Metropolitan Washington Council of Governments
National Capital Region Transportation Planning Board

The Use of Cutlines for Model Validation

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Executive Summary

The Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board (TPB) engaged Vanasse Hangen Brustlin (VHB) to review the use of cutlines for model validation. TPB currently uses screenlines to compare estimated (model-forecasted) and observed traffic volumes at regional locations as part of validation; however, travel forecasting staff has expressed interest in applying cutlines for future validation tests to compare estimated and observed data at a more detailed level, particularly for forecasting work to support project planning studies.

This memo concludes that TPB should consider placement of the recommended screenlines for its next model validation. Easily obtaining reliable observed data at screenline crossings is still a potential problem, so TPB staff may wish to consult with member jurisdictions to prioritize the list of new screenlines and possibly phase them into the validation tests over time. In terms of observed data, accessing the VDOT traffic engineering count database and eventually the freeway data archives for northern Virginia will provide two previously unused and robust observed data sets, but even more data are needed going forward, particularly if TPB puts an even greater emphasis on the use of smaller area screenlines. Greater segmentation of the roadway links for AADT data will be needed. There is an even greater need for improved access to observed transit data in order to make the screenline validation truly multimodal.

However, it is important to remember that validation to small cutlines compared with using regional screenlines is pulling the TPB model in two different directions, and there needs to be a balance between efforts for macroscopic and mesoscopic modeling, using the appropriate tools for each level. The creation and use of specific cutlines and subsequent validation at the beginning of a project planning study will never go away completely; there are simply too many potential study locations to be covered during a typical regional validation cycle. The need to perform screenline checks using the NCHRP 255 methodology will continue as well; TPB staff should consider expanding the sample work performed in this memo for the I-270 and I-66 corridors to the entire regional modeled area and the new screenline system as it is implemented.

Cordons or screenlines usually cover “major” regional travel patterns, but as major destinations become more dispersed, the major travel patterns also become more dispersed, and at that point cutlines may be employed to look at particular locations and the use of local cordoned areas as employed by BMC may be necessary. BMC reports that their local area cordons are included in their regular count program, which cycles through all screenline locations over three years. There may be value in designating areas like Tysons Corner, Bethesda, and others with a local cordon.

Background: Cordons, Screenlines, Cutlines, and the Current TPB System

"Screenlines" is a generic term used to refer to three hierarchical types of imaginary lines placed across a series of parallel facilities or a series of facilities serving the same travel market. In order from broadest to most tightly focused, these lines are:

Cordons – the lines of a cordon form a closed polygon in order to compare estimated and observed traffic flows into and out of the enclosed study area. Examples with the TPB modeled area include the Metro Core Cordon, the cordon around the Capital Beltway (I-495 / I-95), and the external cordon surrounding the modeled area which is used to compare estimated and observed volumes for external-internal (E-I) and internal-external (I-E) trips as well as modeled area through (external-external / E-E) trips.

Screenlines – actual screenlines capture cross-regional travel flows. The best example of this within the TPB modeled area is the Potomac River screenline (see Figure 1).

Cutlines – cutlines capture travel flows through a major corridor. Many of the lines for capturing flows within the TPB modeled area fit this definition even though they are both collectively and individually referred to as screenlines. Screenlines are still an appropriate term within the TPB model for what amount to very long cutlines, although according to FHWA guidelines, cutlines "…should be used to intercept travel along only one axis" (see Figure 2).[1]

The "line" of demarcation and definition between a cutline and a screenline can be somewhat blurry. Validation of a large regional model such as the TPB model requires comparison of estimated and observed traffic volumes at a *regional* level; i.e., county-to-county flows or flows to and/or along parallel facilities within a broad, *regional* travel corridor such as "outer" jurisdictions to "inner" jurisdictions. These long screenlines are in fact agglomerations of potential, shorter cutlines that could be focused on smaller corridors such as I-95 and its major parallel facilities (US 1 in Virginia; US 1, US 29, and MD 295 in Maryland).

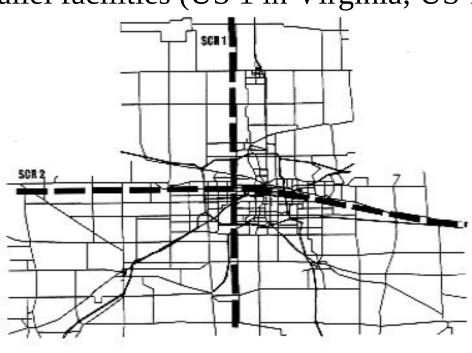

Figure 1: Example of Screenline Locations[2]

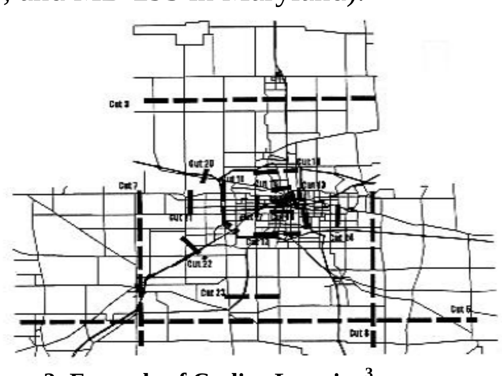

Figure 2: Example of Cutline Location[3]

[1] See Barton-Aschman and Cambridge Systematics (1997). It can be argued that travel patterns in the TPB region have changed radically enough in the intervening ten years since these guidelines were published that meeting this criterion is both difficult and lacking value to the ability to model travel markets, particularly with the percentage of very long and multiaxial trips, such as circumferential travel.

[2] Source: Ibid.

[3] Source: Ibid.

Comparison of modeled versus counted traffic across cordons or screenlines provides an indication of how well a travel demand model performs in replicating major trip patterns and movements throughout the network. The screenline or cordon will usually correspond with a recognized visible boundary feature (a river or major transportation facility) or a well-delineated political boundary (a county or city border). Screenlines typically encompass all facilities that serve the same definable travel corridor to allow for the fact that the model may not perfectly represent competition between parallel facilities. The definition heavily depends on the delineation of the travel corridor. Historically, cutlines have been reserved for use in project planning studies where the study area is a smaller subset of the regional modeled area and the model must be revalidated so that the estimated volumes adequately match the observed data on the network within the study area. Ideally the cutlines are selected at a very early stage of the study to ensure the availability of reliable observed data for use in revalidation and so that adequate time is available for adjustments to model parameters, if necessary. Most recently, cutlines for project planning work have been used successfully with the TPB model for studies such as the Intercounty Connector (ICC), the Base Realignment and Closure (BRAC) Environmental Impact Statement (EIS) for Fort Belvoir, and the various I-270 studies.

Figure 3 shows the existing TPB screenline system. There are 38 regional screenlines in the TPB modeled region in addition to the external cordon. The last model validation compared estimated and observed volumes along the screenlines as well as checking county-to-county flows. Sufficient growth and subsequent changes in regional travel patterns have occurred in the years since the last model validation that some consideration needs to be given to moving screenlines or adding new screenlines. In addition, the screenlines should be easily subdivided for use as cutlines when project planning studies are undertaken or for possible use in regional validation and sensitivity testing.[4]

Literature Review

The primary guiding document on the treatment of screenlines in travel forecasting is National Cooperative Highway Research Program Report Number 255: Highway Traffic Data for Urbanized Area Project Planning and Design (hereafter NCHRP 255). The guidelines contained within NCHRP 255 are so widely used in travel demand forecasting activities around the United States that it is not an understatement to call the report "the bible" on the subject; every other guidance document found in the literature uses the criteria from NCHRP 255 as its starting point and do not radically depart from them.[5] Furthermore, none of the MPOs contacted for this memo follow procedures significantly different than those found in NCHRP 255 or its child documents. Those procedures and guidelines are summarized below:

[4] Sensitivity testing, sometimes referred to as dynamic validation, describes the process by which the model's response to specific, targeted changes in land use or network inputs is tested and documented.
[5] This includes the relevant sections of Barton-Aschman and Cambridge Systematics (1997) and state-level model reasonableness checking and validation documents.

