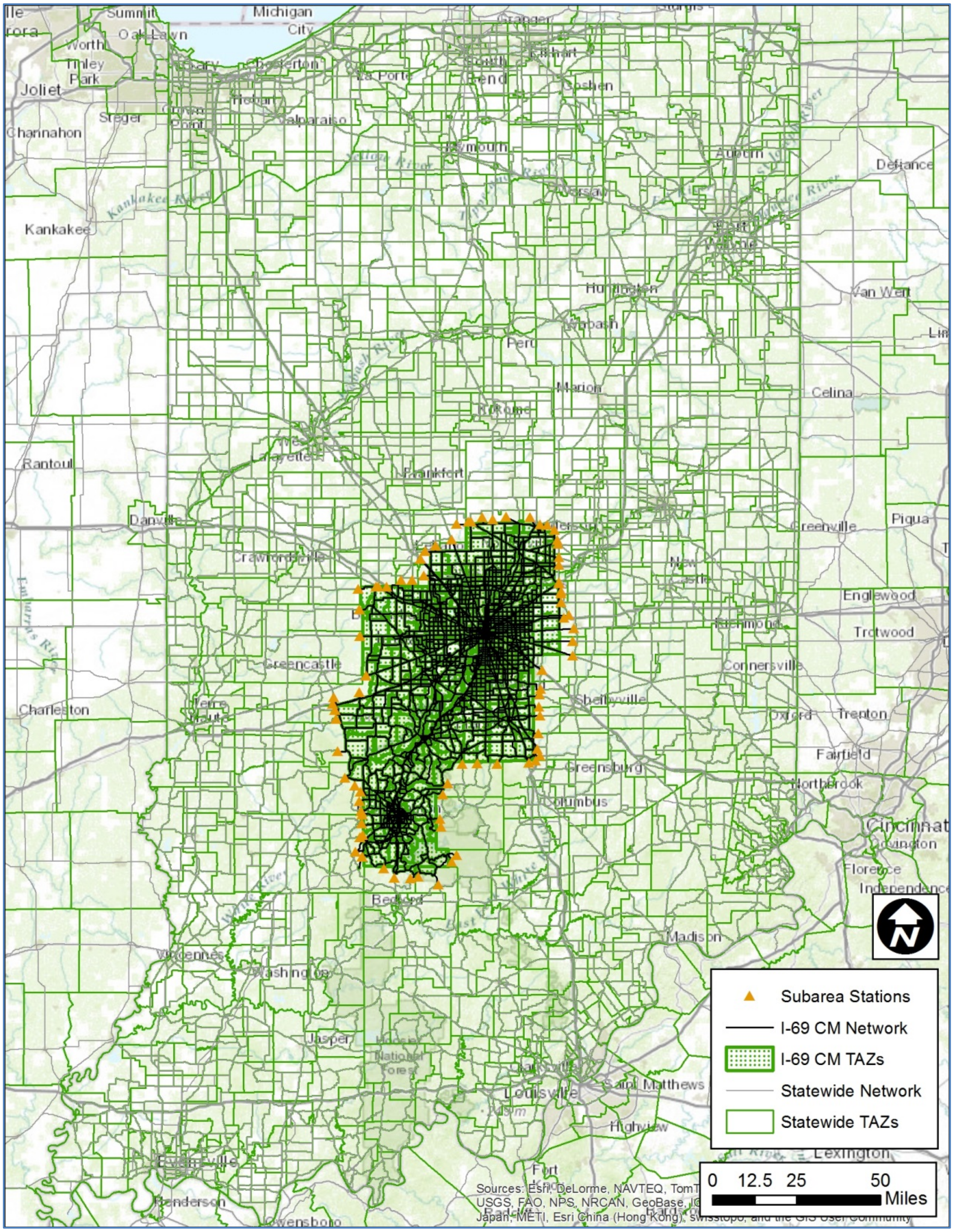
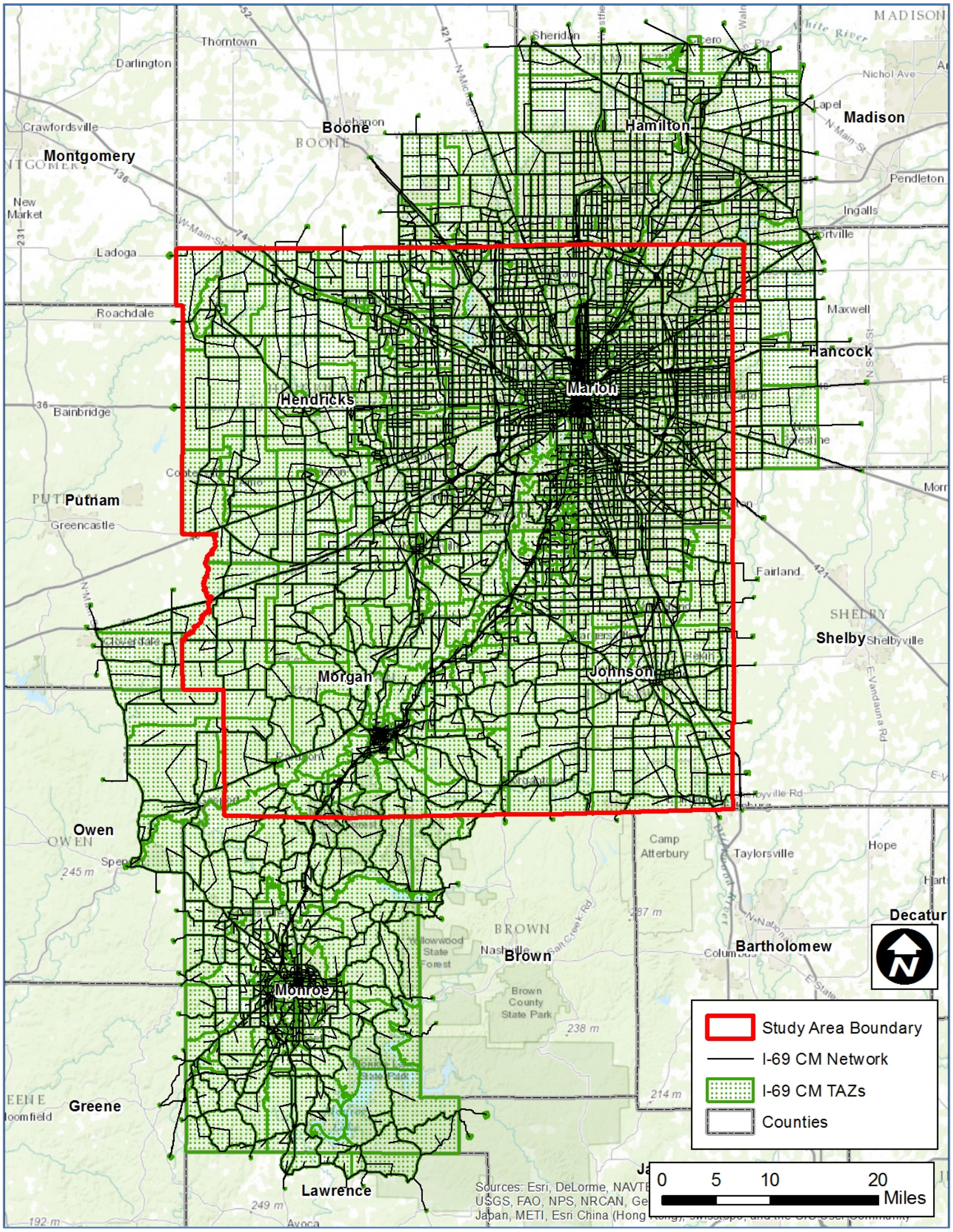


Figure 2: I-69 Corridor Model Network and Zone Detail



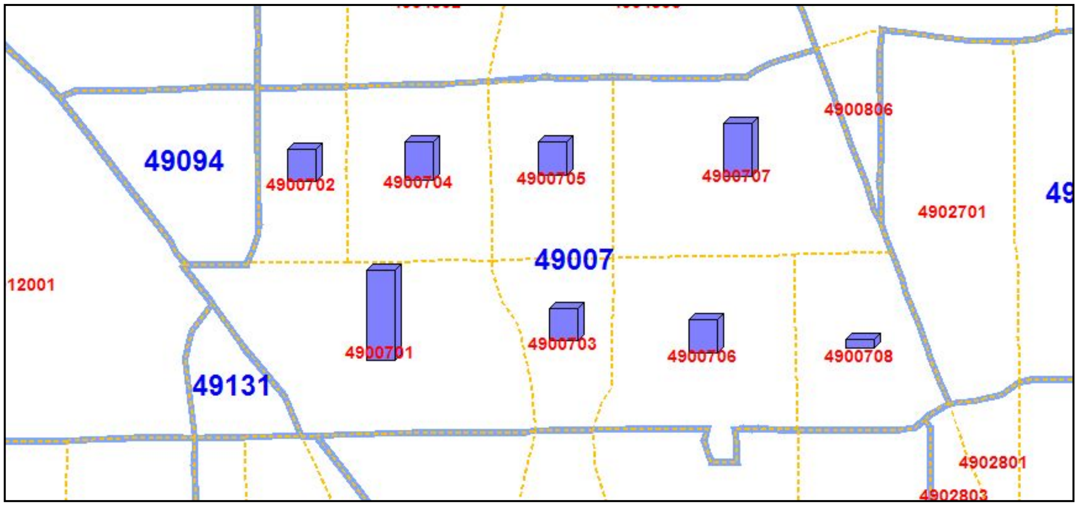
Sources: Esri, DeLorme, NAVTEQ, USGS, FAO, NPS, NRCAN, GeoBase, Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

4.3 Long Distance Demand Extraction from the Statewide Model

The I-69 Section 6 corridor model utilizes the ISTDM to derive external trip volumes in the same manner as the Section 5 corridor model. The corridor model disaggregates the statewide model's demand to a more detailed zone system and network within the corridor for longer distance trips that cross the subarea cordon[7], but local trips with both trip ends within the subarea are generated and modeled entirely by the corridor model. The rationale for this general approach is that the statewide model is specifically developed and best suited to model long distance travel, including the large majority of truck travel; whereas, local daily travel can be modeled more realistically within the corridor model using a hybrid trip-based/tour-based methodology. This methodology can better account for mode choice and trip chaining, decisions such as when travelers make a stop on their way to work or visit several shopping locations before returning home.

Subarea trip tables by vehicle class (private automobiles, four-tire commercial vehicles, single unit trucks and multi-unit trucks) are extracted from the statewide model, but different parts of these origin-destination matrices are used in different ways. The portion of the trip table matrices from the statewide model representing trips between subarea stations (external-external (E-E)[8] trips passing through the corridor subarea) are used directly to represent external through trips in the corridor model. The portion of the trip table matrices from the statewide model representing trips with both origin and destination within the corridor subarea (I-I) are dropped and replaced by trips developed within the corridor model as described in the subsequent section. The two portions of the trip table matrices representing trips with either their origin or destination (but not both) in the

Figure 3: Derivation of Subarea Inbound/Outbound Trip Table (1)



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[7] *The "subarea cordon" is the boundary that encloses the area of the model to be included in the corridor model.*

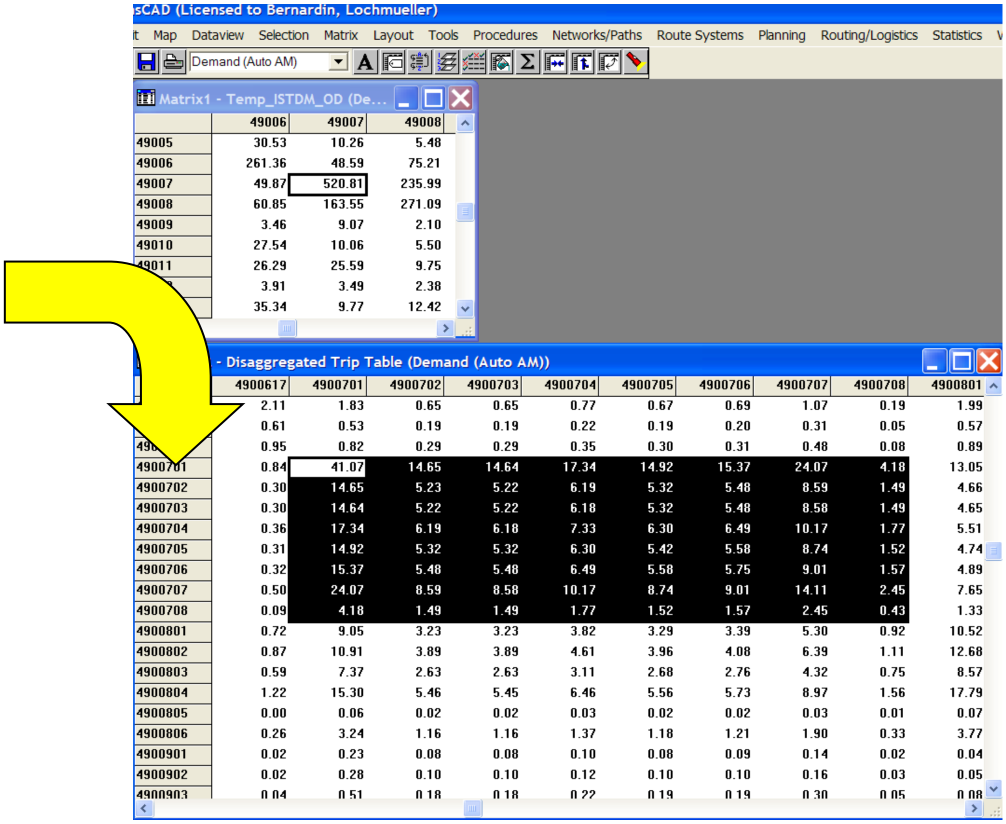
[8] *Trips which originate and end outside of the corridor model boundary while passing through it are designated as external-external (E-E) trips. Trips entirely within the corridor model boundary are designated as internal-internal (I-I) trips. Trips with one trip end within and the other trip end outside of the corridor model boundary are designated at internal-external (I-E) trips.*

corridor subarea (I-E) are disaggregated from the statewide model zone system to the corridor model zone system (which nests within the statewide model zones) on the basis of estimated trip productions and attractions. This process, whereby each row and column in the matrix indexed by statewide model zones becomes one or more rows/columns in the matrix indexed by the corridor model zones, is the same as in the previous corridor model, as illustrated in **Figure 3** and **Figure 4.** This general architecture was implemented for linking the statewide model (ISTDM v7) and the I-69 Section 6 corridor model for trucks.

For autos, the external to internal trips with one trip end outside of the corridor model were based on the magnitude obtained from the ISTDM, but re-distributed by using a gravity model within the corridor model.

In summary, the result of this process is that longer distance travel patterns (including E-E truck trips, E-I truck trips, and E-E auto trips) within the corridor model are taken fairly directly from the statewide model. The magnitude of E-I auto traffic is also taken from the statewide model, but the distribution is performed by the corridor model. The local traffic entirely within the corridor model (I-I trips) is forecasted by a separate process described in the sections that follow.

Figure 4: Derivation of Subarea Inbound/Outbound Trip Table (2)



	49006	49007	49008
49005	30.53	10.26	5.48
49006	261.36	48.59	75.21
49007	49.87	520.81	235.99
49008	60.85	163.55	271.09
49009	3.46	9.07	2.10
49010	27.54	10.06	5.50
49011	26.29	25.59	9.75
	3.91	3.49	2.38
	35.34	9.77	12.42

	4900617	4900701	4900702	4900703	4900704	4900705	4900706	4900707	4900708	4900801
	2.11	1.83	0.65	0.65	0.77	0.67	0.69	1.07	0.19	1.99
	0.61	0.53	0.19	0.19	0.22	0.19	0.20	0.31	0.05	0.57
49	0.95	0.82	0.29	0.29	0.35	0.30	0.31	0.48	0.08	0.89
4900701	0.84	41.07	14.65	14.64	17.34	14.92	15.37	24.07	4.18	13.05
4900702	0.30	14.65	5.23	5.22	6.19	5.32	5.48	8.59	1.49	4.66
4900703	0.30	14.64	5.22	5.22	6.18	5.32	5.48	8.58	1.49	4.65
4900704	0.36	17.34	6.19	6.18	7.33	6.30	6.49	10.17	1.77	5.51
4900705	0.31	14.92	5.32	5.32	6.30	5.42	5.58	8.74	1.52	4.74
4900706	0.32	15.37	5.48	5.48	6.49	5.58	5.75	9.01	1.57	4.89
4900707	0.50	24.07	8.59	8.58	10.17	8.74	9.01	14.11	2.45	7.65
4900708	0.09	4.18	1.49	1.49	1.77	1.52	1.57	2.45	0.43	1.33
4900801	0.72	9.05	3.23	3.23	3.82	3.29	3.39	5.30	0.92	10.52
4900802	0.87	10.91	3.89	3.89	4.61	3.96	4.08	6.39	1.11	12.68
4900803	0.59	7.37	2.63	2.63	3.11	2.68	2.76	4.32	0.75	8.57
4900804	1.22	15.30	5.46	5.45	6.46	5.56	5.73	8.97	1.56	17.79
4900805	0.00	0.06	0.02	0.02	0.03	0.02	0.02	0.03	0.01	0.07
4900806	0.26	3.24	1.16	1.16	1.37	1.18	1.21	1.90	0.33	3.77
4900901	0.02	0.23	0.08	0.08	0.10	0.08	0.09	0.14	0.02	0.04
4900902	0.02	0.28	0.10	0.10	0.12	0.10	0.10	0.16	0.03	0.05
4900903	0.04	0.51	0.18	0.18	0.22	0.19	0.19	0.30	0.05	0.08

4.4 Hybrid Tour-based Local Demand within the Corridor

The demand for local travel within the corridor subarea is estimated within the corridor model using a hybrid tour-based approach. This approach combines aspects of traditional trip-based modeling with more advanced disaggregate tour-based methods used in activity-based models. The approach has been fully implemented by MPOs in Indiana (Evansville MPO, Michiana Area Council of Governments and Columbus MPO) and Tennessee (Knoxville TPO) after a preliminary application in Arkansas (Fayetteville-area model for the Northwest Arkansas Regional Planning Commission). The methodology has also been the subject of multiple published, peer-reviewed journal articles[9] and a webinar by the FHWA's Travel Model Improvement Program.[10]

The hybrid process, illustrated in **Figure 5**, begins by generating a synthetic population of individual households based on the aggregate characteristics of the population encoded in the zones. Then a model predicting households' level of vehicle ownership is applied. The number of tours (round trips beginning and ending at home) for various primary purposes (work, school, other) and the number of stops on those tours are predicted for each household. The dominant mode of travel (private automobile, school bus, public bus, walking, biking) is chosen for the household's tours for each purpose. Then, for automobile tours, grouping households within the same TAZ together in two basic market segments, probable locations of the stops on automobile tours are chosen. Next, for each probable stop location, a preceding location is chosen so that the resulting probable sequences of stops form tours that begin at home and proceed from one stop to the next until returning home. For each trip in the resulting travel pattern, the probability of walking, driving alone, or driving with passengers is predicted, as is the departure time (in 15-minute periods). Finally, the trips are assigned to the roadway network and routes are chosen so that travelers minimize their travel time and costs. The resulting travel times are used to recalculate accessibility variables that reflect congestion, and both are then fed back and used to repeat the process.

The TransCAD GISDK script for the I-69 corridor model's hybrid components was adapted from the Section 5 model and calibrated to local travel data for the corridor. This particular implementation of the hybrid approach uses three basic tour types (work, school and other) and seven stop or activity types (work, school, personal business, shop, eat out, social recreation, and pick-up/drop-off).

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[9] *The following three articles related to the hybrid tour-based travel forecasting methodology appeared in peer-reviewed journals:*

Enhanced Destination Choice Models Incorporating Agglomeration Related to Trip Chaining While Controlling for Spatial Competition. Bernardin, V., F. Koppelman & D. Boyce. Transportation Research Record: Journal of the Transportation Research Board, No. 2132, Transportation Research Board of the National Academies, Washington, DC, 2009, pp. 143-151.

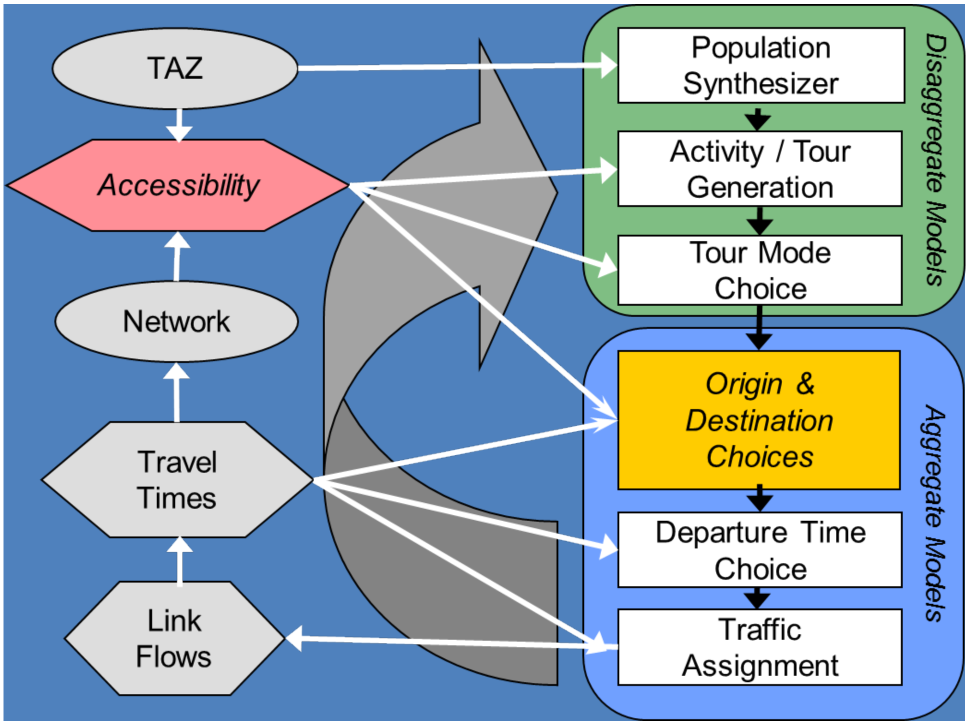
Hierarchical Ordering of Nests in a Joint Mode & Destination Choice Model. Newman, J. & V. Bernardin. Transportation, Vol. 37, No. 4, 2010, pp. 677-688.

From Academia to Application: Results from the Calibration and Validation of the First Hybrid Accessibility-based Model. Bernardin, V. and M. Conger. Transportation Research Record: Journal of the Transportation Research Board, No. 2176, Transportation Research Board of the National Academies, Washington, DC, 2010, pp. 50-58.

[10] *FHWA's Travel Model Improvement Program (TMIP) originally delivered 3/9/2010) http://www.fhwa.dot.gov/planning/tmip/community/webinars/summaries/20100309/index.cfm*

The following section describes each component of the hybrid model process in more detail and gives the model specifications for each component.

Figure 5: Hybrid Tour-based Travel Forecasting System



4.4.1 Population Synthesis

In recent years, there has been a shift away from the application of demand models directly to traffic analysis zones in favor of representing individual households (and sometimes persons) and modeling travel behavior at their level.[11] The shift is driven by the fact that people travel, not zones. Technically, the shift is to avoid the aggregation bias that occurs when non-linear demand models (such as logit models) are applied to aggregate or average characteristics rather than to populations with a range of attributes around their group averages. For example, a mode choice model may predict no significant transit mode share when applied to a zone with 100 households with an average of 2.2 cars per household. However, the same mode choice model, applied to the same households individually, may predict a significant number of transit trips if five of the households have no vehicles and 15 have only one vehicle. Examples like this illustrate that the effects of aggregation bias can be quite significant and have helped motivate the shift to modeling disaggregate synthetic populations. The inputs and outputs for the Population Synthesizer are presented below:

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[11] *National Cooperative Highway Research Program Report 716. Travel Demand Forecasting Parameters and Techniques. Transportation Research Board of the National Academies, Washington, DC, 2010, Chapter 6: Emerging Model Practices.*

- Primary Inputs
  - Zonal Average Household Size
  - Zonal Average Workers per Household
  - Zonal Average Students per Household
  - Zonal Percent of Households with Seniors
  - Zonal Average Household Income
- Secondary Inputs
  - Population Density
  - Percent of Zone within 0.5 mi of Bus Route
  - Urban Design Factor Output
- Synthetic households for each TAZ with
  - Number of persons
  - Number of workers
  - Number of students
  - Presence of seniors
  - Income Group (quartiles)

The I-69 corridor model generates a disaggregate synthetic population of households based on the demographic information associated with the traffic analysis zones. For each zone, individual households are created. Each household has a total number of persons, a number of workers and of students, a number of seniors (residents over the age of 65) and an income variable that indicates which income range the household belongs to: Q1 (under $25,000/year), Q2 ($25,000-$45,000/year), Q3 ($45,000-$75,000/year) or Q4 (over $75,000/year). For the whole corridor model area in 2010, income ranges 1,2,3 and 4 represented 30%, 26%, 24%, and 21% of all households respectively. The number of vehicles available to each household is modeled separately, after population synthesis, based on these household characteristics and other zone-based variables in which the household is located.

The synthetic population is developed in two steps. First, a set of ordered response logit models for each variable (household size, number of workers, etc.) predicts the number of households of each degree of the variables (one person, two persons; zero workers, one worker, two workers, etc.). Second, iterative proportional fitting is used to develop the synthetic population based on a seed population of households and the marginal distributions for each variable provided by the logit models. Unlike the procedures used to develop synthetic populations in many activity-based models, this procedure is entirely deterministic and does not introduce randomness or simulation error into the model through the use of any random draws. This is possible since it is allowed to produce more (or less) individual households than exist in the real population, creating consistency by weighting the households so that their weighted sum is the total actual number of households in each zone.

4.5 Ordered Response Logit Models of Marginal Distributions

Aggregate ordered response logit (ORL) models were developed to model the discrete distributions of each household characteristic variable noted above. These models essentially replace the stratification curves used in many traditional travel models to cross-classify households for trip generation. The models are fairly simple, largely driven by the aggregate zonal average variable describing the distribution which they represent (e.g., the model which determines the number of households with zero, one, two or three or more workers is driven largely by the zonal average number of workers per household).

Ordered response logit models are a special form of nested logit models designed to accommodate the correlation pattern typical of ordinal data, such as the number of persons, workers, etc., in a household. They were tested against simpler multinomial logit models, which assume independence across alternative categories and, in each case, the ordered response model provided better goodness-of-fit to the observed data. Easy Logit Modeling (ELM)[12] was used for all logit model estimation.

To ensure consistency with the zonal averages, the models also include “shadow prices” which guarantee the average characteristics of the synthetic population will agree with averages for each zone. The concept of shadow prices is taken from economics and optimization science. Technically, they are lagrangian multipliers associated with constraints in an optimization problem, in this case, constraints that the observed zonal averages be reproduced.

Conceptually, consider the situation in which the basic relationship between the demand and price for some good is known (from various observations), yet for some other observation(s), the demand is lower than what is predicted based on the known relationship with its price. One way this situation can be addressed, if there is confidence in the basic demand function and the contrary observations, is that an additional, unobserved “shadow price” in addition to the observed price can be postulated to account for the observed demand. This shadow price becomes an additive correction term in the demand function.

In these models, the formula for the shadow prices added to the utility function of alternatives less than the true zonal average is given:

$$s_i = s_{i-1} + (TrueAvg - AltAvg)\ln(EstAvg_{i-1}/TrueAvg)$$

or, for alternatives greater than the true zonal average:

$$s_i = s_{i-1} + (TrueAvg - AltAvg)\ln(TrueAvg/EstAvg_{i-1})$$

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[12] *Easy Logit Model (ELM) was software used for all logit model estimation during this project.* http://elm.newman.me

where *TrueAvg* is the zonal average from the TAZ geographic layer, $EstAvg_{i-1}$ is the resulting zonal average in iteration $i-1$, and *AltAvg* is the average for that alternative (generally equal to the alternative number, except for the last category, e.g., 5+ persons, 3+ workers, etc.).

The models also include some other, secondary demographic variables which are related to the distributions of the primary variable as well. For instance, even for a given average number of students per household for a zone, the number of zero student households is generally greater in zones with more households with seniors (age 65 and older), all other factors being equal.

The model parameters, t-statistics and goodness-of-fit measures are shown in **Table 2** through **Table 5**. The goodness-of-fit of these models is generally quite low, which is not unusual or unexpected for models of disaggregate phenomena based on aggregate variables. However, a reasonable level of confidence can still be had in the synthetic populations which they produce since they are both constrained to agree with zonal average characteristics (through the use of shadow prices) and only applied to factor the observed seed distribution in the subsequent round of iterative proportional fitting. The implied distribution of households (assuming regional average secondary zonal demographic characteristics) before the application of shadow prices are shown in **Figure 6** through **Figure 9**. While the need for the shadow prices is evident for extreme zonal averages, the distributions are clearly reasonable.

The ordered response logit models are applied in TransCAD using its Nested Logit Application module. This produces a table with probabilities for each alternative category. A simple GISDK script converts these probabilities into the marginal distribution of households by zone needed for input for iterative proportional fitting.

Table 2: Aggregate Ordered Response Logit Model for Households

Household Size	Alternative	Parameter
-- Logsum Parameters		
Nest_1	Size_2, Nest_2	0.5
Nest_2	Size_3, Nest_3	0.25
Nest_3	Size_4, Size_5	0.125
-- Alternative Specific Parameters		
CONSTANT	Size_1	3.85
CONSTANT	Size_2	0.43
CONSTANT	Size_4	0.15
CONSTANT	Size_5	0.07
Zonal Average Household Size	Size_1	-1.8173
Zonal Average Household Size	Size_2	-0.2513
Zonal Average Household Size	Size_4	-0.1133
Zonal Average Household Size	Size_5	-0.1499
Zonal Average Household Students	Size_4	0.6335
Zonal Average Household Students	Size_5	0.6848
Zonal Average Household Seniors	Size_2	0.731
Zonal Average Household Size, Squared	Size_4	-0.0313
Zonal Average Household Size, Squared	Size_5	-0.0313

Figure 6: Percent of Households by Number of Persons vs. Zonal Average Household Size (before shadow prices)

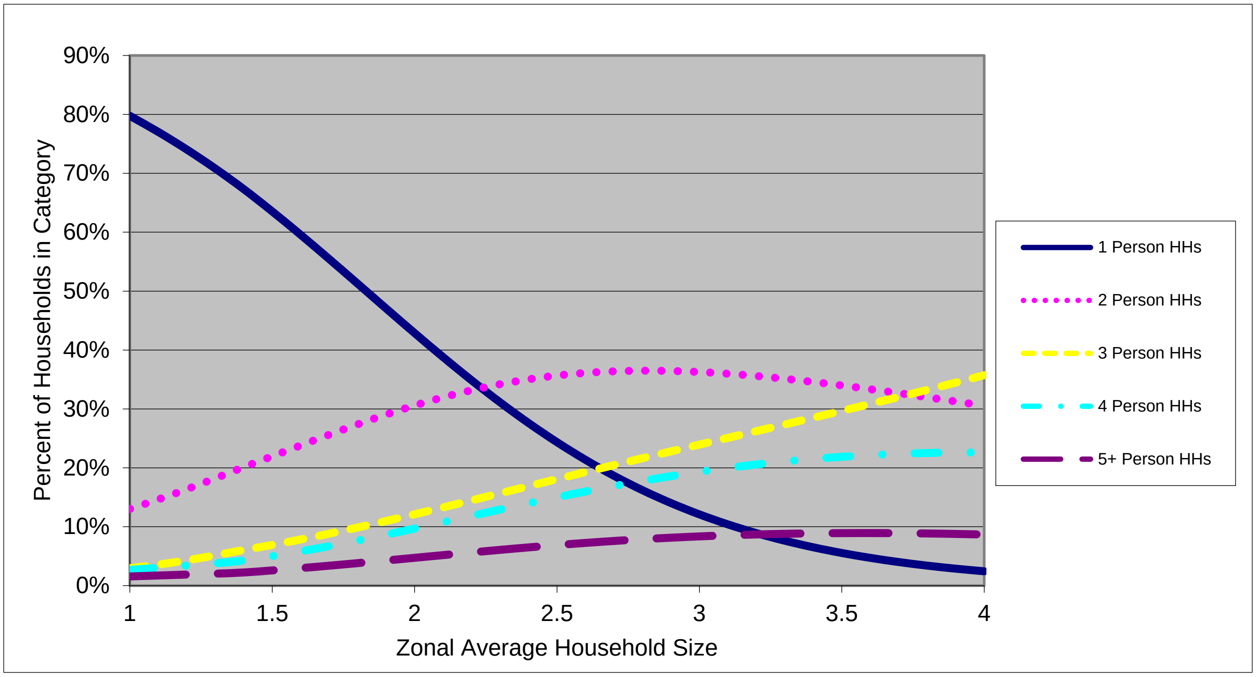


Figure 7: Percent of Households by Number of Workers vs. Zonal Average Household Workers (before shadow prices)

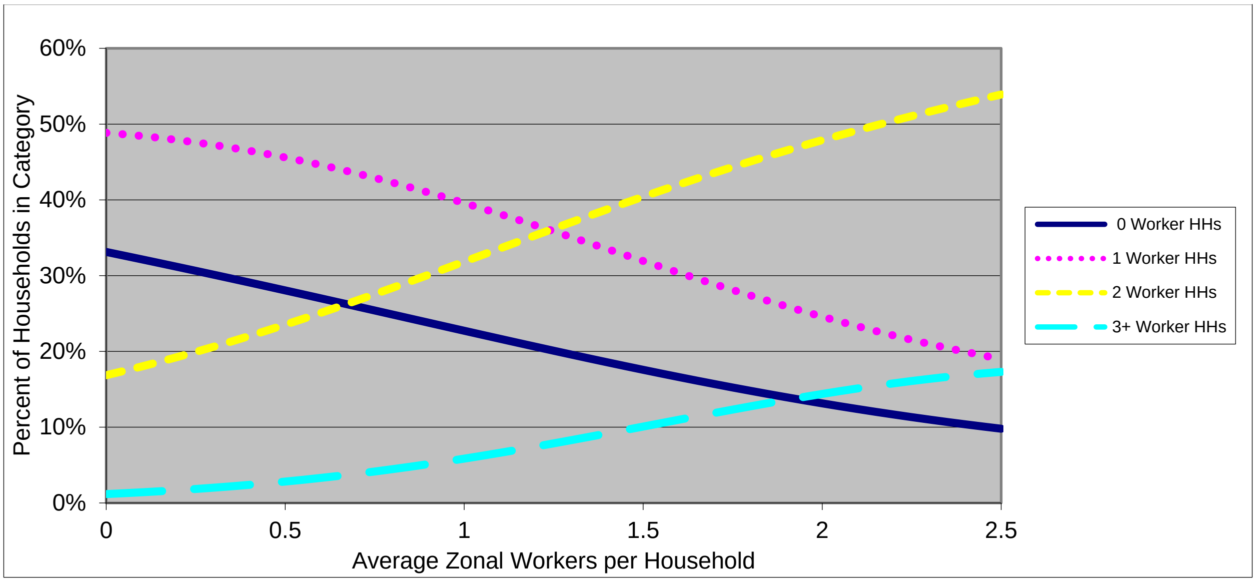


Table 3: Aggregate Ordered Response Logit Model for Household Workers

Household Workers	Alternative	Parameter
-- Logsum Parameters		
Nest_1	alt_1, Nest_2	0.6
Nest_2	alt_2 and alt_3	0.4
-- Alternative Specific Parameters		
CONSTANT	alt_0	-1.3904
CONSTANT	alt_2	-0.625
CONSTANT	alt_3	-1.6916
Zonal Average Household Workers	alt_0	-0.3085
Zonal Average Household Workers	alt_2	0.4607
Zonal Average Household Workers	alt_3	0.9455
Zonal Average Household Seniors	alt_0	3.7267
Population Density	alt_0	0.0827
Zonal Average Household Workers, Squared	alt_2	0.096
Zonal Average Household Workers, Cubed	alt_2	-0.0285

Figure 8: Percent of Households by Number of Students vs. Zonal Average Students per Household (w/o shadow prices)

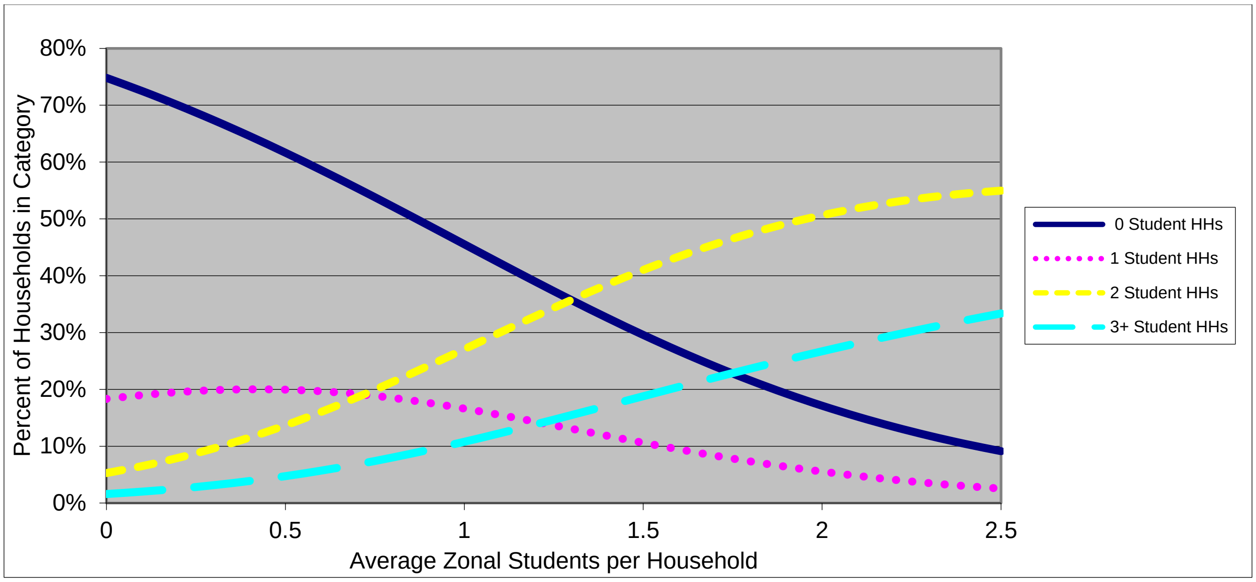


Table 4: Aggregate Ordered Response Logit Model for Household Students

Household Students	Alternative	Parameter
-- Logsum Parameters		
Nest_1	alt_1, Nest_2	0.2
Nest_2	alt_2, alt_3	0.1
-- Alternative Specific Parameters		
CONSTANT	alt_0	0.5937
CONSTANT	alt_2	-0.2637
CONSTANT	alt_3	-0.3839
Zonal Average Household Students	alt_0	-1.0941
Zonal Average Household Students	alt_2	0.3541
Zonal Average Household Students	alt_3	0.3822
Zonal Average Household Seniors	alt_0	2.9499
Zonal Average Household Seniors	alt_2	0.2151
Zonal Average Household Seniors	alt_3	0.2151

Figure 9: Percent of Households by Income Level vs. Zonal Average Annual Household Income

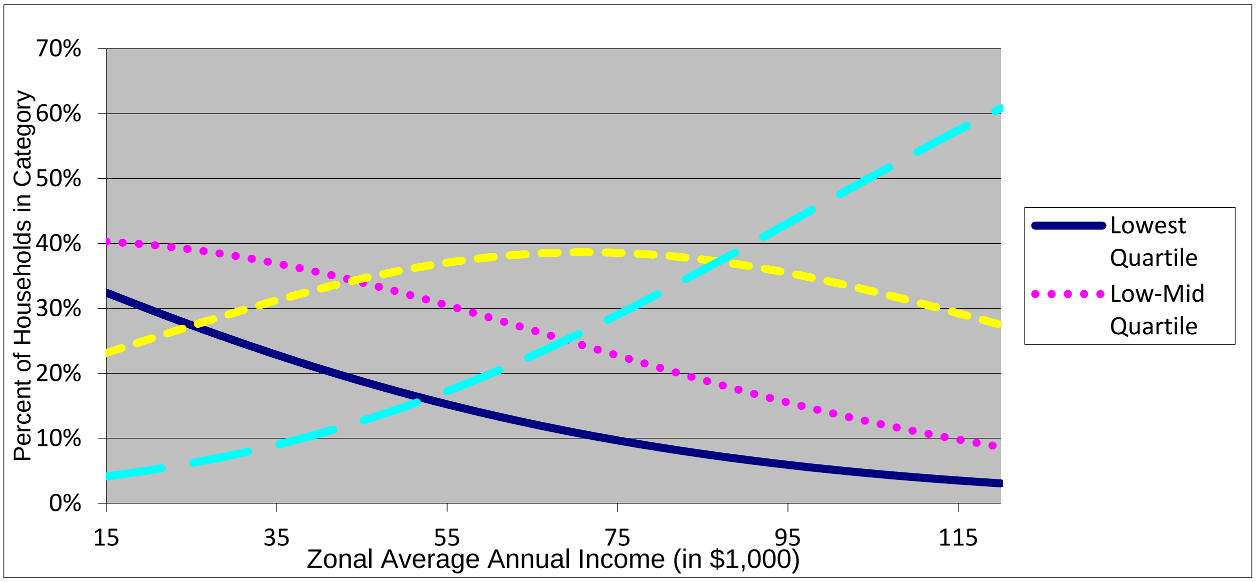


Table 5: Aggregate Ordered Response Logit Model for Household Income

Household Income	Alternative	Parameter
-- Logsum Parameters		
Nest_1	alt_2, Nest_2	0.25
Nest_2	alt_3, alt_4	0.1
-- Alternative Specific Parameters		
CONSTANT	alt_1	1.55
CONSTANT	alt_3	-0.16
CONSTANT	alt_4	-0.28
Zonal Average Household Seniors	alt_1	1.5565
Zonal Average Household Size	alt_1	-0.7402
Zonal Average Household Income	alt_1	-0.0214
Zonal Average Household Income	alt_3	0.0055
Zonal Average Household Income	alt_4	0.0079
Population Density	alt_1	0.0888
Population Density	alt_3	-0.0245
Population Density	alt_4	-0.0326

4.6 Iterative Proportional Fitting

The synthesis of the population is completed using traditional iterative proportional fitting in multiple dimensions, making use of TransCAD’s functionality. TransCAD includes a module for developing synthetic populations with iterative proportional fitting and provides basic documentation of this procedure.

The I-69 corridor model uses the TransCAD module only to produce a multi-dimensional cross-classification table. A simple procedure then enumerates the non-empty cells of the cross-classification table as individual households, weighting them by the cell value, to produce the disaggregate synthetic population. This method is preferred to TransCAD’s built-in functionality to generate a table of individual households because the TransCAD methodology relies on random draws and would introduce simulation error into the model. The corridor model’s method instead is deterministic.

The inputs to the iterative proportional fitting procedure are the marginal distributions produced by the ordered response logit models and a seed or sample population of households and persons. A seed table of the Public Use Microdata Sample (PUMS) from the 2010 Census was selected for this purpose. The use of the household survey sample as a seed distribution for iterative proportional fitting offers consistency with the models of the marginal distributions, which were estimated from the same data and helps ensure convergence.

The population synthesis is constrained to produce the observed average from the Census data for each variable for each zone. The correlation structure (i.e., the tendency of households with more workers also to have more income) was borrowed from the 2012 update of the Evansville Metropolitan Planning Organization (EMPO) travel forecasting model.

The use of shadow prices in the generation of the marginal distributions guarantees that the synthetic population created by iterative proportional fitting will agree with TAZ data, for not only the number of households, but also the number of persons, workers, students and households with seniors in each zone.

4.7 Vehicle Availability

The final characteristic of each household in the synthetic population is the number of vehicles available to it (whether they are owned, leased or ‘company cars’ garaged at home). Because of the importance of vehicle availability in travel demand and the sensitivity of vehicle availability to transportation policies and investments, vehicle availability is not modeled simply as a demographic variable, essentially input to the travel model. Rather, vehicle availability is modeled behaviorally with each household choosing the number of vehicles it will own, lease, etc., based on its demographic characteristics (household size, income, number of workers and seniors), urban design (grid vs. cul-de-sacs) and density of its neighborhood, regional gas prices and its access to transit. The inputs and outputs to the vehicle availability model are presented in **Table 6.**

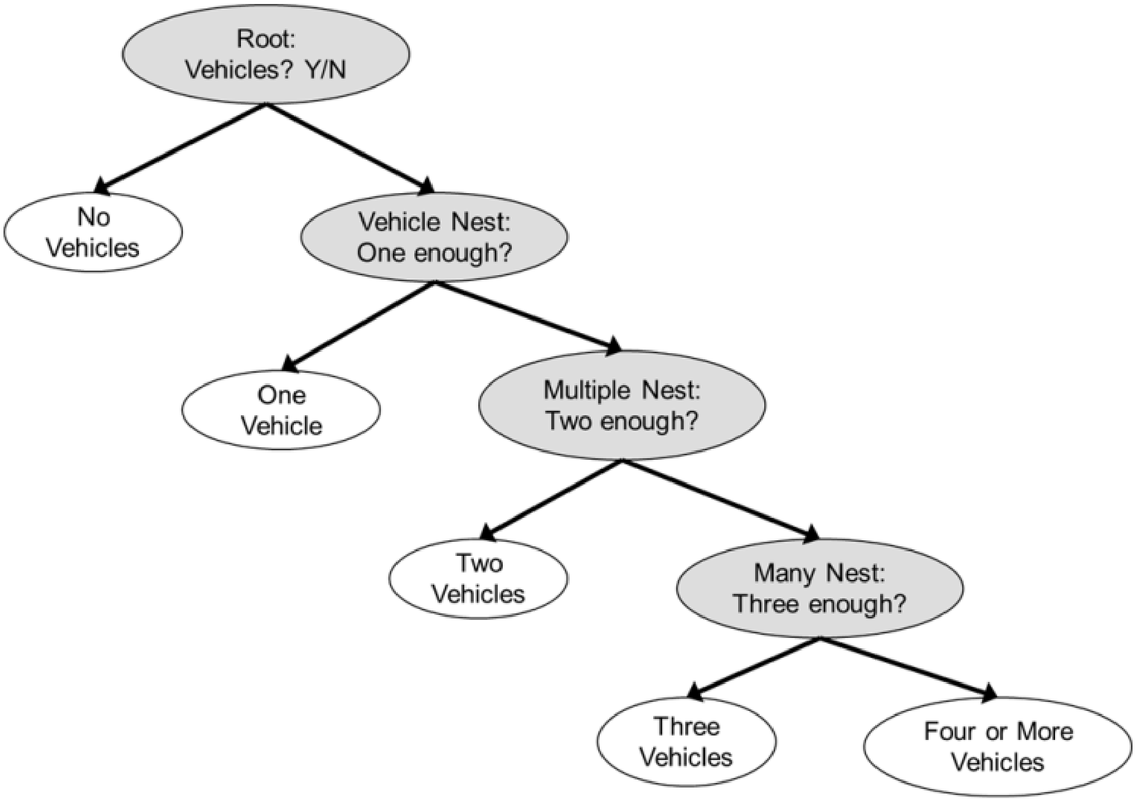
Table 6: Inputs and Outputs to Vehicle Availability

Input Variables	Output
• Individual Household Size • Individual Household Workers • Individual Household Income • Presence/Absence of Seniors in HH • Percent of Zone within .5 mi of Bus Route • Urban Design Factor • Population Density • Gas Price	• Household vehicle availability o Zero vehicles o One vehicle o Two vehicles o Three vehicles o Four or more vehicles

4.7.1 Methodology

The estimation of vehicle availability is accomplished by a disaggregate ordered response logit choice model. The vehicle availability model was originally estimated as part of the 2012 Evansville Metropolitan Planning Organization and further calibrated based on the ACS and CTPP data for the I-69 corridor model. Unlike the aggregate ordered response logit models used in the population synthesizer, this model does not include average zonal vehicle availability as an input/control variable or shadow prices to ensure consistency with an input variable. While those aggregate models are applied to each zone to generate a distribution of households within each zone (and thus have only statistical and no behavioral interpretation), this disaggregate model, applied to the individual households generated by the population synthesizer, can be interpreted as modeling each household's choice of how many vehicles to have in its fleet. In this context, the ordered response nesting structure is consistent with (but does not necessarily imply) the plausible hypothesis that the number of vehicles available to a household is ultimately the product of a series of choices of whether or not to own, lease, etc., one more vehicles. **Figure 10** illustrates the nesting structure of the ordered response logit model with the corresponding series of choices.

Figure 10: Nesting / Choice Structure of Ordered Response Logit Model of Vehicle Availability



The model parameters were estimated using ELM software, and the ORL model was tested against a simpler multinomial logit (MNL) model which would correspond to a single, simple choice of the number of vehicles (assumption of no correlation across alternatives). The chi-squared test shows that the ordered response logit model rejects the null hypothesis that the multinomial logit model is the true model at a high level of confidence (0.02 significance). The parameter estimates and associated t-statistics, together with model goodness-of-fit statistics for both the ORL and MNL models are displayed in **Table 7**.

The model estimation results show that the number of vehicles increases with household size, workers and income and decreases with the number of seniors (for a constant household size). As would be expected, these demographic variables are highly significant and largely dominate a household’s choice of how many vehicles to procure/maintain. However, model estimation results also found that the urban design of the neighborhood (grid vs. cul-de-sac design, as measured by the number of intersection approaches per square mile) was highly significant and denser grid designs correlated with lower vehicle availability. Since income is controlled for as a separate variable, this is likely attributable to the ease of walking and biking in these neighborhoods. Access to transit service (as measured by the percent of the household’s zone within half a mile of a bus route) was also statistically significant and decreased the probable number of vehicles per household. Finally, gas prices were also found to be significant and influenced availability of zero or one vehicles in a household.

Table 7: Ordered Response Logit Model of Vehicle Availability Defining Tour and Stop Types

Variables	Alternatives	ORL		
-- Logsum Parameters		Calibrated	Parameter	t-statistic
Nest_1	alt_1, Nest_2	0.95	0.925	*
Nest_2	alt_2, Nest_3	0.23	0.3	*
Nest_3	alt_3, alt_4	0.57	0.25	*
-- Alternative Specific Parameters		Calibrated	Parameter	t-statistic
CONSTANT	alt_0	-0.05	-1.1651	-0.7299
CONSTANT	alt_1	1.90	1.2998	2.4108
CONSTANT	alt_3	-0.85	-0.616	-4.7002
CONSTANT	alt_4	-1.50	-1.0878	-6.3466
Household Size	alt_0		-0.9133	-4.9575
Household Size	alt_1		-0.626	-8.1295
Household Size	alt_3		0.0307	1.5114
Household Size	alt_4		0.095	3.5415

Variables	Alternatives	ORL		
Income Group (1-4)	alt_0		-2.1948	-7.6064
Income Group (1-4)	alt_1		-0.8468	-10.6018
Income Group (1-4)	alt_3	0.0493	0.0325	1.3273
Income Group (1-4)	alt_4		0.0703	2.1711
Household Workers	alt_0		-2.0688	-6.286
Household Workers	alt_1		-0.8659	-7.176
Household Workers	alt_3		0.2177	7.2266
Household Workers	alt_4		0.3065	7.4587
Household Seniors	alt_0		-0.7122	-2.1165
Household Seniors	alt_1		-0.5433	-3.0336
Household Seniors	alt_4		0.2354	2.8613
Gas Price	alt_0	0.167	0.334	1.5219
Gas Price	alt_1	0.167	0.334	*
Percent of Zone Near Bus	alt_0		1.0345	1.9598
Population Density	alt_3		-0.0254	-1.7874
Population Density	alt_4		-0.055	-2.5702
Urban Design Factor	alt_0		0.5397	2.4031
Urban Design Factor	alt_1		0.2293	4.1239
Urban Design Factor	alt_3	-0.008	-0.0166	-0.9013
Urban Design Factor	alt_4		-0.0476	-2.0672
Network Density	alt_0		0.6206	2.1045
Network Density	alt_1	0.13	0.2669	1.6095
-- Model Statistics				
Log Likelihood at Zero			-2981.8	
Log Likelihood at Constants			-2558.8	
Log Likelihood at Convergence			-1881.0	
Rho Squared w.r.t. Zero			0.369	
Rho Squared w.r.t Constants			0.265	

In order to maintain the deterministic nature of the model and avoid introducing randomness (and the associated need to do multiple runs to obtain an average result), rather than use random draws to realize the choice probabilities as is frequently done in activity-based approaches, a new synthetic population of households, broken out by number of vehicles, is created, using the probabilities of vehicle availability to re-weight the population.

