Sabra, Wang & Associates, Inc.
Engineers • Planners • Analysts

MEMORANDUM

To:	Howard County Office of Transportation, Department of County Administration
From:	Sabra, Wang & Associates, Inc.
Subject:	Howard County BRT Phase II Travel Forecasting Model Enhancements and Validation
Date:	September 24, 2015

The purpose of this memorandum is to document the travel forecasting model selection, development, and 2010 validation for the Howard County BRT Phase II study. An initial Howard County (HoCo) 2010 model forecast was presented and briefly reviewed with Howard County Staff in the Project Progress meeting on November 20th 2014. This memorandum provides additional detail on the model development and validation effort that has taken place since that initial run and documents the overall process. One key goal of the exercise was to make sure that the changes to the TAZ boundaries, demographic inputs, and networks needed to represent alternatives in the study corridor did not distort the relationships that the basic BMC model is built upon or the results of the forecasts. The current Howard County 2010 model has corrected differences found in the early runs in the resultant trip productions and attractions, trip distribution, mode split and assignments, and is now consistent with the adopted BMC 4.3 travel model and Round 8 cooperative demographic and land use forecasts used as inputs. This is crucial in order to maintain credibility with the BMC and regional planning/decision making process.

The overall Howard County BRT Phase II study was to be an extension of previous conceptual work performed to evaluate a Bus Rapid Transit network for the County, including linkage to other activity centers and transit systems in the Baltimore/ Washington Region. The purpose of the overall study is to provide additional detail and rigor not part of the previous work, and filter/refine alternatives to a level that can be carried forward to the next stage of right of way design and preliminary engineering. The Phase II effort focuses on three primary corridors (US 29, Broken Land Parkway, and the new Route 1), and examines ancillary feeder transit services, landside services such as park and rides and pedestrian accessibility, preliminary construction and operating costs, and alternative land use plans to support high quality transit service within and between them.

Sections on: the model selection and development; comparisons of the inputs that drive the results of any travel forecasting model (HoCo 2010 versus the BMC 4.3 2010 Base), and comparison of the results/validation between the models and observed data follow. Next steps are then summarized.

Model Selection and Development:

The original scope of the model development effort was to build upon the travel forecasting model, demographic data, and base transportation networks used for the initial Howard County BRT Study (Phase I) study and to refine this model for suitability to forecast the US 1 corridor BRT which was not examined in the previous effort. This included providing additional network and zone detail and updating demographic detail to enhance the model structure (zones and socioeconomic data) as appropriate, but did not include substantial recalibration/validation (since Phase I model was validated in the previous effort).

In initial discussions with Howard County, Baltimore Metropolitan Council (BMC), and others it became apparent that the travel forecasting model and demographic data used for the Howard County BRT

Phase I effort were significantly out of date and would be questioned by the BMC and other regional partners if used for the study. It therefore was necessary to carry out a model comparison and review between the Howard County BRT Phase I, the BMC 4.3 model, and MWCOG Version 2.3 models and TAZ/Demographic Structures. This entailed mapping the BRT Phase I TAZs, reviewing model structures, and carrying out summaries of each model's networks, inputs, and outputs. A presentation of the results and recommendation to use the use the most recently adopted 4.3 BMC Model for the Phase II study was made and approved during the June 24th Project Kickoff Meeting.

The additional activities associated with the mode development and validation are: These include:

- The BMC 4.3 model includes four jurisdictions (Montgomery, Prince George's and Frederick Counties and the District of Columbia) within the MWCOG region in order to capture travel to and from the BMC area properly in both generation, distribution, and assignment. However, as as one move further away from the BMC boundaries, an areas influence on the BMC transportation system and travel diminishes. Consequently, BMC aggregates the MWCOG detailed TAZs for use in their model as the distance increases. Very large sector level TAZs result within then Washington I 4-95 Beltway. This caused unanticipated TAZ splits and network updates in the Southern portions of the US 29 and US 1 corridors in Montgomery County and PG County in order to account for the transit access for potential stations in these areas.
- Likewise, there was additional data development and GIS/database updates to account for the service changes caused by the formation of the RTA of Central Maryland in July of 2014, and updates to the Prince George's County, The Bus. These service changes were identified and coded into a "current" year network and model (2010 networks and data were used for the validation).
- Coordination and collaboration with the Montgomery County US 29 Rapid Transit System Project Corridor analysis, assumptions and forecasts which is examining BRT service within Montgomery County along US 29. Particularly important will be consistent representation of transit service speeds and capacities between the two forecasts.
- Additional GIS processing and troubleshooting to implement the BMC Transit Access procedures which require advanced ARC GIS tools and licenses.
- Coding additional transit services in the US 29 and US 1 corridors necessitated by the discovery that the BMC 4.3 Model has no local/express service represented for Montgomery County, Prince George's County, or the District of Columbia even though these jurisdictions are within the model region.
- Potential modifications to the BMC 4.3 model and coding to account for:
  - Changes in transit service and trips that originate and terminate within the MWCOG region (intra MWCOG Trips) along US 29 and US 1 (to be used in the future networks.
  - Connections/transfers to the Metro Red Line and the Purple Line LRT at the Silver Spring Transit Center for the US 29 BRT, and the Metro Green line and the Purple line LRT to the US BRT.
- Additional post processing of transit boarding's and assignments for parallel service.