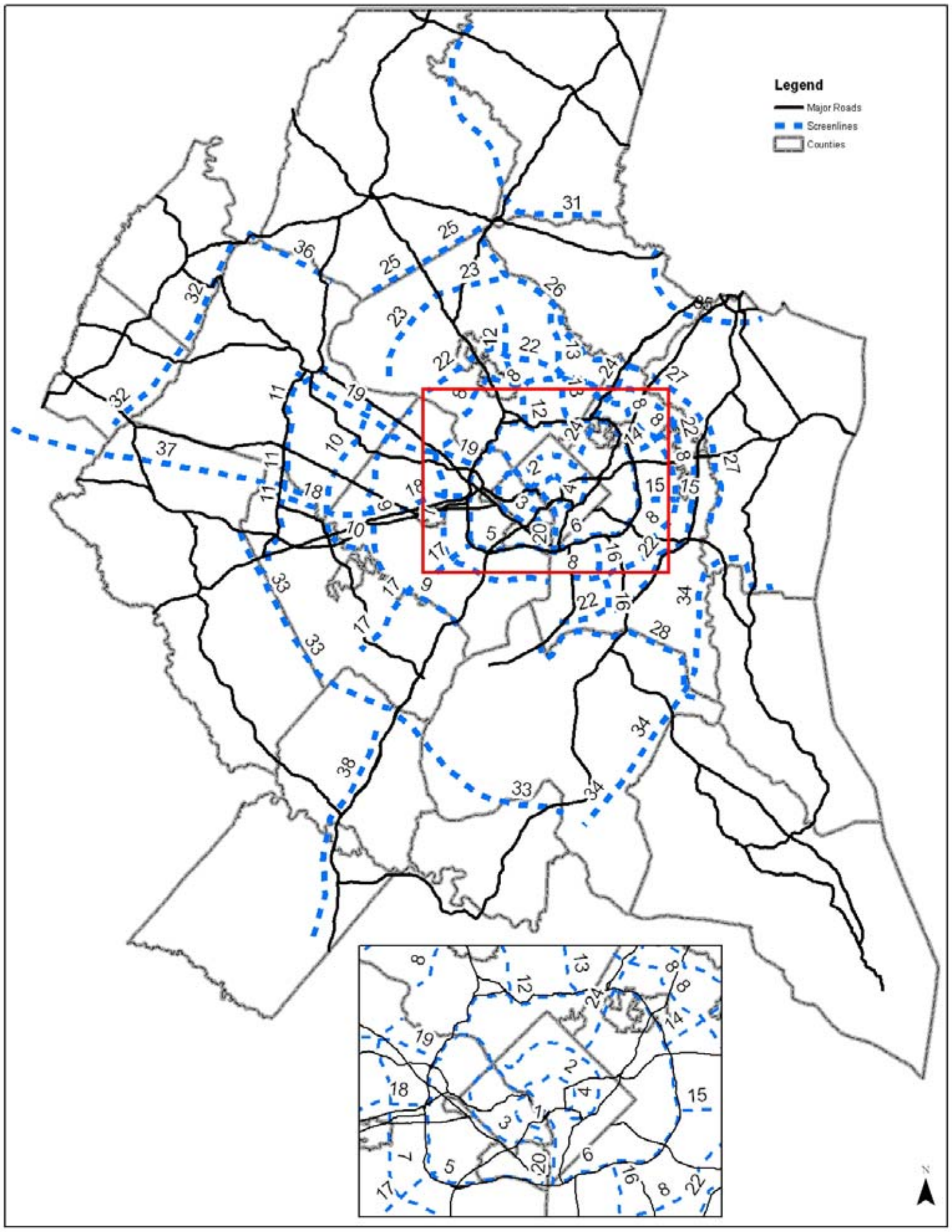

Figure 3: Existing TPB Screenline System (Source: TPB GIS)

NCHRP 255 Overview

NCHRP 255 details the procedures that MPOs should use to validate traffic counts and traffic assignment volumes modeled during travel demand forecasting. The methodology includes the use of screenlines as count validation points and includes procedures for adjusting the modeled volumes on each link to more closely replicate count data.

Selecting Screenlines

Creating meaningful and useful screenlines requires familiarity with the transportation network. NCHRP 255 recommends that several rules be followed when selecting locations for screenlines and for determining which links should be included in the analysis.

- A single screenline should capture traffic on all roadways that are alternatives in a corridor. Non-parallel facilities in the same area should not be included in the screenline.
- Zone connectors should not be included in screenline analyses under most circumstances.
- Each screenline should ideally cross between three and seven road facilities. The report recommends ten facilities as the practical maximum.
- Screenlines should only be long enough to capture the recommended number of roadways. Lengths of up to five miles may be appropriate in low density areas, while two miles is recommended in denser urban areas.
- Screenlines should be located between major roadway interchanges (or every two miles). This will allow for checks on the changes in volume along the length of individual facilities.

Base Year Checks

To determine if any adjustments to the model assignment forecasts will be necessary, modeled volumes from a base-year scenario should be compared to actual traffic counts from that year. The comparisons should be done for each identified screenline by totaling the volumes on each parallel facility. NCHRP 255 establishes guidelines for the "maximum desirable deviation" between the modeled volumes and the traffic counts for each screenline. The allowable percentage of deviation decreases as the volumes moving through a screenline increase. If the base year volumes exceed the maximum desirable deviation, several corrective actions may be taken, including:

- Check for and correct errors in the model itself and then re-run the model.
- Extend the screenline, making sure that the additional facilities captured serve the same travel market as those traversed by the original screenline.
- Factor the screenline volumes based on the difference between the base year assignment and the base year traffic counts.

The report contains maximum desirable deviation curves for both individual count locations and screenlines.

Modeled Volume Adjustments

NCHRP 255 provides detailed procedures for adjusting modeled assignment volumes for links on screenlines with larger than desirable deviations. These procedures adjust the volume on each link of a screenline in order to realize forecasted volumes that are closer to the actual traffic counts. These procedures balance volumes on each link while accounting for future changes including increased capacities on specific facilities.

Current MPO Practice

The number, type and location of screenlines vary between MPOs based on the size and geography of the urban area. The Atlanta Regional Commission (ARC) recently increased its number of screenlines from 16 to 22 in conjunction with the expansion of its modeled region to meet conformity requirements. A list of the ARC screenlines and the results of their recent Year 2000 validation is shown in Table 1 below. A map of the ARC screenlines is shown in Figure 4. The maximum desirable deviation standards are taken from the curves in NCHRP 255 and the calculated deviation values (based on ARC's regression lines that fit sections of the NCHRP curves) applied using a TP+ script.

