



MEMORANDUM

*District of Columbia**Bowie**College Park**Frederick County**Gaithersburg**Greenbelt**Montgomery County**Prince George's County**Rockville**Takoma Park**Alexandria**Arlington County**Fairfax**Fairfax County**Falls Church**Loudoun County**Manassas**Manassas Park**Prince William County*

August 27, 2004

To: TPB Technical Committee

From: Mike Clifford

Subject: Status Report on the Air Quality Conformity Analysis of the 2004 Constrained Long Range Plan (CLRP) and FY2005-2010 Transportation Improvement Program (TIP), and on Transportation Emissions Reduction Measures (TERMs)

This memo provides an overview of the status of key activities for the air quality conformity analysis of the 2004 CLRP and FY2005-10 TIP. Staff has been proceeding with the specified work tasks since the TPB's April 21, 2004 approval of project submissions and the scope of work for the effort. Activities on several parallel work tasks are proceeding as described below.

Transportation Network Coding Activities

Staff is currently reviewing coding of the highway, transit and HOV networks for all of the analysis years, 2005, 2015, 2025 and 2030.

Land Activity Forecasts

Draft Round 6.4 Cooperative Forecasts, originally provided to TPB staff in May, are being revised for year 2010 and beyond to reflect the two different ICC alignments. The revised forecasts (Round6.4A) are being developed by affected jurisdictions and are scheduled to be discussed at the September 8, 2004 meeting of the Metropolitan Development Policy Committee. Travel demand modeling work will proceed as soon as the Round6.4A land activity forecasts (for the 'post-ICC' analysis years 2015 - 2030) are received.

Transit Fare Increases

Fare increases recently instituted at several transit properties have now been incorporated into the transit fare matrices which are applied in modal choice calculations.

Travel Model Refinements (Version 2.1D)

Refinements to TPB's model set continue in process. Staff briefed the TPB on the model refinement process at a work session prior to the July 21, 2004 TPB meeting (see Appendix A), and presented the latest draft (#28) of the Version 2.1D travel model to the Travel Forecasting Subcommittee at its July 23, 2004 meeting (see Appendix B). This draft is being updated to reflect additional developmental work to better integrate the travel demand and mobile emissions post-processor models. A new draft model version (the production version to be applied in the conformity assessment) is scheduled to be presented to the Travel Forecasting Subcommittee at its September 17, 2004 meeting.

Mobile6.2 Emissions Factor Model

EPA has issued an updated version 6.2 of its emissions factor model. Following tests of the new model, staff applied it on a production basis to prepare updated mobile source emissions factors for each of the conformity analysis years. This work has been completed and is currently under review.

Transportation Emission Reduction Measure (TERM) Analysis

TERM analysis refers to the offline emissions benefit assessment of transportation projects and programs which cannot be analyzed through representation in highway, transit and HOV network analysis. These measures address: (1) projects which have been implemented, i.e., benefits explicitly included in past emissions budget comparisons, (e.g., such TERMS provided 2005 emissions benefits of 4.0 and 8.3 tons per day for VOC and NOx, respectively, in the conformity assessment of the 2003 CLRP and FY2004-09 TIP), and (2) potential projects which may be implemented in the future, especially in the mitigation of excess emissions associated with a given forecast year.

1. Implemented Projects - A complete listing of all TERMS used in previous conformity assessments is reflected in a table called the TERM Tracking Sheet. This table lists and arrays descriptive information for each project, including: the TIP or CLRP document in which the project first appeared; implementation status; completion date; emissions reduction estimates by year; and project category. Staff is now completing work activity to refine the previously estimated emissions benefits of each project in the table. This need arises due to the fact that each year the input assumptions, travel demand or emissions rates for a measure may change.

The following two examples illustrate the need for revisions of emissions benefit estimation for individual TERM projects:

- (1) The removal of a project's offline credit due to its travel impacts being included within the travel demand model 'estimated to observed'

relationships. Specifically, as the model's validation year moves forward through time, some projects are eventually reflected in the observed data for the validation year, and inclusion of additional offline benefits would doublecount the reductions.

(2) Recalculation of benefits through refined travel monitoring procedures after implementation. Specifically, in the latest program evaluation of the telecommuting TERM, refined survey questions narrowing the definition of telecommuting will lower 'observed' rates of telecommuting.

2. *Potential TERMS* - Each year, as part of air quality planning for conformity and for state implementation plan (SIP) work, staff analyzes prospective transportation measures which are advanced for consideration in the event additional reductions are required to demonstrate adherence to conformity budgets or to address SIP needs.

Updated Tracking Sheet results and draft results for potential TERMS will be presented to the TPB Technical Committee in a separate memorandum of August 27, 2004 from Mr. Sivasailam.

Summary

Work is proceeding on several parallel fronts on the air quality conformity analysis, including TERM evaluation. With the receipt of Round 6.4A land activity forecasts expected on September 8, completion of technical work activities and a draft report for the conformity assessment is now scheduled for release at the October 1, 2004 TPB Technical Committee and Steering Committee meetings.

**Proposed Work Program to
Address Six Topics Identified in
TRB Modeling Review**

Transportation Planning Board

July 21, 2004

OVERVIEW OF TRB REVIEW

- 1) Letter of May 8, 2002 from TPB Chairman Phil Mendelson to TRB requesting an “arms-length” review of TPB procedures
- 2) COG/TPB contract with TRB effective January 1, 2003:
 - ❖ Review the performance of TPB’s Version 2.1C travel model and mobile emissions post-processor
 - ❖ Provide guidance on future model upgrades, survey and other data needs, and detail (grain) of travel analysis
 - ❖ Contract for \$130K over calendar year 2003, extended through May 2004
 - ❖ First TRB letter report dated September 8, 2003; TPB staff comments dated September 8, 2003
 - ❖ In response to TRB Committee’s request, detailed TPB Work Program Document prepared and submitted by TPB staff on December 24, 2003
 - ❖ Second and final TRB letter report dated May 10, 2004; TPB staff comments dated May 13, 2004

FIRST TRB LETTER REPORT

- 1) Letter dated September 8, 2003 provides eleven “Observations” by TRB Committee with accompanying discussion
- 2) TPB staff comments dated September 8, 2003 based on brief review of advance copy of TRB Committee letter:
 - ❖ Agree with five observations – no further attention required
 - ❖ Agree that three observations offer improvement potential that TPB staff can address
 - ❖ Believe that remaining three observations require further information and discussion

SECOND TRB LETTER REPORT

- 1) Provides overall observations on the state of travel demand modeling practice and the availability of documentation on current practices throughout the U.S.
- 2) Includes TPB Work Program Document of December 24, 2003 as Attachment 4, and discusses responses provided in the Document to the six topics identified in the TRB Committee's first letter report:
 - ❖ Improving model validation
 - ❖ Truck and commercial vehicle travel
 - ❖ Bus network characterization
 - ❖ Use of adjustment factors
 - ❖ Speed feedback incorporating mode choice
 - ❖ Traffic speed and volume estimation for air pollution emissions estimation
- 3) Responds to questions posed by TPB staff in December 24, 2003 Work Program on options for future data collection programs and model improvements

OVERALL OBSERVATIONS BY TRB COMMITTEE ON STATE OF TRAVEL DEMAND MODELING IN THE U.S.

