Progress Report : TPB Version 2.3 travel model on the 3,722-TAZ area system

Special meeting of the
Travel Forecasting Subcommittee

April 29, 2011

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National Capital Region Transportation Planning Board (TPB)

Today's agenda

- Activities on the Version 2.3 model development since February 28
- Experience regarding model running times
- Updated calibration/validation results for year 2007
- Initial transit assignment results for 2007
- Evaluation of model results for 2040

Current disposition of the Ver. 2.3 model

- Version 2.3 model has evolved since February (currently Ver. 2.3.17)
  - Unanticipated changes were deemed necessary for a 2040 run
  - Network errors cleaned
  - Scripting errors detected and corrected
  - Cube Cluster implemented in highway assignment
  - Evaluation of incremental model refinements hampered by excessive running times
- Version 2.3 model will continue to evolve, pending model testing and sensitivity checking, some of which is already underway
- Release of the model
  - Draft Version 2.3 model (2.3.17) will be released to interested agencies next week, pending "replication runs" now in progress
- Recommendation of TPB staff
  - For those who can wait: Obtain model in November 2011, after the TPB has approved the air quality conformity analysis (making it the official TPB travel model)
  - For those who cannot wait: Submit your request to Ron Kirby as indicated on the website (http://www.mwcog.org/transportation/activities/models/documentation.asp)

Observations from last TFS meeting

- V2.3 trip rates lower than V2.2 trip rates
- V2.3 trip lengths higher than V2.2 trip lengths
- Base year (2007) V2.3 VMT tracks well with observed HPMS figures
- Biases in estimated link volumes by time period noted
  - AM, PM period volumes overestimated
  - “Night” period VMT underestimated
- Limitations on TPB’s ground count sample noted
  - Only 23% of highway links crossing screenlines included daily count
  - Limitations on hourly count samples even more stringent

Changes to the Version 2.3 Model

- Adjusted k-factors
- Recalibrated mode choice model
- Modified time-of-day model
- Changed free-flow speeds and capacities
- Implemented Cube Cluster (distributed processing) in traffic assignment
- Modified traffic assignment algorithm
  - Now using Frank-Wolfe instead of bi-conjugate FW, since BC FW combined with Cube Cluster resulted in slightly different modeled results
- Made network updates
- Note: The calibration report and user's guide are currently being updated

Recent hwy. assignment changes

- TPB has reverted back to the Frank-Wolfe equilibrium algorithm currently used in Version 2.2 instead of Bi-conjugate algorithm which attains tighter convergence faster by comparison
- Why? Bi-conjugate algorithm results with/without distributed processing (DP) do not match
- This is an unfortunate turn of events
- Citilabs has been notified and is working to correct this issue

Model run times

- Model run times have gone up substantially in Ver. 2.3, compared to Ver. 2.2
- Causes
  - Increase in number of zones
    - No. of zones: 3722/2191 = 1.70
    - No. of interchanges: $3722^2/2191^2 = 2.89$
  - Traffic assignment refinements in Version 2.3
    - User classes went from 5 to 6 (Commercial vehicle added)
    - Higher convergence threshold
      - Relative gap of 0.001 (1×10^{-3}) or 200 user equilibrium iterations
    - Time-of-day periods went from 3 to 4 (AM, MD, PM, NT)

Model run times

- Factors affecting model run times
  - Computer hardware
  - Traffic assignment algorithm
  - Convergence criteria
  - Distributed processing (Cube Cluster)
  - Year modeled
- Traffic assignment accounts for over half the model run time

Sample run times

Run No.	Computer Hardware	Travel Model Ver.	Simulation Year	Traffic Assignment Algorithm	Closure Criteria: Relative Gap	Closure Criteria: Max UE Iters	Cube Cluster	No. of Cores	Run Time (hrs)
35	New Srvr	Ver2.3.13_3722TAZ	base (2007)	bi-conjugate FW	0.001	50	no	n/a	45
37	New Srvr	Ver2.3.13_3722TAZ	base (2007)	bi-conjugate FW	0.001	50	yes	4	31
23	New Srvr	Ver2.3.11_3722TAZ	base (2007)	bi-conjugate FW	0.001	200	no	n/a	66
42	Old Srvr	Ver2.3.12_3722TAZ	base (2007)	bi-conjugate FW	0.001	200	no	n/a	72
54	New Srvr	Ver2.3.17_3722TAZ	base (2007)	Frank-Wolfe	0.001	200	yes	4	47
57	New Srvr	Ver2.3.17_3722TAZ	future (2040)	Frank-Wolfe	0.001	200	yes	4	51

- Run times range from 47 to 72 hours
- Running intra-step distributed processing (IDP) in highway assignment with 4 cores cuts total model run time by about 30% (31/45 = 0.69)
- Bi-conjugate FW saves time over FW, but does not currently work with Cube Cluster
- Future-year model runs take longer due to increased congestion

Existing TPB hardware specs

	OldServr	NewServr
	tms2	tms3
Processor Name	Intel(R) Xeon(R) CPU X5365 @ 3.00GHz	Intel(R) Xeon(R) W5580 CPU @ 3.20GHz
Number of processors in system	2	2
Active cores per processor	4	4
Total number of cores	8	8
L2 Cache	2 x 4 MB	4 x 256 KB
Memory	4.0 GB	4.0 GB
Hard drive	NAS (N drive), 1.99 TB	NAS (O drive), 1.99 TB
Operating system	Windows Server Enterprise, SP2, 32-bit	Windows Server Standard, SP2, 32-bit

Updated calibration\validation

- Minor changes made to trip gen. & trip dist.
- Mode choice model recalibrated due to systemic error in PNR link generation
- Traffic assignment parameters adjusted to improve validation against counts by facility type
- Time of day model modified to improve validation against observed counts by time period

Year-2007 HBW trip distribution results

Est./Obs. HBW Motorized Person Trip PRODUCTIONS

Jurisdiction	Estimated	Observed	Difference (Est - Obs)	Ratio (Est / Obs)
DC CR	32,161	31,735	426	1.01
DC NC	244,666	245,660	-994	1.00
MTG	531,284	529,267	2,017	1.00
PG	446,552	448,378	-1,826	1.00
ARLCR	6,465	8,334	-1,869	0.78
ARNCR	120,155	124,766	-4,611	0.96
ALX	83,801	88,448	-4,647	0.95
FFX	653,955	646,709	7,246	1.01
LDN	156,838	147,807	9,031	1.06
PW	241,588	241,023	565	1.00
FRD	143,682	144,836	-1,154	0.99
CAR	79,338	74,869	4,469	1.06
HOW	139,084	137,970	1,114	1.01
AAR	244,938	248,419	-3,481	0.99
CAL	48,667	47,948	719	1.01
STM	76,889	77,480	-591	0.99
CHS	80,525	77,226	3,299	1.04
FAU	34,183	31,762	2,421	1.08
STA	64,973	63,142	1,831	1.03
CL/JF	32,925	31,327	1,598	1.05
SP/FB	61,189	60,264	925	1.02
KGEO	12,023	14,099	-2,076	0.85
Total	**3,535,881**	**3,521,469**	14,412	1.00

Est./Obs. HBW Motorized Person Trip ATTRACTIONS

Jurisdiction	Estimated	Observed	Difference (Est - Obs)	Ratio (Est / Obs)
DC CR	645,663	641,323	4,340	1.01
DC NC	258,299	238,582	19,717	1.08
MTG	448,384	456,241	-7,857	0.98
PG	309,719	318,144	-8,425	0.97
ARLCR	73,783	64,941	8,842	1.14
ARNCR	155,872	156,761	-889	0.99
ALX	83,745	83,821	-76	1.00
FFX	602,986	612,731	-9,745	0.98
LDN	99,146	103,235	-4,089	0.96
PW	127,542	132,265	-4,723	0.96
FRD	105,032	97,779	7,253	1.07
CAR	52,676	49,305	3,371	1.07
HOW	105,237	107,977	-2,740	0.97
AAR	200,710	205,801	-5,091	0.98
CAL	27,506	22,263	5,243	1.24
STM	64,044	65,703	-1,659	0.97
CHS	48,896	42,573	6,323	1.15
FAU	19,592	14,924	4,668	1.31
STA	34,383	30,202	4,181	1.14
CL/JF	21,030	17,412	3,618	1.21
SP/FB	46,427	44,597	1,830	1.04
KGEO	5,208	14,891	-9,683	0.35
Total	**3,535,880**	**3,521,471**	**14,409**	**1.00**

* Ver. 2.3.17, 2007 Pseudo Round 8.0 land use

Year-2007 tot. person trip distribution results

Est./Obs. TOTAL Motorized Person Trip PRODUCTIONS

Jurisdiction	Productions		Difference	Ratio
	Estimated	Observed	(Est - Obs)	(Est / Obs)
DC CR	269,704	290,848	-21,144	0.93
DC NC	1,057,363	1,083,078	-25,715	0.98
MTG	2,743,376	2,725,241	18,135	1.01
PG	2,074,739	2,048,505	26,234	1.01
ARLCR	49,955	44,222	5,733	1.13
ARNCR	515,983	531,832	-15,849	0.97
ALX	382,196	375,980	6,216	1.02
FFX	3,169,867	3,184,873	-15,006	1.00
LDN	725,316	709,810	15,506	1.02
PW	1,181,939	1,172,356	9,583	1.01
FRD	665,854	666,073	-219	1.00
CAR	427,454	417,727	9,727	1.02
HOW	735,867	727,125	8,742	1.01
AAR	1,426,341	1,439,345	-13,004	0.99
CAL	244,597	252,821	-8,224	0.97
STM	315,119	322,332	-7,213	0.98
CHS	401,438	405,128	-3,690	0.99
FAU	147,608	138,876	8,732	1.06
STA	294,821	302,827	-8,006	0.97
CL/JF	150,140	128,917	21,223	1.16
SP/FB	314,321	334,593	-20,272	0.94
KGEO	49,984	50,105	-121	1.00
Total	**17,343,982**	**17,352,614**	**-8,632**	**1.00**

Est./Obs. TOTAL Motorized Person Trip ATTRACTIONS

Jurisdiction	Attractions		Difference	Ratio
	Estimated	Observed	(Est - Obs)	(Est / Obs)
DC CR	1,082,824	1,077,129	5,695	1.01
DC NC	1,052,322	996,355	55,967	1.06
MTG	2,684,965	2,715,844	-30,879	0.99
PG	1,782,552	1,814,424	-31,872	0.98
ARLCR	155,404	110,141	45,263	1.41
ARNCR	556,941	560,504	-3,563	0.99
ALX	424,115	392,899	31,216	1.08
FFX	3,164,019	3,184,563	-20,544	0.99
LDN	644,914	658,723	-13,809	0.98
PW	1,017,385	1,035,642	-18,257	0.98
FRD	585,691	586,331	-640	1.00
CAR	400,511	401,513	-1,002	1.00
HOW	701,276	712,184	-10,908	0.98
AAR	1,340,885	1,359,732	-18,847	0.99
CAL	211,537	216,162	-4,625	0.98
STM	289,270	299,101	-9,831	0.97
CHS	381,110	379,007	2,103	1.01
FAU	130,901	110,615	20,286	1.18
STA	260,592	241,517	19,075	1.08
CL/JF	128,820	114,827	13,993	1.12
SP/FB	314,062	343,740	-29,678	0.91
KGEO	33,883	41,661	-7,778	0.81
	17,343,979	**17,352,614**	**-8,635**	**1.00**

* Ver. 2.3.17, 2007 Pseudo Round 8.0 land use

Estimated & Observed 2007 Transit Trips

		Simulated	Observed - On-Board Surveys		
		Trips	Trips	Diff. (E- O)	Ratio (E/O)
HBW	Transit	732,948	756,180	-23,232	0.97
	Pct. Transit	20.70%	21.40%	-0.70%	0.97
HBS	Transit	26,737	26,938	-201	0.99
	Pct. Transit	0.90%	0.90%	0.00%	1.00
HBO	Transit	187,041	187,871	-830	1.00
	Pct. Transit	2.90%	2.90%	0.00%	1.00
NHW	Transit	108,424	108,803	-379	1.00
	Pct. Transit	7.00%	7.00%	0.00%	1.00
NHO	Transit	44,566	44,795	-229	0.99
	Pct. Transit	1.50%	1.50%	0.00%	1.00
TOTAL	Transit	1,099,716	1,124,587	-24,871	0.98
	Pct. Transit	6.30%	6.50%	-0.20%	0.97

