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Appendix F:

VRE Haymarket Extension Model Update

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This technical memorandum briefly outlines the model developed for alternative analyses of VRE Commuter Rail extension to Haymarket. The model is referred to as VRE model and is built on top of the post-process Nested Logit MWCOG model developed for FHWA White House Area Transportation Study project (WHATS Model). The WHATS model itself is built on top of the MWCOG-WMATA model developed for DC and Columbia Pike Alternatives Analyses. Both the WMATA and WHATS model utilized MWCOG version 2.1 D model as the parent model. The VRE model adopts the latest MWCOG version 2.2 model as the parent model. The general framework of all three models (WMATA, WHATS and VRE) are similar and the user's guide prepared for MWCOG-WMATA model can be used to execute the VRE model (refer to "Users Guide for Transit Component of Washington Regional Demand Forecasting Model.doc").

This document is organized into five sections. The background of the model evolution to the one calibrated for the base year i.e. 2002 is described in the first section. This is followed by a brief discussion on the calibration targets that are used in this study. Section 3 presents in greater detail the changes and updates that are made to the model. The calibration and validation results from the model after the updates and enhancements made to the model are reported in Section 4.

1. Background

The model developed for alternatives analyses of Virginia Railway Express's (VRE) extension to Haymarket (VRE Model) is continuation of the model work done for the FHWA White House Area Transportation Study project (WHATS Model). The WHATS model structure is based on the model developed for alternatives analyses study for Columbia Pike and District of Columbia LRT corridors (MWCOG-WMATA Model). The three models mentioned above (WMATA, WHATS, and VRE models) use the standard MWCOG travel demand model inputs (networks, trip tables and highway skims) but have a detailed transit model that applies a Nested Logit Mode Choice Model as a post-process step. The WMATA and WHATS model used MWCOG version 2.1 D model as the parent model. The VRE model adopts the latest MWCOG version 2.2 model as the parent model. The key difference between the WMATA model and the WHATS (and VRE) model is the market segmentation structure in the mode choice model. The WMATA model divided the MWCOG modeling region into 20 markets (based on production and attraction) and developed transit constant at geographic market, sub-mode and access mode level. This detailed model stratification resulted in high number of transit constants in the MWCOG-WMATA model – one for each sub-mode (Commuter Rail, Metro Rail, Bus-Metro Rail, and All Bus path), mode of access (walk, drive, and kiss-ride), and market segment. Due to lack of sufficient and reliable observed transit ridership data at such detailed level, the MWCOG-WMATA model structure was revised for WHATS project to eliminate transit constants by sub-mode and geographic market segmentation. The revised WHATS model developed transit constants by mode of access and income group where applicable. The current model for VRE adopted the model structure developed for WHATS project and utilized the latest MWCOG version 2.2 model as the parent model. The Commuter Rail ridership calibration targets for VRE model are re-estimated using the 2007/2008 MARC and VRE Commuter Rail on-board surveys. Additional model enhancements, as described below, are

made in the VRE model to improve the estimation of long distance Commuter Rail trips. The VRE model is calibrated to base year 2002 and the Commuter rail ridership on VRE Manassas line is validated to Year 2008.

2. Transit Calibration Targets (2002)

The VRE model is calibrated to year 2002 transit targets developed using 2002 Metro Rail on-board survey and 2000 WMATA bus survey for the calibration of MWCOG-WMATA model. For the VRE model, information from the recent 2007/2008 Commuter Rail on-board survey (MARC and VRE) and ridership information from FTA's National Transit Database (NTD) is utilized to fine-tune original commuter rail calibration targets. The 2002 transit targets developed for calibrating 2002 WMATA model are used for non-Commuter rail transit modes (Bus, Metro-rail and Bus/Metro-rail). Table 1 summarizes the transit calibration targets by trip purpose, by mode of access, and by time-of-day. The VRE model does not have sub-modal transit constants, hence only the sub-totals by mode of access, trip purpose and time of day are utilized for calibrating the model.

3. Changes/Updates to the Model

Several changes/updates have been made to the VRE model to improve the ridership estimates for calibration and validation years. These changes can be further categorized as network related changes, software related changes, and other changes. The following sub-sections will discuss each one in further detail.

3.1 *Network related changes*

The headways, coding, and running times of Metro Rail and Commuter Rail routes for 2002 and 2008 model transit line files (Mode3 and Mode4) are validated / updated based on the published schedule. Regional commuter express routes serving travel market from sub-urban to DC core are only allowed to drop-off passengers in the in-bound direction and pick-up passengers in the out-bound direction once they enter Pentagon and DC core area. In the model, the transit lines for these routes are re-coded with the individual stops designated as board-only or alight-only so that the regional commuter and express routes operate properly. The Metrorail station database is updated: Pentagon City station is designated as mid-line park-&-ride and West Falls Church metro station is designated as end-of-line park-&-ride station. Shadow prices are added to station database to redistribute the park-&-ride demand at Metrorail stations. Finally, several enhancements are made to the highway and transit networks to facilitate more comprehensive access connectors around the rail stations. The enhanced network coding around rail stations is similar to the coding done for WMATA model (refer to "MWCOG_Network_Coding_Guide_revised_Feb08.doc").

3.2 *Software related changes*

The auto access connector program "autoacc3.exe" is updated with revised back-tracking restriction. The back-tracking restrictions are relaxed slightly to achieve better connectivity and improved assignment of survey based trip tables. The auto-connector program is also updated to correct for error in coding impedance on long kiss-ride links to Pentagon (slugger links).

The program "a1format.exe" is updated to read additional input file to append pedestrian environment factor in the master A2Deck file.

The program "stopsv2.exe" is updated to read revised transit line coding format.