- “-- There are few universally accepted guidelines or standards of practice for these models or their application”
- “In both this letter and its deliberations generally, the committee is relying primarily on members’ experience and judgment”
- “TPB has undertaken to collect information from other MPOs---for comparative analysis of modeling practices---the committee anticipates that this effort will continue to be challenging”
- “TRB, with sponsorship from the U.S. Department of Transportation, is undertaking a study to gather information and prepare a synthesis of practice on metropolitan area travel demand modeling. This study should be useful to TPB.”

OVERALL TPB STAFF OBSERVATIONS ON TRB REVIEW

- 1) TRB review has been a very productive and valuable undertaking
- 2) Use of the Version 2.1C model was approved by federal agencies in February 2004 for the 2003 CLRP update and FY2004-2009 TIP
- 3) Some refinements to the Version 2.1C model recommended by the TRB Committee are being incorporated into the Version 2.1D model to be used for conformity analysis for the 2004 CLRP and FY2005-2010 TIP
- 4) Other refinements will be incorporated into future versions of the TPB model as time and resources permit
- 5) December 24, 2003 Work Program will be reviewed and revised to address fully the comments by the TRB Committee in its second letter report of May 10, 2004

TOPIC 1: IMPROVING MODEL VALIDATION

TRB comment: Base year modeled link volumes do not match observed traffic counts and transit ridership as closely as committee members would expect.

TPB staff response:

- (1) Short-term: Improvements achieved through refined volume/delay functions, zonal area types, and network coding.
- (2) Longer-term: Continued refinement of network representation, use of the FTA Summit model to compare transit alternatives

TOPIC 2: LIGHT DUTY COMMERCIAL VEHICLES

(Package delivery, postal, courier, service technicians using light duty vehicles)

TRB Comment: Combining business and commercial trips in the non-home-based trip category is not advisable.

TPB Staff Response:

(1) Short-term: Consultant engaged to develop additional light duty commercial vehicle classification counts to adjust base year vehicle trip tables.

(2) Long-term: Monitor ongoing research activities on accounting for light duty commercial vehicles.

TOPIC 3: BUS NETWORK CHARACTERIZATION

TRB Comment: The use of fixed bus speeds in TPB networks may misstate the influence of transit in estimates of future trip distribution and mode choice.

TPB Staff Response:

(1) Short-term: Bus speeds adjusted for congestion delays in the out-years.

(2) Longer-term: More comprehensive analysis and coding of future bus services and priority treatments.

TOPIC 4: USE OF ADJUSTMENT FACTORS

TRB Comment: TPB makes extensive use of adjustment factors to enhance the match between simulated and observed base-year data.

TPB Staff Response:

(1) Short-term: All adjustment factors reviewed, and some removed or dampened as employment and other data inputs are refined.

(2) Longer term: Continuing review, refinement, and documentation of adjustment factors.

TOPIC 5: SPEED FEEDBACK AND MODE CHOICE

TRB Comment: TPB's feedback of highway and transit times to trip distribution "bypasses mode choice."

TPB Staff Response:

- (1) Short-term: Good agreement between speeds in distribution, mode choice, and assignment assured by using input speeds from earlier modeling results for years analyzed, and running additional iterations of the entire process.
- (2) Medium-term: Integrate post-processor with travel demand model to reflect impacts of peak-spreading on peak speeds.
- (3) Longer-term: Review weighting of highway and transit times in impedance function for trip distribution; assess alternative functional forms for impedance functions; monitor ongoing research and development activities on "speed feedback"

TOPIC 6: HOURLY TRAFFIC VOLUMES, SPEEDS, AND EMISSIONS ESTIMATION

TRB Comment: TPB's estimates of hourly traffic volumes, speeds, and emissions are not strictly based upon assigned peak and off-peak link volumes and speeds produced by the travel models

TPB Staff Response:

- (1) Short-term: Review alternative approaches for improving time-of-day forecasts by travel models

- (2) Medium-term: Integrate post-processor into travel model so that the effects of peak-spreading are reflected in assigned peak and off-peak link volumes and speeds.

- (3) Longer-term: Monitor ongoing research and development activities on time-of-day modeling and peak-spreading

ONGOING ASSISTANCE FOR ENHANCING TPB TRAVEL MODELS

- 1) Comprehensive external review can be conducted only infrequently
- 2) Federal Travel Model Improvement Program (TMIP) can provide ongoing assistance
 - ❖ Cooperatively funded and supported by FHWA, FTA, DOT/OST, and EPA
 - ❖ Managing ongoing applied research
 - ❖ Funding TRB Synthesis project
 - ❖ Familiar with travel demanding forecasting and air quality analysis needs and practices nationwide
 - ❖ Can quickly identify sources of specialized knowledge and expertise

Appendix B

Status of the TPB Regional Travel Model, Version 2.1 D

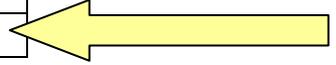
Presented to the Travel Forecasting Subcommittee
on July 23, 2004

Mark Moran, COG/TPB

National Capital Region Transportation Planning Board (TPB)
Metropolitan Washington Council of Governments (COG)

Model releases

Model version	Release date
Version 2.1 C	December 2002
Version 2.1 D, Draft #16	March 2004
Version 2.1 D, Draft #18	May 2004
Version 2.1 D, Draft #28	July 2004 (Today)



Modeling information presented today

- 1994
- 2000
- 2030
- All model runs used Round 6.4 land use, adjusted for consistent definition of employment for all jurisdictions

Version 2.1D #28 Model results also presented at 7/21/04 TPB meeting

- 2030 CLRP with Round 6.4 adjusted land use
- 2030 CLRP+ (Regional Congestion Management Program) with Round 6.4 adjusted land use, which was the base for the following land use alternatives
 - 2030 CLRP+ with land use alternative 1: Higher HH growth in region
 - 2030 CLRP+ with land use alternative 2: Transit oriented development
 - 2030 CLRP+ with land use alternative 3: Region undivided
 - 2030 CLRP+ with land use alternative 4a: More HH growth in inner areas
 - 2030 CLRP+ with land use alternative 4b: More job growth in outer areas

Technical enhancements to the Version 2.1 travel model

Version 2.1 D, Draft #16 (Released March 2004)

- Improved sensitivity to highway pricing / toll modeling
- Updated free-flow lookup tables for link speeds and capacities
- Revised freeway volume/delay function (VDF)
- Increased the *maximum* number of iterations used in equilibrium traffic assignment, from 10 to 20
- Added capability to incorporate overrides in zonal area-type
- Reduced the number and magnitude of K factors
- Increased the number of speed feedback iterations (from three to six) to ensure consistency of speed inputs/outputs
- Made the algorithm for transit path building more robust (TRNBUILD PATHSTYLE parameter changed from 1 to 0)¹
- Adjusted the value of the in-vehicle travel time (IVTT) coefficient in the HBW mode choice model, so that OVTT/IVTT = 2.5 (was 1.5), the value recommended in recent guidance from the Federal Transit Administration (FTA)
- Updated NHB F-Factors

