GEN2/VER 2.3.84 MODEL

Validation and sensitivity testing

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Presentation overview

Objective: To apprise the subcommittee on staff's developmental work on the Ver. 2.3 series of models

- Ver 2.3.84 is the most recent developmental model version

Today's presentation:

- Review of new features included in 2.3.84 Model
- Validation performance of the 2.3.84 Model
- Sensitivity test findings using the 2.3.84 Model
- Conclusions

Background on current and planned travel modeling versions

Model	Description	Notes
Ver 2.3.75	Currently adopted production model	Model currently available to stakeholders upon request
Ver 2.3.78	Model being used for the 2020 AQC analysis	Includes minor changes to the 75 model
Ver 2.3.84	Latest developmental model	Includes more substantial changes to the 78 model
Ver 2.4	Model planned for production use in the future	Essentially the 84 model with possible changes deemed necessary pending evaluations

Ver 2.3.84 Model refinements

1. **Updated external trip distribution process** (presented at the March 18, 2018 TFS meeting);
2. Increased free-flow speed look-up values used in the traffic assignment process (+15%);
3. Removed bridge penalties in the construction of path-building within the traffic assignment process;
4. Removed some trip production rate modification factors (P-mods) used in trip generation; and
5. **Re-calibrated nested-logit mode choice (NLMC)**
   - Recent updates to commuter rail calibration targets,
   - Model refinements related to external auto person trips, and
   - Adjustments to commuter rail path-building parameters.

Performance summaries

- Validated to most recent (2014) observed data
- Summaries indicate both current (2.3.75 model) and developmental (2.3.84 model) results
- Summaries evaluated:
  - Daily jurisdictional VMT
  - Daily regional link volumes by facility type
  - Daily regional Pct. RMSE by facility type
  - Daily screenline crossings
  - Daily regional transit boardings by sub-mode

VMT performance (est./obs. ratio) by jurisdiction, 2014

- VMT on-network facilities (local VMT is excluded)
- Performance for TPB member jurisdictions is mostly improved
- Frederick Co. over-estimation has been investigated; no modeling-related problems have been identified thus far

	Jurisdiction	E/O Ratio V2.3.75	E/O Ratio V2.3.84
	District of Columbia	1.03	1.00
	Montgomery County	1.09	1.01
	Prince George's County	0.98	0.92
	Arlington County	0.96	0.99
	City of Alexandria	1.00	1.02
TPB Member Area	Fairfax County	1.00	1.01
	Loudoun County	1.11	1.01
	Prince William County	1.01	1.00
	Frederick County	1.13	1.12
	Charles County	0.92	0.94
	Total	**1.03**	**1.00**
Non-TPB Member Area	**Total**	**1.02**	**1.02**
	Grand Total	**1.02**	**1.00**

Notes:

* The observed VMT data is from HPMS.

ǂ Observed VMT is for the entire Spotsylvania County while Estimated is for northern portion of county

‡ Fauquier County urbanized area is part of TPB Planning Area. Fauquier is not included as a TPB member this summary as the HPMS VMT data is only available for the whole county.

§ **FDOT standard** for estimated-over-observed VMT Areawide is ±5% (acceptable) and ±2% (preferable).

VMT Performance (est./obs. ratio) by facility type, 2014

- E/O ratios are based on a sample of ~6,700 directional daily link volumes
- The E/O ratios shown for the 75 and 84 models appear quite comparable
- All of these closely meet the "acceptable" standard

	E/O Ratio		Standard ł	
FTYPE	**V2.3.75**	**V2.3.84**	**Acceptable**	**Preferable**
Freeway	1.07	1.06	±7%	±6%
Major Arterial	1.07	1.08	±15%	±10%
Minor Arterial	1.13	1.10	±15%	±10%
Collector	0.74	0.74	±25%	±20%
Expressway	0.95	0.91	±15%	±10%
Total	**1.06**	**1.04**	***±5%***	***±2%***

ł **FDOT standards** for VMT by facility type, which are also cited in the FHWA and VDOT manuals

% RMSE performance by facility type, 2014

- RMSE's were developed from a sample of ~6,700 E/O network link volumes
- Historically, the %RMSE statistics for TPB models have been observed to be ~20% for freeways and ~40% for all sampled links
- %RMSE values from the 75 and 84 models are comparable

