Review of the Travel Forecasts and Analyses in the I-30 Planning and Linkages Report

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President

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Executive Summary

This report, Phase 1 of our study and recommendations, examines the methodology used in the Arkansas Highway and Transportation Department's (AHTD) decision to replace the 6-lane I-30 bridge over the Arkansas River with a 10-bridge to reduce projected traffic congestion. . Phase 2 of this project, to be delivered in May, will evaluate alternatives that focus on arterial street capacity.

The primary conclusion of this report is that AHTD's 10-lane bridge plan will not produce its projected traffic congestion relief because it is based on erroneous traffic projections. AHTD it claims that:

> … the 10-lane Downtown C/D [Collector/Distributor] Alternative would best relieve congestion… (PEL Report, p. 20).

This finding, however, ignores well-documented induced travel impacts. Specifically, AHTD's computer modeling fails to account completely for:

- The shift in auto and truck traffic from I-440 and other routes to I-30;
- The shift in number of trips from off-peak times to peak travel;
- The increase in congestion and resulting bottlenecks in downtown ramp areas.

The analysis in this report enhances AHTD's modeling to account for some of these effects. This improved modeling shows that, rather than reducing congestion, building the proposed 10-lane bridge will shift traffic from other times and locations to the I-30 bridge, concentrate noise and pollution downtown, reduce the effectiveness of other components of the regional road network, and lead to further unnecessary and expensive freeway widening projects. The enhanced modeling estimates that if freeway capacity were doubled, the southbound peak hour traffic volume on the I-30 Bridge would increase by 78% immediately.

This finding is further supported by a recent statistical analysis of congestion across 74 regions, which found that expanding freeway capacity does not relieve regional congestion. In sharp contrast, enhancing local street capacity strongly reduces regional congestion. In regions rich with a strong local street system, drivers can avoid severe freeway bottlenecks. In Phase 2, we will be modeling alternatives for the Central Arkansas region that focus on expansion of the street system. These will include:

- Construction of a Chester Street Bridge
- Conversion of I-30 in central Little Rock to a combination of express lanes with a boulevard without ramps (ramps pushed beyond central city)
- Full conversion of I-30 in central Little Rock to a boulevard.

Urban Freeway Expansion Efforts to End Congestion – 80 Years of Failure

Highway builders have been promising that the next round of urban freeway expansion will solve urban freeway congestion since the beginning of urban freeway construction in the United States 80 years ago. In the 1930s, Robert Moses built a series of freeways in the New York City region. As documented in Robert Caro's *The Power Broker*, after each freeway failed to provide the congestion relief promised, Moses promised that the next round of construction would do so. This never worked. Urban freeway expansion has similarly failed to solve urban freeway congestion across the United States in the years since (See Figure 1).

Urban freeway congestion cannot be solved through expansion because ***induced travel always follows roadway expansion***. The larger roads just fill up with traffic again. Induced travel is sometimes described by the phrase: "Build it and they will come."

Four types of induced travel are especially relevant to the proposed freeway-widening project:

1) *Rerouting* - The uncongested speed on the I-30 Bridge is at least twice as fast as on the Broadway and Main Street bridges, but the congested speed is much slower – particularly southbound during the morning peak hour. If I-30 operated at its posted speed, many of the cars now using the Broadway and Main Street bridges would shift to I-30.

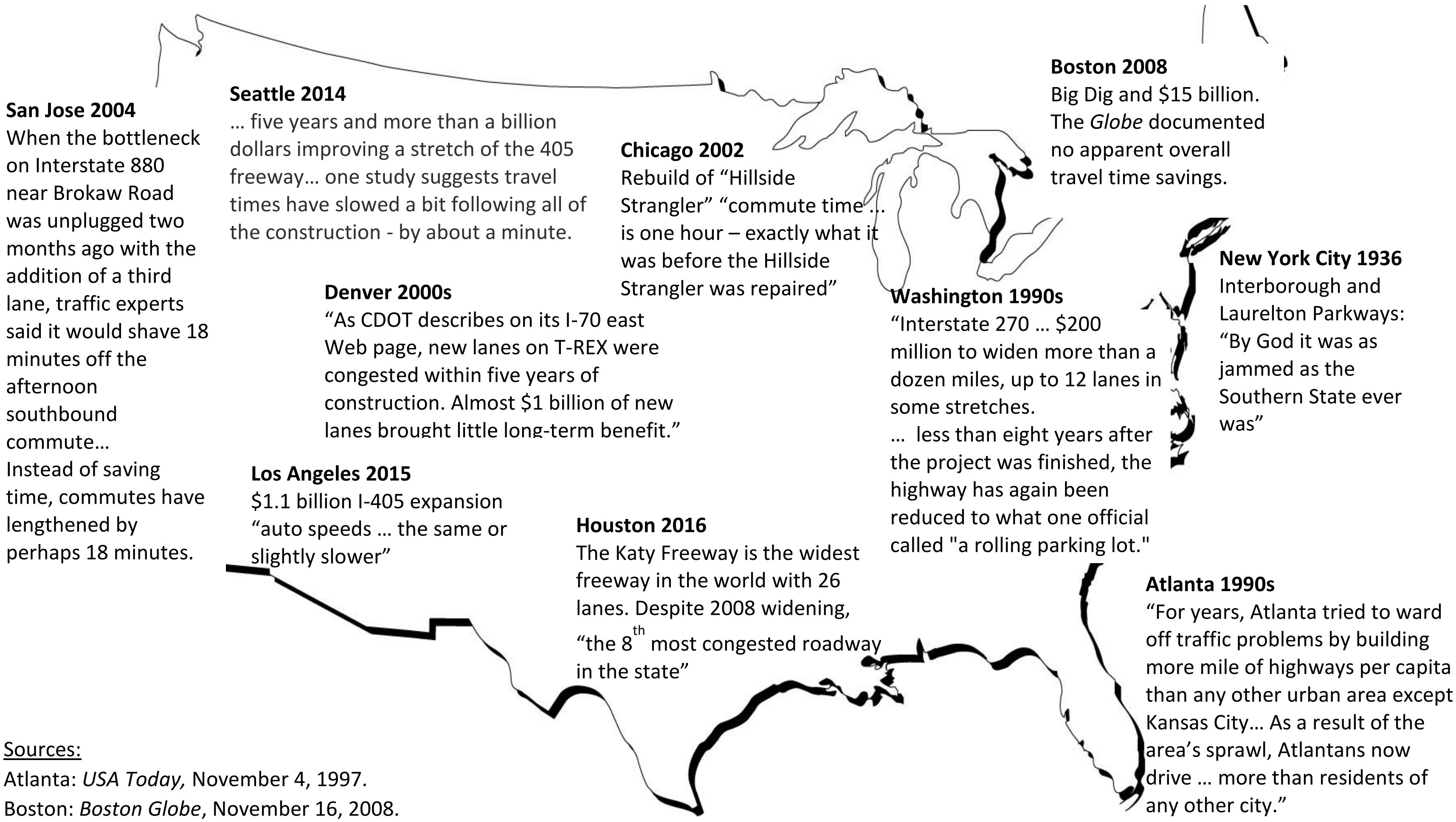
2) *Time shifts* – If there were no congestion on the I-30 Bridge, some travelers who avoid the peak travel period now would shift their trips into the peak travel period.

3) *Destination shifts* – If there were no congestion on the I-30 Bridge, some travelers would be encouraged to change their destinations to cross the river during peak periods.