Mode Choice Market Segments

- Rules for market segmentation
  - Household income levels (1, 2, 3, 4)
  - Seven superdistricts => 20 geographic market segments

		1 DC core	2 VA core	3 DC urban	4 MD urban	5 VA urban	6 MD suburban	7 VA suburban
1	DC core	1	2	3	3	3	4	4
3	DC urban	1	2	3	3	3	4	4
4	MD urban	5	6	7	7	7	8	8
2	VA core	9	10	11	11	11	12	12
5	VA urban	9	10	11	11	11	12	12
6	MD suburban	13	14	15	15	15	16	16
7	VA suburban	17	18	19	19	19	20	20

Year-2007 mode choice performance results by purpose and market segment

Market	HBW		HBS		HBO		NHW		NHO		ALL	
Segment	Target	Model	Target	Model	Target	Model	Target	Model	Target	Model	Target	Model
1	121,156	120,830	2,516	2,494	32,693	32,643	29,816	29,838	9,430	9,407	195,611	195,211
2	10,475	10,274	145	140	3,142	3,110	4,281	4,292	1,880	1,857	19,923	19,673
3	71,016	70,406	6,941	6,925	41,914	41,917	24,992	25,074	11,535	11,542	156,398	155,863
4	20,938	18,528	1,238	1,250	5,028	5,021	6,633	6,453	2,681	2,728	36,518	33,980
5	20,376	19,892	202	182	3,493	3,441	2,089	2,083	467	453	26,627	26,051
6	1,753	1,706	32	33	183	173	192	193	35	32	2,195	2,138
7	15,410	15,275	900	889	6,656	6,605	2,084	2,056	1,014	1,002	26,064	25,827
8	6,056	5,999	390	372	2,659	2,638	1,901	1,885	1,056	1,047	12,062	11,941
9	46,277	45,356	197	183	7,689	7,572	5,427	5,429	2,540	2,461	62,130	61,001
10	7,160	7,073	247	246	938	922	2,977	2,953	586	570	11,908	11,763
11	20,454	18,725	1,397	1,371	5,681	5,634	4,626	4,604	2,260	2,235	34,418	32,569
12	5,473	4,846	466	471	1,991	1,935	1,703	1,662	374	352	10,007	9,264
13	122,128	118,147	377	358	11,153	11,123	4,701	4,719	966	951	139,325	135,298
14	14,072	13,682	27	22	1,436	1,420	493	479	295	287	16,323	15,890
15	68,062	66,130	1,779	1,765	16,478	16,471	3,984	3,988	2,077	2,043	92,380	90,397
16	42,095	41,998	5,444	5,434	21,809	21,786	4,505	4,468	3,970	3,963	77,823	77,648
17	76,030	71,137	218	202	7,192	7,102	3,220	3,205	753	808	87,413	82,454
18	21,412	20,626	21	32	1,061	1,025	676	654	123	114	23,293	22,451
19	41,081	38,659	597	584	6,262	6,148	1,838	1,792	871	855	50,649	48,038
20	24,756	23,661	3,804	3,784	10,413	10,356	2,665	2,596	1,882	1,861	43,520	42,257
Total Transit	756,180	732,948	26,938	26,737	187,871	187,041	108,803	108,424	44,795	44,566	1,124,587	1,099,715

Year-2007 mode choice performance results by submode & access mode

	HBW		HBS		HBO		NHW		NHO		ALL	
Mode	**Target**	**Model**	**Target**	**Model**	**Target**	**Model**	**Target**	**Model**	**Target**	**Model**	**Target**	**Model**
CR	19,968	19,806	21	413	667	1,103	0	563	824	834	21,480	22,719
MR	374,943	341,871	5,468	5,463	66,997	65,929	68,228	67,328	19,822	19,393	535,458	499,984
BUS	192,354	196,193	18,714	17,306	92,078	91,458	25,466	25,781	18,627	18,454	347,239	349,192
BUS/MR	168,915	175,078	2,735	3,555	28,129	28,551	15,109	14,752	5,522	5,886	220,410	227,821
Access	**HBW**		**HBS**		**HBO**		**NHW**		**NHO**		**ALL**	
Mode	**Target**	**Model**	**Target**	**Model**	**Target**	**Model**	**Target**	**Model**	**Target**	**Model**	**Target**	**Model**
WALK	499,990	475,538	25,794	24,078	157,854	155,990	92,681	92,497	37,012	36,168	813,331	784,271
PNR	198,123	197,972	663	786	21,647	22,320	9,108	9,048	3,853	4,232	233,394	234,359
KNR	58,067	59,438	481	1,872	8,370	8,731	7,014	6,879	3,930	4,167	77,862	81,086
Total Person	3,527,846	3,535,199	2,868,019	2,874,636	6,454,331	6,461,132	1,548,793	1,552,280	2,899,404	2,905,451	17,298,393	17,328,698
Total Transit	756,180	732,948	26,938	26,737	187,871	187,041	108,803	108,424	44,795	44,566	1,124,587	1,099,715
Transit Pct	21.4%	20.7%	0.9%	0.9%	2.9%	2.9%	7.0%	7.0%	1.5%	1.5%	6.5%	6.3%

LOS “E” capacities & free-flow speeds used in highway assignment

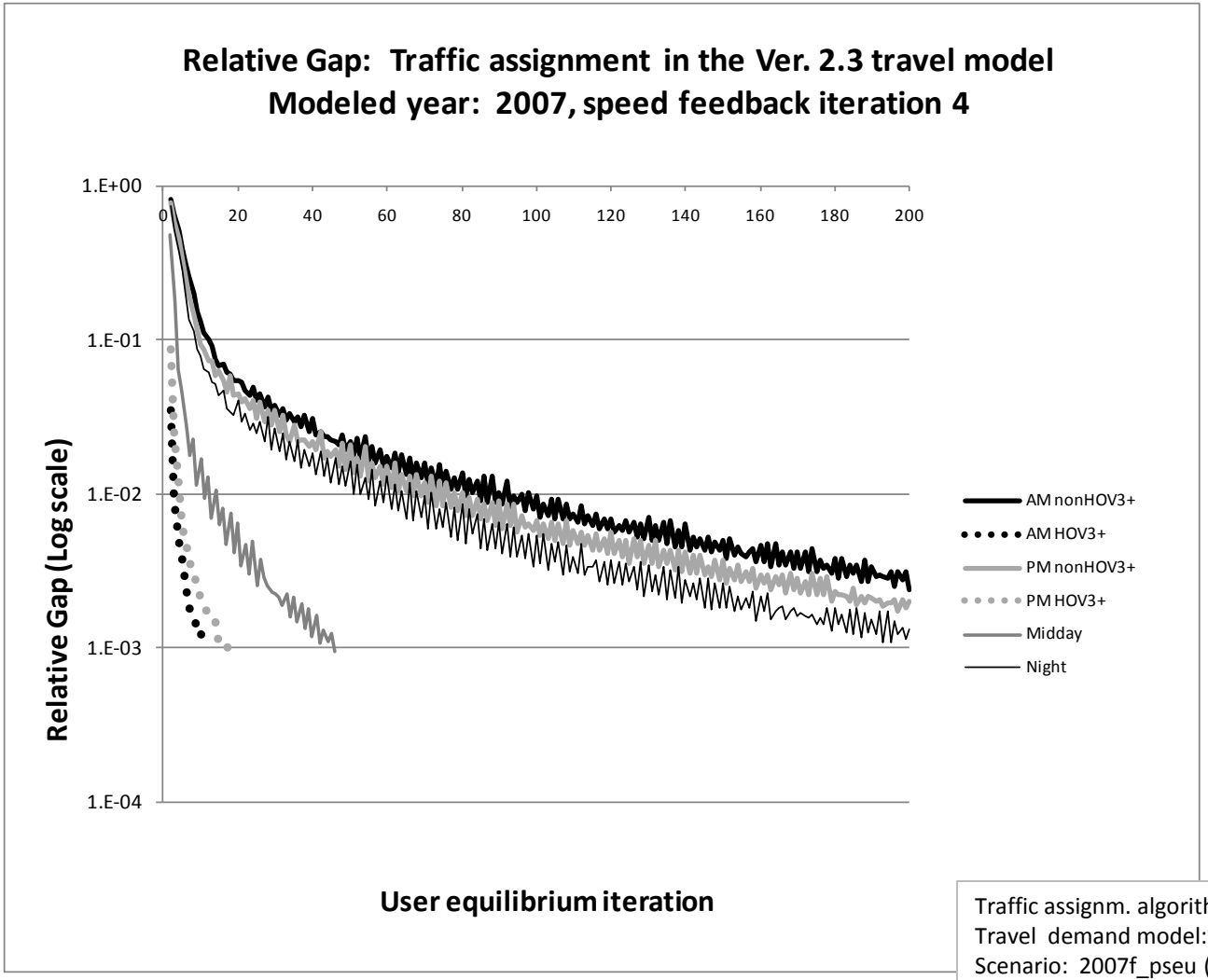
	Area type					
	1	**2**	**3**	**4**	**5**	**6**
Freeways	1900	1900	2000	2000	2000	2000
Major Arterials	600	800	960	960	1100	1100
Minor Arterials	500	600	700	840	900	900
Collectors	500	500	600	800	800	800
Expressways	1100	1200	1200	1400	1600	1600

	Area type					
	1	**2**	**3**	**4**	**5**	**6**
Freeways	55	55	60	60	65	65
Major Arterials	35	35	45	45	50	50
Minor Arterials	35	35	40	40	40	45
Collectors	30	30	30	35	35	35
Expressways	45	45	50	50	50	55

Peak-hour factors used in highway assignment

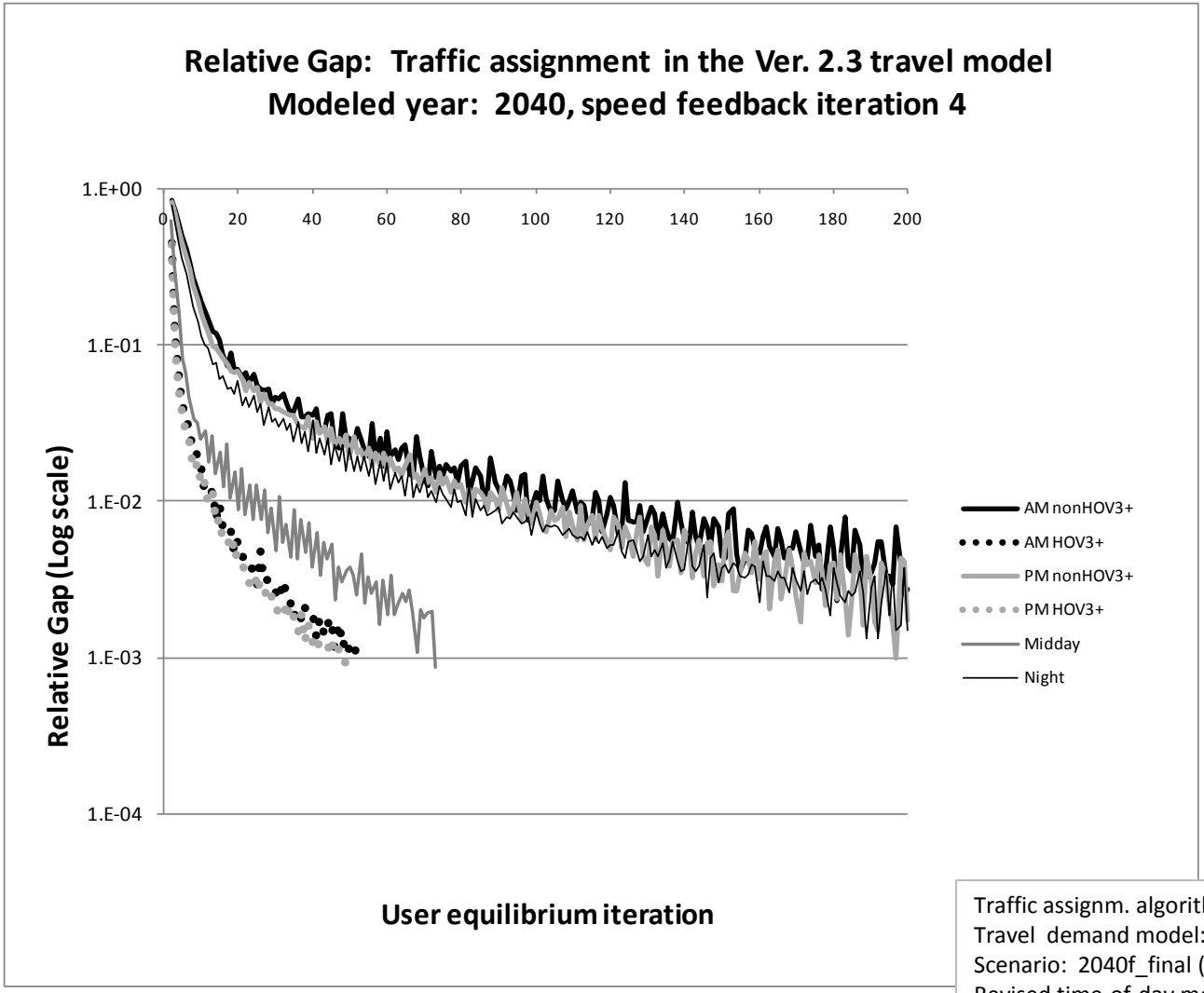
Period	Hours in Period	Saturation Percent	Peak Hour Percent
AM Peak (6-9 AM)	3	33.3%	41.7%
Midday (9AM-3PM)	6	16.7%	17.7%
PM Peak (3-7PM)	4	25.0%	29.4%
Night/Early Hrs.	11	9.1%	35.0%