	Percent RMSE	
Facility Type	**V2.3.75**	**V2.3.84**
Freeway	22	22
Major Arterial	38	37
Minor Arterial	52	49
Collector	76	75
Expressway	34	34
Ramp	13	12
Total:	43	**42**

ǂ VDOT standard for percent RMSE areawide; FDOT areawide standard is 45% (acceptable) and 35% (preferable)

Screenline crossing performance (Est./Obs. ratios), 2014

	E/O Ratios				E/O Ratios		
Screenline	V2.3.75	V2.3.84	Standard *	Screenline	V2.3.75	V2.3.84	Standard *
1	0.74	0.74	±10%	20	0.93	0.90	±10%
2	1.26	1.19	±10%	22	1.05	0.98	±10%
3	0.89	0.91	±10%	23	1.60	1.27	±20%
4	1.22	1.17	±10%	24	0.90	0.87	±10%
5	0.84	0.86	±10%	25	1.32	1.23	±10%
6	1.03	1.01	±10%	26	2.10	1.68	±20%
7	0.97	0.97	±10%	27	1.49	1.30	±10%
8	1.10	1.03	±10%	28	0.75	0.77	±10%
9	0.77	0.77	±10%	31	2.21	2.17	±10%
10	0.95	0.94	±10%	32	1.76	2.06	±20%
12	1.00	0.94	±10%	33	1.11	1.05	±20%
13	1.21	1.13	±10%	34	1.17	1.12	±10%
14	1.06	1.05	±10%	35	0.93	1.01	±10%
15	0.90	0.83	±10%	36	2.11	1.61	±20%
16	0.94	0.81	±10%	37	2.00	1.91	±20%
17	0.91	0.95	±10%	38	0.70	0.72	±10%
18	0.88	0.89	±10%				
19	0.80	0.78	±10%	**Total:**	**1.01**	**0.98**	**N/A**

Note:

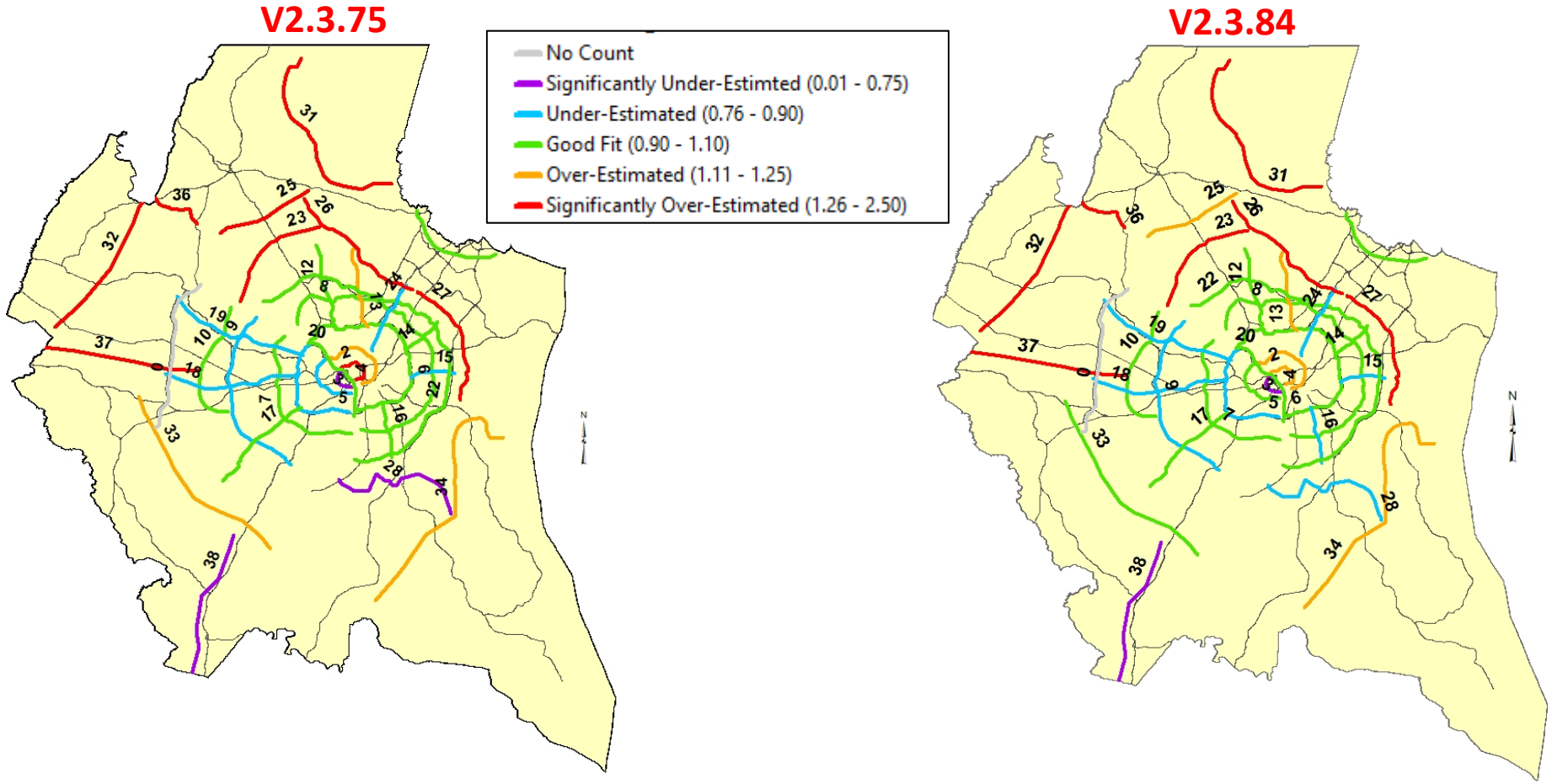
50k and ±20% for screenline volumes smaller than 50k). VDOT standard is much more stringent.