Version 2.1 D, Draft #18 (Released May 2004)

- Adjusted Round 6.4 land use so that
 - it makes use of a consistent definition for employment across all jurisdictions in the modeled area
 - it matches 1990 and 2000 CTPP data
- Reduced K factors further
- Reduced magnitude of transit adjustment factors

¹ The normal transit path building process selects paths by saving the best paths to every node for every mode that accesses the node. Pathstyle=1 saves only the single best path into a node, is considerably faster, and uses less RAM. But, Pathstyle=1 has certain problems built into it: most notably are the problems that can arise if certain mode-to-mode combinations are precluded, or restricted, due to transfer penalties. The default style of 0, does much more work by processing more combinations, but it can increase path building time by a factor of three or four. (Source: Citilabs TP+ documentation)

Technical enhancements to the Version 2.1 travel model

Version 2.1 D, Draft #28 (Released July 23, 2004: TODAY)

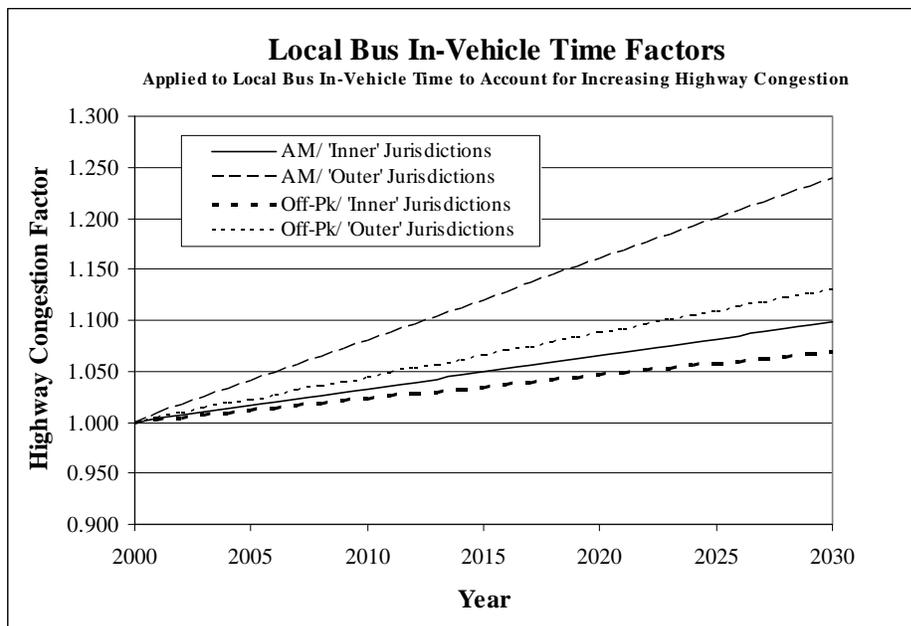
- Added bus speed model => Speeds of local bus service decrease with increasing traffic congestion. This resulted in a drop in total estimated transit trips of about 1% in 2030.
- Revised method for developing walk-access-to-transit links
- Re-estimated the mode choice model (statistical re-estimation) to account for:
 - Revised walk-access links (mentioned above)
 - FTA guidelines regarding ratio of OVTT to IVTT coefficients (OVTT/IVTT = 2.5)
 - Updated internal model year for costs – from 1980 to 1994, the calibration year
- Updated highway toll modeling in the traffic assignment step
- Used a fixed number of iterations (20) in the equilibrium highway assignment
- Updated K-factors to reflect the aforementioned changes

Bus speed model

- Prior to Draft #28 of Version 2.1D: Bus speeds (and headways) in transit networks are obtained from the most recently published schedules. For example:
 - A year-2000 network would have bus speeds based on published schedules from 2000.
 - A year-2030 network would have bus speeds based on the most recently published schedules, say 2003.
- TRB review committee suggested bus speeds should be a function of link congestion (as is the case with traffic speeds in the highway network).
- Bus speed models can be problematic => Proceed with caution
 - Bus speeds should be a function of traffic speeds, but traffic speeds are also influenced by bus speeds => interactive effect (not just one way)
 - Linking bus speeds to highway congestion will not yield realistic future bus service for lines benefiting from priority treatments, such as signal preemption.
 - Hyper-congested link problem that arises in out-year forecasts. Highway assignment process will tend to send auto trips around these links, but bus routes are fixed.
- Existing approaches:
 - Use a flat factor on bus in-vehicle time, say 1.5, applied to the restrained highway time. Drawback: Overly simplistic.
 - Relate bus speeds to highway link speeds based on facility type and area type. Drawback: Almost impossible to calibrate against base-year scheduled bus times on a line-by-line basis.
 - Apply a unique speed decay factor for each transit line. Drawback: Cumbersome to implement and potentially inconsistent on a highway facility basis.

Bus speed model

- Chosen approach:
 - Factor bus in-vehicle time skims in a graduated manner, so that near-term bus times (derived from published schedules) are essentially unaffected, while bus times in later years are increased over time, but to a measured degree.
 - Local bus service is affected, but not express bus service.
 - Local bus service:
 - Mode 1: Metrobus
 - Mode 6: Inner suburban bus service such as Ride-On in Montgomery Co.
 - Mode 8: Smaller services in outer-ring jurisdictions, such as Loudoun and Howard counties.
 - AM peak and off-peak highway arterial speeds were summarized by jurisdiction and analyzed
 - Final bus time factors
 - AM period, Inner jurisdictions
 - AM period, Outer jurisdictions
 - Off-peak period, Inner jurisdictions
 - Off-peak period, Outer jurisdictions
 - Jurisdictions:
 - Inner: DC, Alexandria, Arlington, Montgomery, Prince George’s, and Fairfax Counties
 - Outer: Prince William, Loudoun, Frederick, Anne Arundel, and Howard Counties
 - This is a first step. Understanding and modeling the relationship between bus and highway speeds in a more rigorous way is a research area that TPB should continue to explore.



Ref: lbusfac_lkup.xls

Summary of changes to K factors

	Travel Model			
	2.1C	2.1D #16	2.1D #18	2.1D #28
Number of K factors	68	59	55	52
Number of K factors removed	--	9	13	17
Of the remaining K factors, the number reduced in magnitude	--	13	32	31
Number of K factors added	--	0	0	1*

* K factor added: Prince William Co. to DC core (value 3.0)

Model results: 1994 vehicle miles of travel (thousands)

Jurisdiction	Est/Obs		
	Estimated	Observed	Ratio
0 District of Columbia	8,500	7,875	1.08
1 Montgomery	17,633	17,129	1.03
2 Prince George's	19,511	20,333	0.96
3 Arlington	3,992	4,124	0.97
4 Alexandria	1,954	2,072	0.94
5 Fairfax	21,917	22,979	0.95
6 Loudoun	2,565	2,902	0.88
7 Prince William	5,687	6,221	0.91
9 Frederick	6,260	4,879	1.28
<i>COG Member Jurisdictions Subtotal:</i>	<i>88,019</i>	<i>88,514</i>	<i>0.99</i>
10 Howard	7,973	6,990	1.14
11 Anne Arundel	8,400	8,580	0.98
12 Charles	1,717	2,007	0.86
<i>1,478 Zone Cordon Subtotal</i>	<i>106,109</i>	<i>106,091</i>	<i>1.00</i>
14 Carroll	2,329	2,167	1.07
15 Calvert	1,178	1,280	0.92
16 St. Mary's	1,136	1,166	0.97
17 King George	660	559	1.18
18 Fredericksburg	532	663	0.80
19 Stafford	3,127	2,935	1.07
20 Spotsylvania	1,412	1,940	0.73
21 Fauquier	2,013	2,104	0.96
22 Clarke	594	492	1.21
23 Jefferson	994	601	1.65
<i>Outer Counties Subtotal</i>	<i>13,975</i>	<i>13,907</i>	<i>1.00</i>
Expanded Cordon Total	120,084	119,998	1.00

	MSA Summary		
	Estimated	Observed	Est/Obs Ratio
DC	8,500	7,875	1.08
MD	46,299	45,628	1.01
VA	39,242	41,233	0.95
Total MSA	94,041	94,736	0.99

The table reflects highway links with coded ground counts.