Traffic Assignment Convergence



Traffic assignm. algorithm: Frank-Wolfe
Travel demand model: Ver2.3.17_3722TAZ
Scenario: 2007f_pseu (Pseudo Rnd 8.0 LU)
Revised time-of-day model

Traffic Assignment Convergence

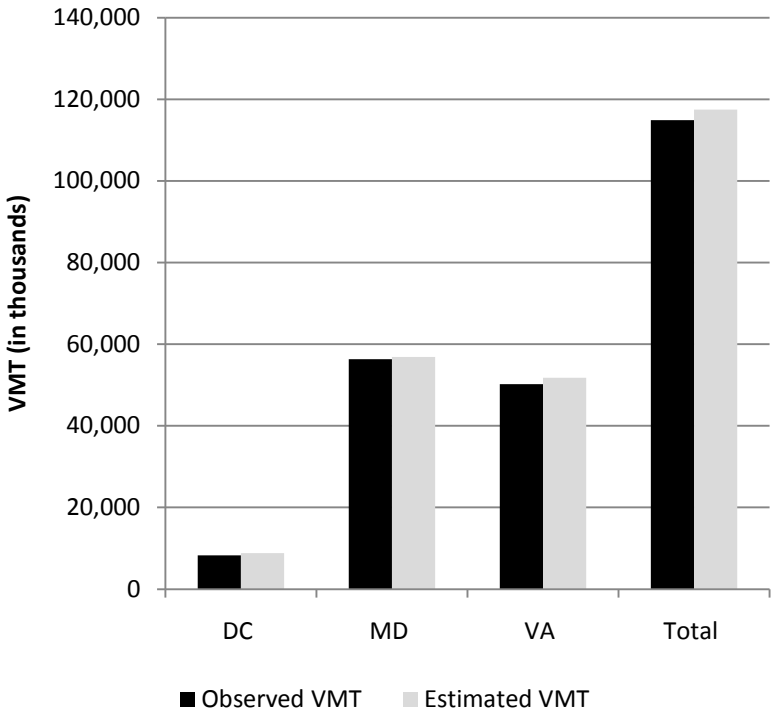


Traffic assignm. algorithm: Frank-Wolfe
Travel demand model: Ver2.3.17_3722TAZ
Scenario: 2040f_final (Rnd 8.0)
Revised time-of-day model

2007 VMT by State for MSA

VMT in thousands

State	Observed VMT	Estimated VMT	Difference	Pct. Difference
DC	8,272	8,790	518	1.06
MD	56,366	56,909	542	1.01
VA	50,238	51,754	1,517	1.03
Total	114,876	117,453	2,577	1.02



Previous version of this table had been found on page 116 in calibration report

2007 VMT (in 000s) by Jurisdiction

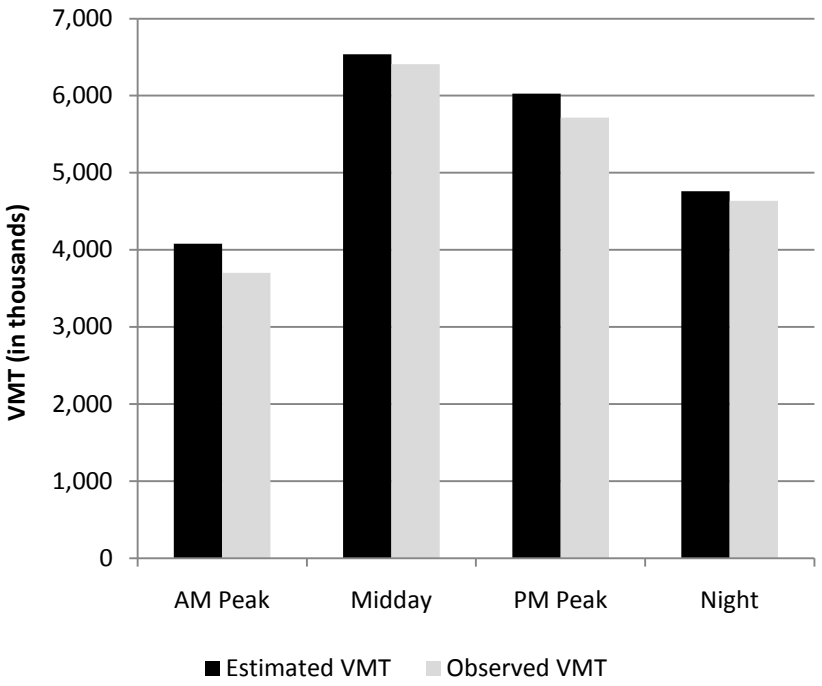
Jurisdiction	Observed VMT	Estimated VMT	Difference (E-O)	Ratio (E/O)
District of Columbia	8,272	8,790	518	1.06
Montgomery County	19,890	20,815	925	1.05
Prince George's County	23,316	22,277	-1,039	0.96
Arlington County	4,392	4,289	-103	0.98
City of Alexandria	1,958	2,022	65	1.03
Fairfax County	26,799	26,250	-549	0.98
Loudoun County	5,260	6,414	1,154	1.22
Prince William County	8,000	8,732	732	1.09
Frederick County	7,842	8,905	1,063	1.14
Howard County	10,094	10,194	99	1.01
Anne Arundel County	15,330	14,871	-459	0.97
Charles County	3,348	3,064	-285	0.92
Carroll County	3,395	4,315	920	1.27
Calvert County	1,971	1,849	-122	0.94
St. Mary's County	2,195	2,102	-93	0.96
King George County	789	699	-90	0.89
City of Fredericksburg	948	814	-135	0.86
Stafford County	3,829	4,047	218	1.06
Spotsylvania County	3,300	2,077	-1,222	0.63
Fauquier County	3,149	3,063	-87	0.97
Clarke County	770	982	213	1.28
Jefferson County	1,082	1,376	294	1.27
Total	155,927	157,944	2,017	1.01

Previous version of this table had been found on page 116 in calibration report

2007 VMT by Time of Day

VMT (in thousands) based on 1,717 links with hourly traffic counts

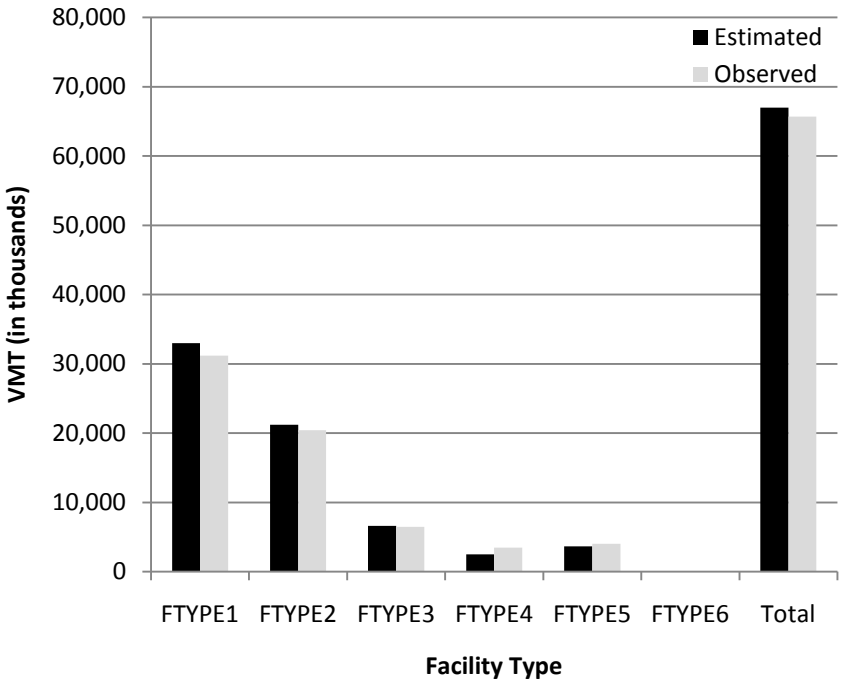
Time of Day	Estimated	Observed	Difference (E.-O.)	Ratio (E./O.)
AM Peak	4,078	3,701	377	1.10
Midday	6,535	6,411	125	1.02
PM Peak	6,025	5,713	312	1.05
Night	4,759	4,636	123	1.03
Total	21,397	20,460	937	1.05



VMT by Facility Type

VMT (in thousands) based on 6,563 links with daily traffic counts

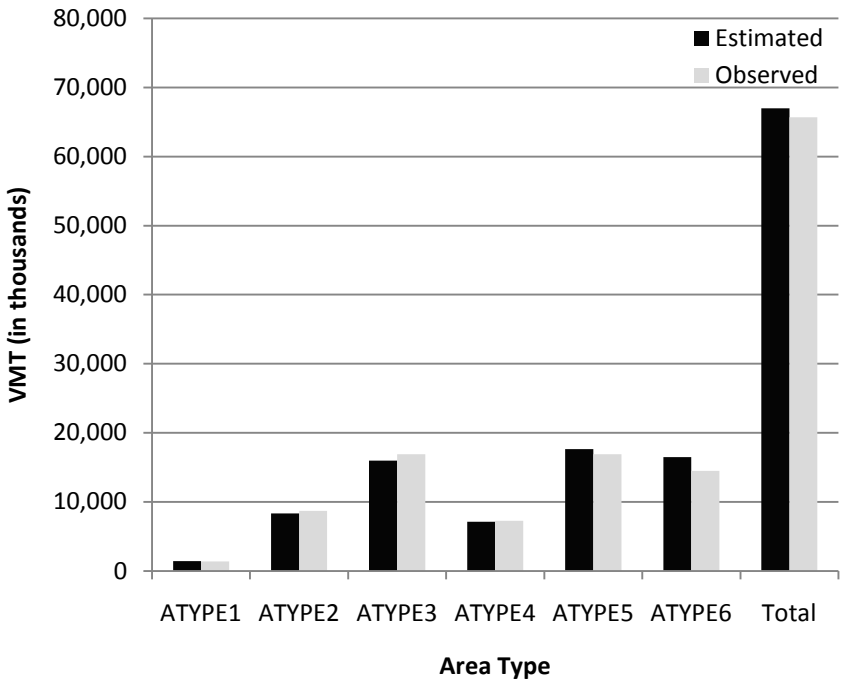
FTYPE	Estimated	Observed	Estimated/ Observed
1	32,986	31,204	1.06
2	21,213	20,407	1.04
3	6,597	6,492	1.02
4	2,512	3,483	0.72
5	3,639	4,009	0.91
6	35	73	0.48
Total	66,982	65,667	1.02