- Screenline performance of 84 model is mostly comparable/slightly better than the 75 model
-Ratios reflect only screenline links where observed volumes exist;
-screeline links are not fully populated with observed counts

Screenline crossing performance (Est./Obs. ratios), 2014

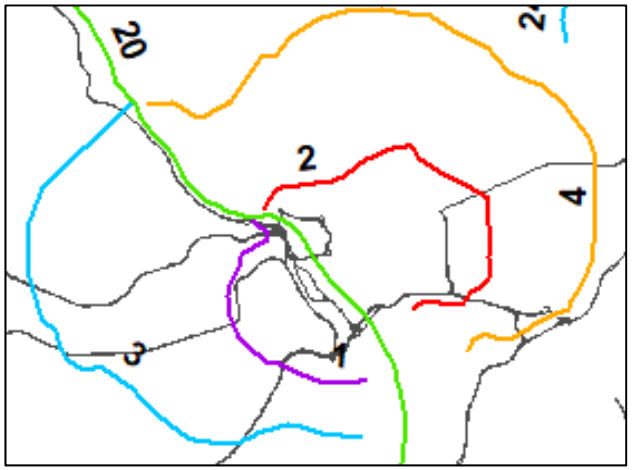
- The maps on the next two slides display the screenline locations. Screenlines are colored according to their daily volume E/O ratios.
- Many screenlines located in regional core and inner suburb validate well (shown in green)
- Many screenlines near external count stations, especially those in Maryland, are over-estimated (shown in red or orange).
- Screenline #20 (Potomac River Screenline) validates fairly well (see inset map)
- Slide 12 shows the two Virginia screenlines (#1 and #3) intersecting with Screenline #20 from the 75 model are both under-estimated. By contrast, the 84 model shows improvement (#1 remains the same and #3 becomes good fit)
- The two DC screenlines (#2 and #4) are both over-estimated in both models, but, for model 84, Screenline #2 is better fit than for model 75.

