Item #2

TPB Version 2.3 Travel Model on the 3,722-TAZ area system: Status report

Presentation to the TPB Travel Forecasting Subcommittee

November 18, 2011

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

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Discussion topics

- Contents of documentation
- Recent refinements/adjustments to the model
- Latest model validation results
- Findings of the 2011 CLRP forecasts
- Looking ahead
  - Issues
  - Planned refinements
  - Upcoming studies

Version 2.3 model is adopted

- TPB staff has completed Version 2.3 model work using 2011 CLRP networks and Round 8.0a land activity

- The Version 2.3 model became the adopted regional model for the Washington, D.C. area on November 16 when the TPB adopted the following resolutions:
  - R5- 2012: TPB determines the 2011 CLRP conforms to the CAAA
  - R6-2012: TPB approves the 2011 CLRP

- Adoption specifically entails:
  - The **inputs** to the analysis: 2011 CLRP network and input assumptions
  - The **travel model** used in the conformity assessment
  - **Findings** of the conformity analysis

Recent history of Version 2.3 travel model releases

- April: Version 2.3.17 Draft
- June: Version 2.3.27/28 Draft
- **Today: <u>Version 2.3.36</u> Final/Adopted**

Distinguishing features of Version 2.3

- New, more detailed zone system: 3,722 TAZs
- New data:
  - 2007/08 HTS, 2007 ACS, Transit O-B Surveys, and 2007 traffic counts
  - HTS survey area covered entire modeled region
- Technical refinements:
  - Nested Logit (NL) mode choice model
  - Subdivided NHB among NH-Work & NH-Other
  - Non-motorized travel includes work and non-work
  - Added, modified time periods
  - Other items

Contents of Version 2.3 Documentation

Calibration report contents

List of Chapters	List of Appendices
Introduction	A. Model adjustment factors
Inputs to the Travel Model	B. Year-2007 Jurisdictional trip summary by mode (Est. and Obs.)
Demographic models	C. Year-2007 mode choice est. vs. target totals by market segment
Trip Generation	
Trip Distribution	
Mode choice	
Time-of-Day Model	
Traffic Assignment/Feedback	
Validation	

User's guide contents

List of Chapters	List of Appendices
Introduction	A. Flowcharts
Set-Up and Hwy. Network Building	B. Batch files
Highway Skim File Development	C. Cube Voyager Scripts
Auto Driver Trip Development	D. AEMS Fortran Control Files
Pre-Transit Network Processing	
Transit Skim File Development	
Transit Fare Development	
Demographic Submodels	
Trip Generation	
Trip Distribution	
Mode Choice	
Time-of-Day Processing	
Traffic Assignment	
Transit Assignment	

Refinements and adjustments to the model

Recent refinements to the Version 2.3 model (since August)

- Model calibration revisited
  - **Adjusted observed HTS–based auto person targets and recalibrated mode choice model**

- Corrections
  - Corrected night period peaking factor from 0.35 to 0.15 in Average_Link_Speeds.s
  - Corrected toll values on Dulles Toll road in 2007 highway network

- Other
  - Updated/streamlined/enhanced scripts and batch files

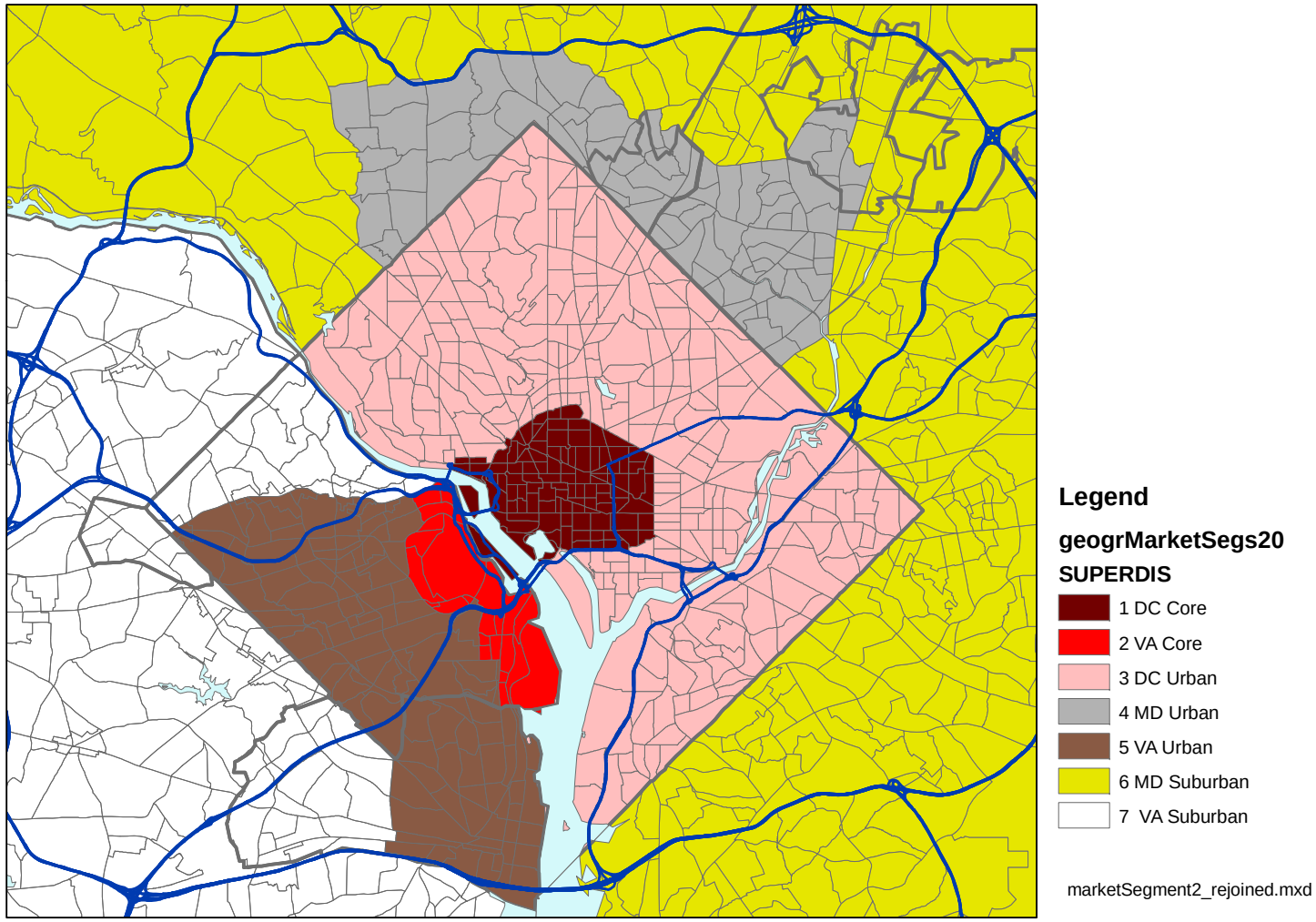
HOV 3+ problems identified with early runs of model (V2.3.27)

- HBW HOV 3+ trips found missing from known markets, e.g.,
  - From Fairfax to DC Core
  - From Prince William to Arlington/DC
- Jurisdictional distribution of HBW 3+ auto person trips found unreasonable
- HOV 3+ volumes on I-95/I-395 low
  - About one half of prior V.2.2 HOV3+ volumes
  - HOV 3+ volume predominantly mostly non-commuter traffic

Investigation

- Auto person “targets” used in the mode choice model calibration (from the HTS) reviewed
  - Targets used in mode choice calibration are based on 20 large-area interchange market segments
  - Auto person targets are prepared by occupant groups (SOV, HOV-2occ., HOV 3+occ.)