Table 1: Atlanta Regional Commission Screenlines and Year 2000 Validation Results (Source: Atlanta Regional Commission)

Screenline	Assigned Volume	Traffic Count	Volume / Count Ratio	Percent Deviation	Maximum Desirable Deviation (+/-)
Chattahoochee River	1,371,296	1,299,756	1.06	5.50%	8.27%
Inner Rail Ring	1,537,742	1,489,970	1.03	3.21%	7.83%
Outside of I-285	2,769,930	2,778,592	1.00	-0.31%	6.13%
South Atlanta - East/West	683,089	656,921	1.04	3.98%	10.83%
North Atlanta - East/West	621,623	571,619	1.09	8.75%	11.44%
Central Atlanta - north of I-20	1,358,561	1,313,793	1.03	3.41%	8.23%
Corridor south of Marietta	402,583	374,168	1.08	7.59%	13.52%
I-20 Corridor east of Douglasvill	144,106	137,303	1.05	4.95%	20.09%
I-75 Corridor north of Jonesboro	305,607	303,223	1.01	0.79%	14.69%
I-85 Corridor north of Norcross	401,453	375,894	1.07	6.80%	13.50%
GA 400 Corridor north of Buckhead	148,050	159,613	0.93	-7.24%	18.93%
I-20 Corridor east of I-285	226,171	230,181	0.98	-1.74%	16.38%
GA 400 Corridor in Roswell	157,985	197,000	0.80	-19.80%	17.42%
SR 20 Corridor west of Cumming	36,448	32,894	1.11	10.80%	35.33%
I-85 Corridor south of Fairburn	135,972	115,800	1.17	17.42%	21.49%
Lake Lanier	82,811	88,276	0.94	-6.19%	23.92%
I-985 South of Gainesville	82,862	66,900	1.24	23.86%	26.69%
West Region N/S	149,852	133,013	1.13	12.66%	20.35%
East Region N/S	129,794	133,146	0.97	-2.52%	20.34%
I-75 South of Locust Grove	150,441	137,733	1.09	9.23%	20.07%
Alcovy River	153,929	159,708	0.96	-3.62%	18.93%
Flint River	218,479	196,692	1.11	11.08%	17.43%
Totals	11,268,784	10,952,194	1.03	2.89%	3.56%

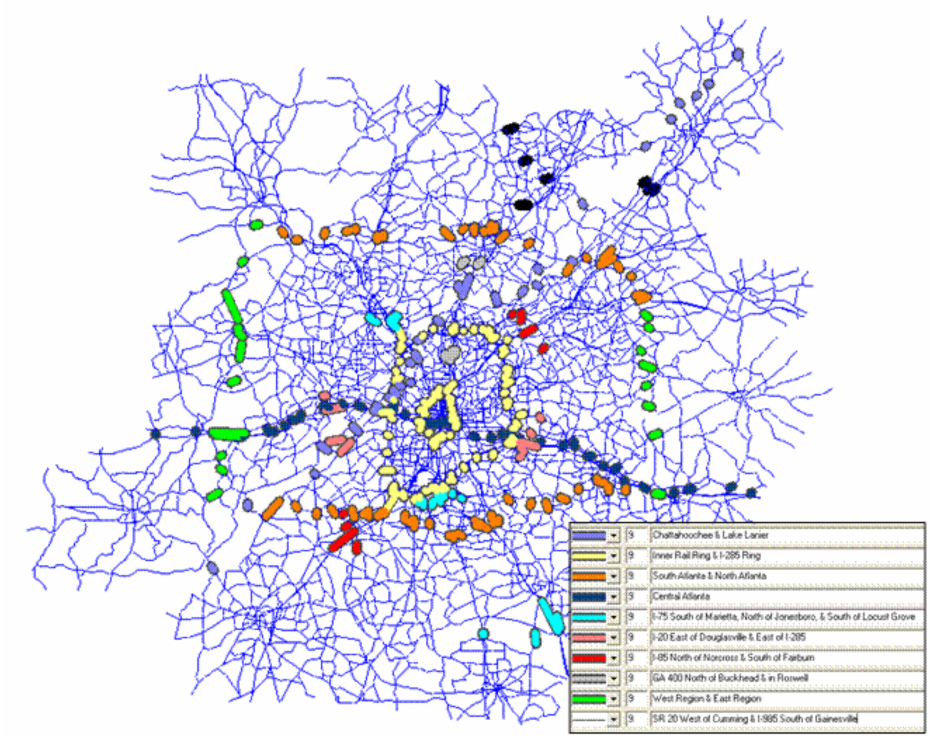

Figure 4: ARC Screenlines (Source: Atlanta Regional Commission)

The Baltimore Metropolitan Council (BMC) uses 52 screenlines which are divided into four categories:

- 12 Baltimore City screenlines follow the city borders, the limits of the core area and a few major corridors within the city.
- 24 circumferential screenlines capture traffic flows entering and leaving the city at various distances.
- 11 corridor screenlines capture traffic flows in major corridors throughout the region.
- 5 Local Area Cordons capture traffic leaving and entering secondary urban centers in the Baltimore region (Columbia, Towson, Westminster, Bel Air, and Annapolis).

Maps of the BMC screenlines are shown in Figures 5 through 8.[6]

[6] The BMC validation report clarifies their use of the word screenlines, stating that "the term "screenline" as used by BMC staff refers to an imaginary line that intersects one or more roads which is used to evaluate traffic flows in an area. Most screenlines used by BMC staff are technically called "cutlines" or "cordon lines." BMC's use is similar to that of TPB.

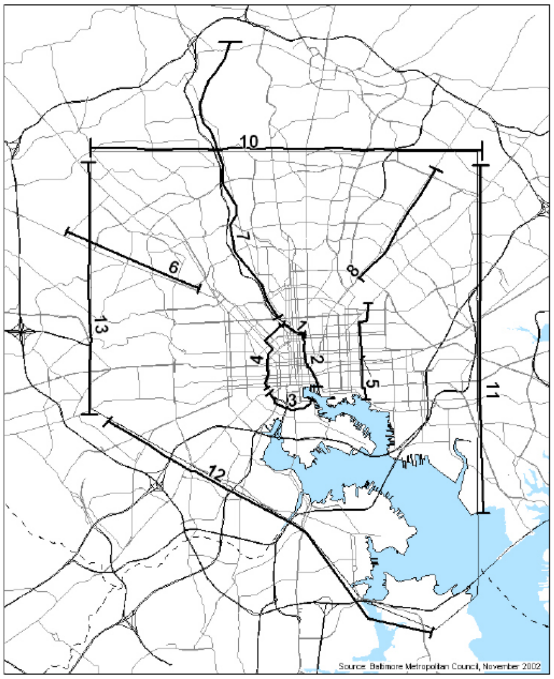

Figure 5: BMC City Screenlines (Source: BMC)

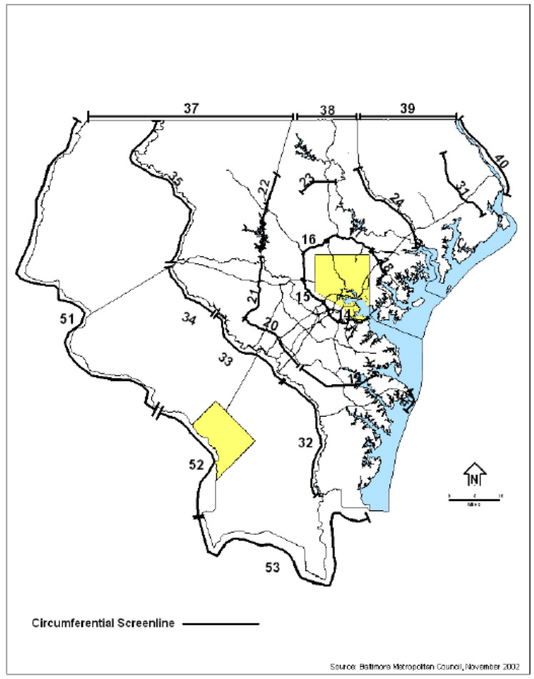

Figure 6: BMC Circumferential Screenlines (Source: BMC)

The Regional Transportation Commission (RTC) of Southern Nevada, the MPO for the Las Vegas metropolitan area, uses two sets of screenlines. The first, called "k-factor screenlines" are located on the boundaries of the 18 k-factor districts. These districts form 27 screenlines that are used to measure the flow between adjacent districts of the city. An additional 44 screenlines are used to measure corridor flows on major facilities. The New York Metropolitan Transportation Council (NYMTC) uses an extensive three-tiered system of screenlines that includes volume counts on over 2200 links. 26 screenlines divide the region along county borders, and additional screenlines are used to divide each county into quadrants and sub-quadrants. The Metropolitan Transportation Commission (MTC), the MPO for the San Francisco Bay Area, places screenlines at all county borders and some intervening screenlines within certain counties based on regional travel markets and the level of urbanization. MTC also includes a separate screenline for the eight bridges crossing San Francisco Bay and its tributaries.