The validation focused on modifying the networks and service representation as represented in the BMC 4.3 2010 Base model.

Traffic Analysis Zone (TAZ) Refinement.

Traffic Analysis Zones (TAZs) are one of the basic building blocks of any travel forecast since they are the source of information about the travelers, where they want to go and characteristics of both. Having TAZs that are more detailed around potential station locations and along the corridor in order to

separate out Transit Oriented Development, walk drive, and feeder bus access is particularly important for any transit alternatives and feasibility study. Consequently, the US 29, Broken Land Parkway, and US 1 corridors defined in the original scope of work for this study and potential extensions of the Northern US 1 Corridor to serve Arundel Mills and BWI and the Broken Land Parkway Corridor to serve Fort Meade and Odenton Marc Station were both driven and examined within Google Earth and the Sabra Wang GIS Database in order to refine the TAZ splits for the study. The goal was to incorporate as many potential station areas as possible early on in order to avoid additional work later in the study. It was also discovered that the BMC TAZs in the Southern sections of the US 29 and US1 corridors were aggregations of the Montgomery and Prince George's County and MWCOG TAZs and did not have the detail to support the study analysis properly. Therefore, an additional 166 TAZ were defined for the new forecasting model. These have been provided to Howard County in a previous deliverable and are also shown in Figure 1. The potential stations are color coded by corridor and also include the locations for possible extensions (in blue), and the Montgomery County Rapid Transit System t proposed station locations (in grey). The new split TAZs are shown in light blue.

Network Modifications and Refinement.

In addition to adding centroid connectors to the split TAZs, additional network detail was also added to provide more detail and traffic loading along the corridors, especially near potential station locations. These network additions are shown in Figure 3 - Figure 4. Figure 3 shows the network additions in and around Columbia Md. Of note, is the inclusion of Old Columbia Pike parallel to US 29 just South of MD 198 (see Figure 2). As shown in Figure 4, additional detail was also included along the Northern US 1 corridor to help with access to the new TAZs and potential station locations.

After the study was initiated the Regional Transit Agency of Central Maryland was formed which