- Source: i6_highway_assignment.rpt (v21D_perf94_28.xls)

Model results: 2000 vehicle miles of travel (thousands)

Jurisdiction			Est/Obs
	Estimated	Observed	Ratio
0 District of Columbia	6,684	5,854	1.14
1 Montgomery	15,381	14,934	1.03
2 Prince George's	18,973	20,009	0.95
3 Arlington	3,432	3,555	0.97
4 Alexandria	1,428	1,254	1.14
5 Fairfax	23,117	23,050	1.00
6 Loudoun	3,958	3,821	1.04
7 Prince William	6,507	6,317	1.03
9 Frederick	7,452	6,528	1.14
<i>COG Member Jurisdictions Subtotal:</i>	<i>86,932</i>	<i>85,322</i>	<i>1.02</i>
10 Howard	8,342	8,035	1.04
11 Anne Arundel	12,277	11,494	1.07
12 Charles	2,137	2,742	0.78
<i>1,478 Zone Cordon Subtotal</i>	<i>109,688</i>	<i>107,593</i>	<i>1.02</i>
14 Carroll	2,619	2,496	1.05
15 Calvert	1,327	1,690	0.79
16 St. Mary's	1,528	1,628	0.94
17 King George	677	567	1.19
18 Fredericksburg	322	534	0.60
19 Stafford	3,679	3,151	1.17
20 Spotsylvania	1,548	1,803	0.86
21 Fauquier	2,443	2,372	1.03
22 Clarke	725	579	1.25
23 Jefferson	994	673	1.48
<i>Outer Counties Subtotal</i>	<i>15,862</i>	<i>15,493</i>	<i>1.02</i>
Expanded Cordon Total	125,550	123,086	1.02

	MSA Summary		
	Estimated	Observed	Est/Obs Ratio
DC	6,684	5,854	1.14
MD	45,270	45,903	0.99
VA	42,121	41,148	1.02
Total MSA	94,075	92,905	1.01

The table reflects highway links with coded ground counts.
Source: i6_highway_assignment.rpt (v21D_perf00_28.xls)

Model results: 1994 screenline volumes (thousands)

Screenline No.	Screenline Location	Estimated Volume	Observed Volume	Est./Obs.
1	Ring 1, Virginia	747	802	0.93
2	Ring 1, DC	974	915	1.06
3	Ring 3, Virginia	941	866	1.09
4	Ring 3, DC	1005	966	1.04
5	Beltway, Virginia	1103	1078	1.02
6	Beltway, Maryland	1636	1591	1.03
7	Ring 5, Virginia	1108	1154	0.96
8	Ring 5, Maryland	1462	1368	1.07
9	Ring 7, Virginia	629	598	1.05
10	Eastern Loudoun Co.	244	230	1.06
11	US 15, Loudoun / Pr. William Co.	155	156	0.99
12	Central Montgomery Co. Radial	499	472	1.06
13	Eastern Montgomery Co. Radial	372	370	1.01
14	NE. Pr.Geo. Co. Radial	298	318	0.94
15	Central Pr.George's Co. Radial	263	238	1.11
16	Southern Pr.George's Co. Radial	233	214	1.09
17	Southern Fairfax / Pr. Wm. Radial	391	390	1.00
18	Central Fairfax Co. Radial	569	544	1.05
19	VA Route 7 Radial	447	466	0.96
20	Beltway & 'Inner' Potomac River Crossings	999	892	1.12
22	Central Mtg./P.G. Radial	1351	1196	1.13
23	NE Montgomery Co. Radial	155	136	1.14
24	Montgomery / Pr.Geo. Co. border	435	444	0.98
25	Montgomery/ Frederick Co. border	83	78	1.06
26	Montgomery / Howard Co. border	358	256	1.40
27	Pr.Geo. / Anne Arundel Co. Border	291	290	1.00
28	Charles / Pr.Geo. Co. Border	107	108	0.99
	<i>Inner Screenline Subtotal</i>	<i>16,855</i>	<i>16,136</i>	<i>1.04</i>
31	Frederick / Carroll Co. Border	116	58	2.00
32	Western Loudoun Co. Border	92	54	1.70
33	'Outer' Southwestern Circumferential	286	226	1.27
34	'Outer' Southeastern Circumferential	92	94	0.98
35	South of Baltimore City	813	782	1.04
36	'Outer' Northwestern Radial	79	28	2.82
37	'Outer' Western Circumferential	30	24	1.25
38	'Outer' I-95 (South) Radial	149	174	0.86
	<i>Outer Screenline Subtotal</i>	<i>1,657</i>	<i>1,440</i>	<i>1.15</i>
	Grand Total	18,512	17,576	1.05

Notes:

- The estimated figures reflect highway links with coded ground counts only.
- The estimated link volumes that have been rounded to thousands as the observed volumes are coded in thousands.
- Source: i6_highway_assignment.rpt (v21D_perf94_28.xls)