4) *Land use shifts* – A faster freeway system would encourage sprawl development. Metroplan has expressed concern about this type of induced demand:

   Land development and forecast population scenarios that incorporate the impacts of substantial freeway widening beyond the six through lanes were not developed since such a policy would encourage additional urban sprawl, resulting in increased VMT and delay, which are inconsistent with the plan.[i]

Figure 1: 80 Years of Failure in Trying to Solve Urban Freeway Congestion through Expansion



<u>Sources:</u>

Atlanta: *USA Today,* November 4, 1997.
Boston: *Boston Globe*, November 16, 2008.
Chicago: *Daily Herald*, October 3, 2002.
Denver: *Denver Post*, June 22, 2015
Houston: Mayor Sylvester Turner, January 28, 2016.
Los Angeles: *LA Weekly* $1 Billion and Five Years Later, the 405 Congestion Relief Project is a Fail, March 4, 2015.
New York City: Robert Caro, *The Power Broker: Robert Moses and the Fall of New York*, 1975.
San Jose: *San Jose Mercury*, January 23, 2004.
Seattle: *Southern California Public Radio*, October 10, 2014.
Washington: *Washington Post*, January 4, 1999.

The combination of these four types of induced travel would offset any potential congestion relief from the proposed project. After reviewing an extensive set of research studies, researchers at the University of California concluded:

> *Thus the best estimate for the long run effect of highway capacity on VMT is an elasticity close to 1.0, implying that in congested metropolitan areas, adding new capacity to the existing system of limited access highways is unlikely to reduce congestion or associated GHG [greenhouse gas emissions] in the long-run.*[ii]

An elasticity of 1.0 means that widening I-30 from 6 lanes to 8 lanes would increase traffic by 33%, widening I-30 from 6 lanes to 10 lanes would increase traffic by 67%, and widening I-30 from 6 lanes to 12 lanes would increase traffic by 100%. Whether I-30 is 6 lanes, 8 lanes, 10 lanes or 12 lanes – the level of regional congestion would be the same.

A Need for Smarter Computer Models

The traffic forecasts in the PEL report begin with trend extrapolation (PEL *Traffic Technical Report*, April 2, 2015, p. 17-29). An annual growth rate of 1.0% was used to escalate weekday peak hour traffic crossing the I-30 Bridge (PEL *Traffic Count Plan, Traffic Projection Plan and Traffic Forecast*, p. 30, January 27, 2015). A 1.0% growth rate compounded over 27 years (2014-2041) represents a 31% increase in traffic volume, which is equivalent to another full lane of vehicles in each direction on the bridge. This clearly could not happen if the bridge stays at 6 lanes! In the PEL report Level 2 analyses, it was assumed that this 1.0% growth assumption would be realized regardless of how many freeway lanes there would be in the future – i.e. there was no consideration given to induced travel.

In the Level 3 analyses, some effort was made to account for induced travel as shown in the table reproduced here from the PEL *Traffic and Safety Report*, p. 8.

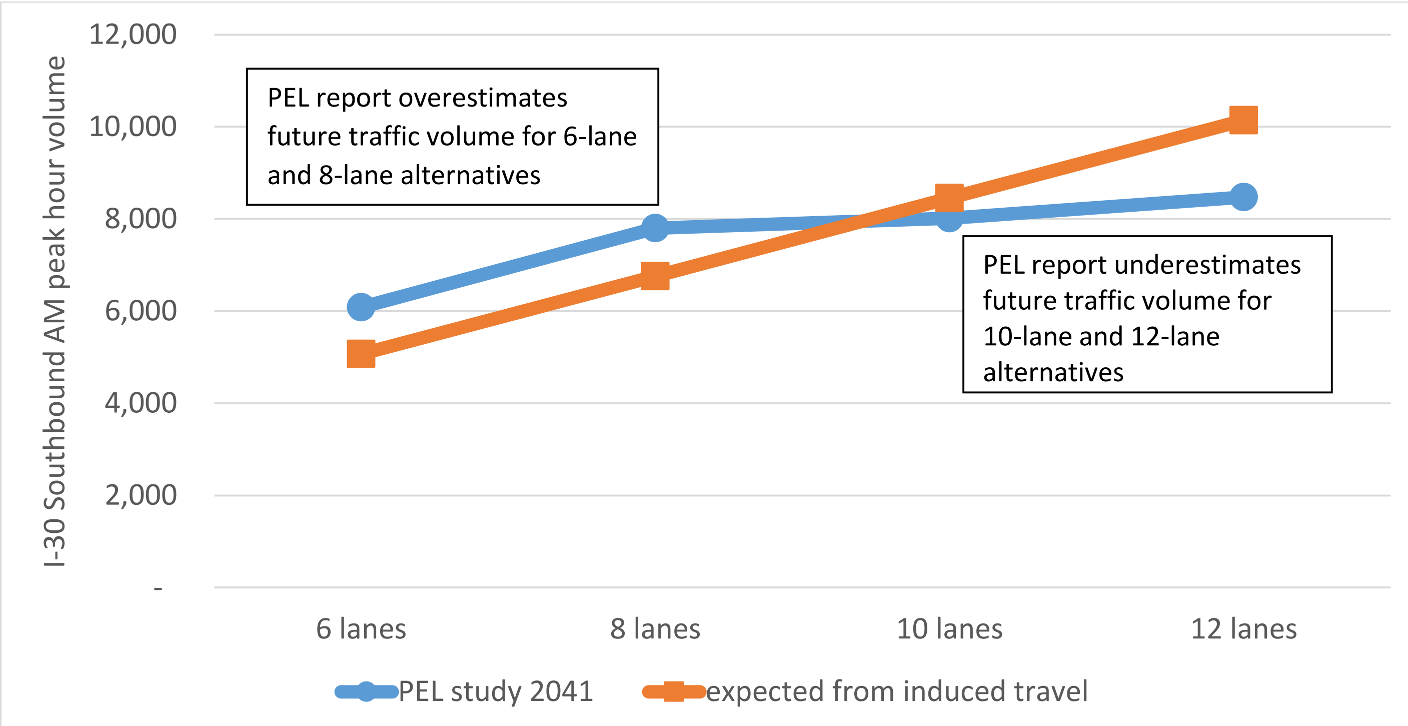
Table 2: 2041 Forecast Adjustments

I-30 PEL Assumption	Forecast Assumption
Future 6-Lane	Base Assumption **minus 13-15%** main lane volumes
Future 8-Lane	Base Assumption
Future 10-Lane	Base Assumption **plus 4-7%** main lane volumes
Future 12-Lane	Base Assumption **plus 10-13%** main lane volumes

Source: HNTB Corporation - Base assumption is shown in Appendix 2

These adjustments made to the baseline traffic forecasts in the PEL report are much smaller than those that would be expected from the induced traffic research literature (illustrated in Figure 2).

Figure 2: 2041 I-30 Bridge AM Peak Hour Southbound Traffic Volume – PEL report vs. Expected Volume from Induced Travel



The I-30 Bridge is a primary bottleneck in the region. The induced traffic response to widening would follow the orange line in Figure 2 unless the I-30 bridge traffic volume were constrained by upstream and downstream bottlenecks. Given the limited extent of the current project, this could occur. However, if the project simply moves the bottleneck to other locations, this would mean that the project would fail to achieve its purpose.

The PEL report 2041 traffic forecasts are insensitive to induced travel because the adjustments are based on the Metroplan regional travel demand model. This model takes the locations of households and jobs, and estimates weekday traffic flows. The Metroplan model has two fatal flaws that make it unable to account realistically for induced travel. First, it is a daily model that does not calculate peak hour, peak direction traffic at all. Second, it does not properly model bottlenecks and spillback – the backed up vehicles that queue behind bottlenecks.