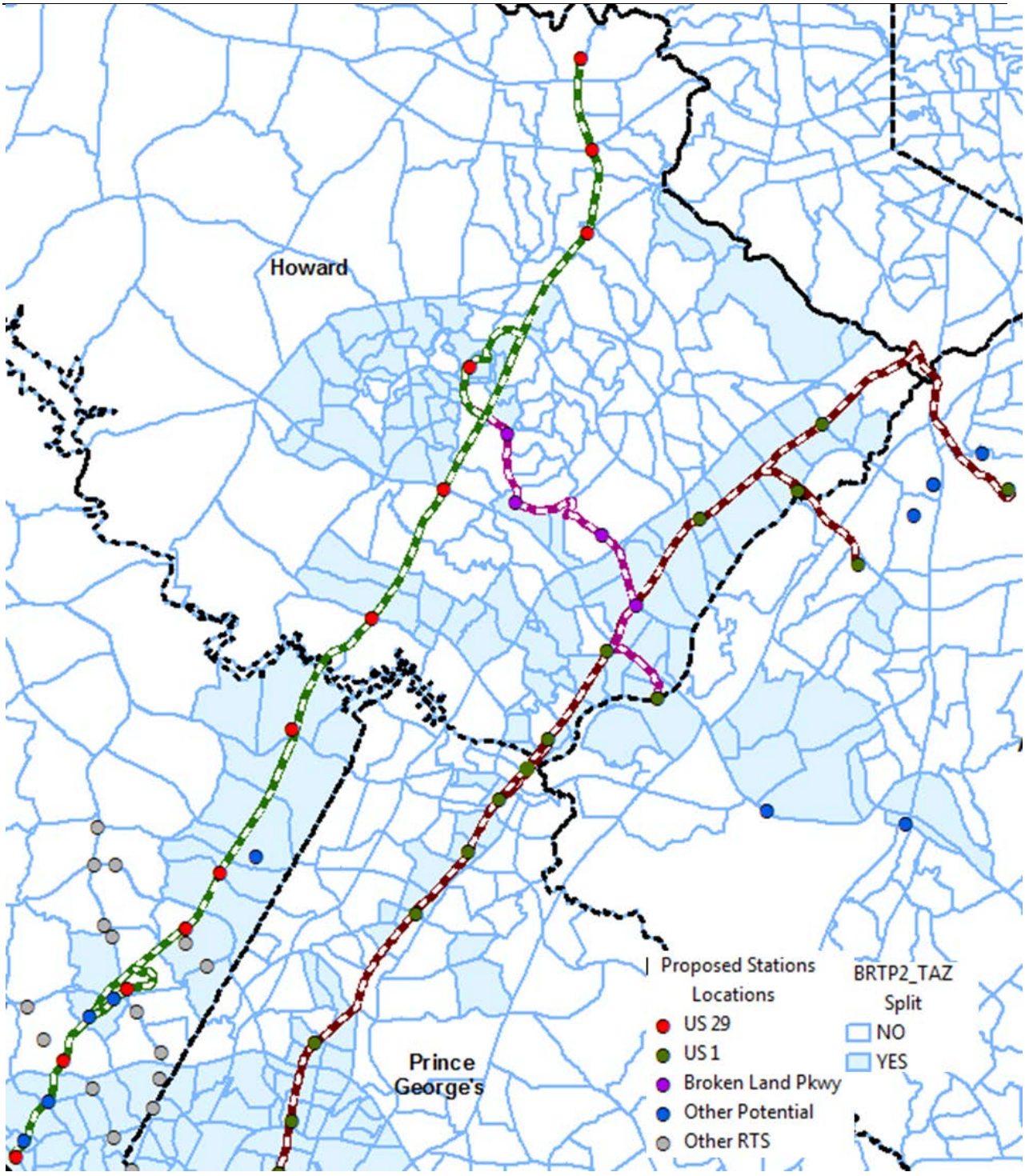

Figure 1 TAZ splits and Potential Station Locations

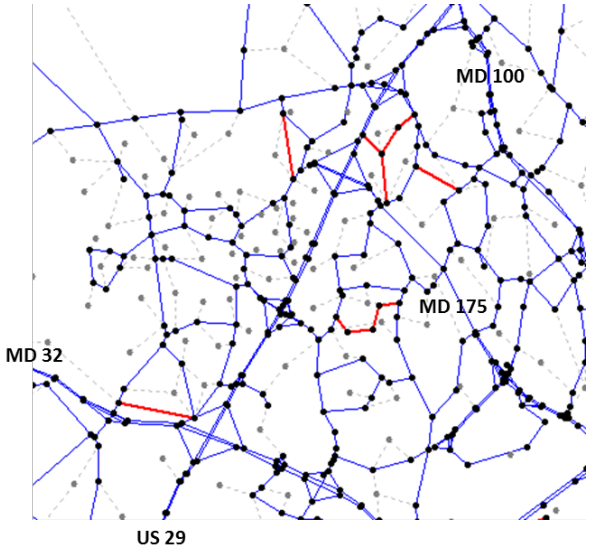

Figure 3 New Network detail in and around Columbia Md

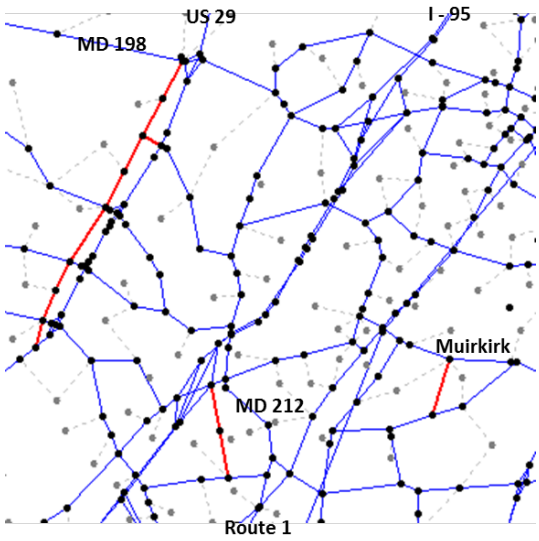

Figure 2 New Network Detail Along US 29 & MD 212

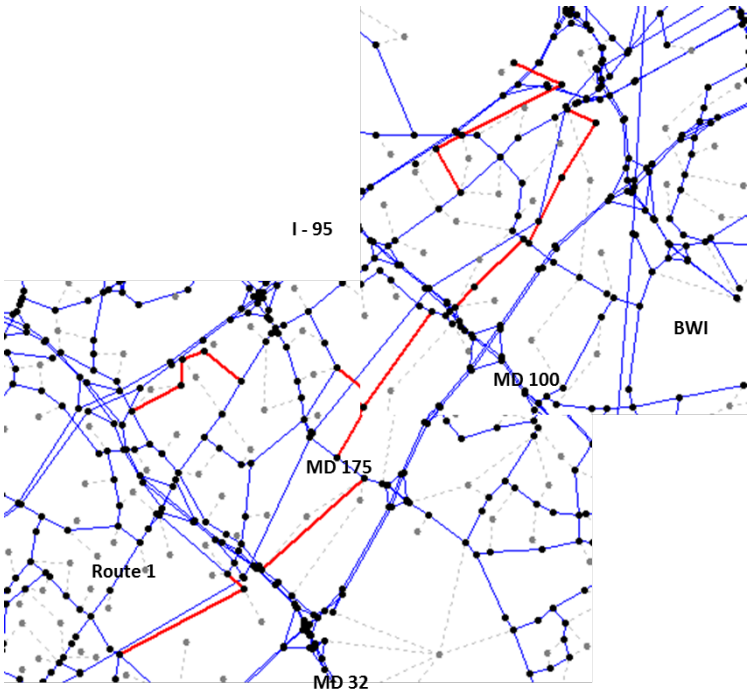

Figure 4 New Network Detail Along the Northern US 1 Corridor

Input Comparison: HoCo 2010 with BMC 4.3 2010 Base

This section compares the Howard County 2010 (HoCo2010) model inputs (demographics and network characteristics) with the BMC 2.43 2010 Base model inputs. As mentioned, one of the goals of this validation exercise was to make sure that no differences were introduced simply due to TAZ splits,

additional network detail, and modifications to the model scripts and processes. For example, in our initial round of disaggregating the Households within each split TAZ by household size, income quartile, and number of workers (using a process developed previously by BMC) we controlled by the number of total households but did not control by the number of households within each size, income, and number of workers group. This resulted in a shift within the split TAZs from higher income to lower income, smaller and fewer workers and a significant reduction in the trip productions and attractions. Consequently, the households within each split TAZ were redistributed a second time to control for the size, income, and worker distributions found in the parent BMC zone.

Table 1 Number of TAZs Comparison

	TAZs		
County	BMC 4.3	HOCO	HOCO
Baltimore City	330	330	0
Anne Arundel Co.	256	265	9
Baltimore Co.	380	380	0
Carroll Co.	99	99	0
Harford	155	155	0
Howard	167	230	63
District of Columbia	35	35	0
Montgomery	115	146	31
Prince George's	195	258	63
Frederick	35	35	0
Internal TAZs	1402	1568	166
External Station	42	42	0
Grand Total	1444	1610	166

As discussed in the previous section, TAZs were split along the each of the corridors and around potential station locations to better capture differences in transit access, and provide for feeder service and traffic assignment. A comparison is shown in Table 1. This includes 9 additional TAZ in Anne Arundel, 63 in Howard, 31 in Montgomery, and 63 in Prince George's County. The splits in Montgomery and Prince George's Counties basically reverse the aggregation of MWCOG and local model TAZs that BMC uses for their 4.3 model