Super-districts used in mode choice model calibration market segment s



20 geographic market segment definitions

		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

Assessment :

-Overall auto occupancies appear too low

-No notable occupancy differentials between market segments as one would expect

- -Trips to DC, VA core should be higher particularly for Virginia origins
- -1.14 to 1.29 based on 2006 AM central employment core counts

-A low occupancy guarantees a dearth of HOV-3+s!!

HTS HBW Auto Occupancies

Market Segment	Prod Area	Attr Area	Original HTS Auto Occ.
1	DC	DC core	1.06
2	DC	VA core	1.06
3	DC	Urban DC, MD,VA	1.05
4	DC	Suburban MD,VA	1.05
5	MD urb	DC core	1.06
6	MD urb	VA core	1.05
7	MD urb	Urban DC, MD,VA	1.06
8	MD urb	Suburban MD,VA	1.06
9	VA core/urb	DC core	1.06
10	VA core/urb	VA core	1.06
11	VA core/urb	Urban DC, MD,VA	1.05
12	VA core/urb	Suburban MD,VA	1.05
13	MD suburban	DC core	1.06
14	MD suburban	VA core	1.06
15	MD suburban	Urban DC, MD,VA	1.05
16	MD suburban	Suburban MD,VA	1.06
17	VA suburban	DC core	1.04
18	VA suburban	VA core	1.04
19	VA suburban	Urban DC, MD,VA	1.04
20	VA suburban	Suburban MD,VA	1.06
Total			1.05

Plan A: Return to HTS, develop Auto Persons by Occ. Group based on reported occupancy

Findings:

-Overall auto occupancies are increased

-Improved differential car occupancies between market segments, but still, occupancies appear too low

-Jurisdictional distribution of 3+ HOVs (not shown) remain unreasonable

- HTS HBW auto occupancy, original and revised

Market Segment	Prod Area	Attr Area	Original HTS Auto Occ.	Revised HTS Auto Occ.
1	DC	DC core	1.06	1.08
2	DC	VA core	1.06	1.00
3	DC	Urban DC, MD,VA	1.05	1.03
4	DC	Suburban MD,VA	1.05	1.05
5	MD urb	DC core	1.06	1.10
6	MD urb	VA core	1.05	1.00
7	MD urb	Urban DC, MD,VA	1.06	1.09
8	MD urb	Suburban MD,VA	1.06	1.09
9	VA core/urb	DC core	1.06	1.17
10	VA core/urb	VA core	1.06	1.06
11	VA core/urb	Urban DC, MD,VA	1.05	1.05
12	VA core/urb	Suburban MD,VA	1.05	1.04
13	MD suburban	DC core	1.06	1.13
14	MD suburban	VA core	1.06	1.10
15	MD suburban	Urban DC, MD,VA	1.05	1.10
16	MD suburban	Suburban MD,VA	1.06	1.09
17	VA suburban	DC core	1.04	1.15
18	VA suburban	VA core	1.04	1.11
19	VA suburban	Urban DC, MD,VA	1.04	1.10
20	VA suburban	Suburban MD,VA	1.06	1.09
Total			1.05	1.09

Plan B: Compare 2000 CTPP auto occupancies to HTS

- CTPP occupancies are higher and more in line with expectations regarding commuting occupancies
  - Overall occ. About 1.10
  - Occupancies to DC core from 1.16 – 1.29
  - Occupancies to VA core from 1.13 – 1.26
  - Distribution of 3+ persons (not shown) are reasonable

• HTS HBW Auto occupancies

Market Segment	Prod Area	Attr Area	Original HTS Auto Occ.	2000 CTPP
1	DC	DC core	1.06	1.20
2	DC	VA core	1.06	1.14
3	DC	Urban DC, MD,VA	1.05	1.16
4	DC	Suburban MD,VA	1.05	1.12
5	MD urb	DC core	1.06	1.16
6	MD urb	VA core	1.05	1.15
7	MD urb	Urban DC, MD,VA	1.06	1.12
8	MD urb	Suburban MD,VA	1.06	1.10
9	VA core/urb	DC core	1.06	1.17
10	VA core/urb	VA core	1.06	1.13
11	VA core/urb	Urban DC, MD,VA	1.05	1.11
12	VA core/urb	Suburban MD,VA	1.05	1.09
13	MD suburban	DC core	1.06	1.19
14	MD suburban	VA core	1.06	1.15
15	MD suburban	Urban DC, MD,VA	1.05	1.10
16	MD suburban	Suburban MD,VA	1.06	1.08
17	VA suburban	DC core	1.04	1.29
18	VA suburban	VA core	1.04	1.26
19	VA suburban	Urban DC, MD,VA	1.04	1.12
20	VA suburban	Suburban MD,VA	1.06	1.07
Total			1.05	1.10

Final actions taken

- HTS HBW auto occupant person trips **adjusted** by occupant group; adjustments made by market segment to match 2000 CTPP distributions
- Adjustment did not impact total person trips or transit targets
- Mode Choice model was **recalibrated** with adjusted auto person targets
- New zone-level HTS modal trip tables created to allow for jurisdictional summaries

Model validation results

Comparison of 2007 Estimated and Observed Home Base Work (HBW) and Non-Work Trips by Mode

		Simulated V2.3.36	Observed (2007/08 HTS & Trn On-Board Surveys)		
		Trips	Trips	Diff (E-O)	Ratio (E/O)
HBW	Transit	716,400	755,700	-39,300	0.95
	Auto Person	2,806,600	2,856,600	-50,000	0.98
	Auto Driver	2,576,400	2,609,000	-32,600	0.99
	Motorized Person	3,522,900	3,612,300	-89,400	0.98
	Avg. Auto Occupancy	1.09	1.09	0.00	1.00
	Transit Percentage	20.33	20.90	-0.57	0.97
Non-Work	Transit	361,100	368,400	-7,300	0.98
	Auto Person	13,409,200	13,393,600	15,600	1.00
	Auto Driver	9,040,600	9,067,300	-26,700	1.00
	Motorized Person	13,770,300	13,762,000	8,300	1.00
	Avg. Auto Occupancy	1.48	1.48	0	1.00
	Transit Percentage	2.62	2.68	0	0.98
Total	Transit	1,077,500	1,124,100	-46,600	0.96
	Auto Person	16,215,700	16,250,100	-34,400	1.00
	Auto Driver	11,617,000	11,676,300	-59,300	0.99
	Motorized Person	17,293,200	17,374,300	-81,100	1.00
	Avg. Auto Occupancy	1.40	1.38	0.02	1.01
	Transit Percentage	6.23	6.50	-0.27	0.96