Screenline crossing performance (Est./Obs. ratios) Map, 2014

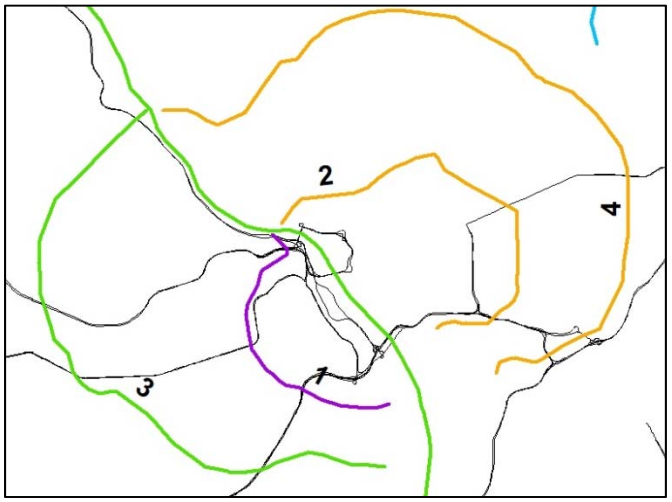


Screenline crossing performance (Est./Obs. ratios) Map, 2014

V2.3.75



V2.3.84



- No Count
- Significantly Under-Estimted (0.01 - 0.75)
- Under-Estimated (0.76 - 0.90)
- Good Fit (0.90 - 1.10)
- Over-Estimated (1.11 - 1.25)
- Significantly Over-Estimated (1.26 - 2.50)

Transit ridership performance (E/O boardings) by sub-mode, 2014

	Observed ("O")*	V2.3.75	V2.3.75 E/O*
Metrorail	737,679	746,541	1.01
MARC	20,189	28,200	1.40
VRE	9,266	4,075	0.44
All Bus	648,083	715,273	1.10
Total:	**1,415,217**	**1,494,089**	**1.06**

	Updated Obs ("O")**	V2.3.84	V2.3.84 E/O**
Metrorail	737,679	744,443	1.01
MARC	20,171	17,304	0.86
VRE	16,311	10,468	0.64
All Bus	648,083	704,713	1.09
Total:	**1,422,244**	**1,476,926**	**1.04**

Notes:

* Observed 2014 Metrorail ridership data is extracted from WMATA Crystal Reports System. Since Silver Line opened in July 2014 and its 2014 ridership data is not available, 2015 Silver Line station counts are used instead.

** Data Source: Version 2.5 Model Development Report

‡ FDOT standard for total area transit trips from Mode Choice is ±2% (acceptable) and ±1% (preferable).

- The validation statistics of V2.3.84 have improved over the V2.3.75 statistics (for MARC and VRE).
- The improvement can be attributed to the updates to the observed data (validation targets) and model adjustments related to commuter rail path finding.

Sensitivity Tests: Background

- All tests pivot off of the **V2.3.84** model
- Based on year **2014**
- Tests examined:
  1. Add one lane (each direction) to American Legion Bridge
  2. Close Memorial Bridge
  3. Increase transit service: Double the frequency of inbound VRE: Fredericksburg to Washington-Union Station (VFRED1I)
  4. Raise Metrorail fare by 25 cents, systemwide

Test 1: Add Lanes to American Legion Bridge

- Test Question: How does model respond to increases in roadway capacity?

- Test Description: Add one lane to the American Legion Bridge in each direction

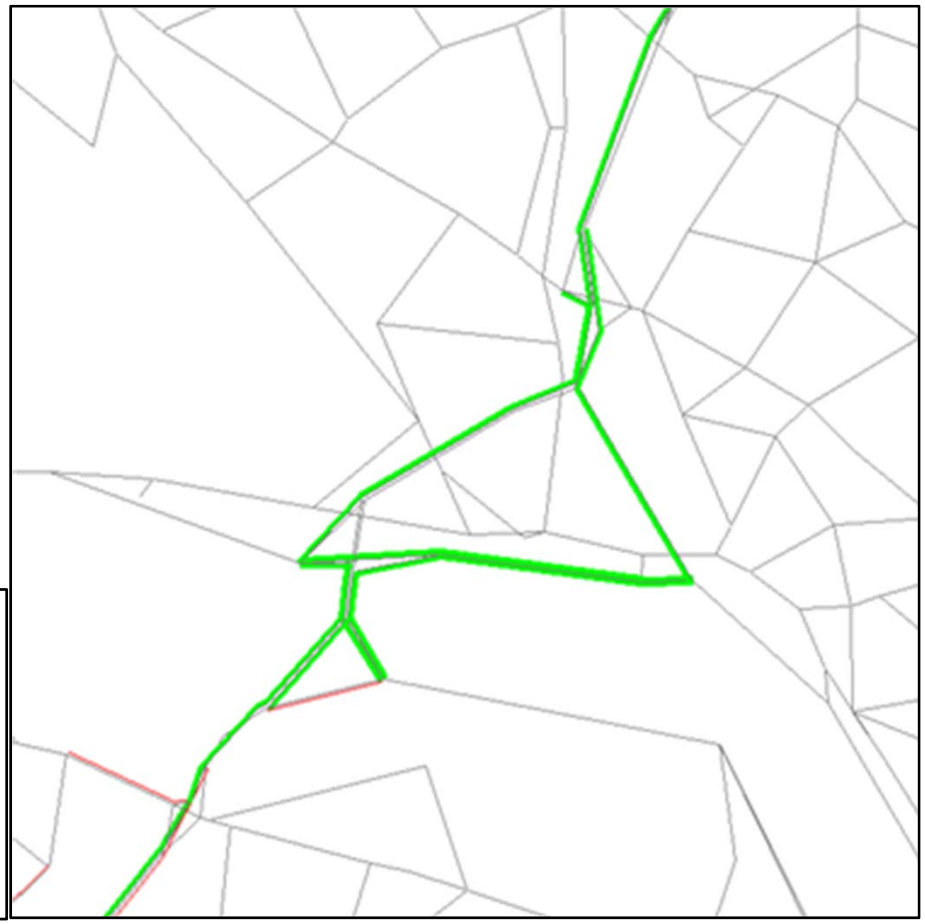
Test 1: Add Lanes to American Legion Bridge Results