3.3 Other changes

Pedestrian Environment Factor:

The revised MWCOG-WMATA models developed for FHWA White House Area Transportation Study (WHATS) and Virginia Railway Express (VRE) extension to Haymarket study utilize a measure of area's "walk-ability" known as the Pedestrian Environment Factor (PEF). In other words, the walk-ability of the neighborhood influences whether an individual chooses a drive access or a walk access transit trip. In the case of walk access transit trips the pedestrian environment plays an important role both at the production and the attraction end. But in the case of drive access transit trips the pedestrian environment primarily at the attraction end influences the mode choice of the trip. The PEF is defined as the number of Census blocks in a TAZ divided by the area of the TAZ in square miles. A greater density of census blocks implies a more regular street network and more local streets, both of which improve walking and biking conditions.

PEF for MWCOG modeled region and downtown Washington DC area are mapped in Figure 1 and Figure 2 below. Zones with a dense street grid will have a much higher pedestrian environment score (70+) than zones in suburban areas with relatively few intersecting streets (less than 10). Since the PEFs are taken from the Census block group definition, it will be inferred for future conditions based on analogy to existing, similar development.

The pedestrian environment factor variable is added to the mode choice model to move much of the explanatory power of the model out of the market segment constants and into a defensible land-use attribute. This variable makes the walk to transit options more attractive for D.C. urban residential areas. It also helps Maryland urban areas generate more walk to transit trips than Virginia urban areas as observed in the transit survey. This variable reduces the overall walk to transit trips in Virginia without significantly dampening the walk to transit from the denser areas of Arlington and Alexandria.

The variable that is used in the mode choice model is intended to capture the fact that the highest walk to transit shares occur in locations where both ends of the trip are walk accessible to transit. The highest drive-to-transit trips occur in locations where the attraction end is highly walk-accessible and production-end is less walk-accessible.

The logic used to compute the PEF utility component for walk-to-transit trips is as follows:

- A middle PEF value is assumed and the computations of PEF factor are made relative to the middle PEF. For MWCOG model, the MiddlePEF value is assumed to be 75
- Relative PEF of production end of trip: $\text{ProductionPEF} = \text{Production zone PEF} - \text{MiddlePEF}$
- Relative PEF of attraction end of trip: $\text{AttractionPEF} = \text{Attraction zone PEF} - \text{MiddlePEF}$

- PEF-Walk Variable = $\text{Min}(\text{ProductionPEF}, \text{AttractionPEF})$

A similar procedure is used to compute the PEF Drive-Transit Utility component:

- A middle PEF value is assumed and the computations of PEF factor are made relative to the middle PEF. For MWCOC model, the MiddlePEF value is assumed to be 75.
- Relative PEF of production end of trip: $\text{ProductionPEF} = \text{Production zone PEF} - \text{MiddlePEF}$
- Relative PEF of attraction end of trip: $\text{AttractionPEF} = \text{Attraction zone PEF} - \text{MiddlePEF}$
- Sign of PEF utility: Default PEFSign = -1. If ($\text{ProductionPEF} > 0$ and $\text{AttractionPEF} < 0$) then PEFSign = +1
- PEF-Drive Variable = $\text{PEFSign} * (\text{ProductionPEF} / \text{MiddlePEF}) * \text{AttractionPEF}$

The coefficient for PEF variable in the utility equation is set to +0.05. Figure 3 and Figure 4 show a three dimensional rendering of PEF-Walk and PEF-Drive variable with respect to production and attraction end PEF.

Adjustments to PEF: Initial model results indicated that the PEF for the Virginia attractions needs to be reduced by 30% from the value estimated using the definition, to match the observed ridership in Virginia. In contrast, from observation and experience we found that the PEF for the Pentagon and Crystal city region needs to be increased further to better represent the walk-ability around the Crystal city and Pentagon region.