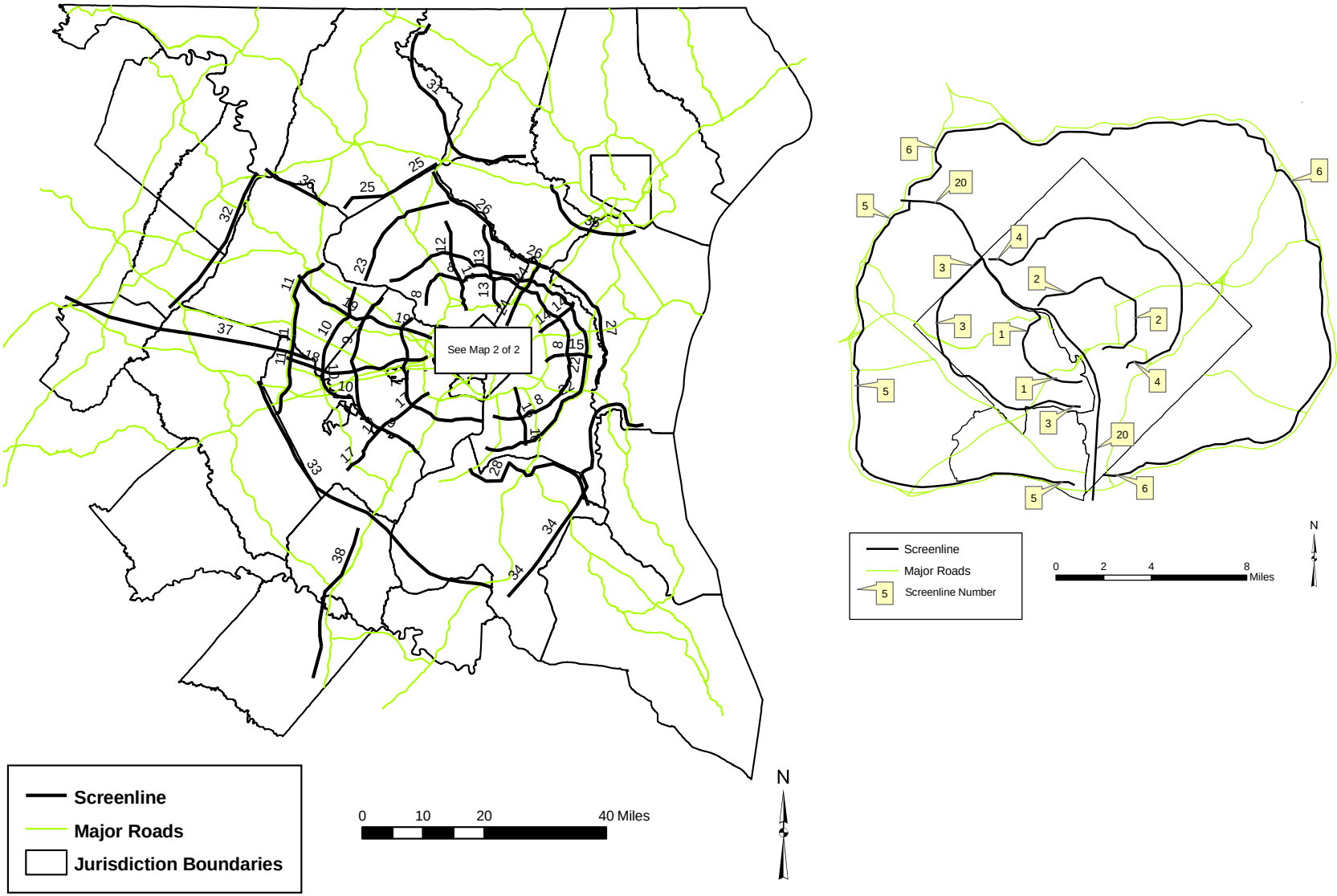
2007 Estimated/Observed (HPMS) VMT for the Washington, DC MSA

State	Observed VMT	Estimated VMT	Difference	Pct. Difference
DC	8,271,900	8,929,239	657,339	1.08
MD	56,366,301	55,859,589	-506,712	0.99
VA	50,237,805	50,495,080	257,275	1.01
Total	114,876,006	115,283,908	407,902	1.00

Year 2007 Estimated and Observed Daily Screenline Crossings (where percent links with counts >=50)

Screenline	Estimated	Observed	Difference	Ratio	Screenline Links	Screenline Links with Counts	Pct. Links with Counts
1	432,188	541,123	-108,935	0.80	44	24	0.55
2	913,400	770,152	143,248	1.19	74	60	0.81
3	744,547	769,828	-25,281	0.97	58	44	0.76
4	1,048,019	844,084	203,935	1.24	74	68	0.92
6	1,526,646	1,517,908	8,738	1.01	118	68	0.58
10	470,090	437,926	32,164	1.07	24	18	0.75
11	255,449	218,070	37,379	1.17	34	20	0.59
13	435,242	367,212	68,030	1.19	20	10	0.50
14	263,130	323,644	-60,514	0.81	12	8	0.67
15	268,910	326,882	-57,972	0.82	16	8	0.50
17	157,650	175,348	-17,698	0.90	42	22	0.52
19	310,789	398,144	-87,355	0.78	50	27	0.54
20	1,130,839	897,896	232,943	1.26	14	14	1.00
23	234,069	237,578	-3,509	0.99	31	18	0.58
25	138,663	109,804	28,859	1.26	12	8	0.67
28	172,704	231,106	-58,402	0.75	26	24	0.92
31	180,641	78,014	102,627	2.32	30	20	0.67
33	337,117	290,636	46,481	1.16	22	16	0.73
34	111,655	96,922	14,733	1.15	18	14	0.78
35	688,805	855,788	-166,983	0.80	36	30	0.83
36	50,040	11,702	38,338	4.28	8	6	0.75
37	40,774	30,784	9,990	1.32	16	16	1.00
38	185,109	266,540	-81,431	0.69	32	26	0.81
Total	**10,096,476**	**9,797,091**	**299,385**	**1.03**	**811**	**569**	**0.70**

Regional Screenlines



Percent RMSE by Facility Type

Facility Type		% RMSE
FTYPE1	Freeway	24%
FTYPE2	Major Arterial	38%
FTYPE3	Minor Arterial	57%
FTYPE4	Collector	82%
FTYPE5	Expressway	35%
All FTYPEs		43%

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Findings of the 2011 CLRP Forecasts

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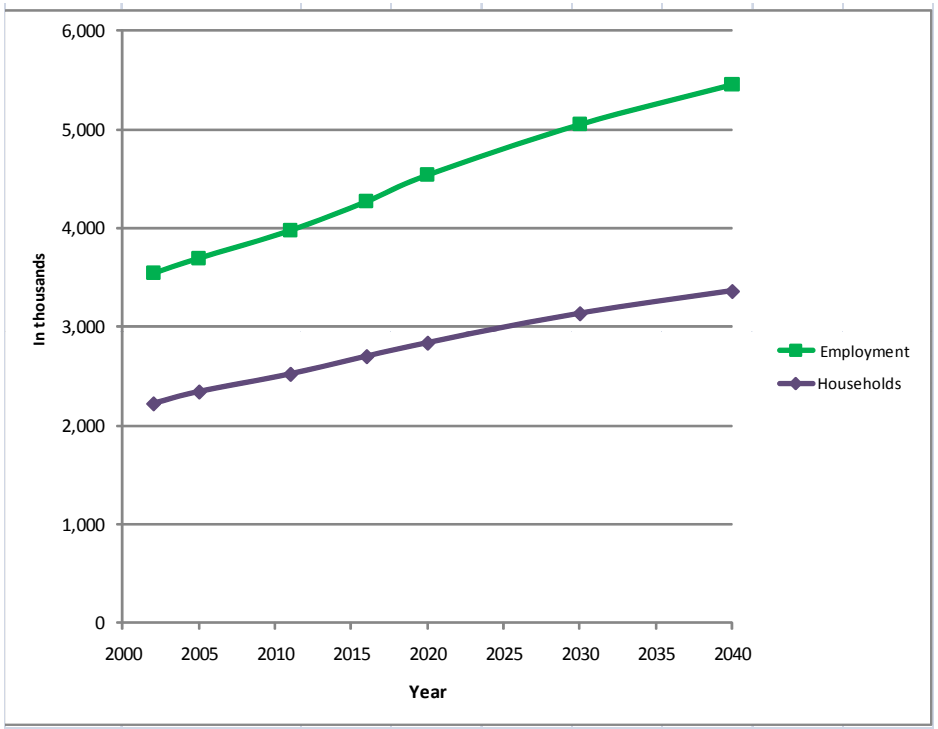
Comparison of HHs and Jobs Round 8.0a Land use