Table 2 shows differences in the number of links, directional center line miles and lane miles between the BMC 4.3 Base 2010 Network and the Howard County (HoCo) 2010 network as finalized in the validation effort. The changes in network characteristics are mostly due to the addition of centroid connectors to the new split zones. They also include the new network detail discussed in the last section. As shown the changes also occur in Anne Arundel, Howard, Montgomery, and Prince George's Counties. Howard County has the most new links added to the Network, while Prince George's has the most Lane miles added to the network. Again, these are mostly due to centroid connectors. Even with the TAZ splits in Prince George's the TAZs in Howard are much smaller providing finer grained access.

Last, Table 3 provides a comparison of the BMC 4.3 and HoCo Land Use and demographic inputs used for the Model. Both are based on the BMC Round 8 cooperative forecasts and new 2010 census information released in 2013. The BMC 4.3 model uses a detailed atomistic synthetic population generator, POPGEN, and subzone Census data to distribute households within each zone across household size, income quartile, and workers per household (a 5 x 4 x 4 matrix). As stated, special care was taken to insure that the total households, population, workers, and employment by category for each parent BMC TAZ were maintained when disaggregating to the split sub-zones. The consultant team did not have access to this process, and initially implemented the BMC process used in prior versions for this disaggregation. The subzone disaggregation turned out to be a factor in replicating the BMC 4.3 results. Consequently, A second round of analysis was required to also ensure that the within zone distribution of households by size of household, income quartile, and number of workers was also maintained when the disaggregation occurred (trip generation is particularly sensitive to these distributions since trip rates vary by household size, income levels, and workers). As shown, the overall totals are retained at the county level for all demographic variables (within +- 2).