In traditional travel models, the various component models (trip generation, gravity models, mode split, time-of-day split, etc.) are segmented by trip purposes with separate component models for each trip purpose. In the updated I-69 corridor model design, the component models are segmented in a slightly different way. Mode and destination choice is segmented by stop (or activity) types, while departure time choices are segmented by tour type. The generation of tours and stops are accomplished by an initial group of regression models. This is similar to traditional trip generation, except that tours and stops are generated rather than trips. The following pages outline tour and stop types for the updated I-69 corridor model.

4.7.2 Tour Types

Tour types play an important role in the model. Both mode and time-of-day (or departure time) choice models are developed for each tour type, and the number of tour types is a critical determinant of the run time of the model.

Three tour types are used for the I-69 corridor model: work tours, school tours, and other (non-work) tours. A fourth tour type, university tours, which has substantially different trip characteristics, is represented by its own sub-model. The university tours is defined and outlined in **Appendix C** of this report. This division of tours, noted in **Table 8**, offers a good balance between behavioral fidelity and run time, capturing a great deal of the temporal and modal variation using only three tour types.

Table 8: Tour Types

Tour Type	Percent Tours	Frequency (/hh/day)
Work Tours	33.78%	1.20
School Tours	7.74%	0.27
Other Tours (Non-Work)	58.47%	2.07

The mode shares for each tour type, shown in **Figure 11** are clearly distinct. Work tours are dominated by private automobiles, which comprise 97 percent of all work tour trips. Primary and secondary school tours use automobiles and school buses as the main tour modes (57 percent and 41 percent, respectively), while walk/bike trips comprise about 1.3 percent. Other (non-work) tours, similar to work tours, predominantly choose automobiles (96 percent) but with a larger share of walk/bike at 3.17 percent.

Tours with both work and K12 school stops were defined to be school tours and generally appeared to be high-school students with after-school jobs. (Distinct in many ways, college/university tours of full time students making off campus trips are analyzed separately. A detailing of university tours can be found in **Appendix C** of this report.)

4.7.3 Stop/Activity Types

Stop (or activity) types are defined by a combination of their purpose or activity type. A total of eight stop types are used in the I-69 corridor model. In **Figure 11**, each stop type, its percentage share, and frequency are defined. Once these stops are generated, they are distributed to specific tour types in a separate activity allocation model.

This framework, which generates stops separately from tours and then allocates them, does not limit a stop to one specific tour type (e.g. a shopping stop can be done on work tour, school tour, or other tour).

Figure 11: Mode Shares by Tour Type

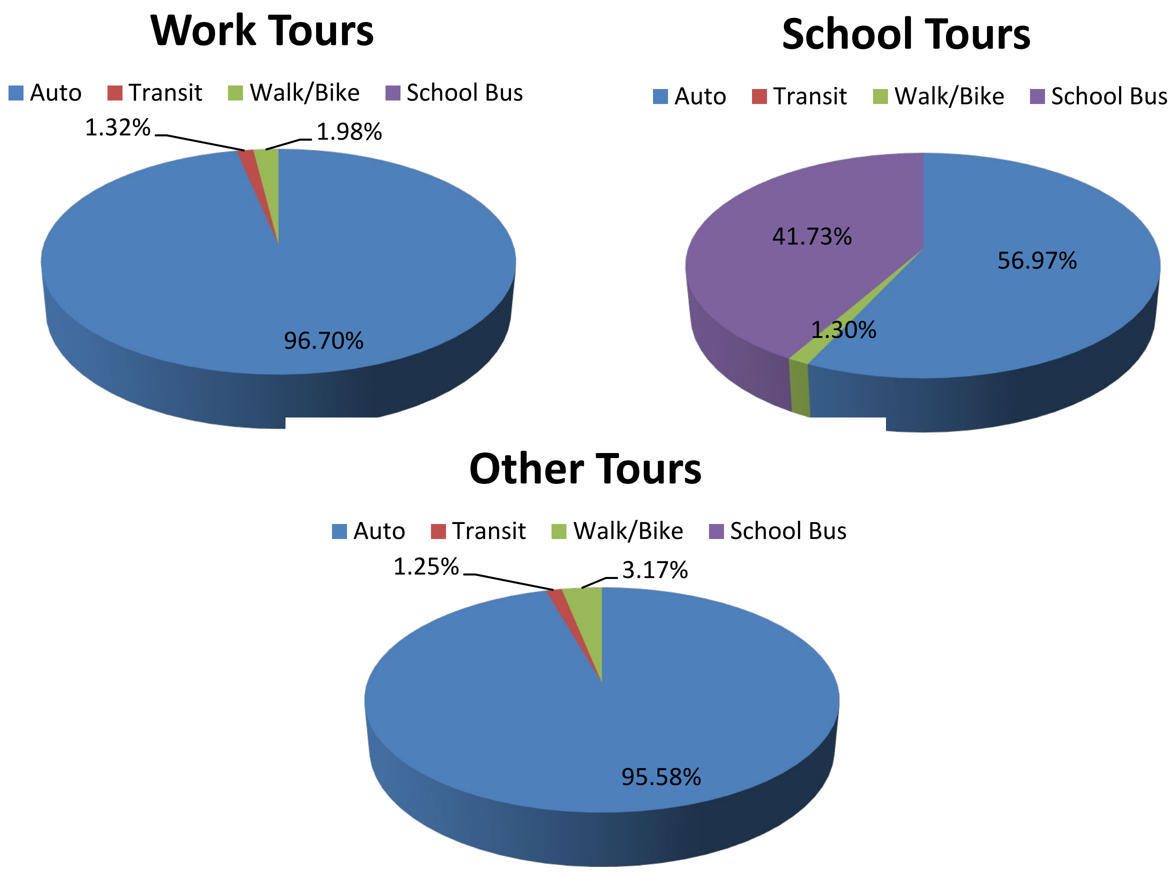


Table 9: Stop/Activity Types

Stop Type	% Stops	Activities and Criteria	Frequency (Stops/hh/day)
Work Stops	20%	Work or Work Related	1.62
University Stops	1%	Post-secondary, College, or Trade School. Part time off-campus students only.	0.05
School Stops	6%	Primary & Secondary School	0.48
Shopping Stops	17%	Incidental & Major Shopping	1.33
Personal Business Stops	12%	Banking, Medical, Personal Services	1.00
Social & Recreational Stops	18%	Social, Civic, Church, Community	1.48
Eating Stops	11%	Restaurants, Diners	0.86
Travel Stops	15%	Pick-up/Drop-off Passengers or Change of Mode	1.21

4.8 Tour and Stop Generation

The updated I-69 Corridor Travel Model generates tours and stops rather than trips for I-I travel. The number of tours and stops of each type is estimated using either multiple regression or multinomial logit models applied to the disaggregate synthetic population of households. The different methodologies (either regression or multinomial logit) were chosen for each tour and stop type based on which performed better for each.

The updated model calculates tours and stops and then allocates stops to tours. This method offers additional behavioral fidelity and also allows for an improved goodness-of-fit of both tours and stops. This advanced framework offers improved sensitivity over traditional models.

While cross-classification models were once viewed as an advance over regression (or multinomial logit) models for generating trips, this was due to their ability to reduce aggregation bias compared to other models, which were applied to zones as a whole. By applying regression models instead to a disaggregate population, aggregation bias is eliminated altogether in the approach adopted here. In this context, these models offer two advantages over traditional cross-classification models used for generating trips. First, they allow the incorporation of more variables. While cross-classification models are limited to two or three variables at most, regression models can include more variables, introducing sensitivity in resulting trip rates to gas prices and accessibility variables[13] in addition to the basic demographic characteristics. Second, the use of regression

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[13] *The accessibility variables in the I-69 corridor model are used in place of the more traditional area type variables (CBD, Suburban, Rural, etc.). The accessibility of each zone is a measure of aggregate travel time to all activities/attractions in the modeled area. A distance decay factor is included so that nearby attractions increase the accessibility more than distant ones. The effect is to create a continuous version of an area type variable, in which downtown areas, in close proximity to many destinations, have the highest accessibilities and rural locations have the lowest.*

models allows the limitation of the non-linearities in the model's travel rates to the two with plausible behavioral explanation: satiation effects (e.g., decreasing marginal increase in trips for each additional household member) and interaction effects (e.g., vehicles and workers increasing together increasing travel more than either increasing by itself). Some satiation effects were incorporated in tour generation equations through the use of logarithmic transformations. Although interaction effects were widely tested, the only interaction effect which proved statistically significant was the interaction of gas prices and household income; increasing gas prices decreased certain stop rates, but only for low income households.

As **Table 10** illustrates, the tour and stop generation models do offer sensitivity to considerably more variables than traditional cross-classification models. Each of these variables had a statistically significant effect and offers intuitive behavioral plausibility. The complete list of the tour and stop generation equations is available in **Appendix B** of this report.

Table 10: Factors Affecting Household Tour and Stop Generation

		Workers	Non-Workers	Students	Seniors	Vehicles	Income	Gas Price	Access-ibility
Tours	Work Tours	+			-		+		+
	School Tours			+	-		+		
	Other Tours	-	+		+	+	+		
Stops	Work Stops	+			-	+	+		
	University Stops	+		+	+	+	+		
	School Stops			+			+		
	Shopping Stops	+	+		+	+	+		+
	Personal Business Stops	-		-	+	+		-	+
	Social & Recreational Stops	-	+			+	+	-	
	Eating Stops			+		+	+		+
	Travel Stops	+	+	+	-	+	+	+	+

Key	+	Variable (column) increases tour/stop rate (row)	-	Variable (column) decreases tour/stop rate (row)		Variable (column) not used for tour/stop rate (row)

The number of work tours was generally a simple function of the number of workers. That is, the number of workers is the dominant predictive variable, compared to other variables, in generating work tours. Vehicle ownership proved insignificant once accessibility was introduced into the model. The presence of seniors in a household made work tours slightly less frequent, perhaps because senior workers are less likely to work full time. Accessibility, on the other hand, makes work tours marginally more frequent because it implies that commute times are shorter, so it is easier to get back and forth between home and work and workers can go home for lunch, return to work after dinner, etc.

Many stop generation factors are similar. Increases in income, vehicles, and accessibility increase most stop types. This indicates that those with higher incomes who have shorter travel times make more stops. Many stop types (social, recreational, eating, shopping, etc.) are positively correlated with higher incomes. By contrast, higher gas prices typically decrease the number of stops made.

In the new hybrid tour-based framework, there are no attraction generation models. Rather, attractions are modeled as part of the stop location choice models, instead of inputs to trip distribution. The model script does generate attractions, but only because TransCAD requires it. Attractions are part of the stop location choice models and are documented with them.

4.9 Activity Allocation Choice

The I-69 corridor model includes an activity allocation sub model that used household survey estimated logit models to allocate activities (stop types) to tour types. The logit models were applied using the I-69 corridor model zonal and network layers, while the model parameters themselves were obtained from the 2012 Evansville Metropolitan Planning Organization model. The model parameters utilized in the I-69 corridor model were further calibrated based on the NHTS data and the Central Indiana Travel Survey. The output of the activity allocation models are the number of each activity type that occurs on each tour type by household. There are seven activity types generated for each household in the generation step. Five of these activities are allocated to tours by allocation choice; work and school activities need not be allocated since they only occur on work tours and school tours, respectively. The activities generating include eating, personal business, shopping, social/recreation, travel, and university (part time off-campus students). **Table 11** shows which activities are allowed on each tour type in the model.

Table 11: Activity Types Possible on Each Tour Type

Tour Type	Activity Types Possible
Work Tour	Work, Eat, Personal Business, Shopping, Social/Recreation, Travel Activity, and University (part time)
Other Tour	Eat, Personal Business, Shopping, Social/Recreation, Travel Activity, and University (part time)
School Tour (K12)	School, Eat, Personal Business, Shopping, Social/Recreation, Travel Activity
University (Full Time)	Full Time student tours are handled separately in the stop sequence and stop location choice models, tours of this type do not use an activity allocation choice model. (reference to University Full Time section)

The activity allocation models were estimated using ELM software and then calibrated to match observed activity shares by tour in the original household survey on which the models were based. The following tables show the final parameters in each model.

4.9.1 Eat Activity Allocation Model

In the eat activity allocation model, the probability that an eating activity would occur on an Other tour was sharply decreased as the number of household workers grew. This makes sense as more household workers would lead to more work tours were eat activities might occur. Working members of the household are more likely to make an eating activity stop as part of a work tour rather than on a separate other tour. Naturally, with increased K12 students in the household, the probability of an eat activity on a school tour increased. Middle income households were found to increase the probability of an eat activity on a school tour. The eat activity model is provided in **Table 12**.

Table 12: Eat Activity Allocation Model

Variable	Tour Type Alternative	Parameter	t-stat
-- Generic Parameters			
LnS (Number of tours of each type)		1	Constrained
-- Alternative Specific Parameters			
CONSTANT	School	-1.99234	*
CONSTANT	Other	0.98547	*
HHSIZE	Other	0.1368	1.8162
HHInc2(middle income household)	School	0.8321	2.3205
NOWRK (number of workers in HH)	Other	-0.6353	-6.3506
NOK12 (number K12 students)	School	0.561	4.3024
-- Model Statistics			
Log Likelihood at Zero		-1178.0848	
Log Likelihood at Constants		-832.4787	
Log Likelihood at Convergence		-654.4228	
Rho Squared w.r.t. Zero		0.4445	
Rho Squared w.r.t Constants		0.2139	
Adjusted Rho Squared w.r.t. Zero		0.4386	
Adjusted Rho Squared w.r.t Constants		0.2074	

**Calibrated Parameter. Original Estimated were -2.6264 and 0.9098 for School Tour and Other Tour respectively.*

4.9.2 Personal Business Activity Allocation Model

In the personal business activity allocation model, higher numbers of household vehicles had a negative effect on personal business stops on school tours. Increased bus fare had a negative effect on personal business stops on other tours. The percentage of streets with a sidewalk at the origin and destination zones had a positive effect on personal business stops on other tours. As with eating tours, increases in household workers decrease the likelihood of allocating personal business to another tour, while more students increased the likelihood of personal business on a school tour. The highest income quartile of households was the only quartile to not have a significant parameter for allocating personal business to other tours. **Table 13** presents the personal business activity allocation model.

Table 13: Personal Business Activity Allocation Model

Variable	Alternative	Parameter	t-stat
-- Generic Parameters			
Ln(Number of tours of each type)		1	Constrained 1
-- Alternative Specific Parameters			
CONSTANT	School	-0.51002	*
CONSTANT	Other	0.75628	*
HHSIZE	Other	0.3737	4.6895
Veh_HH	School	-0.4932	-2.2081
HHInc1 low (Low income household)	Other	2.7066	4.8696
HHInc2 med (Middle income household)	Other	2.3774	4.398
HHInc3 med-high (High income household)	Other	0.4387	2.3175
NOWRK (Number of workers)	Other	-0.8277	-8.1754
NOK12 (Number of K12 students in household)	School	0.905	6.4768
BusFareAdj1_2 (bus fare for low/med income)	Other	-2.183	-3.8441
PctSdwlk (% Sidewalk at home zone)	Other	-0.7101	-2.8715
-- Model Statistics			
Log Likelihood at Zero		-1513.7859	
Log Likelihood at Constants		-926.4916	
Log Likelihood at Convergence		-660.1593	
Rho Squared w.r.t. Zero		0.5639	
Rho Squared w.r.t Constants		0.2875	
Adjusted Rho Squared w.r.t. Zero		0.556	
Adjusted Rho Squared w.r.t Constants		0.2761	

**Calibrated Parameter. Original Estimated were -1.5411 and 0.5974 for School Tour and Other Tour respectively.*

4.9.3 Shopping Activity Model

In the shopping activity model, besides the expected trend of increasing numbers of workers and students decreasing the likelihood of allocating shopping activities to Other tours, a higher number of household vehicles decreased the likelihood of a shopping activity on a school tour. This is explained as households with fewer vehicles likely allocate more activities to fewer auto tours, so that a one vehicle household would be more likely to make a shopping activity on a school tour rather than making a separate Other tour for that activity. The shopping activity model is provided in **Table 14**.

Table 14: Shopping Activity Allocation Model

Variable	Tour Type Alternative	Parameter	t-stat
-- Generic Parameters			
LnS		1	Constrained
-- Alternative Specific Parameters			
CONSTANT	School	-1.15802	*
CONSTANT	Other	1.11124	*
HHSIZE	Other	0.4332	4.3555
Veh_HH (Vehicles per household)	School	-0.4939	-2.1648
NOWRK (Number of household workers)	Other	-0.7624	-8.8174
NOK12 (Number of K12 students)	School	0.6982	5.3423
NOK12 (Number of K12 students)	Other	-0.3942	-3.2338
-- Model Statistics			
Log Likelihood at Zero		-1882.2707	
Log Likelihood at Constants		-1090.062	
Log Likelihood at Convergence		-812.8743	
Rho Squared w.r.t. Zero		0.5681	
Rho Squared w.r.t Constants		0.2543	
Adjusted Rho Squared w.r.t. Zero		0.5639	
Adjusted Rho Squared w.r.t Constants		0.2483	

**Calibrated Parameter. Original Estimated were -1.5411 and 0.926 for School Tour and Other Tour respectively.*

4.9.4 Social Recreation Activity Allocation Model

In the social recreation activity allocation model, beside the expected trend of increasing numbers of workers and students decreasing the probability of allocating this activity to Other tours, it was found that the higher income households were less likely to allocate social recreation activities to

Other tours. It is plausible that this demographic is more likely to chain social recreation activities on work tours. The social/recreation activity allocation model is given in **Table 15**.

Table 15: Social/Recreation Activity Allocation Model

Variable	Tour Type Alternative	Parameter	t-stat
-- Generic Parameters			
Ln (Number of Tours of each type)		1	
-- Alternative Specific Parameters			
CONSTANT	School	-0.50992	*
CONSTANT	Other	-0.01129	*
HHSIZE	School	0.2915	2.0393
HHSIZE	Other	0.5453	4.8394
HHInc3 med high (Middle income household)	Other	-0.617	-3.8897
HHInc4 high	Other	-0.7928	-4.6194
NOWRK (Number of workers)	Other	-0.5809	-6.6738
NOK12 (Number of students)	School	0.3864	2.269
NOK12 (Number of students)	Other	-0.2189	-1.6678
-- Model Statistics			
Log Likelihood at Zero		-2124.5332	
Log Likelihood at Constants		-1332.713	
Log Likelihood at Convergence		-1033.2042	
Rho Squared w.r.t. Zero		0.5137	
Rho Squared w.r.t Constants		0.2247	
Adjusted Rho Squared w.r.t. Zero		0.5085	
Adjusted Rho Squared w.r.t Constants		0.2177	

**Calibrated Parameter. Original Estimated were -1.5411 and -0.0048 for School Tour and Other Tour respectively.*

4.9.5 Travel Activity Allocation Model

A travel activity in this model is defined as a trip made to chauffeur someone else. In the travel activity allocation model, beside the expected trend that increased numbers of workers and students decreases the probability of allocating this activity to Other tours, it was found that more household vehicles increased the probability of a travel activity on an Other tour. Higher vehicles availability makes it more likely that someone could make an Other tour to chauffeur someone. With fewer vehicles, a household would be more likely to chain a travel activity on a work or school tour. **Table 16** shows the travel activity allocation model.

Table 16: Travel Activity Allocation Model

Variable	Alternative	Parameter	t-stat
-- Generic Parameters			
Ln (Number of Tours of each type)		1	Constrained
-- Alternative Specific Parameters			
CONSTANT	School	-0.72954	*
CONSTANT	Other	0.45906	*
HHSIZE	Other	-0.0941	-1.5682
Veh_HH (Vehicles per household)	Other	0.3705	4.8272
HHInc2 (Medium income household)	Other	0.45	3.1027
NOWRK (Number of workers)	Other	-0.462	-4.6899
NOK12 (Number of K12 students)	School	0.2819	3.8436
-- Model Statistics			
Log Likelihood at Zero		-1558.3623	
Log Likelihood at Constants		-1285.9961	
Log Likelihood at Convergence		-1018.669	
Rho Squared w.r.t. Zero		0.3463	
Rho Squared w.r.t Constants		0.2079	
Adjusted Rho Squared w.r.t. Zero		0.3412	
Adjusted Rho Squared w.r.t Constants		0.2029	

4.9.6 University Activity Allocation Model for Part Time Off-Campus Students

In the university activity allocation model, part time students making university stops as part of work or Other tours, the percentage of sidewalks at the origin and destination zones significantly decreased the probability that a university activity would be made as part of a work tour. This suggests that a part time student who lives near a walkable campus is better able to make a separate Other tour for his/her university activity. Conversely, origins and destinations with poor walkability would perhaps make the student more inclined to chain their university as part of a work tour. The university activity allocation model is provided in **Table 17**.

Table 18 shows (for the 2010 base year) the percentage of activities allocated to Work, School (K12), and Other tours respectively for the total I-69 Corridor Area.

Table 17: University Activity Allocation Model

Variable	Tour Type Alternative	Parameter	t-stat
-- Generic Parameters			
LnS (Number of Tours of each type)		0.8322	3.4058
-- Alternative Specific Parameters			
CONSTANT	Work	-0.99408	-1.8073
NOWRK (Number of workers)	Work	0.2095	0.9592
PctSdwlk (% Sidewalk at home zone)	Work	-1.3789	-1.9917
-- Model Statistics			
Log Likelihood at Zero		-102.7149	
Log Likelihood at Constants		-80.393	
Log Likelihood at Convergence		-71.0304	
Rho Squared w.r.t. Zero		0.3085	
Rho Squared w.r.t Constants		0.1165	

**Calibrated Parameter. Original Estimated was -1.1444.*

Table 18: Total I-69 Corridor Model Area Activity Allocation

Tour Type	Eat	Personal Business	Shopping	Social ./ Rec	Travel	Univ. (Part Time)	Work	School
Work Tour	30.2%	21.8%	23.2%	10.6%	29.6%	29.5%	100.0%	0%
Other Tour	60.6%	69.3%	70.4%	73.6%	54.6%	70.5%	0%	0%
School Tour (K12)	9.1%	8.9%	6.5%	15.7%	15.7%	0%	0%	100.0%

4.10 Tour Mode Choice

In the I-69 corridor model, as an activity-based model, determines the mode of travel in two stages: tour mode choice and trip mode choice. First, after tours are generated, they are assigned a primary mode by tour mode choice models. Later, after the spatial distribution of stops creates trips, individual trips are assigned a mode, based on the primary mode of the tour, in trip mode choice models.

The I-69 corridor model makes use of four primary or tour modes:

- Private automobile
- Public transit

- Walk/bike
- School bus

The primary mode or 'tour mode' for a tour is determined by a simple set of definitions or rules.

- Any tour containing a school bus trip is a (K12) school tour.
- Any remaining (non-school bus) tour containing a public transit trip is a public transit tour.
- Any remaining (non-transit) tour containing a private automobile trip is an auto tour whose primary tour mode is auto, but may contain non-motorized trips as part of the tour, i.e. a tour where one drove to work but then walked to lunch.
- Any remaining tour, which contains only walk or bike trips, is a walk/bike tour.

In this framework, the primary choice determining transit mode share, etc., is tour mode choice. In Tour mode choice, tours that use school bus, transit, and non-motorized modes as the primary mode are accounted for by origin zone, but not distributed or assigned. As a result, trip mode choice, which occurs after stop location choice and stop sequence choice, ultimately reduces mostly to the determination of vehicle occupancy for auto tours. Even in advanced activity-based models, fixed shares or other simple heuristics have been used for trip mode choice; whereas, tour mode choice models are more comparable to mode choice in traditional models.

The Tour Mode Choice model allocates Work, School (K12), and Other tours to their respective modal shares. Full time university tours are handled separately in the University tour sub-model, described in **Appendix C** of this report. It should be noted that the I-69 corridor model's focus on mode choice is primarily on defining a reasonable auto tour mode share in the I-69 corridor. Further modeling of the non-auto mode tours after they are separated in Tour Mode Choice is not a primary objective of this model as it would be in an MPO-level model used for transit ridership forecasting purposes.

Table 19 illustrates the variety of response variables incorporated into tour mode choice for each tour purpose. The variables are grouped into four broad categories: level-of-service variables, cost variables, demographic variables and built environment variables. The choice of primary mode for tours was sensitive to variables in each category for most tour types.

There is a key difference between the tour mode choice models (such as used by the I-69 corridor model) and those common in traditional 4-step models as well as activity-based models. They differ in how they measure the level-of-service provided by each competing mode and the related assumption of the hierarchy of travelers' choices (i.e., whether travelers' destination choices depend more on their mode choices or vice versa).

Table 19: Factors Affecting Tour Mode Choice

	Level of Service			Costs		Demographics			Built Environment		
	Accessibility by mode	Walk Time to Parks	% of TAZ Near Bus	Gas Price (for Low and Med Income HHs)	Bus Fare (for Low Income HHs)	Workers	Income	Vehicles per HH	Percent Sidewalks	Activity Diversity*	Intersection Density*
Work Tours											
Auto	🟩 +			🟥 -	🟨 +			🟨 +	🟧 -		🟧 -
Bus	🟩 +			🟨 +	🟥 -			🟥 -	🟧 -		🟧 -
Walk	🟩 +			🟨 +	🟨 +			🟨 +	🟩 +		🟩 +
School Tours											
Auto	🟩 +			🟥 -		🟩 +		🟨 +			🟧 -
Walk	🟩 +			🟩 +		🟨 -		🟨 +			🟩 +
School Bus	🟩 +			🟩 +		🟨 -		🟥 -			🟧 -
Other Tours											
Auto	🟩 +	🟧 -	🟧 -	🟥 -			🟨 +	🟨 +		🟧 -	🟧 -
Bus	🟩 +	🟧 -	🟩 +	🟨 +			🟥 -	🟥 -		🟩 +	🟧 -
Walk	🟩 +	🟩 +	🟧 -	🟨 +			🟨 +	🟥 -		🟧 -	🟩 +
Key	🟩 + Directly increases probability										
	🟨 + Indirectly increases Probability										
	🟧 - Indirectly Decreases probability										
	🟥 - Directly decreases probability										
	Blank cells indicate the column variable was not found significant for the row alternative										

**Activity diversity is defined a variable that scales the quantity and variety of activity at each zone including Households, Total Employment, Univ. Enrollment, K12 Enrollment, Retail, Services, Social and Recreation opportunities, and food/lodging.*

***Intersection Density is defined as intersection approaches per square mile.*

In activity-based models, as in traditional four-step models, (tour) mode choice is modeled conditional on (after) destination choice (or distribution) and can therefore use actual travel times between origins and destinations as level-of-service variables. This traditional model structure was first developed for very large metropolitan areas with significant choice rider markets (composed of those who can choose auto vs. transit) and is more sensitive to changes in level-of-service provided by transit improvements and for testing their impacts on transit route ridership. However, it may be oversensitive to level-of-service variables and a source of optimism bias in transit forecasts, since this model structure assumes that travelers are more likely to change mode than destination. This may well be the case for affluent choice riders for their work commute in large cities; however, there are many situations in which it seems more reasonable to assume the contrary that travelers are more likely to change destinations than mode. This contrary assumption (that travelers are more likely to change destinations than mode) is appropriate for this region, given limited transit choices for most trips.

“Reverse hierarchy” models such as the I-69 corridor model, which represent destination (or stop location) choice conditional on mode choice, still take the level-of-service provided by competing modes into account and allow for changes in ridership based on improvements to transit or highway modes. However, they do not measure the level-of-service provided by each mode by the travel times between origins and destinations but indirectly by the accessibility to various types of destinations provided by each mode to a given residence zone. Both the traditional and reverse model hierarchies are shown in **Figure 12.**

The accessibility variables used in tour mode choice are logsums based on a simplified gravity version of the utility of the stop location choice models. These logsum accessibilities include only the impedance and attraction (or size) variables; whereas, the actual destination choice models used other variables, as well. The inclusion of these accessibilities as proxy variables for the expected utility of stop location choice in the tour mode choice models allows for the interpretation of the two component models as a single nested logit model of the combined choice of tour mode and stop location. There is some loss of statistical efficiency in estimating the models sequentially in this manner, rather than simultaneously; however, simultaneous estimation of such models remains an advanced practice and is not possible with commercially available software. The combination of these two models in this fashion allows for reciprocal sensitivity of mode choice to destination choice as well as vice versa but at the cost of requiring the feedback of these accessibility variables in addition to travel times in the model application.

The Tour Mode Choice models in the I-69 corridor model are based on the 2012 Evansville Metropolitan Planning Organization model. The model parameters were calibrated based the IndyGo ridership data and the ACS data. The models are applied using zonal and network attributes from the I-69 corridor model area. The Transit accessibility logsums are obtained by overlaying a GIS layer of the Indianapolis area fixed route transit systems on the highway network and zonal layer. The percent each of each zone within 1/2 mile of a transit line is calculated. The percentage of each zone within this buffer area is used together with the employment, land use activity, and population attributes of the zone and an approximation of bus travel time between zones to determine the transit accessibility logsum for each zone. Non-motorized accessibility logsums are obtained in a similar fashion where level-of-service or travel time is based on an assumption of 30 mph on all non-freeway facilities.

Figure 12: Travel Model Hierarchies

Traditional Hierarchy	**Reverse Hierarchy**
Assumption: Travelers are more likely to change ***mode*** than ***destination***.	**Assumption:** Travelers are more likely to change ***destination*** than ***mode***.
1. Destination Choice: Where will I go?	1. Mode Choice: How will I go (drive, walk, bus, etc.)?
↓	↓
2. Mode Choice: How will I go (drive, walk, bus, etc.)?	2. Destination Choice: Where will I go?

The choice of primary mode for work tours was modeled using a nested logit model, as shown in **Figure 13**, grouping the private automobile and public transit alternatives together as motorized modes. This structure implies that people who drive to work are more likely to switch to take a bus than to walk/bike and transit riders are more likely to switch to driving than to walking/biking.

As is commonly observed in mode choice models, the number of household vehicles decreased the probability that workers would commute by bus. Gas prices for low and middle income families decreased the probability of choosing auto, while for the same families, bus fare prices had a negative effect on choosing the bus. The percentage of sidewalks in a zone and the net density variable, a measure of intersection approach density on the street network, had a strong positive effect on walking and biking. The nested logit model for work tours is provided in **Table 20.**

Figure 13: Nesting of Travel Mode for Work Tours

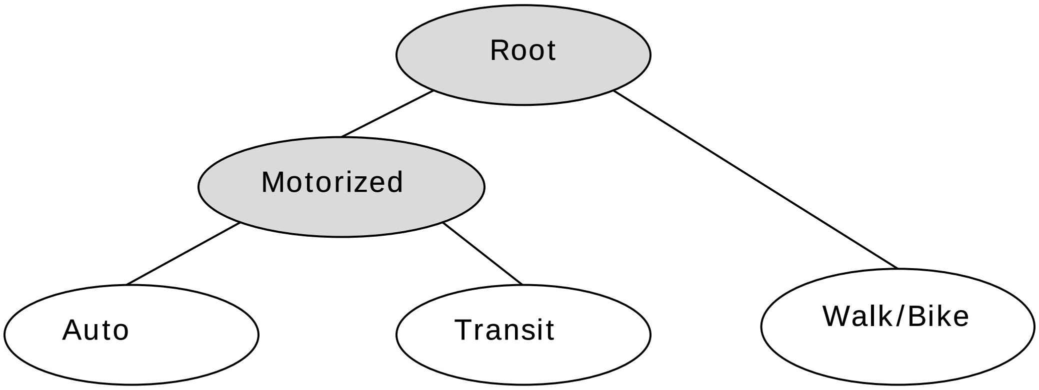

Table 20: Disaggregate Nested Logit Model of Work Tour Mode Choice

Variable	Mode Alternative	Parameter	t-statistic
-- Logsum Parameters			
Motorized		0.2839	-3.6979
-- Generic Parameters			
Access (General accessibility of home zone)		0.1611	1.3174
-- Alternative Specific Parameters			
CONSTANT	Bus	1.1	*
CONSTANT	WalkBike	-4.7	*
VehHH (Vehicles per household)	Bus	-2.3507	-1.4471
GasINC12 (Gas price for low and med. income HH)	Auto	-0.4169	-1.5069
BusINC1 (Bus fare for low income HH)	Bus	-0.4825	-1.1505
NetDensity2 (Intersection approach density of HH zone)	WalkBike	0.8821	2.1817
PctSdwlk (Percent sidewalk for HH zone)	WalkBike	2.4792	2.6504
-- Model Statistics			
Log Likelihood at Zero		-2171.1325	
Log Likelihood at Constants		-227.5963	
Log Likelihood at Convergence		-147.5657	
Rho Squared w.r.t. Zero		0.932	
Rho Squared w.r.t Constants		0.3516	
Adjusted Rho Squared w.r.t. Zero		0.9279	
Adjusted Rho Squared w.r.t Constants		0.3181	

** Constants were adjusted in calibration with the original data set in order to reproduce observed mode shares; the original estimated constants were -0.1228 and -6.1443 and for Transit and Walk/Bike respectively.*

The choice of primary mode for school tours was modeled using a nested logit model, as shown in **Figure 14**, grouping the private auto and school bus alternatives together as motorized modes and walk/bike as non-motorized. This structure implies that students who take a motorized mode to school are more likely to switch between school bus and auto modes than walking to school.

This seems reasonable for school travel, suggesting that students who walk to school are different in some way, likely that they live within a short distance to the school.

For the school tours, the accessibility parameter was significant, implying that the level-of-service (travel times) provided by the competing modes are important in the choice among them. Since there was no school bus network with which to calculate accessibilities for this mode, the general automobile accessibility was used as it seemed reasonable that it would correlate fairly well with school bus accessibility. However, this accessibility is arguably higher than actual school bus accessibility (given dwell times and the indirectness of school bus routings); this suggests that the school bus bias constant to be less than it would otherwise be.

The model is sensitive to household vehicle availability; higher auto availability decreased the probability of walking/biking or school bus. It also reveals that higher gas prices decrease the probability of students being driven/driving to school for low and middle income households. There were very few observations of public bus use for school tours in the data set used to estimate the model, and hence, the data did not confirm these or other effects on public bus use. The number of workers in a household increased the likelihood of driving. The nested logit model for school tours is provided in **Table 21.**

Figure 14: Nesting of Travel Mode for School Tours

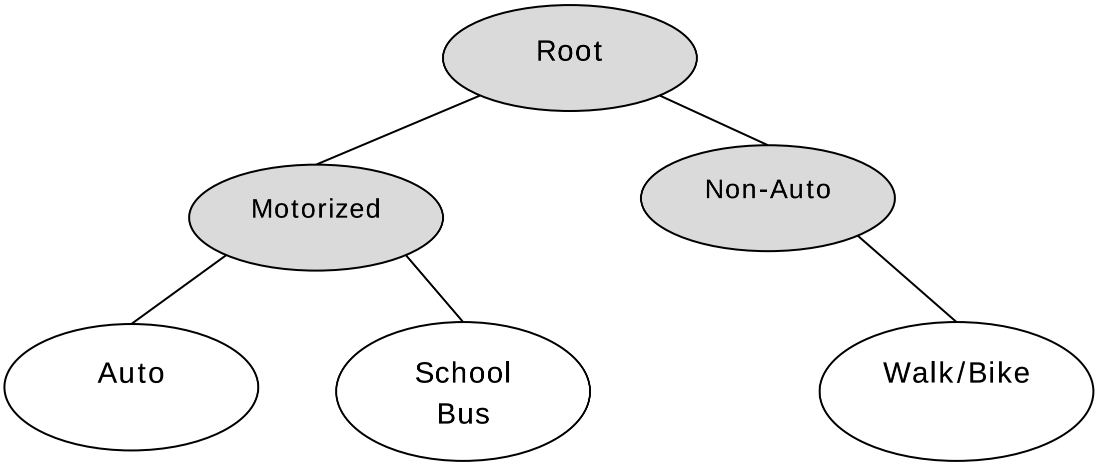

Figure 15: Nesting of Travel Mode for Other Tours

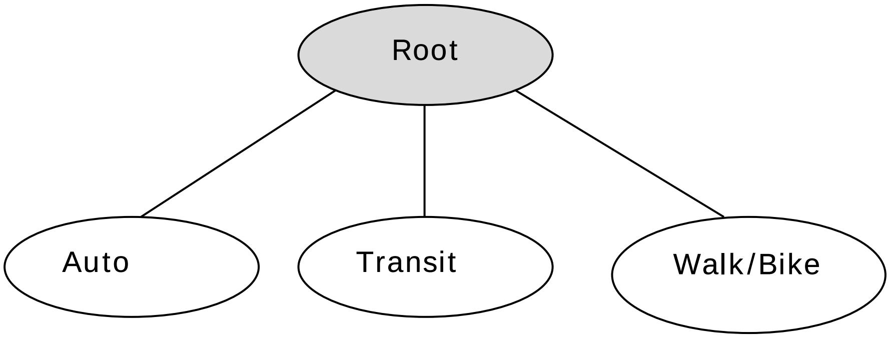

Table 21: Disaggregate Nested Logit Model of School Tour Mode Choice

Variable	Mode Alternative	Parameter	t-statistic
-- Logsum Parameters			
Motorized		0.2	Constrained
-- Generic Parameters			
Access (General accessibility of home zone)		0.1979	3.5676
-- Alternative Specific Parameters			
CONSTANT	WalkBike	-3.545	*
CONSTANT	SchoolBus	1.205	*
VehHH (Vehicles per HH)	SchoolBus	-0.4075	-5.583
NoWork (Number of workers per HH)	Auto	0.0665	3.0364
GasINC12 (Gas prices for low and med inc. HH)	WalkBike	0.4834	1.721
GasINC12 (Gas Prices for low and med inc. HH)	SchoolBus	0.0389	1.7091
NetDens2 (Intersection approach density of HH zone)	Walk/Bike	1.3529	3.9781
-- Model Statistics			
Log Likelihood at Zero		-870.0734	
Log Likelihood at Constants		-640.0861	
Log Likelihood at Convergence		-588.7967	
Rho Squared w.r.t. Zero		0.3233	
Rho Squared w.r.t Constants		0.0801	
Adjusted Rho Squared w.r.t. Zero		0.3129	
Adjusted Rho Squared w.r.t Constants		0.069	

** Constants were adjusted in calibration with the original data set in order to reproduce observed mode shares; the original estimated constants were -3.5571 and 0.6695 and for Walk/Bike and School Bus respectively.*

The choice of primary mode for Other tours did not group the private automobile and public transit alternatives together as motorized modes as for work tours. This structure, as shown in **Figure 15**, implies that people who drive are as likely to switch to walk/bike as they would be to use transit and vice versa.

Significant demographic variables in the other tour mode choice model included vehicles per household (which had a strong negative effect on transit choice). Vehicles per household also has a negative effect on walking, but less than for transit. Household income had a negative effect on transit choice, meaning higher income households decrease the probability of choosing transit. Net density had a strong positive effect on walk/bike choice; accessibility to parks also had a lesser positive effect on walk/bike choice. The nested logit model for Other tours is provided in **Table 22.** Mode shares by tour purpose are provided in **Table 23**.

Table 22: Disaggregate Nested Logit Model of Other Tour Mode Choice

Variable	Mode Alternative	Parameter	t-statistic
-- Generic Parameters			
Access (General accessibility of home zone)		0.057	0.4852
-- Alternative Specific Parameters			
CONSTANT	Bus	-9.290	*
CONSTANT	WalkBike	-4.826	*
VehHH (Vehicles per household)	Bus	-10.304	-6.0817
VehHH (Vehicles per household)	WalkBike	-0.6814	-2.4108
HHInc (Household income)	Bus	-0.6539	-1.4917
GasPrice	Auto	-1.3507	-7.6308
PctBUS (Percent of home zone near bus service)	Bus	3.253	2.77
ActDiv (Activity diversity of home zone)	Bus	5.2545	3.014
NetDens2 (Intersection approach density of home zone)	WalkBike	1.0444	4.0193
WlkAccPRK (Walk accessibility to parks)	WalkBike	0.1719	1.6185
-- Model Statistics			
Log Likelihood at Zero		-3196.0232	
Log Likelihood at Constants		-663.7779	
Log Likelihood at Convergence		-437.5304	
Rho Squared w.r.t. Zero		0.8631	
Rho Squared w.r.t Constants		0.3408	
Adjusted Rho Squared w.r.t. Zero		0.8597	
Adjusted Rho Squared w.r.t Constants		0.3263	

**Constants were adjusted in calibration with the original data set in order to reproduce observed mode shares; the original estimated constants were -5.6726 and -7.3274 for Walk/Bike and Bus respectively.*

Table 23: Mode Shares by Tour Purpose for the Total I-69 Model Area

Total Model	Work Tours	School (K12) Tours	Other Tours
Auto	96.7%	57.0%	95.6%
Transit	1.3%	0.0%	1.3%
Walk/Bike	2.0%	1.3%	3.2%
School Bus	0.0%	41.7%	0.0%

4.11 Stop Location Choice

The updated model structure produces a spatial distribution of trips using a double destination choice framework of stop location and stop sequence choice models. The stop location choice models, which are the subject of this chapter are versions of those featured in the paper "*Enhanced Destination Choice Models Incorporating Agglomeration Related to Trip-Chaining while Controlling for Spatial Competition*," which appeared in Transportation Research Record 2132 in 2009.[14]

The double destination choice framework adopted here offers a substantial improvement over traditional trip-based models such as the I-69 corridor model used for Sections 1 through 4. The spatial distribution of trips in traditional models, based on a single gravity model for each trip purpose, is open to several serious critiques. Most crucially, traditional trip distribution models are not consistent with the basic physical requirement that (essentially) all daily travel is conducted in closed tours, and can therefore produce travel patterns, which are inconsistent with real-world events. This is a serious problem with traditional models. Only slightly less serious is the problem that traditional models are insensitive to trip-chaining efficiencies (e.g., the tendency of travelers to group their stops together into convenient tours, such as stopping at restaurants near their workplace or frequent shopping locations, etc.). The double destination choice framework employed in the updated I-69 Corridor Travel Model (used for Sections 5 and 6) addresses both of these problems with traditional models and does so in a different way than activity-based models have.

The basic behavioral framework implied by the double destination choice of stop locations and sequences is straightforward. First, travelers choose all the destinations or locations at which they will stop during the day – where they will go. Next, travelers choose an origin for each destination they will visit – where they will go from. The choice of origins must obey the constraint that each place that they visit is an origin exactly as many times as it is a destination. This "traveler conservation constraint" requires that as many travelers arrive at as leave each location every day so that travelers are never created or destroyed in the model. This constraint, together with the basic structure of the model, ensures that it will produce physically possible trips consistent with closed tours. The implementation of this constraint on stop sequences is addressed in the following chapter.

This section, focused on the stop location choice models, addresses the incorporation of convenience and trip-chaining efficiencies among other effects. These effects, in particular, are incorporated by introducing special accessibility variables measuring a destination's convenience to other probable stop locations (complementary destinations) into the choice of stop locations. This, however, is only one of several effects incorporated in this destination choice procedure which are generally excluded from traditional gravity models. The destination or stop location choice models presented here are of a general (universal or mother) logit form and can be

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[14] *"Enhanced Destination Choice Models Incorporating Agglomeration Related to Trip Chaining While Controlling for Spatial Competition." Bernardin, V., F. Koppelman & D. Boyce. Transportation Research Record: Journal of the Transportation Research Board, No. 2132, Transportation Research Board of the National Academies, Washington, DC, 2009, pp. 143-151.*

considered as generalizations of more traditional gravity models. The general logit formula for the probability of a stop location, j, for a residence location, h, is given below.

$$P_{j|h} = \frac{e^{V_{j|h}}}{\sum_{j'} e^{V_{j'|h}}}$$

Here, Vj|h represents the utility or attractiveness of location j to a resident of h. It is straightforward to demonstrate that the formula reduces to that of a singly constrained gravity model in the case below where Aj are the number of attractions to j and fj|h is the friction factor for the destination j and origin h.

$$V_{j|h} = \ln(\mathrm{A_j}) + \ln(\mathrm{f_{hj}})$$

It can further be shown (Daly, 1982) that the doubly constrained gravity model can be represented by introducing a third term to the utility (a shadow price corresponding to the lagrangian multiplier for the attraction constraint). Destination choice models, such as the stop location choice models presented here, build from this basic gravity model by simply adding terms for other variables or factors in the utility or attractiveness of destinations (Vj|h). This flexible general approach allows not only for the incorporation of trip-chaining efficiencies but for any number of response variables. The stop location choice models for the I-69 Corridor Travel Model incorporate the effects of various impedances, not only travel times but also the psychological boundary represented by roadway and railroad crossings, the effects of traditional attraction or size variables such as employment, enrollment, etc., as well as the effects of other destination qualities such as their accessibility to complements and to substitutes, their degree of activity diversity (mixed uses) and the cost of gas and the effects of traveler characteristics such as income or the centrality (accessibility) of their residence. Factors affecting stop location choice are presented in **Table 24**.

Most of the effects are incorporated in the model by adding terms to the utility function (Vj|h). However, the traveler heterogeneity effects related to income and residence location are handled differently. Income was used to segment the model and estimate separate work location choice models for low income workers (whose stop choices tend to be different) and other workers.

Table 24: Factors Affecting Stop Location Choice

	Impedance					Destination qualities				Destination size (Attractions)							
	Time x Residence Access	Interstate Crossing	Water/River Crossing	County Line Crossing	Intra-zonal	Access to Substitutes	Access to Complements	Bus Availability	Sidewalks	Agri & Construction Employment	Industrial Employment	Retail Employment	Food & Lodging Employment	Professional, Medical, Government Employment	Other Services Employment	Enrollment	Households
Work	-	-	-		+		+	+		*	*	*	*	*	*		
School	-			-	-										-	+	-
Shop	-	-	-		+	-	+					+					
Personal Business	-		-	-	+	-	+							+	-		
Social & Recreational	-		-		+	-	+		+				+	+	+		+
Eat	-	-	-		+	-	+						+				
Travel	-		-		+	-	+					+	+		+	+	+

Note: All factors for each stop are outlined in its respective table

**Varies based on HH Income*

Most of the effects are incorporated in the model by adding terms to the utility function (Vj|h). However, the traveler heterogeneity effects related to income and residence location are handled differently. Income was used to segment the model and estimate separate work location choice models for low income workers (whose stop choices tend to be different) and other workers.

In many gravity models, a gamma function is used as the friction factor function. However, in this model (as in many destination choice models) an exponential function of travel time (t) is used as the friction factor function (f_hj=e^(β_t t_hj)) so that the term in the utility simplifies (β_t t_hj) and the willingness-to-travel parameter, β_t, can be easily estimated.

The travel times include terminal times, generally assumed at two minutes, except for the downtown areas with pay parking where the terminal time is assumed to be four minutes. The stop location choice model for work activities is provided in **Table 25**.

Table 25: Stop Location Choice Model for Work Activities

Variable	Parameter
--Size Parameters	[Q1, Q2, Q3, Q4]
Retail Employment (A_{1j})	0.00, -0.02, -0.11, -0.58
Agriculture & Construction Employment (A_{2j})	-0.43, 0.10, 0.32, 0.16
Industrial Employment (A_{3j})	-0.45, -0.10, 0.27, 0.63
Food & Lodging Employment (A_{4j})	0.49, -0.60, -4.27, -10.99
Professional Services & Government Employment (A_{5j})	-0.24, -0.21, 0.10, 0.54
Other Service Employment (A_{6j})	-0.10, 0.23, -0.10, -1.28
--Generic Parameters	
Travel Time (t_{hj})	Q1: -0.2227 Q2: -0.1409 Q3 & Q4: -0.1093
Water Crossings (x_{1hj})	-0.0974
I-465 Crossings (x_{2hj})	-0.3162
Percent of Destination Zone within ½ Mile of Bus (x_{5j})	Q1: 0.4384
Access to Substitutes (a_{0j})	0.0608
Intrazonal (x_0)	0.6000

The work location choice models use standard attraction or size variables, employment by broad industry categories. In estimation, the parameters for the different industry categories were allowed to vary in order to capture any tendency of workers with different income levels to be employed in different industries. In application, the attractions are calculated slightly differently. The total attraction for all work stops is simply the total employment for a zone. The attractions are apportioned between each income level based on the ratio of attractions predicted using the parameters from estimation, and balanced to the number of stops produced for each stop type in generation. Hence, the total work attractions are proportional to the total employment for a zone, but low income workers are more likely to be employed in the retail or food sector and less likely to work in the industrial or service sectors. The work stop location choice models are "doubly constrained" such that the models must assign exactly one stop for every attraction.

The travel time, interacted with residence accessibility as described above, was found to be highly significant in work location choice models for all income ranges, indicating that all travelers prefer work locations closer to home, but this preference is greater for urban residents than rural residents. River crossings and interstate crossings were also found to decrease the utility or attractiveness of a location, acting as additional impedance variables.

The work location choice model also shows that zones with greater access to bus routes are more attractive work locations for Q1 workers. This is reasonable, since low income workers are less likely to own cars and more likely to depend on public transit service, making locations served by transit more attractive.

The work location choice model also incorporates the accessibility of substitute destinations as a variable, making it a competing destinations model (Fotheringham, 1983, 1986). The highly significant positive parameter associated with this variable indicates significant agglomeration effects. In other words, work locations near other work locations (such as those in downtown areas) are generally more attractive than isolated locations for middle and higher income workers.

Work location choice models for all income levels are statistically superior to gravity models, but are still limited in explanatory power without more detailed information about the precise industries at locations and the income/occupations of workers. The stop location choice model for school activities is shown in **Table 26**.

Table 26: Stop Location Choice Model for School Activities

Variable	Parameter
--Size Parameters	
Student Enrollment	1
Other Services Employment	-0.5785
Households	-0.4752
--Generic Parameters	
Travel Time x Residence Access	-0.0267
County Line Crossings	-0.0271
Accessibility of Destination to Enrollment	-0.5229
Intrazonal	-0.6000

The school location choice model used an accessibility variable as an attraction variable in order to capture observed behavior. The surveys upon which the school location choice were based included a number of observations of school reported activities in zones with no enrollment, but immediately adjacent to or relatively near zones with enrollment. For instance, there were many cases in which school enrollment and school activities appeared on opposite sides of the street dividing two zones. Further, the definition of school activities in the survey included pre-school/day care facilities, which are not necessarily precisely co-located with enrollment. For this reason, service employment (including day care providers) was introduced as an attraction variable, but it proved insignificant. The approach ultimately adopted here, instead, was to introduce accessibility to enrollment as an attraction variable, so that school stops would be attracted not only to zones with school enrollment but also to nearby zones.

Most stop location models, including schools, include travel time from home (interacted with residence accessibility). County line crossings presented significant barriers for school location choice. This is reasonable, since school districts generally follow county lines and only private school students generally attend school out of their district. **Table 27** shows the stop location choice model for shopping activities.

Table 27: Stop Location Choice Model for Shopping Activities

Variable	Parameter
--Size Parameters	
Retail Employment (A_{3j})	1
--Generic Parameters	
Travel Time x Residence Access ($a_{0h}t_{hj}$)	Q1: -0.0225 Q2-Q4: -0.0168
Gas Cost [for Income Q1]	-0.0398
River Crossings (x_{1hj})	-0.6893
I-465 Crossings	-0.5636
Accessibility of Destination to Substitutes (a_{1j})	-1.1478
Accessibility to Complements (a_{2j})	1.1360
Intrazonal (x_0)	0.0500

The choice of shopping stop locations also depends significantly on the travel time (interacted with residence accessibility), river crossing, and a major road crossing. It also incorporated the potential stop location’s accessibility to nearby substitutes (similar and presumably competing nearby attractions), making it an agglomerating and competing destination choice model (Bernardin et al., 2009). The positive (highly significant) parameter on the accessibility to complements indicates that shoppers prefer non-shopping locations (such as banking or medical activities) which are close to probable retail locations.