Employment

Travel Model	Land Use	2002	2005	2011	2016	2020	2030	2040
Ver2.2	Rnd 8.0 (2010 CLRP)	3,544,852	3,700,075	3,982,448	4,276,603	4,544,538	5,056,869	5,457,004
Ver 2.3.36	Rnd 8.0a (2011 CLRP)	3,544,828	3,697,250	3,978,310	4,272,759	4,540,907	5,054,023	5,456,960

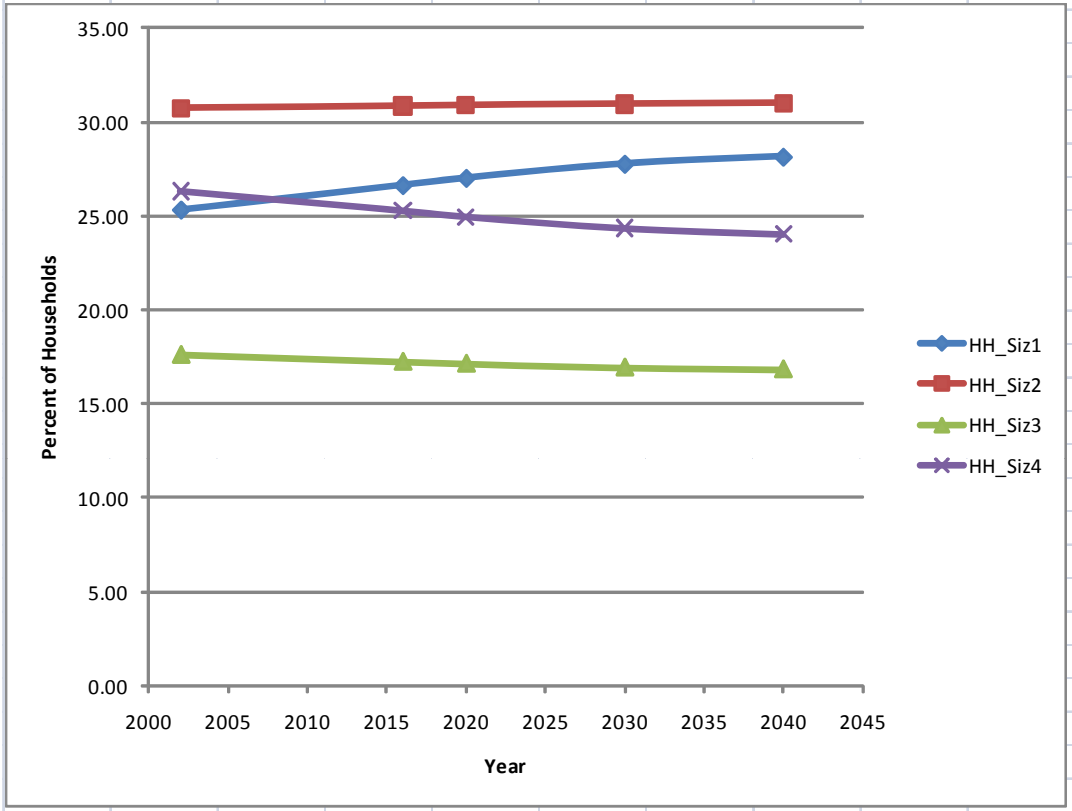
Households

Travel Model	Land Use	2002	2005	2011	2016	2020	2030	2040
Ver2.2	Rnd 8.0 (2010 CLRP)	2,223,890	2,344,561	2,524,150	2,702,192	2,838,522	3,134,320	3,359,740
Ver 2.3.36	Rnd 8.0a (2011 CLRP)	2,223,806	2,344,536	2,523,119	2,702,262	2,839,041	3,136,772	3,362,449

Note: Years 2020, 2030, and 2040 are from the Amended 2010 CLRP

Version 2.3.36
HH Size shares over time

- Forecasts of one-person household share increasing
- Forecasts of two-person household share is generally holding constant
- Forecasts of three- and four-person household shares are declining
- Reason: Cooperative forecasts of households and population imply declining household size

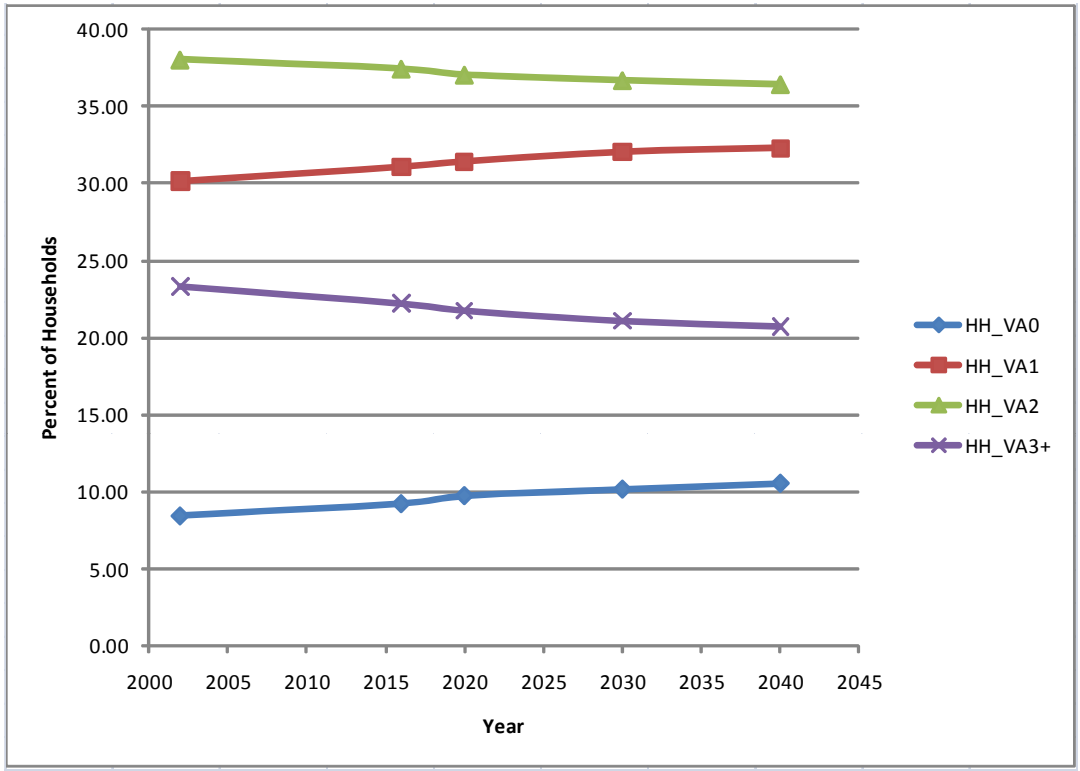


Percent of Households by Size over time

HH Size	2002	2016	2020	2030	2040
HH_Siz1	25.34	26.64	27.02	27.77	28.15
HH_Siz2	30.74	30.84	30.88	30.94	30.99
HH_Siz3	17.61	17.24	17.14	16.94	16.84
HH_Siz4	26.32	25.29	24.96	24.35	24.02
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Version 2.3.36
HH vehicles available shares over time