Figure 1: MWCOG Regional Area Pedestrian Environment Factor

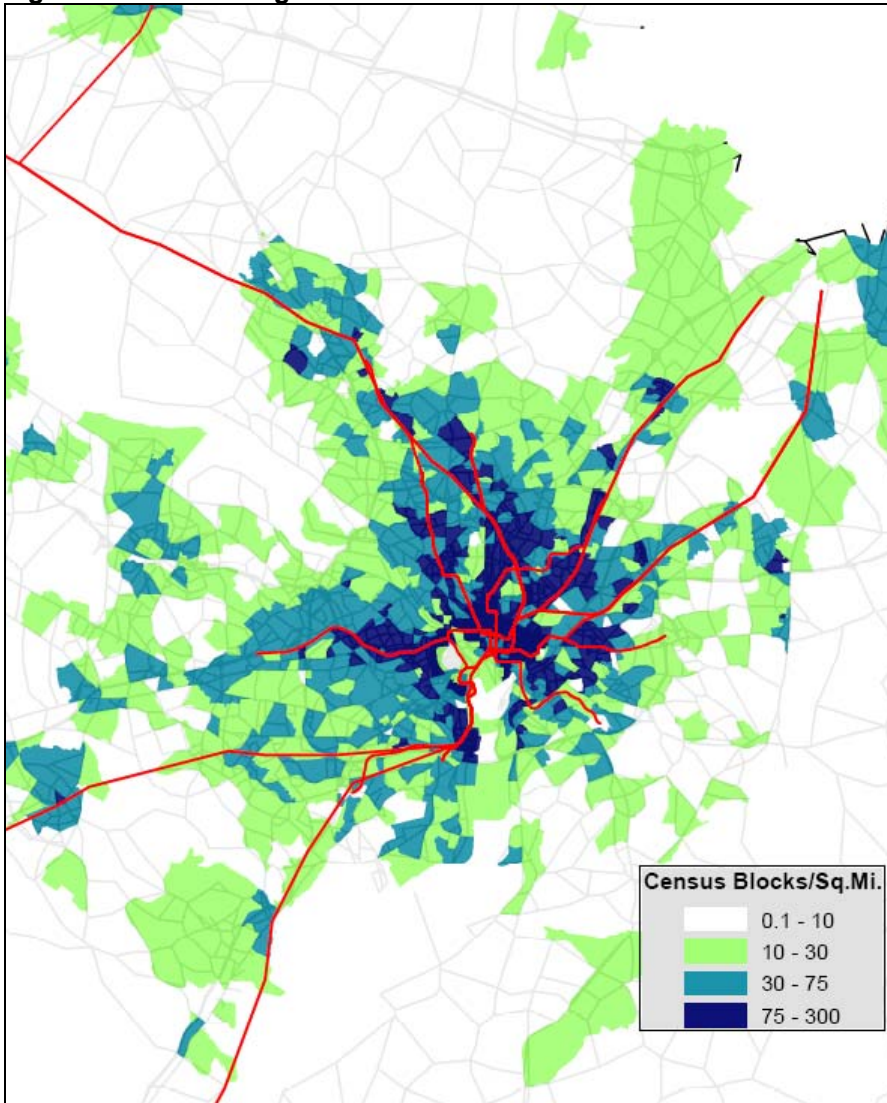


Figure 2: Downtown Area Pedestrian Environment Factor

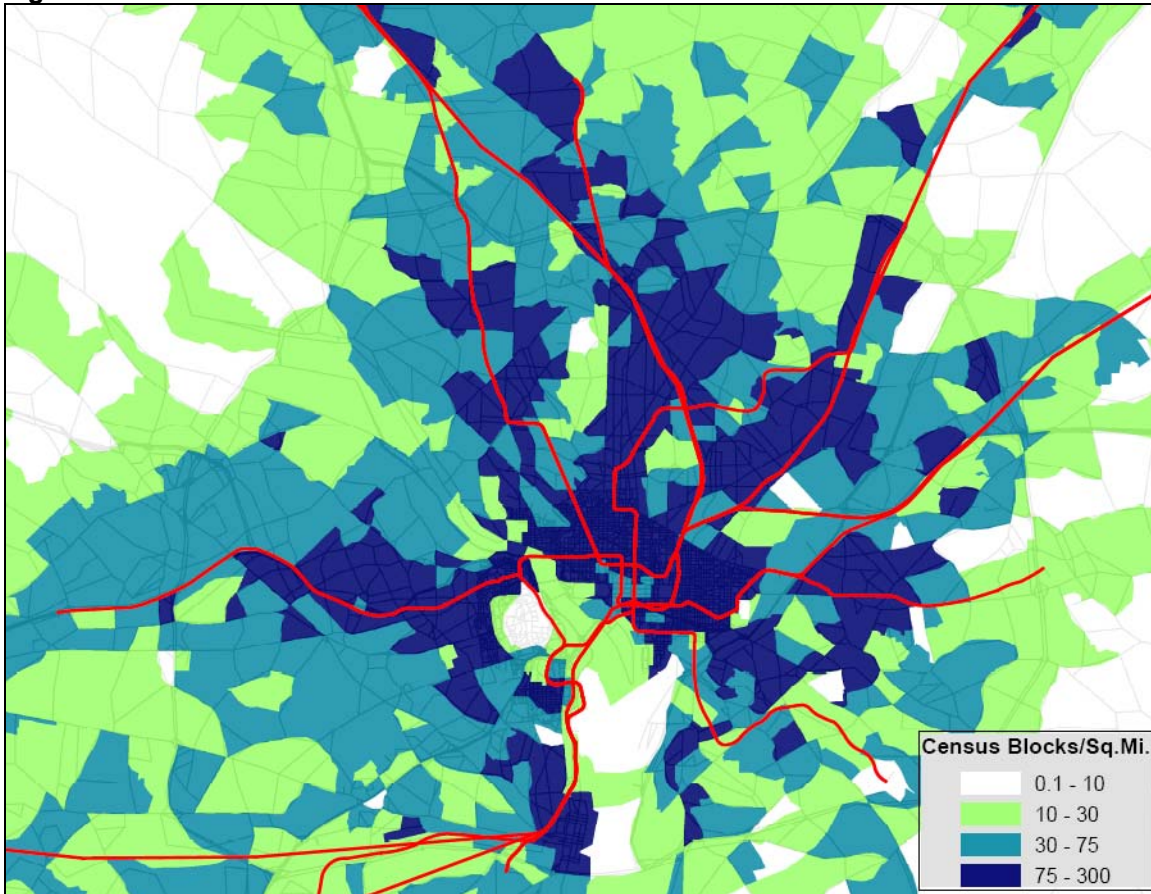


Figure 3 PEF factor for Walk-to-Transit

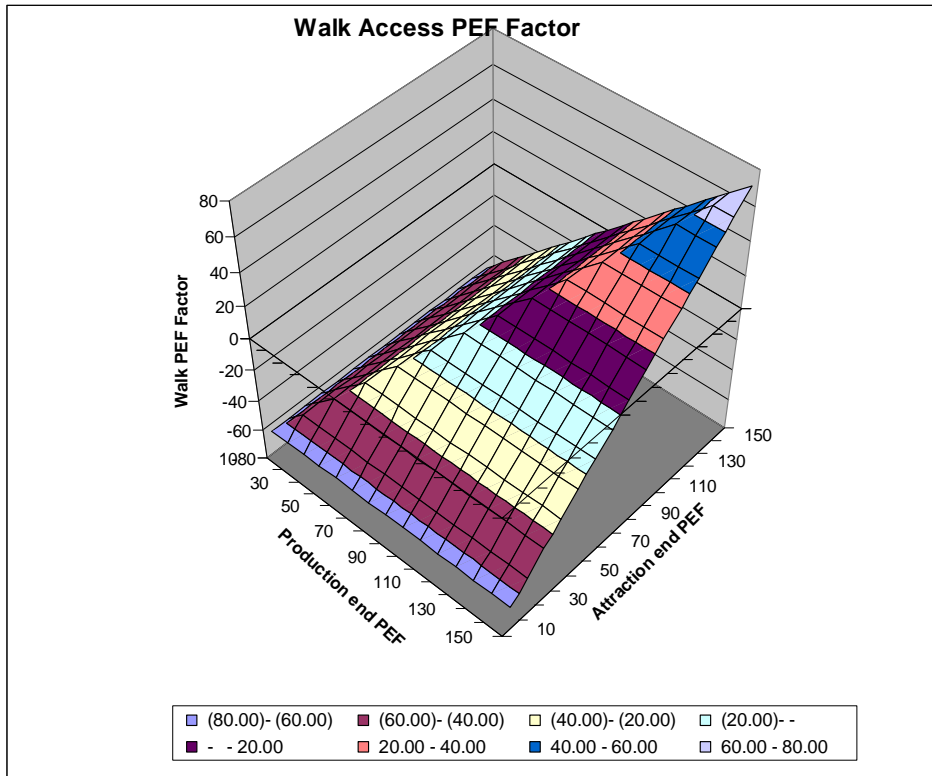
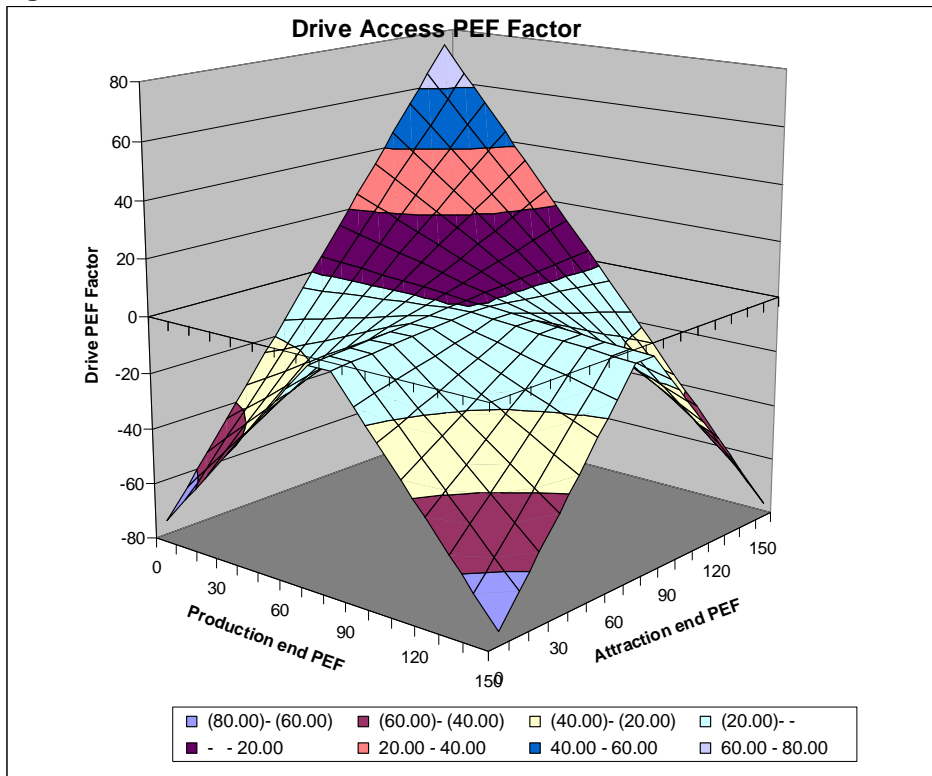


Figure 4 PEF factor for Drive-to-Transit



CTPP based Home Based Work Trip Tables: It was observed that the work trip tables output from the standard MWCOG model did not adequately represent long distance commuter trips. Typically the commuter rail serves long distance commuter trips, and to improve the commuter rail trip distribution it was necessary to either update the MWCOG trip table or replace it with survey based tables. For the VRE model, the home based work trip tables are replaced by trip tables generated using CTPP data. MWCOG provides CTPP based work trip tables at the MWCOG TAZ level. These tables are developed using CTPP part-3 journey to flow data. But the MWCOG's CTPP tables are not stratified by model income group. To stratify the tables by MWCOG income group, data from CTPP part 1 and part 2 tables are used to develop income splits at the model interchange level. To develop home based work trip tables for various modeling years, a FRTAR process is developed that uses the marginals from the MWCOG output HBW tables but utilizes CTPP based trip distribution by income to output model year specific trip tables.

4. Model Calibration (2002) and Validation (2008) results

This section summarizes the VRE model calibration and validation summary results after all the model updates outlined above. The VRE model is calibrated to year 2002 inputs and transit calibration targets by trip purpose and mode of access. The transit ridership comparisons (model vs. observed) at the sub-mode and geographic level provides a powerful tool to assess the model. The calibrated mode choice constants are summarized in Table 2. Table 3 and Table 4 summarize and compare the bus ridership for the calibration year 2002. The transit assignment summaries for buses are grouped by the transit company operating the service, aggregated at the sub-mode level. Summaries are also provided at the geographic level. The metro-rail station level boarding summaries are provided in Table 5. This table compares the estimated 2002 productions and attractions at each station (on the various metro lines) to the observed entrance and exit count data.

The 2002 calibrated model is run for year 2008 and the VRE Manassas line ridership from 2008 model is compared to the observed FY2008 ridership from VRE on-board survey. Table 6 compares the observed and modeled 2008 peak period (AM and PM) VRE Manassas line ridership by station.