In a freeway system, there is one path between an origin and a destination. This path passes through a series of bottlenecks. Bottleneck locations can include merges at on-ramps, diverges at off-ramps, queues behind off-ramps, and merge areas as mainline traffic crosses other mainline traffic. Most of freeway delay is due to spillback and delay behind bottlenecks. A bottleneck may reduce throughput equivalent to part of a travel lane, a full travel lane, or (in the case of extreme bottlenecks) more than one travel lane. Figure 3 illustrates a case where the bottleneck is equivalent to one lane of traffic. Vehicles spillback behind the bottleneck. The travel lanes may operate at different speeds, but all travel lanes behind the bottleneck are impacted. Downstream of the bottleneck, traffic flows well – at least until the next bottleneck is reached.

Figure 3: Bottleneck and Spillback Illustration

The Metroplan model does not model bottlenecks and spillback correctly. Instead, it uses a very simplified approximation that was standardized in regional travel demand models 50 years ago when computers were much less powerful. (This problem is not limited to Metroplan but is present in planning agencies throughout the U.S.) This flawed model is illustrated in Figure 4.

Figure 4: Bottleneck as modeled in the Metroplan model

In the Metroplan model, spillback does not occur behind bottlenecks, and there are no delays calculated behind bottlenecks. Instead, the model implicitly assumes that the vehicles can somehow squeeze through the bottleneck with a small delay assigned to the point of the bottleneck only. This type of model allows traffic volumes to exceed physical capacity – as the traffic volumes do for the 6-lane and 8-lane alternatives in Figure 2. This type of model also does not account adequately for induced travel in the 10-lane and 12-lane alternatives.

The authors of the PEL report are partially aware of limitations in the Metroplan model, and instead emphasize use of a second model, VISSIM. Although the VISSIM model does account for bottlenecks and spillback, it can do so accurately only if the traffic volumes are correct. In this case, the VISSIM traffic volumes are based on the unrealistic traffic forecasts shown in Figure 2. Therefore, the extremely detailed outputs from the VISSIM modeling are useless because they represent “garbage in – garbage out.”

The PEL report does not model any of the four components of induced travel completely. It partially models two of the components - *Rerouting* and *Destination Shifts*. However, the modeling of these two components is undermined by the two fatal flaws in the Metroplan model described above. The PEL report makes no effort to model the other two components of induced travel – *Time Shifts* and *Land Use Shifts*. Modeling these two components is challenging, and therefore they often are omitted from models. However, when components of induced travel are omitted from models, it should be assumed that the models underestimate induced travel. Metroplan suggests that the omission regarding *Land Use shifts* should be addressed by developing different land use scenarios for the freeway expansion alternatives:

> *If the current limited freeway expansion policy were replaced with an expansive freeway building policy, the land use/development/population assumptions used in Imagine Central Arkansas would no longer be valid and would need to be redeveloped for the CARTS model results and any corridor specific VISSIM model results to have validity.*[iii]

Traffic Forecasts Using a Smarter Model

We have implemented an enhanced version of the Metroplan model that better accounts for induced travel – although as discussed below, it does so incompletely. This enhanced model addresses the two fatal flaws in the Metroplan model discussed above. First, the daily travel estimates are factored into peak hour/peak direction traffic volumes for the morning and afternoon peak commuting hours. Second, we have substituted a more advanced computation procedure for route choice than the 50-year old procedure used in the Metroplan model. This more advanced model properly models bottlenecks and spillback as illustrated in Figure 3. The enhanced model is described more completely in Appendix 2.

In the data collected in the PEL report, the slowest freeway speeds observed were on the I-30 Bridge southbound in the morning peak hour. Travelers crossing the river during the peak hour choose among three central bridges (I-30, Main Street, and Broadway), and the freeway bridges several miles to the east (I-440) and west (I-430). Figure 5 shows the enhanced model estimates of the paths and estimated traffic volumes on the three central bridges during the weekday morning peak hour today.

To test what would happen if freeway congestion were eliminated today, we have doubled the number of lanes for all freeways and ramps in the region. This goes beyond the scope of the proposed project, but making the test global is necessary to assure that bottlenecks are not simply moved outside the widened area. Metroplan writes:

> *During the analysis of alternatives in the PEL, it was determined that additional widening of I-630 west to University Avenue and I-30 west to 65th Street, both outside the study area, would be necessary to avoid vehicles queuing into the corridor and affecting traffic operations.*[iv]

Extending the widening to these areas would move the bottlenecks to the next section, and so forth. If the ultimate goal is to eliminate freeway congestion, the induced travel test must include the entire freeway system.

In this test, the number of vehicles crossing the river during the morning peak period is kept the same as it is today. Figure 6 shows the resulting paths and traffic volumes.

Figure 5: Paths of Weekday Morning Peak Hour Southbound River Crossings Today (Enhanced Model)