- Forecasts of zero- and one-vehicle household shares increasing
- Forecasts of two- and three plus-vehicle household shares are decreasing
- Reason: Declining household sizes and increasing transit accessibility



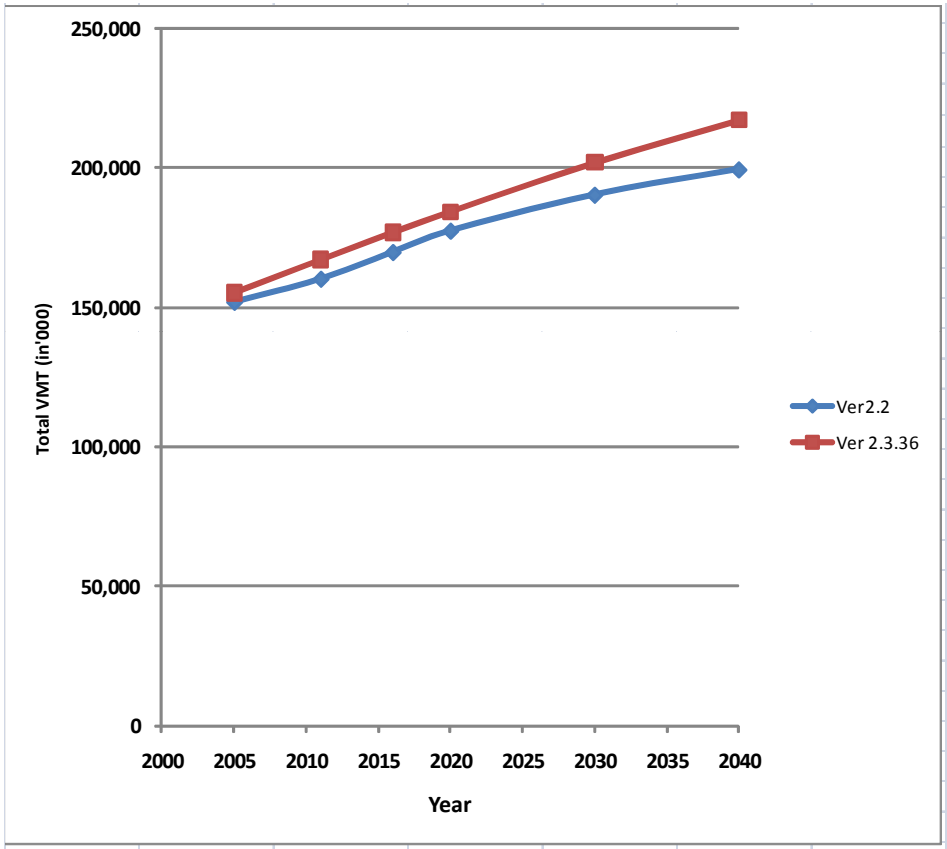
Percent of Households by Vehicles Available over time

Veh. Av.	2002	2016	2020	2030	2040
HH_VA0	8.47	9.25	9.77	10.19	10.56
HH_VA1	30.15	31.07	31.42	32.03	32.28
HH_VA2	38.04	37.45	37.06	36.70	36.44
HH_VA3+	23.34	22.22	21.75	21.08	20.72
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Comparison of Total VMT (Version 2.2 vs. Version 2.3.36 Travel Model)

Version 2.3 VMT is higher than that of Version 2.2, in part, because the network is more detailed –

What used to be intra-zonal travel is now inter-zonal travel



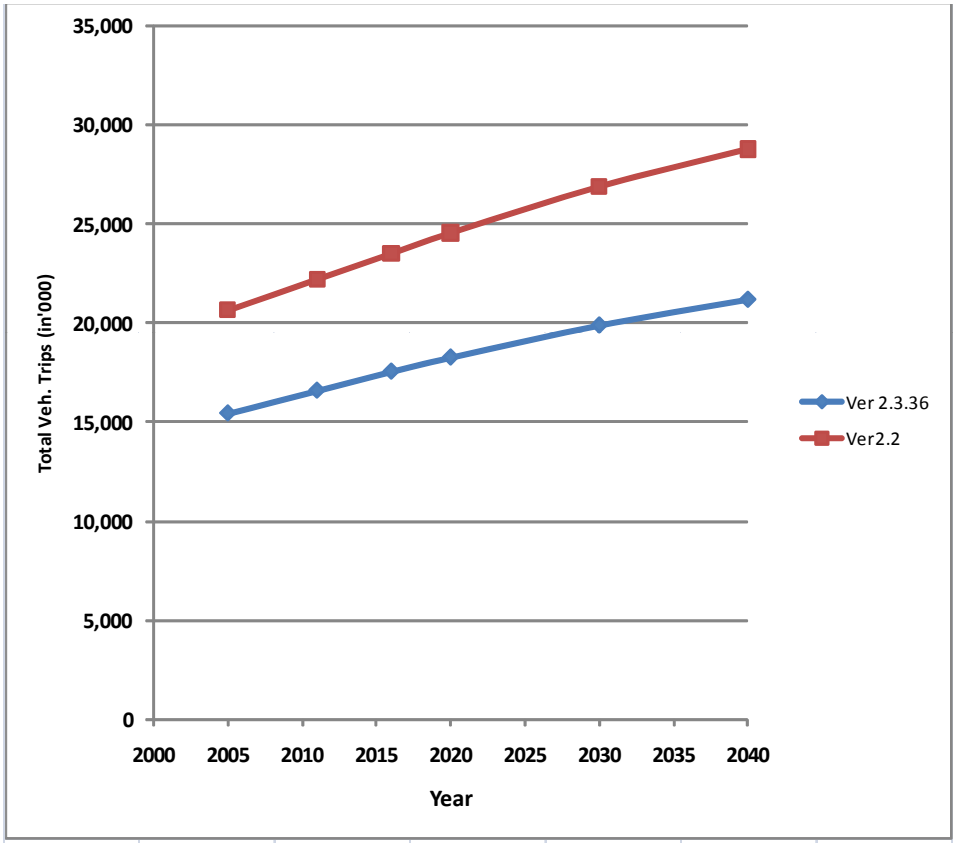
Total VMT

Travel Model	2005	2011	2016	2020	2030	2040
Ver2.2	152,063,583	160,327,029	169,884,385	177,530,270	190,421,575	199,463,681
Ver 2.3.36	155,301,301	167,126,118	176,980,133	184,427,424	201,999,848	217,182,430

Note: Years 2020, 2030, and 2040 are from the Amended 2010 CLRP

Comparison of Total Vehicle Trips (Version 2.2 vs. Version 2.3.36 Travel Model)