APPENDIX

Appendix 1: Users Guide for Transit Component of Washington Regional Demand Forecasting Model.doc

Appendix 2: MWCOG_Network_Coding_Guide_revised_Feb08.doc

Table 1: VRE Haymarket Model - 2002 Transit Targets

Path #	HBW			HBO+HBS			NHB			ALL PURPOSE		
	PEAK	OFF-PEAK	DAILY	PEAK	OFF-PEAK	DAILY	PEAK	OFF-PEAK	DAILY	PEAK	OFF-PEAK	DAILY
WK-BUS	147,608	60,767	208,375	37,195	64,967	102,162	20,020	24,619	44,640	204,823	150,353	355,177
WK-BUS/MR	72,081	30,168	102,249	8,760	15,547	24,306	7,023	8,858	15,881	87,864	54,573	142,436
WK-MR	82,288	45,707	127,995	12,908	28,408	41,315	26,649	48,809	75,458	121,845	122,924	244,768
WK-CR	1,770	427	2,197	81	221	302	128	606	734	1,979	1,254	3,233
ALL-WALK	303,746	137,069	440,815	58,943	109,142	168,085	53,821	82,892	136,713	416,510	329,103	745,614
PNR-BUS	11,063	4,554	15,618	503	879	1,382	1,521	1,871	3,392	13,088	7,304	20,392
PNR-BUS/MR	7,358	2,403	9,761	473	693	1,166	306	294	600	8,138	3,389	11,527
PNR-MR	105,452	36,049	141,501	6,773	11,610	18,383	3,914	5,218	9,131	116,139	52,876	169,015
PNR-CR	18,209	2,339	20,548	62	188	249	92	134	226	18,363	2,661	21,023
ALL-PNR	142,083	45,345	187,427	7,812	13,369	21,181	5,833	7,516	13,349	155,728	66,230	221,957
KNR-BUS	3,474	1,430	4,905	507	886	1,393	1,001	1,231	2,232	4,983	3,547	8,530
KNR-BUS/MR	3,459	1,556	5,015	621	1,019	1,640	719	745	1,464	4,799	3,320	8,119
KNR-MR	28,816	10,379	39,196	2,449	3,724	6,173	1,700	3,254	4,954	32,965	17,358	50,323
KNR-CR	1,336	365	1,701	48	130	178	10	153	163	1,394	648	2,042
ALL-KNR	37,086	13,731	50,817	3,625	5,760	9,384	3,429	5,384	8,813	44,140	24,874	69,014
GRAND TOTAL	482,915	196,145	679,060	70,380	128,271	198,650	63,083	95,792	158,875	616,378	420,207	1,036,585

Table 2: VRE-Haymarket Model - 2002 Calibration Constants

	HBW Peak				HBW Off-Peak			
	Inc 1	Inc 2	Inc 3	Inc 4	Inc 1	Inc 2	Inc 3	Inc 4
LOV	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HOV2	-0.7630	-0.7630	-0.7630	-0.7630	-1.0501	-1.0501	-1.0501	-1.0501
HOV3+	-1.2727	-1.2727	-1.2727	-1.2727	-1.3169	-1.3169	-1.3169	-1.3169
WLK CR	5.2918	2.8918	1.2918	0.2918	6.0667	3.5667	2.0667	1.5667
WLK BUS	5.2918	2.8918	1.2918	0.2918	6.0667	3.5667	2.0667	1.5667
WLK BU/MR	5.2918	2.8918	1.2918	0.2918	6.0667	3.5667	2.0667	1.5667
WLK METRO	5.2918	2.8918	1.2918	0.2918	6.0667	3.5667	2.0667	1.5667
PNR CR	0.1277	-0.9723	-1.4723	-2.0723	-1.5184	-1.5184	-1.5184	-1.5184
PNR BUS	0.1277	-0.9723	-1.4723	-2.0723	-1.5184	-1.5184	-1.5184	-1.5184
PNR BU/MR	0.1277	-0.9723	-1.4723	-2.0723	-1.5184	-1.5184	-1.5184	-1.5184
PNR METRO	0.1277	-0.9723	-1.4723	-2.0723	-1.5184	-1.5184	-1.5184	-1.5184
KNR CR	-0.6835	-1.7835	-2.2835	-2.8835	-2.0282	-2.0282	-2.0282	-2.0282
KNR BUS	-0.6835	-1.7835	-2.2835	-2.8835	-2.0282	-2.0282	-2.0282	-2.0282
KNR BU/MR	-0.6835	-1.7835	-2.2835	-2.8835	-2.0282	-2.0282	-2.0282	-2.0282
KNR METRO	-0.6835	-1.7835	-2.2835	-2.8835	-2.0282	-2.0282	-2.0282	-2.0282

	HBO Peak				HBO Off-Peak			
	Inc 1	Inc 2	Inc 3	Inc 4	Inc 1	Inc 2	Inc 3	Inc 4
LOV	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HOV2	0.2498	0.2498	0.2498	0.2498	0.1002	0.1002	0.1002	0.1002
HOV3+	0.1497	0.1497	0.1497	0.1497	0.0003	0.0003	0.0003	0.0003
WLK CR	0.6412	-1.4588	-3.2588	-3.5588	1.0715	-0.1285	-1.8285	-2.1285
WLK BUS	0.6412	-1.4588	-3.2588	-3.5588	1.0715	-0.1285	-1.8285	-2.1285
WLK BU/MR	0.6412	-1.4588	-3.2588	-3.5588	1.0715	-0.1285	-1.8285	-2.1285
WLK METRO	0.6412	-1.4588	-3.2588	-3.5588	1.0715	-0.1285	-1.8285	-2.1285
PNR CR	-4.7387	-4.7387	-4.7387	-4.7387	-3.8686	-3.8686	-3.8686	-3.8686
PNR BUS	-4.7387	-4.7387	-4.7387	-4.7387	-3.8686	-3.8686	-3.8686	-3.8686
PNR BU/MR	-4.7387	-4.7387	-4.7387	-4.7387	-3.8686	-3.8686	-3.8686	-3.8686
PNR METRO	-4.7387	-4.7387	-4.7387	-4.7387	-3.8686	-3.8686	-3.8686	-3.8686
KNR CR	-3.8796	-4.9796	-5.5796	-5.8796	-4.3592	-4.3592	-4.3592	-4.3592
KNR BUS	-3.8796	-4.9796	-5.5796	-5.8796	-4.3592	-4.3592	-4.3592	-4.3592
KNR BU/MR	-3.8796	-4.9796	-5.5796	-5.8796	-4.3592	-4.3592	-4.3592	-4.3592
KNR METRO	-3.8796	-4.9796	-5.5796	-5.8796	-4.3592	-4.3592	-4.3592	-4.3592