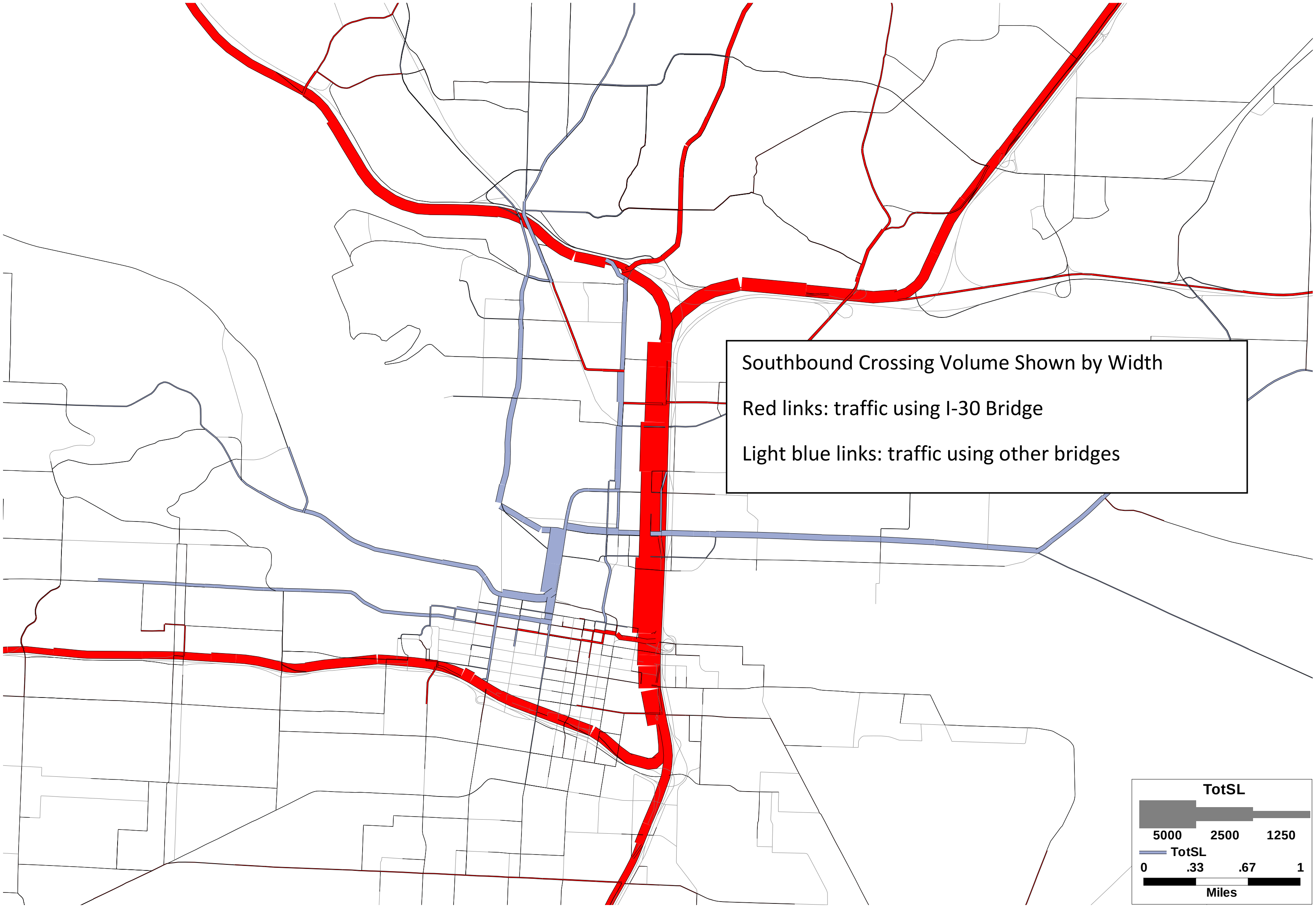
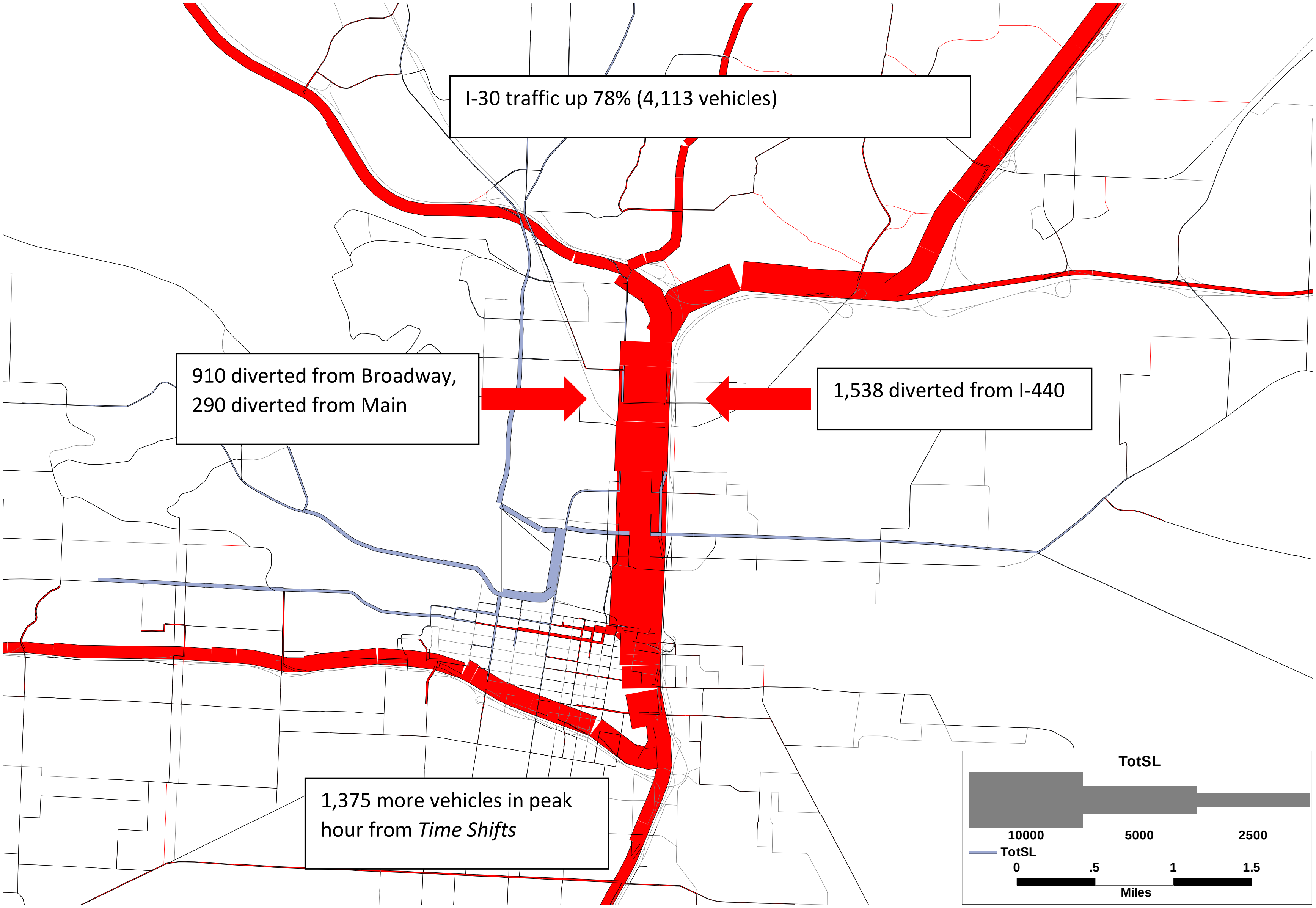


Figure 6: Weekday Morning Peak Hour Southbound River Crossings if Freeway Capacity Were Doubled Given Same Traffic Level as Today

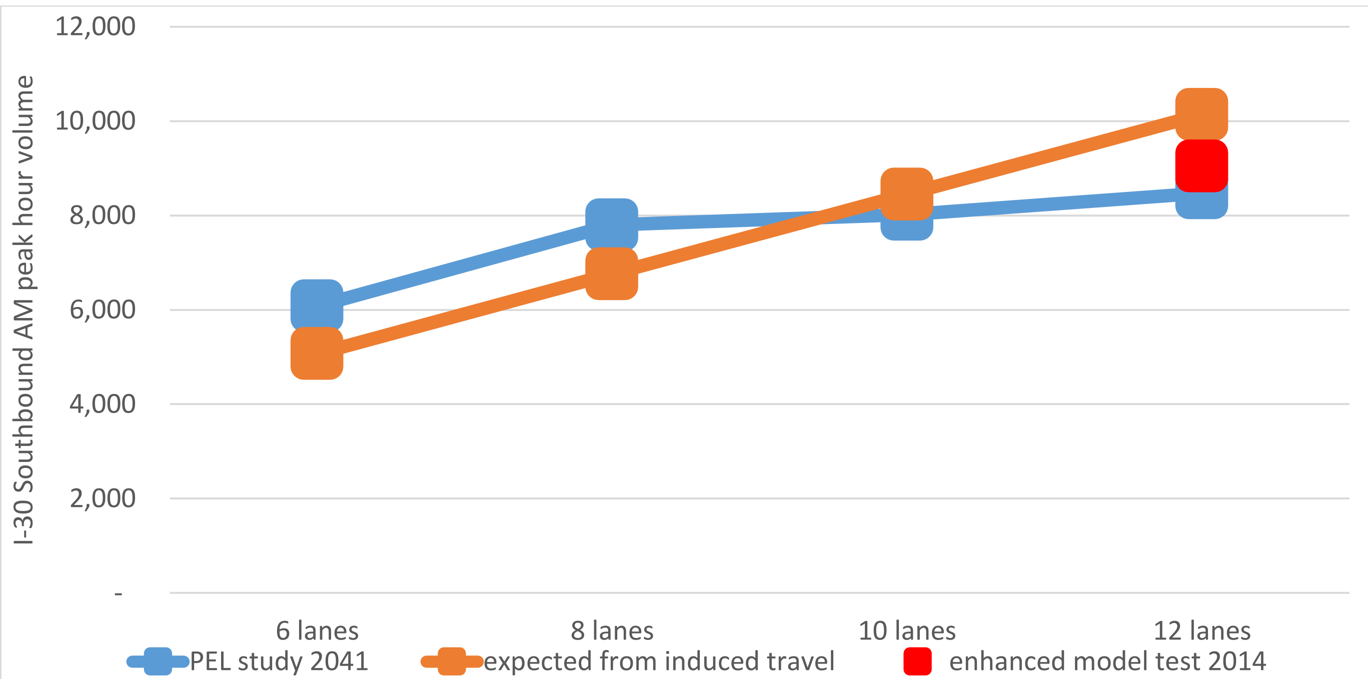


As shown in Figure 6, **the enhanced model estimates that if freeway capacity were doubled, the southbound peak hour traffic volume on the I-30 Bridge would increase by 78% immediately**. Two-thirds of the increased traffic is from *Rerouting* from other bridges - Broadway, Main, and I-440. The enhanced model shows much more *Rerouting* than the basic Metroplan model used in the PEL report because it treats bottlenecks and spillback much more accurately.