- Added capacity on the American Legion Bridge results in increased volumes, decreased V/C ratios and increased speeds
- Resulted in a net increase of total volumes southbound by 1,050 (0.81%) and northbound by 786 (0.61%)

		Southbound			Northbound		
		Base	**Alt**	**Diff**	**Base**	**Alt**	**Diff**
	Lanes	5	6	1	5	6	1
AM	Volume	24,140	24,344	205	26,559	26,939	379
	V/C	1.01	0.85	-0.16	1.11	0.94	-0.17
	Speed (mph)	35	62	27	17	49	32
	Lanes	5	6	1	5	6	1
MD	Volume	39,406	39,538	132	38,573	38,653	80
	V/C	0.70	0.58	-0.11	0.68	0.57	-0.11
	Speed (mph)	69	71	2	70	72	2
	Lanes	5	6	1	5	6	1
PM	Volume	37,186	37,832	646	32,754	33,022	269
	V/C	1.09	0.93	-0.17	0.96	0.81	-0.15
	Speed (mph)	18	51	33	43	65	22
	Lanes	5	6	1	5	6	1
NT	Volume	28,819	28,886	68	31,846	31,904	58
	V/C	0.43	0.36	-0.07	0.48	0.40	-0.08
	Speed (mph)	73	73	1	73	73	1
Daily	**Volume**	**129,550**	**130,600**	**1,050**	**129,732**	**130,518**	**786**
	Pct Diff			***0.81%***			***0.61%***

Test 1: Add Lanes to American Legion Bridge Daily Volume difference

- Volume increase (green) on bridge and neighboring facilities



Red: Decrease in Volume
Green: Increase in Volume
Tolerance: +/- 500 vehicles
Relative gap threshold: 10^{-4}

Test 2: Close Memorial Bridge

- Test Question: How does model respond to reductions in roadway capacity?