The Denver Regional Council of Governments' (DRCOG) 2001 validation of its trip-based model used eight regional screenlines and cordons around downtown Denver and the City of Boulder. The Puget Sound Regional Council (PSRC), the MPO for the Seattle-Tacoma region, uses 71 screenlines for model validation. The Denver and Seattle screenlines are shown in Figure 9 and Figure 10, respectively.

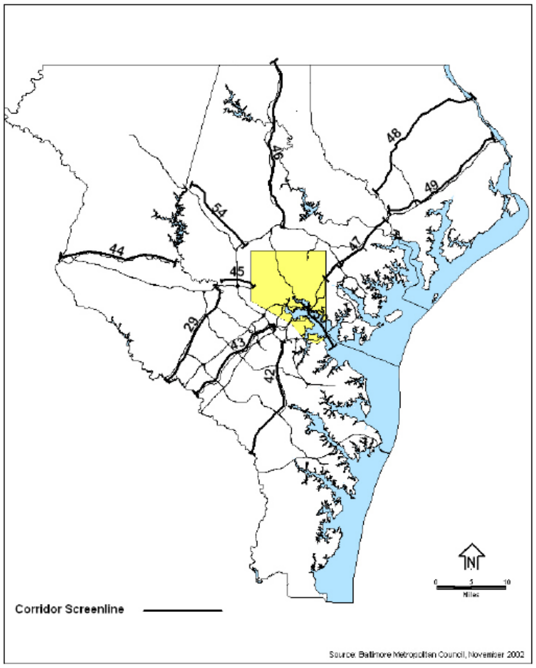

Figure 7: BMC Corridor Screenlines (Source: BMC)

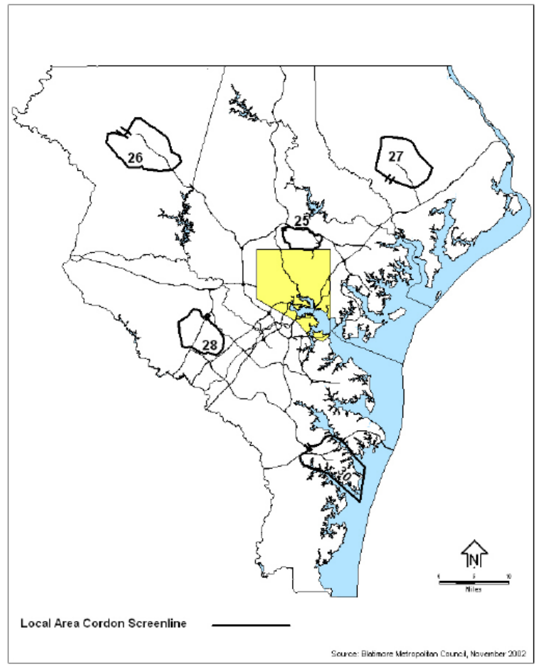

Figure 8: BMC Local Area Cordons (Source: BMC)

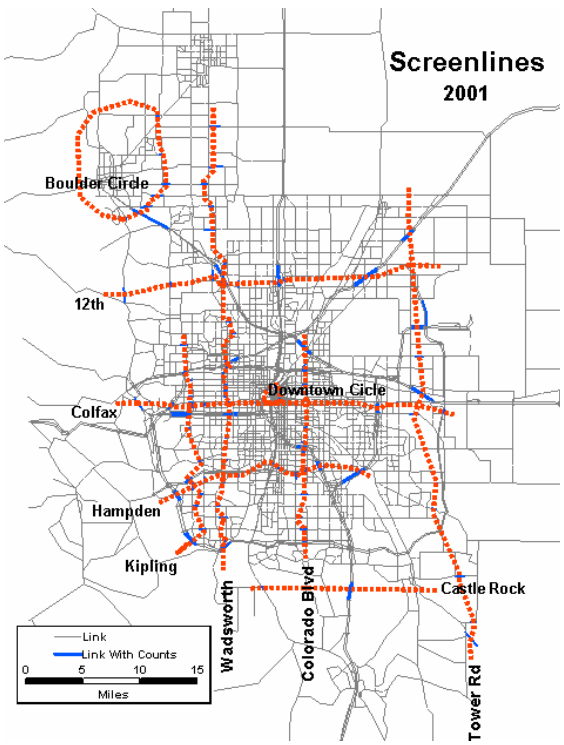

Figure 9: DRCOG Screenline System (Source: DRCOG)

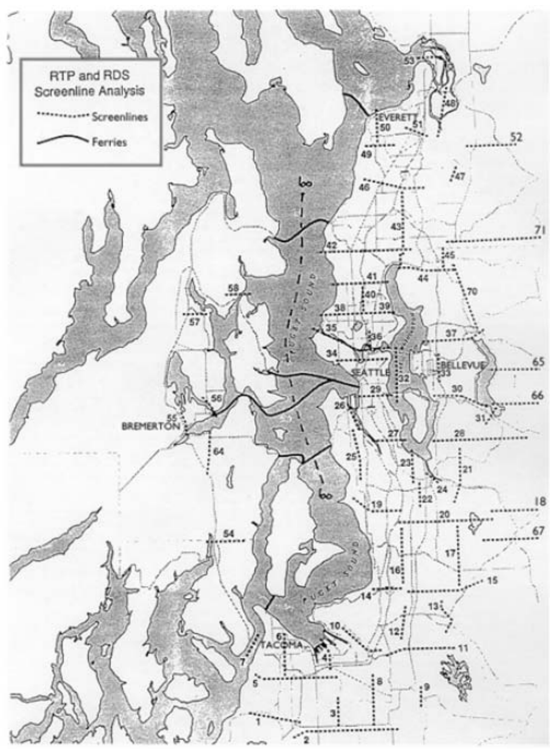

Figure 10: PSRC Screenline System [7]

The Southern California Association of Governments (SCAG), the Los Angeles MPO, used 16 regional screenlines for its year 2000 model validation. The Maricopa Association of

[7] Source: Dailey, *et al* (2002)

Governments (MAG) in Phoenix is using a new system of 74 screenlines for its upcoming validation. The recently validated version 4.0 of the Central Florida Regional Planning Model (CFRPM), which covers District 5 (Orlando / Cocoa / Daytona area) of the Florida Department of Transportation (FDOT), used 54 regional cutlines over a nine-county area.[8] The SCAG and MAG systems are shown in Figure 11 and Figure 12 and the cutlines by area in the CFRPM model are shown in Figures 13 through 19.