This measure of locations’ convenience to alternatives means the model does reflect trip-chaining. Moreover, it also reflects differential spatial competition among locations through the accessibility to substitutes variable, which is also highly significant. If only a single destination accessibility variable is included in the model, the differential spatial competition masks the trip-chaining effects since both of these effects operate over similar distances, in this case, and the spatial competition effects are stronger. The use of two destination accessibility variables allows for the identification of both effects and appears significant throughout the stop location choice model.

The other activities stop location models outlined in the tables below offer logically significant size variables for the associated stop. For instance, Professional Service employment is constrained for personal business stops, Social and Recreational for destination households, eating stops for food employment, and travel stops for various passenger transfer locations (total employment, retail, food, K-12 enrollment, households). Similarly, they share common trends in utility variables, which favors intrazonal travel and complement locations and is discouraged by travel time (interacting with residence accessibility), major roadway crossings, river & waterway crossings, gas price, and substitute locations. **Table 28** through **Table 31** provide the stop location choice models for personal business, social/recreational, eating, and travel activities, respectively.

Table 28: Stop Location Choice Model for Personal Business Activities

Variable	Parameter
--Size Parameters	
Professional Services & Government Employment	1
Other Services Employment	-0.2680
--Generic Parameters	
Travel Time x Residence Access	Q1: -0.0184 Q2 & Q3: -0.0180 Q4: -0.0178
River Crossings	-1.0492
County Line Crossings	-0.3783
Railroad Crossings	-0.0886
Accessibility of Destination to Substitutes (a_{1j})	-0.8404
Accessibility to Complements (a_{2j})	0.8586
Intrazonal	0.1500

Table 29: Stop Location Choice Model for Social and Recreational Activities

Variable	Parameter
--Size Parameters	
Professional Services & Government Employment	1
Other Services Employment	0.8037
Food & Lodging Employment	0.5179
Park Acres	5.0759
Households	1.1191
--Generic Parameters	
Travel Time x Residence Access	Q1: -0.0195 Q2 & Q3: -0.0175 Q4: -0.0167
River Crossings	-1.0542
Percent of Sidewalks in Destination Zone	0.3970
Accessibility of Destination to Substitutes (a_{1j})	-0.9957
Accessibility to Complements (a_{2j})	0.7285
Intrazonal	0.5000

Table 30: Stop Location Choice Model for Eating Activities

Variable	Parameter
--Size Parameters	
Food & Lodging Employment	1
--Generic Parameters	
Travel Time x Residence Access	Q1: -0.0151 Q2: -0.0146 Q3 & Q4: -0.0138
Gas Cost	Q1 & Q2: -0.3102 Q3 & Q4: -0.2812
River Crossings	-0.8631
Railroad Crossings	-0.0335
I-465 Crossing	-0.3851
Accessibility of Destination to Substitutes (a_{1j})	-0.2783
Accessibility to Nearby Attractions (a_{2j})	0.3193
Intrazonal	-0.5000

Table 31: Stop Location Choice Model for Travel Activities

Variable	Parameter
--Size Parameters	
Total Employment	1
Retail Employment	Q1, Q3 & Q4: 0.3821 Q2: 1.2651
Food & Lodging Employment	Q1 & Q2: 2.3571 Q3 & Q4: 0.9629
Other Service Employment	Q1 & Q2: 0.8198 Q3 & Q4: 1.0956
K-12 Enrollment	Q1 & Q2: 1.8482 Q3 & Q4: 1.4992
Households	Q1 & Q2: 2.4265 Q3 & Q4: 1.4582
--Generic Parameters	
Travel Time x Residence Access	Q1 & Q2: -0.0217 Q3: -0.0236 Q4: -0.0289
Gas Cost	Q1 & Q2: -0.1338
River Crossings	-0.8123
Accessibility of Destination to Substitutes (a_{1j})	0.5948
Accessibility to Nearby Attractions (a_{2j})	-0.7222
Intrazonal	0.2000

Table 32 provides selected calibration statistics for the various activity types.

Table 32: Calibration Statistics for Activities

	Mean Travel Time from Home (min)	Percent Intrazonal
Work Stops	14.6	3.1
School Stops	9.0	3.9
Shopping Stops	10.3	4.5
Personal Business Stops	10.6	4.0
Social & Recreational Stops	11.0	5.4
Eating Stops	11.8	2.4
Travel Stops	8.4	7.1
All Stops	11.3	4.5

4.12 Stop Sequence Choice

Stop sequence choice models comprise the second half of the double destination choice framework in the I-69 corridor model. These models, which are more procedural than behavioral, simply "connect the dots" produced by stop location choice to form trips and tours.

There is one stop sequence choice model for each tour purpose. All the stop location matrices produced by the stop location choice models for one tour purpose are added together to create a table (matrix) of all the out-of-home stops, by location, for each residence location. The number of tours of that purpose is then added to the diagonal to account for stops at home. Each row vector (residence zone) in the stop location matrix then becomes the row and column marginal vector to which a gravity model is constrained. This procedure enforces the traveler conservation constraint and ensures that all travel takes place in closed tours. The stop sequence choice model is therefore essentially only a doubly constrained gravity model, applied to each residence zone, in which both the row and columns are constrained to the same vector.

There are only three subtle differences between the gravity models used to perform stop sequence choice and traditional gravity models. The first is that they are applied once for each residence zone, rather than once for all residence zones. The second is the need for a special shadow price or factor to account for the split between in-home stops and out-of-home stops within the home zone in order to preserve the number of trips and tours. The third difference is the interpretation and treatment of travel times in this context.

It is important to remember that within the context of stop sequence choice, the stop locations are fixed as an input to which the stop sequence choice is constrained. The role of travel time in stop sequence choice is therefore not to determine where travelers will go, but rather which stops, at what distances from each other, travelers will combine into trips and tours. This sequencing or combining of stops pertains mainly to the generation of non-home-based trips, since the residence location and stop locations already essentially define home-based trips. In this context, the main function of travel time is to ensure nearby out-of-home stops are combined into trips and tours to generate non-home-based trips of appropriate length. For this purpose, travel time functions relatively similarly to traditional models and its parameter should be expected to be negative since travelers prefer to combine stops into tours with shorter non-home-based trips (to minimize their total travel time for the tour). However, for home-based trips in stop sequence choice, the stochastic minimization of travel time has already been accomplished (in stop location choice) so any travel time effects are to correct for the home-based trip ends being closer or farther from home than other stop locations for a given tour type. The parameter on travel time for home-based trips should therefore be expected to be small in magnitude, but unlike in traditional models may be either positive or negative. Stop sequence choice model parameters are provided in **Table 33**.

Table 33: Stop Sequence Choice Model Parameters

Trip Type	Travel Time	Intrazonal
Work Stops	14.6	3.1
School Stops	9.0	3.9
Shopping Stops	10.3	4.5
Personal Business Stops	10.6	4.0
Social & Recreational Stops	11.0	5.4
Eating Stops	11.8	2.4
Travel Stops	8.4	7.1
All Stops	11.3	4.5

Given the limited number of model parameters presented in **Table 33**, the parameters were simply calibrated to reproduce observed trip lengths as is standard practice for gravity models rather than formally statistically estimated. The residence zone intrazonal factors are presented as shadow prices (in units of utility or ‘utils’). The parameters were originally calibrated as part of the 2012 Evansville Metropolitan Planning Organization model and later updated based on the ACS data and the Central Indiana Travel Survey for use in I-69 corridor model. The model parameters were applied to the I-69 corridor model and resulted in reasonable assignment validation statistics. The modeled average trip lengths for auto trips internal to the I-69 corridor model are shown in **Table 34**.

Table 34: Stop Sequence Choice Model Statistics

Total I-69 Model Internal Auto Trips	Percent Intrazonal	Average Length (min)
WorkTours_TotalTrips	4.0	11.6
WorkTours_TourHBTrips	2.1	12.8
WorkTours_TourNHTrips	6.9	9.8
SchoolTours_ TotalTrips	3.6	8.0
SchoolTours_TourHBTrips	3.7	7.7
SchoolTours_ TourNHTrips	3.2	8.6
OtherTours_TotalTrips	4.5	9.2
OtherTours_ TourHBTrips	2.0	9.6
OtherTours_ TourNHTrips	11.6	8.3

The I-69 Section 6 hybrid model generates daily activities performed by residents and groups them together to form tours. For example, each home-based tour begins and ends at home and includes one or more stops along the tour, while designating a particular activity as the primary activity of the tour. The tour-based hybrid model does not compute trip attractions as is generally done in a trip based four-step model. The attraction ends of trips in a tour are determined based on stop location and stop sequence choice models.

The Central Indiana Travel Survey (CITS)[15] provides information on average trips per household and average trips per person for each of the four counties in the model study area. Since the model does not directly generate trips by households, the tour and intermediate stop information was used to estimate trips comparable to those reported in the household survey. By adding the number of tours and intermediate stops, the total number of trips can be determined. **Table 35** compares the modeled average trips per household and the average trips per person by county to the data collected during the CITS.

Table 35: Modeled vs. CITS Data Average Trip Rates

County	CITS Data	Modeled
Average Trips per Household		
Hendricks County	11.58	11.96
Johnson County	8.62	11.78
Marion County	8.72	10.35
Morgan County	9.86	11.3
Average Trip per Person		
Hendricks County	4.27	4.31
Johnson County	3.66	4.14
Marion County	3.77	4.19
Morgan County	4.02	4.23

As a validation check for the distribution component of the I-69 Section 6 model, modeled average trip lengths and average travel times were compared against data collected for each tour type (**Table 36**). The observed average trip length and travel time information were obtained from the CITS.

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[15] *Central Indiana Travel Survey Final Report. Issued March 11, 2011. Indianapolis Metropolitan Planning Organization. Retrieved from: https://d16db69sqbolil.cloudfront.net/mpo-website/downloads/Technical-Studies/Central_Indiana_Travel_Survey_2008-2009.pdf*

Table 36: Modeled vs. CITS Data Average Trip Lengths and Travel Times

Tours	CITS Data	Modeled
Average Trip Lengths (miles)		
Work Trip	7.52	6.49
School Trip	2.91	3.54
Other Trip	5.62	4.94
Average Travel Times (minutes)		
Work Trip	22.26	22.72
School Trip	17.62	15.48
Other Trip	19.84	19.12

4.13 Trip Mode Choice

As stated earlier, in the I-69 corridor model, as in activity-based models, the mode of travel is modeled in two stages: tour mode choice and trip mode choice. First, after tours are generated, they are assigned a primary mode by tour mode choice models. Then, after the stop location and sequence choice models create trips, these trips are assigned a mode, based on the primary mode of the tour, in trip mode choice models.

Trip mode choice models were only developed for private automobile tours according to the scope of this model development effort and the needs of the I-69 Corridor study. The one exception to this is the full-time student University tours sub-model, described in **Appendix C** of this report, which allows for the selection of all modes in trip mode choice. In this context, trip mode choice reduces primarily to the determination of vehicle occupancy or walking trips that occur on an automobile tour. The I-69 corridor model generally uses four trip modes for automobile tours:

- Walk
- SOV (Single Occupancy Vehicle)
- HOV2 (High Occupancy Vehicle, 2 Passengers)
- HOV3+ (High Occupancy Vehicle, 3 or More Passengers)

The trip mode shares are predicted by aggregate multinomial (or, in some cases, nested) logit models for the home-based and non-home-based trips of each tour purpose. These models are applied to entire trip tables, based on the aggregate characteristics of the origin and destination zones associated with trips. There is, therefore, significant information loss, and the models do not perform as well as disaggregate models might. However, they do manage to predict vehicle occupancy (as well as walk trips on auto tours), incorporating a variety of plausible effects related to gas price, trip length, urban design, general accessibility, degree of commercial vs. residential activity, average zonal household size, average zonal vehicle availability, average and K-12 enrollment.

In the framework of this model design, time is only introduced and dealt with in the departure time choice models, applied after trip mode choice. Despite the use of the term ‘sequence’ which generally implies time, the stop location and sequence choice models do not incorporate time. They produce trips consistent with tours, but do not determine the direction of tours or trips. Origins and destinations are arbitrarily defined at this stage (and the trip tables are symmetric so that trips in one direction are equally probable as in the opposite direction). Thus, any zonal variables used in trip mode choice are applied to both trip ends. Factors affecting trip mode choice are presented in **Table 37**.

Table 37: Factors Affecting Trip Mode Choice

	Gas Price	Ln WalkTime	Avg Intersection Density	Average HH Size	Vehicles per HH	EMPOPR	Avg Population Density	adj FFTime	Log (K12 Enroll)	Activity Diversity	Percent Sidewalk	Avg K12 Enroll	EPDPPD	Log TotEmp
Work Tour Home Based														
Walk	+	-		-		-	-							
SOV	-	-		-		-	+							
HOV2	+	-		+		-	+							
HOV3+	+	-		+		-	+							
Work Tour Non-Home Based														
Walk	+			-				-	-					
SOV	-			-				-	-					
HOV2	+			+				-	+					
HOV3	-			+				-	+					
University Trips														
Walk	+	-								+	+			
SOV	-	+								-	-			
HOV2	-	+								-	-			
HOV3	-	+								-	-			
School Tour Home Based														
Walk		-					-		-					
SOV		+					-		🟩					
HOV2		+					+		-					

	Gas Price	Ln WalkTime	Avg Intersection Density	Average HH Size	Vehicles per HH	EMPOPR	Avg Population Density	adj FFTime	Log (K12 Enroll)	Activity Diversity	Percent Sidewalk	Avg K12 Enroll	EPDPPD	Log TotEmp
HOV3		🟢 +		🟩 +			🟩 +		🟥 -					
School Tour Non-Home Based														
Walk	🟢 +			🟩 +			🟩 +					🟥 -	🟥 -	
SOV	🟥 -			🟧			🟧					🟢 +	🟢 +	
HOV2	🟢 +			🟧			🟩 +					🟥 -	🟢 +	
HOV3	🟢 +			🟧			🟩 +					🟥 -	🟥 -	
Other Tour Home Based														
Walk	🟩 +		🟩 +	🟧 -	🟢 +					🟩 +				🟧 -
SOV	🟧 -		🟧 -	🟧 -	🟢 +					🟢 +				🟧 -
HOV2	🟩 +		🟧 -	🟧 -	🟢 +					🟥 -				🟩 +
HOV3	🟧 -		🟧 -	🟩 +	🟥 -					🟥 -				🟩 +
Other Tour Non-Home Based														
Walk	🟩 +	🟥 -					🟧 -		🟥 -	🟢 +				
SOV	🟧 -	🟢 +					🟧 +		🟢 +	🟢 +				
HOV2	🟩 +	🟢 +					🟩 +		🟩 +	🟥 -				
HOV3	🟧 -	🟢 +					🟧 +		🟩 +	🟥 -				

Key	🟩 + Direct Increase
	🟢 + Indirect Increase
	🟧 - Indirect Decrease
	🟥 - Direct Decrease
	Blank cells indicate the column variable was not significant to the row alternative.

The trip mode choice models are segmented first by tour type, following the earlier component models, and second by the more traditional home-based, non-home-based distinction. As in traditional models, non-home-based trips (which can no longer be tied to the trip-maker or their residence zone after this information is discarded in stop sequence choice) are more difficult to explain and relate to model variables. However, unlike in traditional models, these models do have the advantage of being segmented by tour type and retaining that information about the tour's primary purpose, and perhaps owing to this fact, the non-home-based models performed comparably to the home-based trip mode choice models.

Nearly all of the trip mode choice models, beginning with the home-based trips on work tours, show that increased walk time (or its log transform) decreases the probability of walk trips. This is reasonable, since walk trips, particularly on tours using an automobile, will tend to be short. Intersection approach density, measuring the connectivity or walkability of the street network, also increases the probability of walk trips, as does higher gas prices. The work tour home-based trip mode choice model is provided in **Table 38**.

The non-home-based trips on work tours, whose model is shown in **Table 39**, also show that larger average household sizes increase the probability of carpooling, since most carpooling is done among members of the same household. More commercial areas, as indicated by the employment to population ratio, are less likely to attract carpools, again owing to the fact that most carpooling is related to shared travel by families. General accessibility, however, which measures both the commercial and residential opportunities nearby, decreases the probability of driving alone (thereby increasing the probability of carpooling).

As in the case of the home-based trips, non-home-based trips on work tours with a private automobile are more likely to be walking trips if the walk time is short, there is good street connectivity (high intersection approach density) and gas prices are high. The percent pay parking within a zone also increased the probability of walking for non-home-based trips, and slightly increased the probability of carpooling, as did higher gas prices. More commercial locations (as measured by the employment to population ratio) slightly decreased the probability of carpooling.

Table 38: Work Tour Home-Based Trip Mode Choice Model

Variable	Mode Alternative	Parameter	t-statistic
-- Generic Parameters			
-- Alternative Specific Parameters			
CONSTANT	HOV2	-4.0445	*
CONSTANT	HOV3	-4.9023	*
CONSTANT	Walk	-3.4709	*
avgHHSize (Avg. HH size of O and D zones)	HOV2	0.212	1.1395
avgHHSize (Avg. HH size of O and D zones)	HOV3	0.212	1.#IO
LNWalkT (LN of walk time)	Walk	-0.39	-2.0403
GASInc (Gas price for Low Income HH)	SOV	-3.945	-0.8552
avgPOPD (Avg Population density of O and D zones)	HOV2	0.0866	2.3191
avgPOPD (Avg Population density of O and D zones)	HOV3	0.0866	1.#IO
avgNDENS (Avg network density of O and D zones)	Walk	0.59	3.3374
EMPOPR (Avg total population of O and D zones)	HOV2	-0.0741	-1.3228
EMPOPR (Avg total population of O and D zones)	HOV3	-0.2342	-1.4744
-- Model Statistics			
Log Likelihood at Zero		-2788.6197	
Log Likelihood at Constants		-963.4777	
Log Likelihood at Convergence		-948.2961	
Rho Squared w.r.t. Zero		0.6599	
Rho Squared w.r.t Constants		0.0158	
Adjusted Rho Squared w.r.t. Zero		0.6556	
Adjusted Rho Squared w.r.t Constants		0.0064	

**Calibrated Constants, original constants were -3.0348, -4.1443, and -3.5404 for HOV2, HOV3 and Walk initially.*

Table 39: Work Tour Non-Home-Based Trip Mode Choice

Variable	Mode Alternative	Parameter	t-statistic
-- Generic Parameters			
TravelTime		-0.0078	-1.9194
-- Alternative Specific Parameters			
CONSTANT	HOV2	-3.7016	*
CONSTANT	HOV3	-4.4848	*
CONSTANT	WALK	-5.9054	*
avgHHSize	HOV2	0.0935	1.1103
avgHHSize	HOV3	0.0935	Constrained
GasPrice	HOV2	0.144	1.0131
GasPrice	HOV3	0.144	Constrained
GasPrice	WALK	0.7716	2.4492
LOGK12 (Log of avg. K12 enrollment of O and D zones)	HOV2	0.1161	2.3902
LOGK12 (Log of avg. K12 enrollment of O and D zones)	HOV3	0.3759	4.7408
Adjfftime (Free flow travel time)	HOV3	-0.0078	**
avgNDENS (Avg. network density of O and D)	WALK	0.5347	6.3928
-- Model Statistics			
Log Likelihood at Zero		-3232.0006	
Log Likelihood at Constants		-1616.946	
Log Likelihood at Convergence		-1576.2782	
Rho Squared w.r.t. Zero		0.5123	
Rho Squared w.r.t Constants		0.0252	
Adjusted Rho Squared w.r.t. Zero		0.5086	
Adjusted Rho Squared w.r.t Constants		0.0195	

**Calibrated Constants, initial constants were -2.1754, -3.6665, and -5.9446, 1.92, 1.92 1.0288 for HOV2, HOV3,Walk, GasPrice HOV2, GasPrice HOV3, and GasPrice walk.*

***Asserted.*

The trip mode choice models for university student trips (**Table 40**) are usually calibrated than estimated, since they are supported by less data. A single model is used for both home-based and non-home-based trips including on-campus and off-campus trips. These university trips are full time students, as opposed to part time students whose university activities are made as part of

Work tours or Other tours. The University tour trip mode choice model differs from the Work, School (K12), and Other tour purposes in that it is applied to trips on all full-time university tours and not solely auto tours as with the other tour purposes. The SOV and HOV trips only are retained for vehicle trip assignment.

Table 40: Mode Choice for University Student Trips

Variable	Mode Alternative	Parameter	t-statistic
-- Generic Parameters			
avgACC		1.1576	1.3845
-- Alternative Specific Parameters			
CONSTANT	HOV2	-2.5	*
CONSTANT	HOV3	-1.7	*
CONSTANT	Walk	40	**
CONSTANT	Transit	-1.5	**
avgVEHpp (Avg veh per person of O and D zones)	HOV3	-18.2952	-2.7691
GasPrice	HOV3	0.2	**
avgVEHpp (Avg veh per person of O and D zones)	Transit	-0.688	**
GasPrice	Transit	0.2	**
avgADIV (Avg. activity diversity of O and D zones)	HOV2	-3.4859	-1.7399
avgADIV (Avg. activity diversity of O and D zones)	Walk	4.2106	**
WalkTime	Walk	-0.5	**
GasPrice	Walk	1.0	**
PctSdwlk (Avg pct Sidewalk of O and D zones)	Walk	1.667	**
avgNDENS (Avg. network density of O and D)	Walk	4.8245	1.3967
-- Model Statistics			
Log Likelihood at Zero		-197.3781	
Log Likelihood at Constants		-82.9208	
Log Likelihood at Convergence		-74.3544	
Rho Squared w.r.t. Zero		0.6233	
Rho Squared w.r.t Constants		0.1033	
Adjusted Rho Squared w.r.t. Zero		0.5878	
Adjusted Rho Squared w.r.t Constants		0.0531	

**Calibrated constants, -0.1311, 9.2967, -5.1735 were the originals for HOV2, HOV3.*

***Asserted.*

Trip mode choice for other school tours (**Table 41**) is predicted by multinomial logit models. For home-based trips, the probability of carpooling is increased by zonal average household size and by population density. Primary and secondary school enrollment likewise decreases the vehicle occupancy. This may seem counter-intuitive, but the locations for these trips, which are attracted to enrollment are already fixed, and here for trip mode choice, the enrollment generally is simply an indicator of the presence of a high school. High schools typically have significantly higher enrollment and are the only locations, which can attract students driving alone.

Table 41: School Tour Home-based Trip Mode Choice

Variable	Mode Alternative	Parameter	t-statistic
-- Generic Parameters			
-- Alternative Specific Parameters			
CONSTANT	HOV2	0.3190	*
CONSTANT	HOV3	-0.9574	*
CONSTANT	Walk	0.6186	*
avgHHSize	HOV3	0.5094	2.0759
LNWalkT (LN of walk time)	Walk	-0.7896	-2.2634
LogK12 (Log of avg. K12 enrollment of O and D zones)	HOV2	-0.1746	-1.5816
LogK12 (Log of avg. K12 enrollment of O and D zones)	HOV3	-0.2854	-2.5917
LogK12 (Log of avg. K12 enrollment of O and D zones)	Walk	-0.593	-2.1282
avgPOPD (Avg Population density of O and D zones)	HOV2	0.0005	4.9966
avgPOPD (Avg Population density of O and D zones)	HOV3	0.0003	2.8808
avgPOPD (Avg Population density of O and D zones)	Walk	0.0007	3.293
-- Model Statistics			
Log Likelihood at Zero		-574.4091	
Log Likelihood at Constants		-478.4688	
Log Likelihood at Convergence		-451.7694	
Rho Squared w.r.t. Zero		0.2135	
Rho Squared w.r.t Constants		0.0558	
Adjusted Rho Squared w.r.t. Zero		0.1944	
Adjusted Rho Squared w.r.t Constants		0.0388	

**Calibrated constants, -0.2137, -0.8754, -0.3461 were the originals for HOV2, HOV3, Walk.*

The model for non-home-based trips on school tours (**Table 42**) with an automobile also shows that higher vehicle occupancies are less likely where higher enrollment indicates the presence of a high school. It also shows that walking is more likely in accessible areas with good street connectivity.

Table 42: School Tour Non Home-Based Trip Mode Choice

Variable	Mode Alternative	Parameter	t-statistic
-- Generic Parameters			
avgACC		0.8345	2.8137
-- Alternative Specific Parameters			
CONSTANT	SOV	-6.959	**
CONSTANT	HOV2	-7.0168	*
CONSTANT	HOV3	-6.5147	*
CONSTANT	Walk	-9.0691	*
GasPrice	SOV	-0.3093	**
avg_K12 (Avg. K12 enrollment of O and D zones)	HOV2	-0.0012	-2.7637
avg_K12 (Avg. K12 enrollment of O and D zones)	HOV3	-0.0012	Constrained
avg_K12 (Avg. K12 enrollment of O and D zones)	Walk	-0.0032	-2.3716
EPDPPD (Pop and Employment Density of O and D)	HOV3	-0.048	*
EPDPPD(Pop and Employment Density of O and D)	Walk	-0.4747	*
avgNDENS (Avg network density of O and D zones)	Walk	1.4676	*
-- Model Statistics			
Log Likelihood at Zero		-386.2147	
Log Likelihood at Constants		-314.4336	
Log Likelihood at Convergence		-292.7951	
Rho Squared w.r.t. Zero		0.2419	
Rho Squared w.r.t Constants		0.0688	
Adjusted Rho Squared w.r.t. Zero		0.2108	
Adjusted Rho Squared w.r.t Constants		0.0398	

**Calibrated constants, -7.7218, 1.9885, -3.6372, 0.0001, -0.0006, and 1.1662 were the originals for HOV2, HOV3, Walk, EPDPP HOV3, EPDPP Walk, and avgNDENS Walk respectively.*

***Asserted*

As for other tour and trip types, increases in household size, gas price, and zonal employment increased the probability of shared ride. Activity diversity, gas price and network density had a positive relationship with walk/bike. The mode choice model for Other tour home-based trips is provided in **Table 43.**

Table 43: Other Tour Home-Based Trip Mode Choice

Variable	Mode Alternative	Parameter	t-statistic
-- Generic Parameters			
-- Alternative Specific Parameters			
CONSTANT	HOV2	-1.7023	*
CONSTANT	HOV3	-2.0796	*
CONSTANT	Walk	-7.7156	*
avgHHSize	HOV3	0.7086	5.0243
GasPrice	HOV2	0.1713	*
GasPrice	Walk	0.6789	*
avgHHVEH (Avg. HH vehicles of O and D zones)	HOV3	-0.3137	-1.987
logEMP (Avg. Log of total employment of O and D)	HOV2	0.2498	2.9446
logEMP (Avg. Log of total employment of O and D)	HOV3	0.2498	2.9446
avgADIV (Avg. activity diversity of O and D zones)	HOV2	-1.2562	-3.2967
avgADIV(Avg. activity diversity of O and D zones)	HOV3	-2.4761	-5.823
avgADIV(Avg. activity diversity of O and D zones)	Walk	2.8211	1.751
avgNDENS (Avg. network density of O and D zones)	Walk	0.5579	2.7357
-- Model Statistics			
Log Likelihood at Zero		-5381.346	
Log Likelihood at Constants		-4225.6695	
Log Likelihood at Convergence		-4182.2218	
Rho Squared w.r.t. Zero		0.2228	
Rho Squared w.r.t Constants		0.0103	

**Calibrated constants, -0.6447, -1.1026, -7.4777, 0.2284, 0.9053 were the original constants for HOV2, HOV3, Walk, HOV2, Walk.*

For non-home-based trips on other tours (**Table 44**), the log of K12 enrollment has a positive effect on shared ride and a negative one on walking. Population density increased shared ride but activity diversity did not.

Table 44: Other Tour Non-Home-Based Trip Mode Choice

Variable	Mode Alternative	Parameter	t-statistic
-- Logsum Parameters			
HOV		0.3248	-3.2101
-- Generic Parameters			
-- Alternative Specific Parameters			
CONSTANT	HOV2	-3.09626	*
CONSTANT	HOV3	-2.6525	*
CONSTANT	Walk	-5.27715	*
LNWalkT (LN of walk time)	Walk	-0.6564	-1.7727
GasPrice	HOV2	1.53	*
GasPrice	Walk	2.0476	3.878
LogK12 (Log of avg. K12 enrollment of O and D zones)	HOV2	0.0737	1.9321
LogK12 (Log of avg. K12 enrollment of O and D zones)	HOV3	0.0737	1.9321
LogK12 (Log of avg. K12 enrollment of O and D zones)	Walk	-0.8321	-1.3368
avgPOPD (Avg. population density of O and D zones)	HOV2	0.052	1.5388
avgADIV (Avg. activity diversity of O and D zones)	HOV2	-0.7263	-1.5599
avgADIV (Avg. activity diversity of O and D zones)	HOV3	-0.9498	-1.9652
-- Model Statistics			
Log Likelihood at Zero		-2862.3053	
Log Likelihood at Constants		-2262.1204	
Log Likelihood at Convergence		-2232.3113	
Rho Squared w.r.t. Zero		0.2201	
Rho Squared w.r.t Constants		0.0132	
Adjusted Rho Squared w.r.t. Zero		0.2156	
Adjusted Rho Squared w.r.t Constants		0.0087	

**Calibrated constants, -0.1505, 0.669, -5.8089, 0.2457 were the original constants for HOV2, HOV3, Walk, GasPrice HOV2.*

The results of the Trip Mode Choice models for base year 2010 are shown in Table 45.

Table 45: Modeled Trip Mode Shares by Tour Type for Auto Tours

Trip Mode on Auto Tours	I-69 Corridor Model 2010
Work Tour Non-Home Based Walk	1.3%
Work Tour Non-Home Based SOV	93.4%
Work Tour Non-Home Based HOV2	3.6%
Work Tour Non-Home Based HOV3	1.7%
Work Tour Home Based Walk	0.3%
Work Tour Home Based SOV	94.9%
Work Tour Home Based HOV2	3.4%
Work Tour Home Based HOV3	1.3%
School(K12) Non-Home Based Walk	2.4%
School(K12) Non-Home Based SOV	18.1%
School(K12) Non-Home Based HOV2	32.7%
School(K12) Non-Home Based HOV3	46.7%
School(K12) Home Based Walk	0.5%
School(K12) Home Based SOV	33.0%
School(K12) Home Based HOV2	35.4%
School(K12) Home Based HOV3	31.1%
Other Non-Home Based Walk	0.2%
Other Non-Home Based SOV	70.6%
Other Non-Home Based HOV2	15.9%
Other Non-Home Based HOV3	13.3%
Other Home Based Walk	0.7%
Other Home Based SOV	72.8%
Other Home Based HOV2	15.2%
Other Home Based HOV3	11.2%
Full Time University Transit	14.0%
Full Time University Walk/Bike	3.8%
Full Time University SOV	72.2%

Trip Mode on Auto Tours	I-69 Corridor Model 2010
Full Time University HOV2	8.3%
Full Time University HOV3	1.7%

4.14 Departure Time Choice

The I-69 corridor model includes departure time choice models, which distribute trips throughout the day. The models are capable of producing AM and PM peak period trip tables for assignment. The models were adopted from the 2012 Evansville Metropolitan Planning Organization model. The departure time choice models do not affect the daily assignments only the peak hour assignments that must be apportioned from the daily trip totals. The peak hour assignments were calibrated in part by adjusting the some of the departure time curves in the peak hour to reduce assignment error.

In addition to adding temporal resolution, the departure time choice models add sensitivity to new variables, most notably travel times and accessibility.

The models incorporate accessibility variables which allow departure times to vary geographically in the model, e.g., lower accessibility, rural travelers might generally leave for work earlier (since they have further to go to get to work).

The models are also sensitive to the distributions of population and employment, as in traditional models, so that trips on work tours tend to flow from residential areas to employment areas in the morning and vice versa in the evening, etc. However, this effect is accomplished differently in these models than in traditional models, through the use of a ‘return ratio’ variable. The ‘return ratio’ is not actually the ratio of inbound and outbound trips from home, but a related explanatory variable defined as the natural log of the ratio of the employment to population ratio at the origin versus the employment to population ratio at the destination. Hence, more residential destinations (smaller denominator) and more commercial origins (larger numerator) are associated with higher return ratios, so the model predicts more work/school-related trips later in the day; whereas, more commercial destinations (larger denominator) and more residential origins (smaller numerator) are associated with lower return ratios, so the model predicts more work/school-related trips earlier in the day.

Home-based and non-home-based trips for each tour type are represented by different models, since the first and last trips of a tour have different temporal distributions compared with mid-tour non-home-based trips. This is segmentation is particularly important for midday/lunch traffic which is associated primarily with shorter, mid-tour non-home-based trips, as opposed to the am and pm peaks which are more associated with longer home-based trips.

Differences in the timing of SOV and HOV trips are also reflected in the models through the incorporation a binary variable in the departure time choice models.

The distribution of traffic throughout the day is also indirectly responsive to a number of variables, which are not included in the departure time choice models directly but affect the number of trips and tours of various types. These variables include the number of workers, students, seniors, etc. These effects can be significant even though they are indirect, as the model will, for instance, reflect a decrease in am and pm peak departures with an increase in the number of seniors, since they generate fewer work tours.

The departure time choice models are multinomial logit pseudo-continuous discrete choice models. Although applied similar to typical MNL discrete choice models, the models are mathematically consistent with a continuous interpretation/representation of time. Models of this type have been used in some activity-based models, such as for San Francisco, and can theoretically be used to predict the number of trips for any arbitrary period of time, of any duration (see Abou Zeid et al., 2004). The consistency with a continuous treatment of time is accomplished through the interaction of explanatory bias variables with trigonometric functions of time. Although this results in a large number of variables, the number of variables is actually less than would be needed to incorporate the bias effects directly. Given this structure, the best measure of statistical significance of an explanatory variable is given by the chi-squared test on the full set of interaction terms. However, t-tests were still used to eliminate unnecessary terms wherever possible.

The trigonometric functions are identified in **Table 46** through **Table 52** by a suffix of one through six, which refers to the length of their period (e.g., SIN3). The postscript, P, is included in the trigonometric function (to produce periods of various lengths) in the following way:

$$SINP \stackrel{\text{def}}{=} \sin\left(\frac{2\pi \mathrm{P}}{24}\mathrm{t}\right)$$

where t is the time of the day in hours (and fractions of hours) from midnight.

Table 46: Estimated Departure Time Choice Model for Home-based Trips on Work Tours

Variable	Parameter	t-stat	Variable	Parameter	t-stat
-- Size Parameter					
SIZ	1	*			
-- Bias Parameters					
TTIME	-0.0761	-2.02	Dest. Accessibility x COS5	0.2375	3.84
SIN1	4.5109	4.1	ReturnRatio x SIN2	0.1006	6.75
SIN2	5.1547	3.92	ReturnRatio x SIN3	0.0807	5.88
SIN3	1.1117	1.61	ReturnRatio x COS1	-0.1143	-2.51
SIN4	-1.8233	-2.83	ReturnRatio x COS2	-0.1839	-4.41
SIN5	-1.2269	-1.79	ReturnRatio x COS3	-0.1844	-4.7
SIN6	-1.433	-3.7	ReturnRatio x COS4	-0.1299	-4.48
COS1	-0.3885	-0.69	ReturnRatio x COS5	-0.0692	-3.21
COS2	-5.6293	-3.86	HOV x SIN1	-0.3727	-3.19
COS3	-6.2058	-3.23	HOV x SIN5	-0.7726	-6.61
COS4	-4.9984	-3.37	HOV x SIN6	-0.7783	-5.56
COS5	-2.1274	-2.82	HOV x COS2	-0.7828	-4.78
COS6	-0.5161	-3.56	HOV x COS3	-0.8062	-4.13
Origin Accessibility x SIN 2	0.309	12	HOV x COS4	-1.2686	-4.77
Origin Accessibility x SIN 3	0.1339	6	HOV x COS5	-1.479	-5.92
Origin Accessibility x SIN 5	-0.1403	-6.23	HOV x COS6	-0.3192	-1.96
Origin Accessibility x COS1	-0.3705	-5.64	BRIDGES x SIN1	-3.1583	-2.73
Origin Accessibility x COS2	-0.5603	-8.66	BRIDGES x SIN2	-5.5073	-2.77
Origin Accessibility x COS3	-0.6508	-10	BRIDGES x SIN3	-7.7858	-2.91
Origin Accessibility x COS4	-0.4327	-8.67	BRIDGES x SIN4	-6.0898	-2.53
Origin Accessibility x COS5	-0.262	-7.44	BRIDGES x SIN5	-3.9419	-2.46
Dest. Accessibility x SIN1	-0.2666	-2.73	BRIDGES x SIN6	-1.832	-2.47
Dest. Accessibility x SIN2	-0.5187	-5.11	BRIDGES x COS3	1.4223	2.2
Dest. Accessibility x SIN4	0.3495	4.43	BRIDGES x COS4	2.7348	2.56
Dest. Accessibility x SIN5	0.271	3.22	BRIDGES x COS5	2.6918	2.75
Dest. Accessibility x SIN6	0.1518	3.19	BRIDGES x COS6	1.7201	2.43
Dest. Accessibility x COS2	0.6659	5.31			
Dest. Accessibility x COS3	0.8942	5.13			
Dest. Accessibility x COS4	0.6282	4.84			
-- Model Statistics					
Log Likelihood at Zero				-16132.24	
Log Likelihood at Constants				-14430.15	
Log Likelihood at Convergence				-14146.1	
Rho Squared w.r.t. Zero				0.1231	

** One size variable must be constrained, not all can be identified.*

Table 47: Estimated Departure Time Choice Model for Non-home-based Trips on Work Tours

Variable	Parameter	t-stat	Variable	Parameter	t-stat
-- Size Parameter					
SIZ	1	*			
-- Bias Parameters					
TTIME	0.1775	3.23	ReturnRatio x COS2	0.4216	4.37
SIN1	0.1504	0.15	ReturnRatio x COS3	0.4055	4.25
SIN2	-0.9092	-0.66	ReturnRatio x COS4	0.2551	4.03
SIN3	-2.4223	-2.42	ReturnRatio x COS5	0.0995	3.49
SIN4	-2.6949	-4.83	BRIDGES x SIN2	0.5489	3.17
SIN5	-0.8095	-2.72	BRIDGES x SIN5	-0.6056	-3.33
SIN6	-0.9351	-3.84	BRIDGES x SIN6	-0.3436	-2.25
COS1	-2.9706	-3.85	HOV x COS2	-1.9508	-9.44
COS2	-3.7152	-3.03	HOV x COS3	-1.6551	-5.81
COS3	-1.4399	-0.9	HOV x COS4	-1.3834	-4.9
COS4	0.1185	0.08	HOV x COS5	-0.9047	-3.78
COS5	0.2878	0.31	BRIDGES_SOV1	3.1269	3.37
COS6	1.1185	2.66	BRIDGES_SOV2	3.629	3.72
Origin Accessibility x SIN 2	0.1425	3.48	BRIDGES_SOV3	2.7463	3.44
Origin Accessibility x SIN 3	0.2547	4.66	BRIDGES_SOV6	-1.0467	-2.43
Origin Accessibility x SIN 4	0.1041	2.24	BRIDGES x COS1	5.0897	5.2
Origin Accessibility x COS3	-0.232	-4.93	BRIDGES x COS3	-2.2868	-3.95
Origin Accessibility x COS4	-0.279	-3.5	BRIDGES x COS4	-2.0159	-3.35
Origin Accessibility x COS5	-0.198		BRIDGES x COS5	-1.9864	-3.29
Origin Accessibility x COS6	-0.1448	-3.14			
Dest. Accessibility x SIN4	0.1363	5.54			
Dest. Accessibility x SIN6	0.0695	3.01			
Dest. Accessibility x COS1	-0.3744	-4.76			
Dest. Accessibility x COS2	-0.0885	-1.99			
ReturnRatio x SIN1	-0.1442	-2.05			
ReturnRatio x SIN2	-0.1315	-1.69			
ReturnRatio x SIN3	-0.0704	-1.72			
ReturnRatio x SIN6	0.0441	2.91			
ReturnRatio x COS1	0.2866	3.08			
-- Model Statistics					
Log Likelihood at Zero				-11595.59	
Log Likelihood at Constants				-11028.91	
Log Likelihood at Convergence				-10936.67	
Rho Squared w.r.t. Zero				0.0568	

** One size variable must be constrained, not all can be identified.*

Table 48: Estimated Departure Time Choice Model for Trips on University Trip Tours

Variable	Parameter	t-stat	Variable	Parameter	t-stat
-- Size Parameter					
SIZ	1	*			
-- Bias Parameters					
TTIME	-0.1875	-1.56	Dest. Accessibility x SIN5	-1.3077	-0.84
SIN1	-46.6015	-1.53	Dest. Accessibility x SIN6	-0.3878	-0.7
SIN2	-57.1636	-1.71	Dest. Accessibility x COS1	-1.2697	-0.72
SIN3	-32.981	-1.8	Dest. Accessibility x COS2	-3.2444	-0.69
SIN4	-5.6469	-0.35	Dest. Accessibility x COS3	-2.8721	-0.53
SIN5	5.7671	0.44	Dest. Accessibility x COS4	-1.3766	-0.38
SIN6	4.4052	0.9	Dest. Accessibility x COS5	-0.3176	-0.21
COS1	-0.4708	-0.03	Dest. Accessibility x COS6	-0.1396	-0.35
COS2	43.4057	1.02	ReturnRatio x SIN1	0.9907	0.57
COS3	61.6358	1.22	ReturnRatio x SIN2	1.237	0.63
COS4	46.9888	1.32	ReturnRatio x SIN3	1.2474	1.23
COS5	20.5049	1.32	ReturnRatio x SIN4	0.7202	0.89
COS6	5.8108	1.4	ReturnRatio x SIN5	0.0656	0.09
Origin Accessibility x SIN 1	3.7877	1.42	ReturnRatio x SIN6	-0.118	-0.4
Origin Accessibility x SIN 2	5.7746	1.77	ReturnRatio x COS1	-0.0554	-0.06
Origin Accessibility x SIN 3	4.6982	2.21	ReturnRatio x COS2	-0.5998	-0.25
Origin Accessibility x SIN 4	2.2489	1.82	ReturnRatio x COS3	-0.8355	-0.29
Origin Accessibility x SIN 5	0.4186	0.46	ReturnRatio x COS4	-1.147	-0.55
Origin Accessibility x SIN 6	-0.2616	-0.65	ReturnRatio x COS5	-0.8328	-0.89
Origin Accessibility x COS1	0.9727	0.72	ReturnRatio x COS6	-0.474	-1.9
Origin Accessibility x COS2	-2.1464	-0.65			
Origin Accessibility x COS3	-4.7157	-1.12			
Origin Accessibility x COS4	-4.6184	-1.41			
Origin Accessibility x COS5	-2.3941	-1.48			
Origin Accessibility x COS6	-0.6358	-1.35			
Dest. Accessibility x SIN1	1.6643	0.52			
Dest. Accessibility x SIN2	1.0314	0.32			
Dest. Accessibility x SIN3	-0.7293	-0.46			
Dest. Accessibility x SIN4	-1.6421	-0.85			
-- Model Statistics					
Log Likelihood at Zero				-1001.221	
Log Likelihood at Constants				-892.7591	
Log Likelihood at Convergence				-892.1926	
Rho Squared w.r.t. Zero				0.1089	

** One size variable must be constrained, not all can be identified.*

Table 49: Estimated Departure Time Choice Model for Home-based Trips on School Tours

Variable	Parameter	t-stat	Variable	Parameter	t-stat
-- Size Parameter					
SIZ	1	*			
-- Bias Parameters					
TTIME	-0.3017	-2.62	Dest. Accessibility x COS3	4.897	6.52
SIN1	28.7542	6.67	Dest. Accessibility x COS4	3.64	6.92
SIN2	35.7089	6.61	Dest. Accessibility x COS5	1.5486	6.41
SIN3	20.3265	6.94	ReturnRatio x SIN1	0.1093	3.86
SIN4	2.5732	3.3	ReturnRatio x SIN6	0.0635	2.2
SIN5	-5.8431	-5	ReturnRatio x COS5	-0.0582	-1.9
SIN6	-5.2509	-6.97	ReturnRatio x COS6	-0.036	-1.42
COS1	-13.1207	-5.48	BRIDGES x SIN2	-0.7963	-3.81
COS2	-35.4322	-7.09	BRIDGES x SIN3	-2.4447	-5.92
COS3	-43.8264	-6.9	BRIDGES x SIN4	-2.436	-6.47
COS4	-35.2228	-7.68	BRIDGES x SIN5	-1.6494	-6.36
COS5	-16.5408	-7.66	HOV x COS2	-1.5258	-7.14
COS6	-3.1687	-9.81	HOV x COS3	-1.6964	-6.88
Origin Accessibility x SIN 2	0.8928	11.3	HOV x COS6	0.797	5.25
Origin Accessibility x SIN 3	0.6262	9.14			
Origin Accessibility x SIN 5	-0.3131	-4.95			
Origin Accessibility x SIN 6	-0.3828	-5.93			
Origin Accessibility x COS1	-0.5251	-1.9			
Origin Accessibility x COS2	-0.9405	-3.92			
Origin Accessibility x COS3	-1.2665	-6.1			
Origin Accessibility x COS4	-1.038	-7.48			
Origin Accessibility x COS5	-0.5903	-5.97			
Dest. Accessibility x SIN1	-2.6129	-5.11			
Dest. Accessibility x SIN2	-3.9178	-6.17			
Dest. Accessibility x SIN3	-2.1852	-7			
Dest. Accessibility x SIN5	0.8544	6.17			
Dest. Accessibility x SIN6	0.7006	7.57			
Dest. Accessibility x COS1	1.1975	3.73			
Dest. Accessibility x COS2	3.7336	6.23			
-- Model Statistics					
Log Likelihood at Zero				-5773.793	
Log Likelihood at Constants				-4626.186	
Log Likelihood at Convergence				-4447.595	
Rho Squared w.r.t. Zero				0.2297	

** One size variable must be constrained, not all can be identified.*

Table 50: Estimated Departure Choice Model for Non Home-based Trips on School

Variable	Parameter	t-stat	Variable	Parameter	t-stat
-- Size Parameter					
SIZ	1	*			
-- Bias Parameters					
TTIME	-0.3017	-2.62	Dest. Accessibility x COS3	4.897	6.52
SIN1	28.7542	6.67	Dest. Accessibility x COS4	3.64	6.92
SIN2	35.7089	6.61	Dest. Accessibility x COS5	1.5486	6.41
SIN3	20.3265	6.94	ReturnRatio x SIN1	0.1093	3.86
SIN4	2.5732	3.3	ReturnRatio x SIN6	0.0635	2.2
SIN5	-5.8431	-5	ReturnRatio x COS5	-0.0582	-1.9
SIN6	-5.2509	-6.97	ReturnRatio x COS6	-0.036	-1.42
COS1	-13.1207	-5.48	BRIDGES x SIN2	-0.7963	-3.81
COS2	-35.4322	-7.09	BRIDGES x SIN3	-2.4447	-5.92
COS3	-43.8264	-6.9	BRIDGES x SIN4	-2.436	-6.47
COS4	-35.2228	-7.68	BRIDGES x SIN5	-1.6494	-6.36
COS5	-16.5408	-7.66	HOV x COS2	-1.5258	-7.14
COS6	-3.1687	-9.81	HOV x COS3	-1.6964	-6.88
Origin Accessibility x SIN 2	0.8928	11.3	HOV x COS6	0.797	5.25
Origin Accessibility x SIN 3	0.6262	9.14			
Origin Accessibility x SIN 5	-0.3131	-4.95			
Origin Accessibility x SIN 6	-0.3828	-5.93			
Origin Accessibility x COS1	-0.5251	-1.9			
Origin Accessibility x COS2	-0.9405	-3.92			
Origin Accessibility x COS3	-1.2665	-6.1			
Origin Accessibility x COS4	-1.038	-7.48			
Origin Accessibility x COS5	-0.5903	-5.97			
Dest. Accessibility x SIN1	-2.6129	-5.11			
Dest. Accessibility x SIN2	-3.9178	-6.17			
Dest. Accessibility x SIN3	-2.1852	-7			
Dest. Accessibility x SIN5	0.8544	6.17			
Dest. Accessibility x SIN6	0.7006	7.57			
Dest. Accessibility x COS1	1.1975	3.73			
Dest. Accessibility x COS2	3.7336	6.23			
-- Model Statistics					
Log Likelihood at Zero				-5773.793	
Log Likelihood at Constants				-4626.186	
Log Likelihood at Convergence				-4447.595	
Rho Squared w.r.t. Zero				0.2297	

** One size variable must be constrained, not all can be identified.*

Table 51: Estimated Departure Time Choice Model for Home-based Trips on Other Tours

Variable	Parameter	t-stat	Variable	Parameter	t-stat
-- Size Parameter					
SIZ	1	*			
-- Bias Parameters					
TTIME	-0.1293	-2.92	Dest. Accessibility x COS3	0.4874	6.97
SIN1	-3.8954	-2.93	Dest. Accessibility x COS4	0.6728	6.05
SIN2	-1.6067	-0.98	Dest. Accessibility x COS5	0.5654	6.39
SIN3	3.6235	2.82	Dest. Accessibility x COS6	0.1576	4.59
SIN4	4.8551	4.92	ReturnRatio x SIN1	0.1007	3.32
SIN5	2.6377	4.04	ReturnRatio x SIN2	0.0519	1.92
SIN6	0.2341	0.7	ReturnRatio x SIN3	-0.0674	-3.22
COS1	-1.8346	-3.77	ReturnRatio x SIN4	-0.0705	-3.39
COS2	2.9155	2.09	ReturnRatio x COS2	-0.1176	-4.05
COS3	3.8633	2.07	ReturnRatio x COS3	-0.1174	-4.47
COS4	0.4647	0.31	ReturnRatio x COS5	0.066	4.38
COS5	-2.1238	-2.56	ReturnRatio x COS6	0.0509	3.83
COS6	-1.307	-4.64	BRIDGES x SIN1	-2.8896	-5.98
Origin Accessibility x SIN 1	0.7209	4.54	BRIDGES x SIN2	-1.9793	-5.61
Origin Accessibility x SIN 2	0.8815	4.88	BRIDGES x SIN3	1.041	3.03
Origin Accessibility x SIN 3	0.1825	1.71	BRIDGES x SIN4	2.8275	4.68
Origin Accessibility x SIN 4	-0.3258	-3.65	BRIDGES x SIN5	1.9944	4.7
Origin Accessibility x SIN 5	-0.479	-6.08	BRIDGES x SIN6	0.6295	4.58
Origin Accessibility x SIN 6	-0.1974	-4.97	HOV x COS1	1.8091	4.65
Origin Accessibility x COS2	-0.8009	-5.34	HOV x COS2	4.2687	4.82
Origin Accessibility x COS3	-1.3216	-6.2	HOV x COS3	4.7919	5.25
Origin Accessibility x COS4	-0.9707	-6.2	HOV x COS4	2.4876	5.65
Origin Accessibility x COS5	-0.3907	-6.1	HOV x COS6	-0.4543	-4.41
Dest. Accessibility x SIN1	-0.3089	-4.67	BRIDGES_SOV1	-1.6755	-2.45
Dest. Accessibility x SIN2	-0.7659	-6.56	BRIDGES_SOV2	3.5492	3.65
Dest. Accessibility x SIN3	-0.7475	-5.88	BRIDGES_SOV3	7.3189	3.55
Dest. Accessibility x SIN4	-0.4437	-5.95	BRIDGES_SOV4	4.6967	3.67
Dest. Accessibility x SIN6	0.0892	3.47	BRIDGES_SOV6	-0.7086	-2.54
Dest. Accessibility x COS1	-0.2894	-5.73	BRIDGES x COS2	3.1381	3.14
			BRIDGES x COS4	-3.8874	-3.4
			BRIDGES x COS5	-2.805	-3.37
-- Model Statistics					
Log Likelihood at Zero				-5773.793	
Log Likelihood at Constants				-4626.186	
Log Likelihood at Convergence				-4447.595	
Rho Squared w.r.t. Zero				0.2297	

** One size variable must be constrained, not all can be identified.*

Table 52: Estimated Departure Time Choice Model for Non Home-based Trips on Other Tours

Variable	Parameter	t-stat	Variable	Parameter	t-stat
-- Size Parameter					
SIZ	1	*			
-- Bias Parameters					
TTIME	0.2536	3.6	ReturnRatio x COS5	0.1252	4.5
SIN1	-1.7207	-1.35	BRIDGES x SIN1	-0.8861	-9.54
SIN2	-1.5904	-1.14	BRIDGES x SIN2	-0.7323	-5.14
SIN3	-1.0401	-1	BRIDGES x SIN3	-0.4513	-3.27
SIN4	-0.296	-0.3	BRIDGES x SIN5	0.2295	2.76
SIN5	-0.6487	-0.99	HOV x COS3	0.5272	3.87
SIN6	-0.0075	-0.04	HOV x COS4	0.5711	3.23
COS1	-0.8502	-0.56	HOV x COS5	0.1728	1.69
COS2	-0.7439	-0.33	BRIDGES_SOV1	-57.6373	-2.36
COS3	-0.1846	-0.08	BRIDGES_SOV3	88.3398	2.48
COS4	-0.037	-0.02	BRIDGES_SOV4	84.9478	2.51
COS5	-0.4799	-0.79	BRIDGES_SOV5	28.0967	2.55
COS6	-0.2989	-2.03	BRIDGES x COS1	62.8001	2.55
Origin Accessibility x SIN 1	-0.1474	-2.36	BRIDGES x COS2	131.7242	2.48
Origin Accessibility x SIN 3	0.2333	2.33	BRIDGES x COS3	88.8834	2.5
Origin Accessibility x SIN 4	0.2137	1.76	BRIDGES x COS5	-29.9393	-2.71
Origin Accessibility x SIN 5	0.171	2.6	BRIDGES x COS6	-12.2068	-2.89
Origin Accessibility x COS1	0.4201	2.14			
Origin Accessibility x COS2	0.7054	3.02			
Origin Accessibility x COS3	0.3778	1.97			
Origin Accessibility x COS4	0.1493	1.78			
Dest. Accessibility x SIN1	0.0652	1.71			
Dest. Accessibility x COS1	-0.7916	-6.37			
Dest. Accessibility x COS2	-0.6171	-5.84			
Dest. Accessibility x COS3	-0.2827	-3.95			
Dest. Accessibility x COS4	-0.1601	-3.63			
ReturnRatio x SIN5	0.0577	2.33			
ReturnRatio x SIN6	0.0469	2.05			
ReturnRatio x COS2	0.033	1.67			
ReturnRatio x COS3	0.078	2.76			
ReturnRatio x COS4	0.1178	3.27			
-- Model Statistics					
Log Likelihood at Zero				-10643.86	
Log Likelihood at Constants				-10286.01	
Log Likelihood at Convergence				-10200.07	
Rho Squared w.r.t. Zero				0.0417	

4.14.1 External Trips

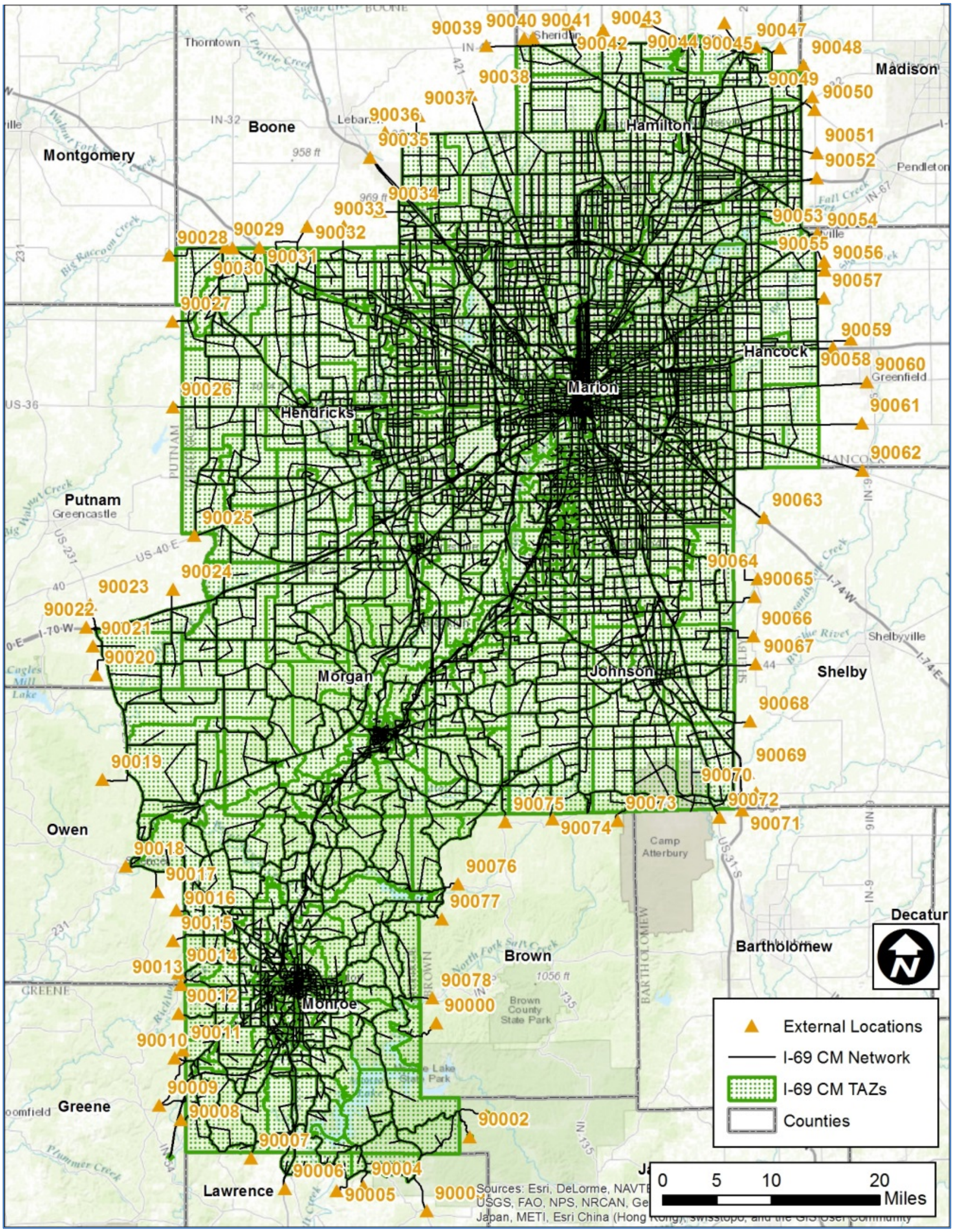
Trips with at least one trip-end outside the study area are considered external trips. External trips are further classified as External-Internal (EI) trips if only one trip-end falls outside the study area and as external-external (EE) trips if both trip-ends fall outside the study area. These external trips require special treatment in the travel demand modeling process. As outlined in the introductory section titled "Long Distance Demand Extraction from the Statewide Model", the Indiana Statewide Model version 7 was used to obtain auto and truck demand at the external loading points (stations) of the I-69 corridor model. **Figure 16** shows the location of the I-69 corridor model external stations.