The Version 2.3 trip rates are substantially low than Version 2.2 trip rates



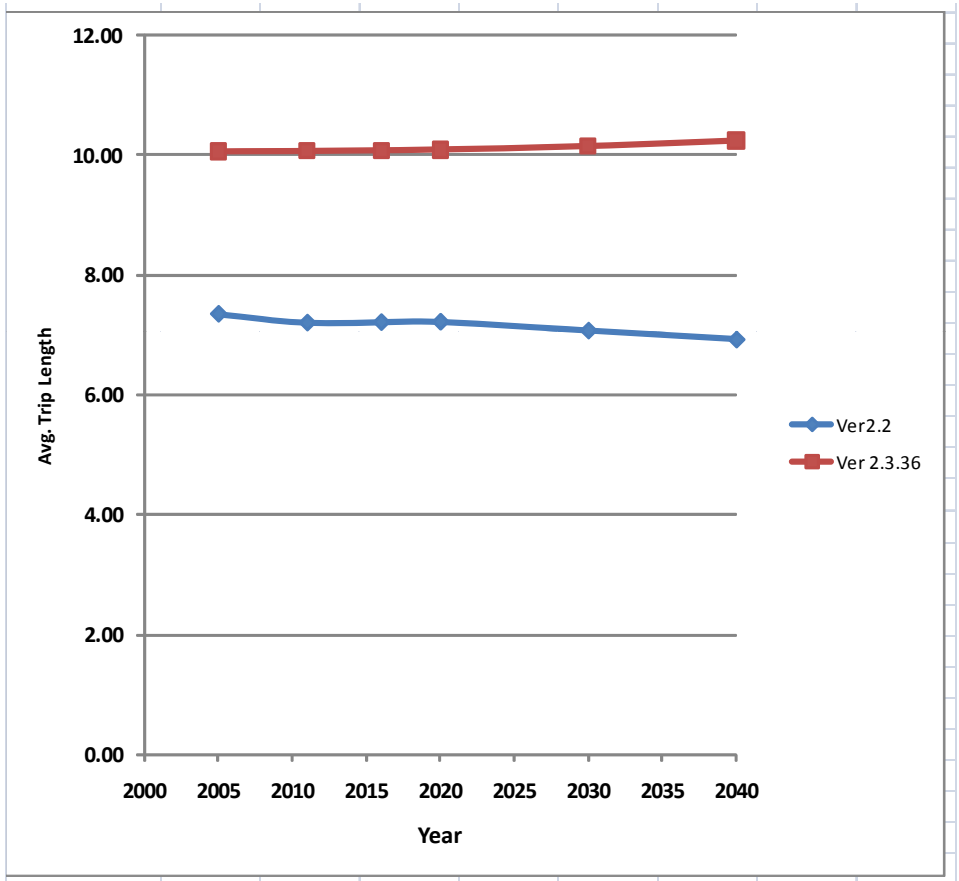
Total Vehicle Trips

Travel Model	2005	2011	2016	2020	2030	2040
Ver2.2	20,670,521	22,236,285	23,535,219	24,574,366	26,906,137	28,793,212
Ver 2.3.36	15,436,551	16,594,669	17,559,767	18,276,881	19,899,329	21,204,906

Note: Years 2020, 2030, and 2040 are from the Amended 2010 CLRP

Comparison of Average Trip Length (Version 2.2 vs. Version 2.3.36 Travel Model)

The Version 2.3 trip lengths are substantially higher than Version 2.2 trip lengths

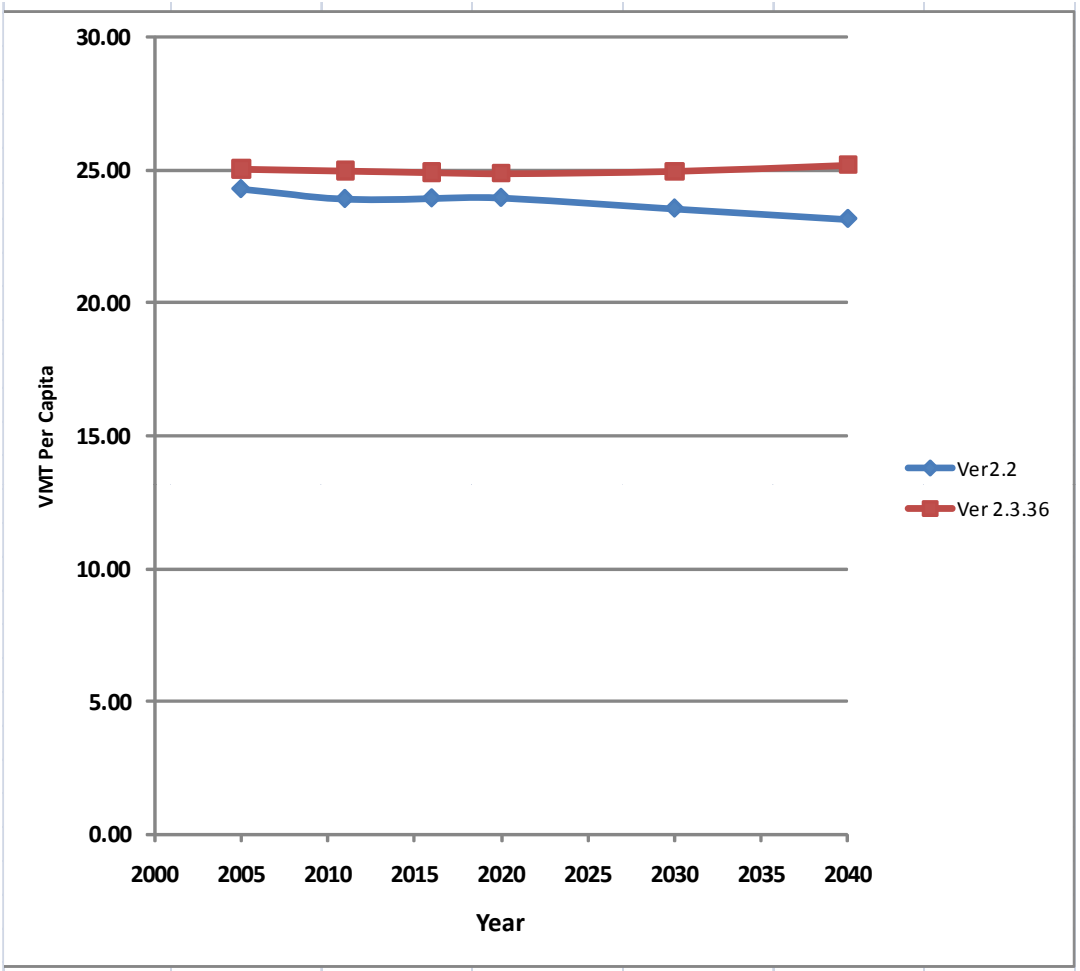


Average Trip Length

Travel Model	2005	2011	2016	2020	2030	2040
Ver2.2	7.36	7.21	7.22	7.22	7.08	6.93
Ver 2.3.36	10.06	10.07	10.08	10.09	10.15	10.24

Comparison of VMT Per Capita (Version 2.2 vs. Version 2.3.36 Travel Model)

- Version 2.3 does not replicate the decline shown from the Version 2.2 travel model