The other one third of the increased traffic is caused by *Time Shifts* In the enhanced model, the same number of travelers leave their homes during each hour in both alternatives. However, given the level of congestion present today, southbound queues north of the bridge lengthen during peak periods. This queue meters the traffic so that the number of vehicles crossing the bridge during the peak 60 minutes is lower than the number leaving their homes and heading for the bridge. Without congestion, there would be no such metering effect, and the volume crossing the bridge in the peak hour would be higher than it is with congestion.

As shown in Figure 7, the enhanced model traffic estimate of induced travel that would occur if the capacity of the freeway system were doubled today (based on 2014 data) is greater than any of the PEL report estimates for 2041.

Figure 7: Southbound Weekday Morning Peak Hour Traffic on I-30 Bridge: Data and Forecasts



The amount of induced travel shown by the red marker in Figure 7 understates the full amount of induced travel. Table 1 summarizes the components of induced travel that are modeled in 1) the PEL report, 2) the enhanced model test presented above, and 3) a more complete version of the enhanced model that will be used to evaluated alternatives in Phase 2 of this work. Given that none of the models completely accounts for induced travel, the orange markers in Figures 4 and 7 should be considered the best estimate of future morning peak hour southbound traffic on the I-30 Bridge.

Table 1: Accounting for Inducted Travel Components in Different Models

	Rerouting	*Time Shifts*	*Destination Shifts*	*Land Use Shifts*
PEL report	**Partly**	**No**	**Partly**	**No**
Enhanced model	**Yes**	**Partly**	**No**	**No**
Enhanced model: Phase 2	**Yes**	**Partly**	**Yes**	**No**

Negative Impacts of Widening Urban Freeways

Widening urban freeways wastes huge amounts of money, but the negative consequences go far beyond that. For Little Rock, they would include:

- Shifting traffic (including truck traffic) and pollution from I-440 into the heart of the region – In the freeway expansion test summarized in Figures 2 and 3, almost half of the southbound morning peak hour traffic on the I-440 Bridge shifts to the I-30 Bridge when congestion is eliminated. The region should be encouraging traffic, and especially truck traffic, to use I-440 to bypass the core of the region.
- Increasing urban street congestion in ramp areas – Expanding the urban freeway system would concentrate even higher traffic volumes at ramp intersections with local streets. Local street systems work best when traffic is dispersed.
- Leading the region into an endless cycle of widening other freeways – The proposed project would create bottlenecks upstream and downstream. This would create a "need" for further widening projects. Metroplan has expressed serious reservations about the traffic and financial implications of starting down this path.

> *Metroplan is specifically concerned about (1) the impact that adding significant new capacity to a critical freeway segment will have on the overall network in terms of induced travel, (2) the potential for the project to negatively impact existing system bottlenecks or create new ones and (3) the additional widenings in the freeway network likely to occur under current AHTD standards and practice in order to address those worsening points of congestion. Finally, the financial implications that the full cost of the project and the suggested and implied additional freeway widenings will have on the constrained LRMTP and the broader transportation vision for central Arkansas.* [v]

Useful Approaches to Reducing Traffic Congestion

Urban congestion is present throughout the U.S., but it is much worse in some regions than others. We have good data as to how congestion compares across regions because INRIX collects data from cellphones and other electronic devices and publishes the INRIX Index annually.

> *The INRIX Index represents the barometer of congestion intensity. For a road segment with no congestion, the INRIX Index would be zero. Each additional point in the INRIX Index represents a percentage point increase in the average travel time of a commute above free-flow conditions during peak hours. An INRIX Index of 30, for example, indicates a 20-minute free-flow trip will take 26 minutes during the peak travel time periods with a 6-minute (30 percent) increase over free-flow*. [vi]

The 2013 INRIX index ranges from 1 to 36 (highest for the Honolulu region). The Little Rock region had an INDEX of 4.2, which was the 56th worst out of 74 regions.

We did a cross sectional statistical analysis using the data from 74 U.S. regions and presented my findings at the 2016 Annual Meeting of the Transportation Research Board.[vii] We found that more local street capacity is strongly related to less congestion, but that more freeway capacity makes no difference at all. The public policy implications are that it is critical that an adequate network of streets be constructed in growing areas rather than relying too much on a system of freeways. In already-congested areas, more local street capacity likely would be more effective at reducing congestion than adding freeway capacity. Otherwise, the analysis suggests that congestion is more a sign of regional success than a problem than can be solved. Only two other independent variables were found to be highly significant in predicting congestion: income and population. Higher incomes increase congestion. Higher incomes attract population growth, which also increases congestion.

> **Urban traffic congestion is primarily on freeways. It cannot be reduced by expanding freeways. However, it can be reduced by expanding the street system.**

This might appear counter-intuitive, but it should not. In regions with a rich local street system, drivers can avoid severe freeway bottlenecks. In regions without a rich local street system, they are stuck spilling back behind the bottlenecks. It is no coincidence that in the INRIX dataset, the Honolulu region had both the greatest congestion and the least street capacity per person of any of the 74 regions.

In Phase 2, we will be modeling alternatives for the Little Rock region that focus on expansion of the street system. These will include:

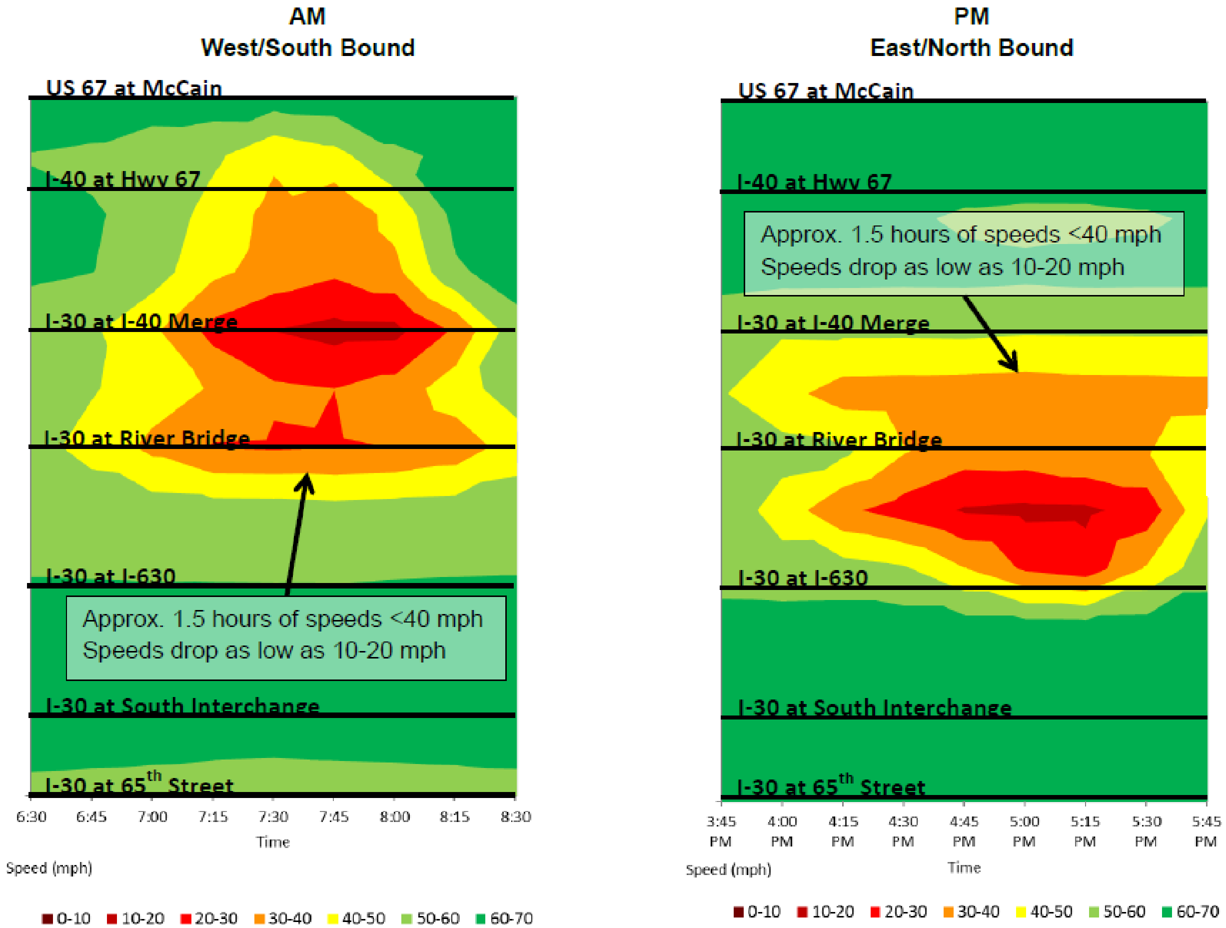
- Construction of the Chester Street Bridge (which would divert much more traffic than AHTD has concluded from a poor model)
- Converting I-30 in central Little Rock to a combination of express lanes without ramps and a boulevard
- Full conversion of I-30 in central Little Rock to a boulevard