VMT by Area Type

VMT (in thousands) based on 6,563 links with counts

FTYPE	Estimated	Observed	Estimated/ Observed
1	1,410	1,374	1.03
2	8,306	8,698	0.95
3	15,984	16,899	0.95
4	7,131	7,276	0.98
5	17,649	16,914	1.04
6	16,504	14,506	1.14
Total	66,982	65,667	1.02



RMSE Analysis

Daily link volume pct. RMSE by Facility Type

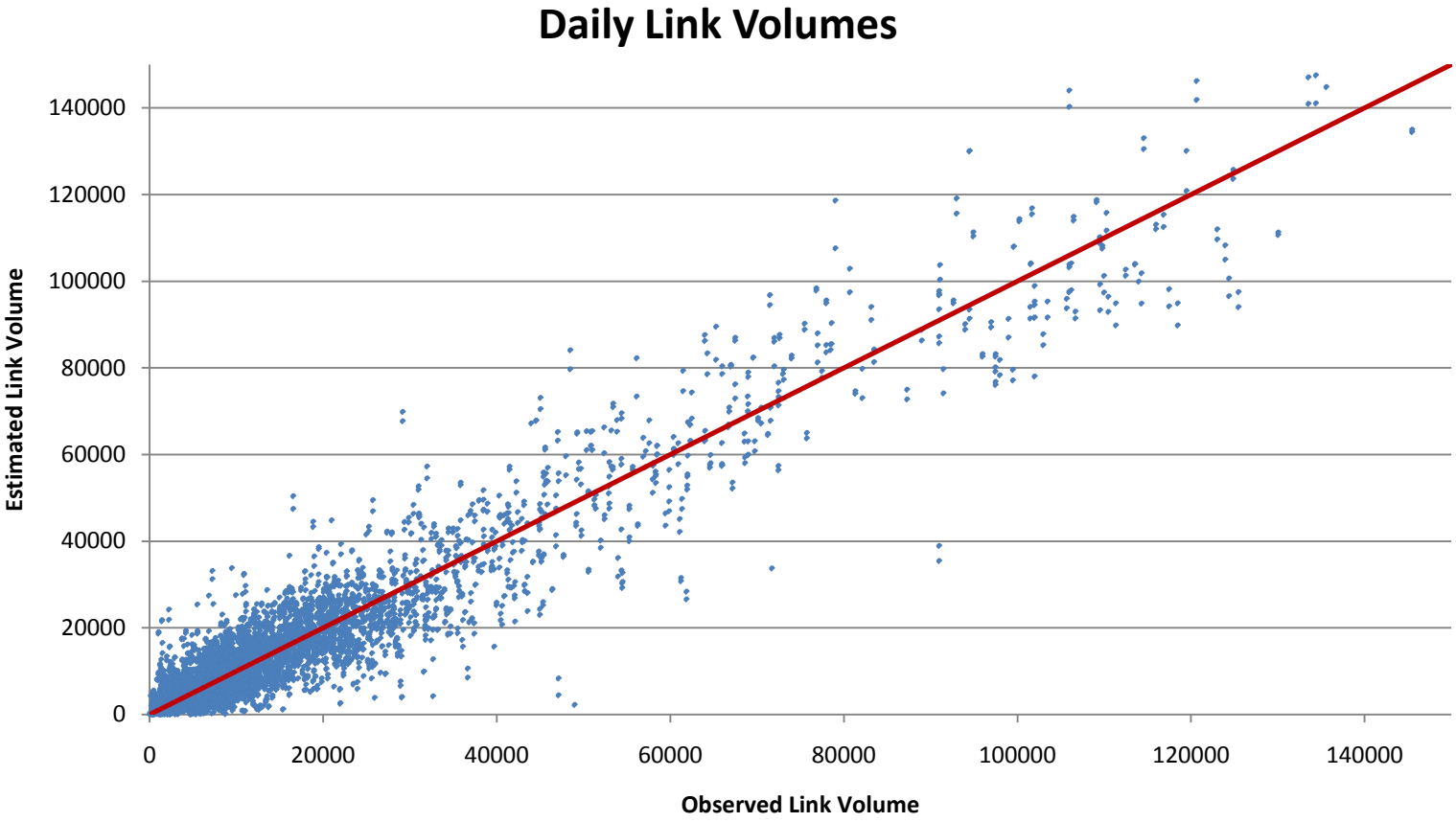
Facility Type		% RMSE
FTYPE1	Freeway	21%
FTYPE2	Major Arterial	38%
FTYPE3	Minor Arterial	56%
FTYPE4	Collector	81%
FTYPE5	Expressway	35%
All FTYPEs		41%

RMSE Analysis

Period link volume pct. RMSE by Facility Type

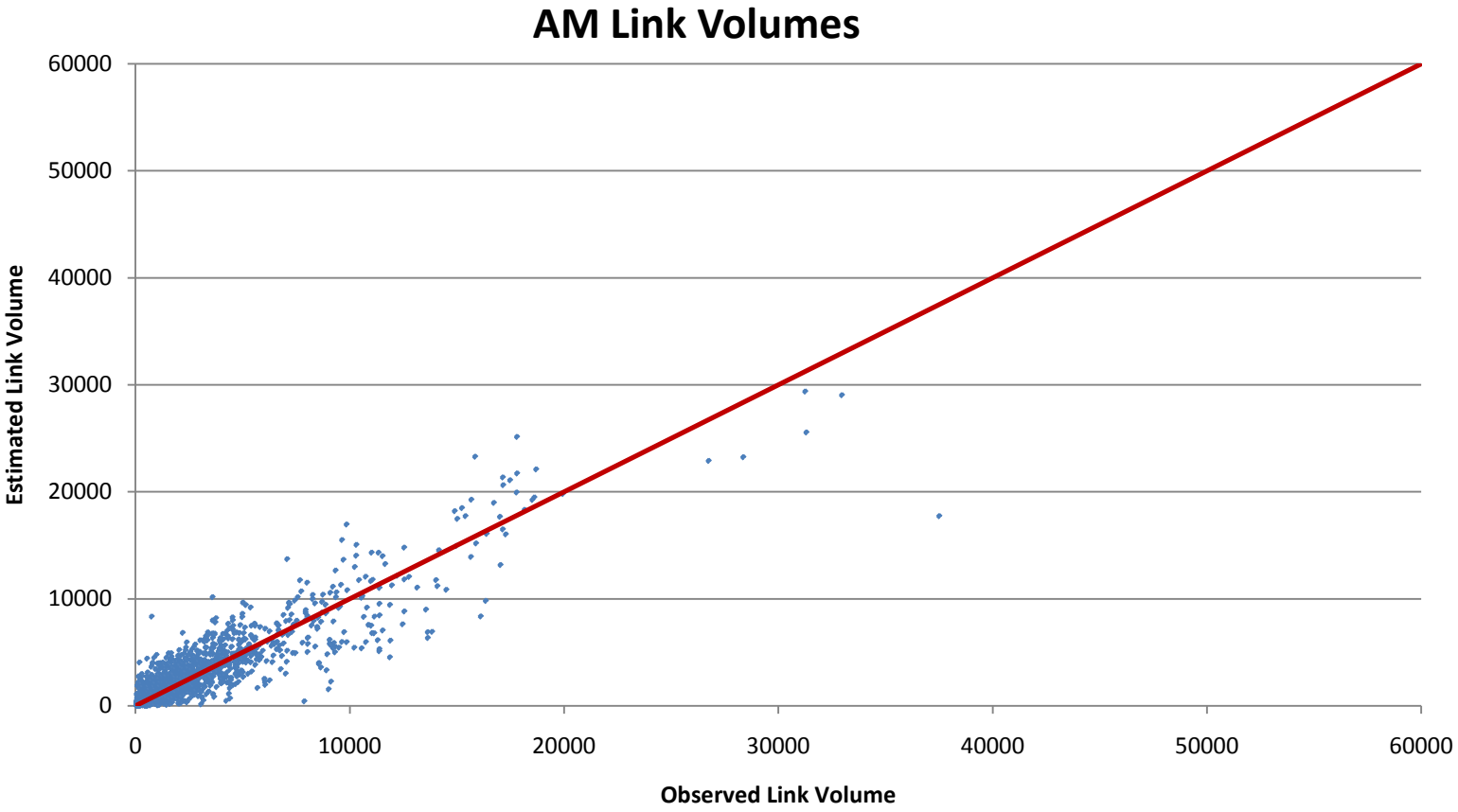
Facility Type	AM	Midday	PM	Night
1 Freeway	35%	23%	29%	29%
2 Maj. Arterial	48%	38%	40%	46%
3 Min. Arterial	80%	63%	69%	84%
4 Collector	97%	95%	84%	101%
5 Expressway	46%	34%	40%	40%
Total	57%	42%	47%	52%