	NHB Peak				NHB Off-Peak			
	Inc 1	Inc 2	Inc 3	Inc 4	Inc 1	Inc 2	Inc 3	Inc 4
LOV	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HOV2	-0.8035	-0.8035	-0.8035	-0.8035	-0.7930	-0.7930	-0.7930	-0.7930
HOV3+	-1.3081	-1.3081	-1.3081	-1.3081	-1.2847	-1.2847	-1.2847	-1.2847
WLK CR	-2.7631	-2.7631	-2.7631	-2.7631	-2.6639	-2.6639	-2.6639	-2.6639
WLK BUS	-2.7631	-2.7631	-2.7631	-2.7631	-2.6639	-2.6639	-2.6639	-2.6639
WLK BU/MR	-2.7631	-2.7631	-2.7631	-2.7631	-2.6639	-2.6639	-2.6639	-2.6639
WLK METRO	-2.7631	-2.7631	-2.7631	-2.7631	-2.6639	-2.6639	-2.6639	-2.6639
PNR CR	-5.8788	-5.8788	-5.8788	-5.8788	-6.1069	-6.1069	-6.1069	-6.1069
PNR BUS	-5.8788	-5.8788	-5.8788	-5.8788	-6.1069	-6.1069	-6.1069	-6.1069
PNR BU/MR	-5.8788	-5.8788	-5.8788	-5.8788	-6.1069	-6.1069	-6.1069	-6.1069
PNR METRO	-5.8788	-5.8788	-5.8788	-5.8788	-6.1069	-6.1069	-6.1069	-6.1069
KNR CR	-6.7379	-6.7379	-6.7379	-6.7379	-6.5965	-6.5965	-6.5965	-6.5965
KNR BUS	-6.7379	-6.7379	-6.7379	-6.7379	-6.5965	-6.5965	-6.5965	-6.5965
KNR BU/MR	-6.7379	-6.7379	-6.7379	-6.7379	-6.5965	-6.5965	-6.5965	-6.5965
KNR METRO	-6.7379	-6.7379	-6.7379	-6.7379	-6.5965	-6.5965	-6.5965	-6.5965

Table 3: 2002 VRE Haymarket Model Assignment - Bus Ridership summary

Bus Boardings by Company	2002 Observed Boardings	2002 Model Boardings	Observed Percent Difference
Metrobus - District of Columbia	276,476	284,117	3%
Metrobus - Maryland	123,868	111,451	-10%
Metrobus - Virginia	77,420	100,599	30%
Alexandria DASH	9,330	9,417	1%
Arlington Transit ART	837	2,627	214%
Fairfax Connector	24,765	17,990	-27%
Laurel Connector	1,500	999	-33%
Loudoun County Transit	838	441	-47%
Omni Ride	2,355	10,098	329%
Omni Link	3,798	299	-92%
Ride-On	74,515	37,303	-50%
The Bus	8,271	2,338	-72%
City of Fairfax CUE	3,250	2,377	-27%
MTA Commuter Bus	8,100	14,636	81%
Other outer services	1,115	4,010	260%
Total Bus Boardings	616,438	598,702	-2.9%

Ridership Summary by Operator	2002 Observed Boardings	2002 Model Boardings	Observed Percent Difference
Metrorail	838,481	915,148	9%
Commuter Rail	26,298	31,026	18%
Metrobus - District of Columbia	276,476	284,117	3%
Metrobus - Maryland	123,868	111,451	-10%
Metrobus - Virginia	77,420	100,599	30%
Other Bus Operators	138,674	102,535	-26%
Total Transit Boardings	1,481,217	1,544,876	4.3%

Table 4: 2002 VRE Haymarket Model Assignment - Bus Ridership summaries by sub – divisions

Metrobus - District of Columbia	2002 Observed Boardings	2002 Model Boardings	Observed Percent Difference
Anacostia Area Routes	11,501	3,157	-73%
Express Routes	936	893	-5%
North to DC Core Routes	97,338	98,242	1%
Northwest to Southeast Routes	29,692	64,397	117%
Northwest to DC Core Routes	11,893	19,051	60%
Other Routes	7,639	2,754	-64%
East to DC Core Routes	45,974	42,658	-7%
Cross-town Routes	71,503	53,516	-25%
Subtotal	276,476	284,668	3.0%
Metrorail (On + Off)/2	357,349	359,255	0.5%
Total	633,825	643,923	1.6%

Metrobus - Maryland	2002 Observed Boardings	2002 Model Boardings	Observed Percent Difference
Express Routes	5,411	14,373	166%
Feeder Bus Routes	2,193	974	-56%
Radial Bus Routes	75,139	60,946	-19%
Cross-town Routes	41,125	35,158	-15%
Subtotal	123,868	111,451	-10.0%
Metrorail (On + Off)/2	131,836	140,592	6.6%
Total	255,704	252,043	-1.4%

Metrobus - Virginia	2002 Observed Boardings	2002 Model Boardings	Observed Percent Difference
Radial - Columbia Pike Routes	10,306	9,235	-10%
Express Routes	6,846	10,336	51%
Feeder Routes	7,940	10,136	28%
Radial - Other Routes	37,533	60,810	62%
Cross-town Routes	14,795	10,082	-32%
Subtotal	77,420	100,599	29.9%
Metrorail (On + Off)/2	142,632	159,082	11.5%
Total	220,052	259,681	18.0%