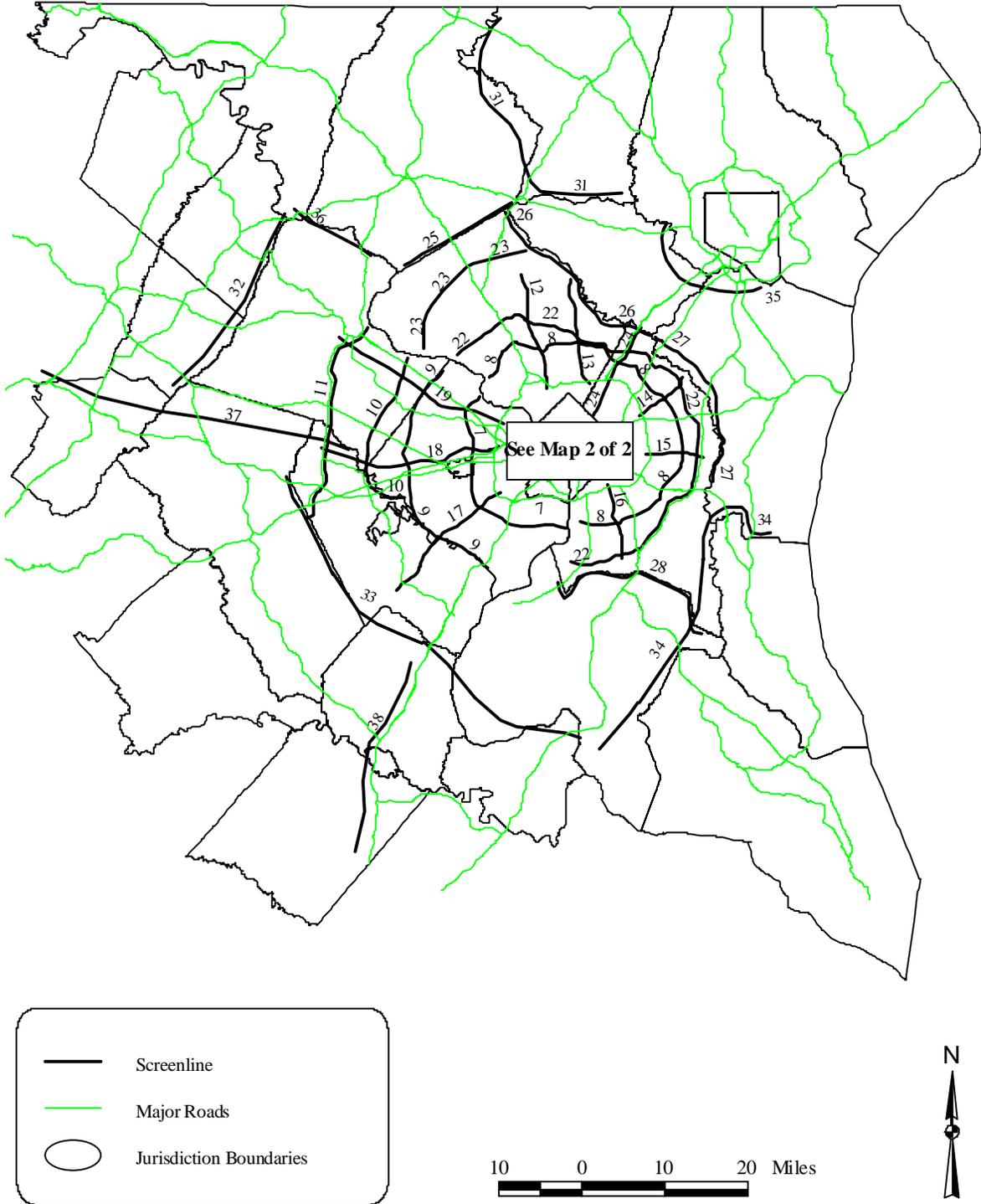
Model results: 2000 screenline volumes (thousands)

Screenline No.	Screenline Location	Estimated Volume	Observed Volume	Est./Obs.
1	Ring 1, Virginia	637	686	0.93
2	Ring 1, DC	816	680	1.20
3	Ring 3, Virginia	686	648	1.06
4	Ring 3, DC	973	870	1.12
5	Beltway, Virginia	1143	910	1.26
6	Beltway, Maryland	1512	1476	1.02
7	Ring 5, Virginia	1037	1116	0.93
8	Ring 5, Maryland	1385	1268	1.09
9	Ring 7, Virginia	788	716	1.10
10	Eastern Loudoun Co.	353	302	1.17
11	US 15, Loudoun / Pr. William Co.	178	148	1.20
12	Central Montgomery Co. Radial	384	398	0.96
13	Eastern Montgomery Co. Radial	315	314	1.00
14	NE. Pr.Geo. Co. Radial	307	308	1.00
15	Central Pr.George's Co. Radial	284	294	0.97
16	Southern Pr.George's Co. Radial	235	210	1.12
17	Southern Fairfax / Pr. Wm. Radial	407	360	1.13
18	Central Fairfax Co. Radial	696	658	1.06
19	VA Route 7 Radial	524	466	1.12
20	Beltway & 'Inner' Potomac River Crossings	1025	972	1.05
22	Central Mtg./P.G. Radial	1250	1158	1.08
23	NE Montgomery Co. Radial	180	144	1.25
24	Montgomery / Pr.Geo. Co. border	379	392	0.97
25	Montgomery/ Frederick Co. border	106	92	1.15
26	Montgomery / Howard Co. border	378	342	1.11
27	Pr.Geo. / Anne Arundel Co. Border	328	312	1.05
28	Charles / Pr.Geo. Co. Border	149	164	0.91
	<i>Inner Screenline Subtotal</i>	<i>16,455</i>	<i>15,404</i>	<i>1.07</i>
31	Frederick / Carroll Co. Border	132	82	1.61
32	Western Loudoun Co. Border	114	64	1.78
33	'Outer' Southwestern Circumferential	315	226	1.39
34	'Outer' Southeastern Circumferential	108	100	1.08
35	South of Baltimore City	911	886	1.03
36	'Outer' Northwestern Radial	93	42	2.21
37	'Outer' Western Circumferential	40	32	1.25
38	'Outer' I-95 (South) Radial	179	174	1.03
	<i>Outer Screenline Subtotal</i>	<i>1,892</i>	<i>1,606</i>	<i>1.18</i>
	Grand Total	18,347	17,010	1.08

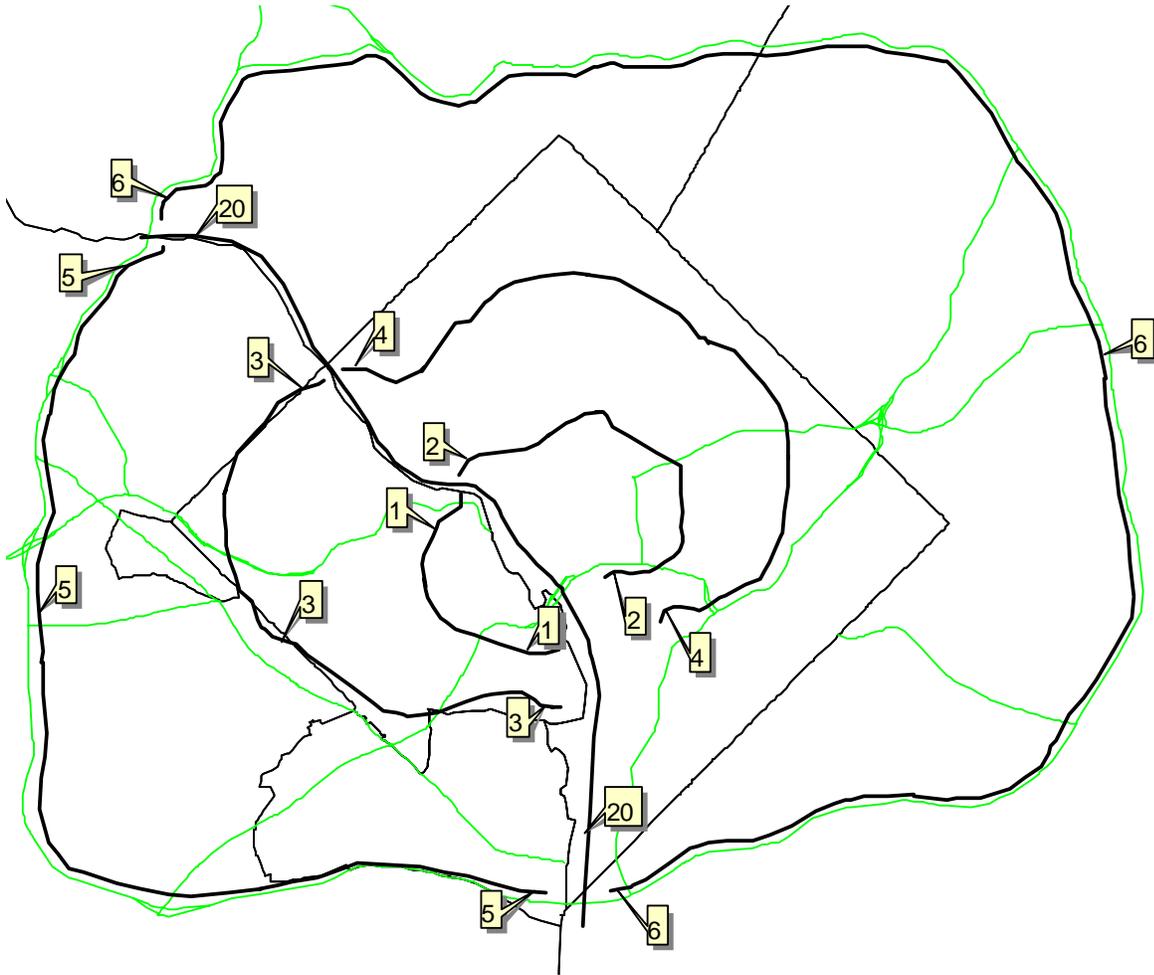
Notes:

- The estimated figures reflect highway links with coded ground counts only.
- The estimated link volumes that have been rounded to thousands as the observed volumes are coded in thousands.
- Source: i6_highway_assignment.rpt (v21D_perf00_28.xls)

Screenline locations, Map 1 of 2



Screenline locations, Map 2 of 2



	Screenline
	Major Roads
	Screenline Number



Model results: RMSE of traffic volumes at link level, 1994

Facility Type	Volume Range	Links Count	Ave Obs Volume	Ave Est Volume	Diff. (Obs-Est)	Pct Diff.	RMSE	Pct RMSE
Freeways	1.00-9.99K	20	7.10	20.30	-13.20	-185.92	19.51	274.74
	10.00-19.99K	106	14.45	26.36	-11.91	-82.38	16.44	113.77
	20.00-29.99K	143	24.60	33.43	-8.83	-35.87	12.63	51.35
	30.00-39.99K	171	34.56	39.05	-4.49	-12.99	11.75	33.99
	40.00-49.99K	147	45.24	46.22	-0.98	-2.17	13.45	29.73
	50.00-59.99K	84	54.94	64.50	-9.56	-17.40	16.34	29.74
	60.00-69.00K	63	64.05	58.32	5.73	8.95	16.18	25.27
	70.00-79.00K	43	72.95	77.26	-4.30	-5.90	15.44	21.17
	80.00-89.99K	81	85.59	77.44	8.15	9.52	17.07	19.94
	90.00-99.99K	62	95.08	81.32	13.76	14.47	20.19	21.23
	100.00-109.99K	124	103.97	85.44	18.52	17.82	25.03	24.07
	110.00-119.99K	36	114.61	88.22	26.39	23.02	30.96	27.01
	120.00-129.99K	2	127.00	80.50	46.50	36.61	46.72	36.79
130.00-139.99K	6	138.00	106.17	31.83	23.07	40.71	29.50	
Subtotal:		1,088	55.58	54.92	0.66	1.19	17.52	31.52
Maj Arterials	1.00-9.99K	1,491	6.31	9.95	-3.64	-57.60	6.41	101.57
	10.00-19.99K	2,913	14.28	16.36	-2.08	-14.56	6.66	46.63
	20.00-29.99K	1,211	24.10	21.88	2.22	9.19	7.38	30.62
	30.00-39.99K	322	33.06	24.08	8.98	27.17	11.89	35.97
	40.00-49.99K	26	43.38	36.62	6.77	15.60	11.92	27.47
	50.00-59.99K	12	55.33	39.33	16.00	28.92	17.00	30.71
Subtotal:		5,975	15.50	16.43	-0.93	-5.97	7.19	46.39
Minor Arterials	1.00-9.99K	2,692	5.05	6.24	-1.20	-23.70	3.61	71.60
	10.00-19.99K	494	12.28	9.36	2.92	23.78	5.62	45.81
	20.00-29.99K	56	22.11	12.70	9.41	42.57	11.65	52.68
	30.00-39.99K	4	31.00	13.00	18.00	58.06	18.00	58.06
	40.00-49.99K	1	44.00	21.00	23.00	52.27	23.00	52.27
Subtotal:		3,247	6.49	6.84	-0.36	-5.49	4.31	66.40
Collectors	1.00-9.99K	2,531	4.01	3.98	0.03	0.86	2.92	72.81
	10.00-19.99K	353	12.52	6.69	5.83	46.55	7.57	60.44
	20.00-29.99K	30	22.47	8.67	13.80	61.42	15.61	69.49
	30.00-39.99K	2	39.00	8.00	31.00	79.49	31.00	79.49
Subtotal:		2,916	5.26	4.36	0.90	17.09	4.19	79.60
Expressways	1.00-9.99K	46	7.17	10.07	-2.89	-40.30	5.07	70.69
	10.00-19.99K	120	14.50	19.09	-4.59	-31.67	8.96	61.82
	20.00-29.99K	98	23.92	29.28	-5.36	-22.40	8.63	36.06
	30.00-39.99K	94	33.77	31.61	2.16	6.40	8.45	25.02
	40.00-49.99K	35	42.09	30.69	11.40	27.09	13.10	31.12
	50.00-59.99K	3	56.00	33.00	23.00	41.07	23.04	41.15
Subtotal:		396	23.31	24.66	-1.36	-5.83	9.05	38.83
Grand Total		13,622	14.59	14.87	-0.29	-1.96	7.60	52.09

Note:

$$RMSE = \sqrt{\frac{\sum (Obs.Count - Sim.Count)^2}{n}}$$

where n= the number of observations in each facility type / volume range group

Source: rmse_vol_94.s (7/14/04)