2007 Estimated vs. Observed Directional Volumes



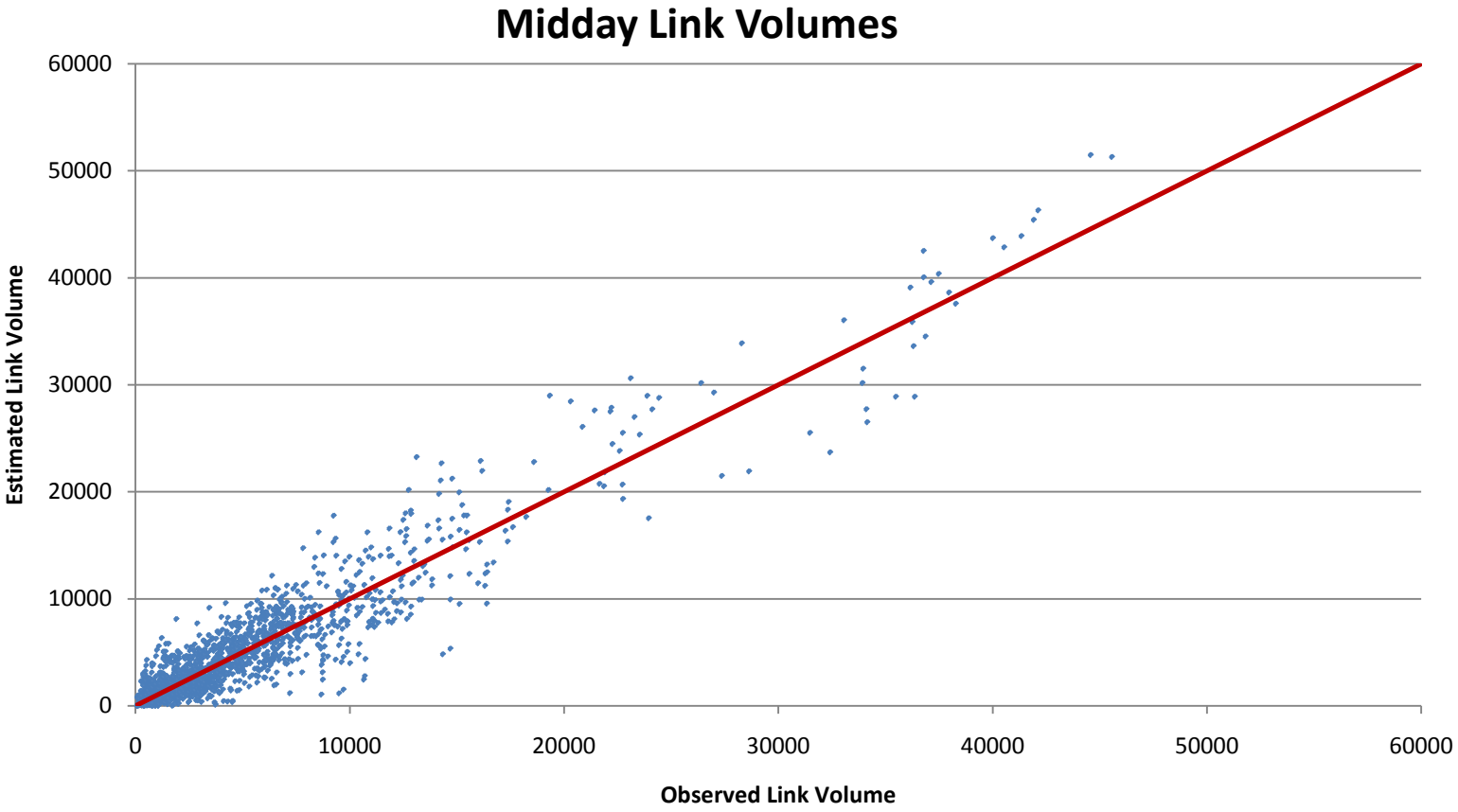
Based on 6,563 links with daily counts

2007 Estimated vs. Observed AM Peak Period Volumes



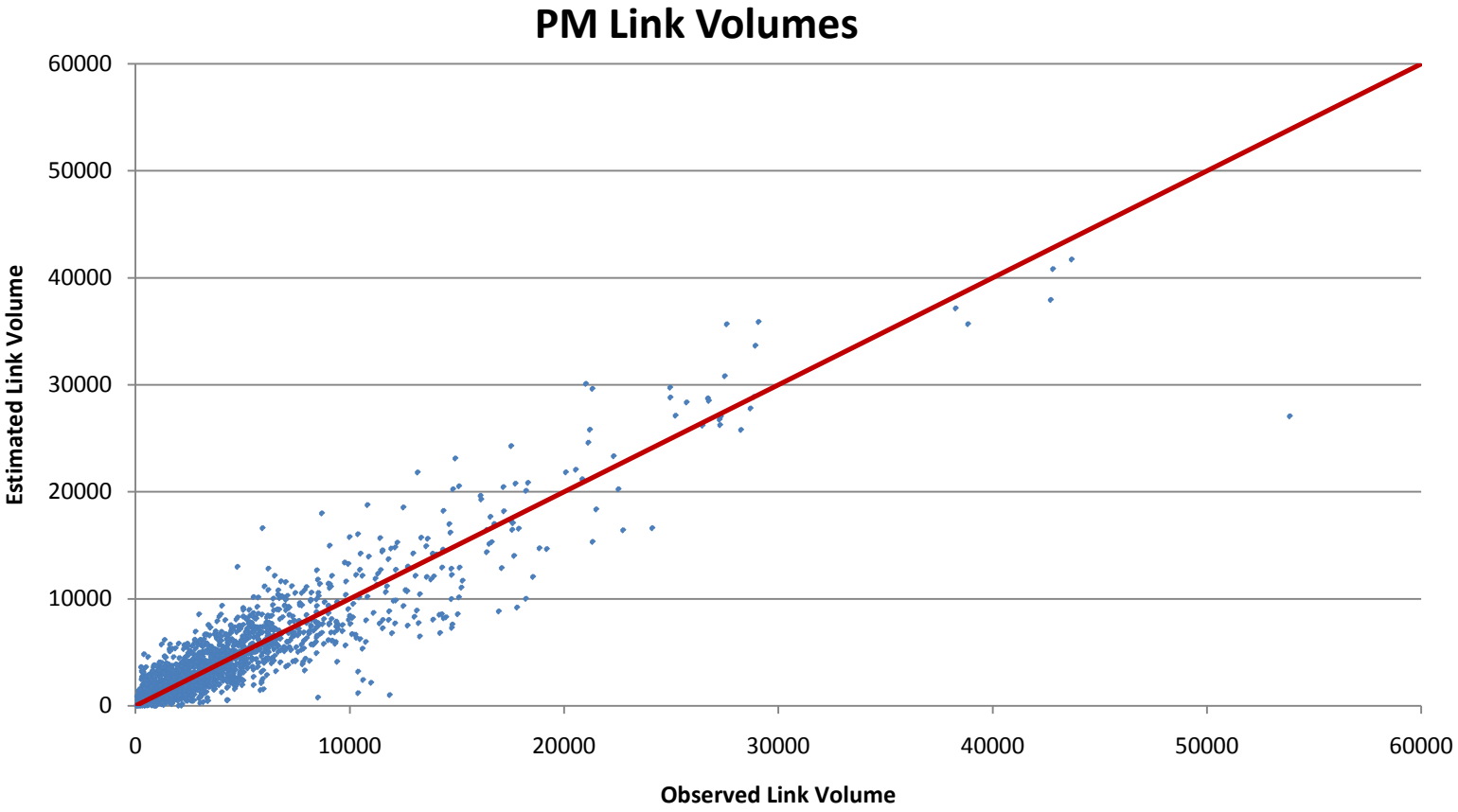
Based on 1,717 links with daily counts

2007 Estimated vs. Observed Midday Period Volumes



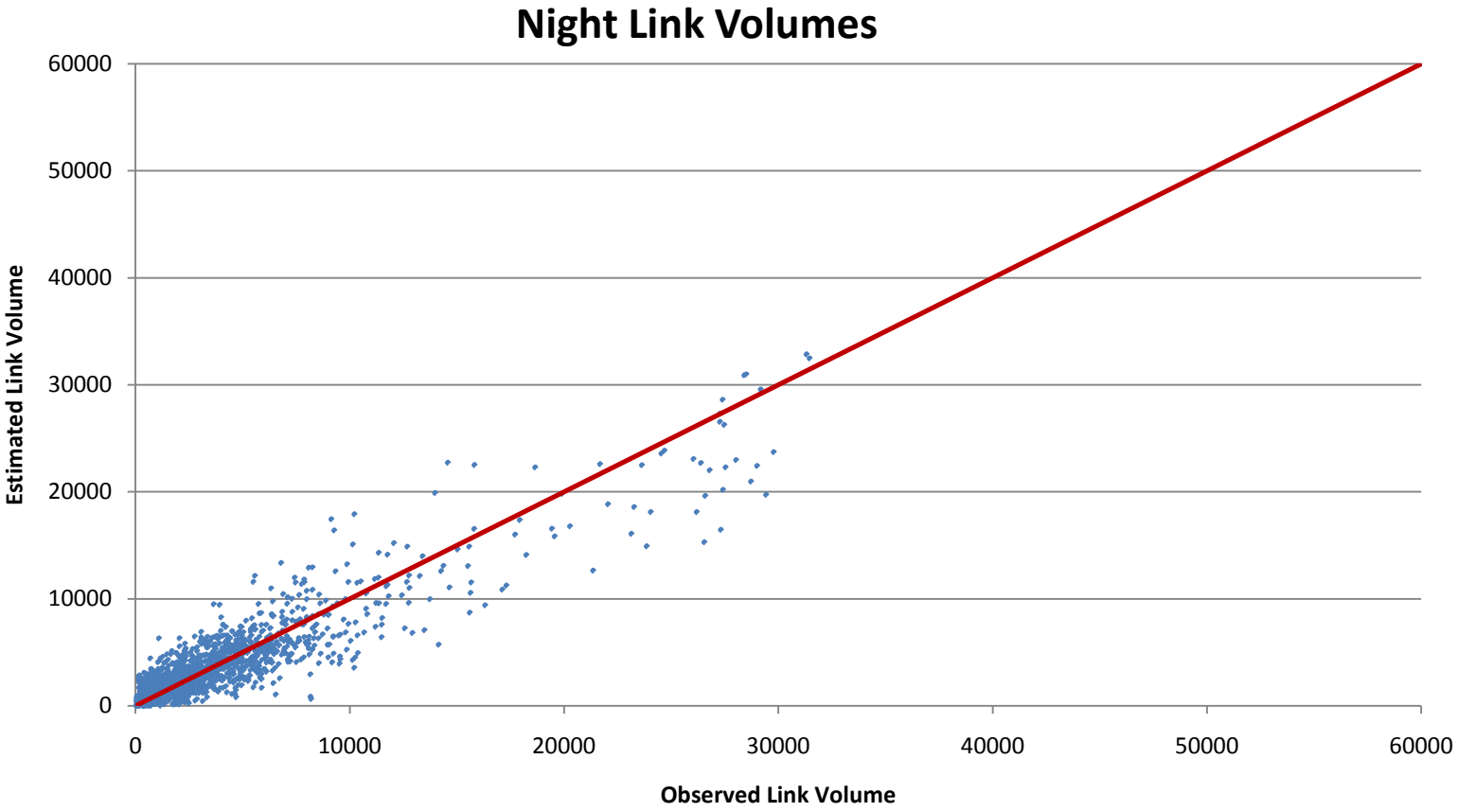
Based on 1,717 links with daily counts

2007 Estimated vs. Observed PM Peak Period Volumes



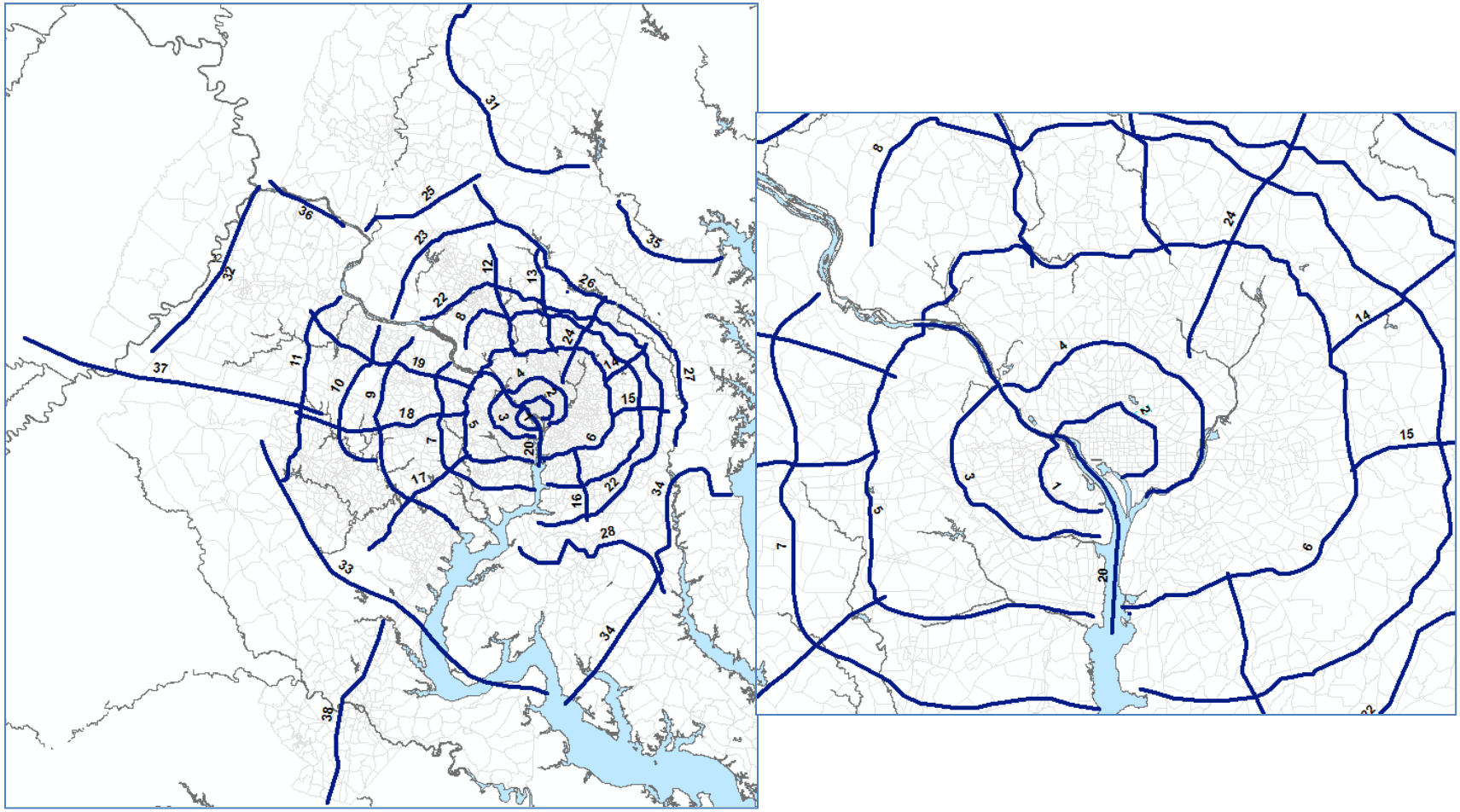
Based on 1,717 links with daily counts

2007 Estimated vs. Observed Night Period Volumes



Based on 1,717 links with daily counts

Screenlines



Screenline Crossings

Screenline	Estimated	Observed	Difference	Ratio	Screenline links	Screenline links with counts	Proportion of links with counts
1	436,139	541,123	-104,984	0.81	46	24	0.52
2	899,896	770,152	129,744	1.17	74	60	0.81
3	753,565	769,828	-16,263	0.98	58	44	0.76
4	1,052,037	844,084	207,953	1.25	74	68	0.92
5	615,541	535,254	80,287	1.15	64	22	0.34
6	1,495,078	1,479,360	15,718	1.01	121	67	0.55
7	609,364	630,970	-21,606	0.97	74	36	0.49
8	1,489,718	1,394,110	95,608	1.07	106	48	0.45
9	550,901	548,542	2,359	1.00	56	26	0.46
10	494,468	437,926	56,542	1.13	24	18	0.75
11	264,730	218,070	46,660	1.21	34	20	0.59
12	419,728	470,410	-50,682	0.89	34	16	0.47
13	437,702	376,062	61,640	1.16	20	12	0.60
14	272,301	323,644	-51,343	0.84	12	8	0.67
15	283,047	326,882	-43,835	0.87	16	8	0.50
16	129,254	142,540	-13,286	0.91	12	2	0.17
17	165,768	175,348	-9,580	0.95	42	22	0.52
18	391,605	457,548	-65,943	0.86	50	22	0.44
19	331,108	399,939	-68,831	0.83	50	28	0.56
20	1,119,001	897,896	221,105	1.25	14	14	1.00
22	1,153,506	1,121,760	31,746	1.03	144	50	0.35
23	234,032	237,578	-3,546	0.99	30	18	0.60
24	345,696	364,500	-18,804	0.95	32	12	0.38
25	133,100	109,804	23,296	1.21	12	8	0.67
26	90,167	40,888	49,279	2.21	18	8	0.44
27	310,403	238,732	71,671	1.30	16	10	0.63
28	175,556	231,106	-55,550	0.76	26	24	0.92
31	178,546	78,014	100,532	2.29	30	20	0.67
32	38,055	26,900	11,155	1.41	10	2	0.20
33	341,596	290,636	50,960	1.18	20	16	0.80