Table 5: 2002 VRE Haymarket Model Assignment: Metrorail summary

Red From Shady Grove to DuPont Circle	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Shady Grove	11,101	14,973	13,037	18,333	1,505	9,919	-24%
Rockville	4,191	5,404	4,797	7,221	2,796	5,009	4%
Twinbrook	4,409	4,525	4,467	2,889	4,732	3,811	-15%
White Flint	4,293	4,543	4,418	2,918	1,564	2,241	-49%
Grosvenor-Strathmore	3,877	3,546	3,712	7,049	1,490	4,270	15%
Medical Center	4,801	4,432	4,617	2,192	3,677	2,935	-36%
Bethesda	9,635	8,700	9,167	14,297	17,857	16,077	75%
Friendship Heights	8,892	9,834	9,363	14,686	7,710	11,198	20%
Tenleytown-AU	6,119	5,922	6,020	10,414	7,787	9,101	51%
Van Ness-UDC	6,557	7,611	7,084	5,209	2,519	3,864	-45%
Cleveland Park	5,474	5,119	5,296	4,983	646	2,815	-47%
Woodley Park-Zoo/Adams Morgan	6,109	4,751	5,430	9,471	2,998	6,235	15%
DuPont Circle	24,040	24,939	24,490	12,261	40,993	26,627	9%
Total	99,498	104,298	101,898	111,923	96,274	104,099	2%

Red From Glenmont to Judiciary Square	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Glenmont	5,457	6,552	6,005	11,005	287	5,646	-6%
Wheaton	4,759	3,928	4,343	6,469	2,957	4,713	9%
Forest Glen	2,076	2,035	2,056	4,469	628	2,549	24%
Silver Spring	12,484	13,159	12,822	20,088	14,218	17,153	34%
Takoma	6,335	5,859	6,097	9,816	2,338	6,077	0%
Fort Totten	6,023	5,519	5,771	14,474	1,338	7,906	37%
Brookland-CUA	6,616	6,099	6,357	3,154	1,975	2,565	-60%
Rhode Island Ave-Brentwood	5,224	3,729	4,477	14,821	5,379	10,100	126%
New York Ave-Florida Ave-Gallaudet U	0	0	NA	NA	NA	NA	NA
Union Station	29,439	29,592	29,515	18,138	24,734	21,436	-27%
Judiciary Square	10,201	11,979	11,090	1,614	20,429	11,022	-1%
Total	88,614	88,452	88,533	104,048	74,283	89,166	1%

Green From Greenbelt to West Hyattsville	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Greenbelt	7,015	7,539	7,277	13,245	1,026	7,136	-2%
College Park-U of MD	3,333	4,435	3,884	2,048	1,327	1,688	-57%
Prince George's Plaza	4,321	3,907	4,114	4,266	922	2,594	-37%
West Hyattsville	3,452	2,270	2,861	4,083	684	2,384	-17%
Total	18,121	18,151	18,136	23,642	3,959	13,801	-24%

Green and Yellow Lines From Fort Totten to Mt. Vernon	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Fort Totten	6,023	5,519	5,771	14,474	1,338	7,906	37%
Georgia Ave-Petworth	3,950	2,747	3,349	8,654	3,971	6,313	89%
Columbia Heights	5,339	3,368	4,354	9,171	2,900	6,036	39%
U Street/African-Amer Civil War Memorial/Cardozo	3,744	3,564	3,654	4,446	8,388	6,417	76%
Shaw-Howard U	3,326	2,488	2,907	2,775	2,557	2,666	-8%
Mt Vernon Sq 7th St- Convention Center	1,969	1,126	1,547	4,649	8,418	6,534	322%
Total	24,351	18,812	21,582	44,169	27,572	35,871	66%

Green From Branch Avenue to Waterfront	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Branch Ave	5,355	7,845	6,600	19,719	156	9,938	51%
Suitland	5,461	6,226	5,844	9,432	436	4,934	-16%
Naylor Road	2,628	2,135	2,382	3,392	197	1,795	-25%
Southern Avenue	4,984	5,517	5,251	9,420	272	4,846	-8%
Congress Heights	1,951	1,424	1,688	4,443	645	2,544	51%
Anacostia	7,228	5,197	6,212	10,706	1,686	6,196	0%
Navy Yard	3,173	2,864	3,019	1,773	6,985	4,379	45%
Waterfront-SEU	3,814	3,945	3,880	4,253	4,596	4,425	14%
Total	34,594	35,155	34,874	63,138	14,973	39,056	12%

Blue and Yellow Lines to Pentagon City	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Franconia-Springfield	8,591	8,659	8,625	12,170	615	6,393	-26%
Van Dorn Street	3,919	3,031	3,475	6,039	714	3,377	-3%
Huntington	7,482	8,095	7,788	19,537	455	9,996	28%
Eisenhower Avenue	1,447	1,110	1,278	980	677	829	-35%
King Street	5,899	5,629	5,764	6,935	6,883	6,909	20%
Braddock Road	3,429	4,495	3,962	8,224	3,502	5,863	48%
Ronald Reagan Washington National Airport	6,016	2,860	4,438	105	121	113	-97%
Crystal City	13,168	12,527	12,847	6,005	19,079	12,542	-2%
Pentagon City	14,196	8,415	11,305	20,213	8,118	14,166	25%
Total	64,147	54,819	59,483	80,208	40,164	60,186	1%

Blue From Largo to Benning Road	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Largo Town Center	0	0	NA	NA	NA	NA	NA
Morgan Boulevard	0	0	NA	NA	NA	NA	NA
Addison Road-Seat Pleasant	6,013	6,444	6,228	12,559	393	6,476	4%
Capitol Heights	2,135	1,887	2,011	4,580	664	2,622	30%

Benning Road	2,952	2,272	2,612	10,900	690	5,795	122%
Total	11,100	10,603	10,851	28,039	1,747	14,893	37%