The I-69 corridor model has 80 external stations where traffic can enter or exit the model's roadway network to and from the surrounding areas. The vehicle types are auto (which includes 4-tire commercial vehicles), single unit truck (SUT) and multiple unit truck (MUT).

The following steps were taken to create the input file of daily external trips for each vehicle type in the 2010 Base year:

- The ISTDM v7 was run with the highway and freight network assumptions for the 2010 base scenario.
- The output highway network and trip table from the ISTDM were input into a stand-alone tool used only for external demand input creation developed by CDM Smith for the Section 5 corridor model called The Corridor Disaggregate Tool. This sub-application disaggregated the ISTDM demand that had one or both ends outside of the I-69 corridor model. The tool translates the ISTDM external demand into an input trip table for the corridor model that is compatible with the finer resolution zone structure of the I-69 corridor model. The tool outputs a trip table containing the necessary matrices for external Auto, SUT and MUT. **Figure 3** and **Figure 4** help illustrate the disaggregation of external demand from the statewide to the corridor model.
- The 2010 observed AADT for Auto and Truck were coded onto the external station links of the I-69 corridor model where counts were available.
- The external demand tables were adjusted to ensure that the marginals (row and column totals) matched the observed AADTs at the corridor model external stations. This was accomplished by a manual process whereby the External to Internal (EI) as well as the Internal to External (IE) trips were factored and the External to External (EE) portion of the matrices were Fratar-adjusted to a new set of factored marginal equal to the observed AADT. The EI, IE, and EE portions of the matrix were then re-combined. This process ensured that the adjusted external demand retained the ISTDM's ratio of EI to EE for each marginal. This adjustment was performed once during the creation of the input external demand trip table, not during the course of a corridor model run.

Figure 16: I-69 Corridor Model External Stations



Sources: Esri, DeLorme, NAVTE… USGS, FAO, NPS, NRCAN, Ge… Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

- After the input external demand trip tables for the corridor model were created, the SUT and MUT external demand tables were assigned directly in the corridor model utilizing the distribution from the ISTDM. For Autos, only the EE portion of the table used the ISTDM distribution. The EI portion of the Auto external demand was distributed by the corridor model itself using a gravity model.

The following steps were taken to create the daily external trip table for each vehicle type in all future model years.

- The ISTDM v7 was run with highway and freight network assumptions consistent with the future I-69 corridor scenario. The ISTDM Build network included Section 6 of I-69. The ISTDM Build TAZs included the induced growth in households and employment allocated by the land use panels in addition to the No-build households and employment.
- The Corridor Disaggregate Tool is run to translate the external demand from the ISTDM to the corridor model as in the base year example.
- The future year external demand tables are proportionally adjusted based on the base year error with respect to AADT at the external stations. The adjustment is determined by the average of the absolute and percent of base year error at each individual external station as was determined in the base year example. The same method as the base year is used to adjust the tables, factoring the EI and IE portions of the matrices and Fratar adjusting the EE portion, to retain the EI to EE proportionality from the ISTDM. As in the base year this process is performed once to the input demand table, not during the course of a corridor model run.

As in the base year, the SUT and MUT external truck trips use the distribution from the external demand table which is derived from the ISTDM, as do the Auto EE trips. The magnitude of the Auto EI trips is obtained from the external demand table but distributed by the corridor model. The base year 2010 Daily volumes at the corridor model's external stations are shown in the table below. Some stations had no demand allocated from the ISTDM and were rural county/ local roads with no available observed count data. These stations were not assigned any external demand to the corridor model.

4.14.2 Internal Truck Model

Based on the method recommended in Quick Response Freight Manual (1996), a commercial vehicle model was developed for predicting trips for four-tire commercial vehicles, SUTs, and MUTs inside of the I-69 corridor model area. The model uses a four-step process. These steps are trip generation, distribution, choice of time-of-day and trip assignment.

The inputs to trip generation are the number of employees and the number of households by TAZ. The daily trip generation rates shown in **Table 53** and **Table 54** are for trip origins (O) and destinations (D). These rates were obtained by adjusting the original generation rates in the Quick Response Freight Manual. To replicate the current truck traffic condition in the study area, these rates were further adjusted by factors calculated using a genetic algorithm, with four-tire commercial vehicles adjusted by 0.10.

Table 53: Daily Four-Tire Vehicle Trip Generation Rates

Generator (Employment and Household)	Four-Tire Vehicle Trip Destinations (or Origins) per Unit per Day
Agriculture, Mining and Construction	1.11
Manufacturing, Transportation, Communications, Utilities & Wholesale Trade	0.938
Retail	0.888
Office and Services	0.437
Households	0.251

Table 54: Daily Truck Vehicle Trip Generation Rates

Generator (Employment and Household)	Commercial Vehicle Trip Destinations (or Origins) per Unity per Day	
	Trucks (Single Unit, 6+ Tires)	Trucks (Combination)
Agriculture, Mining and Construction	0.0613	0.4943
Manufacturing, Transportation, Communications, Utilities & Wholesale Trade	0.1205	0.0032
Retail	0.5297	1.5022
Office and Services	0.0002	0.1791
Households	0.6484	--

The productions of External-Internal and Internal-External (EI-IE) truck trips are obtained from the Indiana Statewide Travel Demand Model (ISTDM). The final daily truck trips are summarized in **Table 55**.

Table 55: Summary of Daily Truck Trip Generation

Trip Type	Number of Trips
4-tire Commercial Vehicle	96,292
Internal SU Truck	104,359
Internal MU Truck	38,176
EI-IE SU Truck	40,726
EI-IE MU Truck	150,868

A gravity model was employed to distribute internal truck zonal trip origins to destinations. The ISTDM was used to determine the trip distribution for the EI-IE truck trips as well as the EE truck trips.

For internal truck trips, friction factors recommended in Quick Response Freight Manual were used as a starting point and then adjusted to replicate the local traffic condition.

The Internal truck trip tables are factored into AM and PM peak hour tables using the factors in **Table 56** below which were calibrated heuristically through monitoring the peak hour assignment response. The AM and PM peak EI and EE trip tables are added to the internal peak truck share to create the total peak hour truck table.

Table 56: Truck Time of Day Factors

Period	4-Tire Com. Vehicle	Internal SU Truck	Internal MU Truck
AM	9.95%	5%	14%
PM	11.75%	3%	12.5%

For each assignment time period (daily, AM peak, and PM peak), a two-step assignment procedure is implemented. The first step, which is referred to as "priority pre-loading", is to assign the external trips and the truck trip tables onto the roadway network separately. Then the internal auto trips are assigned onto the network with considerations of these preloading volumes.

CHAPTER 5 – DAILY TRAFFIC ASSIGNMENT AND VALIDATION

A validation of the daily traffic for the I-69 Section 6 corridor model was performed to ensure the reasonableness of the model for use in producing forecasts for the I-69 Section 6 FEIS. Given this purpose, the validation focused on the four-county region including Hendricks, Johnson, Marion, and Morgan counties, which are the I-69 Section 6 study area.

The goal of validation is to document and reduce, where possible, the model's error or difference between modeled traffic volumes and observed traffic counts on the roadway network. Given the variability in traffic counts themselves and the numerous assumptions required as inputs to travel models, no model can achieve perfect "zero-error", rather a model is considered well-calibrated or validated when its errors fall within certain tolerance limits.

Various states such as Michigan, Ohio, Tennessee and Florida have adopted specific criteria which a model must meet in order to be considered validated. However, the new edition of FHWA's Travel Model Improvement Program's *Travel Model Validation and Reasonableness Checking Manual*[16] emphasizes the limitations of simple criteria for determining a model's validity and the need to evaluate a model's reasonableness in light of many considerations, some of which are difficult to quantify. In keeping with this, Indiana, like most states, does not have a set of defined numerical criteria for establishing a model's validation, but rather determines the validity of a model through professional judgment based on a thorough and balanced analysis of the model's error statistics.

The following section presents the validation of the I-69 Section 6 corridor model as used in conjunction with the statewide model for reproducing traffic flows in the I-69 Section 6 study area, and the four-county region specifically. Within this area, the model was validated against over 1,370 traffic counts collected by INDOT and local agencies, shown in **Figure 17**.

A script was used to generate error statistics for the:

- area as a whole,
- functional classes,
- volume group ranges,
- designated screenlines,
- designated corridors,
- area types, and
- counties

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[16] *Travel Model Validation and Reasonableness Checking Manual published by FHWA's Travel Improvement Program on September 24, 2010. Retrieved from* *http://media.tmiponline.org/clearinghouse/FHWA-HEP-10-042/FHWA-HEP-10-042.pdf*

Error statistics reported and used for diagnosing the possible sources of model error include:

- average percent error
- root mean square error
- mean absolute percentage error

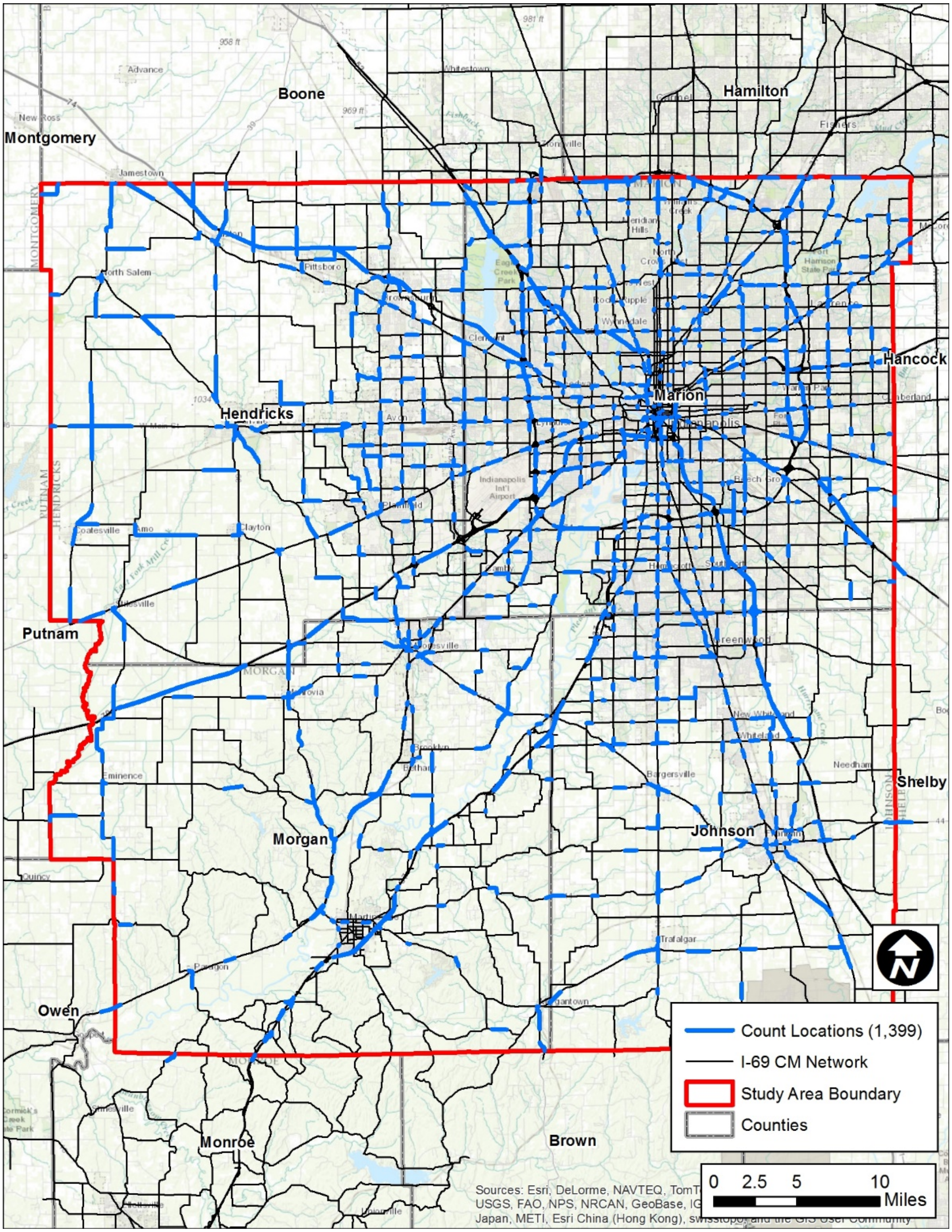
The simple average percent error of the model volumes versus traffic counts is straightforward to understand, but even it can be misleading as a very poor model can have 0% average error, as a result of over-loading and under-loading errors cancelling each other.

The percent root mean square error (% RMSE) is perhaps the most commonly used error statistic in validating traffic forecasting models and perhaps the single best overall error statistic for comparing loadings to counts since it does not allow errors of opposite sign to cancel each other. It has the following mathematical formulation:

$$\%RMSE = \frac{\sqrt{\frac{\sum(Count - Loading)^2}{Number\ of\ Observations}}}{Average\ Count} \times 100$$

The percent root mean square error (% RMSE) is perhaps the most commonly used error statistic in validating traffic forecasting models and perhaps the single best overall error statistic for comparing loadings to counts since it does not allow errors of opposite sign to cancel each other. It has the following mathematical formulation:

Figure 17: Daily Traffic Counts for Model Validation



Sources: Esri, DeLorme, NAVTEQ, TomT
USGS, FAO, NPS, NRCAN, GeoBase, IG
Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

$$\%RMSE = \frac{\sqrt{\frac{\sum(Count - Loading)^2}{Number\ of\ Observations}}}{Average\ Count} \times 100$$

The Mean Absolute Percentage Error (MAPE) has also been included as complimentary to the RMSE and representative of the absolute error based goodness-of-fit statistics. It is becoming a common error statistic in many other forms of computer modeling. It complements the RMSE in that the RMSE treats larger volumes as more important (i.e., it's most important to have Interstates right, not so important to have local street right); whereas, the MAPE treats all observations/errors equally. The MAPE is calculated using the following formula:

$$MAPE = \frac{\left|\frac{Count - Loading}{Count}\right|}{Number\ of\ Observations}$$

Error statistics by functional class, area type, and overall are presented in **Table 57**. The model error statistics look quite reasonable overall. Urban area models are frequently considered well validated when their %RMSE is in the low thirties; whereas, larger regional and statewide models are generally expected to have somewhat higher errors. The I-69 Section 6 corridor model with the statewide model inputs is well validated with a 35.97 % RMSE, achieving urban model validation standards in 4-County region counties overall despite the largely rural character of Morgan and Johnson Counties.

Table 57: Error Statistics by Functional Class for 4-County Region

Class	Area	# of Obs.	Mean Count	Mean Modeled	% Error	% RMSE	MAPE
Interstate	Urban	121	47,520	49,891	4.99%	11.38%	9.71
	Rural	26	25,794	24,983	-3.15%	9.85%	10.08
Other Freeway	Urban	37	15,370	14,458	-5.93%	18.20%	16.87
Principal Arterials	Urban	321	20,892	18,753	-10.24%	35.83%	30.02
	Rural	54	12,269	12,067	-1.64%	16.74%	13.49
Minor Arterials	Urban	304	13,918	13,349	-4.09%	50.99%	46.82
	Rural	66	9,442	8,597	-8.95%	36.33%	31.79
Collectors	Urban	157	6,859	8,252	20.31%	64.00%	72.73
	Rural Major	192	4,498	5,642	25.42%	60.82%	81.86
	Rural Minor	62	4,179	4,612	10.38%	65.96%	86.57
Locals	Urban	9	5,912	6,193	4.75%	89.49%	49.96
	Rural	21	1,570	1,650	5.11%	38.10%	36.89
All		1370	15,627	15,467	1.04%	35.97%	45.62

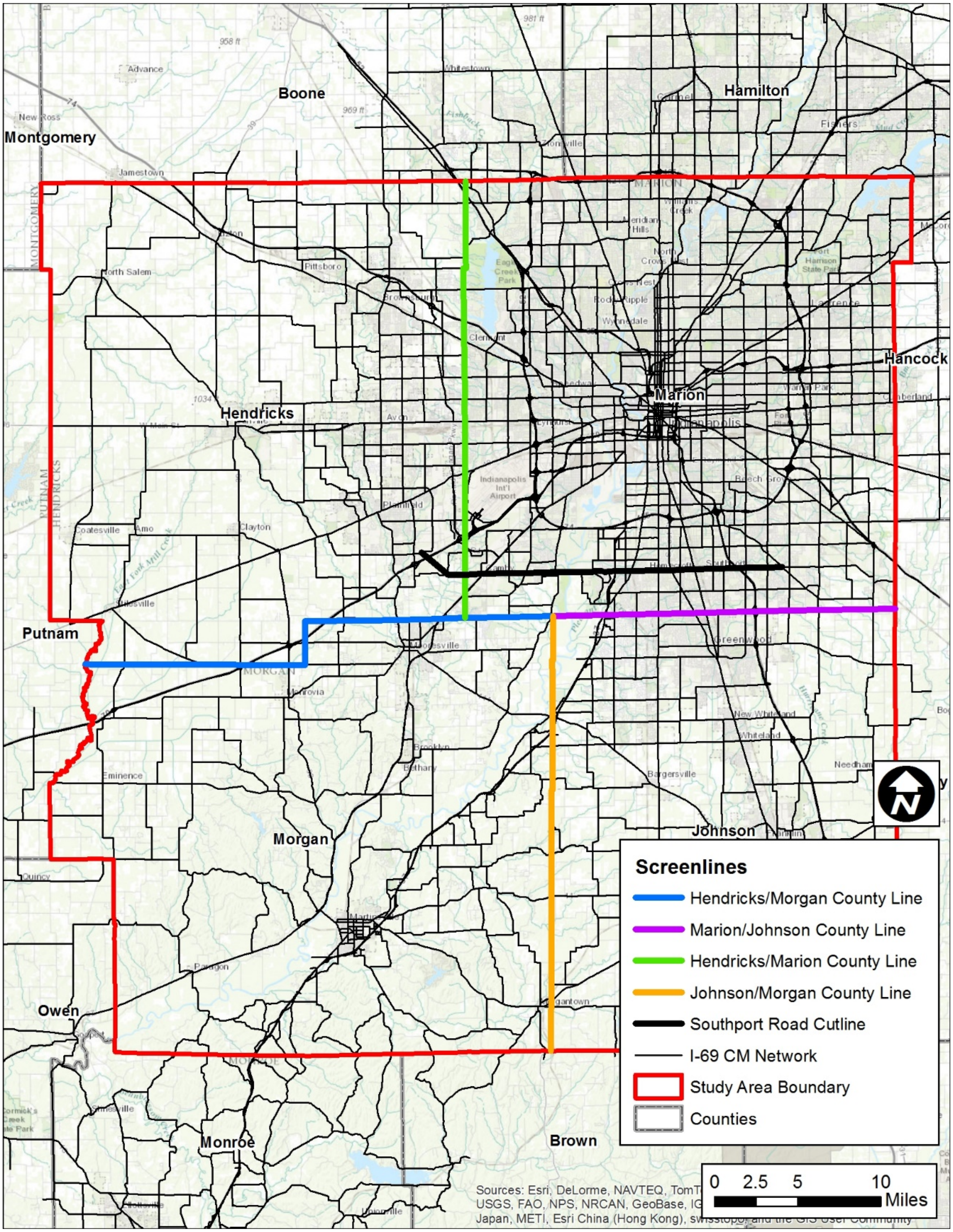
The errors by volume group are given in **Table 58**. In interpreting, it is important to note that the counts on divided facilities are treated separately (i.e., a separate comparison is made for northbound and southbound segments on these facilities). The table displays the expected general pattern of higher errors on lower volume groups and decreasing errors on higher volume groups.

Four "screenlines" and one cutline were also used to validate the origin-destination patterns and traffic flows in the corridor model. **Figure 18** presents the screenlines and cutline used in the corridor model. The results, displayed in **Table 59**, show that the screenline errors also demonstrate the model's validity.

Table 58: Error Statistics by Volume Group for the 4-County Region

Volume Group	# of Obs.	Mean Count	Mean Load	% Error	% RMSE	MAPE
0 to 500 AADT	18	351	1,047	198.32%	373.10%	223.14
501 to 1,000 AADT	44	788	1,968	149.68%	279.46%	164.50
1,001 to 2,000 AADT	77	1,455	2,682	84.26%	147.32%	104.68
2,001 to 3,000 AADT	71	2,424	4,363	79.95%	160.53%	100.34
3,001 to 4,000 AADT	59	3,460	4,604	33.06%	81.68%	57.26
4,001 to 5,000 AADT	77	4,499	6,109	35.79%	77.07%	56.71
5,001 to 6,000 AADT	50	5,467	6,577	20.30%	66.81%	46.79
6,001 to 8,000 AADT	108	6,851	7,799	13.83%	47.06%	38.31
8,001 to 10,000 AADT	113	9,080	9,106	0.28%	49.48%	38.21
10,001 to 12,000 AADT	110	10,899	11,734	7.66%	35.27%	26.71
12,001 to 15,000 AADT	138	13,498	13,460	-0.28%	36.28%	24.80
15,001 to 20,000 AADT	126	17,243	14,618	-15.23%	36.15%	28.81
20,001 to 25,000 AADT	106	21,784	18,092	-16.95%	35.06%	28.47
25,001 to 30,000 AADT	71	27,402	24,692	-9.89%	33.01%	25.21
30,001 to 40,000 AADT	109	33,815	31,610	-6.52%	29.44%	20.91
40,001 to 50,000 AADT	47	44,436	45,892	3.28%	13.84%	10.20
> 50,000 AADT	55	61,097	63,521	3.97%	9.90%	7.68

Figure 18: Corridor Model Screenlines



Sources: Esri, DeLorme, NAVTEQ, TomTom, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Table 59: Model Screenline/Cutline Comparison

Screenline/Cutline	Number of Observations	Length	Count Volume	Model Volume	% Error
Hendricks-Marion Co. Line	17	17.09	289,953	315,734	-8.17%
Hendricks-Morgan Co. Line	11	18.70	128,028	123,960	3.28%
Johnson-Marion Co. Line	10	3.35	239,209	233,847	2.29%
Johnson-Morgan Co. Line	7	3.30	44,044	43,639	0.93%
Southport Rd.	12	6.88	276,741	271,709	1.85%

Errors are also reported specifically for the SR 37 corridor and various subsections of it throughout the three counties in **Table 60.** The analysis shows that the model volumes and the traffic counts are similar on SR 37, which is the primary focus of this modeling effort.

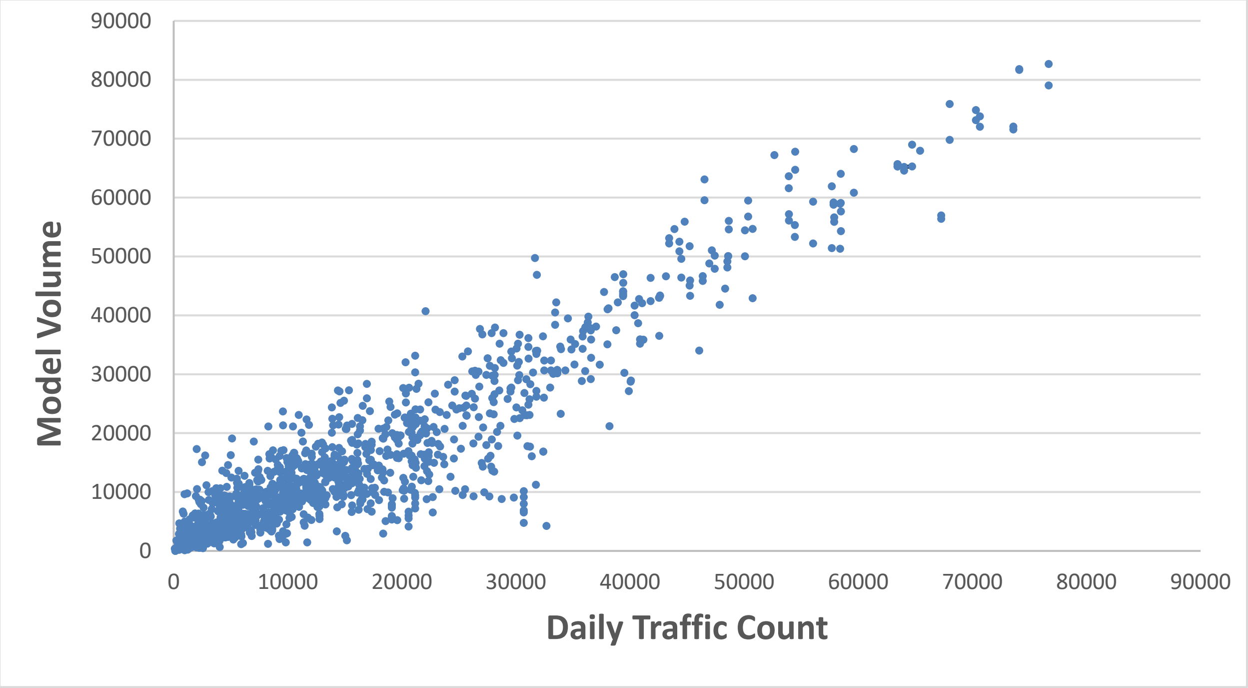
Table 60: SR 37 Modeling Output

Corridor	Number Of Observations	Length	Count Volume	Model Volume	% Error	% RMSE
SR 37	66	23.80	859,730	836,772	2.74%	11.48%
- in Marion County	20	5.33	232,836	240,941	-3.36%	8.94%
- in Johnson County	12	2.79	263,946	255,404	3.34%	9.27%
- in Morgan County	34	15.68	362,948	340,427	6.62%	14.47%

A scatterplot compares the model volumes versus the traffic counts in **Figure 19.** It is clear that the points are clustered reasonably closely to the diagonal, visually confirming the model's goodness of fit.

Overall, the I-69 model performs well in 4-Counties region and achieves a 35.97 % RMSE, compared to 33.3 % RMSE of the ISTDM and 40.4 % of the Indianapolis MPO model. Error statistics by functional class, volume group, screenline and specifically on the SR 37 corridor all confirm that the model's errors are well within acceptable ranges and generally not statistically significant. Visual examination of the scatterplot of model volumes versus counts further confirms this. It is therefore reasonable to conclude that the I-69 Section 6 corridor model with inputs from the statewide model is well calibrated and validated by observed traffic counts in Hendricks, Marion, Johnson, and Morgan Counties.

Figure 19: Model Volume vs. Daily Traffic Counts



Validation of the I-69 Section 6 corridor model was discussed in a series of meetings held throughout 2015 and 2016 with the FHWA (Indiana Division and Resource Center), INDOT and the Indianapolis MPO (IMPO). Summaries of each meeting are provided in **Appendix A** of this document.

I-69 corridor model RMSE values were discussed at meetings in April and May 2015 and considered acceptable. The overall model RMSE in the four-county region is 36%, and the RMSE of the higher-functional classification facilities is approximately 15%.

Additional validation was conducted in May through July of 2017, in conjunction with focused evaluation of 2045 no-build and build alternative forecasts in Marion County. Comparison of I-69 corridor model forecasts with historic counts and with 2035 forecasts from the ISTDM and IMPO travel demand model raised questions that warranted further investigation, particularly along I-465. Forecasts outside of Marion County were considered acceptable. The primary issues that were investigated are summarized below and described in more detail in the meeting minutes.

- Total volumes at locations in Marion County. During review of 2045 I-69 corridor model forecasts in Marion County, discrepancies among forecasts from the three travel demand models were observed at a few locations. US 31 and I-65 south of I-465 were the primarily locations discussed. These locations were reviewed and acceptable explanations were identified or adjustments were made to the corridor model. The I-65 volume differences were due to the I-69 corridor model incorporating more recent assumptions about I-65 capacity than the IMPO model. The volume differences on US 31 were partially due to this same issue and due to a link speed coding error on US 31 that was corrected.

- Freeway truck volumes in Marion County. I-69 corridor model truck volume forecasts on portions of I-70 and I-465 in southwest Marion County appeared to be low compared to 2035 ISTDM forecasts. In response to this observation, the consultant team conducted additional model validation focused on truck volumes. Findings and adjustments were as follows:
    - The ISTDM considers FHWA vehicle classes 3-13 to be trucks, while the I-69 corridor model only considers vehicle classes 5-13 to be trucks. Thus the ISTDM would appear to report higher truck volumes than the corridor model even if there were no differences. This explained much of the apparent observed differences.
    - Some adjustments were made to the I-69 corridor model traffic analysis zone structure and network loading in the vicinity of the Indianapolis International Airport to better reflect actual conditions. This improved the correspondence between the corridor model and ISTDM truck volumes in this area. Still, the ISTDM lacks the local road network detail of the I-69 CM and may thus be overestimating trucks on the freeway network in the airport vicinity.
    - The ISTDM uses special truck trip generators in the vicinity of the airport that are not used in the I-69 CM.

  After investigation of this issue and minor adjustments to the I-69 corridor model, it was agreed that the truck forecasts are sufficient for use in the FEIS.

- I-465 counts adjustments. A review of historic counts along I-465 between I-70 and I-65 shows great variability in traffic volumes over the past several years. This is thought to be primarily due to several large construction projects that have affected traffic flow through the area—either increasing or decreasing I-465 traffic volumes. The I-69 corridor model and the ISTDM were both calibrated using counts from 2010 and 2011, years when some I-465 counts were thought to be low due to nearby construction. This has resulted in 2025 and 2045 traffic forecasts for some locations on I-465 that show little growth when compared to more recent 2015 and 2016 traffic counts.

  After the DEIS was submitted, 2017 traffic counts were released along the I-465 corridor. For the FEIS, based on INDOT's recommendations, the 2010 I-69 CM modeled volumes along I-465 were adjusted to closely match the 2016/2017 traffic counts. The count dates and truck count information were also adjusted based on INDOT staff recommendations. For the FEIS, the 2010 and forecast year volumes (2025 and 2045) were readjusted to account for the revised count information. The change between the 2010 modeled volume and the observed counts (the "delta") was calculated using the ratio method (percentage difference) and the difference method (absolute difference). Considering the benefits and drawbacks of each method, a delta value was estimated for each segment. This delta was carried forward and applied to the forecast year modeled volumes (2025 and 2045) to establish adjusted forecast volumes. This methodology is consistent to the process recommended in NCHRP Report 765: “Analytical Travel Forecasting Approaches for Project-Level Planning and Design”. The detailed project level volume forecasting methodology in presented in Appendix F.

CHAPTER 6 – POST PROCESSING

During the I-69 corridor modeling process, the assigned model networks were post-processed to produce data related to vehicle miles traveled, vehicle hours traveled, road level of service designation, crash estimates, and energy consumption. A tool called Post_Alt was developed to generate this data from the completed corridor model assignments. The methods used in the Post_Alt tool are described in the paragraphs below.

6.1 VHT and VMT Estimates

VHT and VMT estimates from Post_Alt are calculated using the distance, time, and assigned volume attributes of the assigned highway networks. The GIS based TransCAD platform on which the I-69 corridor model is built makes this calculation very straightforward. VHT and VMT can be easily stratified by highway link level of service once that attribute has been added onto each network link by Post_Alt.

6.2 Crash Estimates

The crash calculations in Post_Alt are based largely on two methods of hazard analysis, Road HAT (A. Tarko, Purdue University) and the Interactive Highway Safety Design Model (IHSDM)/Highway Safety Manual (HSM). Factors from published INDOT crash rates were used to calibrate the crash tool for a previous model. The tool calculates mainline crashes and intersection crashes using a variety of physical facility attributes, speeds, and assigned volumes. The output is in annual crashes by severity, fatal, personal injury and property damage only. In **Table 61**, a comparison of the published annual crash rates[17] for Hendricks, Johnson, Marion, and Morgan Counties and the base year 2010 I-69 corridor model results shows a close replication of the total crashes by category. Crash predictions generated by Post Alt were useful in estimating the overall safety benefits of I-69 Section 6 and comparing the benefits among preliminary alternatives that used different routes through the study area. The Post Alt methodology was not used for comparing the safety of the reasonable alternatives for I-69 Section 6, which are all routed in the SR 37 corridor and have only minor differences in design and connectivity. This analysis was conducted using the IHSDM software, as described in **Section 5.6**.

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[17] *Observed crashes are published in Indiana Crash Facts 2010. Retrieved from http://www.in.gov/cji/files/T_Fact_Book_2010.pdf.*

Table 61: Comparison of Post_Alt Crash Results to Observed Crash Data

Crash Type	Hendricks County		Marion County		Morgan County		Johnson County	
	Observed	2010 Post_Alt I-69 CM	Observed	2010 Post_Alt I-69 CM	Observed	2010 Post_Alt I-69 CM	Observed	2010 Post_Alt I-69 CM
Fatal Crashes	11	22	71	48	3	10	9	19
Personal Injury Crashes	591	745	5084	5334	324	334	614	705
Property Damage Only Crashes	2874	2845	22364	22432	1205	1237	2363	2795
Total Crashes	3476	3612	27519	27814	1532	1582	2986	3519

6.3 Energy Consumption Estimates

Post_Alt calculates vehicle fuel consumption using FHWA’s Highway Economic Requirements System based on methodology in the HERS Tech Report v3.45. The methodology calculates fuel consumption and cost based on an assumed breakout of auto and truck vehicle class distribution as well as differentiating between running consumption and stopping consumption. The 2010 fuel cost parameters were $3.24 per gallon of gasoline and $3.52 per gallon of diesel. Assumptions about fuel usage were that all Autos used gasoline, single unit trucks used 70% gasoline and 30% diesel, while multi-unit trucks used 100% diesel. The output of the energy consumption estimate is in gallons and dollars per day by vehicle type: auto, SUT, and MUT.

APPENDIX A

Meeting Summaries, INDOT and FHWA Coordination on Model Development

Appendix A Meeting Summaries

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FINAL MEETING MINUTES

Section 6 Travel Demand Modeling Coordination Meeting

HNTB 11th Floor Main Conference Room

March 16, 2015 at 2 p.m. EDT

Attendee	Organization
Sarah Rubin (via phone)	INDOT
Roy Nunnally (via phone)	INDOT
Anna Gremling (via phone)	Indianapolis MPO
Andrew Swenson	Indianapolis MPO
Catherine Kostyn	Indianapolis MPO
Bill Wiedelman	HNTB
Matt Miller	HNTB
Sarah Baty	HNTB
Chris Beard	Lochmueller Associates

I. I-69 Corridor Modeling Status Update and Schedule

- Chris Beard discussed the I-69 Corridor model. Model calibration to existing traffic volumes is complete, and interim 2045 traffic forecasts have been developed for No Build and multiple build configurations. Build models have been run for an I-69 configuration that remains on SR 37 through Section 6, one that leaves SR 37 to tie into I-70 and one the leaves SR 37 to tie into I-65. Minor tweaking is ongoing.
- The updated ISTDM received from INDOT at the end of January has been run to provide external inputs for the I-69 Corridor model. This includes revisions to the future network made by INDOT. Chris confirmed to the MPO that the project to widen I-70 west of the Indianapolis Airport is no longer included in the future I-69 Corridor model network.
- The I-69 consultants will update the draft memo of projects included in the 2045 No Build network to reflect input from INDOT.
- The I-69 Corridor model includes all of Hendricks, Johnson, Marion and Morgan Counties, plus parts of other counties in the Indianapolis Metropolitan Area.
- The interim forecasts developed for the I-69 Corridor model use straight line extrapolation of 2010-2035 growth trends for socio-economic data from the ISTDM. Population and employment inputs to the MPO model and the ISTDM were reviewed during development of the interim I-69 model. Population forecasts were similar, but employment forecasts differed significantly between the ISTDM and the MPO model. During a January 23, 2015 conference call with INDOT and MPO staff, it was decided to use the ISTDM forecasts as the basis of the I-69 interim model.
- Roy Nunnally noted that the differences between the MPO model and ISTDM could be because the ISTDM includes induced demand from construction of the I-69 project. REMI modeling and land use panels were used to estimate the project impacts. INDOT used to maintain separate model layers reflecting conditions with and without induced

travel demand, but no longer maintains the layer without induced demand after the 2020 forecast year.

- Andy Swenson was not aware that INDOT was including induced demand in their ISTDM forecasts. He will request clarification from INDOT via e-mail.
- Modeling to support evaluation of I-69 S6 Conceptual Alternatives is expected to be complete by April 2015. Modeling to support more detailed Preliminary Alternatives will be conducted during the Summer of 2015, and modeling to support evaluation of the Reasonable and Feasible Alternatives (those advanced to the DEIS) will begin in the Fall of 2015. The draft agenda distributed before the meeting had the latter two dates reversed, but a corrected agenda was provided at the meeting and is attached.

II. 2045 Population and Employment Forecasts

- The I-69 consultants expect that INDOT and the MPO will provide updated 2045 population and employment forecasts for use in modeling the Reasonable and Feasible Alternatives for the I-69 DEIS. These forecasts are needed to replace the interim straight line forecasts described above. The forecasts are needed by September 2015 to meet the I-69 project schedule.
- The MPO expects to be able to provide 2045 population and employment forecasts to the I-69 consultants within the desired timeframe. The MPO has started development of the UrbanSim model as a tool to allocate population and employment growth within the metro area. They were previously using LUCI2, but found that it is too simplistic and doesn’t account for induced demand. The MPO anticipates initial UrbanSim model runs to be conducted this Summer, with fine-tuning through the Fall. The modeling will support development of the Long Range Transportation Plan update (Ryan Wilhite, project manager).
- Andy Swenson noted that forecasts from the MPO model and the ISTDM are often quite similar, citing the I-65 Worthsville Road interchange as an example. Roy Nunnally agreed and stated that INDOT sometimes uses the MPO model instead of the ISTDM because it has denser network in the urban area.
- INDOT is not currently working to update the ISTDM from a 2035 forecast year to a 2045 forecast year. Roy expects that a consultant contract to perform this work is 6-8 months away. He expects this will include Tredis forecasts at the county level. INDOT has previously worked in conjunction with MPOs to allocate growth, using a rating system of Low, Medium and High growth.
- The I-69 consultants will provide INDOT with a proposed approach to develop the required population and employment forecast information needed to run the I-69 Corridor model and evaluate the Reasonable and Feasible Alternatives. This will be done within the next 30 days and sent to INDOT and the MPO for review.
- Statewide and county population forecasts to 2050 are currently available from the Indiana Business Research Center (contact Carol Rogers?). A source of employment forecasts through 2045 is not certain. It is possible the Woods & Poole has forecasts that can be used if 2045 forecasts are available now or soon.

III. Economic Analysis Method

- Chris Beard discussed a proposed approach to economic analysis for the I-69 project that would use a combination of the Tredis model and land use panels to allocate growth. Tredis accounts for the impacts of the project on existing residential and businesses. It does not account for redistribution of growth within the metro area however. The land use panels would be expected to help identify how I-69 could reallocate anticipated growth at a regional and local level.
- Land use panels would be composed of planners, land use specialists, possibly developers and elected officials.
- The MPO expects to use land use panels, along with the Indianapolis Regional Transportation Council, for its work. Andy has provided Chris Beard with a list of potential names for an I-69 land use panel.
- The I-69 consultants will recommend I-69 Section 6 land use panel membership for review by INDOT and the MPO.

Action Item	Responsible Party	Due Date
HNTB	Update and re-submit draft No Build Projects memo to INDOT	4/1/15
HNTB	provide proposed approach to develop population and employment forecasts for Reasonable and Feasible Alternatives evaluation	4/17/15
HNTB	recommend I-69 Section 6 land use panel membership	4/17/15

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

FINAL MEETING MINUTES

Section 6 Travel Demand Modeling Coordination Meeting

HNTB 11th Floor Main Conference Room

April 22, 2015 at 9 a.m. EDT

Attendee	Organization
Kevin Hetrick	INDOT
Sarah Rubin (via phone)	INDOT
Roy Nunnally (via phone)	INDOT
Korey Chu (via phone)	INDOT
Sarah Ornelas (via phone)	INDOT
Andrew Swenson	Indianapolis MPO
Catherine Kostyn	Indianapolis MPO
Larry Heil	FHWA
Bill Wiedelman	HNTB
Matt Miller	HNTB
Sarah Baty	HNTB
Chris Beard	Lochmueller Associates
Chris Joannes	Lochmueller Associates
Udit Molakatalla	Lochmueller Associates

I. 2010 Base Year Validation

- Chris Beard discussed the 2010 Corridor Model calibration. The percent error, RMSE and MAPE were presented. The lowest error is on higher functional class facilities.
- Lochmueller investigated high RMSE on arterials that was questioned previously by Roy. RMSE was incorrectly including arterials outside of the 4-county study area. The corrected RMSE is better.
- Screenline volumes at Southport Road show the Section 6 model better matches counts at this location than the Section 5 model did.
- The I-69 consultant will request validation statistics for the ISTDM and the MPO model for comparison with the I-69 model.

II. 2045 Population and Employment Forecasts

- The interim forecasts developed for the I-69 Corridor model use straight line extrapolation of 2010-2035 growth trends for socio-economic data from the ISTDM and the Indianapolis MPO travel demand model. Population forecasts from the ISTDM and MPO model were similar, and MPO numbers were used. ISTDM employment forecasts were higher than MPO forecasts, and ISTDM forecasts were used based on previous discussions with INDOT and the MPO.
- Both INDOT and the MPO will be updating their models in the next year and extending forecast to 2045. However, it is unlikely that updated population and employment forecasts for these models will be completed in time for use by the I-69 project team in

their modeling. The forecasts would need to be complete by the fall of 2015 to meet the I-69 project schedule

- The I-69 consultant will recommend a procedure for developing 2045 population and employment forecasts for use in the I-69 corridor model. This will be provided to INDOT and the MPO for review.
- There was discussion of using a land use panel to help in the distribution of population and employment growth to model traffic analysis zones. The MPO plans to use a panel during its model update, and Andy Swenson thought it would be beneficial to use some of the same people for the I-69 land use panels. The land use panels currently included in the I-69 EIS scope of work will be used to evaluate induced growth.
- TheI-69 consultant will provide the MPO with TAZ information from the I-69 corridor model.

III. 2045 No-Build Forecast

- The No Build forecast shows that key Interstate system will be congested, including I-465 east of SR 37, I-70 west of SR 267 and I-65 near I-465.
- SR 37 north of Martinsville does not show unacceptable congestion, but the LOS generated by the travel demand model underestimates arterial congestion at signalized intersections. This will be evaluated in more detail as the study progresses.
- The external trips used in the I-69 corridor model were generated from ISTDM runs that include I-69 Section 6 as built.
- In the 2045 No-Build scenario, I-69 Section 5 is assumed to be a 4-lane freeway, but could require 6 lanes. Kevin Hetrick confirmed that this capacity expansion would be the responsibility of INDOT rather than the I-69 Section 5 developer.
- The I-69 corridor model will be updated as needed during the EIS process to reflect changes to the MPO TIP, the INDOT STIP and the INDOT 5-Year Construction Plan. A 2016 – 2019 TIP & STIP are expected this summer.
- Larry Heil discussed changes occurring in air quality requirements. New ozone standards are expected by the end of 2015, and PM 2.5 requirements could change also. It is possible that hot spot analysis may not be required for this EIS.

IV. 2045 Build Forecast

- SR 37 LOS north of SR 144 is worse under the Build alternative because the comparison of freeway LOS to arterial is misleading. A more understandable presentation of information will be developed for public meetings.
- The LOS on I-465 near the I-69 interchange improves under the Build Alternative because that segment of I-465 is widened with the project.
- Total volume on the model network increases in the Build alternative. This is at least partially due to traffic diverting from local roads to higher class facilities that are included in the screenline total.
- Although there is no meaningful impact on overall study area congestion, travel times from Martinsville to Indianapolis are faster with the construction of I-69 Section 6

V. Upcoming Schedule

- An agency coordination meeting will be held on April 30, and stakeholder and public meetings will be held in mid-May.
- If there is a decision to evaluate alternatives outside of the SR 37 corridor, then the I-69 project team will set another modeling coordination meeting with the MPO to discuss travel forecasting for those alternatives.

Responsible Party	Action Item	Due Date
HNTB/Lochmueller	Request model validation statistics from Korey Chu (ISTDM) and Catherine Kosytn (IMPO model) for comparison with the I-69 model	5/1/15
HNTB/Lochmueller	Provide the MPO with I-69 model TAZ information	5/1/15
HNTB/Lochmueller	Recommend a procedure for developing 2045 population and employment forecasts	5/1/15
HNTB/Lochmueller	Develop options to present the congestion relief at the public meeting.	4/29/15

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FINAL MEETING MINUTES

Section 6 Travel Demand Modeling Coordination Meeting

HNTB 11th Floor Main Conference Room

May 26, 2015 at 10 a.m. EDT

Attendee	Organization
Sarah Rubin	INDOT
Kevin Hetrick	INDOT
Roy Nunnally (via phone)	INDOT
Korey Chu (via phone)	INDOT
Sarah Ornelas (via phone)	INDOT
Andrew Swenson	Indianapolis MPO
Catherine Kostyn	Indianapolis MPO
Larry Heil	FHWA
Michelle Allen	FHWA
Bill Wiedelman	HNTB
Matt Miller	HNTB
Sarah Baty	HNTB
Chris Beard (via phone)	Lochmueller Associates
Udit Molakatalla (via phone)	Lochmueller Associates

I. Project Status

- Matt Miller and Bill Wiedelman provided a brief background on the status of the I-69 Section 6 project. INDOT and FHWA have made the decision to proceed with evaluating Section 6 alternatives outside of the Tier 1 selected SR 37 corridor. Thirteen Conceptual Alternatives have been developed and evaluated along with the SR 37 corridor. These results have been shared with resource agencies, stakeholders and the public over the past few weeks.