Ref.: v21d_RMSETP94_28.xls

Model results: RMSE of traffic volumes at link level, 2000

Facility Type	Volume Range	Links Count	Ave Obs Volume	Ave Est Volume	Diff. (Obs-Est)	Pct Diff.	RMSE	Pct RMSE
Freeways	1.00-9.99K	23	8.04	18.48	-10.43	-129.73	13.46	167.36
	10.00-19.99K	144	15.72	25.92	-10.20	-64.91	14.43	91.80
	20.00-29.99K	64	25.14	39.33	-14.19	-56.43	17.34	68.96
	30.00-39.99K	200	35.17	41.03	-5.86	-16.65	12.00	34.11
	40.00-49.99K	162	43.87	50.31	-6.44	-14.69	16.50	37.61
	50.00-59.99K	119	54.21	61.65	-7.44	-13.72	14.38	26.52
	60.00-69.00K	137	64.67	64.27	0.40	0.62	13.78	21.31
	70.00-79.00K	104	73.88	73.36	0.53	0.72	16.70	22.61
	80.00-89.99K	90	84.60	78.06	6.54	7.74	17.01	20.11
	90.00-99.99K	127	95.09	84.90	10.20	10.72	19.24	20.23
	100.00-109.99K	85	104.68	96.88	7.80	7.45	16.69	15.94
	110.00-119.99K	47	115.36	105.04	10.32	8.95	21.74	18.85
	120.00-129.99K	36	125.06	98.44	26.61	21.28	32.92	26.33
130.00-139.99K	28	137.86	95.11	42.75	31.01	45.32	32.87	
Subtotal:		1,366	61.18	61.48	-0.31	-0.50	17.56	28.71
Maj Arterials	1.00-9.99K	1,314	6.53	10.63	-4.10	-62.80	7.12	109.01
	10.00-19.99K	2,615	14.32	17.27	-2.96	-20.65	7.25	50.62
	20.00-29.99K	1,289	23.67	23.12	0.55	2.32	6.95	29.38
	30.00-39.99K	312	32.30	26.41	5.89	18.23	9.61	29.76
	40.00-49.99K	24	42.75	35.25	7.50	17.54	17.89	41.84
	50.00-59.99K	12	52.67	31.67	21.00	39.87	23.35	44.33
Subtotal:		5,566	15.86	17.68	-1.82	-11.49	7.45	47.00
Minor Arterials	1.00-9.99K	1,739	4.91	6.01	-1.10	-22.34	3.54	71.95
	10.00-19.99K	398	12.74	10.16	2.58	20.24	5.58	43.82
	20.00-29.99K	37	22.70	12.65	10.05	44.29	12.94	57.00
	30.00-39.99K	8	35.00	21.12	13.88	39.64	17.04	48.69
Subtotal:		2,182	6.75	6.94	-0.18	-2.71	4.42	65.48
Collectors	1.00-9.99K	1,571	3.78	3.79	-0.01	-0.35	2.73	72.26
	10.00-19.99K	201	12.33	7.43	4.90	39.73	6.88	55.80
	20.00-29.99K	32	21.69	13.62	8.06	37.18	12.28	56.61
Subtotal:		1,804	5.05	4.37	0.68	13.42	3.80	75.27
Expressways	1.00-9.99K	26	6.85	11.38	-4.54	-66.29	5.86	85.65
	10.00-19.99K	90	15.44	19.20	-3.76	-24.32	7.48	48.42
	20.00-29.99K	128	24.50	29.88	-5.38	-21.97	9.66	39.45
	30.00-39.99K	86	34.37	33.15	1.22	3.55	9.43	27.44
	40.00-49.99K	44	44.77	31.20	13.57	30.30	15.83	35.36
	50.00-59.99K	28	54.29	34.07	20.21	37.24	22.85	42.09
Subtotal:		402	27.74	27.43	0.31	1.10	11.28	40.68
Grand Total		11,320	18.27	19.12	-0.85	-4.65	8.67	47.44

Note:

$$RMSE = \sqrt{\frac{\sum (Obs.Count - Sim.Count)^2}{n}}$$

where n= the number of observations in each facility type / volume range group

Source: rmse_vol_00.s (7/14/04)

Ref.: v21d_RMSETP00_28.xls

Model results: Mode choice**1994**

		Est	Obs	Diff. (Est-Obs)	Ratio (Est/Obs)
HBW	Transit person trips	434,765	457,306	-22,541	0.95
	<i>Percent transit</i>	<i>16.24%</i>	<i>16.88%</i>	<i>-0.64%</i>	<i>0.96</i>
HBS	Transit person trips	25,821	27,825	-2,004	0.93
	<i>Percent transit</i>	<i>1.20%</i>	<i>1.30%</i>	<i>-0.10%</i>	<i>0.93</i>
HBO	Transit person trips	142,752	139,367	3,385	1.02
	<i>Percent transit</i>	<i>2.16%</i>	<i>2.15%</i>	<i>0.01%</i>	<i>1.00</i>
NHB	Transit person trips	135,693	117,963	17,730	1.15
	<i>Percent transit</i>	<i>2.80%</i>	<i>2.50%</i>	<i>0.30%</i>	<i>1.12</i>
Total	Transit person trips	739,031	742,461	-3,430	1.00
	<i>Percent transit</i>	<i>4.53%</i>	<i>4.63%</i>	<i>-0.10%</i>	<i>0.98</i>

2000

		Est	Obs	Diff. (Est-Obs)	Ratio (Est/Obs)
HBW	Transit person trips	503,040	538,582	-35,542	0.93
	<i>Percent transit</i>	<i>16.81%</i>	<i>17.81%</i>	<i>-1.00%</i>	<i>0.94</i>
HBS	Transit person trips	34,094	33,262	832	1.03
	<i>Percent transit</i>	<i>1.39%</i>	<i>1.36%</i>	<i>0.03%</i>	<i>1.02</i>
HBO	Transit person trips	164,266	151,645	12,621	1.08
	<i>Percent transit</i>	<i>2.24%</i>	<i>2.08%</i>	<i>0.16%</i>	<i>1.08</i>
NHB	Transit person trips	156,594	166,461	-9,867	0.94
	<i>Percent transit</i>	<i>2.91%</i>	<i>3.09%</i>	<i>-0.18%</i>	<i>0.94</i>
Total	Transit person trips	857,994	889,950	-31,956	0.96
	<i>Percent transit</i>	<i>4.72%</i>	<i>4.90%</i>	<i>-0.18%</i>	<i>0.96</i>

Notes:

1. Results are "screened" at the jurisdiction-to-jurisdiction level, i.e., they include data from only those est/obs cell pairs that have data in BOTH the obs. AND the corresponding est. cell.

2. 1994 Subdirectory: cgv21d_28\1994_tip9499_rnd64a; Run date: 7/14/04

3. 2000 Subdirectory: cgv21d_28\2000_tip0005_rnd64a; Run date: 7/14/04

Ref.: compare_mceo_scr_94_00.xls

Model results: Trip crossings

Metro Core Cordon

Inbound / 6:00 AM to 9:00 AM Outbound / 4:00 PM - 7:00 PM

	Estimated (1994)	Observed (1993)	Est/Obs Ratio	Estimated (1994)	Observed (1993)	Est/Obs Ratio
Total Vehicles	219,000	212,000	1.03	277,200	206,800	1.34
Transit Pass.	139,400	166,700	0.84	N/A	175,700	N/A

	Estimated (2000)	Observed (1999)	Est/Obs Ratio	Estimated (2000)	Observed (1999)	Est/Obs Ratio
Total Vehicles	220,300	225,800	0.98	281,000	222,300	1.26
Transit Pass.	151,100	166,000	0.91	N/A	153,900	N/A

Notes:

- Simulated figures from MWCOG Version 2.1 D (Draft #18) model (05/19/04).
 - Observed figures from available MWCOG Metro Core Cordon Reports.
The 1999 figures are currently in draft and unpublished.
 - Transit trips include Metrorail, Metrobus, commuter rail, and commuter bus service
 - Vehicle trips include autos, buses, trucks and motorcycles
 - All figures have been rounded to the nearest hundred
 - The 1999 and 2001 figures are currently in draft and unpublished.
- Ref.: sqzchksx_v21d_28.xls

Beltway Cordon

Inbound / 6:00 AM to 9:00 AM Outbound / 4:00 PM - 7:00 PM

	Estimated (1994)	Observed (1995)	Est/Obs Ratio	Estimated (1994)	Observed (1995)	Est/Obs Ratio
Total Vehicles	322,000	374,800	0.86	436,700	399,000	1.09
Transit Pass.	55,400	63,600	0.87	N/A	61,800	N/A

	Estimated (2000)	Observed (2001)	Est/Obs Ratio	Estimated (2000)	Observed (2001)	Est/Obs Ratio
Total Vehicles	307,800	376,700	0.82	483,100	400,700	1.21
Transit Pass.	62,500	75,400	0.83	N/A	75,200	N/A

Notes:

- Simulated figures from MWCOG Version 2.1 D (Draft #18) model (05/19/04).
 - Observed figures from available MWCOG Beltway Cordon Reports.
The 2001 figures are currently in draft and unpublished.
 - Transit trips include Metrorail, Metrobus, commuter rail, and commuter bus service
 - Vehicle trips include autos, buses, trucks and motorcycles
 - All figures have been rounded to the nearest hundred
- Ref.: sqzchksx_v21d_28.xls

Model results: 1994, 2000, and 2030

		V2.1D #28 1994	V2.1D #28 2000	V2.1D #28 2030
Land Use				
	Households	1,940,449	2,144,177	3,012,414
	Employment	3,273,042	3,441,356	5,138,239
	Population	5,245,630	5,746,025	7,783,770
Motorized Trips / Trip Rates				
	HBW	3,721,019	4,150,792	6,059,898
Motorized Person Travel (Internal & External)	HBS	2,815,310	3,123,393	4,430,249
	HBO	8,622,756	9,531,757	13,325,883
	NHB	6,284,539	6,978,330	9,779,472
	Total Person Trips	21,443,624	23,784,272	33,595,502
<i>Motorized Person Trips per HH</i>		<i>11.05</i>	<i>11.09</i>	<i>11.15</i>
<i>Motorized Person Trips per Capita</i>		<i>4.09</i>	<i>4.14</i>	<i>4.32</i>
Non-Motorized HBW Trips		166,795	180,199	282,239
Auto Driver Travel (Internal & External)	HBW	2,901,112	3,237,009	4,705,383
	HBS	2,209,243	2,435,133	3,455,268
	HBO	5,917,257	6,507,947	9,154,691
	NHB	4,876,709	5,416,586	7,579,243
	Total Auto Dr.	15,904,321	17,596,675	24,894,585
Auto Passenger Travel (Internal & External)	HBW	362,765	392,397	586,466
	HBS	576,411	652,822	919,550
	HBO	2,550,111	2,855,356	3,930,110
	NHB	1,268,981	1,403,593	1,973,292
	Total Auto Pass.	4,758,268	5,304,168	7,409,418
<i>Auto Occupancies (Internal & External)</i>	HBW	<i>1.13</i>	<i>1.12</i>	<i>1.12</i>
	HBS	<i>1.26</i>	<i>1.27</i>	<i>1.27</i>
	HBO	<i>1.43</i>	<i>1.44</i>	<i>1.43</i>
	NHB	<i>1.26</i>	<i>1.26</i>	<i>1.26</i>
	Total Auto Occ.	1.30	1.30	1.30
Transit Travel (Internal Only)	HBW	457,142	521,386	768,049
	HBS	29,656	35,438	55,431
	HBO	155,388	168,454	241,082
	NHB	138,849	158,151	226,937
	Total Int'l Transit	781,035	883,429	1,291,499
<i>Transit Percentage</i>	HBW	<i>12.29%</i>	<i>12.56%</i>	<i>12.67%</i>
	HBS	<i>1.05%</i>	<i>1.13%</i>	<i>1.25%</i>
	HBO	<i>1.80%</i>	<i>1.77%</i>	<i>1.81%</i>
	NHB	<i>2.21%</i>	<i>2.27%</i>	<i>2.32%</i>
	Total Transit Pct.	3.64%	3.71%	3.84%
Truck Travel	Medium Wgt.	284,426	304,799	454,443
	Heavy Wgt.	145,957	159,097	286,582
Miscellaneous & Through	Misc. Auto Dr.	483,232	583,921	847,389
	Through Auto Dr.	31,816	40,706	98,796
	Through Trucks	26,190	32,752	79,469
	Airport Auto Drs.	n/a	22,612	56,694
TOTAL VEHICLE TRIPS		16,875,942	18,740,562	26,717,958
Vehicle-Miles-Traveled				
Regional VMT		127,728,889	143,611,915	208,174,304
<i>VMT per Capita</i>		<i>24.35</i>	<i>24.99</i>	<i>26.74</i>
<i>VMT per HH</i>		<i>65.82</i>	<i>66.98</i>	<i>69.11</i>

Note: For 1994 and 2000, NO transit constraint through the core was assumed (i4_mc_summary.tab)

For 2030, the 2005 transit constraint through the core was used (i4_mc_consummary.tab)

Ref.: vfs_v21d_28_yrs94_00_30.xls

Conclusions

- We have added a bus speed model that makes the speeds of future local bus service a function of the congestion on the highway system. This addresses issue number 3 (bus speeds) raised by the TRB review panel.
- We are getting as good or better fits with this draft of the Version 2.1D model as the previous draft, but with fewer K factors. K factors were reduced to 52, of which over half were dampened, i.e., moved closer to 1.00. This addresses issues number 1 (improving model validation) and number 4 (use of adjustment factors) raised by the TRB review panel.

Next steps

Short term (possibly before air quality conformity analysis)

- Alternative model structures will be tested regarding speed feedback loop. This would be to address issue number 5 (speed feedback and mode choice), and possibly issue number 6 (hourly traffic volumes, speeds, and emissions estimation) raised by the TRB review panel. These alternative structures may include:
 - Possible inclusion of the post-processor into the four-step travel model
 - Possible inclusion of the full mode choice model in each speed feedback iteration, instead of just the first and fourth iteration
 - Possible reduction in the number of speed feedback iterations (currently six).

Longer term

- Commercial / truck modeling work. Addresses issue number 2 (Light duty commercial vehicles with NHB trips) raised by the TRB review panel.
- Advanced transit modeling methods are being investigated. Addresses issue number 5 (speed feedback and mode choice) raised by the TRB review panel.

Issue	Addressing issues raised by the TRB review panel		
	V 2.1D #28	Short term	Long term
1. Improving model validation	X		
2. Light duty commercial vehicles with NHB trips			X
3. Bus speeds	X		
4. Use of adjustment factors	X		
5. Speed feedback and mode choice		X	X
6. Hourly traffic volumes, speeds, and emissions estimation		X	

Requesting the model

- The Version 2.1D model is in draft as of July 23, 2004
- Copies of the Version 2.1D Draft #28 travel model will be available upon written request