34	117,758	96,922	20,836	1.21	18	14	0.78
35	820,206	954,748	-134,542	0.86	36	32	0.89
36	53,877	11,702	42,175	4.60	8	6	0.75
37	42,653	30,784	11,869	1.39	16	16	1.00
38	193,049	266,540	-73,491	0.72	32	26	0.81
Total	16,439,153	15,840,302	598,851	1.04	1,429	827	0.58

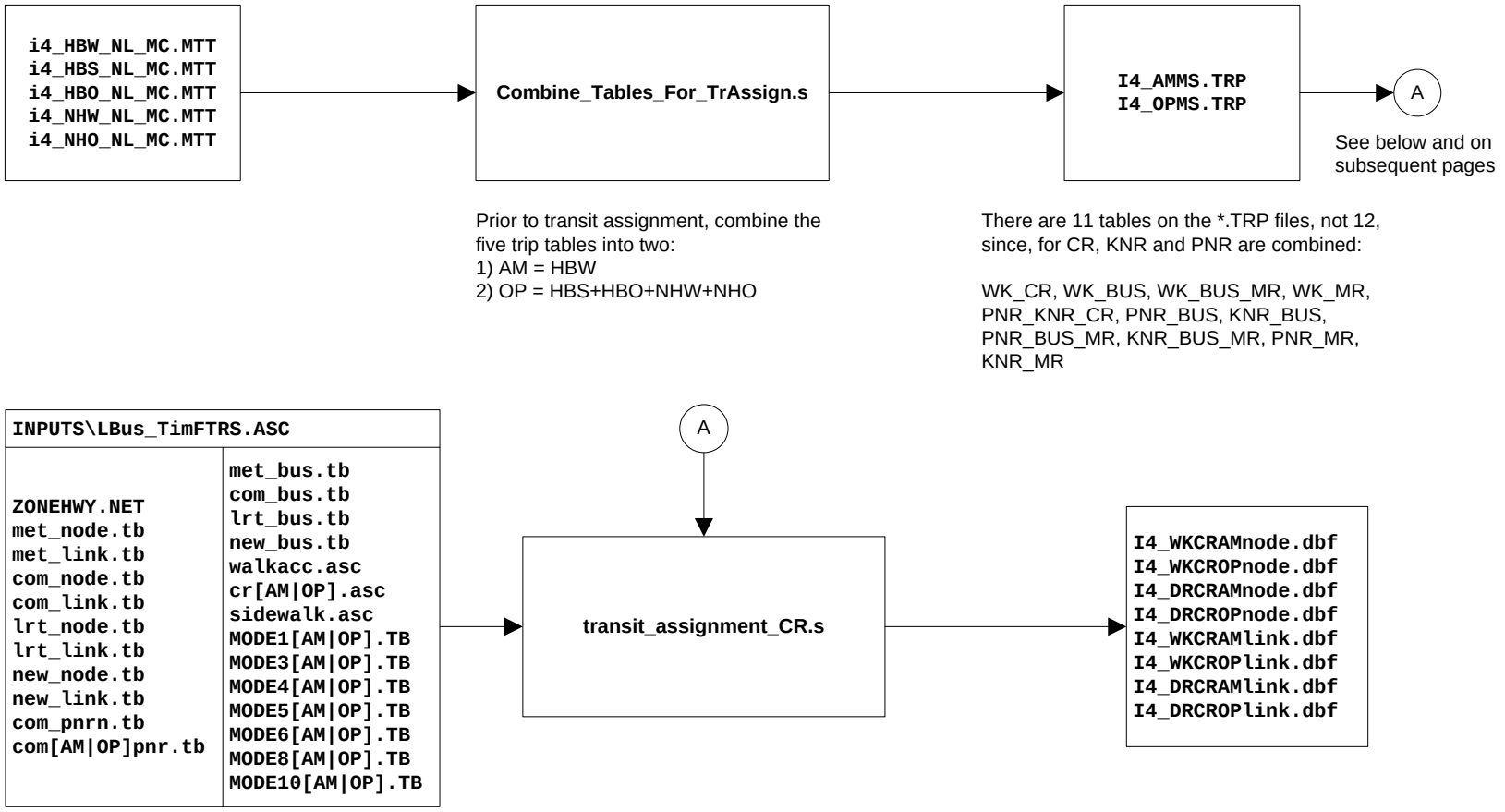
Transit Assignment

- Applied at the end of the travel model run (after the highway assignment in the fourth speed feedback iteration)
- Transit_Assignment.bat
  - Performs the transit assignment for each of the four transit submodes (CR, MR, AB, BM)
  - Results in TRNBUILD DBF NODEO and LINKO files (loaded link files)
- TranSum.bat
  - Consolidates the loaded link DBF files into two time-of-day periods (AM and off-peak): LINEVOL.EXE
  - Summarizes the loaded link DBF files: LINESUM.EXE

Transit_Assignment.bat

- Consolidation of trip tables (Combine_Tables_For_TrAssign.s)
  - HBW => AM peak
  - HBS+HBO+NHW+NHO => Off peak
- Transit assignment scripts
  - transit_assignment_CR.s
  - transit_assignment_MR.s
  - transit_assignment_AB.s
  - transit_assignment_BM.s

Transit_Assignment.bat



Transit_Assignment.bat

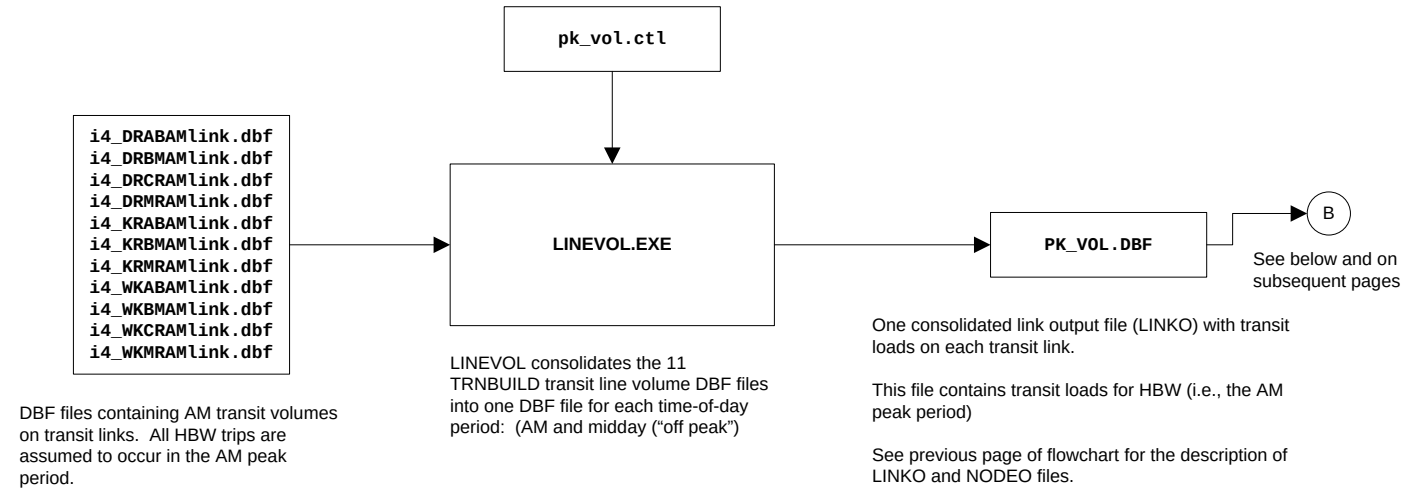
Link output files (LINKO) and node output files (NODEO) from the assignment. NODEO files include the X,Y coords. **LINKO files include**:

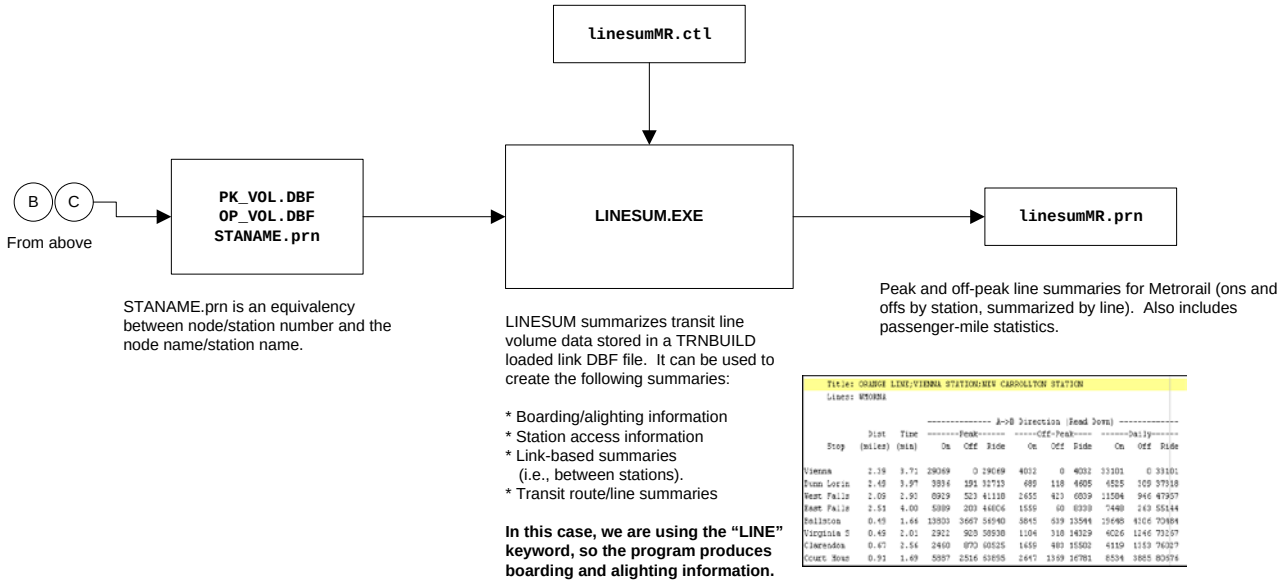
A — A-node of link
B — B-node of link
TIME — A-B time (hundredths of minutes)
MODE — Mode of link (1-255)
COLOR — User designated drawing color
STOP_A — 1 = A is a stop node
STOP_B — 1 = B is a stop node
DIST — A-B distance
NAME — Name of line on this link
FREQ — Service frequency (min)
PLOT — Always = 0

The following are included due to transit assignment
SEQ — Link sequence in the line
OWNER — Line owner (1st ten characters)
AB_VOL — Volume
AB_BRDA — Number of trip boardings a A
AB_XITA — Number of exits at A
AB_BRDB — Number of boardings at B
AB_XITB — Number of exits at B
(last 5 variables are also repeated for B-A direction)

See p. 916 of Citilabs, Inc., "Cube Voyager Reference Guide, Version 5.1.2" (Citilabs, Inc., October 22, 2010).