- Once the comment period for the Conceptual Alternatives has ended on June 2, the alternatives will be screened to a few Preliminary Alternatives that will be developed and evaluated in more detail. Near the end of 2015, these Preliminary Alternatives will be screened again to identify the Reasonable and Feasible alternatives that will be evaluated in the DEIS.

II. I-69 Corridor Model (CM) 2010 Base Year Validation

- As a follow-up to conversation at the last coordination meeting, Chris Beard presented a comparison of validation statistics among the I-69 CM, the ISTDM and the MPO travel demand model. The I-69 CM validation compares favorably with both of these models. The root mean square error and percent error are comparable to both models.

- FHWA expects that by the time of the DEIS we will be able to confirm that the I-69 CM, ISTDM and MPO model are checked against each other and shown to be consistent. This information will be included in the travel demand modeling appendix information to the DEIS. Interim modeling information and results will also be provided in alternative screening documentation.

III. Alternatives Modeling Results

- Chris Beard presented modeling results for the I-69 S6 Conceptual Alternatives. The Conceptual Alternatives were divided into four geographic groups, and a representative alternative was coded into the I-69 CM for each geographic group. 2045 model results were provided for each of the following four representative alternatives:
    - I-69 following SR 37
    - I-69 leaving SR 37 to the west and joining I-70 between SR267 and SR39, near Mooresville
    - I-69 leaving SR 37 to the east and joining I-65 near Franklin
    - I-69 leaving SR 37 to the west and following Mann Road to I-465
- Graphics showing the volume and Level of Service changes on S6 study area roads under each alternative were presented and discussed. This detailed information was not provided at public meetings. However, it is expected that this information will be provided to the public later this year, and the LOS improvement graphics provided in today's presentation will need to be replaced with something more understandable.
- Forecast traffic volumes at a Southport Road screenline were compared among the alternatives, as were the travel time savings from Martinsville to the airport, downtown Indianapolis and I-69 on the northeast side. It was noted that the travel times presented at the meeting should be checked (namely the time savings for the Eastern Alternatives to the Airport), as they appear to reflect older results that have since been updated.
- The I-70 alternative assumed widening of I-70 from SR 267 to the new I-69/I-70 interchange. The SR 37 and Mann Road alternatives assumed widening of I-465 from SR 67 to US 31. These areas of widening were assumed in the model runs.
- I-65 is congested in the 2045 No Build condition, and routing I-69 to I-65 results in significant diversion of traffic from the congested I-65 to alternate parallel local roads. No widening of I-65 was assumed because of the extensive areas of widening

that would be required and because the congested conditions are not caused by the I-69 project.

- At this time, modeling is focused on daily volumes and on segment conditions rather than intersection conditions. Some LOS results appear to be counter-intuitive. This will be addressed during modeling of the Preliminary Alternatives to be evaluated during the remainder of 2015.

- INDOT would like to obtain model output to look more closely at network volume changes. This will be provided to INDOT and the MPO.

- There was discussion about whether overall congestion reduction is an appropriate goal for the I-69 project and whether the conclusion that no alternatives provide meaningful congestion reduction is an appropriate conclusion. The SR37 and Mann Rd alternatives provided slightly over 1% reduction in daily vehicle hours spent in congested (LOS E or F) conditions. The other alternatives provided zero reduction.

- There was discussion of the importance of showing the impacts of the alternatives on freight movement. Freight movement impacts will be incorporated into the evaluation, both by identifying travel times to major intermodal facilities and through an economic analysis using TREDIS modeling. This level of evaluation was considered too detailed for this initial screening of Conceptual Alternatives.

- It would be useful to show total vehicle-hours of travel and vehicle-hours of delay for the alternatives. Showing this information categorized by functional class and corridor would be helpful. This information will be provided in model results for Preliminary Alternatives.

IV. Sensitivity Analyses

- I-465 widening from SR 67 to US 31 was assumed for the SR 37 and Mann Road Conceptual Alternatives but not for those alternatives that go to I-70 or I-65. INDOT wanted to assure that these differences in assumptions did not have a significant impact on conclusions about the performance of the various alternatives, so the I-65 and I-70 alternatives were modeled with the I-465 widening in place to determine how results would differ. It was found that the volumes through this segment of I-465 would increase with an additional lane in each direction, but the overall amount of travel in congested conditions (a primary measure of effectiveness) changed by only 0.5 to 1.3% for each alternative.

- Modeling for previous sections of I-69 had assumed that a new I-69 Ohio River Bridge between Henderson, Kentucky and Evansville, Indiana would be in place.

Because this bridge is not included in any current cost-constrained transportation plan, its construction will not be assumed for the Section 6 modeling. The effect of excluding this project from modeling was investigated by running the most recent version of the ISTDM provided by INDOT both with and without the bridge in place. Modeling results forecast that volumes on SR 37 through the Section 6 study area would increase by less than 1,000 vehicles per day with construction of the bridge. This represents an increase of between 0.5% and 2% of forecast traffic volumes.

V. Next Steps

- Chris Beard described the next steps for travel demand modeling on the I-69 Section 6 project. These include
    - Submittal to INDOT of a proposed methodology for developing final 2045 population and employment forecasts for the I-69 CM
    - More detailed modeling of Preliminary Alternatives to help identify number of lanes and proposed access locations.
    - Refinement and enhancement of I-69 CM procedures and network during the modeling of Preliminary Alternatives.
- The proposed method for developing 2045 population and employment forecasts for the I-69 CM would use county population totals from Woods & Poole and county employment totals from the Indiana Business Research Center. Uniform growth of the TAZ totals in the ISTDM would be used until they match the countywide totals. These inputs will be used to run the ISTDM and develop external trips for the I-69 CM. Within the I-69 CM, county control totals will be allocated to TAZs manually, and then land use panels will be used to review these allocations. This is a separate use of land use panels than has already been proposed by the consultants, which is to use land use panels to assist in allocating induced growth.

- There was a discussion about whether INDOTs project to update the ISTDM will produce population and employment forecasts in time for use by the I-69 consultants. If these forecasts are available by this fall or winter, they could be useful to the I-69 modeling. Roy will identify a target date for completion of ISTDM population and employment forecasts.

Action Items

Responsible Party	Action Item	Due Date
HNTB/Lochmueller	Provide I-69 CM output for Conceptual Alternatives to INDOT and the MPO	6/5/15
HNTB/Lochmueller	Determine whether 2045 Woods & Poole forecasts can be shared with the MPO	6/5/15
INDOT	Identify the date when updated ISTDM demographics are likely to be available	6/5/15

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting. These meeting minutes represent the understanding of the events that occurred.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

FINAL MEETING MINUTES

Section 6 Travel Demand Modeling Meeting

HNTB 11th Floor Main Conference Room

December 16, 2015 at 10:00 a.m. EDT

Attendee	Organization
Jim Earl	INDOT
Roy Nunnally (via phone)	INDOT
Andrew Swenson	Indianapolis MPO
Ryan Wilhite	Indianapolis MPO
Michelle Allen	FHWA
Bill Wiedelman	HNTB
Matt Miller	HNTB
Eric Swickard (via phone)	Lochmueller Associates
Chris Beard	Lochmueller Associates
Matt Schriefer (via phone)	Lochmueller Associates

Meeting Purpose

The purpose of this meeting was to discuss INDOT and Indianapolis MPO comments on the proposed 2045 demographic inputs to the I-69 Section 6 corridor travel demand model and to determine whether adjustments to the proposed inputs are necessary.

Overview of 2045 Demographic Forecast Method for I-69 Model

Chris Beard and Matt Schriefer provided an overview of the methodology used to develop the 2045 demographic forecasts proposed for use in the I-69 Section 6 corridor model. These forecasts are for the 2045 No Build condition, with I-69 Section 6 not constructed. Separate forecasts will be developed for the Build alternatives.

- The I-69 project team originally anticipated that demographic forecasts developed by INDOT and the Indianapolis MPO would be used for the I-69 corridor model. However, 2045 forecasts are not yet available from INDOT or the MPO, and therefore INDOT requested that the I-69 project team develop forecasts for use in the corridor model.
- Indiana Business Research Center (IBRC) 2045 county population forecasts were used for control totals in each of the four counties in the study area (Hendricks, Johnson, Marion and Morgan). 2045 employment county control totals were from Woods and Poole forecasts.
- Within the 4-county study area, county-wide control totals were allocated to traffic analysis zones (TAZs) using the CommunityViz software (http://placeways.com/communityviz/index.html). Outside of the study area, control totals were allocated to ISTDM TAZs using growth proportionate to the population and employment in each TAZ.
- An expert land use panel was used to adjust the CommunityViz forecasts of where growth would occur. No growth was shifted from county to county. Two major adjustments were highlighted. In Morgan County, forecast employment growth was shifted away from the SR 37 corridor

toward Mooresville because it was based on construction of I-69, which is not assumed in this no-build condition. In Marion County, some employment and population growth was redistributed from throughout the county to downtown Indianapolis and other areas along the proposed Red Line transit route (http://plan2020.com/plans/lu/tod/).

- The interim 2045 population and employment forecasts used in the corridor model were based on straight line growth of the 2010-2035 county trends from the ISTDM. Compared to these interim forecasts, the new 2045 forecasts generally show more population growth in Marion County and less in the surrounding counties. These differences are caused by the updated forecasts received from IBRC and Woods and Poole.

Discussion

- There was some discussion about the IBRC and Woods and Poole forecasts. It was noted that Woods and Poole forecasts are different than REMI forecasts used by the state.
- The MPO is comfortable with the assumptions and demographic forecasts used for the I-69 Section 6 model. They believe the adjustments made due to Land Use Panel input are reasonable. They will review the I-69 corridor model demographic data as input to their model update process, which is just beginning. The MPO would like to obtain information on the TAZs and centroid connector used in the model. The corridor model TAZs are nested within the Indiana Statewide Travel Demand Model (ISTDM).
- INDOT will also try to use the I-69 model demographic information when they start their model update in 2016.

Model Adjustments/Next Steps

- Neither the MPO nor INDOT request that any changes be made to the proposed 2045 No Build demographic forecasts developed by the I-69 project team.
- It was agreed that it will not be useful to compare the interim and final demographic forecasts when describing the I-69 travel demand forecasting process. However, it would be useful to compare the 2045 forecasts with 2010 actual and 2015 estimated values.

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting. These meeting minutes represent the understanding of the events that occurred.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

FINAL MEETING MINUTES

Section 6 Travel Demand Modeling Meeting

HNTB 11th Floor Main Conference Room

March 17, 2016 at 2:00 p.m. EDT

Attendee	Organization
Jim Earl	INDOT
Frank Baukert (via phone)	INDOT
Korey Chu (via phone)	INDOT
Andrew Swenson	Indianapolis MPO
Ryan Wilhite	Indianapolis MPO
Robert Dirks	FHWA
Michelle Allen (via phone)	FHWA
Eryn Fletcher (via phone)	FHWA
Eric Pihl (via phone)	FHWA
Jeremy Raw (via phone)	FHWA
Matt Miller	HNTB
Udit Molakatalla	Lochmueller Associates
Eric Swickard (via phone)	Lochmueller Associates
Michael Grovak	Lochmueller Associates
Dustin Riechmann	Lochmueller Associates

Meeting Purpose

The purpose of this meeting was to discuss INDOT, FHWA, and Indianapolis MPO comments on the proposed 2045 demographic inputs to the I-69 Section 6 corridor travel demand model under the SR 37 build alternative that follow the SR 37 corridor. This included a review of the process used to develop the build alternative inputs based on the previously developed inputs for the no build alternative.

Overview of 2045 Build Alternative Demographics Development

Udit Molakatalla provided a brief description of the process used to develop 2045 demographic forecasts for the SR 37 build alternative of I-69 Section 6 and of the role and results of the February 29, 2016 Land Use Panel (LUP) meeting. The previously developed demographics for the no-build alternative were the starting point. The TREDIS economic forecasting model was then used to forecast total additional population and employment that would be generated within the 4-county study area between the 2010 base year and the 2045 forecast year due to the completion of I-69 Section 6. This is termed “induced growth.” The total region-wide induced growth of population and employment were broken into countywide control totals based on each county’s share of existing population and employment and its forecasted share of vehicle travel on I-69. These countywide control totals were provided to the LUP at the February 29 meeting for allocation to traffic analysis zones (TAZ) within each county. The LUP had a separate panel for each county, consisting of planners, engineers and development professionals associated with that county.

At the February 29 meeting the Land Use Panel members were asked to allocate the forecasted induced population and employment for each county to TAZ within that county. They were also asked to identify where any forecast population and employment growth that they had previously allocated for the no-build alternative would shift to different locations if I-69 Section 6 were constructed along the SR 37 corridor.

Udit described the results of the Land Use Panel allocation exercise at the February 29 meeting. Of the four counties, only representatives from Morgan County chose to redistribute any of the previously allocated no-build growth in response to I-69 construction.

Discussion

- INDOT and the MPO believe the proposed allocations of induced and redistributed growth proposed for the SR 37 build alternative are acceptable and do not request any adjustments.
- Eryn Fletcher mentioned that she thought some Land Use Panel representatives wanted to redistribute no-build growth but this was not identified at the meeting. Others who were facilitating the meeting are not aware of this issue, but the consultants will follow up with Land Use Panel members to confirm whether they wish to provide additional input.
- There was a question regarding whether the process of allocating growth to TAZ included input from real estate professionals and considerations of accessibility. It was explained that the Land Use Panel members included both economic development professionals and a representative from the Metropolitan Indianapolis Board of Realtors. Those who facilitated the Land Use Panel meetings agreed that discussion within the groups included considerations of utilities and clustering of development.
- There was a discussion regarding consideration of the regional plan in the development of the 2045 forecasts. I-69 Section 6 is included in the MPO’s long range transportation plan. Other projects included in the cost constrained long range plans for both the state and the Indianapolis MPO are included in the modeling for the I-69 project. However, both MPO and INDOT forecasts of population and employment currently have a horizon year of 2035. Given the timetable for building Section 6, it was determined that 2045 is the appropriate forecast year for this project. It also was determined at the beginning of the Section 6 project that the INDOT and MPO models and plans would not be updated in time to provide inputs for the I-69 Section 6 forecasts. The Section 6 demographic inputs are being developed by the I-69 consultants in coordination with the MPO and INDOT. Both the MPO and INDOT have reviewed and the process and results to date and consider them to be reasonable. The MPO is currently starting to develop 2045 demographic inputs as it updates its LRTP over the next year. It will compare its forecasts to the forecasts developed by the I-69 consultants and use the I-69 data (including LUP input) to the extent possible.
- FHWA representatives noted that there needs to be a reasonable explanation for differences between the project forecasts and regional forecasts. The project team should be prepared to re-run some parts of the EIS analysis if the forecasts differ in order to assure that they would not result in different recommendations.
- The I-69 consultants will schedule a 1-hour phone call for Tuesday March 22, 2016 to answer additional questions that the FHWA Resource Center staff (its model development specialists) may have regarding the I-69 Section 6 model.

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting. These meeting minutes represent the understanding of the events that occurred.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

FINAL MEETING MINUTES

Section 6 Traffic Modeling Meeting

Teleconference Meeting

March 22, 2016 at 2:00 p.m. EDT

Attendee	Organization
Michelle Allen	FHWA – Indiana Division
Eryn Fletcher	FHWA – Indiana Division
Eric Pihl	FHWA – Resource Center
Frank Baukert	INDOT
Catherine Kostyn	Indianapolis MPO
Andrew Swenson	Indianapolis MPO
Ryan Wilhite	Indianapolis MPO
Matt Miller	HNTB
Michael Grovak	Lochmueller Group
Chris Joannes	Lochmueller Group
Udit Molakatalla	Lochmueller Group
Dustin Riechmann	Lochmueller Group
Eric Swickard	Lochmueller Group

This meeting was a follow up to a meeting held on March 17. At that March 17 meeting FHWA, INDOT and the Indianapolis MPO reviewed the Section 6 Land Use Panel's (LUP) inputs to the I-69 Corridor Model. At that time, FHWA requested a follow up meeting to further discuss technical issues related to the I-69 Corridor model. In today's meeting, Mr. Pihl of the FHWA Resource Center posed a series of questions related to the model structure and development. Mr. Molakatalla of the Lochmueller Group was the primary staff member who addressed the questions. He was assisted by other Lochmueller and Indianapolis MPO staff. These questions and staff responses are given below.

I. How does the model differ from a classic four-step model?

The I-69 Corridor "Hybrid" Model combines elements of traditional "four-step" trip-based model and "activity-based" tour-based models, providing a distinct advantage over the traditional trip based model without the drawbacks of activity-based models (e.g. runtime, data needs).

The model generates synthetic populations of individual households based on the aggregate characteristics of the population encoded in the TAZs. The number of tours of various purposes (work, school, other, etc.) and number of stops on these tours are predicted for each household. The primary travel mode is then modeled for the household's tours by trip purpose. Stop location and stop sequence choice models are employed to identify the probable locations and sequence of stops on automobile tours. For each individual trip in the resulting tours, the probability of walking, driving alone or with passengers is predicted. The trips are then assigned on the model network. The resulting travel times are used to recalculate accessibility variables in the tour generation step, until the roadway volume differences between consecutive iterations is minimal. The assignment typically required 3 iterations to achieve convergence.

Mr. Pihl cited as a positive factor the similarity of the corridor model's assignment structure to that of the Evansville MPO model. He noted that he had become familiar with the Evansville model in previous work with FHWA.

II. How does the Corridor Model integrate with the Indiana Statewide Travel Demand Model (ISTDM)?

Subarea extractions from the ISTDM were used to develop external trip matrices for the corridor model. Appropriate network changes were made to the ISTDM model to reflect the model alternative scenarios.

III. What are the general results of the validation analysis for the corridor model?

The model documentation is currently being prepared. The model achieved an overall RMSE of 36% in the four county model area. %RMSE was also calculated by facility type and volume groups. Screenlines were also used to validate the origin-destination patterns and traffic flows within the four-county region.

Validation measures generally have been very acceptable. For some facility classes (freeways and rural arterials), the RMSE has been near (above and below) 15%.

The Indianapolis MPO requested a copy of the corridor model validation report. This request will be forwarded to INDOT, which would provide the report to the MPO when it is completed.

IV. How were truck assignments conducted?

The E-E trip matrices were obtained from the sub-area analysis of the ISTDM. The I-E/E-I trip generation and distribution was estimated based on the method recommended in ***Quick Response Freight Manual II***. The model utilizes a two-step assignment procedure, which involves "priority pre-loading" of external trips and the truck trip tables onto the roadway network. Trips are distributed using a gravity function.

V. How does the model forecast travel by time of day?

The Corridor Model includes a compound departure time choice model. The model parameters in the departure time choice model (which is a nested logit model) are based upon survey data.

VI. The model uses log sums for accessibility. Is it sensitive to the feedback process?

Yes, the travel times from the assignment step are used to recalculate the accessibility variable as part of the feedback process. The accessibility logsums are sensitive to congested travel times.

VII. Could this model be used to support the Title VI/EJ analysis?

This is one of the benefits of the corridor "hybrid" model compared to traditional four-step aggregate models. Generating synthetic populations of individual households reduces zonal aggregation bias and better addresses needs of the environmental justice analysis. The model could be used to measure accessibility differences among TAZs.

VIII. Could you describe the hierarchy of models used in the project, in particular the handoff to the microsimulation model from the corridor model?

There is a hierarchy of four models used for the travel forecasting process. These are:

- Indiana Statewide Travel Demand Model (ISTDM)

- The I-69 Corridor Model (which has more detailed highway network and TAZ zone structure within the modeled area)
- TREDIS regional economic forecasting model
- TransModeler microsimulation model

The following paragraphs explain how these four models interact to produce travel forecasts for this study.

ISTDM forecasts are run for both no build and build conditions. IE (Internal-External), EI (External-Internal) and EE (External-External) trips are “fed” into the Corridor Model from the ISTDM assignments. The corridor model redistributes ISTDM trip ends within the Corridor Model area. This means that the Corridor Model determines the TAZ of origin/destination for the “I” end of IE and EI trips.

(TREDIS) forecasts induced growth due to the Section 6 project. This growth is allocated to TAZs within the Corridor Model by Land Use Panels using a Delphi process. No-build assignments do not include this induced growth; build assignments do include this induced growth.

A subarea extraction from the Corridor Model assignment provides trip tables for TransModeler. Current plans are to use TransModeler forecasts to analyze operations of the I-69/I-465 interchange.

IX. Is the network in the Corridor Model consistent with the E + C network in the Indianapolis MPO Model?

Matt Miller stated that this was the case at the outset of the model development process. The current MPO Long Range Plan was used to determine the E + C network.

Action Item	Responsible Party	Due Date
Prepare Corridor Model Validation Report	Lochmueller Group	April 22, 2016
Forward Corridor Model Validation Report to Indianapolis MPO	INDOT	TBD

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

FINAL MEETING MINUTES

Section 6 Traffic Forecast Review

HNTB Office – Downtown Indianapolis
May 31st, 2016 from 2:00 p.m.-4:00 p.m. EST

Attendee	Organization
Andrew Swenson	Indy MPO
Sarah Rubin	INDOT
Jim Earl	INDOT
Dan McCoy	INDOT
Roy Nunnally	INDOT
Frank Baukert (via webcast)	INDOT
Michelle Allen (via webcast)	FHWA
Eric Piehl (via webcast)	FHWA
Eryn Fletcher (via webcast)	FHWA
Matt Miller	HNTB Corporation
Sarah Baty	HNTB Corporation
Carl Camacho	Lochmueller Group
Michael Grovak	Lochmueller Group
Chris Joannes	Lochmueller Group

1) Introductions

a. Welcome and introductions
b. Matt explained that this would be an informal meeting to discuss select areas where traffic forecasts are of particular importance, particularly along I-465 between I-70 and I-65. The I-69 Section 6 project team wants to confirm with INDOT, the IMPO and FHWA that the forecasts are reasonable before completing traffic analysis.
c. Three maps (Recent Counts vs. Modeled Volumes, I-69 CM vs. ISTDM vs. IMPO Modeled Volumes, and Peak Hour I-69 CM Modeled Volumes) were utilized during the meeting to solicit comments from the various agencies and identify issues that would need additional investigation prior to gaining consensus on the forecast results.

2) **Recent Counts vs. I-69 CM Modeled Volumes**

   a. Eric Piehl voiced concerns about the extreme variability in the traffic counts year-to-year. Annual fluctuations observed on I-465 make determining a realistic base year volume difficult to establish.
      - There is the potential that large-scale construction projects have been causing major traffic pattern fluctuations on higher classification facilities in recent years.
      - There was a sense that 2013 and 2014 counts were low due to construction activity, though the major construction on the west side of I-465 occurred around 2010.

   b. Dan McCoy expressed concerns about some of the 2045 traffic forecasts being lower than 2014 counts – that is a "red flag" that could be questioned by the public.

   c. Michael Grovak stated that the national trend of growth in VMT has remained relatively flat for the last decade and is now growing at a much slower rate than before the Great Recession.
      - Roy Nunnally supported that analysis and expressed that as long as a viable explanation can be provided, a lower growth rate than originally expected on I-465 would be acceptable.

   d. Andrew Swenson mentioned that the Freight Analysis Framework (FAF) is predicting a major increase in truck traffic in Indiana (possibly a 30%-40% increase over the next 25 years). He asked if the corridor model was predicting a similar increase.
      - It was explained by the project team that the majority of the truck trips are extracted from the ISTDM, so it would reflect a similar growth predicted by the statewide model.

   e. Roy Nunnally would like to see the Passenger Car Equivalent (PCE) factored volumes to determine if the growth of truck traffic (which is pre-loaded onto the model network) could be limiting the traffic growth potential on I-465.

   f. Dan McCoy would like to see the assumed capacity of I-465 and other major facilities to determine if they are approaching capacity.

   g. Eric Piehl inquired if the project team had performed any select link analyses to analyze traffic patterns.
      - The project team responded that they have not, but that it was something that could be performed quickly.
      - It could be difficult to draw many conclusions from a select link analysis without observed origin-destination travel data with which to compare the results. Such O-D data has not been gathered in Indianapolis since the latter part of the previous decade.
      - Eric also suggested reviewing the underlying trip length distributions for reasonableness (this was done during model validation).

3) **I-69 CM vs. ISTDM vs. IMPO Model "Build" Results**

   a. Andrew Swenson stated that the IMPO model may have some external loading errors causing its forecasts to differ significantly with those from the ISTDM and I-69 CM in the southern portion of Marion County.
      - Andrew will also to check to see if externals are loaded onto a free flow or congested network in the IMPO model.
      - He also noted that Catherine Kostyn was out of the office. It would be toward the middle of June that IMPO travel model assignments could be made to consider items identified at this meeting.

   b. Eryn Fletcher questioned how many lanes were assumed in the IMPO model at the north end of I-69, as they had previously assumed fewer lanes than the ISTDM and I-69 CM.

- Andrew Swenson and Jim Earl stated that the INDOT Amendment to the Indy MPO LRTP had increased the number of lanes to be consistent among the other agencies and the I-69 project team.

4) I-69 Build vs. No Build Model

a. The project team stated that scenarios assuming both six lanes and eight lanes on I-465 were evaluated. The eight-lane scenarios would be able to handle the projected volumes with limited congestion. Peak hour volumes in the six-lane scenarios were on the high end of what can be accommodated on that type of facility. Those volumes are served at lower levels of service and reliability.

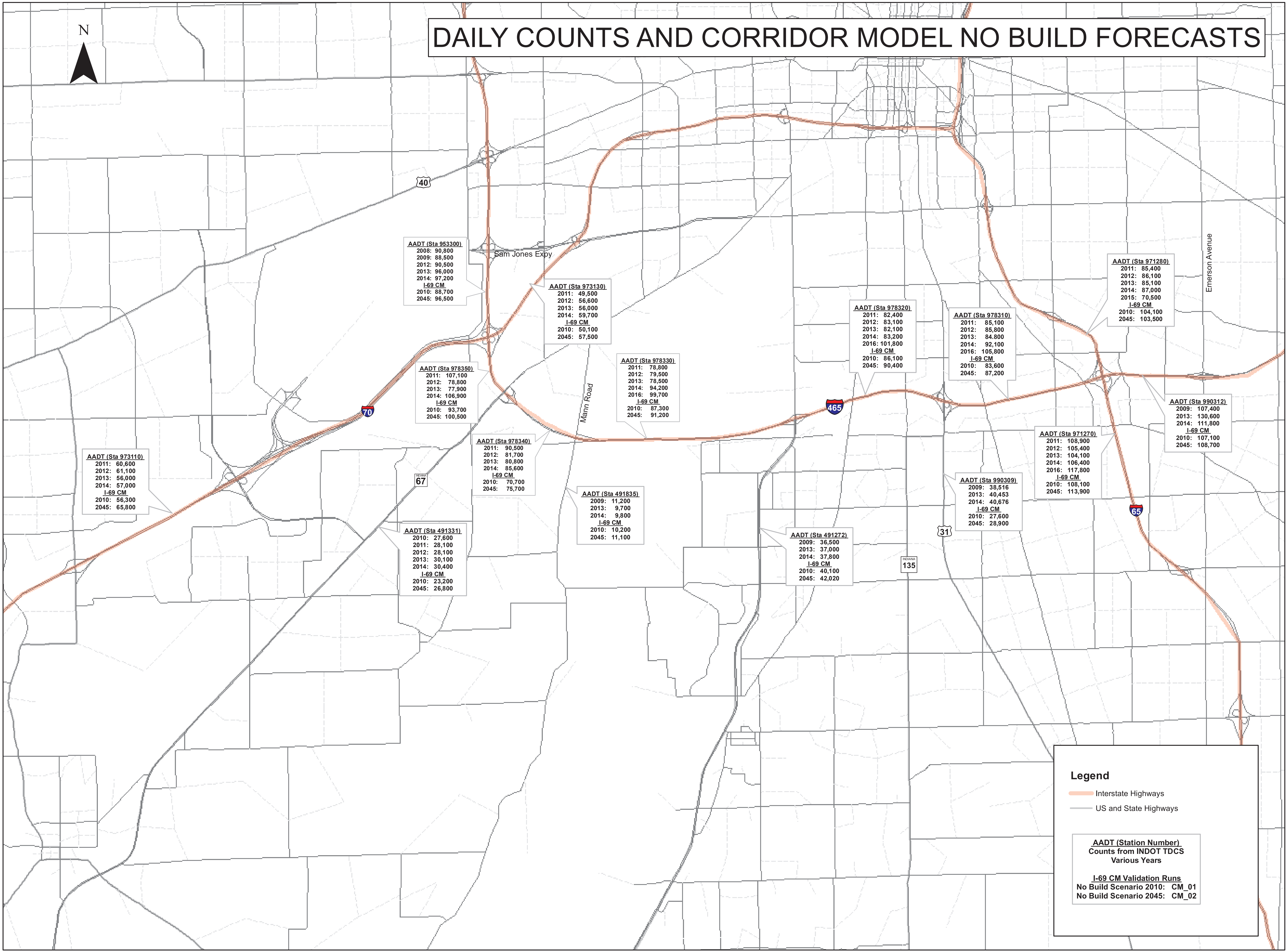
5) Meeting Wrap Up and Next Steps

a. There was general agreement that the no-build traffic forecast questions were more important to address than the build forecasts.
b. Roy Nunnally marked up paper copies of the three maps provided. These markups identified specific link volumes where he would like further information or follow up.
c. Identified issues will be investigated. It was noted that some of the issues will simply require a logical explanation to be documented. There was consensus that after necessary due diligence is performed; the agencies will be comfortable with moving forward with the traffic forecasts.
d. The deliverables listed below will be provided as follow-up to this meeting:
    - Maps with forecast PCE, volume-to-capacity ratio, and truck forecast
    - Model calibration document
e. There are some general questions that will need to be addressed in the DEIS:
    - Why was a 2010 base year used instead of something more recent?
    - Explain the rationale for higher am truck splits.
    - Identify assumptions for future year truck growth.
    - Are induced land-use assumptions used in the socioeconomic forecasts?

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting. These meeting minutes represent the understanding of the events that occurred.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

DAILY COUNTS AND CORRIDOR MODEL NO BUILD FORECASTS



AADT (Sta 953300)
2008: 90,800
2009: 88,500
2012: 90,500
2013: 96,000
2014: 97,200
I-69 CM
2010: 88,700
2045: 96,500

AADT (Sta 973130)
2011: 49,500
2012: 56,600
2013: 56,000
2014: 59,700
I-69 CM
2010: 50,100
2045: 57,500

AADT (Sta 978350)
2011: 107,100
2012: 78,800
2013: 77,900
2014: 106,900
I-69 CM
2010: 93,700
2045: 100,500

AADT (Sta 973110)
2011: 60,600
2012: 61,100
2013: 56,000
2014: 57,000
I-69 CM
2010: 56,300
2045: 65,800

AADT (Sta 978340)
2011: 90,500
2012: 81,700
2013: 80,800
2014: 85,600
I-69 CM
2010: 70,700
2045: 75,700

AADT (Sta 491331)
2010: 27,600
2011: 28,100
2012: 28,100
2013: 30,100
2014: 30,400
I-69 CM
2010: 23,200
2045: 26,800

AADT (Sta 491835)
2009: 11,200
2013: 9,700
2014: 9,800
I-69 CM
2010: 10,200
2045: 11,100

AADT (Sta 978330)
2011: 78,800
2012: 79,500
2013: 78,500
2014: 94,200
2016: 99,700
I-69 CM
2010: 87,300
2045: 91,200

AADT (Sta 978320)
2011: 82,400
2012: 83,100
2013: 82,100
2014: 83,200
2016: 101,800
I-69 CM
2010: 86,100
2045: 90,400

AADT (Sta 491272)
2009: 36,500
2013: 37,000
2014: 37,800
I-69 CM
2010: 40,100
2045: 42,020

AADT (Sta 978310)
2011: 85,100
2012: 85,800
2013: 84.800
2014: 92,100
2016: 105,800
I-69 CM
2010: 83,600
2045: 87,200

AADT (Sta 990309)
2009: 38,516
2013: 40,453
2014: 40,676
I-69 CM
2010: 27,600
2045: 28,900

AADT (Sta 971280)
2011: 85,400
2012: 86,100
2013: 85,100
2014: 87,000
2015: 70,500
I-69 CM
2010: 104,100
2045: 103,500

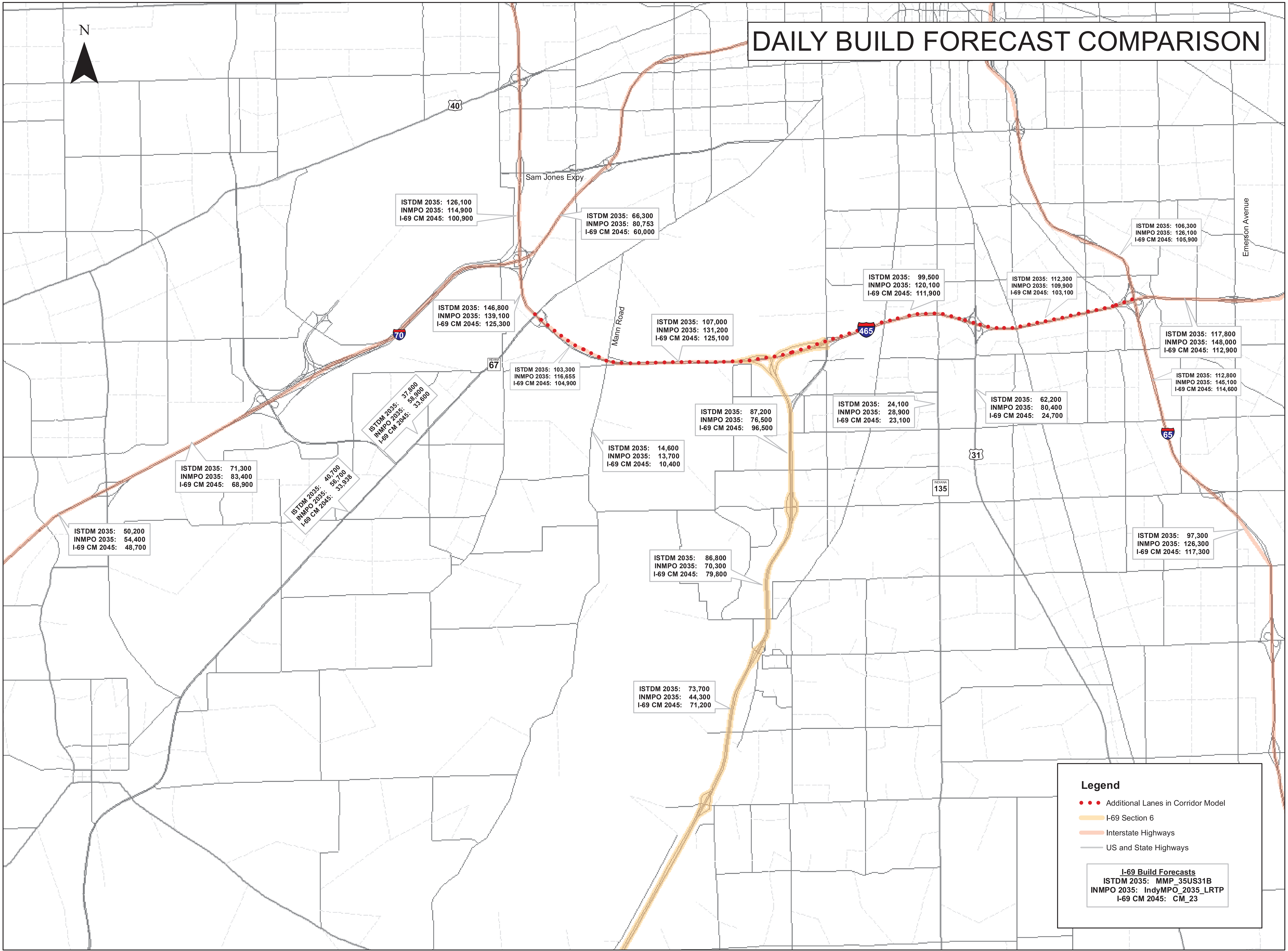
AADT (Sta 971270)
2011: 108,900
2012: 105,400
2013: 104,100
2014: 106,400
2016: 117,800
I-69 CM
2010: 108,100
2045: 113,900

AADT (Sta 990312)
2009: 107,400
2013: 130,600
2014: 111,800
I-69 CM
2010: 107,100
2045: 108,700

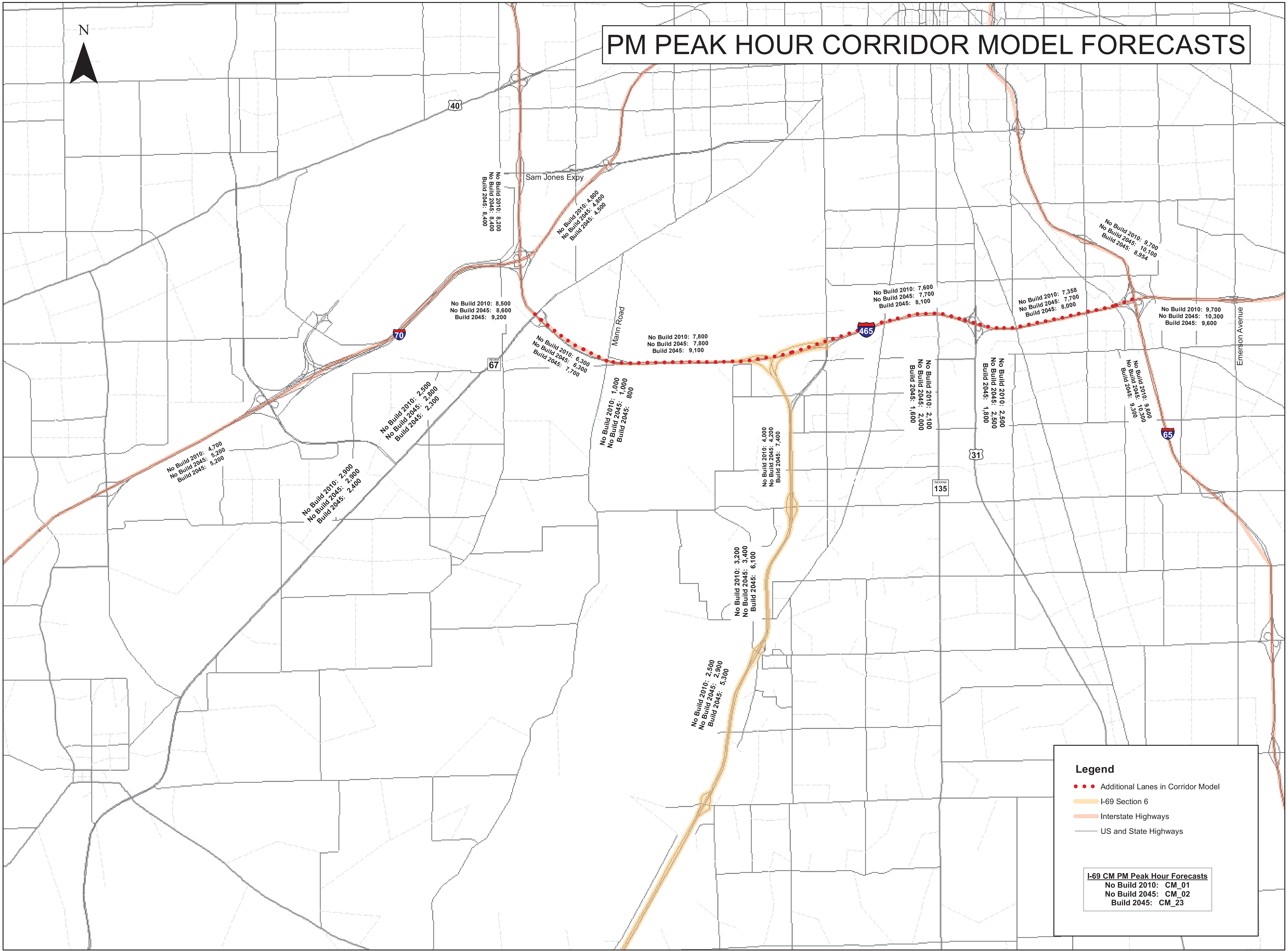
AADT (Station Number)
Counts from INDOT TDCS
Various Years

I-69 CM Validation Runs
No Build Scenario 2010: CM_01
No Build Scenario 2045: CM_02

DAILY BUILD FORECAST COMPARISON



PM PEAK HOUR CORRIDOR MODEL FORECASTS



FINAL MEETING MINUTES

Section 6 Traffic Forecast Review

Webex
July 25, 2016 from 10:00 a.m.-11:00 a.m. EST

Attendee	Organization
Jim Earl	INDOT
Roy Nunnally	INDOT
Korey Chu	INDOT
Dan McCoy	INDOT
Paul Schmidt	INDOT
Frank Baukert	INDOT
Tim Miller	HNTB Corporation
Matt Miller	HNTB Corporation
Sarah Baty	HNTB Corporation
Eric Swickard	Lochmueller Group
Michael Grovak	Lochmueller Group
Udit Molakatalla	Lochmueller Group

1) Purpose of Meeting

This meeting is part of ongoing coordination on the traffic forecasting for the I-69 Section 6 Tier 2 EIS. Items discussed are a follow-up to a Model Coordination Meeting on May 31. The project team addressed issues discussed during that meeting and provided updated forecast on June 15. This meeting is addressing specific issues identified in email correspondence from Roy Nunnally dated July 13.

2) Daily Truck Volume Comparison at External Stations

a. A new version of the ISTDM model I-69 build scenario was obtained on 07/22/16. The latest version of the ISTDM output was compared to the corridor model. The ISTDM trucks include vehicle classes 3-13, while the Corridor Model only considers vehicle classes 5-13 trucks. To better compare the model outputs, classes 3-4 were removed from ISTDM truck totals. The forecast are compared in Table 1.

3) Daily Truck Comparison at Key Interstate Locations

a. Table 2 compares the 2035 ISTDM, “2045 ISTDM”, and the Corridor Model. The “2045 ISTDM” is the version of the ISTDM that was run to generate external trips for the Corridor

Model. These 2045 demographics were developed by the consultant and include development induced by I-69.

   b. Truck growth on I-465 east of I-69 and on I-65 is as expected after the recent model refinements. The growth on I-465 west of I-69 and on I-70 is still somewhat lower than expected by INDOT. The Corridor Model zones and traffic loading areas were adjusted by the consultant to better match reality in the vicinity of Indianapolis International Airport. The loading between the Corridor Model and ISTDM is somewhat different because the Corridor Model is more detailed. The methodologies for truck trips are different between the two models. The ISTDM has a special generator for the airport, while the Corridor Model does not utilize special generators. It was agreed that the current forecast is sufficient for use in the DEIS, but apparent low truck growth on I-465 and I-70 in the airport vicinity will be investigated as the corridor model is further refined moving forward.

4) **Volume Differences**
   a. The Corridor Model forecast on US 31 is low compared to the ISTDM and the MPO’s model. This is partially due to the added travel lanes on I-65. These added lanes are reflected in the Corridor Model, but not in the latest ISTDM runs. The added lanes on I-65 pull traffic from US 31. The Corridor Model forecast for 2010 is comparable to the 2009 traffic counts. This will be further investigated and documented moving forward.

5) **Passenger Car Equivalents**
   a. The factor used to calculate passenger car equivalent (PCE) factor used in the model differs from guidance in the Highway Capacity Manual (HCM). In the HCM, a factor of 1.5 is recommended, but a higher factor is used in the assignment portion of the model. The factor from the HCM will be used for LOS calculations in the DEIS.

6) **Meeting Wrap Up and Next Steps**
   a. The forecast are sufficient for use in the DEIS
   b. The zones and traffic loading in the airport vicinity will be revisited when the modeling to support the Interstate Access Document is completed.
   c. Volume forecast differences US 31 will be reviewed as the modeling to support the Interstate Access Document is completed.
   d. Frank Baukert and Korey Chu will be included on modeling correspondence for this project.

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting.

Attachments:
Table 1
Table 2
Table 3

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

Comparison of ISTDM and I-69 Corridor Model

Table 1 - Daily Truck[1] Volume Comparison at External Stations

Facility	External Station	Segment	2035 ISTDM[2]	2045 I-69 CM
I-70	West	West of SR 231	13,814	14,090
	East	East of CR 600 W	20,266	20,926
I-65	South	South of SR 252	12,490	13,091
	North	North of SR 267	18,956	22,907
I-74	West	West of SR 39	9,041	6,892
	East	East of Acton Rd	13,165	13,212
I-69	North	North of SR 238	10,554	10,818

Notes

1. Daily truck volumes from the I-69 CM include vehicle classes 5-13. The ISTDM model output includes 3-13, but vehicle classes 3-4 were removed for this comparison.

2. 2035 ISTDM model output obtained from INDOT on 07/22/16.

July 22, 2016

DRAFT and DELIBERATIVE

Table 2 - Comparison of ISTDM and I-69 Corridor Model

Daily Truck[1] Volume Comparison at Key Interstate Locations

Facility	Segment	2035 ISTDM[2]	2045 ISTDM[3]	2045 I-69 CM
I-70	CR 1100 W - SR 39	14,626	15,400	15,500
	Airport-I-465	29,366	31,000	20,400
	Holt Rd - Harding St	16,527	16,800	16,600
	I-65 - Keystone Ave	25,665	24,400	25,800
	Emerson Ave - Shadeland Ave	22,798	22,100	24,900
	Post Rd - CR 600 W	21,752	22,600	32,800
I-65	SR 252 - SR 44	12,605	12,800	17,300
	Main St - County Line Rd	13,703	17,500	22,700
	I-465 - Keystone Ave	8,721	8,600	18,800
	I-70 - Pennsylvania Ave	20,787	16,700	23,600
	MLK - 38th St	12,800	11,600	19,600
	I-465 - 71st St	16,266	14,700	15,000
	Whitestown Pkwy - SR 267	19,899	20,500	23,100
I-465	SR 67 - Mann Rd	19,947	25,300	17,100
	US 31 - I-65	15,221	24,300	22,900
	I-74 - Shadeland Ave	18,893	18,400	24,400
	Pendleton Pike - Shadeland Ave	22,745	21,000	21,600
	I-69 - Allisonville Rd	21,721	22,300	22,600
	Meridian St - Michigan Rd	14,314	13,600	17,200
	86th St - 71st St	12,944	14,400	9,400
	38th St - I-74	23,419	26,000	14,100
	Washington St - Sam Jones Expy	28,558	30,500	15,800
I-69	SR 144 - Smith Valley Rd	12,075	16,500	14,400
	Smith Valley Rd - County Line Rd	12,842	16,400	15,000
	County Line Rd - Southport Rd	13,349	16,800	15,500
	Southport Rd - Epler Rd	13,376	17,200	16,200
	I-465 - 82nd St	19,730	20,700	18,300
	96th St - 116th St	10,104	10,400	17,100
	SR 37 - SR 238	11,866	11,700	10,700

Notes

1. Daily truck volumes include vehicle classes 5-13. The ISTDM model output includes 3-13, but vehicle classes 3-4 were removed for this comparison.
2. 2035 ISTDM model output obtained from INDOT on 07/22/16.
3. "2045 ISTDM" refers to a version of the ISTDM run using the 2045 demographic forecasts developed by the I-69 Section 6 Consultant. This model run was performed to generate external trips for the I-69 Corridor Model.

Table 3 - Comparison of ISTDM and I-69 Corridor Model

Indianapolis Int'l Airport Vivinity Demographic Forecasts

Location	ISTDM TAZ	I-69 CM TAZs	EMPLOYMENT			HOUSEHOLDS		
			2035 ISTDM[1]	2045 ISTDM[2]	2045 I-69 CM	2035 ISTDM[1]	2045 ISTDM[2]	2045 I-69 CM
Indianapolis Intl' Airport	49127	1318, 2110, 1317	4,333	4,706	4,706	127	18	18
Plainfield Industrial Area	32014	246	9,496	8,821	8,821	1,016	1,138	1,138
	32054	281, 280, 282	12,633	11,536	11,553	116	65	65
Area South of Indianapolis Int'l Airport	49070	1061, 1062, 1063, 1064, 1065, 1066, 1060	2,669	3,223	3,251	1,046	1,219	1,219
Area East of Indianapolis Int'l Airport	49112	1282, 1283	3,615	3,802	3,802	336	315	315
	49057	983, 982, 985, 984,986, 987	9,797	9,820	9,820	1,652	1,950	1,950
I-465 and 86th St	49045	917, 918, 919, 920, 921, 922	31,495	35,777	35,777	3,107	3,228	3,228
	49129	1321, 1322, 1323, 1324	10,729	12,328	12,328	185	155	155

Notes

1. 2035 ISTDM model output obtained from INDOT on 07/22/16.

2. "2045 ISTDM" refers to a version of the ISTDM run using the 2045 demographic forecasts developed by the I-69 Section 6 Consultant. This model run was performed to generate external trips for the I-69 Corridor Model.

FINAL MEETING MINUTES

Section 6 Traffic Forecast Review

Webex
July 26, 2016 from 2:00 p.m.-3:00 p.m. EST

Attendee	Organization
Andrew Swenson	Indianapolis MPO
Catherine Kostyn	Indianapolis MPO
Matt Miller	HNTB Corporation
Sarah Baty	HNTB Corporation
Udit Molakatalla	Lochmueller Group

1) Purpose of Meeting

This meeting is part of ongoing coordination on the traffic forecasting for the I-69 Section 6 Tier 2 EIS. Items discussed are a follow-up to a Model Coordination Meeting among INDOT, the MPO and the project team on May 31, 2016. On July 15, 2016, Sarah Baty provided the MPO with an email and attachments to describe I-69 Corridor Model validation efforts and results that address comments from the 5/31/16 coordination meeting and subsequent comments from INDOT Long Range Planning staff. The purpose of this July 26 meeting was to discuss MPO comments on the July 15 email information and on the overall status of the I-69 Corridor Model.

2) Truck Volumes

- INDOT had concerns that truck volumes in the I-69 CM were lower than those shown in the ISTDM.. The latest version of the ISTDM output was compared to the corridor model.
- One reason for truck volume discrepancies observed by INDOT is that the ISTDM includes vehicle classes 3-13 as trucks, while the Corridor Model only considers vehicle classes 5-13 as trucks. (Class 3 includes two-axle, four-tire single unit trucks, and Class 4 includes buses). To better compare the model outputs, classes 3-4 were removed from ISTDM truck totals.
- ISTDM truck forecasts and I-69 CM truck forecasts were compared at I-69 CM external links. The forecasts were generally similar.
- ISTDM truck forecasts and I-69 CM truck forecasts were compared at several internal freeway locations. The forecasts were generally similar except in areas of I-70 and I-465 near the Indianapolis International Airport. There are thought to be two causes of these differences:
    - The network and TAZs of the I-69 CM were adjusted in the vicinity of the airport to better reflect actual network connectivity and loading points.
    - The ISTDM has special generators at the airport and other nearby truck generators that are not reflected in the I-69 CM.
- The external to external truck trips in the I-69 CM are from the ISTDM externals. Internal truck trips are based on the Quick Response Freight Model.

3) Passenger Car Equivalents

- There was discussion during the 5/31 meeting of the possible reasons for apparent low ADT growth shown by the I-69 CM along I-465. It was thought that this might be caused by growth in truck volumes that limits the capacity for growth in automobile volumes.
- A Passenger Car Equivalent (PCE) analysis examined the potential that lack of growth on I-465 is due to large growth in trucks. The analysis showed that this is likely the case.
- The factor used to calculate passenger car equivalent (PCE) in the model is different for single-unit trucks and multi-unit trucks. In the HCM, a factor of 1.5 is recommended, but a higher factor is used in the assignment portion of the model. The factor from the HCM will be used for LOS calculations in the DEIS.
- The total of truck trips (SUT and MUT) were calibrated. The forecast mix of single-unit trucks vs. multi-unit trucks has not been verified against past counts.

4) General Comments

- There are still some differences between forecast from the MPO model and the I-69 CM. There was a discussion of what level of difference would be considered acceptable. Udit Molakatalla. Suggested that differences in forecast Levels of Service between the models could be an indicator of unacceptable differences.
- FHWA modeling experts will be provided an opportunity to review the forecasts and methodologies of the I-69 CM.