Table 2 Highway Network Comparison

BMC 4.3 2010 Base

Network Links

County	Expressway	Freeway	Primary Arterial	Minor Arterial	Collector	Ramp	Centroid Connector	Transit Access Road	Total
Baltimore City	106	67	1794	1649	433	175	1520	24	5768
Anne Arundel Co.	124	256	480	788	693	322	962	22	3647
Baltimore Co.	331	96	1069	1522	1169	364	1598	46	6195
Carroll Co.	5	0	295	230	528	15	438	0	1511
Harford Co.	30	0	263	386	474	59	624	16	1852
Howard Co.	69	133	258	529	616	212	674	18	2509
Washington DC	54	80	1067	1391	1093	69	364	0	4118
Montgomery Co.	228	24	834	768	440	131	474	2	2901
Prince George's Co.	148	143	800	650	860	185	678	22	3486
Frederick Co.	61	73	127	224	206	66	148	0	905
Total	1156	872	6987	8137	6512	1598	7480	150	32892

Link Miles

County	Expressway	Freeway	Primary Arterial	Minor Arterial	Collector	Ramp	Centroid Connector	Transit Access Road	Total
Baltimore City	36.06	29.62	293.35	298.16	61.83	44.76	343.42	1.65	1,108.84
Anne Arundel Co.	67.26	125.99	219.57	343.65	279.15	94.31	575.13	2.88	1,707.95
Baltimore Co.	170.32	46.8	318.42	593.23	649.43	102.04	826.06	4.8	2,711.10
Carroll Co.	3.25	0	170.84	190.8	444.84	3.35	421.52	0	1,234.61
Harford Co.	36.2	0	143.47	239.45	345.17	15.15	478.61	0.57	1,258.62
Howard Co.	63.11	59.1	113.14	213.59	303.58	67.35	382.55	3.05	1,205.46
Washington DC	20.9	24.02	171.99	271.6	214.59	6.05	140.23	0	849.39
Montgomery Co.	115.5	13.66	375.26	523.62	328.24	33.58	378.05	0.12	1,768.03
Prince George's Co.	105.92	76.31	374.39	337.71	515.51	63.94	458.23	2.87	1,934.89
Frederick Co.	78.88	94.56	129.81	309.14	350.46	19.75	241.92	0	1,224.52
Total	697.41	470.06	2,310.25	3,320.95	3,492.80	450.3	4,245.72	15.93	15,003.42

Lane Miles (AM)

County	Expressway	Freeway	Primary Arterial	Minor Arterial	Collector	Ramp	Centroid Connector	Transit Access Road	Total
Baltimore City	123.27	63.82	665.56	448.35	70.54	52.95	2,403.92	11.53	3,839.95
Anne Arundel Co.	181.1	288.98	354.98	432.76	319.35	109.92	4,025.93	20.14	5,733.16
Baltimore Co.	515.35	99.22	625.55	785.09	687.09	122.01	5,782.43	33.61	8,650.35
Carroll Co.	9.76	0	220.1	204.15	451.16	3.35	2,950.66	0	3,839.18
Harford Co.	116.66	0	226.71	259.9	348.05	16.33	3,350.28	3.99	4,321.91
Howard Co.	201.18	157.17	188.95	279.5	321.49	72.31	2,677.84	21.34	3,919.78
Washington DC	69.07	57.95	439.87	544.25	322.65	8.18	981.61	0	2,423.58
Montgomery Co.	328.85	31.41	839.54	661.74	357.68	42.66	2,646.33	0.85	4,909.05
Prince George's Co.	360.4	167.45	813.54	500	568.22	90.73	3,207.61	20.1	5,728.05
Frederick Co.	184.43	175.11	165.26	316.39	371.15	22.51	1,693.43	0	2,928.29
Total	2,090.07	1,041.11	4,540.06	4,432.14	3,817.37	540.95	29,720.04	111.54	46,293.29

HoCo 2010 Network Summary (150112)

Network Links

Expressway	Freeway	Primary Arterial	Minor Arterial	Collector	Ramp	Centroid Connector	Transit Access Road	Total
106	67	1794	1649	433	175	1520	24	5768
124	256	480	790	707	322	998	22	3699
331	96	1069	1522	1169	364	1598	46	6195
5	0	295	230	528	15	438	0	1511
30	0	263	386	474	59	624	16	1852
69	134	260	533	668	212	798	18	2692
54	80	1067	1391	1093	69	364	0	4118
228	24	836	786	442	131	576	2	3025
148	143	800	650	868	185	846	22	3662
61	73	127	224	206	66	148	0	905
1156	873	6991	8161	6588	1598	7910	150	33427