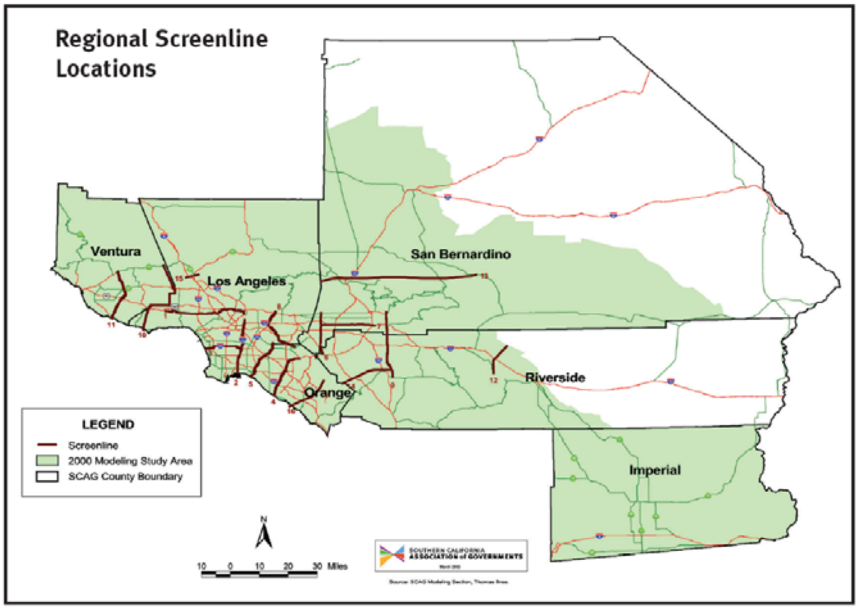

Figure 11: SCAG Screenline Locations (source: SCAG)

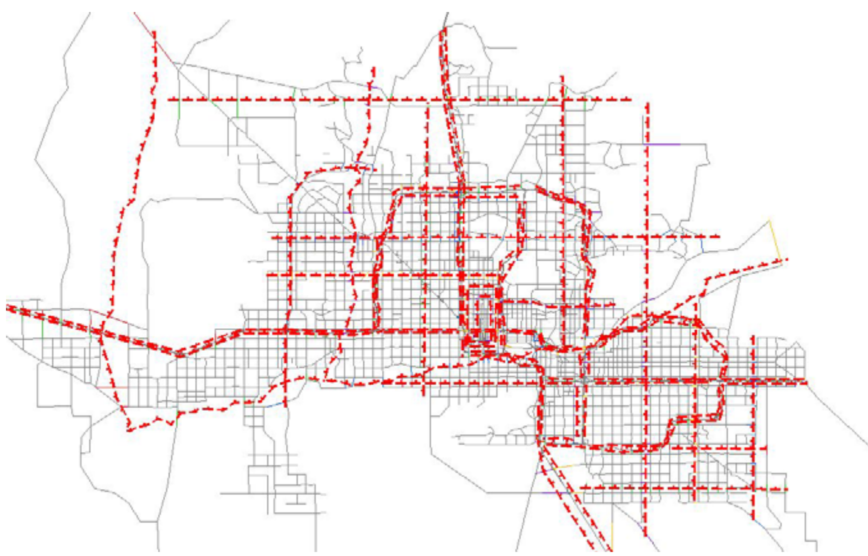

Figure 12: MAG Screenline Locations (source: MAG)

[8] The CFRPM is based on the Florida Standard Urban Transportation Model Structure (FSUTMS).

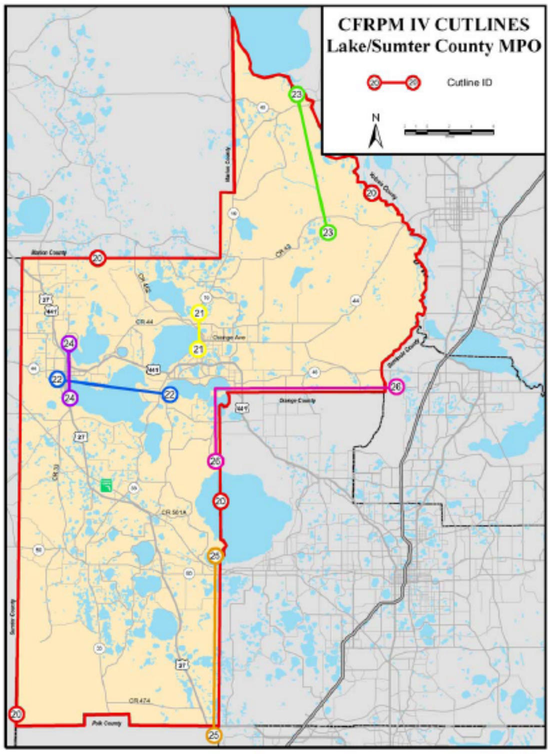

Figure 13: CFRPM Lake/ Sumter County Cutlines[9]

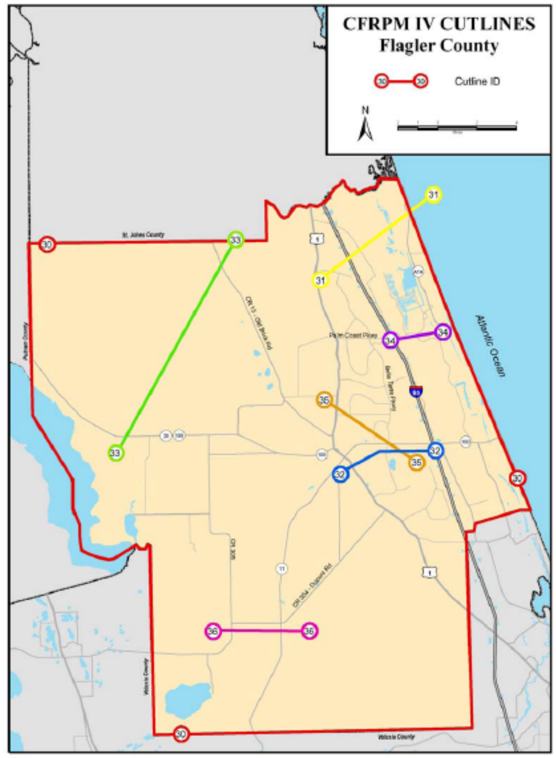

Figure 14: CFRPM Flagler County Cutlines

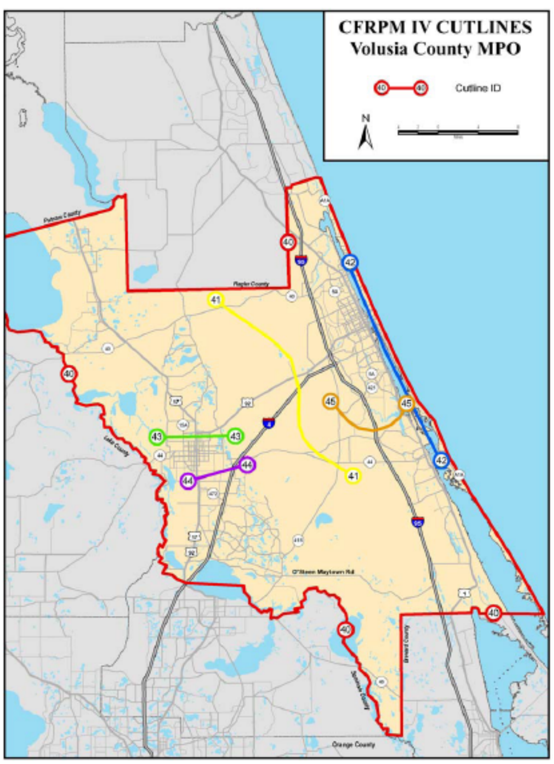

Figure 15: CFRPM Volusia County Cutlines

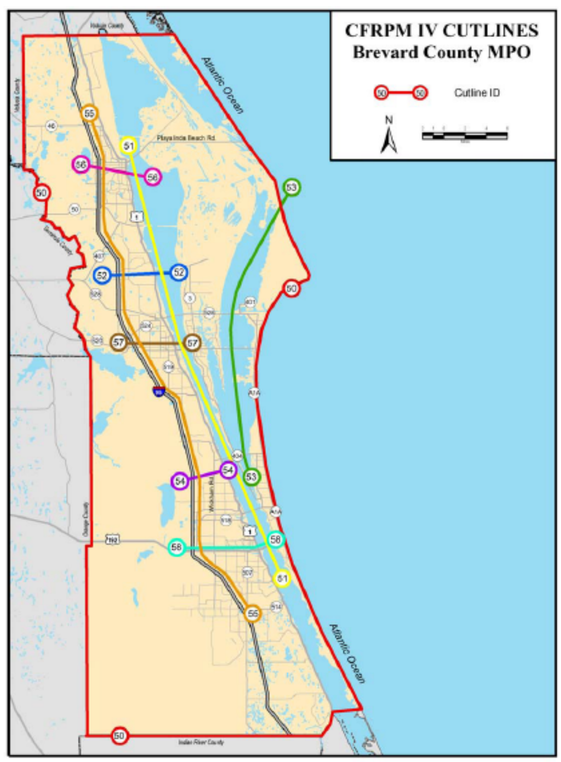

Figure 16: CFRPM Brevard County Cutlines

[9] Source for figures 12-19: HNTB (2006).