Appendix A – Additional Technical Comments

The PEL report presents model output as if it were data. In doing so, it exaggerates existing congestion. The PEL report makes extensive use of the type of diagram reproduced in Figure A-1 below.

Figure A-1: Reproduced from PEL Traffic and Safety Report, p. 22

Figure 8: Existing 2014 Peak Hour Speed Profiles



Source: I-30 PEL Vissim models

The title of the figure is “Existing 2014 Peak Hour Speed Profiles.” A note at the bottom indicates that it is model output rather than data. This would be acceptable if the model was based on actual data. However, a close reading of the PEL report and analysis of the raw data collected for the PEL report shows that the model is not based on data, but instead is based on inflated traffic data.

Here is the sequence of steps the PEL report used to produce the graphic.

1) Counted traffic and measured speeds in the study area
2) Validated with VISSIM model with the traffic counts and measured speeds
3) Inflated the traffic counts
4) Reran the VISSIM model with the inflated traffic numbers
5) Reported the VISSIM inflated traffic model outputs as existing conditions

Table A-1 below summarizes the actual field data collected at the PEL report for freeway locations A1, A2 and A3

Table A-1: Summary of speed data (averages across 2 weekdays)

	A1 eastbound	A1 westbound	A2 northbound	A2 southbound	A3 northbound	A3 southbound
Minimum speed (5-minute periods)	46 mph	21 mph	33 mph	31 mph	37 mph	31 mph
AM duration <40 mph	0 min	40 min	0 min	85 min	15 min	0 min
PM duration <40 mph	0 min	0 min	20 min	0 min	0 min	15 min
Average AM peak hr (7:15 -8:15)	68 mph	36 mph	61 mph	34 mph	47 mph	61 mph
Average PM peak hr (4:30 – 5:30)	56 mph	66 mph	41 mph	34 mph	63 mph	42 mph
24-hour average	67 mph	63 mph	56 mph	58 mph	60 mph	58 mph

Note: the average speeds are calculated by weighting by the vehicle counts in each 5-minute period

The text on the PEL report figure for both the AM and PM peak periods: “Approx 1.5 hours of speeds < 40 mph; Speeds drop as low as 10-20 mph.” In the data, the speed did not drop below 20 mph at any location (averaged across 5 minutes and over 2 days), so 10 mph is an exaggeration. The speed only dropped below 30 mph at one location – the southbound morning peak traffic on the I-30 Bridge. Therefore, “10-20 mph” is completely wrong for the afternoon peak period. The southbound bridge location also was the only location where the duration of travel under 40 mph approached the “1.5 hours” given. At the other locations, the duration of < 40 mph was 15 minutes and 40 minutes in the peak direction. There is significant congestion in the study area, but the PEL report overstates the level of existing congestion.

It appears that the VISSIM model was validated with the actual counts and speeds as shown in Vissim Methodology Report Figures 4 and 5 (p. 18-19).

Then the counts were inflated. The justification appears to be stated in this text from the PEL report:

> *Hourly k-factors varied by location. Mainline (A-Counts) count k-factors ranged from 7.93% -12.12% in the peak direction. K-Factors were reviewed and found to indicate oversaturated conditions (lower k-factors). ADT's were calculated by taking the raw counts, applying a seasonality factor, and applying the growth rate by the number of years. Through balancing with upstream under saturated counts, counts were increased to represent true demand. (PEL Traffic Count Plan, Traffic Projection Plan and Traffic Forecast, p. 34)*

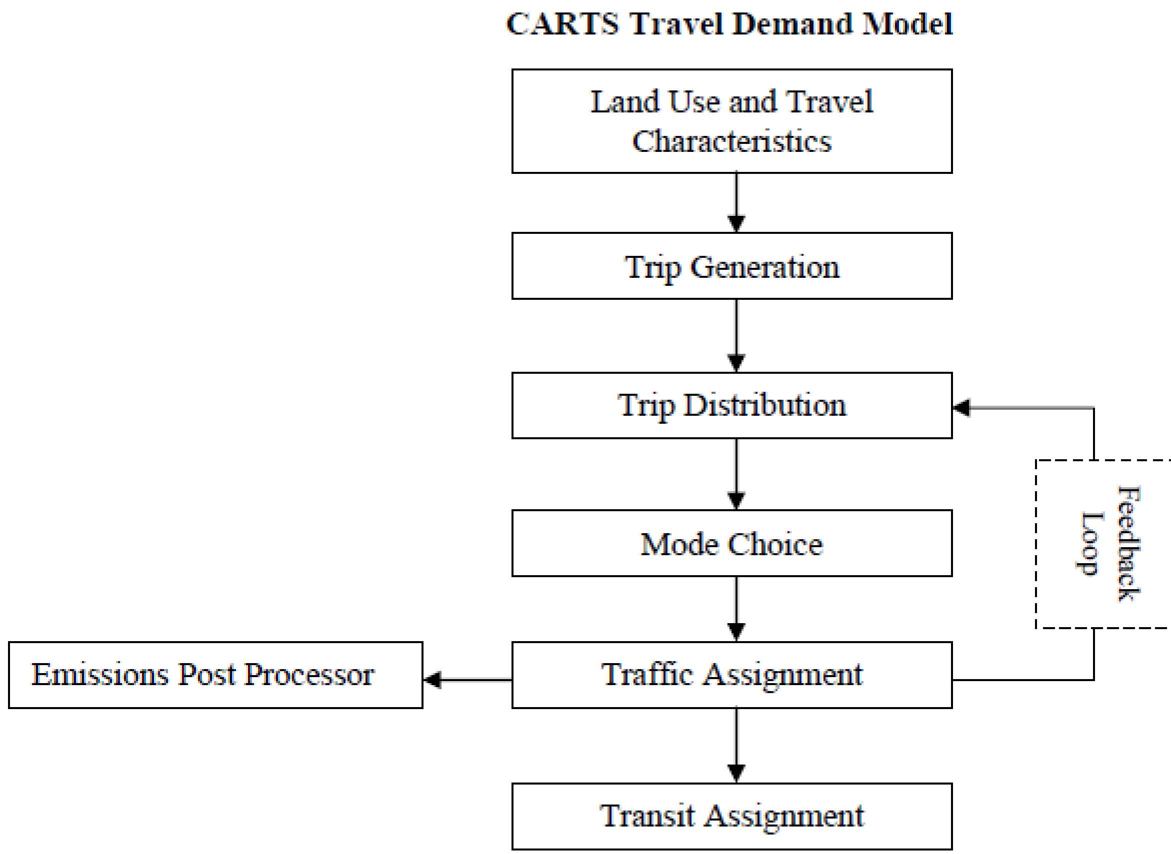
This is not "true demand". This is "false demand". The observed traffic volume represents the equilibrium between the demand for travel and the supply of roadway capacity. As is demonstrated in the main section of this report, traffic volumes would be much higher on the study roadways if there were no congestion. However, this level of traffic is only consistent with the widening scenario. It could not be present on the current roadway system.