Link Miles

Expressway	Freeway	Primary Arterial	Minor Arterial	Collector	Ramp	Centroid Connector	Transit Access Road	Total
36.06	29.62	293.35	298.16	61.83	44.76	343.42	1.65	1,108.84
67.26	125.99	219.57	343.65	293.94	94.31	607.95	2.88	1,755.55
170.32	46.8	318.42	593.23	649.43	102.04	826.06	4.8	2,711.10
3.25	0	170.84	190.8	444.84	3.35	421.52	0	1,234.61
36.2	0	143.47	239.45	345.17	15.15	478.61	0.57	1,258.62
63.11	59.1	113.14	216.2	328.34	67.35	408.09	3.05	1,258.38
20.9	24.02	171.99	271.6	214.59	6.05	140.23	0	849.39
115.5	13.66	375.26	531.98	328.78	33.58	405.24	0.12	1,804.12
105.92	76.31	374.39	337.71	519.46	63.94	501.99	2.87	1,982.60
78.88	94.56	129.81	309.14	350.46	19.75	241.92	0	1,224.52
697.41	470.06	2,310.25	3,331.92	3,536.83	450.3	4,375.03	15.93	15,187.74

Lane Miles (AM)

Expressway	Freeway	Primary Arterial	Minor Arterial	Collector	Ramp	Centroid Connector	Transit Access Road	Total
123.27	63.82	665.56	448.35	70.54	52.95	2403.92	11.53	3,839.95
181.1	288.98	354.98	432.76	334.13	109.92	4255.65	20.14	5,977.65
515.35	99.22	625.55	785.09	687.09	122.01	5782.43	33.61	8,650.35
9.76	0	220.1	204.15	451.16	3.35	2950.66	0	3,839.18
116.66	0	226.71	259.9	348.05	16.33	3350.28	3.99	4,321.91
201.18	157.17	188.96	282.86	346.25	72.31	2856.66	21.34	4,126.73
69.07	57.95	439.87	544.25	322.65	8.18	981.61	0	2,423.58
328.85	31.41	839.54	670.83	358.21	42.66	2836.68	0.85	5,109.02
360.4	167.45	813.54	500.00	572.17	90.73	3513.91	20.1	6,038.30
184.43	175.11	165.26	316.39	371.15	22.51	1693.43	0	2,928.29
2090.07	1041.11	4,540.07	4,444.59	3,861.40	540.95	30,625.23	111.54	47,254.97

Difference

Network Links

Total
0
52
0
0
0
183
0
124
176
0
535

Link Miles

Total
0
48
0
0
0
53
0
36
48
0
184

Lane Miles (AM)

Total
0
244
0
0
0
207
0
200
310
0
962

Table 3 Land Use and Demographic Comparison

BMC 2.43 2010 Base

Jurisdiction	Households	Population (in HH)	Persons/ Household	Workers	Workers/ Household	Employ-ment
Baltimore City	249,889	595,723	2.38	272,158	1.09	381,772
Anne Arundel Co.	199,375	523,510	2.63	265,303	1.33	323,148
Baltimore County	316,715	784,214	2.48	401,890	1.27	446,250
Carroll County	62,406	163,815	2.62	83,696	1.34	70,890
Harford County	90,218	242,082	2.68	119,733	1.33	104,670
Howard County	104,749	284,763	2.72	147,187	1.41	181,381
Washington DC	266,707	561,702	2.11	NA	NA	1,734,879
Montgomery County	359,041	952,819	2.65	NA	NA	508,615
Prince George's	306,031	850,968	2.78	NA	NA	344,109
Frederick County	84,800	229,203	2.70	NA	NA	98,695
Total	2,039,931	5,188,799	2.54	1,289,967	1.26	4,194,409

Ho Co 2010

Jurisdiction	Households	Population (in HH)	Persons/ Household	Workers	Workers/ Household	Employ-ment
Baltimore City	249,889	595,723	2.38	272,158	1.09	381,772
Anne Arundel Co.	199,375	523,510	2.63	265,303	1.33	323,148
Baltimore County	316,715	784,214	2.48	401,890	1.27	446,250
Carroll County	62,406	163,815	2.62	83,696	1.34	70,890
Harford County	90,218	242,082	2.68	119,733	1.33	104,670
Howard County	104,751	284,761	2.72	147,186	1.41	181,381
Washington DC	266,707	561702	2.11	NA	NA	1,734,880
Montgomery County	359,041	952817	2.65	NA	NA	508,615
Prince George's	306,029	850968	2.78	NA	NA	344,110
Frederick County	84,800	229203	2.70	NA	NA	98,695
Total	2,039,931	5,188,795	2.54	1,289,966	1.26	4,194,411