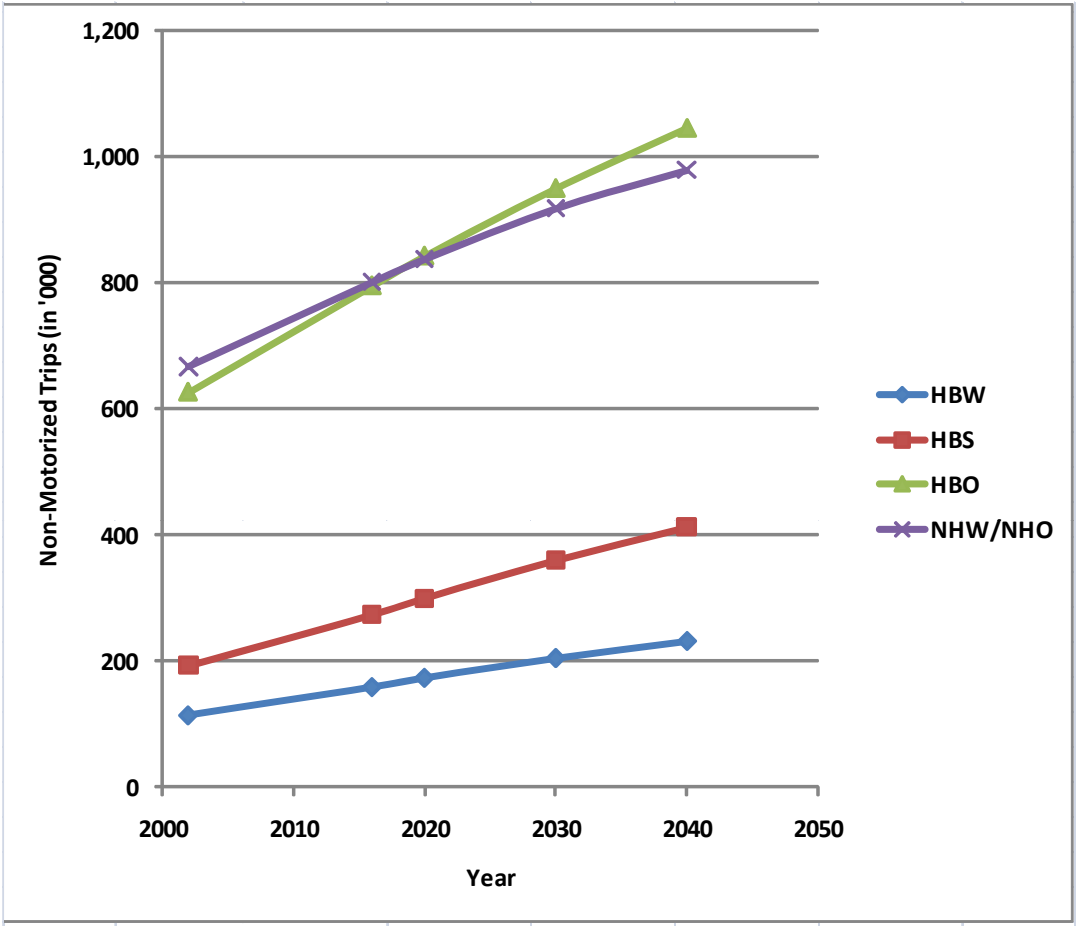


VMT Per Capita

Travel Model	2005	2011	2016	2020	2030	2040
Ver2.2	24.28	23.91	23.93	23.95	23.55	23.16
Ver 2.3.36	25.05	24.98	24.92	24.88	24.97	25.20

Version 2.3.36
Non-motorized (bicycle and pedestrian) travel forecasts

- Non-motorized travel forecasts increase as mixed use density grows in the region
- Growth is shown for all modeled purposes
- Non-motorized growth rate is higher than that of motorized travel

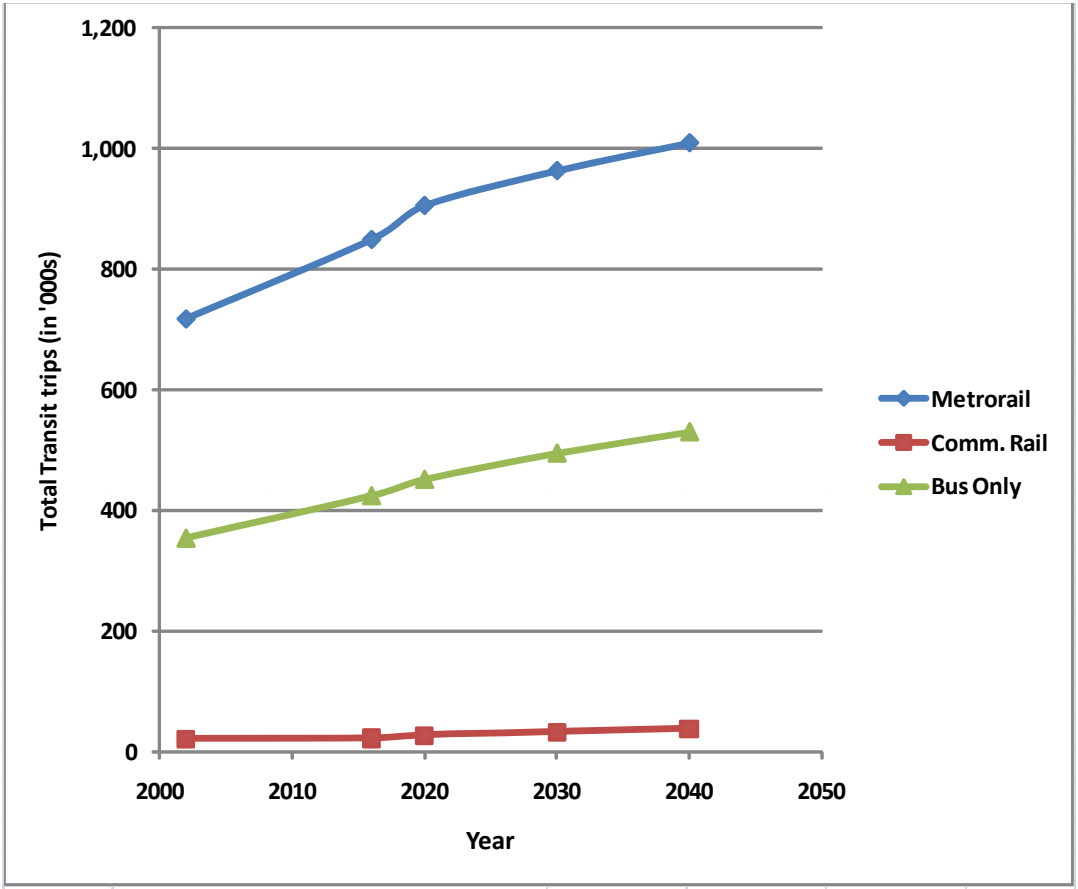


Non-Motorized Trips

Purpose	2002	2016	2020	2030	2040
HBW	115,095	159,306	173,790	204,676	231,323
HBS	193,186	274,083	300,453	360,391	412,596
HBO	626,195	795,370	842,615	950,053	1,045,568
NHW/NHO	666,986	801,383	837,764	918,294	979,275
TOTAL	**1,601,462**	**2,030,142**	**2,154,622**	**2,433,414**	**2,668,762**

Version 2.3.36 Transit forecasts by submode

- All transit trips are growing across all submodes
- Metrorail has the highest rate of growth
- Commuter rail shows moderate growth
- Metrorail constraint imposed beyond year 2020 (for trips to and through the regional core area)