TranSum.bat





Title: ORANGE LINE;VIENNA STATION:NEW CARROLLTON STATION
Lines: WNORNA

Stop	Dist (miles)	Time (min)	A->B Direction (Read Down) Peak On	Peak Off	Peak Pkde	Off-Peak On	Off-Peak Off	Off-Peak Pkde	Daily On	Daily Off	Daily Pkde
Vienna	2.39	3.71	29369	0	29369	4032	0	4032	33101	0	33101
Dunn Lorin	2.49	3.97	3834	191	32713	686	118	4605	4525	309	37318
West Falls	2.08	2.90	6929	523	41110	2655	423	6839	11584	946	47957
East Falls	2.53	4.00	5889	203	46806	1555	60	6339	7480	263	55144
Ballston	0.49	1.66	13803	3667	56940	5845	539	13544	19648	4206	70884
Virginia S	0.49	2.01	2921	908	58938	1104	318	14329	4026	1246	73267
Clarendon	0.47	2.56	2460	870	60525	1659	483	15502	4119	1353	76027
Court Hous	0.91	1.69	5857	2516	63855	2647	1369	16781	8534	3885	80576

TranSum.bat

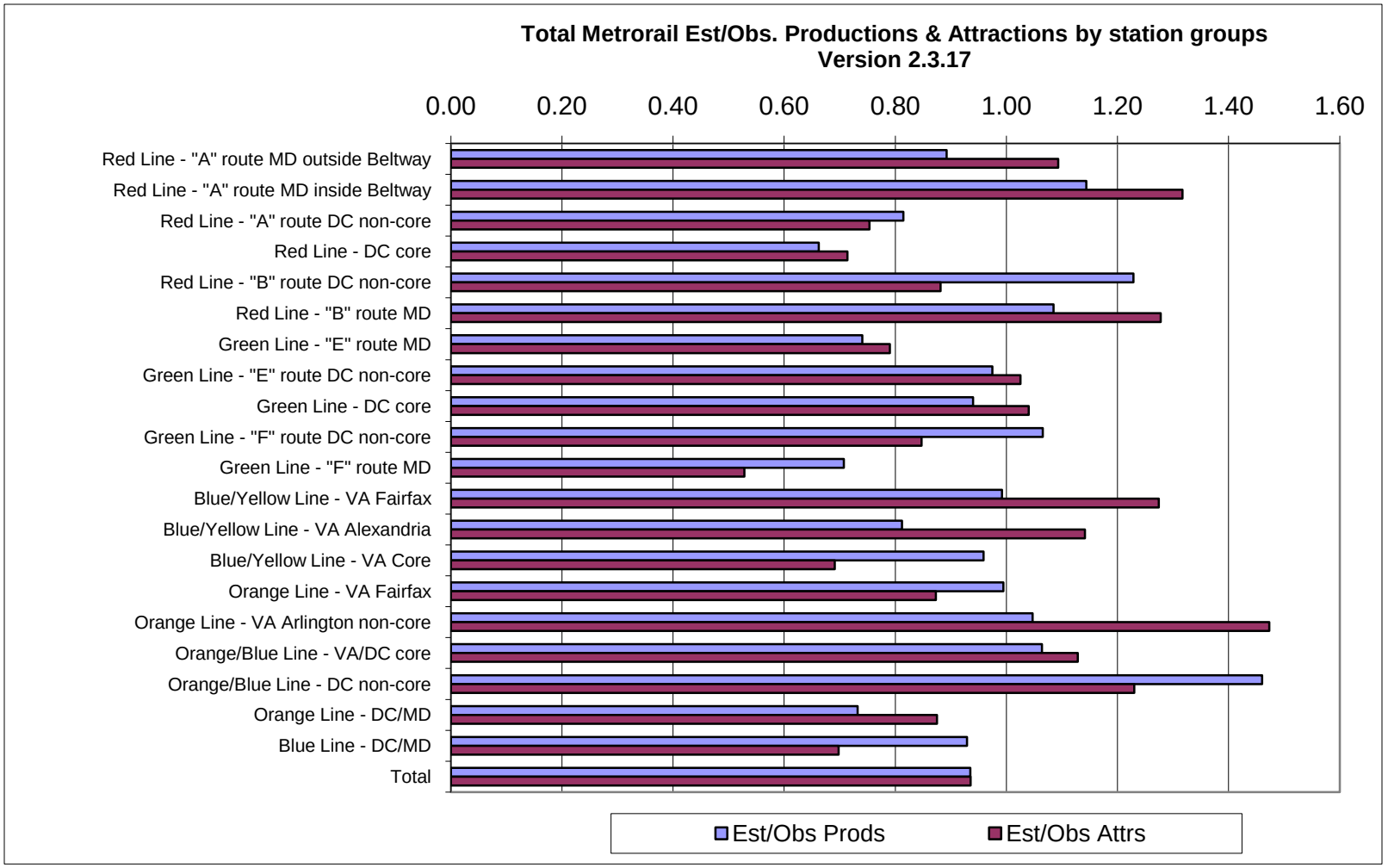
linesumMR.prn ("line" keyword)

```
*****************************************
|                                       |
|          LINESUM - Version 1.7        |
|        Copyright (c) 2011 by AECOM    |
|         Fri Apr 22 11:36:15 2011      |
|                                       |
*****************************************


Control File = ..\..\controls\linesumMR.ctl

Transit Summary Reports

Peak Line File = o:\model_dev\ver2.3.17_3722taz\2007f_pseu\transum\pk_vol.dbf

Off-Peak Line File = o:\model_dev\ver2.3.17_3722taz\2007f_pseu\transum\op_vol.dbf
Transit Summary Reports
Fri Apr 22 11:36:16 2011  LINESUM  page 2



   Title: BLUE LINE;FRANCONIA/SPRINGFIELD STA;LARGO TWN CTR STA
   Lines: WMBLUA

                          -------------- A->B Direction (Read Down) -------------  ------
            Dist   Time   -------Peak------  -----Off-Peak----  ------Daily------  ------
   Stop   (miles) (min)      On   Off  Ride      On   Off  Ride      On   Off  Ride      On

Franconia-    3.49   6.14  13792     0 13792    2929     0  2929   16721     0 16721       0
Van Dorn S    3.86   4.95   7761   137 21415    2113    62  4980    9874   199 26395     117
King Stree    0.68   2.02   3631  1243 23804     765   589  5156    4396  1832 28960     197
Braddock R    2.80   4.46   3540   617 26727    1183   454  5888    4723  1071 32615     146
National A    0.49   2.59     10    32 26703      34     4  5918      44    36 32621      24
Crystal Ci    0.76   2.02   2738  1317 28124    1422   256  7081    4160  1573 35205      81
Pentagon C    0.61   0.99   2552   736 29941    1453   370  8164    4005  1106 38105     188
Pentagon      1.24   2.91  12732  3905 38768    2558   589 10134   15290  4494 48902    1330
Arlington     0.99   2.08     18     0 38786      83     0 10216     101     0 49002      40
Rosslyn       1.35   3.12   2997 12240 29542    1634  3982  7866    4631 16222 37408    6475
Foggy Bott    0.57   2.08    851  6812 23582    1615  2052  7431    2466  8864 31013     804
Farragut W    0.38   0.97    521  9090 15014    1011  1787  6653    1532 10877 21667     658
```

access.prn ("access" keyword)

```
*****************************************
|                                       |
|          LINESUM - Version 1.7        |
|        Copyright (c) 2011 by AECOM    |
|         Fri Apr 22 11:37:00 2011      |
|                                       |
*****************************************


Control File = ..\..\controls\access.ctl

Station Access Summary

Peak Line File = o:\model_dev\ver2.3.17_3722taz\2007f_pseu\transum\pk_v

Off-Peak Line File = o:\model_dev\ver2.3.17_3722taz\2007f_pseu\transum\
Station Access Summary
Fri Apr 22 11:37:01 2011  LINESUM  page 2



   Title: Station Access
   Modes: 11-16

   Stop     Mode   Node   Board  Alight

   8001       11    507      13       0
              11    508      23       0
              11    509      89       0
              11    511     161       0
              11    512      72       0
              11    513      50       0
              11    514      70       0
              11    515      39       0
              11    516      22       0
              11    517      14       0
              11    518      19       0
              11    521       5       0
```

Metrorail Trips



Source for obs. data: 2008 Metrorail Passenger Survey

Highway Capacity Differences V2.2 vs. V2.3 networks

LANE-MILE SUMMARY (Off-Peak Network)

Model	TAZ System	Year	Facility Type --> Fwy	Maj	Min	Coll	Exp	Total
Version 2.2	2191 TAZs	2005	3,401.84	6,908.01	4,273.91	4,128.17	523.89	19,235.82
	2191 TAZs	2040	4,333.30	7,436.41	5,026.18	4,148.36	714.68	21,658.93
Version 2.3	3722 TAZs	2007	3,509.46	6,990.89	4,638.16	5,984.66	546.31	21,669.48
	3722 TAZs	2040	4,448.47	7,532.91	5,263.83	6,015.51	747.2	24,007.92
Change (V2.3 - V2.2)		2005/07	107.62	82.88	364.25	1,856.49	22.42	2,433.66
		2040	115.17	96.50	237.65	1,867.15	32.52	2,348.99
Pct.Change		2005/07	3.2%	1.2%	8.5%	45.0%	4.3%	12.7%
		2040	2.7%	1.3%	4.7%	45.0%	4.6%	10.8%

2040 system reflects 2010 CLRP

Version 2.3 2040 Scenario

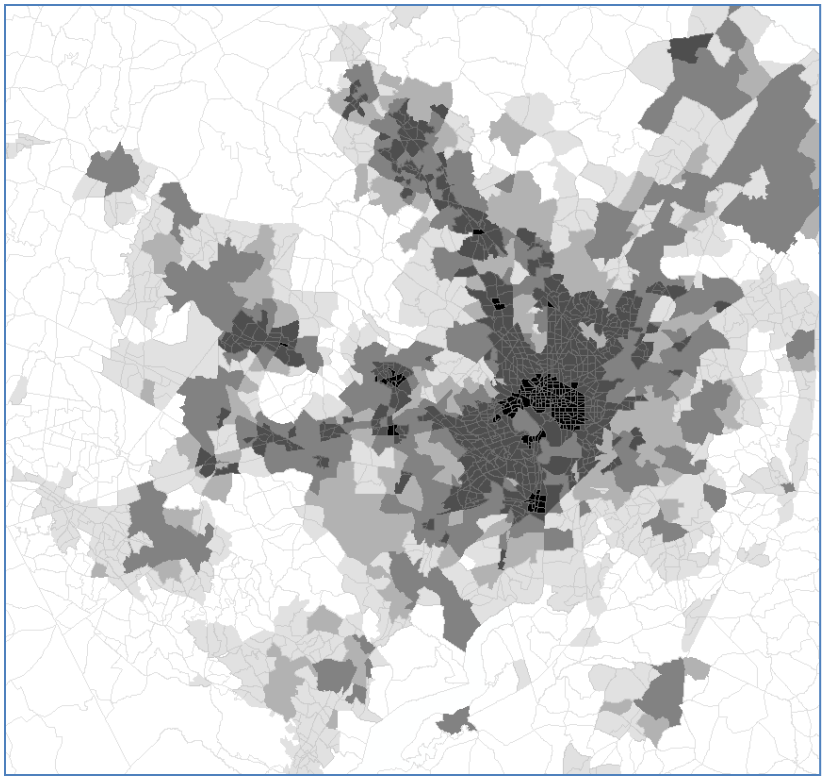
- Existing Version 2.2 approach used:
  - "Base" model run used reflecting HOV 3+ operation on No. Virginia HOT lane facilities (used to develop HOV 3+ LOS skims).
  - "Final" model run reflecting normal HOT lane operations (SOVs pay while HOV 3+ vehicles go free). HOT lane tolls are pre-processed on a freeway segment and time period basis. "Base" HOV 3+ skims are used during mode choice
- Version 2.2 HOT lane toll rates where preserved for Version 2.3 run
- The "transit constraint" process was not considered