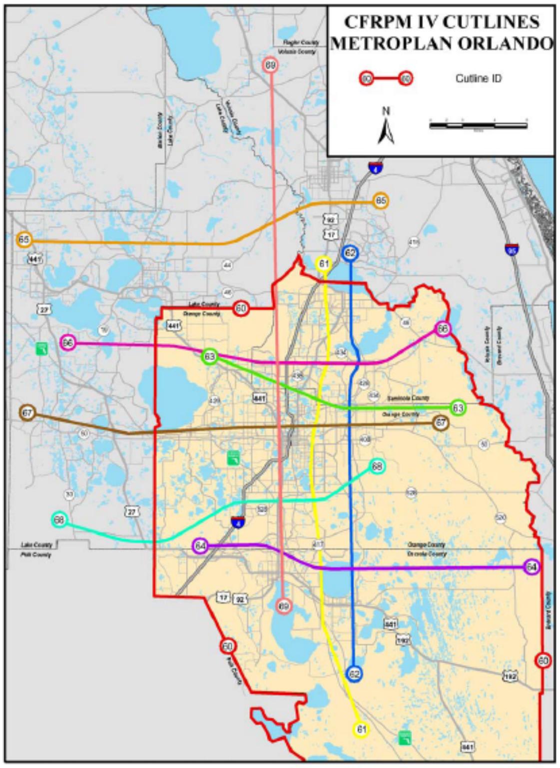

Figure 17: CFRPM Metroplan Orlando Cutlines

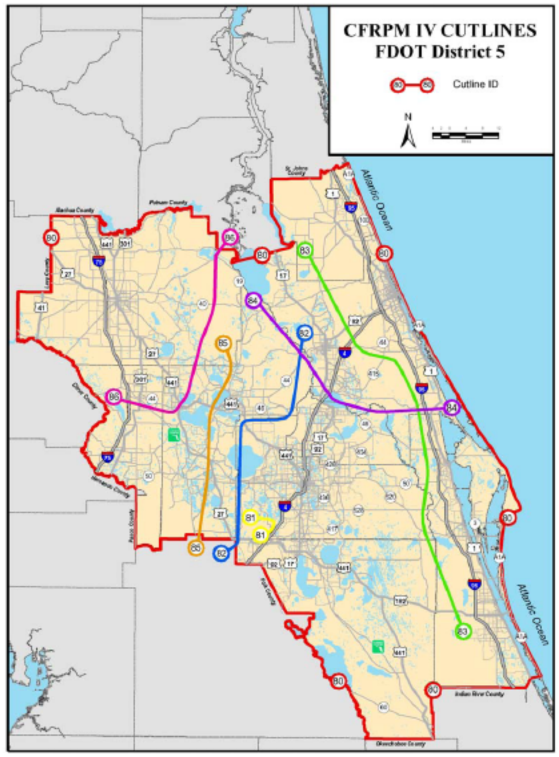

Figure 18: CFRPM FDOT District 5 Cutlines

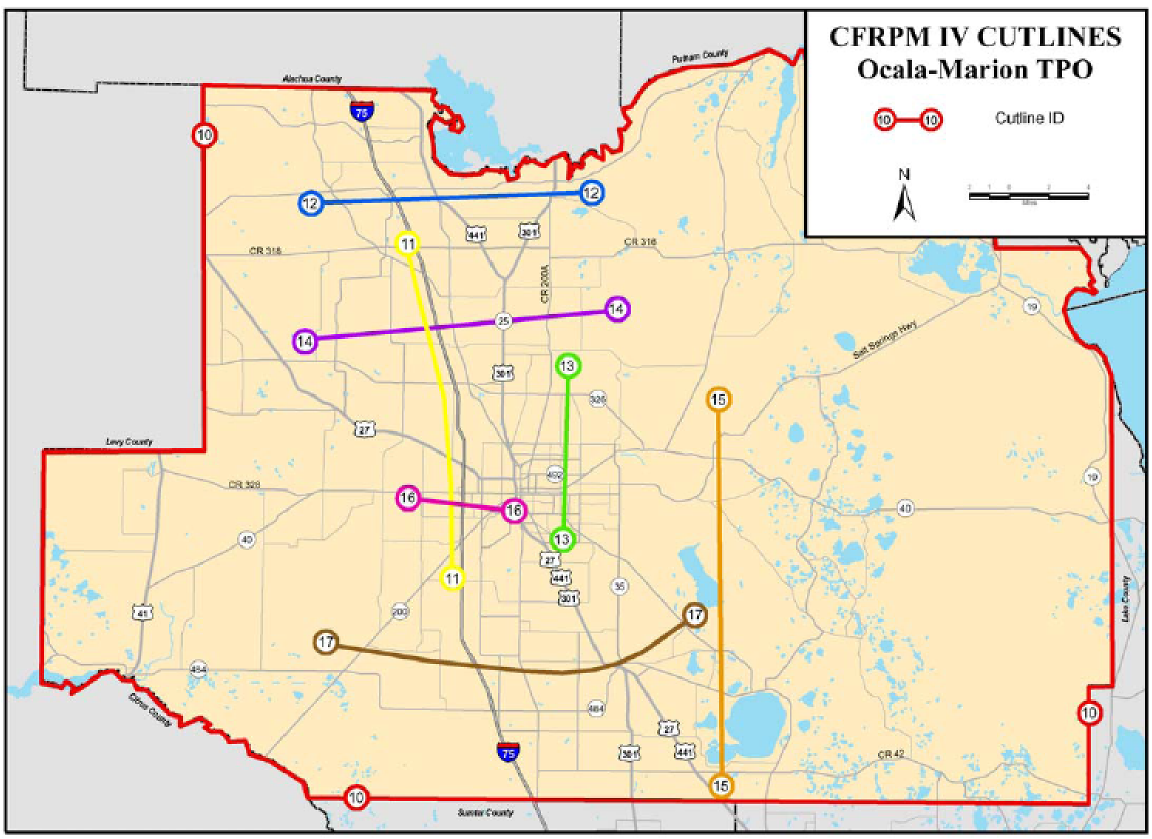

Figure 19: CFRPM Ocala / Marion Counties Cutlines

As noted previously, all of the above mentioned MPOs use the volume adjustment procedures and the "maximum desirable deviation" methodology outlined in NCHRP 255 (and refined in federal and state model validation manuals) for validation of screenline volumes.

Proposed New TPB Screenlines

Introduction

The following methodology was used to identify the proposed new screenlines for the TPB region:

- Review existing screenlines.
- Consider changes in regional and sub-regional travel markets based on growth / shifts in population and employment.
- Overlay existing screenline system on 2006 Constrained Long Range Plan (CLRP) projects as secondary measure of where future analysis may be needed.
- Professional judgment.
- Check proposed new screenlines against NCHRP 255 guidelines.

This evaluation process can and should be repeated periodically, particularly with the Transportation Improvement Program (TIP) to serve as a check on model performance and to ensure that the data needed to support project planning studies will be available, especially if new traffic counts need to be taken. Table 2 below lists the new screenlines, their location, and their reason for recommendation. Figure 20 below shows the 23 proposed new screenlines and Figure 21 overlays the proposed new screenlines on the existing screenlines.