The traffic volume increases assumed in the PEL report for base year conditions are arbitrary, with the resulting numbers representing neither real traffic numbers, nor the amount of traffic that would be present without congestion.

Artificially inflating the traffic volumes turns the VISSIM modeling to mush. Assuming more vehicles are present than can actually be on the roads causes the VISSM model to calculate large numbers of "unserved vehicles"; i.e. input vehicles that never actually enter the microsimulation. A few unserved vehicles in microsimulation can just indicate the limitations of microsimulation. When there is a large number of lost vehicles as in the future 6-lane and 8-lane models, it indicates that there is a serious problem with the traffic inputs. The modeling does not represent the real world.

Appendix B – Description of Enhanced Model

Metroplan and AHTD use the Central Arkansas Regional Transportation Study (CARTS) Travel Demand Model to predict future traffic volumes and assess transportation projects within Faulkner, Lonoke, Pulaski, and Saline Counties. The CARTS Travel Demand Model is a standard four-step model as illustrated in this figure reproduced from CARTS model documentation (*Model Validation Final Report, Revised for TransCAD 6.0*, Revised by Metroplan in April of 2012, p. 5)



In the four-step model, the number of trips at each household and non-residential location are calculated in the Trip Generation step. The origins and destinations are joined together into one-way trip segments in the Trip Distribution Step. In the Mode Choice step, the trips are split between different modes, and auto person trips are converted to auto vehicle trips. The auto vehicle trips are assigned to the roadway network in the Traffic Assignment step.

This sequential process is a crude approximation of a set of simultaneous decisions made by travelers. The "Feedback Loop" is intended to make sure that the decisions that travelers make about destination choice and mode choice are informed by congested travel times. If the feedback loop process worked perfectly, the model would account for induced travel – except for long-term induced travel from land use changes.

As discussed above, there are two reasons that the CARTs model cannot account for induced travel completely. First, it is a daily model. Traffic congestion is a peak-period, peak-direction problem that is impossible to account for in a daily model. We have addressed this problem by factoring the CARTS model trip table into peak period trip tables based on surveys by Arkansas residents living in Metropolitan Areas as recorded in the 2012 National Household Travel Survey (2012). In the Phase 1 test presented above, morning and afternoon peak-hour trip tables were developed. In Phase 2, the entire 24-hour weekday will be modeled as a set of four time periods.

Second, the traffic assignment algorithm in the CARTS model, "Static Traffic Assignment" or "STA", does not compute travel times accurately for congested freeways. STA models treat each roadway segment as independent. STA models have no queues and no spillback affecting upstream roadway segments.

> *In a static model, inflow to a link is always equal to the outflow: the travel time simply increases as the inflow and outflow (volume) increases. The volume on a link may increase indefinitely and exceed the physical capacity … as represented by a volume-to-capacity (V/C) ratio > 1… The drawback of using V/C is that it does not directly correlate with any physical measure describing congestion (e.g., speed, density, or queue.*[viii]

Dynamic traffic assignment (DTA) models have been developed that address these problems. A 2012 reference on modeling practice states: "The DTA methodology offers a number of advantages relative to the STA methodology, including the ability to address traffic congestion, buildup, spillback, and oversaturated conditions through the explicit consideration of time-dependent flows and the representation of the traffic network at a high spatial resolution."[ix]

Studies that have compared STA and DTA for the same case study have found large differences in model performance measures. Boyles et. al. concluded: "The results indicate that traditional static models have the potential to significantly underestimate network congestion levels in traffic networks, and the ability of DTA models to account for variable demand and traffic dynamics under a policy of congestion pricing can be critical."[x] In a study of choice between managed lanes (ML) and general purpose lanes (GPL) by the Florida Department of Transportation, it was concluded that: "the difference in the travel time of using the GPL or the alternative ML, and the resulting number of travelers that decide to choose the ML, is considerably underestimated by static assignment. "[xi]

In the enhanced model, DTALite software[xii] (7) substitutes for the STA algorithm in TransCAD. DTA can be implemented at a very fine level of detail. However, in this work the emphasis is on practicality. Simplifications include:

- Only network data already in the CARTS model is used.
- Intersections are not modeled explicitly.
- Each of the time periods is modeled in abbreviated form as a 120-minute simlulation with 60 minutes of initial seed time to load the roadway network, followed by a 60-minute analysis period,

In Phase 2, we will integrate DTA into the CARTS model feedback process. A more complete description of this model will be included in the Phase 2 report.

Appendix C – Norman Marshall Resume

NORMAN L. MARSHALL, PRESIDENT

EDUCATION:

Master of Science in Engineering Sciences, Dartmouth College, Hanover, NH, 1982
Bachelor of Science in Mathematics, Worcester Polytechnic Institute, Worcester, MA, 1977

PROFESSIONAL EXPERIENCE:

Norm Marshall helped found Smart Mobility, Inc. in 2001. Prior to this, he was at RSG, Inc. for 14 years where he developed a national practice in travel demand modeling. He specializes in analyzing the relationships between the built environment and travel behavior, and doing planning that coordinates multi-modal transportation with land use and community needs.

Regional Land Use/Transportation Scenario Planning

California Air Resources Board – Led team including the University of California in $250k project that reviewed the ability of the new generation of regional activity-based models and land use models to accurately account for greenhouse gas emissions from alternative scenarios including more compact walkable land use and roadway pricing. This work included hands-on testing of the most complex travel demand models in use in the U.S. today.

Chicago Metropolis Plan and Chicago Metropolis Freight Plan (6-county region)— developed alternative transportation scenarios, made enhancements in the regional travel demand model, and used the enhanced model to evaluate alternative scenarios including development of alternative regional transit concepts. Developed multi-class assignment model and used it to analyze freight alternatives including congestion pricing and other peak shifting strategies. Chicago Metropolis 2020 was awarded the Daniel Burnham Award for regional planning in 2004 by the American Planning Association, based in part on this work.

Envision Central Texas Vision (5-county region)—implemented many enhancements in regional model including multiple time periods, feedback from congestion to trip distribution and mode choice, new life style trip production rates, auto availability model sensitive to urban design variables, non-motorized trip model sensitive to urban design variables, and mode choice model sensitive to urban design variables and with higher values of time (more accurate for “choice” riders). Analyzed set land use/transportation scenarios including developing transit concepts to match the different land use scenarios.

Mid-Ohio Regional Planning Commission Regional Growth Strategy (7-county Columbus region)—developed alternative future land use scenarios and calculated performance measures for use in a large public regional visioning project.

Chittenden County (2060 Land use and Transportation Vision Burlington Vermont region) – leading extensive public visioning project as part of MPO's long-range transportation plan update.

Municipal Planning

Flagstaff Metropolitan Planning Organization – Implemented walk, transit and bike models within regional travel demand model. The bike model includes skimming bike networks including on-road and off-road bicycle facilities with a bike level of service established for each segment.