Land activity change: 2007-2040

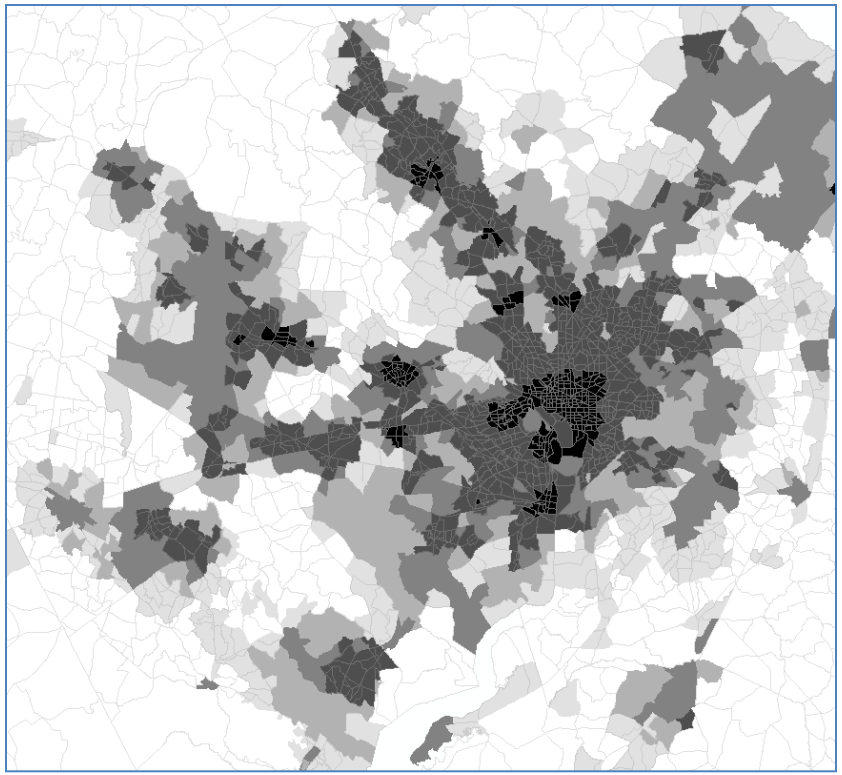
	2007 Psuedo Rnd 8.0			2040 Rnd 8.0			Difference (2040-2007)			Ratio (2040/2007)		
Jur	HH	Total Pop.	Jobs	HH	Total Pop.	Jobs	HH	Total Pop.	Jobs	HH	Total Pop.	Jobs
DC	252,137	528,398	762,884	338,980	760,538	977,163	86,843	232,140	214,279	1.34	1.44	1.28
Mtg	342,690	899,437	501,908	463,000	1,198,997	723,000	120,310	299,560	221,092	1.35	1.33	1.44
Pgeo	293,982	774,696	351,650	360,110	950,119	474,635	66,128	175,423	122,985	1.22	1.23	1.35
Arl	91,109	186,501	192,911	124,207	251,969	281,308	33,098	65,468	88,397	1.36	1.35	1.46
Alx	61,430	117,944	113,315	90,555	188,287	160,447	29,125	70,343	47,132	1.47	1.60	1.42
Ffx	380,539	987,566	654,312	502,041	1,326,117	917,484	121,502	338,551	263,172	1.32	1.34	1.40
Ldn	92,185	245,818	139,679	158,299	439,707	285,415	66,114	193,889	145,736	1.72	1.79	2.04
PW	139,095	395,402	143,294	231,495	639,197	280,697	92,400	243,795	137,403	1.66	1.62	1.96
Frd	82,594	221,395	127,300	147,529	406,401	175,109	64,935	185,006	47,809	1.79	1.84	1.38
Car	61,096	169,190	64,455	81,453	220,066	92,331	20,357	50,876	27,876	1.33	1.30	1.43
How	99,393	270,737	158,277	135,065	328,465	268,828	35,672	57,728	110,551	1.36	1.21	1.70
AnnAr	190,389	489,662	284,632	234,335	581,364	433,501	43,946	91,702	148,869	1.23	1.19	1.52
Calv	29,255	82,530	34,002	40,301	108,882	49,003	11,046	26,352	15,001	1.38	1.32	1.44
Stm	36,561	99,315	56,547	66,509	173,832	80,731	29,948	74,517	24,184	1.82	1.75	1.43
Chs	50,065	135,992	60,700	85,901	224,871	83,097	35,836	88,879	22,397	1.72	1.65	1.37
Fau	22,935	59,845	24,294	63,154	175,906	42,932	40,219	116,061	18,638	2.75	2.94	1.77
Stf	39,400	114,982	42,306	86,205	258,499	74,224	46,805	143,517	31,918	2.19	2.25	1.75
Clk/Jeff	24,013	63,459	25,410	49,835	112,225	35,606	25,822	48,766	10,196	2.08	1.77	1.40
Fbg/Spots	42,736	114,273	57,755	84,100	224,262	105,600	41,364	109,989	47,845	1.97	1.96	1.83
KGeo	8,228	23,220	6,304	16,659	44,265	19,339	8,431	21,045	13,035	2.02	1.91	3.07
TOTAL	2,339,832	5,980,362	3,801,935	3,359,733	8,613,969	5,560,450	1,019,901	2,633,607	1,758,515	1.44	1.44	1.46

Area Types 2007 and 2040

2007



2040



Daily Version 2.3
VMT change
from 2007 to 2040 at
the
Jurisdiction level

Jurisdiction	2007	2040	Difference	Ratio
DC	8,789,589	10,106,835	1,317,246	1.15
Mtg	20,814,606	26,657,608	5,843,002	1.28
PG	22,276,597	28,700,028	6,423,431	1.29
Arl	4,288,672	4,898,728	610,056	1.14
Alx	2,022,118	2,761,358	739,240	1.37
FFx	26,250,161	34,978,309	8,728,148	1.33
Ldn	6,414,267	11,348,198	4,933,931	1.77
PW	8,731,849	14,245,502	5,513,653	1.63
Frd	8,904,510	13,533,059	4,628,549	1.52
How	10,193,661	14,753,149	4,559,488	1.45
Aar	14,870,616	20,517,151	5,646,535	1.38
Chs	3,063,895	4,602,668	1,538,773	1.50
Car	4,314,615	5,830,728	1,516,113	1.35
Cal	1,848,940	2,642,532	793,592	1.43
St.M	2,102,111	2,990,877	888,766	1.42
Kgeo	698,753	1,384,653	685,900	1.98
Fbg	813,841	1,263,518	449,677	1.55
Stf	4,047,317	7,015,484	2,968,167	1.73
Spts	2,077,316	3,987,972	1,910,656	1.92
Fau	3,062,522	5,817,928	2,755,406	1.90
Clk	982,498	1,658,259	675,761	1.69
Jeff	1,375,996	2,189,289	813,293	1.59
Total	157,944,449	221,883,831	63,939,382	1.40

Daily link volume change from 2007 to 2040 at the screenline level

Screenline Link Volume Growth: 2007 to 2040

	2007		2040			
Screenline	Volume	No. of Links	Volume	No. of Links	Difference	Pct. Difference
1	782,844	44	914,768	44	131,924	17%
2	957,835	74	1,079,704	74	121,869	13%
3	911,245	58	1,068,857	60	157,612	17%
4	1,052,037	74	1,203,836	76	151,799	14%
5	1,172,037	62	1,390,798	65	218,761	19%
6	1,694,105	117	2,512,046	118	817,941	48%
7	1,194,672	74	1,470,693	78	276,021	23%
8	1,675,867	100	2,206,369	114	530,502	32%
9	915,021	56	1,331,179	56	416,158	45%
10	517,292	24	786,721	26	269,429	52%
11	310,277	34	498,745	34	188,468	61%
12	546,369	34	708,599	38	162,230	30%
13	497,012	20	641,240	22	144,228	29%
14	286,037	12	341,552	12	55,515	19%
15	311,543	16	385,514	16	73,971	24%
16	161,223	12	299,803	16	138,580	86%
17	476,985	42	691,818	44	214,833	45%
18	646,940	50	959,371	58	312,431	48%
19	640,153	50	973,706	52	333,553	52%
20	1,119,001	14	1,375,686	20	256,685	23%
22	1,688,468	140	2,339,668	147	651,200	39%
23	248,625	30	366,109	33	117,484	47%
24	460,091	32	582,429	32	122,338	27%
25	164,762	12	248,833	14	84,071	51%
26	468,874	18	616,294	19	147,420	31%
27	428,798	16	552,108	16	123,310	29%
28	182,884	26	272,449	26	89,565	49%
31	204,842	30	284,186	30	79,344	39%
32	135,476	8	215,441	8	79,965	59%
33	341,596	20	582,063	24	240,467	70%
34	166,338	18	234,768	18	68,430	41%
35	827,917	36	1,174,734	36	346,817	42%
36	98,508	8	141,474	8	42,966	44%
37	42,653	16	110,948	18	68,295	160%
38	202,817	32	356,660	32	153,843	76%
Total	21,531,143	1409	28,919,169	1484	7,388,026	34%

Summary of V2.2 & V2.3 demographic and travel forecasts

	Version 2.2 / 2,191 TAZs			Version 2.3 / 3,722 TAZs		
	2005/Rnd8.0	2040/Rnd8.0	Ratio ('40/'05)	2007/PseuRnd8	2040/Rnd 8	Ratio ('40/'07)
Households	2,344,561	3,359,740	1.43	2,339,832	3,359,733	1.44
Jobs	3,700,075	5,457,004	1.47	3,801,935	5,560,450	1.46
HH Population	6,124,771	8,452,490	1.38	5,860,693	8,452,483	1.44
HH & GQ Population	6,262,508	8,613,982	1.38	5,980,362	8,613,969	1.44
Internal Transit	1,040,008	1,625,001	1.56	1,085,073	1,625,009	1.50
Internal Auto Person	21,786,677	29,602,271	1.36	16,210,967	22,832,149	1.41
Internal Motor Person	22,826,685	31,227,272	1.37	17,296,040	24,457,158	1.41
Transit Percentage	4.56%	5.20%	1.14	6.27%	6.64%	1.06
Internal Auto Driver	17,280,287	23,715,159	1.37	11,656,208	16,080,484	1.38
Internal Auto Occ.	1.26	1.25	0.99	1.39	1.42	1.02
Int. Motr. Trips/HH	9.74	9.29	0.95	7.39	7.28	0.98
Int. Motr. Trips/Capita	3.73	3.69	0.99	2.95	2.89	0.98
Total Vehicles	**20,670,521**	**28,776,604**	1.39	**15,352,738**	**21,407,179**	1.39
Total_VMT	152,063,583	199,813,810	1.31	157,944,449	221,883,832	1.40
VMT/Capita	24.28	23.20	0.96	26.41	25.76	0.98
VMT/HH	64.86	59.47	0.92	67.50	66.04	0.98
VMT/Trip	7.36	6.94	0.94	10.29	10.36	1.01

Conclusions

- Version 2.3 model developing is continuing
- Documentation is also in a state of flux
- TPB staff will service outstanding requests of the model next week
- TPB staff recommends that agencies wait until November (when the model will be adopted) before using the model
- Sensitivity testing of Version 2.3 has already begun- we welcome the input of the TFS for testing ideas
- Our next meeting (May 20) will be back in phase with the two-month schedule