5) Meeting Wrap Up and Next Steps

- The MPO is comfortable that the I-69 CM forecasts are appropriate for use in the DEIS
- The zones and traffic loading in the airport vicinity will be revisited in the future.
- For Air Quality Conformance, the shapefile or map of Alternative C4, project description, and cost will be provided by August 8.
- Compatibility of network and truck modeling between the different models will be reviewed this fall.

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting. These meeting minutes represent the understanding of the events that occurred.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

FINAL MEETING MINUTES

Section 6 Traffic Meeting

HNTB 11th Floor Main Conference Room

October 5, 2016 at 3:00 p.m. EDT

Attendee	Organization
Jim Earl	INDOT
Paul Schmidt	INDOT
Dan McCoy (via phone)	INDOT
Korey Chu (via phone)	INDOT
Frank Baukert (via phone)	INDOT
James Sturrcok (via phone)	FHWA Resource Center
Eric Pihl (via phone)	FHWA Resource Center
David Petrucci (via phone)	FHWA Resource Center
Eryn Fletcher	FHWA
Joiner Lagpacan	FHWA
Matt Miller	HNTB
Sarah Baty	HNTB
Udit Molakatalla (via phone)	Lochmueller Group
Chris Joannes (via phone)	Lochmueller Group
Dustin Riechmann (via phone)	Lochmueller Group
Eric Swickard (via phone)	Lochmueller Group
Michael Grovak (via phone)	Lochmueller Group

A. Overview of Project and Alternatives

Matt Miller briefed the group on the project. The DEIS preparation for the project is currently underway. Four alternatives are under consideration. All of the alternatives follow the SR 37 corridor, but vary in access road configurations, grade separations, and one interchange location. The DEIS will be published in the first quarter of 2017.

B. Traffic Forecast

Udit Molakatalla described the I-69 Corridor Model. During the forecasting process, the project team has been coordinating with INDOT and the Indianapolis MPO (IMPO). Its forecasts were compared to the Indiana statewide travel demand model (ISTDM) and IMPO's regional model. The external trips (E-E, I-E, E-I) in the I-69 Corridor Model are extracted from the statewide model, and the I-69 Corridor Model TAZ structure is based on the statewide model. The internal trip ends for I-E and E-I trips are redistributed by the corridor model. Corridor model internal (I-I) trips are forecasted using a tour-based hybrid model component. The MPO has acknowledged that the statewide model generally is a better point of comparison for the I-69 Corridor model. This is due in particular to the corridor model incorporating external trips generated by ISTDM.

Demographic Forecast

The ISTDM and MPO model both have a 2035 horizon year, but the horizon year for the project is 2045. The project team created forecasts of 2045 no build and build demographics for use in the I-69 Corridor Model and ISTDM. Countywide demographic control totals for the no build condition were forecasted using standard sources for households (Indiana Business Research Center) and employment (Woods & Poole). Control totals were allocated to TAZs using CommunityViz GIS software and adjusted by consulting a land use panel. The panel is comprised of community leaders, local government officials, and local experts on economic development. TREDIS software was used to forecast induced demand for the I-69 build condition, and the land use panel allocated this additional growth to TAZs.

Post-processing adjustments are being made to the model output to generate peak hour forecasts. The adjustments are based on recent traffic counts; however, the team is using an appropriate level of engineering judgment to address significant year-to-year variations in traffic counts. These count variations are most pronounced on I-465. There was significant construction on freeways and arterials in Indianapolis. Traffic patterns were impacted to such an extent that there isn’t a clear “normal” year for traffic.

Traffic adjustments will be made by calculating the difference between counts conducted in 2015-2016 and those conducted in 2010-2011. Counts taken in 2010-11 were used to validate the model’s 2010 base year assignment. The difference in the counts will be applied to the horizon year forecasts using the ratio method described in NCHRP 765.

C. Traffic Analysis for DEIS Alternatives

Matt Miller described the analysis used in the DEIS. The DEIS includes planning-level LOS analysis for I-69, all cross-streets, and parallel routes in the region. The methodology used in previous sections was based on algorithms in the I-69 Corridor Model post-processer to estimate LOS. This method did not produce expected results for the I-69 Section 6 study area, particularly in the 2045 no build condition. For example, LOS on SR 37 was unrealistically high. The impacts of signal delay on SR 37 LOS are thought too complex for a macroscopic travel demand model to accurately reflect.

Sarah Baty presented an alternate planning-level LOS methodology proposed for use on Section 6. The method is based on the Highway Capacity Manual and is part of the FDOT Q/LOS Handbook. The method uses generalized service volume tables calculated using assumptions about traffic demand and facility characteristics. These assumptions were reviewed and adjusted for conditions in the Section 6 study area. Most notably, the maximum service volumes for a particular LOS were decreased to account for the higher percentage of trucks present on Indiana roadways. Several assumptions made in the original service volume tables were found to be reasonable, including the K-factors and D-factors for traffic flow.

The results of the alternate methodology are more realistic in the horizon year no build condition. LOS for the build alternatives also appears reasonable. INDOT has reviewed this methodology and found it acceptable. Dan McCoy stated that the methodology appears to be sound, although he expressed concern that the traffic volumes on I-465 are lower than expected. Matt Miller stated that traffic forecasts revisions are still underway and the forecasts will be updated for the DEIS if possible. The revised forecasts will be provided in the detailed capacity analysis of the preferred alternative. This detailed analysis will be provided in the Engineer's Report, Interstate Access Document (IAD) and FEIS. Eric Pihl noted that typical application of this method is a feasibility level analysis rather than a DEIS. He stressed that all assumptions should be documented. This method might pass over some of the nuances between LOS D, E, and F.

D. Detailed Traffic Analysis of the Preferred Alternative

Engineer's Report

Sarah Baty described the Engineer's Report, which will include more detailed analysis of the preferred alternative. The tools used will be HCS, Synchro, and Sidra. TransModeler simulation will also be used in the I-69/I-465 interchange influence area. The analysis will focus on the am peak hour and pm peak hour of the horizon year.

Interstate Access Document

The IAD Framework Document which was approved by FHWA and INDOT was distributed to the group prior to the meeting. Traffic simulation will be added to the tools used for the Engineer's Report. There was discussion but no conclusion about whether the area of influence for the IAD should be extended to include the I-465/I-70 interchange. The proximity of the SR 67 and I-70 interchanges is concerning to FHWA and I-70 is a system interchange. However, the I-70 interchange recently underwent a significant interchange modification project as part of the I-465 west leg project, and further improvements as part of the I-69 project are not anticipated by INDOT. There is concern that increasing the study area could further delay the traffic analysis. The topic of increasing the area of influence to include I-70 will be discussed at a later date.

E. Traffic Simulation

Model Development

Sarah Baty described the model development process. The simulation model is built upon a subarea extraction from the I-69 Corridor Model. The extracted trip table is adjusted to match the post-processed peak hour forecasts by using the ODME process. Models for the am peak hour and pm peak hour will be developed.

Performance Measures

The density and LOS will be reported from analysis performed in TransModeler. The density calculations for merge, diverge, and weave are consistent with the HCM process and only include the density in adjacent lanes. In addition, it was suggested that travel time should also be a performance measure.

Calibration

One of the purposes of this meeting was to discuss the expectations for a Calibration Report. A base year simulation model should be calibrated to field data to ensure the model is replicating local driver behavior. Paul Schmidt indicated that INDOT has data that can be used for the calibration process. A link to that information will be given to the project team. A separate meeting will be scheduled to further discuss this process and provide guidance to the project team.

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting. These minutes represent the understanding of the events that occurred.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

DRAFT MEETING MINUTES

Section 6 Traffic Meeting

HNTB 11th Floor Circle Conference Room

November 28, 2016 at 2:00 p.m. EDT

Attendee	Organization
Jim Earl	INDOT
Sarah Rubin (via phone)	INDOT
Roy Nunnally (via phone)	INDOT
Frank Baukert (via phone)	INDOT
Paul Schmidt	INDOT
Dan McCoy	INDOT
Eric Pihl (via phone)	FHWA
Eryn Fletcher	FHWA
Joiner Lagpacan (via phone)	FHWA
Tim Miller	HNTB
Matt Miller	HNTB
Sarah Baty	HNTB
Erick Swickard	Lochmueller Group
Michael Grovak	Lochmueller Group
Udit Molakatalla (via phone)	Lochmueller Group

A. DEIS Appendix Y, Traffic Forecasting

DEIS Appendix Y is currently under INDOT review. It describes the traffic forecasting process, including travel demand model methodology and validation. After INDOT has reviewed the appendix, it will be available for FHWA review. A review meeting will be set for 12/19/16.

B. Traffic Forecast Revisions in Marion County

Need for Adjustments to I-465 Forecasts

The traffic forecast from the Corridor Model were adjusted using recent traffic counts because the initial forecasts were lower than anticipated on I-465. The base model is calibrated to 2010 counts; however, this did not produce traffic assignments comparable with more recent (2015 and 2016) counts. I-465 is a bypass around Indianapolis with competing routes I-65 and I-70 that run through the city. Over the past decade, there have been major construction projects nearly every year. There is significant variation in counts between 2010 and 2016. Years 2010 through 2012 (to which the model is calibrated) were particularly low due to construction at the I-65/I-465 interchange.

NCHRP 765

Recent counts from 2016 (and some from 2014) were used to adjust the forecasts on I-465 and at its interchanges using both the NCHRP 765 ratio and difference methods. The variation in counts is attributable to short-term construction and routing choices. FHWA asked whether changes in land use could explain these variations. INDOT stated that this was not the case; land use in the region changed little between 2010 and 2016.

Traffic Growth on I-465 Over Time

The traffic growth on I-465 in the build and no build condition was discussed. The growth between 2025 and 2045 is low, which is consistent with the ISTDM forecasts.

Increase in I-465 Traffic Between Build and No Build

The increase in I-465 traffic between the build and no build scenarios was discussed. This increase in traffic growth is greater than in ISTDM forecasts. This is explained by the added travel lanes on I-465 which the I-69 model assumes near the I-69/I-465 interchange; these added travel lanes were not included in the ISTDM build scenario. Another explanation of increased traffic flows on I-465 is replacing the existing Harding Street interchange (a source of delay) with a system interchange. In short, the increase in traffic on I-465 in the build scenario is a response to this added capacity. The completion of I-69 Section 6 causes an increase in traffic on I-465; however, I-69 Sections 1 through 5 are completed in the both the build and no build scenarios.

Updating the DEIS

The adjusted traffic forecasts were completed after the development of the DEIS was essentially complete. The best available forecasts at the time are reflected in the current version of the DEIS. The plan is to leave the unadjusted forecasts in the DEIS. If schedule allows, there is the potential to update the traffic forecasts during legal sufficiency review. Updating the traffic forecasts is a significant task that impacts several chapters of the document (for example, noise and energy impacts). It is important to avoid a partially updated document with conflicting information. If there is not sufficient time to update the DEIS, the revisions will be reflected in the FEIS.

Revisions to Traffic Forecasting Memo

The 11/16/16 Project Level Volume Forecasting memo will be adjusted based on discussion during the meeting. This memo describes the process of adjusting the I-69 Corridor Model outputs.

- 3rd column header in Table 1 will be corrected to read “2025” instead of “2045”
- Table 1 will include adjusted base year forecasts
- The memo will explain large differences between original and adjusted volumes. The I-70/I-465 ramps with original volumes less than 200 vpd are examples, as are the Mann Road ramps where adjusted volumes are 30%-40% lower than the original volumes
- The counts used in the adjustment process will be provided

C. Upcoming Traffic Tasks

1. Deliver complete peak hour turning movement forecasts for review
2. MPO review of revised traffic forecasts

3. Calibration of simulation model for I-465 analysis
4. Conduct traffic analysis for horizon year and opening year

D. Action Items

1. The memo on peak hour adjustments will be revised and redistributed by Friday 12/9/16. The unadjusted forecasts and counts used in the process will be added to the memo.
2. Peak hour turning movement forecasts will be provided to INDOT by 12/16/16. Turning movement forecast graphics provided prior to this meeting will be checked to make sure they balance.
3. The DEIS traffic forecasting appendix will be delivered to FHWA to review the week of 12/5/16, which begins the 2-week review period. A meeting to discuss the appendix will be scheduled on Monday 12/19/16.
4. A meeting will be scheduled during the last two weeks of January 2017 to update the team on the status of the simulation model. Erin Fletcher is coordinating Jim Sturrock to choose a date. The calibration report is expected to be completed at the end of March 2017.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

FINAL MEETING MINUTES

Section 6 Traffic Meeting – Review of DEIS Appendix Y

HNTB 11th Floor Circle Conference Room

December 21, 2016 at 1:00 p.m. EST

Attendee	Organization
Jim Earl	INDOT
Sarah Rubin	INDOT
Roy Nunnally (via phone)	INDOT
Frank Baukert (via phone)	INDOT
Dan McCoy	INDOT
Eric Pihl (via phone)	FHWA
Eryn Fletcher (via phone)	FHWA
Tim Miller	HNTB
Matt Miller	HNTB
Sarah Baty	HNTB
Chris Joannes (via phone)	Lochmueller Group
Erick Swickard (via phone)	Lochmueller Group
Michael Grovak (via phone)	Lochmueller Group
Udit Molakatalla (via phone)	Lochmueller Group

A. Meeting Purpose

The purpose of this meeting was to discuss questions and comments that INDOT and FHWA staff may have on DEIS Appendix Y, Travel Demand Forecasting. A draft of this appendix dated November 15, 2016 is currently under review by INDOT and FHWA. It describes the traffic forecasting process, including travel demand model methodology and validation.

B. Discussion

Review comments

- Frank Baukert stated that he is currently in the midst of reviewing Appendix Y and its sub-appendices. At this time the process and results as documented in Appendix Y appear to be acceptable. Frank will conclude his review by Tuesday, 12/27/16. At that time Frank will provide any comments to Sarah Rubin and copy Matt Miller.
- Eric Pihl stated that Appendix Y and its sub-appendices generally look good, providing complete documentation of the process and capturing the details that will be of interest to readers. He recommended that the consultant consider the following:

  - A summary of the forecast results should be included in Appendix Y. It was agreed that the forecast results tables and maps that are currently included in DEIS Section 5.6 will be included as an appendix to Appendix Y.
  - If any special calibration or validation efforts were conducted for the corridor model, these should be cited in addition to the overall model-wide error results. The consultant will review the calibration/validation discussion and add descriptions of coordination, reviews and adjustments that may be omitted.
  - Eric indicated that annual traffic volume growth rates resulting from the forecasts are sometimes identified in the documentation and compared to recent historic growth rates. The consultant has performed some trend analysis along I-465 as part of the recent forecast adjustments (see discussion below). This information reflects forecast adjustments performed after the DEIS and can be included in the FEIS documentation. This type of trend comparison is unlikely to be valuable for SR 37 because growth rates are expected to be higher than recent trends even in the no build condition due to the completion of I-69 Sections 1 through 5.

Forecast adjustments in Marion County

A December 9, 2016 memo provided to INDOT and FHWA describes adjustments that were made to forecasts on and near I-465 in Marion County so that they better reflect traffic volumes observed over the last few years. These adjustments resulted in higher volume forecasts for the future build and no build conditions. These adjustments were made only for the apparent preferred alternative after analysis to support the DEIS had been completed and after DEIS documentation was well underway. The adjusted forecasts will be used as the basis for all analysis going forward and documented in the FEIS, but will not be included in the DEIS.

LOS information in DEIS Chapter 5.6

There was a discussion of the volume and LOS forecasts shown in Table 5.6-1 of the DEIS. The table shows that LOS for the segment of Section 6 between Martinsville and Marion County will operate at the same or slightly better LOS under the build alternatives compared with the no build condition. The public could perceive that there is not much improvement in this segment due to completing I-69. Discussion revealed the following points:

- I-69 (build condition) is forecast to carry more volume than SR 37 would (no build condition)
- Even while carrying more traffic, LOS on I-69 would be as good or better than on SR 37
- Traffic on SR 37 in the no build condition would operate with acceptable LOS through this segment because there is only one traffic signal to cause delay (at SR

144). The advantage of the I-69 freeway is more clearly seen in the congested areas of Martinsville and Marion County.

- Differences in how LOS is measured between freeways and arterials complicate a comparison between the 2 facility types.

C. Action Items

- Meeting minutes will be issued by 12/22/16. The minutes, including any corrections made by attendees, will serve to document review comments on DEIS Appendix Y.
- Frank Baukert will complete his review of Appendix Y by 12/27/16 and will submit comments to Sarah Rubin and Matt Miller.
- The consultant will address comments reflected in the meeting minutes and as submitted by Frank Baukert. The proposed adjustments to the appendix will be reviewed during a Webex meeting on January 4, 2017 at 1pm Eastern.

Details discussed in this meeting are subject to change. This summary is a reflection of the status of these items at the close of the meeting. These minutes represent the understanding of the events that occurred.

Note: This meeting summary documents ongoing, internal agency deliberations. Accordingly, the information contained in this summary is considered to be pre-decisional and deliberative.

APPENDIX B

List of projects added to 2010 No Build Network to specify 2045 No Build Network

Ohio River Bridge Sensitivity Analysis

Tour and stop generation model equations

MEMORANDUM

To: **Sarah Rubin and Jim Earl, INDOT**

From: **Matthew Miller, HNTB**

Date: **October 20, 2016**

Re: **Projects included in the I-69 Section 6 No-Build Network**

Memo Purpose

The purpose of this memo is to describe the criteria for including future transportation capacity improvement projects in the 2045 No-Build road network used for traffic modeling and evaluation of I-69 Section 6. The 2045 No-Build road network used to evaluate I-69 Section 6 includes those committed projects that have been identified in the transportation plans discussed in the "Committed Projects" section of this memo.

Committed Projects

All projects identified as funded for construction in the following four sources are considered to be committed and will be included in the 2045 No-Build network. The travel demand model networks provided to the I-69 project team by INDOT and the Indianapolis MPO include the committed capacity improvement projects from these sources. This memo and the I-69 Section 6 traffic models will be updated as needed based on updated planning documents.

- 2014-2017 Indianapolis Regional Transportation Improvement Program (IRTIP). Within the Indianapolis Metropolitan Planning Area (MPA), the IRTIP identifies funded transportation projects through 2017. This includes both INDOT projects and other significant projects to be constructed by local agencies.
- 2013-2017 Statewide Transportation Improvement Plan (STIP). This document identifies funded INDOT projects throughout the state, both within and outside of the Indianapolis MPA.
- INDOT 5-Year Construction Program. Major capacity expansion projects identified in this internal INDOT list will be considered to be committed. The current program includes projects from 2015 to 2019. While most of these projects can be found in the IRTIP and/or the STIP, the 5-year construction program includes other projects that are expected to be constructed in 2018 or 2019 but are not required to be on the IRETIP or the STIP.
- Indianapolis MPO 2035 Long Range Transportation Plan (LRTP). This document identifies long term transportation needs and projects within the Indianapolis MPA. Projects identified in the cost constrained plan are considered to be committed. These committed projects include projects from the IRTIP as well as INDOT and local projects that have identified funding sources beyond 2017. Illustrative projects identified in this

plan are considered to be unfunded needs and are not considered to be committed projects.

Unfunded Projects of Interest to I-69 Section 6

There are several sources that include capacity improvement projects that are not identified as committed in the above referenced documents and therefore are not included in the I-69 Section 6 2045 transportation network. These sources include:

- Indianapolis MPO Illustrative projects. The staff of the Indianapolis MPO were asked whether any projects beyond those identified as committed projects in the 2035 LRTP should be considered for inclusion in the 2045 transportation network. They indicated that no other projects should be included.
- Indiana's 2013-2035 Future Transportation Needs Report. This report serves as the long range transportation plan for INDOT. This report does not identify anticipated funding resources or specific cost constrained projects. The report does identify a few "High Priority Corridors" of potential influence for I-69 Section 6 No Build network, and are discussed below.

    - *I-69 Ohio River Bridge between Evansville, Indiana and Henderson, Kentu*cky. This project is not identified in any cost constrained plan so it does not meet the screening criteria for use in the Section 6 no-build network. It is not included in the travel demand models for Section 6; however this project was included in the future No Build network for the Tier 2 EISs prepared for Sections 1-5 of I-69 because the project had been included in the Evansville MPO LRTP when those models were run. Because the previous Tier 2 EISs included this project, two separate runs of the Indiana Statewide Travel Demand Model (ISTDM) were prepared—one with and one without this project—to demonstrate the impact that results from this project on the travel demand for I-69 Section 6. It was determined and documented in an October 20, 2016, technical memo that including the I-69 Ohio River Bridge in the no-build network would increase traffic volumes on SR 37 in the Section 6 project area by 1% to 2%.

    - *Illiana Expressway Corridor that provides a connection between I-65 in Lake County Indiana with I-55 and I-57 in northern Illinois*. This project is in the STIP and 5-year construction plan, so it is included in the travel demand models for I-69 Section 6.

- Blue Ribbon Panel on Transportation Infrastructure. Governor Pence's Blue Ribbon Panel on Transportation Infrastructure issued a final report on its proceedings in July 2014. The panel report identifies a long term vision for transportation in Indiana and a shorter term set of project recommendations, prioritized into three tiers. Because no funding or schedules are identified for these projects, they do not meet the screening criteria for inclusion in the I-69 Section 6 traffic model. The proposed projects include:

- *I-69 Ohio River Bridge between Evansville, Indiana and Henderson, Kentucky*. See above for a discussion of this project.
- *I-65 Added Travel Lanes* calls for I-65 to have a minimum of 6 lanes from Stateline to Stateline.
- I-*70 Added Travel Lanes* calls for I-70 to have a minimum of 6 lanes from Stateline to Stateline.
- *Commerce Connector* is a new 4-lane divided “outer beltway” from I-69 northeast of Indianapolis to I-65 northwest of Indianapolis. It would be constructed around the east, south and west sides of Indianapolis.
- All other projects identified with Tier II and Tier III priority.

Summary of Included Projects

It is recommended that the following future added capacity projects be included in the 2045 No-Build transportation network for evaluation of the I-69 Section 6 EIS:

- All projects in the 2014-2017 IRTIP
- All projects in the 2013-2017 STIP
- All projects in the 2015-2019 INDOT 5 Year CN Program
- All projects in Indianapolis cost-constrained Indianapolis LRTP.

Funding Period	No.	Sponsor	Facility	Location	Description
2011-2015	1	Hamilton Co.	146th St (Phase I)	Springmill Rd to Ditch Rd	Widen to 4 lanes
	2	Indianapolis	82nd St	Hague Rd to Fall Creek Rd	Widen to 4 lanes, divided
	3	Carmel	Veteran's Way	Exec Dr to City Center Dr	New 3-lane roadway
2016-2025	4	Boone Co.	146th St (Phase III)	CR 400 S to CR 300 S	New 2-lane roadway, divided
	5	Boone Co.	CR 650 S	SR 267 to I-65 Interchange	Widen to 4 lanes
	6	Boone/Hendricks Co.	Ronald Reagan Pkwy	56th St to SR 267/I-65	New 4-lane roadway, divided
	7	Brownsburg	E Northfield Dr	CR 300 N to CR 400 N	New 2-lane roadway
	8	Carmel	Range Line Rd	136th St to US 31	Widen to 4 lanes
	9	Carmel	116th St	Keystone Ave to Hazel Dell	Widen to 4 lanes
	10	Carmel	131st St	Keystone Ave to Hazel Dell	Widen to 4 lanes
	11	Carmel	Towne Rd	96th St to 116th St	Widen to 4 lanes
	12	Carmel	96th St	Haverstick Rd to Priority Wy W	Widen to 6 lanes
	13	Carmel	96th St	Priority Wy W to White River	Widen to 6 lanes
	14	Fishers	96th St	Lantern Rd to Cumberland Rd	Widen to 4 lanes, divided
	15	Greenwood	Worthsville Rd	I-64 to US 31	Widen to 4 lanes, divided
	16	Hamilton Co.	206th St	Hague Rd/Carrigan Rd to SR 19	Widen to 4 lanes
	17	Hamilton Co.	146th St (Phase II)	Ditch Rd to Towne Rd	Widen to 4 lanes
	18	Hamilton Co.	146th St (Phase III)	Towne Rd to Shelborne Rd	Widen to 4 lanes
	19	Hamilton Co.	146th St (Phase IV)	Shelborne Rd to Boone Co. Line	Widen to 4 lanes
	20	Hancock Co.	Mt Comfort Rd	CR 300 N to CR 400 N	Widen to 4 lanes, divided
	21	Hancock Co.	Mt Comfort Rd	CR 600 N to CR 650 N	Widen to 4 lanes, divided
	22	Hancock Co	Mt Comfort Rd	CR 850 N to CR 1000 N	Widen to 4 lanes, divided
	23	Hancock Co.	CR 300 N	CR 700 W to CR 600 W	Widen to 4 lanes, divided
	24	Hancock Co.	CR 300 N	CR 500 W to CR 400 W	Widen to 4 lanes, divided
	25	Hancock Co.	CR 300 N	CR 600 W to CR 500 W	Widen to 4 lanes, divided
	26	Hendricks Co.	Ronald Reagan Pkwy	CR 300 N to US 136	New 4-lane roadway
	27	Hendricks Co./Avon	CR 100 N	Raceway Rd to SR 267	Widen to 4 lanes, divided
	28	Indianapolis	10th St	Raceway Rd to Tomahawk Trl	Widen to 4 lanes, divided
	29	Indianapolis	79th St	Fall Creek Rd to Sunnyside Rd	Widen to 4 lanes, divided
	30	Indianapolis	Georgetown Rd	86th St to 62nd St	Widen to 4 lanes, divided
	31	Indianapolis	21st St	Post Rd to Mitthoeffer Rd	Widen to 4 lanes, divided
	32	Indianapolis	56th St	Guion Rd to Kessler Blvd	Widen to 4 lanes, divided
	33	Indianapolis	56th St	Raceway Rd to Dandy Trail Rd	Widen to 4 lanes, divided
	34	Indianapolis	56th St	Dandy Trail Rd to I-465	Widen to 4 lanes, divided
	35	Indianapolis	Dandy Trail Rd	Crawfordsville Rd to 34th St	Widen to 4 lanes, divided
	36	Indianapolis	Southport Rd	Bluff Rd to SR 135	Widen to 4 lanes, divided
	37	Indianapolis	Southport Rd	SR 135 to US 31	Widen to 4 lanes, divided

	38	Indianapolis	Payne Rd	79th St to 71st St	New 2-lane roadway
	39	Indianapolis	Zionsville Rd	96th St to 86th St	Widen to 4 lanes, divided
	40	Indianapolis	38th St	Post Rd to Mitthoeffer Rd	Widen to 4 lanes
	41	INDOT	I-69	SR 37 to SR 238	Added travel lanes
	42	INDOT	I-69	SR 238 to SR 13	Added travel lanes
	43	INDOT	I-69	SR 13 to SR 38	Added travel lanes
	44	INDOT	I-70	SR 39 to SR 267	Added travel lanes
	45	INDOT	I-65	SR 44 to Whiteland Rd	Added travel lanes
	46	INDOT	I-65	Whiteland Rd to Main St	Added travel lanes
	47	INDOT	I-65	Main St to County Line Rd	Added travel lanes
	48	INDOT	I-65	Worthsville Rd	New interchange
	49	INDOT	I-65	County Line Rd to Southport Rd	Added travel lanes
	50	Johnson Co.	E-W Corridor	CR 700 N to CR 750 N	New 2-lane roadway
	51	Plainfield	Perimeter Pkwy SW	Center St to Moon Rd	Widen to 4 lanes
	52	Shelbyville	Fairland Rd	CR 400 N to CR 100 N	New 2-lane roadway
	53	Speedway	16th St	Main St to E Town Limits	Realignment
	54	Speedway	25th St	Georgetown Rd Connector	New 4-lane roadway
	55	Speedway	Lynhurst Dr	Moeller Rd – 26th St to 30th St	New 4-lane roadway
	56	Speedway	Holt Rd	10th St to 16th St	Realignment & extension
	57	Westfield	161st St	Union St to Gray Rd	Widen to 4 lanes
	58	Westfield	Springmill Rd	146th St to SR 32	Widen to 4 lanes, divided
	59	Zionsville	96th St	Zionsville Rd to Hamilton Co.	Widen to 4 lanes, divided
	60	Zionsville	Bennett Pkwy	106th St to 96th St	New 2-lane roadway
2026-2035	61	Avon	CR 200 N	Dan Jones Rd to Persimmon	Widen to 4 lanes, divided
	62	Avon	CR 100 S	Ronald Reagan Pkwy to SR 267	Widen to 4 lanes, divided
	63	Brownsburg	CR 625 E	W Northfield Dr to CR 800 N	New roadway and overpass
	64	Carmel	96th St	Keystone Pkwy	New interchange
	65	Carmel	Springmill Rd	96th St to 116th St	Widen to 4 lanes, divided
	66	Carmel	131st St	Hazel Dell to River Ave	Widen to 4 lanes, divided
	67	Greenwood	Worthsville Rd	SR 135 to 5 Points Rd	Widen to 4 lanes, divided
	68	Greenwood	Smith Valley Rd	SR 135 to Emerson Ave	Widen to 4 lanes, divided
	69	Hamilton Co.	206th St	SR 19 to Cumberland Rd	Widen to 4 lanes
	70	Hamilton Co.	Olio Rd	Tegler Ave to SR 38	Widen to 4 lanes
	71	Hamilton Co.	Olio Rd	SR 38 to SR 32	New 4-lane roadway
	72	Hamilton Co.	146th St	SR 37 to Boden Rd	Widen to 6 lanes
	73	Hancock Co.	Mt Comfort Rd	CR 400 N to CR 600 N	Widen to 4 lanes, divided
	74	Hancock Co.	Mt Comfort Rd	CR 650 N to CR 850 N	Widen to 4 lanes, divided
	75	Indianapolis	Township Line Rd	79th St to 71st St	New 4-lane divided roadway
	76	Indianapolis	79th St	Georgetown Rd to Michigan Rd	Widen to 4 lanes, divided

	77	Indianapolis	79th St	Michigan Rd to Township Line	Widen to 4 lanes, divided
	78	Indianapolis	Bluff Rd	West St to Troy Ave	Widen to 4 lanes, divided
	79	Indianapolis	Cooper Rd	Michigan Rd to 62nd St	New 2-lane roadway
	80	Indianapolis	County Line Rd	SR 37 to Morgantown Rd	Widen to 4 lanes, divided
	81	Indianapolis	Girls School Rd	Rockville Rd to 21st St	Widen to 4 lanes, divided
	82	Indianapolis	Thompson Rd	High School Rd to Mann Rd	Widen to 4 lanes, divided
	83	Indianapolis	Township Line Rd	96th St to 79th St	Widen to 4 lanes, divided
	84	Indianapolis	71st St	Georgetown Rd to Michigan Rd	Widen to 4 lanes, divided
	85	Indianapolis	Allisonville Rd	96th St to 86th St	Widen to 6 lanes, divided
	86	Indianapolis	County Line Rd	5 Points Rd to Franklin Rd	New 2-lane roadway
	87	Indianapolis	Fall Creek Rd	Hague Rd to I-465	Widen to 4 lanes, divided
	88	Indianapolis	Girls School Rd	Crawfordsville Rd to 21st St	Widen to 4 lanes, divided
	89	Indianapolis	West St	Raymond St to Bluff Rd	Widen to 4 lanes, divided
	90	Indianapolis	High School Rd	46th St to 56th St	Widen to 4 lanes, divided
	91	Indianapolis	10th St	I-465 to Tomahawk Trl	Widen to 6 lanes, divided
	92	Johnson Co.	Stones Crossing	SR 37 to SR 135	Widen to 4 lanes, divided
	93	Johnson Co.	Clark School Rd	CR 300 to Shelby Co. Line	Widen to 4 lanes, divided
	94	Johnson Co.	CR 200 N	SR 144 to US 31	Widen to 4 lanes, divided
	95	Johnson Co.	Whiteland Rd	CR 225 E to I-65	Widen to 4 lanes, divided
	96	Noblesville	Greenfield Ave	Allisonville Rd to Cumberland	Widen to 4 lanes
	97	Noblesville	Allisonville Rd	146th St to Greenfield Ave	Widen to 4 lanes
	98	Westfield	161st St	Springmill Rd to US 31	Widen to 4 lanes
	99	Westfield	Western Wy	Union St to Western Wy	New 4-lane roadway
	100	Zionsville	CR 375 S	CR 1000 W to US 421	New 2-lane roadway
	101	Zionsville	Templin Rd	Mulberry St to Willow Rd	New 2-lane roadway
	102	Zionsville	CR 875 W	CR 250 S to CR 200 S	New 2-lane roadway
	103	INDOT	US 36	Danville Bypass	New 4-lane roadway
	104	INDOT	SR 39	SR 37 to SR 67	Widen to 4 lanes

MEMORANDUM

To: **Jim Earl, INDOT; Sarah Rubin, INDOT**

From: **Matt Miller, HNTB**

Date: **October 20, 2016**

Re: **I-69 Ohio River Bridge Sensitivity Analysis**

The selection of transportation projects to incorporate into the 2045 horizon year analyses was based on the following criteria:

- Project must be part of a fiscally constrained long-range transportation plan; OR
- Project must be included on an approved Transportation Improvement Plan.

The future I-69 Ohio River Bridge in Evansville does not satisfy either criterion and will not be included in the 2045 analyses. This approach represents a departure from the previous Tier 2 EIS evaluations of other I-69 sections, which did include the I-69 Ohio River Bridge in traffic forecasts because the I-69 Ohio River Bridge was previously included in fiscally constrained transportation plans. Questions have been raised about how the exclusion of this project will impact traffic forecasts within the four-county Section 6 study area. To address these questions, a sensitivity analysis was performed both with and without the I-69 Ohio River Bridge to quantify the impact of that facility on Section 6 traffic. This memo documents the results of that sensitivity analysis, which was conducted in May 2015.

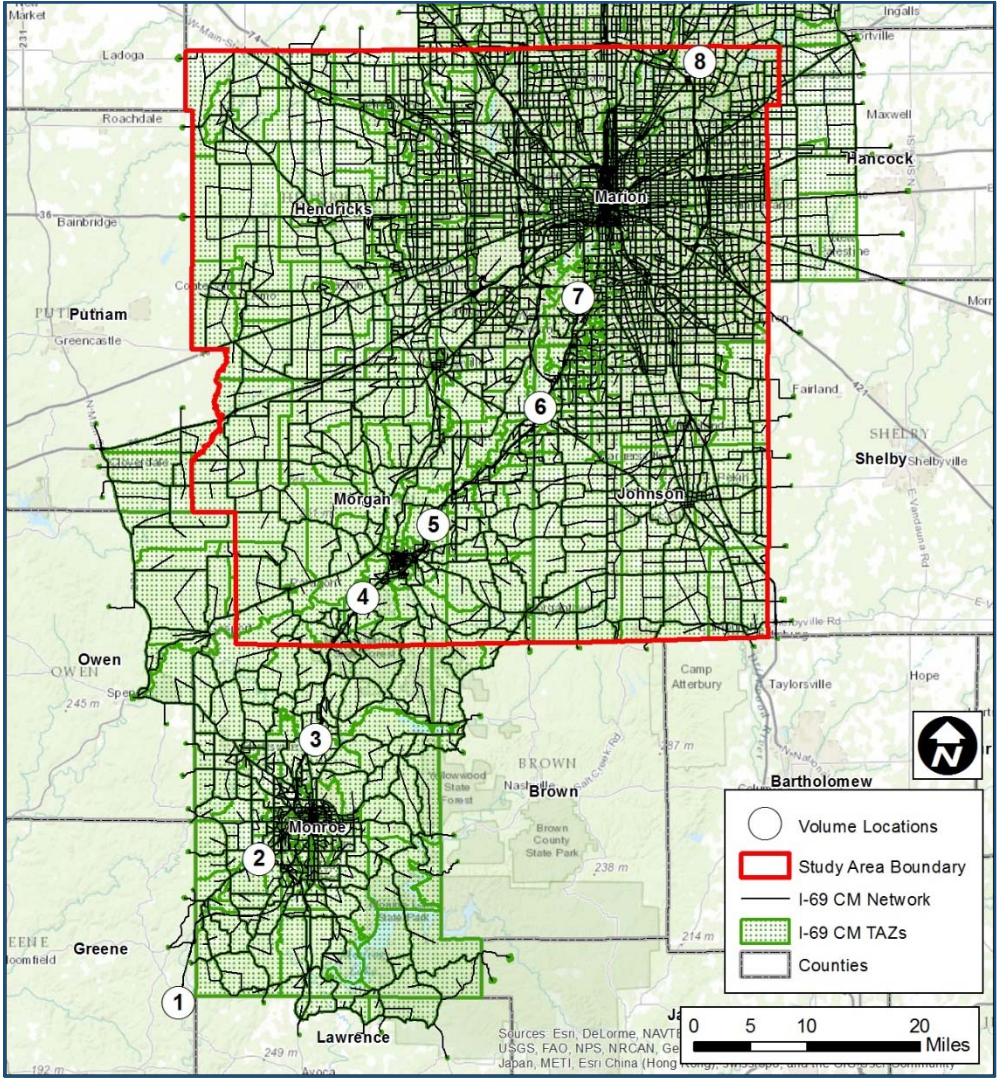
The 2045 ISTDM No-Build scenario was run both with and without the I-69 Ohio River Bridge, and the resulting external volumes were incorporated into runs of the I-69 Section 6 Corridor Model (I-69 CM). The difference in Average Daily Traffic (ADT) volumes forecasted by the I-69 CM for select network links along the I-69/SR 37 corridor is summarized in **Table 1**. These selected links are at fairly regular intervals along the corridor throughout its entire length in the model area, as well as one volume on I-69 north of I-465.

Traffic volumes entering I-69 Section 6 from Monroe County to the south would increase by approximately 2.9 percent if the I-69 Ohio River Bridge were to be included in the model. That impact is reduced farther north along the I-69/SR 37 corridor, resulting in a less than 1 percent change on I-69 north of I-465. It is concluded that the I-69 Ohio River Bridge in Evansville would be too far removed from the Section 6 Study Area to have a meaningful impact on the analysis results.

Table 1: Comparison of 2045 ADT Volumes With and Without I-69 Ohio River Bridge

ID	Location	2045 No-Build without I-69 Bridge	2045 No-Build with I-69 Bridge	% Change
1	I-69 Southern External	30,600	31,500	2.9%
2	I-69 South of SR 37	33,800	34,900	3.3%
3	I-69 North of Walnut	65,100	66,000	1.4%
4	I-69 South of SR 39	59,600	60,500	1.5%
5	SR 37 North of SR 44	37,800	38,600	2.1%
6	SR 37 North of SR 144	44,900	45,400	1.1%
7	SR 37 South of I-465	44,900	45,400	1.1%
8	I-69 North of 82nd St	173,800	174,500	0.4%

Figure 1: Map Illustrating Externals with Change in Volume of 1 Percent or More



Tour and Stop Generation Equations

Table 1. Tour and Stop Generation Regression Models

Tour / Stop Type	Coefficient	Variable
Work Tours	0.677	HH Workers
	-0.157	Income[Q1]
	-0.083	Income[Q2]
	-0.136	HH Seniors
	0.040	General Accessibility
Work Stops	0.930	HH Workers
	0.215	Income[Q2]
	0.353	Income[Q3]
	0.442	Income[Q4]
	0.228	ln(Vehicles per worker)
	0.0002	Network Density
	-0.218	HH Seniors
University Stops	-0.012	Constant
	0.159	HH Workers
	0.058	HH Students
	-0.195	HH Non-students
	0.192	HH Senior
	0.117	HH Homemaker
	0.0001	Network Density
	0.047	Income[Q1&Q2]
	0.199	1 Vehicle
	0.313	2 Vehicles
	0.418	3 Vehicles
	0.575	4+ Vehicles
	-0.329	ln(Vehicles per nonstudent)
Eating Stops	-0.463	Constant
	0.136	HH Students
	0.252	2+ Vehicles
	0.042	General Accessibility
	0.003	TAZ Income
	0.101	Income

Table 2. School Tour Generation Logit Model

School Tours	Alternatives	Parameter
-- Logsum Parameters		
Nest_1	alt2, Nest_2	0.9
Nest_2	alt3, Nest_3	0.81
Nest_3	alt4	0.729
-- Alternative Specific Parameters		
CONSTANT	alt1	-0.898
CONSTANT	alt2	-5.671
CONSTANT	alt3	-10.797
CONSTANT	alt4	-27.345
Income (1-4)	alt1	0.117
Income (1-4)	alt2	0.400
Income (1-4)	alt3	0.508
Income (1-4)	alt4	0.508
HH Students	alt1	-0.220
HH Students	alt2	2.219
HH Students	alt3	4.052
HH Students	alt4	8.711
HH Seniors	alt1	-1.175
HH Seniors	alt2	-1.175
HH Seniors	alt3	-1.175
HH Seniors	alt4	-1.175
ln(Vehicle per non-worker)	alt1	1.810
ln(Vehicle per non-worker)	alt2	1.185
ln(Vehicle per non-worker)	alt3	-0.384
ln(Vehicle per non-worker)	alt4	-5.616

Table 3. Other Tour Generation Logit Model

Other Tours	Alternatives	Parameter
-- Logsum Parameters		
Nest_1	alt1, Nest_1	0.9
Nest_2	alt2, Nest_2	0.81
Nest_3	alt3, Nest_3	0.729
Nest_4	alt4, Nest_4	0.656
Nest_5	alt5, Nest_5	0.59
Nest_6	alt6, Nest_6	0.531
Nest_7	alt7, Nest_7	0.478
Nest_8	alt8, alt9	0.43

Table 3. Other Tour Generation Logit Model

Other Tours	Alternatives	Parameter
-- Alternative Specific Parameters		
CONSTANT	alt1	-1.068
CONSTANT	alt2	-3.185
CONSTANT	alt3	-4.643
CONSTANT	alt4	-5.787
CONSTANT	alt5	-6.897
CONSTANT	alt6	-7.242
CONSTANT	alt7	-7.682
CONSTANT	alt8	-9.576
CONSTANT	alt9	-10.351
HH Workers	alt1, alt2	-0.384
HH Seniors	alt1	2.625
HH Seniors	alt2	2.645
HH Seniors	alt3	2.687
HH Seniors	alt4	2.644
HH Seniors	alt5	2.734
HH Seniors	alt6-alt9	2.154
TAZ Income	alt1-alt9	0.0097
HH NonWorkers	alt1	-0.053
HH NonWorkers	alt2	0.735
HH NonWorkers	alt3	1.056
HH NonWorkers	alt4	1.302
HH NonWorkers	alt5	1.322
HH NonWorkers	alt6	1.430
HH NonWorkers	alt7	1.448
HH NonWorkers	alt8, alt9	1.673
ln(Vehicles)	alt1	0.758
ln(Vehicles)	alt2, alt3	1.845
ln(Vehicles)	alt4	2.212
ln(Vehicles)	alt5-alt7	2.737
ln(Vehicles)	alt8	3.553
ln(Vehicles)	alt9	3.813
Network Density	alt1	0.0006
Network Density	alt2, alt3	0.0008
Network Density	alt4-alt7	0.0012
Network Density	alt8, alt9	0.0016
HH Homemaker	alt1-alt9	2.306

Table 4. School Stop Generation Logit Model

School Stops	Alternatives	Parameter
-- Logsum Parameters		
Nest_1	alt_1, Nest_2	0.9
Nest_2	alt_2, Nest_3	0.81
Nest_3	alt_3, alt_4	0.729
-- Alternative Specific Parameters		
CONSTANT	alt1	-0.119
CONSTANT	alt2	-5.239
CONSTANT	alt3	-10.335
CONSTANT	alt4	-16.849
Income (1-4)	alt1	0.232
Income (1-4)	alt2	0.534
Income (1-4)	alt3	0.580
Income (1-4)	alt4	0.580
HH Students	alt1	-0.179
HH Students	alt2	2.219
HH Students	alt3	3.748
HH Students	alt4	5.199

Table 5. Shopping Stop Generation Logit Model

School Stops	Alternatives	Parameter
-- Logsum Parameters		
Nest_1	alt_1, Nest_2	0.9
Nest_2	alt_2, Nest_3	0.81
Nest_3	alt_3, alt_4	0.729
-- Alternative Specific Parameters		
CONSTANT	alt1	-0.119
CONSTANT	alt2	-5.239
CONSTANT	alt3	-10.335
CONSTANT	alt4	-16.849
Income (1-4)	alt1	0.232
Income (1-4)	alt2	0.534
Income (1-4)	alt3	0.580
Income (1-4)	alt4	0.580
HH Students	alt1	-0.179
HH Students	alt2	2.219
HH Students	alt3	3.748
HH Students	alt4	5.199

Table 6. Shopping Stop Generation Logit Model

Shopping Stops	Alternatives	Parameter
-- Logsum Parameters		
Nest_1	alt_1, Nest_2	0.9
Nest_2	alt_2, Nest_3	0.81
Nest_3	alt_3, Nest_4	0.729
Nest_4	alt_4, Nest_5	0.656
Nest_5	alt_5, alt_6	0.59
-- Alternative Specific Parameters		
CONSTANT	alt1	-2.305
CONSTANT	alt2	-3.369
CONSTANT	alt3	-4.605
CONSTANT	alt4	-6.082
CONSTANT	alt5	-7.297
CONSTANT	alt6	-7.633
HH Size	alt3	0.205
HH Size	alt4	0.319
HH Size	alt5, alt6	0.269
Income (1-4)	alt1-alt6	0.177
HH Seniors	alt1	0.103
HH Seniors	alt2-alt6	0.514
Accessibility	alt4-alt6	0.159
TAZ Income	alt1, alt2	0.005
TAZ Income	alt3, alt4	0.007
TAZ Income	alt5, alt6	0.013
ln(Vehicles)	alt1	0.549
ln(Vehicles)	alt2, alt3	1.059
ln(Vehicles)	alt4	0.709
ln(Vehicles)	alt5, alt6	1.016

Table 7. Personal Business Stop Generation Logit Model

Personal Business Stops	Alternatives	Parameter
-- Logsum Parameters		
Nest_1	alt_1, Nest_2	0.9
Nest_2	alt_2, Nest_3	0.81
Nest_3	alt_3, Nest_4	0.729
Nest_4	alt_4, Nest_5	0.656
Nest_5	alt_5, Nest_6	0.59
Nest_6	alt_6, alt_7	0.531
-- Alternative Specific Parameters		
CONSTANT	alt1	-2.305
CONSTANT	alt2	-3.118
CONSTANT	alt3	-4.225
CONSTANT	alt4	-4.795
CONSTANT	alt5	-5.473
CONSTANT	alt6	-5.680
CONSTANT	alt7	-7.090
HH Size	alt1, alt2	0.124
HH Size	alt3	0.502
HH Size	alt4, alt5	0.631
HH Size	alt6	0.693
HH Size	alt7	0.902
HH Workers	alt1, alt2	-0.073
HH Workers	alt3	-0.282
HH Workers	alt4, alt5	-0.367
HH Workers	alt6, alt7	-0.325
HH Students	alt1, alt2	-0.094
HH Students	alt3	-0.291
HH Students	alt4-alt7	-0.301
HH Seniors	alt1-alt3	0.393
HH Seniors	alt4-alt7	0.705
Accessibility	alt1-alt7	0.062
ln (Vehicles per person)	alt1-alt7	0.598
2+ Vehicles	alt1	0.301
2+ Vehicles	alt2-alt7	0.572
Gas Price for Income[Q1]	alt1-alt3	-0.265
Gas Price for Income[Q1]	alt4-alt7	-0.704

Table 8. Social & Recreational Stop Generation Logit Model

Social & Recreational Stops	Alternatives	Parameter
-- Logsum Parameters		
Nest_1	alt_1, Nest_2	0.9
Nest_2	alt_2, Nest_3	0.81
Nest_3	alt_3, Nest_4	0.729
Nest_4	alt_4, Nest_5	0.656
Nest_5	alt_5, Nest_6	0.59
Nest_6	alt_6, alt_7	0.531
-- Alternative Specific Parameters		
CONSTANT	alt1	-2.683
CONSTANT	alt2	-3.225
CONSTANT	alt3	-5.451
CONSTANT	alt4	-5.899
CONSTANT	alt5	-7.232
CONSTANT	alt6	-8.152
CONSTANT	alt7	-9.882
HH Size	alt1, alt2	0.025
HH Size	alt3	0.035
HH Size	alt4	0.509
HH Size	alt5	0.651
HH Size	alt6	0.705
HH Size	alt7	0.944
Income (1-4)	alt1, alt2	0.141
Income (1-4)	alt3-alt5	0.367
Income (1-4)	alt6,alt7	0.487
HH Workers	alt1	-0.023
HH Workers	alt2	-0.115
HH Workers	alt3	-0.228
HH Workers	alt4	-0.360
HH Workers	alt5, alt6	-0.601
HH Workers	alt7	-0.738
TAZ Income	alt1	0.006
TAZ Income	alt2	0.009
TAZ Income	alt3-alt6	0.010
TAZ Income	alt7	0.017
ln(Vehicles)	alt1	0.762
ln(Vehicles)	alt2	0.973
ln(Vehicles)	alt3, alt4	0.971
ln(Vehicles)	alt5	1.575
ln(Vehicles)	alt6, alt7	1.631
ln(Vehicles per Nonworker)	alt1	0.229
ln(Vehicles per Nonworker)	alt2	0.364
ln(Vehicles per Nonworker)	alt3-alt7	0.520
Population Density	alt1-alt7	0.0001
Gas Price for Income[Q1]	alt1	-0.086
Gas Price for Income[Q1]	alt2-alt7	-0.350

Table 9. Travel Stop Generation Logit Model

Travel Stops	Alternatives	Parameter
-- Logsum Parameters		
Nest_1	alt_1, Nest_2	0.9
Nest_2	alt_2, Nest_3	0.81
Nest_3	alt_3, Nest_4	0.729
Nest_4	alt_4, Nest_5	0.656
Nest_5	alt_5, Nest_6	0.59
Nest_6	alt_6, alt_7	0.531
-- Alternative Specific Parameters		
CONSTANT	alt1	-4.336
CONSTANT	alt2	-3.613
CONSTANT	alt3	-5.323
CONSTANT	alt4	-5.829
CONSTANT	alt5	-6.967
CONSTANT	alt6	-8.220
CONSTANT	alt7	-8.656
HH Size	alt1, alt2	0.195
HH Size	alt3, alt4	0.478
HH Size	alt5	0.709
HH Size	alt6, alt7	0.878
Income (1-4)	alt1, alt2	0.082
Income (1-4)	alt3-alt7	0.181
HH Students	alt1-alt7	0.480
HH Seniors	alt1	-0.811
HH Seniors	alt2-alt7	-0.621
Gas Price	alt1	0.495
Access to Retail	alt1-alt3	0.041
Access to Retail	alt4	0.159
Access to Retail	alt5	0.168
Access to Retail	alt6, alt7	0.266
ln(Vehicles per Nonworker)	alt1	0.927
ln(Vehicles per Nonworker)	alt2	1.111
ln(Vehicles per Nonworker)	alt3-alt7	0.821

APPENDIX C

University Tour Submodel Description

Appendix C: University Student Travel

College/university student travel is an important component of corridor travel demand. University students in the model are grouped into three distinct segments based on the type of student/enrollment:

- Full-time, on-campus students
- Full-time, off-campus students
- Part-time students (assumed to be off-campus)

The travel by each of these groups is treated differently. The full time students are assumed not to be adequately represented in the household surveys and Census data used to generate standard household travel. Therefore, the mod el develops daily tours for these students; whereas, the part-time students are considered to belong to standard households in the model and their college/university related travel is dealt with simply through the use of college/university stops which can be made on work or other tours.

Full-time Student Tours

Many aspects of full-time students' travel are treated the same in the I-69 Corridor Model, but on-campus students' travel is somewhat simpler since their home is campus. In their case, the obvious choice is to define their tours as rooted (beginning/ending) at campus. For off-campus students, however, since home and campus are not the same, the tour must be rooted/generated at one or the other. Since better information is available with regard to the number of students enrolled at a campus and it is easier to forecast this than the number of students residing in each TAZ, off-campus university student tours were also rooted on campus (rather than at home).

Although it is acknowledged that full-time, on-campus students make many trips on-campus for a variety of purposes, this on-campus travel is not represented in the model. However, their travel to off-campus destinations is represented in a simple way, as one-stop tours, from campus to an off-campus destination and back. The *Indiana University Travel Demand Survey* (BLA, 1999) found that on-campus students visited, on average, 0.95 off-campus destinations per day. This rate was used for generating on-campus students' off-campus tours. There were relatively few tours observed with multiple off-campus stops, so it was judged a reasonable simplification to represent full-time, on-campus students' off-campus travel as one-stop round-trips to and from campus.