Difference

Jurisdiction	Households	Population (in HH)	Persons/ Household	Workers	Workers/ Household	Employ-ment
Baltimore City	0	0	0	0	0	0
Anne Arundel Co.	0	0	0	0	0	0
Baltimore County	0	0	0	0	0	0
Carroll County	0	0	0	0	0	0
Harford County	0	0	0	0	0	0
Howard County	2	-2	0	-1	0	0
Washington DC	0	0	0	NA	NA	1
Montgomery County	0	-2	0	NA	NA	0
Prince George's	-2	0	0	NA	NA	1
Frederick County	0	0	0	NA	NA	0
Total	0	-4	0	-1	0.00	2

% Difference

Jurisdiction	Households	Population (in HH)	Persons/ Household	Workers	Workers/ Household	Employ-ment
Baltimore City	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Anne Arundel Co.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Baltimore County	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Carroll County	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Harford County	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Howard County	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Washington DC	0.00%	0.00%	0.00%	NA	NA	0.00%
Montgomery County	0.00%	0.00%	0.00%	NA	NA	0.00%
Prince George's	0.00%	0.00%	0.00%	NA	NA	0.00%
Frederick County	0.00%	0.00%	0.00%	NA	NA	0.00%
Total	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Results/Validation Comparison: HoCo 2010 with BMC 2.43 and observed data.

The results/validation comparison had two purposes: To ensure that the HoCo 2010 model did not distort the basic travel patterns and results produces by the BMC 2.43 2010 base model, and to reasonably be consistent with observed conditions. Therefore comparisons were made and checks carried out on the trip generation productions and attractions, trip distribution and flows between jurisdictions, and basic traffic mode split results. Since, the model is being used for transit alternative validation a screen line level of analysis and checking and not detailed assignment analysis was used. There was also a focus on trips to, from, and within Howard County.

One of the first steps in the carried out by the BMC 4.3 model is Trip Generation which estimates trip "Productions" at the household end and "Attractions" at the work, school, or shopping end of the trip. Productions and attractions must be balanced so that they are equal for trip distribution. The BMC 4.3 Trip Distribution is a function of the households by household size, Income level, and workers per household among other factors. Table 4 provides a summary of the balanced productions and attractions by trip purpose. All of the differences between the two models are within 1.0% with the exception of Heavy Trucks with is 2.2%. This maybe due to the change in size of zones. Overall, there is only a drop of 0.2% in the trip generation results across all purposes.

Table 4 Trip Generation Comparison

Trip Purpose	BMC 4.3 2010 Base P/A	HoCo 2010 P/A	Difference	% Difference
Home Based Work - Income 1	76,518	76,282	-236	-0.3%
Home Based Work - Income 2	265,430	265,013	-417	-0.2%
Home Based Work - Income 3	609,564	607,846	-1,718	-0.3%
Home Based Work - Income 4	2,035,527	2,036,050	523	0.0%
School	1,215,660	1,214,836	-824	-0.1%
Home Based Shopping - Income 1	152,325	151,887	-438	-0.3%
Home Based Shopping - Income 2	260,668	259,818	-850	-0.3%
Home Based Shopping - Income 3	484,278	481,702	-2,576	-0.5%
Home Based Shopping - Income 4	1,469,572	1,466,456	-3,116	-0.2%
Home Based Other - Income 1	286,003	285,564	-439	-0.2%
Home Based Other - Income 2	560,125	559,262	-863	-0.2%
Home Based Other - Income 3	909,931	906,811	-3,120	-0.3%
Home Based Other - Income 4	3,183,154	3,179,234	-3,920	-0.1%
Journey TO Work	990,306	991,992	1,686	0.2%
Journey AT Work	509,369	511,559	2,190	0.4%
Other Based Other	2,920,952	2,920,749	-203	0.0%
Comercial Vehicles	1,012,184	1,003,085	-9,099	-0.9%
Medium Trucks	234,169	231,934	-2,235	-1.0%
Heavy Trucks	197,003	192,761	-4,242	-2.2%
Total	17,372,738	17,342,841	-29,897	-0.2%

Trip Generation provides the inputs to Trip Distribution along with the travel time and costs on the network. The BMC 4.3 model includes a feedback loop to ensure that the congested speeds that are used as inputs are similar to those that result after assignment. Table 5 provides a comparisons of the overall person and vehicle trips from the final feedback loop of Trip Distribution. As shown person trips from and to Howard County vary only by 0.09% and 0.44% respectively. Vehicle trips from Howard County change a little bit more (-0.37%) and also drop instead of increase. This could be due to an increase in non-motorized travel from the zone splits, or a change in where the trips are going. All person trips drop by 0.09% and all vehicle trips drop by 0.61%. These are acceptable variations and are likely due to the slight shifts in the patterns of trip productions and the more detailed zone structure.