Blue and Orange From Stadium-Armory to Federal Center SW	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Stadium-Armory	3,130	2,688	2,909	3,269	1,832	2,551	-12%
Potomac Ave	3,035	3,167	3,101	4,653	1,705	3,179	3%
Eastern Market	4,912	5,137	5,024	6,511	5,501	6,006	20%
Capitol South	6,609	8,395	7,502	3,171	18,612	10,892	45%
Federal Center SW	4,830	5,925	5,377	764	11,630	6,197	15%
Total	22,516	25,312	23,914	18,368	39,280	28,824	21%

Orange Line From Vienna to Court House	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Vienna/Fairfax-GMU	12,293	12,147	12,220	20,148	1,489	10,819	-11%
Dunn Loring-Merrifield	4,468	4,463	4,465	11,546	8,536	10,041	125%
West Falls Church-VT/UVA	8,177	9,479	8,828	12,546	3,507	8,027	-9%
East Falls Church	4,312	4,681	4,497	5,176	1,194	3,185	-29%
Ballston-MU	11,355	16,335	13,845	19,753	7,489	13,621	-2%
Virginia Square-GMU	2,940	2,692	2,816	6,244	2,965	4,605	64%
Clarendon	2,975	3,111	3,043	5,980	5,456	5,718	88%
Court House	6,954	5,709	6,331	15,700	14,289	14,995	137%
Total	53,474	58,618	56,046	97,093	44,925	71,009	27%

Orange From New Carrollton to Minnesota Ave	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
New Carrollton	8,698	8,290	8,494	14,661	1,232	7,947	-6%
Landover	3,195	3,868	3,532	7,212	649	3,931	11%
Cheverly	1,530	1,322	1,426	2,268	548	1,408	-1%
Deanwood	1,945	1,427	1,686	2,194	512	1,353	-20%
Minnesota Ave	2,977	2,355	2,666	3,648	857	2,253	-16%
Total	18,345	17,261	17,803	29,983	3,798	16,891	-5%

All Lines Inside the DC Core	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Pentagon	14,720	16,780	15,750	23,713	11,386	17,550	11%
Arlington Cemetery	1,797	351	1,074	17	0	9	-99%
Rosslyn	15,527	14,758	15,143	7,638	13,036	10,337	-32%
Foggy Bottom-GWU	21,857	19,065	20,461	7,706	42,622	25,164	23%
Farragut North	26,202	27,119	26,661	2,142	41,978	22,060	-17%
Farragut West	24,714	27,998	26,356	4,515	58,947	31,731	20%
McPherson Square	16,700	17,982	17,341	9,993	45,218	27,606	59%
Metro Center	27,548	29,851	28,699	2,624	24,445	13,535	-53%
Federal Triangle	11,489	10,805	11,147	630	2,144	1,387	-88%

Smithsonian	13,409	10,443	11,926	1,036	8,970	5,003	-58%
L'Enfant Plaza	22,716	24,023	23,369	8,274	33,252	20,763	-11%
Archives-Navy Memorial-Penn Quarter	7,817	7,595	7,706	1,366	14,916	8,141	6%
Gallery Pl-Chinatown	14,198	14,700	14,449	3,165	16,350	9,758	-32%
Total	218,694	221,471	220,082	72,819	313,264	193,042	-12%

Summary	2002 Metro-Rail Survey			2002 VRE Haymarket Model			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
Red From Shady Grove to DuPont Circle	99,498	104,298	101,898	111,923	96,274	104,099	2%
Red From Glenmont to Judiciary Square	88,614	88,452	88,533	104,048	74,283	89,166	1%
Green From Greenbelt to West Hyattsville	18,121	18,151	18,136	23,642	3,959	13,801	-24%
Green and Yellow Lines From Fort Totten to Mt. Vernon	24,351	18,812	21,582	44,169	27,572	35,871	66%
Green From Branch Avenue to Waterfront	34,594	35,155	34,874	63,138	14,973	39,056	12%
Blue and Yellow Lines to Pentagon City	64,147	54,819	59,483	80,208	40,164	60,186	1%
Blue From Largo to Benning Road	11,100	10,603	10,851	28,039	1,747	14,893	37%
Blue and Orange From Stadium-Armory to Federal Center SW	22,516	25,312	23,914	18,368	39,280	28,824	21%
Orange Line From Vienna to Court House	53,474	58,618	56,046	97,093	44,925	71,009	27%
Orange From New Carrollton to Minnesota Ave	18,345	17,261	17,803	29,983	3,798	16,891	-5%
All Lines Inside the DC Core	218,694	221,471	220,082	72,819	313,264	193,042	-12%
Total	647,431	647,431	647,431	658,956	658,901	658,929	2%

All Lines by State	2002 Metro-Rail Survey			2002 VRE Haymarket Model MRSUMM			% Diff
				Total			
	On	Off	(On+Off)/2	Ps	As	(P +A)/2	
DC	367,603	361,027	364,315	236,383	482,127	359,255	-1%
MD	131,960	141,429	136,695	213,921	67,263	140,592	3%
VA	147,868	144,975	146,422	208,652	109,511	159,082	9%
Total	647,431	647,431	647,431	658,956	658,901	658,929	2%

Table 6: 2008 peak period (AM and PM) transit boarding comparisons on the VRE Manassas Line (PNA format)

Station Name	Survey 2007		Model 2008	
	Peak On	Peak Off	Peak On	Peak Off
Broad run	1,865	-	1,507	-
Manassas	1,234	5	1,324	80
Manassas park	1,455	-	915	6
Sub total	4,553	5	3,746	86
Burke center	1,226	3	1,277	4
Rolling road	899	-	1,862	2
Backlick road	284	41	820	57
Alexandria	-	655	106	845
Crystal City	-	1,634	-	1,062
L'Enfant	-	3,129	-	4,155
Union Station	-	1,491	-	1,601
TOTAL	6,962	6,964	7,811	7,812