For full-time students, it is important to allow and represent multi-stop tours in order to represent both home and non-home stops off-campus. Again, rates were initially taken from the IU survey which showed an average of 0.81 tours per day for off-campus students with 1.37 stops at home and 0.94 stops at other locations. However, in calibrating the model, it was found necessary to reduce the number of stops at other locations to 0.50 stops per day.

University tours are first created with a special generator macro (a sub-module of the model code) outside of general tour generation. The university tours also do not go through regular tour mode choice. A trip mode choice logit model is applied to the university trips after the stops have been allocated.

Table 1. University Stop Location Choice Model

Variable	Parameter
--Size Parameters	
Population in Households with no Seniors	0.5
Retail Employment [for non-home destinations only]	3.0523
Service Employment [for non-home destinations only]	1
--Generic Parameters	
Travel Time x Residence Accessibility	-0.1106
County Line Crossings	-1.0384
Accessibility of Destination to Complements	1.3717
Accessibility of Destination to Substitutes	-1.0977
Activity Diversity	2.2670
Intrazonal	2.1788

Part-time Student Stops

Part-time students' travel was considered to be a part of household travel and so college/university stops were simply included as a stop type generated by households and made on Work or Other tours. Stop location choice is simply driven by part-time enrollment data on the TAZ layer and departure time choices depend on the tour type, rather than stop type.

APPENDIX D

TREDIS Documentation

Appendix D: TREDIS TECHNICAL DOCUMENATION AND RESULTS

TREDIS is a suite of tools, developed by Economic Development Research Group, Inc. (EDR) that compares economic impacts, benefits and costs of different transportation policies, plans and projects. TREDIS's proprietary data analyzes the structure of local economies and forecasts how those economies are expected to change over time. The processes within the TREDIS model are portrayed in Figure 30. It is used throughout the United States, Canada, and Australia. For the I-69 Section 6 project, INDOT used a TREDIS license, which Purdue University has purchased for INDOT's use. This license allows INDOT to use TREDIS for projects throughout Indiana.

There are a number of technical terms used in this documentation which are explained in a glossary at the end of this document. Terms which are defined in the glossary are noted in the text.

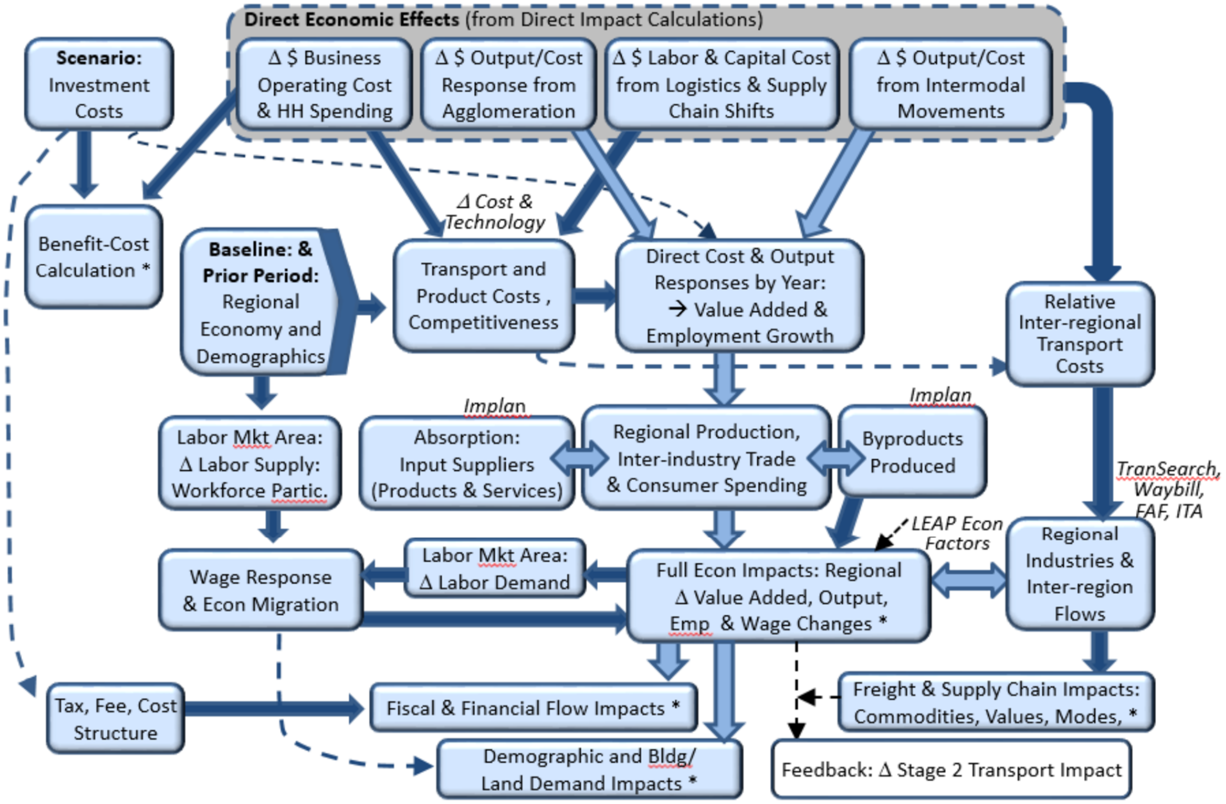


Figure 30: TREDIS Model Structure Forecasts of Study Area Economic Impact[1]

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[1] From *TREDIS ® Technical Document: Economic Adjustment Module, Software Version 4.0, October 29, 2014*, at http://www.tredis.com/images/tech_docs/TREDIS%20400%20-20Economic%20Adjustment%20Tech%20Doc.pdf.

TREDIS uses travel model forecasts for both no-build and build scenarios to forecast the economic impacts of transportation projects. The next section describes how the benefits of alternative transportation projects are used by TREDIS to forecast economic impacts. It also describes how TREDIS uses this increased economic activity to forecast induced population and employment which is a result of this increased economic activity. For the I-69 Section 6 project, several purpose and need measures were calculated by TREDIS for each alternative. These measures include increases in personal income, increases in employment, and increases in employment in key industry categories. These increases were forecasted for the four-county study area and then manually sub-allocated to the individual counties (Morgan, Marion, Johnson and Hendricks counties).

How TREDIS Was Incorporated into the Modeling Process

The I-69 Section 6 EIS considered both baseline and induced economic growth. Baseline growth is that anticipated to occur regardless of the I-69 project. It is forecasted exogenously considering public (e.g. Bureau of Labor Statistics, Bureau of Economic Analysis, Indiana Business Research Center, US Census Bureau, etc.) and proprietary sources (e.g. Woods & Poole Economics), as well as previous and anticipated trends. Induced growth is additional growth that will occur as a result of the I-69 project and it is the focus of the TREDIS analyses.

The analysis framework is illustrated in the chart below. The individual steps and transfer of data between steps are described below and shown in Figure 31:

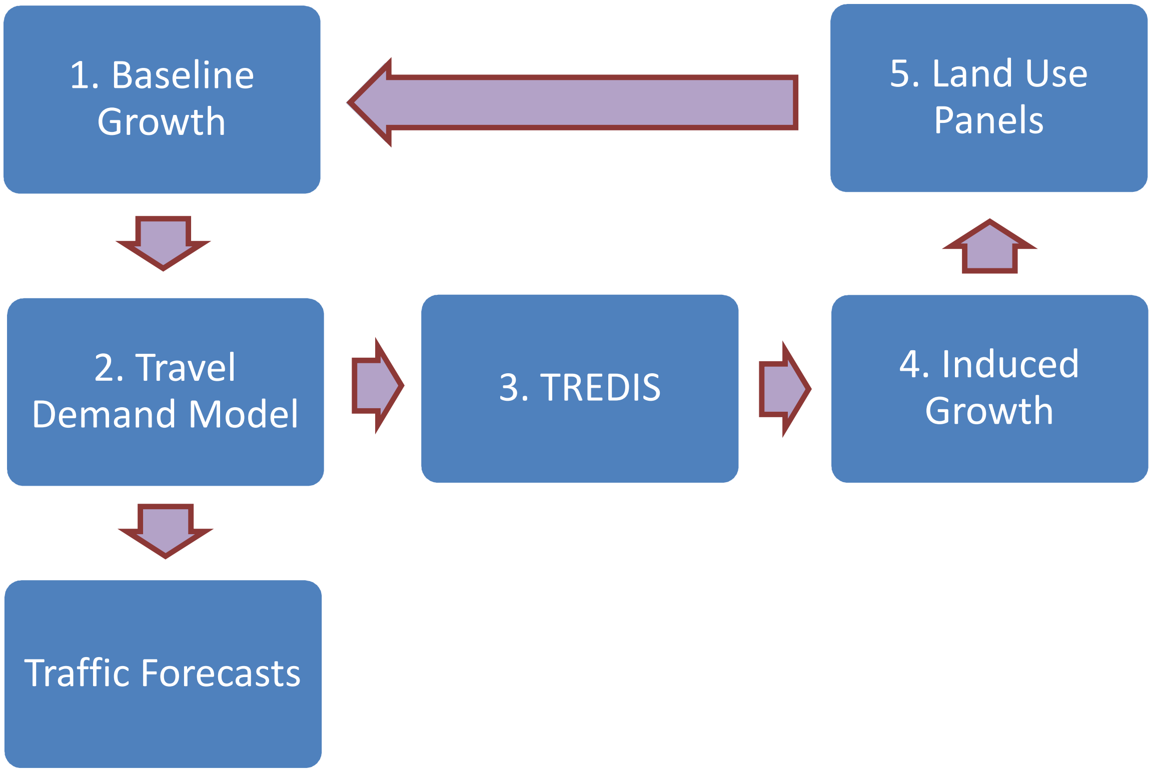

Figure 31: Section 6 Modeling Process

1. Baseline growth forecasts were prepared for the 2045 design year. Population and employment obtained on a county-level basis from Woods & Poole (employment) and Indiana Business Research Center (population). These county-level forecasts were allocated to Traffic Analysis Zones (TAZs) within each county based upon existing trends and land available for development. This allocation process was conducted using a GIS-based land use projection tool called CommunityViz. These allocations were reviewed and in some cases adjusted by the land use panels[2]. These forecasts served as inputs to the Travel Demand Model in Step 2.
2. I-69 Corridor Travel Demand Model was run for the 2045 design year. Both Build and No-build scenarios were run. Both cost[3] savings and increases in accessibility were calculated based on

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[2] There were four land use panels, one for each county in the economic study area (Hendricks, Morgan, Johnson and Marion county).

[3] "Costs" are defined as changes in the flow of dollars in the economy. As such, they are measured and used differently for different kinds of trips. For example, changes in travel time for a recreational trip does not change the flow of dollars in the economy; for such trips, only direct changes in auto operating cost (fuel, tires, lubricants, etc.) change the flow of dollars in the economy. By comparison, travel time for on-the-clock business travel does change the flow of dollars in the economy.

differences between the Build and No-build scenarios. One example of accessibility is increased access to labor markets within a certain distance threshold, which is representative of the ability of businesses to manage their labor costs and stay competitive. These measures represent the direct benefits due to I-69 Section 6.

3. TREDIS was run for the 2045 design year. Inputs to the TREDIS analysis included the direct benefit measures (cost savings and increases in accessibility) determined by the Travel Demand Model in Step 2.
4. TREDIS determined how these benefits resulted in increases in business activity and employment. TREDIS then forecasted increases in employment, population, household income, and economic output that would result. These measures represent induced growth due to I-69 Section 6 and serve as purpose and need performance indicators.
5. The induced growth forecasted by TREDIS and the baseline growth were then reviewed by the land use panels. The panel members reviewed the geographic allocation of the population and employment growth based on their knowledge of zoning, available land, and the development potential of the communities they represent.
6. The baseline and induced growth were reallocated geographically to TAZs based on the input from the land use panels. The final travel demand model run reflected all induced and reallocated growth. This enabled the traffic forecasts to incorporate all anticipated growth in the consensus locations.

TREDIS Inputs

TREDIS requires a number of inputs on both general project characteristics as well as some which are outputs from a travel demand model. The general project information was assumed to be consistent between all of the alternatives evaluated. They included the following. Terms shown in bold type are defined in the glossary.

- **Construction Start Year**: 2022
- **Construction End Year**: 2025
- **Operation Start Year**: 2025
- **Operation End Year**: 2045
- **Constant Dollar Year**: 2015
- Modes of Travel: Passenger Cars, Tractor Trailer Trucks, Light/Medium Duty Trucks
- Study Region Counties: Hendricks, Johnson, Marion and Morgan Counties
- **Linkage Counties**: Vanderburgh County
- **Project Cost**: $1 Billion

Outputs from the travel model were included to compare the no-build scenario with each build alternative. These outputs from the no-build and build alternatives include:

- Total number of annual vehicular trips
- Annual vehicle miles of travel (VMT)
- Annual vehicle hours of travel (VHT)
- Fraction of miles that are congested (a level of service E or F was considered congested for this analysis)
- Fraction of trips that are internal, incoming, outgoing and passing through the study area4
- Fatal, personal injury and property damage/other crashes per 100 million VMT
- Population within a 40 minute drive time of the study area (including the population within the study area)
- Employment within a 180 minute drive time of the study area (including the employment within the study area)
- Average time from within the study area to an international border crossing (the Ambassador Bridge in Detroit, MI was determined to be the closest border crossing)
- Average drive time from within the study area to a freight rail terminal (the Senate Avenue rail terminal and CSX – Indianapolis Avon Yard were determined to be the two qualifying freight terminals in the study area)
- Average drive time from within the study area to a passenger rail terminal (the Indianapolis Amtrak station was the only qualifying passenger rail terminal in the study area)
- Average drive time from within the study area to a domestic airport (the Indianapolis Airport was the only qualifying domestic airport in the study area)
- Average drive time from within the study area to an international airport (Midway Airport in Chicago was the closest qualifying international airport to the study area as determined by the list of qualifying international airports provided by EDR)
- Average drive time from within the study area to an intermodal port facility (the Port of Cincinnati was determined to be the closest qualifying port facility to the study area)

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[4] Definitions of each trip type are provided in the glossary.

Preliminary Alternative TREDIS Forecasts

TREDIS was not used to predict induced growth for the preliminary alternatives. It was used to compare the economic impacts of the different corridor alternatives. The preliminary alternatives included one alternative that follows the existing SR 37 corridor the entire length of the study area from Martinsville to I-465, two corridors that turn off of the SR 37 corridor north of Martinsville to the west and intersect with I-70 west of the Indianapolis Airport, and two corridors that turn off of the SR 37 corridor north of Martinsville to the west and generally follow the Mann Road corridor to I-465. These alternatives are illustrated in Figure 32.

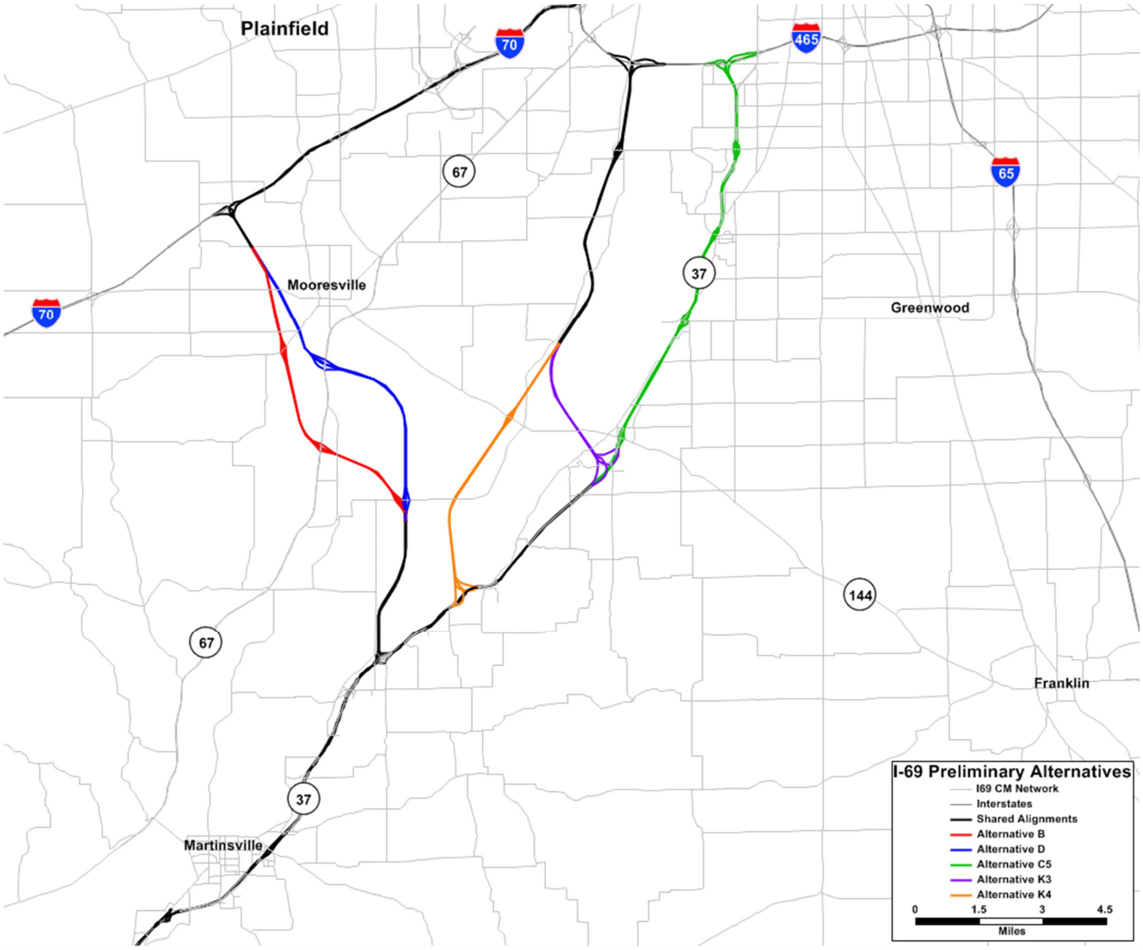

Figure 32: Preliminary Alternative Corridors

The primary economic impacts within the four-county study area produced by TREDIS for the preliminary alternative corridors are provided in Table 88 below: These terms are defined in the glossary.

Alternative	Business Output	Value Added	Jobs	Wage Income
Alternative C5	$3.429 Billion	$2.022 Billion	1,170	$1.474 Billion
Alternative B	$1.989 Billion	$1.147 Billion	415	$891 Million
Alternative D	$2.116 Billion	$1.205 Billion	453	$931 Million
Alternative K3	$3.406 Billion	$2.013 Billion	1,165	$1.468 Billion
Alternative K4	$3.078 Billion	$1.794 Billion	935	$1.319 Billion

Table 88: Preliminary Alternative TREDIS Outputs

As shown in the table above, Alternative C55 (SR 37 Corridor) had the greatest economic impacts of the preliminary corridors, followed by the Mann Road alternatives, with the two I-70 alternatives producing the smallest benefits.

Reasonable & Feasible Alternative TREDIS Forecasts

Refinements of Alternative C5 were carried forward as 'Reasonable and Feasible' alternatives. Four such alignments were evaluated using the I-69 Corridor Model – C1, C2, C3 and C4. The differences between these alternatives (within the travel model) were limited to interchange types, the inclusion or exclusion of an interchange at Ohio Street in Martinsville, and the potential for a direct connection to an existing portion of SR 37 south of I-465.

The primary economic impacts of the three Reasonable and Feasible Alternatives are provided in Table 2 below. It should be noted that the preliminary alternatives were run using TREDIS version 4.0. Subsequently, TREDIS version 5.0 was released with updated parameters and costs. The reasonable and feasible alternatives were run using version 5.0, resulting in differences in higher overall benefits than were shown with the preliminary alternatives. EDR staff was engaged to determine if these differences were reasonable, and it was determined that they are comparable to increases seen in similar projects between the two versions of the software. This increase would have also been seen in the preliminary alternatives outside of the SR 37 corridor, and would not have changed the relative ranking of the preliminary alternatives.

Alternative	Business Output	Value Added	Jobs	Wage Income	Population
Alternative C1	$3.838 Billion	$2.202 Billion	1,402	$1.607 Billion	1,762
Alternative C2	$3.801 Billion	$2.183 Billion	1,381	$1.594 Billion	1,736
Alternative C3	$3.838 Billion	$2.202 Billion	1,402	$1.607 Billion	1,762

Table 89: Reasonable & Feasible Alternative TREDIS Outputs

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[5] Alternative C5 was a preliminary alternative using the SR 37 corridor. The reasonable alternatives analyzed in detail in the EIS (Alternatives C1 through C4) are refinements of Alternative C5.

In order to fully account for the economic benefits of increased market access6, the TREDIS analysis had a single study area consisting of the four counties in the study region (Hendricks, Johnson, Morgan and Marion counties). In consultation with EDR staff, Lochmueller Group devised a manual process to allocate the induced growth in population and employment among the four counties for use in the travel model. This process allocated growth in population and employment to individual counties. The land use panels allocated the county-level growth to specific TAZs in each county.

The growth allocation among the four counties relied on several inputs from the travel model and the no-build demographics. Separate allocation percentages were applied to population growth, industrial employment growth, and non-industrial employment growth. Several factors were weighted to reflect the most likely spatial impact of I-69 on induced growth. Land use factors were 50% of the weighting, while transportation impacts were the remaining 50%.

The land use factors were separated into two categories, each of which represented 25% of the total weighting. The first factor was the percentage of total population and employment each county was projected to contain in the year 2045 (regardless of the completion of I-69). The second factor was the relative percentage of growth between the year 2010 and 2045 in each county for population, commercial employment and industrial employment. This second factor gave greater weight to fast-growing portions of the study area. The transportation factor (which was 50% of the total weighting) was the percentage of mainline I-69 VMT within each county. This factor applied more of the induced growth to portions of the study area with higher levels of I-69 traffic.

EDR advised that this methodology is an appropriate method of manually allocating the induced growth projected by the TREDIS program. The process is graphically represented in Figure 4 below, which provides the results for Alternative C1. This process was repeated for Alternatives C2 and C3; however, the results were so similar that it was deemed unnecessary to provide the ELUP with multiple growth allocation percentages, since it would have a very nominal effect on modeling results.

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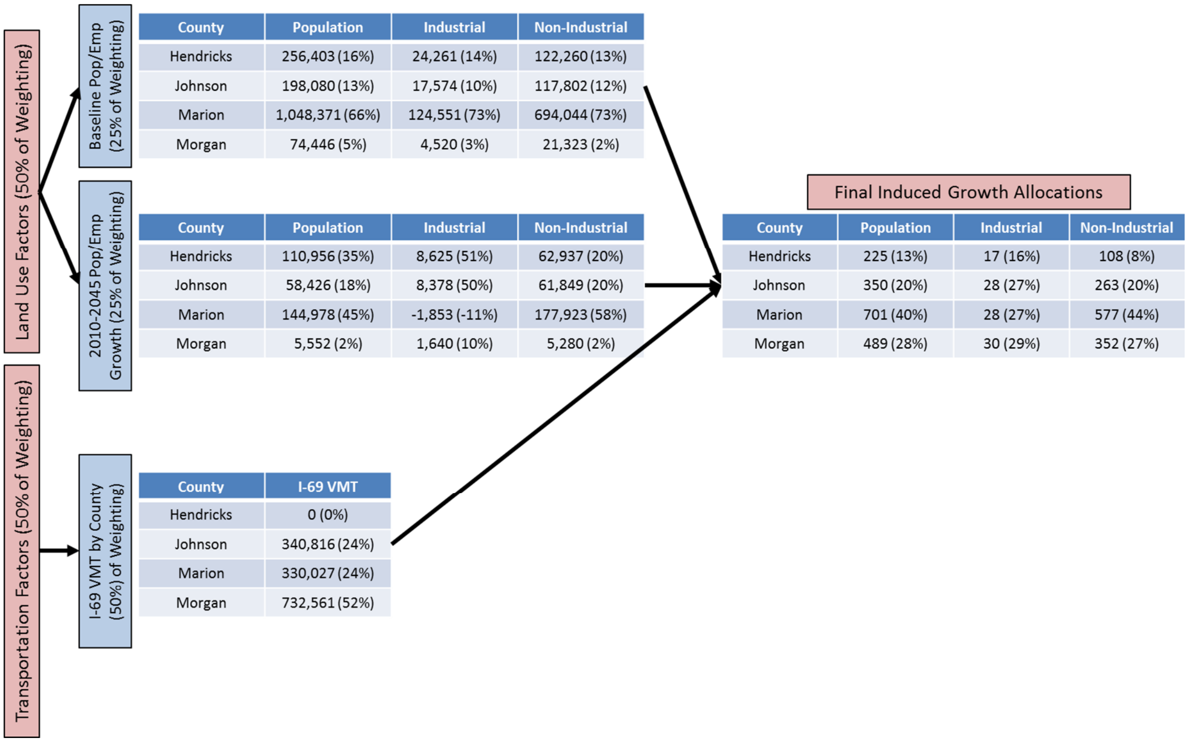
[6] TREDIS measures the economic benefits of increased access for several markets. These include business access to supplier markets, retail customer markets and labor markets. These economic benefits flow “both ways”. For example, business efficiency increases with access to a larger labor force, while workers income potential increases with access to a larger employment market.



County	Population	Industrial	Non-Industrial
Hendricks	256,403 (16%)	24,261 (14%)	122,260 (13%)
Johnson	198,080 (13%)	17,574 (10%)	117,802 (12%)
Marion	1,048,371 (66%)	124,551 (73%)	694,044 (73%)
Morgan	74,446 (5%)	4,520 (3%)	21,323 (2%)

County	Population	Industrial	Non-Industrial
Hendricks	110,956 (35%)	8,625 (51%)	62,937 (20%)
Johnson	58,426 (18%)	8,378 (50%)	61,849 (20%)
Marion	144,978 (45%)	-1,853 (-11%)	177,923 (58%)
Morgan	5,552 (2%)	1,640 (10%)	5,280 (2%)

County	I-69 VMT
Hendricks	0 (0%)
Johnson	340,816 (24%)
Marion	330,027 (24%)
Morgan	732,561 (52%)

County	Population	Industrial	Non-Industrial
Hendricks	225 (13%)	17 (16%)	108 (8%)
Johnson	350 (20%)	28 (27%)	263 (20%)
Marion	701 (40%)	28 (27%)	577 (44%)
Morgan	489 (28%)	30 (29%)	352 (27%)

Figure 33: Manual Allocation Process for Induced Growth

Glossary of Terms

Buffer Time: the additional time a traveler must allocate to a trip because of the inconsistency of travel times to their destinations – usually a result of periodic traffic congestion.

Business Output: net new sales of businesses within the study area induced by the completion of I-69 Section 6.

Commodity Mixes: the assumed amount of each commodity as defined by the Standard Classification of Transported Goods (SCTG).

Constant Dollar Year: due to inflation, the purchasing power of a dollar changes over time, so in order to compare dollar values from one year to another, they need to be converted from nominal dollar values to constant dollar values.

Construction End Year: the year in which substantial construction is expected to end on I-69 Section 6 and all lanes are open to traffic.

Construction Start Year: the year in which substantial construction is expected to begin on I-69 Section 6.

Crash Costs: the costs borne by society associated with vehicular crashes, including loss of life, loss of productivity, medical expenses, property damage and emergency response service costs.

Crew Members per Vehicle: the assumed number of employed individuals per commercial vehicle.

Environmental Costs: the costs related to changes in emissions due to changes in VMT, congestion and fuel consumption.

Freight Tons per Vehicle: the assumed average freight load, by vehicle type, for each commercial vehicle.

Incoming Trips: trips that have their origin outside of the four-county study area, but their destination within the four-county study area.

Internal Trips: trips that have both their origin and destination within the four-county study area.

Jobs: net new long-term (permanent) employment in the study area induced by the completion of I-69 Section 6. Note: short-term construction jobs caused by the construction of the project are not included in this metric.

Linkage Counties: when a large-scale transportation project is completed, it creates increased interaction between the two endpoints of that project. This increase in interaction is defined in the TREDIS program as ‘linkage counties’; therefore, benefits will be impacted by the new connection to an area outside of the defined study area counties.

Operation Start Year: the year in which I-69 Section 6 construction is expected to be complete, and benefits are expected to begin to accrue.

Operation End Year: the final year of the 20-year analysis period for which benefits will be calculated.

Project Cost: the expected total cost of the project. In the case of this analysis, this number was held constant for all scenarios so as to not impact the benefits as final costs had not yet been estimated for the alternatives being evaluated. Regardless, the benefits from the project cost are only experienced between the Construction Start Year and Construction End Year, and do not affect the long-term benefits compiled for each alternative. These long-term benefits are what were used to evaluate the scenarios against each other.

Outgoing Trips: trips that have their origin within the four-county study area, but their destination is outside of the four-county study area.

Through Trips: trips that have both their origin and destination outside of the four-county study area, but use roadway facilities to go through the study area.

Value Added: the net change in Gross Regional Product (GRP) experienced in the study area as a result of the completion of I-69 Section 6.

Value of Time: the opportunity cost of the time that a traveler spends on their journey.

Vehicle Occupancy: the average number of people assumed to be in each vehicle.

Vehicle Operating Costs: costs that vary with vehicle usage, including fuel, tires, maintenance, repairs, and mileage-dependent depreciation costs.

Wage Income: the additional wages earned by workers within the study area as a result of the completion of I-69 Section 6. Note: the wage income received as a result of construction of the project itself are not included in this metric.

APPENDIX E

Travel Forecast Results

Table 1: Forecasted I-69 Section 6 Daily Traffic Volumes by Alternative

SEGMENT	BASE YEAR 2010	NO-BUILD 2045	ALT C1 2045	ALT C2 2045	ALT C3 2045	ALT C4 2045	RPA 2045
Indian Creek to SR 39	24,400	46,900	52,300	51,500	52,900	52,900	53,000
SR 39 to Ohio St	23,100	39,400	47,000	43,700	46,600	46,500	46,700
Ohio St to SR 252	25,300	41,100	46,800	43,700	47,100	47,000	46,500
SR 252 to SR 44	18,600	31,500	38,600	36,700	38,600	38,500	38,200
SR 44 to Henderson Ford Rd	22,400	36,300	47,400	46,400	46,800	47,100	46,900
Henderson Ford Rd to SR 144	21,500	35,800	48,300	47,600	48,300	47,900	47,800
SR 144 to Smith Valley Rd	29,400	43,000	59,000	58,400	58,500	58,400	55,100
Smith Valley Rd to County Line Rd	27,700	38,700	67,100	68,100	67,500	66,300	65,000
County Line Rd to Southport Rd	33,600	41,500	80,600	78,100	77,400	79,100	78,200
Southport Rd to I-465	42,600	44,000	96,100	91,500	91,400	92,900	91,100

Table 2. Preliminary Forecasted I-465 Daily Traffic Volumes

SEGMENT	BASE YEAR 2010	NO-BUILD 2045	ALT C1 2045	ALT C2 2045	ALT C3 2045	ALT C4 2045
SR 67 to Mann Rd	71,100	77,700	105,700	105,600	105,500	106,500
Mann Rd to SR 37/I-69[1]	87,800	93,500	126,300	126,100	126,000	127,200
SR 37/I-69 to US 31[1]	86,700	92,800	113,800	115,300	115,300	115,800
US 31 to I-65	86,000	91,600	108,100	108,400	108,400	108,600

Note: 1) Widened as part of the I-69 Section 6 project.

Table 3: Revised Forecasted I-465 Daily Traffic Volumes

SEGMENT	BASE YEAR 2017	NO-BUILD 2045	RPA 2045
SR 67 to Mann Rd	95,400	102,700	133,700
Mann Rd to SR 37/I-69[1]	106,300	112,500	147,900
SR 37/I-69 to US 31[1]	110,600	117,200	140,700
US 31 to I-65	111,000	117,400	134,500

Notes: 1) Widened as part of the I-69 Section 6 project

Table 4: Forecasted Crossing Road Daily Traffic Volumes by Alternative

ROAD	SEGMENT	BASE YEAR 2010	NO-BUILD 2045	ALT C1 2045	ALT C2 2045	ALT C3 2045	ALT C4 2045	RPA 2045
SR 39	North of Rogers Rd	4,200	7,300	7,800	11,700	8,200	8,200	8,600
Burton Ln	East of SR 37/I-69	2,400	3,300	2,700	3,200	2,800	2,700	920
Ohio St/ Mahalasville Rd	West of SR 37/I-69	10,000	10,200	9,800	6,100	9,600	9,600	10,600
	East of SR 37/I-69	2,800	3,600	9,300	6,100	9,600	9,600	9,400
	East of Schwab Dr	2,300	3,300	5,700	4,300	5,700	5,700	4,300
Grand Valley Blvd/ South St	West of Ohio St	1,600	1,600	4,800	5,200	4,600	4,600	6,000
	Home Ave to Flag Stone Dr/Birk Rd[1]	--	--	8,600	9,200	8,500	8,500	9,600
	Flag Stone Dr/Birk Rd to Cramertown Loop[1]	--	--	4,700	7,000	4,500	4,600	7,200
SR 252/ Hospital Dr	West of SR 37/I-69	10,500	11,300	8,600	8,200	8,200	8,900	9,100
	East of SR 37/I-69	12,000	15,500	13,200	13,800	13,500	13,700	14,100
SR 44/ Reuben Dr	West of SR 37/I-69	6,300	6,300	5,500	6,700	6,000	5,300	5,400
	East of SR 37/I-69	2,800	2,700	3,400	3,000	3,200	3,100	3,100
Egbert Rd	West of Centennial Rd	1,500	1,400	2,000	2,000	2,000	2,000	2,000
	East of Centennial Rd	820	780	2,600	2,600	3,000	1,700	1,800
Henderson Ford Rd/ Centennial Rd	West of SR 37/I-69	3,800	3,300	3,200	3,100	3,100	3,200	3,300
	East of SR 37/I-69	--	--	5,800	5,700	6,200	5,100	5,100
Perry Rd	East of SR 37/I-69	790	750	1,400	1,300	300	1,400	1,000
Tunnel Rd/ Big Bend Rd	West of SR 37/I-69	40	40	1,200	610	960	760	50
Waverly Rd	West of SR 37/I-69	260	430	3,400	3,700	3,700	4,200	4,500
	East of SR 37/I-69	1,200	900	1,400	3,000	1,500	3,000	3,200
Whiteland Rd	East of SR 37/I-69	2,700	4,300	3,200	1,600	3,200	2,300	2,400
SR 144	West of SR 37/I-69	14,600	17,000	17,900	17,800	17,600	17,500	19,700

	East of SR 37/I-69	5,100	8,400	14,100	14,200	13,900	14,100	18,300
Stones Crossing Rd	East of SR 37/I-69	2,900	4,500	6,100	6,200	6,000	6,100	5,900
Smith Valley Rd	West of SR 37/I-69	2,000	2,500	2,500	3,300	2,700	3,300	3,500
	East of SR 37/I-69	9,900	9,700	20,800	22,000	21,500	21,000	21,100
	East of Mullinix Rd	7,800	7,800	14,600	15,800	15,500	13,000	14,200
County Line Rd	West of SR 37/I-69	--	--	5,100	5,000	4,500	5,300	5,200
	East of SR 37/I-69[2]	10,200	12,400	23,000	25,800	25,700	20,800	22,300
	East of Morgantown	8,200	9,500	15,200	15,800	15,700	13,800	14,900
Wicker Rd/ Bluff Rd	West of County Line Rd Ext	2,200	3,400	4,900	5,500	5,100	5,000	5,100
	East of SR 37/I-69	2,300	4,000	2,600	1,800	1,700	2,600	2,600
Southport Rd	West of Tibbs Ave	11,600	14,800	12,400	12,100	12,400	11,500	12,400
	Wellingshire Blvd to Tibbs Ave	17,800	21,500	23,400	22,700	23,000	21,400	23,900
	SR 37/I-69 to Wellingshire Blvd[3]	20,700	24,800	27,400	26,700	26,900	23,600	26,600
	East of SR 37/I-69	15,100	20,200	31,700	31,700	31,100	29,900	29,400
	East of Bluff Rd[2]	14,100	24,000	26,100	25,900	25,900	26,000	25,900
Banta Rd	West of SR 37/I-69	4,600	5,300	5,800	7,200	7,200	5,400	5,300
	East of Harding St	6,700	5,600	5,700	6,600	6,600	6,300	5,900
Edgewood Ave	West of Harding St	4,900	4,900	4,800	3,700	3,600	3,700	3,600
	East of Harding St	5,100	4,800	4,300	3,600	3,600	4,100	4,200
Epler Ave	East of Warman St	2,500	4,000	5,400	6,600	6,600	6,000	6,100
	West of Harding St/ SR 37	5,100	7,100	6,800	8,000	8,000	11,900	13,400
	East of Harding St/ SR 37	3,900	4,100	6,800	4,900	4,900	3,400	3,400
SR 37	Edgewood Ave to I-465	55,600	61,200	31,600	26,800	24,100	26,800	26,800

Notes: 1) New facility built as part of the I-69 Section 6 project. 2) Widened as a committed project before 2045. 3) Widened as part of the I-69 Section 6 project

Table 5: Forecasted Parallel Road Daily Traffic Volumes by Alternative

ROAD	SEGMENT	BASE YEAR 2010	NO-BUILD 2045	ALT C1 2045	ALT C2 2045	ALT C3 2045	ALT C4 2045	RPA 2045
I-65	I-465 to Southport Rd[2]	108,600	136,200	136,200	136,300	136,300	136,200	135,600
	Southport Rd to County Line Rd[2]	92,500	129,400	128,400	128,500	128,600	128,400	128,400
I-70	I-465 to Indianapolis Int'l Airport	78,100	90,700	92,800	92,700	92,800	92,900	95,800
	Ameriplex Pkwy to SR 267	55,700	66,700	67,100	67,000	67,100	67,100	68,500
US 31	South of Thompson Rd	40,600	39,200	37,300	37,200	37,200	37,300	36,900
	South of Southport Rd	31,700	33,200	31,400	31,500	31,600	31,600	31,600
	South of County Line Rd	30,200	31,900	31,500	31,600	31,600	31,600	31,700
	South of Smith Valley Rd	38,100	40,500	40,000	40,000	40,000	40,000	39,900
SR 67	I-465 to High School Rd	37,500	38,600	39,000	39,000	39,000	39,200	39,100
	South of Ameriplex Pkwy	31,800	39,600	37,200	37,200	37,200	37,300	37,600
	North of SR 144	22,500	28,700	25,100	25,200	25,200	25,200	25,600
	North of SR 39	10,900	16,500	12,700	12,900	13,000	12,900	13,100
SR 135	South of Thompson Rd	19,900	19,200	17,100	17,700	17,700	17,500	17,400
	South of Southport Rd	33,400	38,800	37,000	37,200	37,200	37,100	37,100
	South of County Line Rd	39,800	44,300	43,000	43,500	43,500	43,200	43,200
	South of Smith Valley Rd	26,700	35,200	33,900	34,100	34,100	33,900	34,000
Artesian Ave	Mahalasville Rd to Grand Valley Blvd[1]	--	--	--	--	--	--	2,900
Bluff Rd	South of Thompson Rd	8,300	13,800	11,200	10,400	10,400	11,400	10,500
	South of Southport Rd	6,000	10,000	6,500	6,700	6,900	7,000	7,000

Cramertown Loop	Mahalasville Rd to Voyles Rd	160	400	290	540	290	290	170
	Voyles Rd to Grand Valley Blvd	90	200	1,100	1,400	1,100	1,100	970
	Grand Valley Blvd to SR 252	400	670	4,300	6,900	4,200	4,300	4,500
Harding St	North of I-465	20,200	17,900	23,100	21,000	21,000	17,600	23,000
	South of Epler Ave	4,800	6,900	8,700	6,800	6,800	8,200	8,900
	South of Banta Rd	2,800	7,300	6,800	8,500	8,400	6,300	6,200
	South of Southport Rd	6,800	9,500	11,100	11,600	11,600	11,100	11,100
Mann Rd	South of I-465	10,200	11,600	10,600	10,600	10,600	10,500	10,700
	South of Southport Rd	4,800	7,100	5,600	5,600	5,600	5,600	5,800
	North of SR 144	1,700	2,800	1,600	1,600	1,600	1,600	1,500
Morgantown Rd	South of County Line Rd	13,600	14,200	14,400	15,700	15,700	14,200	14,200
	South of Smith Valley Rd	8,300	10,400	10,800	10,800	10,900	10,600	10,800
	North of SR 144	3,500	7,000	6,700	6,700	6,700	6,700	6,500
Mullinx Rd	South of Smith Valley Rd	2,900	4,200	8,900	8,800	8,800	8,900	9,500
Old SR 37	North of SR 144	740	840	7,000	6,700	6,800	6,700	2,500
	South of SR 144	1,800	1,900	8,100	8,300	7,500	8,300	7,800

Notes: 1) New facility built as part of the I-69 Section 6 project. 2) Widened as a committed project before 2045. 3) Widened as part of the I-69 Section 6 project.

Figure 1: Forecasted 2045 Traffic Volumes, SR 39 to Egbert Road

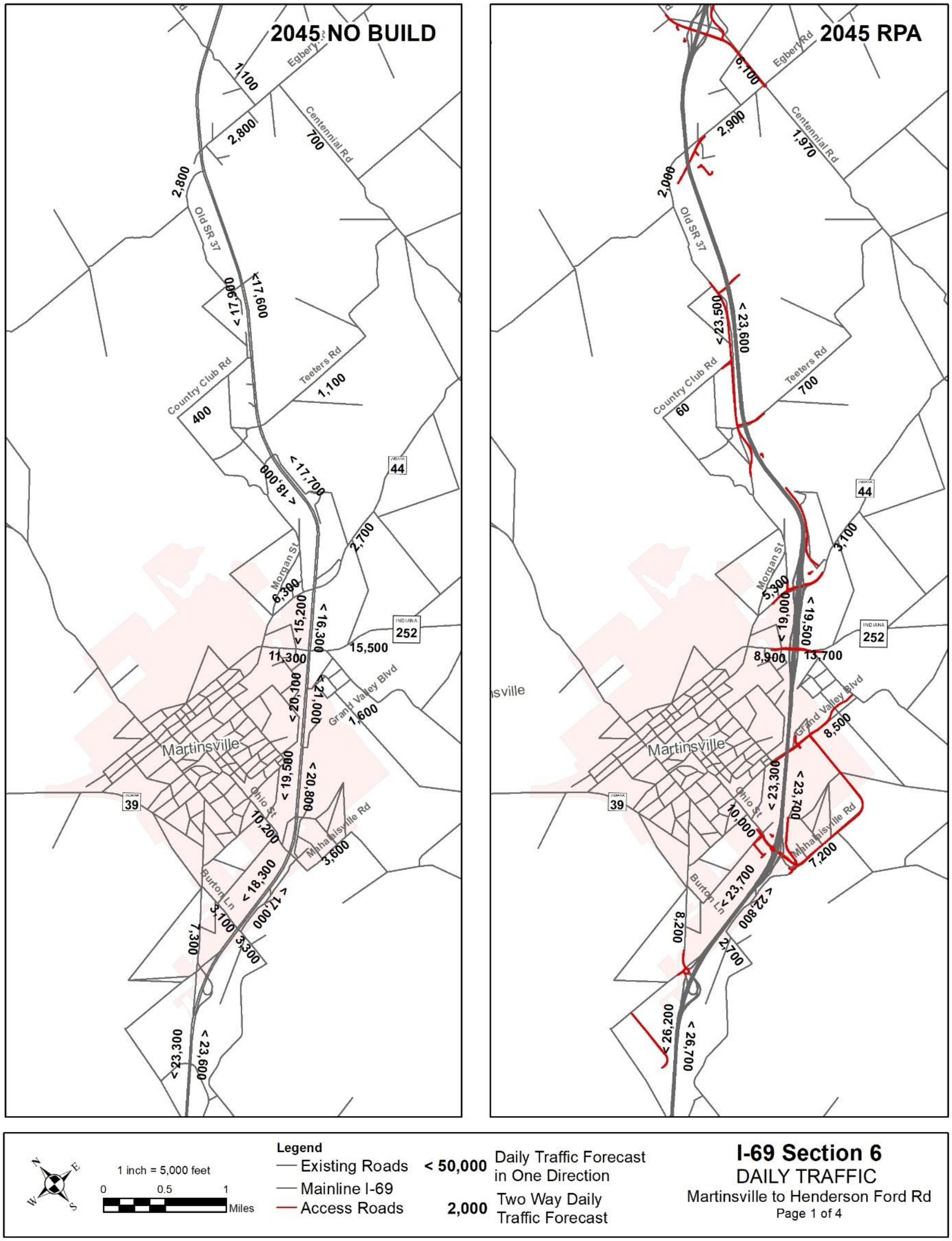


Figure 2: Forecasted 2045 Traffic Volumes, Egbert Road to SR 144

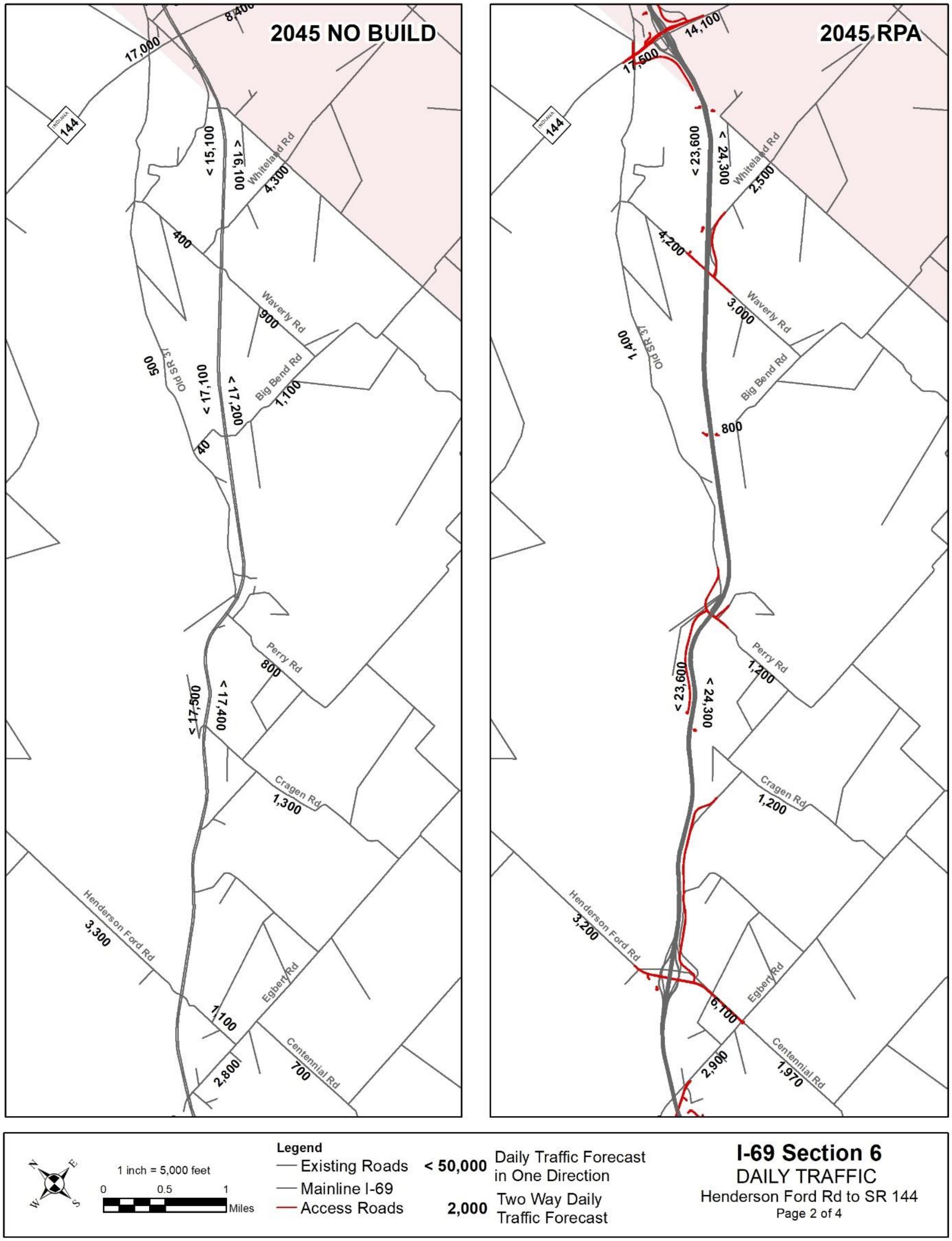


Figure 3: Forecasted 2045 Traffic Volumes, SR 144 to Banta Road

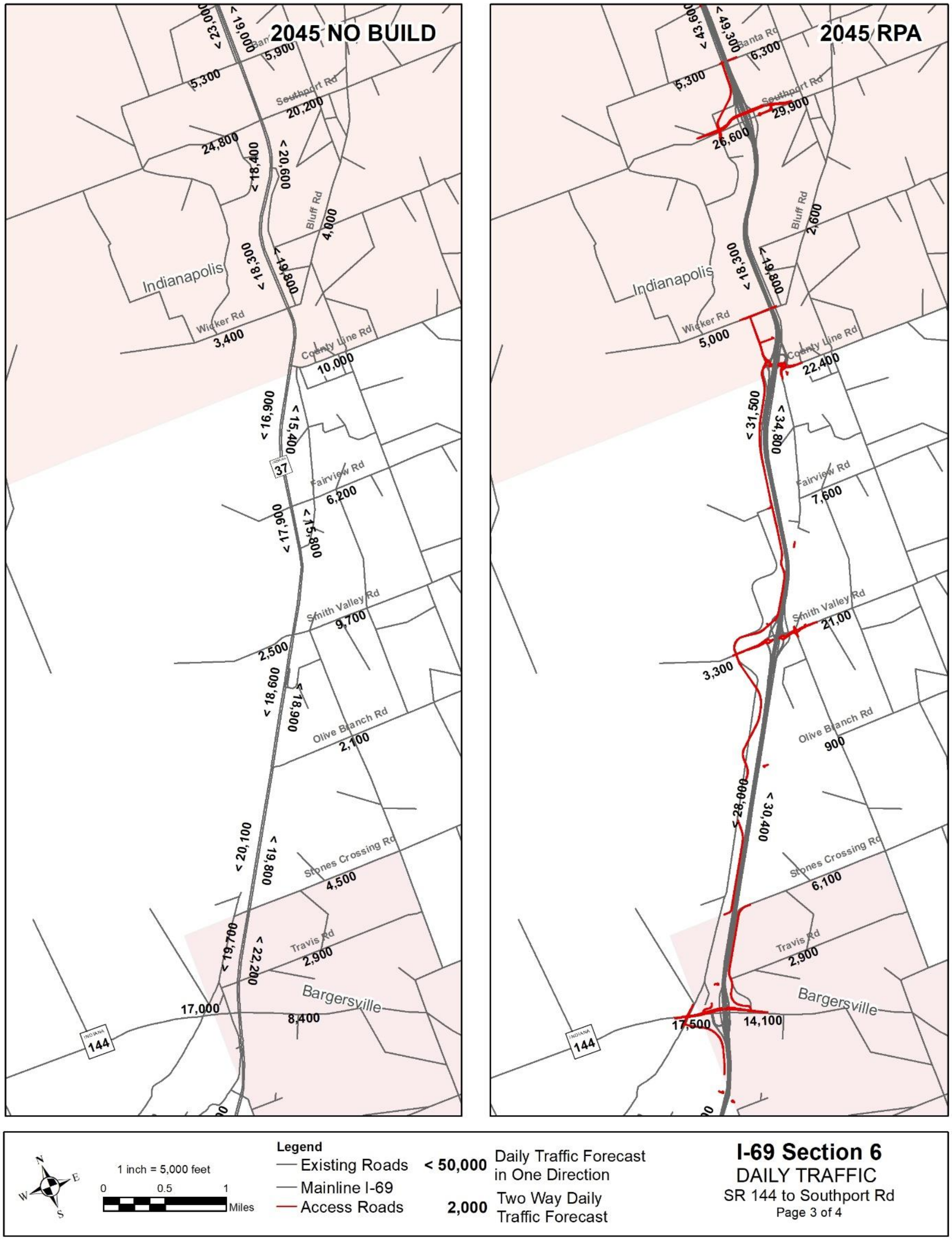


Figure 4: Forecasted 2045 Traffic Volumes, Banta Road to I-465

APPENDIX F

Project Level Volume Forecasting

MEMORANDUM

To: **Matt Miller, HNTB**

From: **Udit Molakatalla, Lochmueller Group**

Date: **July 12th, 2017**

Re: **Project Level Volume Forecasting**

The I-69 Section 6 Corridor Model (CM) was developed as the regional travel forecasting tool for the 4-County I-69 Section 6 Study Area (Hendricks, Johnson, Marion & Morgan counties). The travel demand model is designed for system-wide planning analyses. Forecasted traffic volumes derived directly from the model are not necessarily suitable for corridor level traffic forecast analysis. Since there is no sub-area corridor model or a mesoscopic model for the Section 6 project, the CM is the best available source to estimate project level forecasts. This document presents the methodology adopted to check, refine, and adjust the model outputs to derive roadway segment and turning movement forecasts.