Table 2: Proposed New TPB Screenlines

Screenline Number	Location	Justification
39	Western Loudoun	Population / Employment Growth
40	North / West of Leesburg	Population / Employment Growth
41	East of Leesburg	Growth; potential future studies of VA 7 and Dulles Greenway
42	West of City of Frederick	Extra-regional growth in Washington County; emergence of Frederick County as employment / shopping destination
43	North of City of Frederick	Extra-regional growth in Pennsylvania; emergence of Frederick County as employment / shopping destination
44	South / East of City of Frederick	Supplement for studies in I-270 and I-70 corridors
45	Germantown	Supplement for project planning studies in I-270 corridor
46	Extension of Screenline 12 to District of Columbia line	Capture east-west flows across Rock Creek inside the Capital Beltway
47	Wheaton / Fairland	Demographic changes in this section of Montgomery County
48	Ten Mile Square NW (Arlington / Fairfax Section)	Supplement to Screenline 3; easier boundary to manage
49	Ten Mile Square NW (Montgomery / DC Section)	Supplement to Screenline 2; easier boundary to manage
50	Ten Mile Square NE (Montgomery, Prince	Supplement to Screenline 2; easier boundary to

Screenline Number	Location	Justification
	George's, DC)	manage
51	West of MD 295	Few crossing streets
52	Ten Mile Square SE (Prince George's / DC)	Supplement to Screenline 4
53	Ten Mile Square SW (Fairfax / Alexandria / Arlington)	Supplement to Screenline 3; better capture movements within Alexandria
54	Annandale / US 50	Better capture movements to east-west travel corridor inside Beltway in Northern Virginia
55	Extension of Screenline 37	Growth in area
56	North-South Screenline for SE Loudon and NW Fairfax	Better capture travel between VA 267 and US 50 / I-66 corridors
57	Burke / Clifton	Supplement to Screenline 17; better capture travel from south to I-66 / US 50 corridor
58	2nd ring, west of I-95	Nearby transportation improvements
59	2nd ring, east of I-95	Fort Belvoir / improvements
60	I-95 north of VA 234	Nearby transportation improvements; growth in Prince William County
61	Manassas West	Nearby transportation improvements; growth in Prince William County
62	Manassas East	Nearby transportation improvements; growth in Prince William County

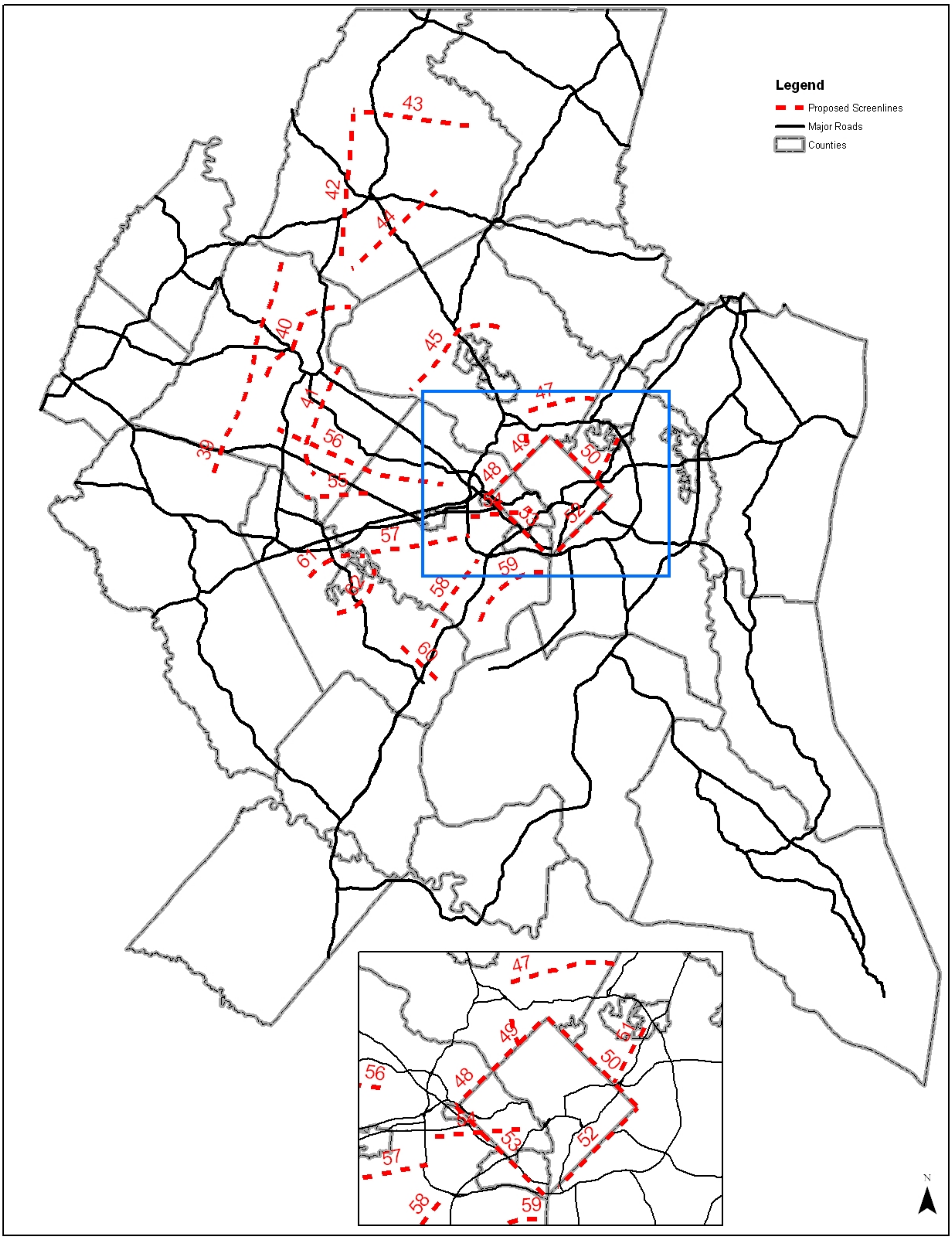

Figure 20: Proposed New Screenlines (Source of Base Data: TPB GIS)