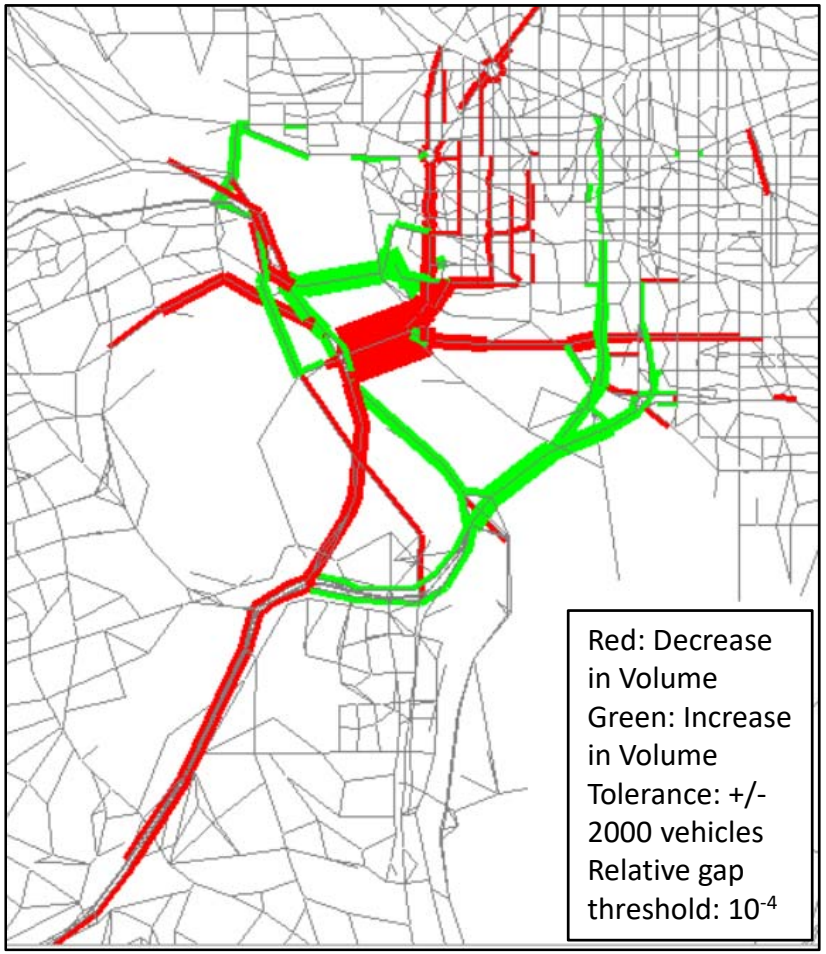
- Test Description: Remove Memorial Bridge from the highway network

Test 2: Close Memorial Bridge Results

- Regional VMT decreases by about 0.05%
- Transit increased by 429 trips or 0.04%
- Auto drivers to DC (from all jurisdictions) decrease by 970 vehicle trips
  - But change is not evenly distributed
    - Auto driver trips from DC: +765
    - Auto driver trips from VA/WVa: -4,099
    - Auto driver trips from MD: +2,364
- All three findings are reasonable

Test 2: Close Memorial Bridge Results

- Reasonable displacement pattern results in the daily volume change plots
- Large decrease (red) where Memorial Bridge used to be
- Moderate increases on the three neighboring bridges (Theodore Roosevelt, 14th Street, and Key)



Test 3: Increase VRE Fredericksburg to Washington-Union Station Service Frequency

- Test Question: How does model respond to increase transit service on an inbound VRE transit line?
- Test Description: Increase (double) the Fredericksburg to Washington-Union Station (VFRED1I) service frequency in peak periods (AM and PM)

	Headway (min)	
Route	Base	Alternative
VFRED1I	30	15

Test 3: Increase VRE Fredericksburg to Union Station Service Frequency Results

- The Fredericksburg line VFRED1I ridership increased by 1,246 or 68%

- Total linked commuter rail trip increased by 2.73%

Test 4: Raise Base Metrorail Fare

- Test Question: How does model respond to a transit fare increase?

- Test Description: Metrorail fares are increased by 25 cents, systemwide

Test 4: Raise Base Metrorail Fare Results

- Base Metrorail fair was raised by 25 cents:
  - AM peak from $2.24 to $2.49 (11% increase)
  - Off-peak from $1.84 to $2.09 (14% increase)
- Metrorail, and other transit sub-modes decline with higher fares

Mode	V2.3.84	Raised Fare	Change	%Change
Commuter Rail	27,699	27,414	-285	-1.03%
Metrorail	521,547	512,692	-8,855	-1.70%
Bus / Metrorail	204,739	198940	-5,799	-2.83%
All Bus	382,907	389,182	6,275	1.64%
All	**1,136,891**	**1,128,228**	**-8,663**	**-0.76%**

- "All bus" trips increased, since their fare was not changed.
- Total transit ridership declined by ~0.8 %
- Auto person trips increase by ~0.1 %

Conclusions

- The performance of the Ver. 2.3.84 model is largely comparable to that of the Ver. 2.3.75 model.
- The model performance has significantly improved in some areas:
  - External trip distribution
  - Commuter rail ridership
- Validation statistics largely met federal or state standards
- The model response to system changes meet expectations, for example,
  - When road capacity is increased, traffic on and near the improved facility increases
  - When transit service is increased on a commuter rail line, ridership on the line and linked commuter rail trip increased
- TPB Staff plans to continue refining the model and investigating
- In conclusion, the performance of TPB's Ver. 2.3 model remains to be reliable at an acceptable level for regional planning purposes

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