The CM was calibrated and validated for a base year of 2010. Traffic forecasts were developed for 2025 and 2045 No-Build and Build scenarios based on projected land use and roadway network information. The model inputs, methodology and validation statistics are detailed in the I-69 Section 6 Corridor Model Technical Documentation, which is Appendix Y to the Section 6 Final Environmental Impact Statement (DEIS). The I-69 Section 6 corridor model was validated against the 2010 observed counts, to provide a consistent base year with the existing ISTDM and Indianapolis MPO models, as well as to make use of Year 2010 census data. It was later identified that the 2010 counts were collected during major construction projects that dramatically affected the traffic volumes, particularly along I-465. Comparing counts during the period from 2010 to 2016 showed significant year-to-year variations, corresponding with significant variation in the location of construction activities. The Indiana Department of Transportation (INDOT) suggested using 2016/2017 traffic counts during this post-processing corridor level traffic forecasting effort in order to better reflect existing and forecast year traffic conditions.

The project study area for this post-processing analysis included:

- I-465, from I-70 to I-65
- SR 37, from Southport Rd. to Hannah Ave (No-Build Condition)
- SR 37, from Epler Ave to Hannah Ave (Build Scenario)
- All intersections, including ramp intersections, along the corridors described above.

Input Data

The following input information was gathered for the project level Average Daily Traffic (ADT) and peak hour forecasts (both AM and PM peaks):

- Directional ADT and peak hour modeled link volumes for the base year as well as each forecast year.
- 2016/2017 segment ADT and peak hour traffic counts from the INDOT traffic count database
- Modeled turning movement counts at the study area intersections for the base and forecast years.
- 2016 turning movement counts at study area intersections.

Adjustment to Observed Counts

The observed traffic counts (including freeway ramp volumes, intersection turning movement and segment counts) within the project study area were collected during different days throughout 2016 and 2017. Even with additional counts performed by the project team, counts were unavailable at some locations for the target count year. Therefore, in order to avoid count error and to ensure proper balancing, the count data was adjusted before use in the forecasting process. This adjustment process is described below.

For freeway segments (I-465) the balancing process involved starting from a freeway segment where the observed traffic counts were considered reasonable. Continuing in the direction of travel 2016/2017 ramp volume counts are added and subtracted until the next known 2016/2017 count location is reached. Engineering judgement was used to balance the counts along I-465 freeway links and contiguous freeways and arterials. The balancing and adjustment process was reviewed by INDOT staff. INDOT made suggestions on using different count dates at certain locations to realistically represent the 2016/2017 volumes. Once the observed counts were adjusted, INDOT reviewed the final balanced count volumes along I-465. An Excel spreadsheet was developed to balance the freeway segment and ramp volumes, which was also later used to ensure balancing of the adjusted forecast year traffic volumes.

ADT and Peak Hour Volume Adjustment

The CM was validated with a system-wide RMSE of 35.97%, achieving urban model validation standards in 4-County region counties overall despite the largely rural character of Morgan and Johnson Counties. Even though the CM was well calibrated and validated to the 2010 base year, inconsistencies between modeled volume and traffic counts are expected. Moreover, based on INDOT's recommendation, the 2010 modeled volume along I-465 were adjusted to more closely match 2016/2017 traffic counts.

Once the balanced traffic counts were established, the 2010 directional modeled volumes were compared against the balanced directional volumes along the roadway segments in the project area. The change between the 2010 modeled volume and the observed counts (the "delta") was calculated using the ratio method (percentage difference) and the difference method (absolute difference). Considering the benefits and drawbacks of each method, a delta value was estimated for each segment. This delta was carried forward and applied to the forecast year modeled volumes to establish adjusted forecast volumes. This methodology is consistent to the process recommended in NCHRP Report 765: "Analytical Travel Forecasting Approaches for Project-Level Planning and Design" (Sections 6.8 & 6.9).

The ramp and segment volumes along I-465 were adjusted for No-Build and Build scenarios. SR 37 mainline segment volumes were adjusted in the No-Build scenario only, using delta values established using the process described above. I-69 and SR 37 mainline volumes were not adjusted in the Build condition since I-69 would be a new facility and is expected to have a significant impact on the remaining portion[a] of SR 37 (between Epler and Hanna Ave), making current observed travel patterns incompatible with forecasted volumes. **Table 1** and **Table 2** presents the AM & PM 2045 Peak Hour No-Build and Build forecast volumes along I-465, respectively. The locations highlighted in green are interstates (I-65 and I-70) intersecting I-465 and the locations highlighted in blue are mainline volumes along I-465. **Table 3** presents the modeled and adjusted 2045 ADT No-Build and Build forecast volumes along I-465, as well as the adjusted 2016/2017 traffic count volumes.

The mainline and ramp truck trips were adjusted and balanced in a similar manner as total traffic.

Turning Movement Volume Adjustment

The factoring procedure recommended in the NCHRP Report 765 (Chapter 6.2 & 6.3) was used to adjust the intersection turning movement volumes in the forecast scenarios. Chapter 6.2 describes the ratio method factoring procedure and Chapter 6.3 describes the difference method factoring procedure. These methodologies are based on the assumption that the future turning movement patterns will be similar in nature to the existing turning movements. Factoring procedures were used to adjust forecast year turning movements based on the relationship between base year turning movement counts and base year model turning movement assignments. While the ratio factoring method was predominantly used, the applicability of difference factoring method was considered and used as appropriate. These adjustments were made only at the intersections where 2016 turning movement count information was available. In other cases (e.g.: I-69 ramp intersections) the modeled forecast year turning volumes were retained.

Once the turning movement volume forecasts were estimated, the turning volumes were further adjusted to ensure that they balanced with mainline segment volumes. Engineering judgement was used as necessary to make further adjustments to the mainline volume forecasts and turning movement forecasts. Checks were made to ensure the future year forecasts appear reasonable when compared to existing count data.

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[a] The remainder of SR 37 within the modeled area will be upgraded to I-69.

Table 1: Modeled and Adjusted AM Peak Hour Forecasts for Year 2045 along I-465

Section	Dir.	Modeled 2010 AM Vol.	Balanced 2016/17 AM Vol.	Modeled 2045 AM No-Build	Adjusted 2045 AM No-Build	Modeled 2045 AM Build	Adjusted 2045 AM Build
	EB	3,193	4,932	3,790	5,530	3,859	5,631
	WB	2,737	3,068	3,148	3,529	3,293	3,693
	EB	2,069	3,839	2,427	4,240	2,490	4,280
	WB	1,743	1,344	1,886	1,536	1,986	1,618
	EB	3,113	3,768	3,490	4,225	3,950	4,746
	WB	3,588	5,118	3,674	5,334	4,270	6,146
EB I-70 to NB I-465	EB	862	1,197	911	1,266	855	1,266
EB I-70 to SB I-465	EB	556	753	735	997	893	1,155
WB I-70 to NB I-465	WB	0	55	0	55	0	55
WB I-70 to SB I-465	WB	385	137	402	155	515	268
NB I-465 to EB I-70	NB	293	510	275	510	372	607
NB I-465 to WB I-70	NB	619	904	769	1,054	963	1,249
SB I-465 to EB I-70	SB	0	347	8	463	8	463
SB I-465 to WB I-70	SB	760	1,012	896	1,149	859	1,149
	EB	3,295	3,299	3,724	3,765	4,490	4,557
	WB	3,639	5,280	3,807	5,577	4,750	6,681
SR 67 Off-Ramp	EB	1,094	757	1,188	850	1,123	805
SR 67 On-Ramp	EB	289	411	277	411	378	505
SR 67 Off-Ramp	WB	243	446	298	547	390	640
SR 67 On-Ramp	WB	1,126	1,262	1,285	1,422	1,153	1,340
	EB	2,489	2,953	2,814	3,326	3,745	4,257
	WB	2,756	4,464	2,819	4,702	3,988	5,981
Mann Rd On-Ramp	EB	590	743	588	743	729	885
Mann Rd Off-Ramp	WB	553	292	529	292	736	391
	EB	3,079	3,696	3,402	4,069	4,475	5,142
	WB	3,309	4,756	3,348	4,994	4,724	6,372
I-465 to I-69 SB System Ramp	EB					1,534	1,534
I-69 NB to I-465 System Ramp	EB					1,533	1,533
I-69 NB to I-465 System Ramp	WB					2,062	2,062
I-465 to I-69 SB System Ramp	WB					1,123	1,123
SR 37 Off-Ramp	EB	981	788	1,116	897	566	454
SR 37 On-Ramp	EB	955	1,184	1,055	1,308	362	449
SR 37 Off-Ramp	WB	1,002	966	1,178	1,142	662	638

Section	Dir.	Modeled 2010 AM Vol.	Balanced 2016/17 AM Vol.	Modeled 2045 AM No-Build	Adjusted 2045 AM No-Build	Modeled 2045 AM Build	Adjusted 2045 AM Build
SR 37 On-Ramp	WB	1,001	1,258	969	1,339	360	617
	EB	3,053	4,092	3,342	4,480	4,270	5,136
	WB	3,311	4,464	3,558	4,797	4,087	5,454
I-465 to SB US 31 System Ramp	EB	779	639	713	639	757	683
I-465 to NB US 31 System Ramp	EB	341	409	323	409	536	622
SB US 31 to I-465 System Ramp	EB	274	239	281	247	296	262
NB US 31 to I-465 System Ramp	EB	918	1,092	869	1,092	819	1,092
I-465 to NB US 31 System Ramp	WB	369	373	402	407	409	414
I-465 to SB US 31 System Ramp	WB	824	575	799	575	796	575
NB US 31 to I-465 System Ramp	WB	903	1,032	828	1,032	708	1,032
SB US 31 to I-465 System Ramp	WB	304	283	304	284	419	399
	EB	3,125	4,375	3,457	4,771	4,092	5,185
	WB	3,297	4,097	3,630	4,463	4,165	5,012
I-465 to SB I-65 System Ramp	EB	696	947	913	1,243	1,057	1,352
I-465 to NB I-65 System Ramp	EB	404	525	285	525	523	728
SB I-65 to I-465 System Ramp	EB	1,172	587	1,154	587	1,127	621
NB I-65 to I-465 System Ramp	EB	1,032	1,690	1,287	2,108	1,231	2,113
I-465 to NB I-65 System Ramp	WB	1,633	1,107	1,647	1,121	1,576	1,121
I-465 to SB I-65 System Ramp	WB	962	1,514	1,216	1,915	1,193	1,915
NB I-65 to I-465 System Ramp	WB	904	864	1,061	1,021	1,182	1,193
SB I-65 to I-465 System Ramp	WB	414	233	322	233	492	357
	EB	4,229	5,180	4,702	5,698	4,871	5,839
	WB	4,574	5,621	5,110	6,245	5,259	6,498
	NB	4,675	6,047	5,642	7,091	5,629	7,121
	SB	3,634	3,938	4,535	4,841	4,596	4,989
	NB	4,775	5,125	5,225	5,608	5,313	5,664
	SB	3,562	2,297	3,882	2,503	3,965	2,700

Table 2: Modeled and Adjusted PM Peak Hour Forecasts for Year 2045 along I-465

Section	Dir.	Modeled 2010 PM Vol.	Balanced 2016/17 PM Vol.	Modeled 2045 PM No-Build	Adjusted 2045 PM No-Build	Modeled 2045 PM Build	Adjusted 2045 PM Build
	EB	3,386	3,511	3,415	3,540	3,540	3,666
	WB	3,746	5,574	4,220	6,049	4,345	6,174
	EB	2,011	1,573	1,946	1,518	2,083	1,643
	WB	2,602	3,508	2,705	3,707	2,905	3,907
	EB	4,253	5,779	4,377	6,023	5,071	6,751
	WB	3,976	3,627	3,988	4,019	4,644	4,863
EB I-70 to NB I-465	EB	994	1,225	1,006	1,241	929	1,164
EB I-70 to SB I-465	EB	668	1,073	743	1,148	954	1,359
WB I-70 to NB I-465	WB	0	174	0	174	0	174
WB I-70 to SB I-465	WB	565	330	586	352	814	580
NB I-465 to EB I-70	NB	287	190	275	191	420	324
NB I-465 to WB I-70	NB	688	1,014	869	1,100	1,093	1,325
SB I-465 to EB I-70	SB	0	170	5	176	5	176
SB I-465 to WB I-70	SB	1,021	1,556	1,233	1,768	1,161	1,696
	EB	4,464	5,456	4,467	5,579	5,673	6,818
	WB	3,956	3,432	4,126	3,895	5,227	5,174
SR 67 Off-Ramp	EB	1,502	1,260	1,592	1,350	1,521	1,290
SR 67 On-Ramp	EB	395	552	397	554	560	717
SR 67 Off-Ramp	WB	281	425	336	480	419	598
SR 67 On-Ramp	WB	1,198	723	1,304	840	1,225	791
	EB	3,358	4,748	3,271	4,783	4,712	6,245
	WB	3,040	3,134	3,157	3,535	4,421	4,981
Mann Rd On-Ramp	EB	716	424	745	453	887	595
Mann Rd Off-Ramp	WB	739	671	704	689	931	897
	EB	4,074	5,172	4,017	5,236	5,599	6,840
	WB	3,779	3,805	3,863	4,224	5,353	5,879
I-465 to I-69 SB System Ramp						2,232	2,232
I-69 NB to I-465 System Ramp						1,489	1,489
I-69 NB to I-465 System Ramp						2,182	2,182
I-465 to I-69 SB System Ramp						1,404	1,404
SR 37 Off-Ramp	EB	1,385	1,314	1,429	1,358	665	665
SR 37 On-Ramp	EB	1,204	1,154	1,344	1,294	679	680
SR 37 Off-Ramp	WB	1,178	1,445	1,280	1,250	717	881

Section	Dir.	Modeled 2010 PM Vol.	Balanced 2016/17 PM Vol.	Modeled 2045 PM No-Build	Adjusted 2045 PM No-Build	Modeled 2045 PM Build	Adjusted 2045 PM Build
SR 37 On-Ramp	WB	1,230	814	1,275	915	640	637
	EB	3,893	5,012	3,931	5,172	4,871	6,112
	WB	3,727	4,436	3,867	4,559	4,651	5,344
I-465 to SB US 31 System Ramp	EB	1,111	987	928	825	1,022	899
I-465 to NB US 31 System Ramp	EB	395	317	370	317	554	476
SB US 31 to I-465 System Ramp	EB	412	380	442	411	449	419
NB US 31 to I-465 System Ramp	EB	1,013	702	1,029	718	1,024	714
I-465 to NB US 31 System Ramp	WB	430	403	446	420	453	427
I-465 to SB US 31 System Ramp	WB	989	1,035	926	1,035	945	993
NB US 31 to I-465 System Ramp	WB	987	713	959	693	862	597
SB US 31 to I-465 System Ramp	WB	439	442	435	442	648	652
	EB	3,812	4,790	4,105	5,159	4,768	5,870
	WB	3,721	4,719	3,846	4,879	4,541	5,515
I-465 to SB I-65 System Ramp	EB	925	1,011	1,156	1,263	1,310	1,418
I-465 to NB I-65 System Ramp	EB	434	412	394	412	610	591
SB I-65 to I-465 System Ramp	EB	1,718	1,215	1,744	1,241	1,674	1,172
NB I-65 to I-465 System Ramp	EB	1,007	1,633	1,360	1,987	1,305	1,932
I-465 to NB I-65 System Ramp	WB	1,611	747	1,626	762	1,559	695
I-465 to SB I-65 System Ramp	WB	1,065	1,614	1,489	2,038	1,411	1,960
NB I-65 to I-465 System Ramp	WB	976	876	1,146	1,047	1,300	1,201
SB I-65 to I-465 System Ramp	WB	477	446	442	446	664	671
	EB	5,178	6,215	5,658	6,712	5,827	6,965
	WB	4,945	5,758	5,373	6,186	5,545	6,298
	NB	4,704	4,055	5,545	4,769	5,559	4,970
	SB	4,895	6,509	5,965	7,849	5,983	7,786
	NB	4,766	2,705	5,058	2,909	5,122	3,123
	SB	5,100	5,545	5,504	6,235	5,601	6,251

Table 3: Modeled and Adjusted Daily Forecasts for Year 2045 along I-465

Section	Dir.	Modeled 2010 Vol.	Balanced 2016/17 Vol.	Modeled 2045 No-Build	Adjusted 2045 No-Build	Modeled 2045 Build	Adjusted 2045 Build
	EB	38,779	54,605	45,959	61,785	46,770	62,597
	WB	39,330	56,512	47,801	64,984	48,908	66,092
	EB	23,033	32,447	28,688	38,448	29,073	37,888
	WB	24,696	30,873	28,683	34,097	30,189	35,606
	EB	43,317	56,242	49,161	64,155	56,555	71,404
	WB	45,920	53,679	48,873	56,920	56,444	64,144
EB I-70 to NB I-465	EB	10,361	15,590	11,063	16,648	10,329	15,914
EB I-70 to SB I-465	EB	8,318	13,225	9,283	14,760	11,300	17,967
WB I-70 to NB I-465	WB	0	1,684	0	1,684	0	1,684
WB I-70 to SB I-465	WB	5,305	3,074	4,907	2,844	6,684	4,622
NB I-465 to EB I-70	NB	2,932	3,759	2,928	3,755	3,786	4,857
NB I-465 to WB I-70	NB	8,504	13,368	10,691	15,556	12,887	17,752
SB I-465 to EB I-70	SB	0	2,898	147	4,316	145	4,315
SB I-465 to WB I-70	SB	11,436	17,029	13,336	19,859	12,516	19,040
	EB	45,504	52,614	49,867	57,584	61,877	70,638
	WB	46,995	53,532	51,428	57,899	62,788	69,155
SR 67 Off-Ramp	EB	13,942	11,312	14,700	12,071	14,205	11,665
SR 67 On-Ramp	EB	4,344	6,353	3,828	5,837	5,350	8,158
SR 67 Off-Ramp	WB	3,522	6,136	3,948	6,880	5,571	9,708
SR 67 On-Ramp	WB	15,330	11,778	16,952	13,401	15,562	12,302
	EB	35,907	47,655	38,996	51,350	53,022	67,131
	WB	35,188	47,790	38,424	51,378	52,797	66,561
Mann Rd On-Ramp	EB	8,157	5,332	7,342	4,800	9,957	6,510
Mann Rd Off-Ramp	WB	8,541	5,532	7,729	5,006	10,427	7,705
	EB	44,064	52,987	46,338	56,150	62,979	73,641
	WB	43,729	53,322	46,153	56,384	63,224	74,266
I-465 to I-69 SB System Ramp	EB					21,970	21,970
I-69 NB to I-465 System Ramp	EB					18,352	18,352
I-69 NB to I-465 System Ramp	WB					24,852	24,852
I-465 to I-69 SB System Ramp	WB					16,770	16,770
SR 37 Off-Ramp	EB	13,952	12,324	14,932	13,304	7,145	6,367
SR 37 On-Ramp	EB	13,147	13,971	13,561	14,411	6,198	7,048
SR 37 Off-Ramp	WB	13,038	14,515	14,427	16,061	7,672	9,306

Section	Dir.	Modeled 2010 Vol.	Balanced 2016/17 Vol.	Modeled 2045 No-Build	Adjusted 2045 No-Build	Modeled 2045 Build	Adjusted 2045 Build
SR 37 On-Ramp	WB	13,330	11,897	13,963	12,531	6,069	5,447
	EB	43,259	54,634	44,967	57,257	58,414	70,704
	WB	43,437	55,940	46,617	59,914	56,746	70,043
I-465 to SB US 31 System Ramp	EB	11,369	10,315	9,231	8,376	10,559	9,704
I-465 to NB US 31 System Ramp	EB	4,177	3,822	3,081	2,819	6,462	6,201
SB US 31 to I-465 System Ramp	EB	4,341	3,631	4,109	3,437	4,498	3,826
NB US 31 to I-465 System Ramp	EB	10,934	11,297	8,507	8,870	8,488	8,852
I-465 to NB US 31 System Ramp	WB	4,913	4,266	4,953	4,307	5,127	4,481
I-465 to SB US 31 System Ramp	WB	10,482	9,883	8,107	7,644	8,427	7,965
NB US 31 to I-465 System Ramp	WB	11,118	10,205	9,995	9,175	9,366	8,546
SB US 31 to I-465 System Ramp	WB	4,724	4,293	4,048	3,679	7,335	6,966
	EB	42,988	55,425	45,272	58,369	54,379	67,477
	WB	42,990	55,591	45,634	59,011	53,599	66,977
I-465 to SB I-65 System Ramp	EB	10,740	12,077	13,556	15,245	15,781	17,470
I-465 to NB I-65 System Ramp	EB	4,240	5,913	1,734	3,408	3,690	5,365
SB I-65 to I-465 System Ramp	EB	17,052	11,211	16,175	10,634	15,215	9,675
NB I-65 to I-465 System Ramp	EB	12,127	20,610	15,581	24,064	13,767	22,251
I-465 to NB I-65 System Ramp	WB	17,711	11,660	15,432	9,382	14,272	8,222
I-465 to SB I-65 System Ramp	WB	12,002	20,915	16,507	25,421	15,535	24,449
NB I-65 to I-465 System Ramp	WB	12,032	10,805	13,766	12,539	15,622	14,396
SB I-65 to I-465 System Ramp	WB	4,570	5,465	1,945	2,841	3,770	4,666
	EB	57,189	69,256	61,736	74,414	63,891	76,568
	WB	56,101	71,896	61,863	78,434	64,014	80,586
	NB	55,320	59,572	68,103	70,042	67,852	69,896
	SB	53,311	63,036	67,124	75,549	67,433	76,090
	NB	53,111	45,730	55,923	46,229	56,425	46,836
	SB	52,192	46,720	55,179	48,358	55,103	48,512

As a part of the manual post-processing process, some isolated locations required relatively large adjustments to freeway ramp volumes to produce realistic and balanced traffic forecasts. While the I-69 CM was well-calibrated as a whole for the 4-County study area, when focusing in on a particular corridor or intersection further refinement is needed to accurately reflect traffic patterns. Traffic volumes that were adjusted substantially include:

- **Westbound I-70 to Northbound I-465 Ramp:** The volume on this ramp was increased substantially to match the observed 2016 travel patterns through the area more closely. Within the I-69 CM, very few vehicles are assigned to this ramp because Sam Jones Expressway provides a slightly shorter travel time between I-70 and I-465 than staying on I-70. While the shorter travel time may be true in reality, most people either do not realize that this alternative route is as efficient, or choose not to use it because it is not fully access controlled. While this difference in localized travel patterns is not a major issue in the overall corridor model, as the I-465/I-70 interchange is within the direct analysis area it was necessary to manually shift a reasonable amount of traffic from Sam Jones Expressway onto westbound I-70. The adjustment is consistent with the available count information.

- **Southbound I-465 to Eastbound I-70 Ramp:** Similarly, Sam Jones Expressway provides a more direct travel path between southbound I-465 and eastbound I-70 than the I-465/I-70 interchange. Drivers may choose not to use this route because it is not fully access controlled, and it is not readily apparent that it is an alternative to using the interchange at I-70 and I-465. Again, this ramp was manually adjusted to more closely reflect observed traffic patterns in 2016 as it is an integral part of the analysis area.

- **SR 67 Ramps & Mann Rd, Ramps:** The CM is a macroscopic regional model and lacks the ability to accurately reflect signal delay and operational delays (saturation flow, queuing), which could cause the difference in route choice patters in the model. This issue is pronounced for trips generated near an interstate with closely spaced interchanges. The coarseness of the regional model makes it imprecise in assigning trips to the SR 67 interchange vs. the Mann Rd interchange. Totals of EB on ramps and WB off ramps at the SR 67 and Mann Rd. interchanges compare well against traffic patterns identified in the 2016 traffic counts. Moreover, with such closely spaced interchanges it is not uncommon for shorter trips in the model to use the interstate versus using the local surface streets. In general, drivers will not get on a freeway facility and get off at the next interchange when acceptable surface roadway connections are available. The model output volumes were therefore adjusted to reflect the 2016 ramp volumes and general area travel patterns.

APPENDIX G

Expert Land Use Panel Meeting Summaries

DRAFT MEETING SUMMARY

Section 6 Land Use Panel (LUP)

Morgan County Division of Family Services
September 29, 2015 from 9:00 a.m.-11:00 a.m. EDT

Attendee	Organization
Brad Beaubien	Indy DMD
Meredith Klekotka	Indy DMD
Brian Gildea	Develop Indy
Harold Gutzwiller	Mooresville Redevelopment Commission
Kenny Hale	Morgan County Planning and Zoning
David Hittle	Johnson County Planning and Zoning
Andrew Swenson	Indy MPO
Ryan Wilhite	Indy MPO
Lindsey Beckman	Morgan County Economic Development Corp.
Chelsey Manns	Morgan County Economic Development Corp.
Cheryl Morphew	Johnson County Economic Development Corp.
Don Reitz	Hendricks County Planning and Zoning
Steve Sullivan	MIBOR
Julie Young	Bargersville Planning and Development
Sarah Rubin	INDOT
Jim Earl	INDOT
Bill Wiedelman	HNTB Corporation
Tim Miller	HNTB Corporation
Eric Swickard	Lochmueller Group
David Goffinet	Lochmueller Group
Matt Schriefer	Lochmueller Group
Chris Beard	Lochmueller Group

I. Introductions (Sarah Rubin)

   a. Welcome and introductions
   b. Project overview and update

II. Land use panel member role and responsibilities (Tim Miller)

   a. Tim discussed the role of a Land Use Panel member. He explained INDOT needs their input on how much and where future development will occur. This information will be incorporated into the I-69, Section 6 traffic model in the no build scenario
   b. The meeting today will focus on a no build condition. The next meeting will assume a build condition.

III. Employment and household forecasts for 2045 no build scenario (Chris Beard)

   a. Chris explained how the 2045 no build forecasts were determined. County control total forecasts were obtained from credible sources, such as the Indiana Business Research Center and Woods & Poole. A land use allocation tool was used to allocate the control total forecasts geographically into Traffic Analysis Zone (TAZ), which are used by the traffic model to assign trips and manage socioeconomic characteristics.

IV. **Control Totals (Matt Schriefer)**

- a. Matt explained the 2045 no build employment and house hold growth will be used as a baseline condition. This baseline condition assumes I-69 will be constructed from Evansville to just south of Martinsville. The purpose of the activity is to re-allocate the future growth within each county as appropriate.
- b. Matt also explained the purpose of the map displays, symbology and numbers.

V. Explanation of re-allocation activity (David Goffinet)

- a. David explained the purpose of the re-allocation exercise and ground rules.
- b. Four breakout groups were formed – one each for Marion, Johnson, Morgan and Hendricks Counties. Land use panel members congregated around a County map that corresponded to the organization they represented.

VI. Results of re-allocation Activity

I. Hendricks County

- a. Household
  - Subtracted 2,703 households from TAZs along proposed Ronald Reagan Parkway that ELUP noted as being planned industrial areas.
  - Added 1,200 households to TAZs along SR 39 between I-70 & US 40 and north of US 40 east of the Town of Clayton. ELUP identified this area as having substantial growth since 2010 and anticipated to continue to grow.
  - Added 1,503 households proportionately to all other TAZs that initially included household growth. Additional households in those TAZs ranged from 1 to 49 more households in each.
- b. Commercial Employment
  - Subtracted 1,866 commercial employees from TAZs along proposed Ronald Reagan Parkway that ELUP noted as being planned industrial areas.
  - Added 100 commercial employees to southwest corner of I-70 interchange at SR 267.
  - Added 500 commercial employees to US 40 corridor west of Plainfield.
  - Added 1,266 commercial employees to areas along and west of SR 39. ELUP identified this area as having growth since 2010 and anticipated to continue to grow.
- c. Industrial Employment
  - Subtracted 1,752 industrial employees from TAZs along and south of I-70, between SR 267 and the Marion County line. ELUP identified this area as low growth area.
  - Added 1,752 industrial employees along proposed Ronald Reagan Parkway that ELUP noted as being planned industrial areas.

I. Johnson County

- a. Household
  - Subtracted 4,200 households from TAZs along US 31 between Smith Valley Road to the north and Tracy Road at New Whiteland to the south. ELUP noted some growth would occur in these TAZs, but not to the extent initially allocated.
  - Subtracted 1,800 households from TAZs immediately north of Franklin. ELUP noted some growth would occur, but would be more spread out to neighboring TAZs.
  - Subtracted 500 households from TAZ at southwest corner of I-65 and SR 44 interchange to the east of Franklin. ELUP noted some growth would occur, but would be spread out to TAZ to the north as well.

- Subtracted 100 households from TAZ on west side of Bargersville. ELUP noted growth would occur more in surrounding TAZs.
- Added 1,000 households to TAZs east of I-65 and south of Rocklane Road to the west of Greenwood. This area was identified by ELUP as growth area.
- Added 1,100 households to TAZs north of Franklin along US 31 to spread out household growth in TAZs to the south.
- Added 700 households to TAZs west and southwest of Franklin, along SR 44, to spread out Franklin area household growth.
- Added 500 households to TAZ at northwest corner of I-65 and SR 44 interchange to the east of Franklin. Moved from TAZ to the south.
- Added 3,300 households to area between SR 37 to the west, US 31 to the east, Smith Valley Road to the north, and Bargersville area to the south. This area was identified by ELUP as a high growth area.

b. Commercial Employment

- Subtracted 2,500 commercial employees from TAZ east of Whiteland, west of I-65, and south of Whiteland Road. ELUP identified this area as an industrial growth area, instead of commercial growth area.
- Added 400 commercial employees to TAZs along US 31 around Whiteland and New Whiteland.
- Added 600 commercial employees along US 31, through and south of Greenwood.
- Added 500 commercial employees along SR 135 corridor between Smith Valley Road and Smokey Row Road. ELUP identified this as a commercial growth corridor.
- Added 500 commercial employees along SR 37 corridor and western end of Fairview Road. This corridor was identified by ELUP as a commercial growth corridor.
- Added 500 commercial employees along SR 135 corridor, eastern end of Fairview Road, and western end of Fry Road. ELUP identified these as commercial growth corridors.

c. Industrial Employment

- Subtracted 704 industrial employees from TAZ west of SR 37 and south of Marion County line. This area was identified by ELUP as having too many constraints and not ideal for industrial development.
- Subtracted 100 industrial employees from TAZ southwest of Bargersville. This area was identified by the ELUP as having less industrial growth than initially allocated. Moved to TAZ to the northwest near SR 37/SR 144 intersection.
- Subtracted 666 industrial employees from northwest corner of I-65/Whiteland Road interchange identified as commercial growth instead of industrial growth by ELUP. Moved to TAZs to the south identified as industrial growth area.
- Added 100 industrial employees to SR 37/SR 144 intersection, east of SR 37 and south of SR 144. Moved from TAZ to the southeast near Bargersville.
- Added 1,370 industrial employees to southwest and southeast corners of I-65/Whiteland Road interchange. This area was identified as an industrial growth area by ELUP.

I. Marion County

a. Household

- Added 6,731 households to TAZs along the Indy Connect Rapid Transit Red Line based on information in the Red Line Transit Oriented Development Strategic Plan. The Station Area Info Sheets and Recent and Planned Development Maps in APPENDIX-ITEM B of the plan were used to determine the proposed household density at each of the proposed Bus Rapid Transit (BRT) stations. Parcel data and aerial photography was used to determine an appropriate amount of potential household growth at each station. The added 6,731 households include almost 4,000 new households in and around downtown.
- Subtracted 6,731 households proportionately from all other TAZs that initially included household growth. Subtracted households in those TAZs ranged from 1 to 36 households in each.

b. Commercial Employment

- Added 39,455 commercial employees to TAZs along the Indy Connect Rapid Transit Red Line based on information in the Red Line Transit Oriented Development Strategic Plan. The Station Area Info Sheets and Recent and Planned Development Maps in APPENDIX-ITEM B of the plan were used to determine the proposed employment density at each of the proposed BRT stations. Parcel data and aerial photography was used to determine an appropriate amount of potential commercial employment growth at each station. The added 39,455 commercial employees include almost 30,000 new commercial employees in and around downtown. In addition to the commercial development noted in the Red Line Transit Oriented Development Strategic Plan, the ELUP also noted 5,000 expected research jobs, and thousands of jobs associated with expansion by Cummins, and anticipated growth by Eli Lilly, Anthem, CityWay, YMCA, and others in the downtown area.
- Added 900 commercial employees to TAZs along I-70, south of the airport, and SR 67 (Kentucky Avenue) between the Hendricks County line and I-465. ELUP noted this area is identified for industrial and business expansion.
- Added 2,500 commercial employees to TAZs along the SR 37 corridor between the Johnson County line and I-465. ELUP noted this area is identified for commercial expansion.
- Subtracted 21,329 commercial employees from TAZs south of I-465 and between SR 37 and SR 67, along and near Mann Road. ELUP does not anticipate this area to grow. Moved some east and west to I-70, SR 67, and SR 37 corridors.
- Subtracted 21,526 commercial employees proportionately from all other TAZs that initially included commercial growth. Subtracted commercial employees in those TAZs ranged from 1 to 36 commercial employees in each.

c. Industrial Employment
   - No change in industrial employment for Marion County. Industrial employment is anticipated to decrease. Therefore, all industrial employment in 2010 was proportionately decreased to 2045 control total. Commercial employment was distributed to some industrial growth areas in Marion County. Commercial employment includes professional and other services employment that includes research and other light industrial type uses.

II. Morgan County

a. Household
   - Subtracted 1,139 households from TAZs in and around Martinsville. ELUP noted that the Mooresville/Monrovia area will grow a lot more than Martinsville.
   - Subtracted 29 households from TAZs along SR 37 corridor and removed growth from a few TAZs that were allocated just 1 household along SR 67 between Martinsville and Mooresville. ELUP noted that growth along SR 37 is likely to occur after I-69 construction, but not in a “no build” scenario.
   - Subtracted 100 households from two TAZs (50 households each) within Mooresville. ELUP noted these TAZs will grow, but not to that extent.
   - Subtracted 102 households from TAZ south of Mooresville and east of SR 67. ELUP noted this TAZ will include commercial and industrial growth, not residential growth.
   - Added 720 households to TAZs east of Mooresville, between SR 144 to the south and the Marion County line to the north. ELUP noted this area is a current and future growth area.
   - Added 125 households to TAZs southeast of Mooresville, between SR 144 and SR 67.
   - Added 525 households to TAZs west and southwest of Mooresville and around Monrovia. ELUP noted this is a future growth area.

b. Commercial Employment
   - Subtracted 750 commercial employees from TAZs in and around Martinsville. ELUP noted that the Mooresville/Monrovia area will grow a lot more than Martinsville.
   - Subtracted 1,961 commercial employees from TAZs along SR 37 corridor between Martinsville and SR 144. ELUP noted that growth along SR 37 is likely to occur after I-69 construction, but not in a “no build” scenario.
   - Subtracted 100 commercial employees from one TAZ within Mooresville. ELUP noted that this TAZ will grow, but not to that extent.
   - Added 100 commercial employees to TAZ along SR 37 on east side of Martinsville. ELUP noted initial allocation somewhat low for area with recent growth.
   - Added 1,200 commercial employees to TAZs in and around Mooresville. ELUP identified this as a current and future growth area.
   - Added 700 commercial employees to TAZs along SR 39, SR 42, and Keller Hill Road around Monrovia. ELUP identified this as a future growth area.
   - (Note: The ELUP from Morgan County stated that the commercial employment control total for Morgan County was too high and the industrial control total was too low. This is based on recent announcements of 100s of new industrial jobs coming to the county. Past Bureau of Economics (BEA) data showing total employees by industry classification was reviewed to see how industrial employment has changed over time. It was decided to use

17.5% of the total employment in 2045 as the total industrial employment. This corresponds to the highest percentage of the total employment made up by industrial employment over the past 10 years. Therefore, 811 more commercial employees were subtracted than were added to shift these commercial employees to industrial employment areas.)

c. Industrial Employment
   - Subtracted 217 industrial employees from TAZs around Martinsville. ELUP noted that very little industrial growth will be in Martinsville. The majority will be south of Mooresville and north of Monrovia.
   - Subtracted 234 industrial employees from TAZs around Waverly, along SR 37. ELUP noted that future growth in this area is likely to occur with the completion of I-69, but not in a "no build" scenario.
   - Added 962 industrial employees to TAZs south and west of Mooresville. ELUP identified these areas as industrial growth areas.
   - Added 300 industrial employees to TAZs along SR 39 and Keller Hill Road north of Monrovia. ELUP identified these areas as future industrial growth areas.
   - Note: The ELUP from Morgan County stated that the industrial employment control total was too low based on recent announcements of new industrial development. Therefore, 811 more industrial employees were added than were subtracted.

III. Findings and presentation

a. A representative for each County gave a brief explanation of findings from the exercise:
   - Morgan County – Panel members suggests that the Employment and Household forecasts should be re-allocated. They noted employment forecasts were too high in Martinsville and along SR 37 and too low in Mooresville.
   - Johnson County – Only minor revisions were need for these forecasts. Johnson County is also in the process of re-doing its Future Land Use map for its Comprehensive Plan. The group focused on re-allocating employment growth near Greenwood and Franklin. The Panel members suggested the residential growth near Bargersville is too low.
   - Marion County – Employment growth is more likely to occur in downtown Indianapolis, while residential growth will likely occur outside the core of downtown.
   - Hendricks County – The allocation from the model is fairly accurate. A suggestion was made to split the TAZ that includes the outdoor mall into two zones. The group also focused employment growth around the airport due to IN Bat hibernacula.

IV. Meeting wrap up (Sarah Rubin)

a. Sarah asked if there were any additional questions or comments. She also gave a preview of the upcoming public information meetings and when they will be held.
b. Sarah suggested any comments or additional input be provided by 10/16/2015
c. Bill Wiedelman also asked that any suggested improvements for future meetings be passed along to Sarah Rubin.

V. Next Steps

a. Information gathered from today will be used to re-allocate 2045 no build employment and household forecasts per Traffic Analysis Zone.
b. The next meeting will be held in the first quarter, 2016. The purpose will be to allocate induced growth from the I-69, Section 6 build Alternatives.

MEETING SUMMARY

Section 6 Land Use Panel (LUP) Meeting #2

Morgan County Division of Family Services
February 29th, 2016 from 1:30 p.m.-3:00 p.m. EST

Attendee	Organization
Lindsey Beckman	Morgan County Economic Development Corporation
Brian Love	City of Martinsville
Catherine Kostyn	Indy MPO
Andrew Swenson	Indy MPO
David Hittle	Johnson County Planning and Zoning
Joe James	Plainfield Planning and Zoning Department
Brad Beaubien	Indianapolis Department of Metropolitan Development
Cheryl Morphew	Johnson County Development Corporation
Jeff Pipkin	Hendricks County Economic Development Partnership
Amber Ross	Develop Indy
Steve Sullivan	MIBOR
Julie Young	Bargersville Planning and Development
Jim Earl	INDOT
Eryn Fletcher	FHWA
Tim Miller	HNTB Corporation
Matt Miller	HNTB Corporation
Eric Swickard	Lochmueller Group
Michael Grovak	Lochmueller Group
Chris Beard	Lochmueller Group
Udit Molakatalla	Lochmueller Group
Chris Joannes	Lochmueller Group

a) **Introductions (Jim Earl)**
   a. Welcome and introductions
   b. Project overview and update

b) **Land use panel member role and responsibilities, induced growth allocation directions (Chris Beard)**
   a. Chris discussed the role of traffic forecasting in the overall EIS. Forecasted traffic volumes are used to assess lane requirements, interchange configurations, provide many purpose and need measures, and identify traffic-related project impacts. Demographic changes are critical inputs into the travel demand model that is used to forecast traffic volumes in 2045.
   b. Chris reviewed the process of the previous land use panel meeting on September 29th, 2015 and explained that the growth allocations determined at that meeting were for the 2045 "No Build" scenario. In the "No Build" scenario Section 6 of I-69 would not be constructed, while Sections 1 through 5 are completed and open to traffic.
   c. Chris explained that the purpose of today's meeting is to allocate the forecast "induced growth." This is the further increase in households and employment between 2010 and 2045 that occurs due to additional economic development triggered by the completion of I-69

Section 6. Chris explained how the TREDIS economic forecasting model was used to estimate growth in population and employment induced by I-69 Section 6.

  d. The “build” scenarios considered for this meeting assume that all alternatives are within the SR 37 corridor selected in the Tier 1 ROD. If additional corridors are carried forward into the DEIS, there will be a separate land use panel meeting at a later date to allocate induced growth for those alternatives.
  e. The induced growth is forecasted for each of the four study area counties, and participants will allocate the total countywide growth within their respective counties. Panel members from Morgan County will be asked to perform two induced growth allocations – one assuming an interchange is provided at Ohio Street in Martinsville, and one assuming that interchange is not provided.
  f. In addition to allocating induced growth, the panel members should also consider whether the “No Build” growth would be redistributed due to the completion of I-69 Section 6. Summary maps with the September panel meeting results will be made available for this purpose.

c) Results of Induced Growth Allocation and “No Build” Re-allocation Activity

I. Hendricks County
  a. The representatives from Hendricks County did not re-allocate any “no build” growth.
  b. Induced Households
    i. Added 100 induced households to the TAZ south of US 40 between CR 400 E and CR 500 E.
  c. Induced Commercial Employment
    i. Added 108 induced commercial jobs to the TAZ on the south side of I-70 on the west side of the SR 267 interchange.
  d. Induced Industrial Employment
    i. Added 17 induced industrial jobs to the TAZ north of I-70 between Ronald Reagan Parkway and the Marion County Line.

II. Johnson County
  a. The representatives from Johnson County did not re-allocate any “no build” growth.
  b. Induced Households
    i. Added 33 induced households to the TAZ on the south side of SR 144 between Whiteland Road and Schoolhouse Lane.
    ii. Added 57 induced households to the TAZ that covers the area between SR 135 on the west, Sawmill Road on the east, Smokey Row Road/Tracy Road on the north and Whiteland Road on the south.
    iii. Added 33 induced households to the TAZ on the south side of County Line Road between Morgantown Road and Peterman Road.
    iv. Added 33 induced households to the TAZ on the west side of the I-69 corridor between Fairview Road and County Line Road.
  c. Induced Commercial Employment
    i. Added 60 induced commercial jobs to the area southeast of the I-69/SR 144 interchange (2 TAZs).
    ii. Added 20 induced commercial jobs to the TAZ south of SR 144 between CR 625 W and Whiteland Road.
    iii. Added 20 induced commercial jobs to the TAZ bounded by CR 625 W on the west, Morgantown Road to the East, Smokey Row Road to the north and SR 144/Whiteland Road to the south.

iv. Added 40 induced commercial jobs to the TAZ at the northeast corner of the I-69/SR 144 interchange.
v. Added 50 induced commercial jobs to the TAZ on the north side of Smith Valley Road between I-69 and Morgantown Road.
vi. Added 25 induced commercial jobs to the TAZ bounded by I-69 on the west, Bluff Road on the east, Fairview Road on the south, and County Line Road.
vii. Added 48 induced commercial jobs to the TAZ on the west side of I-69 between Smith Valley Road and County Line Road.

d. Induced Industrial Employment
    i. Added 10 induced industrial jobs to the TAZ on the east side of Banta Road between Whiteland Road and I-69.
    ii. Added 18 induced industrial jobs to the west side of to the TAZ on the west side of I-69 between Smith Valley Road and County Line Road.

III. Marion County
  a. The representatives from Marion County did not re-allocate any “no build” growth.
  b. Induced Households
    i. Added 112 induced households to the TAZ bounded by SR 67 on the west, Mooresville Road/Mendenhall Road on the east, Mooresville Road to the south and Camby Road on the north.
    ii. Added 200 induced households to the area on both sides of the Southport Road Extension between Mooresville Road and Mann Road (2 TAZs).
  c. Induced Commercial Employment
    i. Added 200 induced commercial jobs to the TAZ on the west side of I-69 between County Line Road and Wicker Road.
    ii. Added 300 induced commercial jobs to the area on both sides of Southport Road on the west side of I-69 (2 TAZs).
    iii. Added 77 induced commercial jobs to the TAZ on the north side of Epler Road between Warman Avenue and Belmont Avenue.
  d. Induced Industrial Employment
    i. Added 28 induced industrial jobs to the TAZ on the north side of Ameriplex Parkway between Flynn Road and Decatur Boulevard.

IV. Morgan County
  a. Households
    i. Scenario with an interchange at Ohio Street
      1. Added 42 induced households to the area north and west of Cramertown Loop, east of I-69 and Mahalasville Road (2 TAZs).
      2. Added 42 induced households to the area east of I-69 between Teeters Road and Egbert Road (2 TAZs).
      3. Added 25 induced households to the TAZ between Old SR 37 and the White River south and west of Waverly.
      4. Added 20 induced households to the TAZ south of Big Bend Road, west of the Johnson County Line.
      5. Added 20 induced households to the TAZ west of I-69 between Waverly Road and the Johnson county Line.

        6. Added 10 induced households to the TAZ north of SR 144 between Kitchen Road and Mann Road.
        7. Added 10 induced households to the TAZ north and west of Centenary Road between Gray Road and Watson Road.
        8. Added 50 induced households to the TAZ south of SR 144 between Johnson Road and Kitchen Road.
    ii. Scenario without an interchange at Ohio Street
        1. Added 42 induced households to the area east of I-69 between Teeters Road and Egbert Road (2 TAZs).
        2. Added 25 induced households to the TAZ between Old SR 37 and the White River south and west of Waverly.
        3. Added 25 induced households to the TAZ south of Big Bend Road, west of the Johnson County Line.
        4. Added 25 induced households to the TAZ west of I-69 between Waverly Road and the Johnson county Line.
        5. Added 25 induced households to the TAZ north of SR 144 between Kitchen Road and Mann Road.
        6. Added 25 induced households to the TAZ north and west of Centenary Road between Gray Road and Watson Road.
        7. Added 50 induced households to the TAZ south of SR 144 between Johnson Road and Kitchen Road.
    iii. Re-allocated “no-build” growth (not affected by the Ohio Street interchange)
        1. Subtracted 170 households from the area north of SR 144 between SR 67 and Mann Road (10 TAZs).
        2. Added 160 households to the area south and east of the I-69 corridor between Perry Road and the Johnson County Line (5 TAZs).
        3. Added 10 households to the bounded by I-69 on the east, Old SR 37 on the west, Tunnel Road on the south and Waverly Road on the north.

b. Commercial Employment
    i. Scenario with an interchange at Ohio Street
        1. Added 100 induced commercial jobs to the area east of I-69 between Ohio Street and SR 252 (5 TAZs).
        2. Added 52 induced commercial jobs to downtown Martinsville due to the direct connection between downtown and I-69 via Ohio Street (4 TAZs).
        3. Added 50 induced commercial jobs to the TAZ at the southeast corner of the interchange at I-69 and Henderson Ford Road.
        4. Added 150 induced commercial jobs to the area east of the I-69 corridor between Perry Road and the Johnson County Line (5 TAZs).
    ii. Scenario without an interchange at Ohio Street
        1. Added 152 induced commercial jobs to the area east of I-69 between Ohio Street and SR 44 (6 TAZs).
        2. Added 50 induced commercial jobs to the TAZ at the southeast corner of the interchange at I-69 and Henderson Ford Road.
        3. Added 150 induced commercial jobs to the area east of the I-69 corridor between Perry Road and the Johnson County Line (5 TAZs).
    iii. Re-allocated “no build” growth (not affected by the Ohio Street interchange)

            1. Subtracted 50 commercial jobs from the TAZ east of SR 67 between Hadley Road and Allison Road.
            2. Subtracted 50 commercial jobs from the TAZ on the north side of SR 144 between Johnson Road and Kitchen Road.
            3. Subtracted 100 commercial jobs from the TAZ on the east side of SR 67 between Old SR 67 and SR 144.
            4. Added 175 commercial jobs along the east side of I-69 between Ohio Street and SR 44 (6 TAZs).
            5. Added 25 commercial jobs to downtown Martinsville (4 TAZs).
            6. Added 50 commercial jobs to the TAZ at the southeast corner of the interchange at I-69 and Henderson Ford Road.
            7. Added 50 commercial jobs south and east of the I-69 corridor between Waverly Road and the Johnson County Line (2 TAZs).

    c. Industrial Employment
        i. Scenario with an interchange at Ohio Street
            1. Added 5 induced industrial jobs to the TAZ east of Mann Road just south of the Marion County Line.
            2. Added 10 induced industrial jobs on both sides of Big Bend Road on the east side of I-69 (2 TAZs).
            3. Added 8 induced industrial jobs to the TAZ on the east side of Ohio Street between Northwest Avenue and South Street.
            4. Added 5 induced industrial jobs to the TAZ on the west side of Cramertown Loop at Leonard Road.
            5. Added 2 induced industrial jobs to the TAZ at the northeast corner of I-69 at the Liberty Church Road interchange.
        ii. Scenario without an interchange at Ohio Street
            1. Added 10 induced industrial jobs to the TAZ on the east of Mann Road just south of the Marion County Line.
            2. Added 20 induced industrial jobs on both sides of Big Bend Road on the east side of I-69 (2 TAZs).
        iii. Re-allocated "no build" growth (not affected by the Ohio Street interchange)
            1. Subtracted 100 industrial jobs from both sides of SR 67 between Merriman Road and Indiana Street (2 TAZs).
            2. Added 20 industrial jobs to the TAZ east of Mann Road just south of the Marion County Line.
            3. Added 30 industrial jobs to the TAZ at the southeast corner of the interchange at I-69 and Henderson Ford Road.
            4. Added 50 industrial jobs southeast of the interchange at I-69 and SR 252 (2 TAZs).

d) Findings and presentation

a. A representative for each County gave a brief explanation of findings from the exercise:
    - Hendricks County – Panel members allocated all of the induced growth to the southeastern portion of the county, noting that the areas around the airport and I-70 would benefit most from the completion of I-69 Section 6. It was determined that a re-

allocation of “no build” growth would not be appropriate due to the completion of I-69 Section 6.

- Johnson County –The induced growth was allocated either along the I-69, between Smith Valley Road and County Line Road, or along County Road 144, east of I-69. It was determined that a re-allocation of “no build” growth would not be appropriate due to the completion of I-69 Section 6.
- Marion County – All of the induced growth was allocated to TAZs in the southwestern portion of the county, close to I-69. The panel members assumed that Southport Road would be upgraded west of the I-69 corridor and would attract the majority of the induced growth. It was determined that a re-allocation of “no build” growth would not be appropriate due to the completion of I-69 Section 6.
- Morgan County – The induced growth was generally split 50/50 between Martinsville and the area around I-69 and SR 144. If an interchange is included at Ohio Street, the City of Martinsville will get a larger proportion of the induced growth than the northern portion of Morgan County. No build growth was re-allocated from the area around Mooresville and I-70 to Martinsville and near interchanges along I-69.

e) Meeting Wrap Up and Next Steps (Chris Beard)

a. Information gathered from today will be used to re-allocate 2045 build employment and household forecasts per Traffic Analysis Zone.
b. The I-69 Team will meet with the Indianapolis MPO, FHWA, and INDOT to get their concurrence on the allocations.
c. The updated TAZ layer will be utilized to run the travel model and further refine the SR 37 Corridor alternatives.