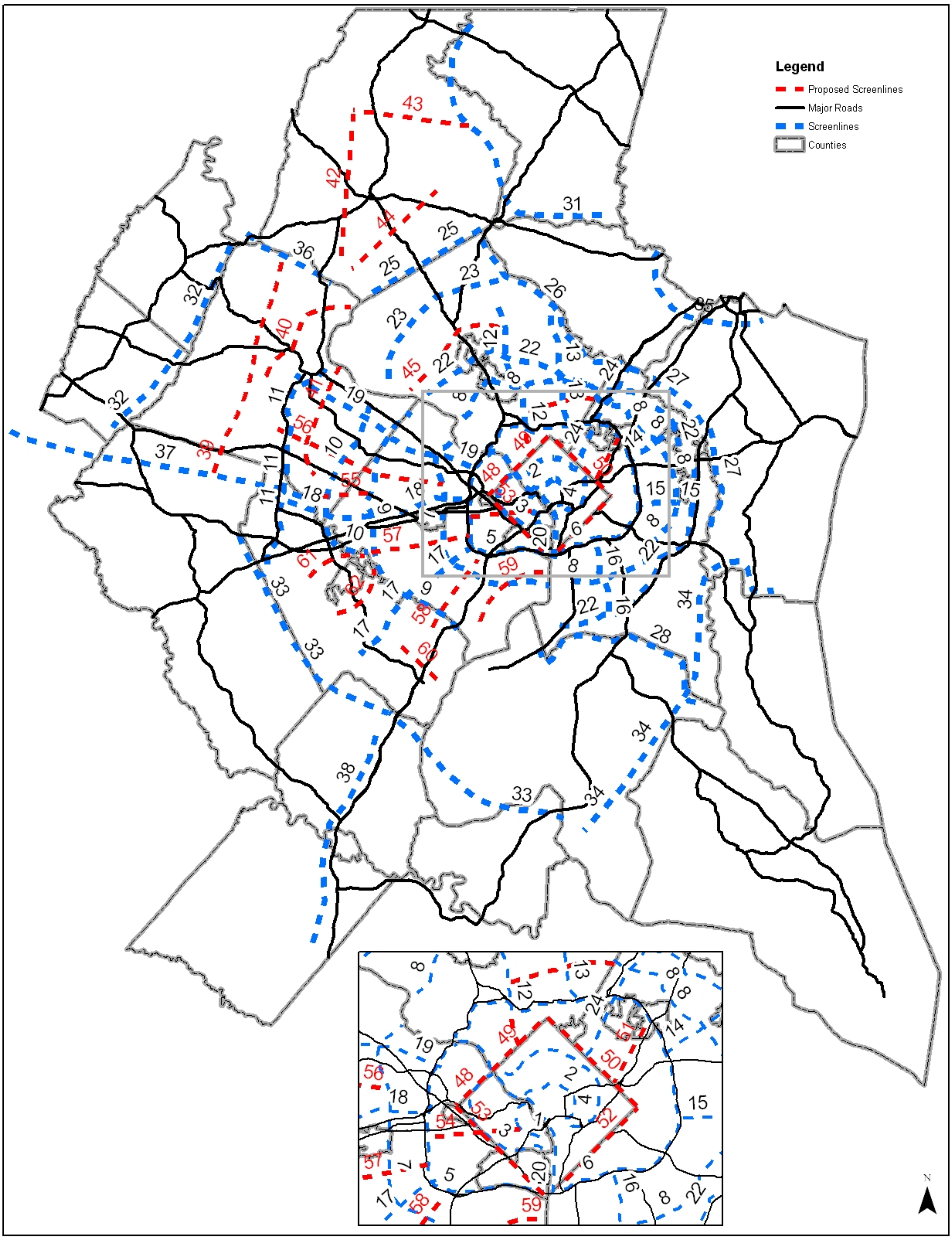

Figure 21: Existing TPB Screenline System with Proposed New Screenlines (Source of Base Data: TPB GIS)

Some screenlines such as 42 and 43 may appear to duplicate information obtained from the external cordon count, but by placing these screenlines TPB can compare estimated volumes with observed data collected by Maryland SHA instead of having to collect its own data. TPB staff may consider the location of some of the new proposed screenlines as guidelines for moving / adjusting the existing screenlines, but our recommendation is that the new screenlines should be added to provide the maximum number of locations for comparison of estimated and observed data during model validation. The screenlines may also be subdivided into cutlines for use in subregional validation for project planning studies.

It is also important to note that several of these new screenlines are intended to be *multimodal* screenlines. In fact, TPB should be treating all screenlines as multimodal when they traverse transit routes (both rail and bus). Certain new screenlines such as number 46 and 51 have specific transit-supportive purposes – to assist with project planning studies for the segments of the Purple Line. It may also be possible in the future to use screenlines for non-motorized travel modes, at least for project planning studies (these modes still have too small shares to really be considered during a regional validation).

Results of 2005 Model Run and Estimated / Observed Volumes Comparison Along Selected Existing and New Screenline Locations

In order to test the validity of the proposed new screenlines, a 2005 model run (using Version 2.1D #50) was completed and the screenline results compared with observed traffic data in selected locations. The observed data set contains counts from the Maryland State Highway Administration (traffic count website) and the Virginia Department of Transportation (website, NoVA traffic engineering database). Two study corridors were analyzed: the I-270 corridor in Frederick and Montgomery counties, extending to the District of Columbia line, and the I-66 corridor in Loudoun and Fairfax counties, extending to the Arlington County line. The initial results for each study corridor are reported in Table 3 and Table 4. Proposed new screenlines are shown in *italics.*

Table 3: Estimated vs. Observed 2005 Screenline Volumes, I-270 Corridor

Screenline / Location	Estimated Volume	Observed Volume	Deviation	Maximum Desirable Deviation
44 Southern Frederick	*119,126*	*107,450*	*11%*	*23%*
25 Montgomery / Frederick Line	115,290	121,176	5%	22%
23 Clarksburg / Northern Montgomery	26,670	36,632	27%	39%
45 Germantown	339,014	309,775	9%	14%
22 Gaithersburg (W of Screenline #12)	344,556	351,462	2%	12%
8 Rockville	303,988	342,863	11%	12%
6 Beltway Cordon	209,789	219,858	5%	17%
49 Ten-Mile Sq NW (Montgomery / DC Line btw Screenlines 46 and Potomac River Screenline)	185,222	132,475	40%	21%

Table 4: Estimated vs. Observed 2005 Screenline Volumes, I-66 Corridor

Screenline / Location	Estimated Volume	Observed Volume	Deviation	Maximum Desirable Deviation
11 US 15 / Eastern Loudoun	192,406	181,000	6%	19%
41 East of Leesburg	142,522	126,000	13%	22%
10 Riding	91,460	69,600	31%	29%
9 Chantilly	492,958	417,200	18%	10%
7 E of Fairfax City	473,868	494,000	4%	7%
5 Beltway Cordon	395,312	431,000	8%	9%
48/53 Ten Mile Sq NW / SW	231,714	221,600	5%	17%

The initial results suggest that some refinement along the proposed new screenlines may be necessary, such as further QA/QC of the observed data sets. In particular, time series analysis of the AADT figures to confirm the overall validity of the 2005 numbers and checks against hourly counts (where available) would be beneficial. These checks may require new or additional data collection.

Conclusions / Recommendations

TPB should consider placement of the recommended screenlines for its next model validation. Easily obtaining reliable observed data at screenline crossings is still a potential problem, so TPB staff may wish to consult with member jurisdictions to prioritize the list of new screenlines and possibly phase them into the validation tests over time. In terms of observed data, accessing the VDOT traffic engineering count database and eventually the freeway data archives for northern Virgina will provide two previously unused and robust observed data sets, but even more data are needed going forward, particularly if TPB puts an even greater emphasis on the use of smaller area screenlines. Greater segmentation of the roadway links for AADT data will be needed. There is an even greater need for improved access to observed transit data in order to make the screenline validation truly multimodal.

However, it is important to remember that validation to small cutlines compared with using regional screenlines is pulling the TPB model in two different directions, and there needs to be a balance between efforts for macroscopic and mesoscopic modeling, using the appropriate tools for each level. The creation and use of specific cutlines and subsequent validation at the beginning of a project planning study will never go away completely; there are simply too many potential study locations to be covered during a typical regional validation cycle. The need to perform screenline checks using the NCHRP 255 methodology will continue as well; TPB staff should consider expanding the sample work performed in this memo for the I-270 and I-66 corridors to the entire regional modeled area and the new screenline system as it is implemented.

Regarding the use of screenlines and cutlines during model sensitivity testing, nothing suggests that the procedures outlined in this memo cannot be applied during sensitivity testing. Placement of screenlines / cutlines does not change with sensititvity testing. However, cutlines located near the network or demographic input changes applied for the sensitivity tests will show amplified results during the test. The sensitivity tests must examine cutline volumes further upstream and downstream of the modifications in order to dampen the amplification and provide a full accounting of the model's response to the test scenario. In addition, care must be taken when conducting the higher magnitude tests (e.g., adding 10,000 or more jobs or households to a single TAZ) that the changes are not significantly altering the travel markets being captured by the cutline or introducing new or secondary travel markets that require the placement of additional cutlines to accurately check the model's response.

Finally, recall that cordons or screenlines usually cover "major" regional travel patterns, but as major destinations become more dispersed, the major travel patterns also become more dispersed, and at that point cutlines may be employed to look at particular locations and the use of local cordoned areas as employed by BMC may be necessary. BMC reports that their local area cordons are included in their regular count program, which cycles through all screenline locations over three years. There may be value in designating areas like Tysons Corner, Bethesda, and others with a local cordon.

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