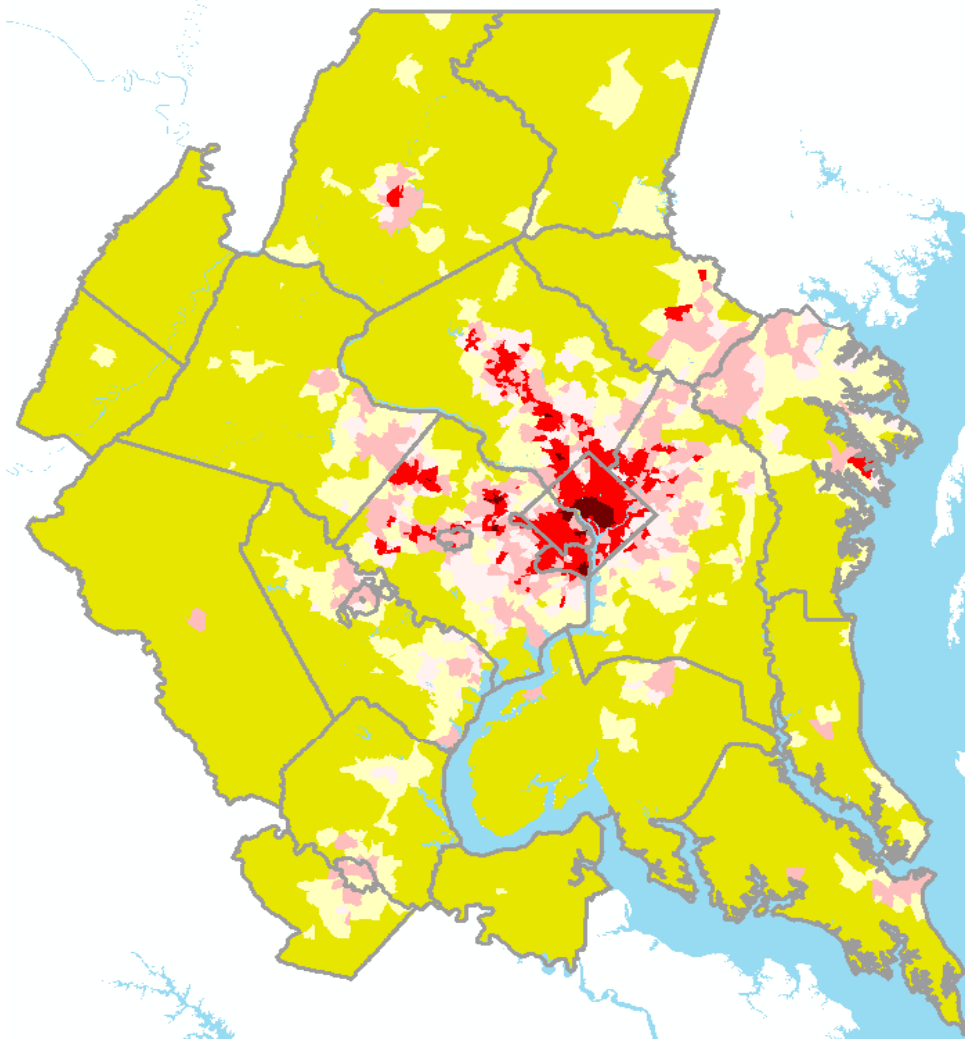
Total Transit Trips by submode

Purpose	2002	2016	2020	2030	2040
Metrorail	718,078	849,695	905,962	963,781	1,009,849
Comm. Rail	20,625	21,658	26,958	32,327	37,718
Bus Only	353,787	423,932	450,844	494,207	529,295
Total Transit	**1,092,490**	**1,295,285**	**1,383,764**	**1,490,315**	**1,576,862**

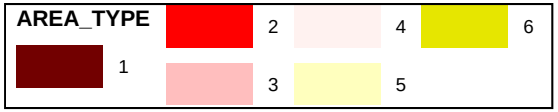
Note: Commuter rail trips include Metrorail trips

Looking ahead

Staff recommendation: further examine the area type system



Area Type	Name
1	High mixed employment and population density
2	Medium/high mixed density
3	Medium employment density
4	Medium population density
5	Low density
6	Rural

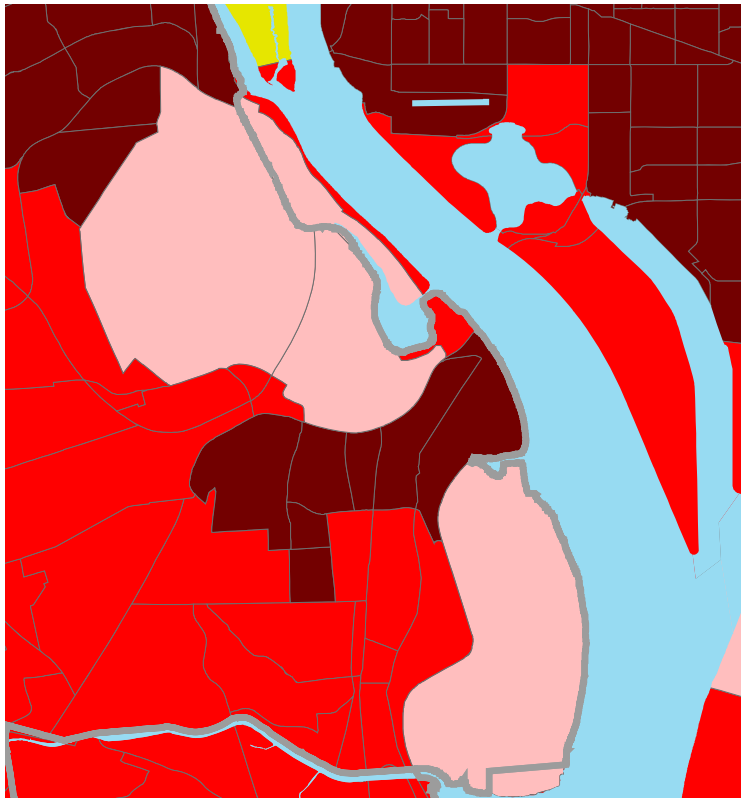


One example: Pentagon

- Pentagon classified as “medium employment density” area

-Why?

“Arlington cemetery effect”- the floating density makes the Pentagon TAZ appear as medium density



Area Type	Name
1	High mixed employment and population density
2	Medium/high mixed density
3	Medium employment density
4	Medium population density
5	Low density
6	Rural

Other Issues

- Running time is still excessive
- TPB staff has noticed that some runs “hang”
  - Under investigation
- Traffic count coverage is still too low
  - We are collecting 2010 counts for next validation
- Model refinement will continue this year
  - New model version will likely be released in a year

Next Steps

- “Replication runs” are in motion to double-check Version 2.3 model results
- Version 2.3 transmittal package is being prepared
  - Memorandum documenting files prepared
  - Transfer medium: COG FTP site
- TFS feedback on documentation is welcomed
- Version 2.3 refinement activities will be ongoing
- Next production model release including refinements: Nov. 2012

Upcoming regional planning work

- State Implementation Plan (SIP) update
  - Years studied: 2002, 2007, 2017, 2025
  - Will involve new EPA MOVES model
- TPB Regional Transportation Priorities Plan (RTPP)
  - Examination of transportation and land use scenarios
  - Will carry on with work begun previously with the Version 2.2 model

Local project planning studies likely involving Version 2.3 travel model

- Virginia
  - Transaction 2040 (NVTA)
  - I-66 Multimodel Study (NVDOT)
  - I-66 Outside the Beltway (VDOT Central Office)
- Maryland
  - ICC Volume Re-evaluation Study (MDSHA)
  - MD 586 Viers Mill Road Study (MDSHA)
- District of Columbia and Federal studies?

Conclusions

- Version 2.3.36 is now released
- Transmittal package is in preparation
- Model refinements to be discussed
- Appreciate feedback from external users