City of Portland, Maine – Implemented model improvements that better account for non-motorized trips and interactions between land use and transportation, and applied the enhanced model to two subarea studies.

City of Honolulu – Kaka'ako Transit Oriented Development (TOD) – applied regional travel demand model in estimating impacts of proposed TOD including estimating internal trip capture.

City of Grand Rapids – Michigan Street Corridor – developed peak period subarea model including non-motorized trips based on urban form. Model is being used to develop traffic volumes for several alternatives that are being additional analyzed using the City's Synchro model

City of Omaha - Modified regional travel demand model to properly account for non-motorized trips, transit trips and shorter auto trips that would result from more compact mixed-use development. Scenarios with different roadway, transit, and land use alternatives were modeled.

City of Dublin (Columbus region) – Modified regional travel demand model to properly account for non-motorized trips and shorter auto trips that would result from more compact mixed-use development. The model was applied in analyses for a new downtown to be constructed in the Bridge Street corridor on both sides of an historic village center.

City of Burlington (Vermont) Transportation Plan – Led team that developing Transportation Plan focused on supporting increased population and employment without increases in traffic by focusing investments and policies on transit, walking, biking and Transportation Demand Management.

Transit Planning

Regional Transportation Authority (Chicago) and Chicago Metropolis 2020 – evaluating alternative 2020 and 2030 system-wide transit scenarios including deterioration and enhance/expand under alternative land use and energy pricing assumptions in support of initiatives for increased public funding.

Capital Metropolitan Transportation Authority (Austin, TX) Transit Vision – analyzed the regional effects of implementing the transit vision in concert with an aggressive transit-oriented development plan developed by Calthorpe Associates. Transit vision includes commuter rail and BRT.

Bus Rapid Transit for Northern Virginia HOT Lanes (Breakthrough Technologies, Inc and Environmental Defense.) – analyzed alternative Bus Rapid Transit (BRT) strategies for proposed privately-developing High Occupancy Toll lanes on I-95 and I-495 (Capital Beltway) including different service alternatives (point-to-point services, trunk lines intersecting connecting routes at in-line stations, and hybrid).

Central Ohio Transportation Authority (Columbus) – analyzed the regional effects of implementing a rail vision plan on transit-oriented development potential and possible regional benefits that would result.

Essex (VT) Commuter Rail Environmental Assessment (Vermont Agency of Transportation and Chittenden County Metropolitan Planning Organization)—estimated transit ridership for commuter rail and enhanced bus scenarios, as well as traffic volumes.

Roadway Corridor Planning

Managed Toll Lanes in the Chicago region (Reason Foundation) – Developed advanced model of the Chicago area that calculates variable tolls by link for seven weekday time periods. The model was used to analyze a comprehensive set of new toll roads and managed toll lanes added to existing freeways.

Hudson River Crossing Study (Capital District Transportation Committee and NYSDOT) – Analyzing long term capacity needs for Hudson River bridges which a special focus on the I-90 Patroon Island Bridge where a microsimulation VISSIM model was developed and applied.

Research

Obesity and the Built Environment (National Institutes of Health and Robert Wood Johnston Foundation) – Working with the Dartmouth Medical School to study the influence of local land use on middle school students in Vermont and New Hampshire, with a focus on physical activity and obesity.

The Future of Transportation Modeling (New Jersey DOT)—Member of Advisory Board on project for State of New Jersey researching trends and directions and making recommendations for future practice.

PUBLICATIONS AND PRESENTATIONS (partial list)

A Statistical Model of Regional Traffic Congestion in the United States, presented at the 2016 Annual Meeting of the Transportation Research Board.

Comparison of Regional Congestion Metrics with Static and Dynamic Assignment Models (unpublished working paper 2015).

Understanding the Transportation Models and Asking the Right Questions. Lead presenter on national Webinar put on by the Surface Policy Planning Partnership (STTP) and the Center for Neighborhood Technologies (CNT) with partial funding by the Federal Transit Administration, 2007.

Sketch Transit Modeling Based on 2000 Census Data with Brian Grady. Presented at the Annual Meeting of the Transportation Research Board, Washington DC, January 2006, and *Transportation Research Record*, No. 1986, "Transit Management, Maintenance, Technology and Planning", p. 182-189, 2006.

Travel Demand Modeling for Regional Visioning and Scenario Analysis with Brian Grady. Presented at the Annual Meeting of the Transportation Research Board, Washington DC, January 2005, and *Transportation Research Record*, No. 1921, "Travel Demand 2005", p. 55-63, 2006.

Chicago Metropolis 2020: the Business Community Develops an Integrated Land Use/Transportation Plan with Brian Grady, Frank Beal and John Fregonese, presented at the Transportation Research Board's Conference on Planning Applications, Baton Rouge LA, April 2003.

Chicago Metropolis 2020: the Business Community Develops an Integrated Land Use/Transportation Plan with Lucinda Gibson, P.E., Frank Beal and John Fregonese, presented at the Institute of Transportation Engineers Technical Conference on Transportation's Role in Successful Communities, Fort Lauderdale FL, March 2003.

Evidence of Induced Travel with Bill Cowart, presented in association with the Ninth Session of the Commission on Sustainable Development, United Nations, New York City, April 2001.

Induced Demand at the Metropolitan Level – Regulatory Disputes in Conformity Determinations and Environmental Impact Statement Approvals, Transportation Research Forum, Annapolis MD, November 2000.

Evidence of Induced Demand in the Texas Transportation Institute's Urban Roadway Congestion Study Data Set, Transportation Research Board Annual Meeting, Washington DC: January 2000.

MEMBERSHIPS/AFFILIATIONS

Member, Transportation Research Board
Leader Modeling Reform Task Force, Congress for the New Urbanism

Endnotes

[i] Metroplan. CARTS Freeway Systems Analysis and LRMTP Impact of the CA0602 I-30 Corridor Cap Improvements, Version 1, p 7. September 2015.

[ii] Research synthesis by Susan Handy, U.C. Davis and Marlon Boarnet, U.S.C. done for the California Air Resources Board in September 2014.

[iii] Metroplan 2015, p 7.

[iv] Metroplan 2015, p. 3.

[v] Metroplan 2015, p. 6.

[vi] INRIX. Scorecard. http://inrix.com/scorecard/methodology-en/ accessed June 12, 2015.

[vii] Marshall, Norman L. A Statistical Model of Regional Traffic Congestion in the United States. Presented at the 2016 Annual Meeting of the Transportation Research Board.

[viii] Chiu, Y., J. Botton, M.l Mahut, A. Paz, R. Balakrishna, T. Waller and J. Hicks. *Dynamic Traffic Assignment: A Primer*. Transportation Research Board, Transportation Research Circular E-C153, 2011.

[ix] Cambridge Systematics, Vanasse Hangen Brustlin, Gallop, C.R. Bhat, Shapiro Transportation Consulting and Martin/Alexious/Bryson. *Travel Demand Forecasting: Parameters and Techniques*. National Cooperative Highway Research Program Report 716, 2012.

[x] Boyles, S., S.V. Ukkusuri, S.T. Waller and K. M. Kockelman. A Comparison of Static and Dynamic Traffic Assignment Under Tolls: A Study of the Dallas-Fort Worth Network, Presented at the 85th Annual Meeting of the Transportation Research Boar, January 2006.

[xi] Florida Department of Transportation, Lehman Center for Transportation Research, URS Corporation and Citilabs. Application of Dynamic Traffic Assignment to Advanced Managed Lane Modeling, November 2013

[xii] DTALite software, documentation, and sample files downloaded from https://code.google.com/p/nexta/ accessed June 12, 2015.