Table 5 Person and Vehicle Trips from Trip Distribution

Person and Vehicle Trips				
	BMC 4.3 2010 Base	HoCo 2010	Difference	% Difference
Person Trips From Howard County	988,352	989,207	855	0.09%
Person Trips to Hourard County	1,052,470	1,057,146	4,676	0.44%
Vehicle Trips From Howard County	823,218	820,203	-3,015	-0.37%
Vehicle Trips to Howard County	811,889	808,508	-3,381	-0.42%
All person Trips	15,929,383	15,915,060	-14,323	-0.09%
All Vehicle Trips	12,637,061	12,560,490	-76,571	-0.61%

Mode choice follows Trip Distribution in the model chain. As shown, there is a small drop in person trips overall of 0.61 % which is consistent with the trip distribution results. While the overall shits are very small there is a more significant drop in SOV and HOV trips versus transit trips (slight increase in mode share). This is shown in the Mode Share part of the table. Note , that what we are seeing are slight variations that indicate that the changes in the model structure are not altering its internal relationships and outputs (this is good).

Table 6 Regional Mode Choice Comparison

Regional Mode Choice				
Person Trips				
Mode	BMC 4.3 2010 Base	HoCo 2010	Difference	% Difference
SOV	7,517,498	7,472,801	-44,697	-0.59%
HOV	7,067,326	7,019,237	-48,089	-0.68%
Transit	941,491	939,797	-1,694	-0.18%
Total	15,526,315	15,431,835	-94,480	-0.61%
Mode Share				
Mode	BMC 4.3 2010 Base	HoCo 2010	Difference	% Difference
SOV	48.42%	48.42%	0.00	0.01%
HOV	45.52%	45.49%	0.00	-0.07%
Transit	6.06%	6.09%	0.00	0.43%
Total	100%	100%	0.00	0.00%

After mode split trips are broken out by time of day and vehicle and transit assignments are carried out. The overall assignment summary is provided in Table 7. Again there are only slight differences across the region in vehicle miles travelled, free flow vehicle hours of travel, and congested vehicle hours of travel. There is a larger impact across Howard County than the region (due to where we were making network, TAZ, and Demographic changes). Interestingly the VMT increases between the two models indicating slightly longer trips. In Howard County the CVHT increases by 0.92% while it only increases by 0.2% across the region. Again this is due to the where we made changes (along our corridors), but all of the changes are not significant.

Table 7 Final Vehicle Trip Assignment Summary

Final Trip Assignment Summary				
Howard County	BMC 4.3 2010 Base	HoCo 2010	Difference	% Difference
Vehicle Miles of Travel (VMT)	10,655,850.00	10,737,948.00	82,098	0.77%
Free-Flow Vehicle Hours of Travel (FVHT)	218,051.00	220,020.00	1,969	0.90%
Congested Vehicle Hours of Travel (CVHT)	279,560.00	282,119.00	2,559	0.92%
VMT/FVHT	48.9	48.8	-0.1	-0.13%
VMT/CVHT	38.1	38.1	-0.1	-0.14%
Region				
Vehicle Miles of Travel (VMT)	114,738,580.75	114,938,127.52	199,547	0.17%
Free-Flow Vehicle Hours of Travel (FVHT)	2,616,145.80	2,617,907.58	1,762	0.07%
Congested Vehicle Hours of Travel (CVHT)	3,254,183.02	3,260,567.57	6,385	0.20%
VMT/FVHT	43.9	43.9	0.0	0.11%
VMT/CVHT	35.3	35.3	0.0	-0.02%

Screenlines are used to check the vehicle flows in and out of an area. They are developed to capture overall travel regardless if there are slight diversions in the routes people take. Figure 5 shows the screenlines developed for the HoCo Model and Table 8 provides a summary of the results. Appendix 1 provides the detailed volumes on all of the links for each screenline, as well as count data where it exists. While the differences remain small there appears to be a shift in volumes to/from the East of US 29 to the West of US 29, and an overall increase in trips crossing east and west of I-95. The most significant change is east west along the eastern Howard County Line, which is also where there were both zone splits and additional network. This maybe due, therefore, to a conversion of within zone to between zone trips. When the assignments are compared to the 24 hour counts (see the Appendix) they seem to be improving overall but the changes remain small.

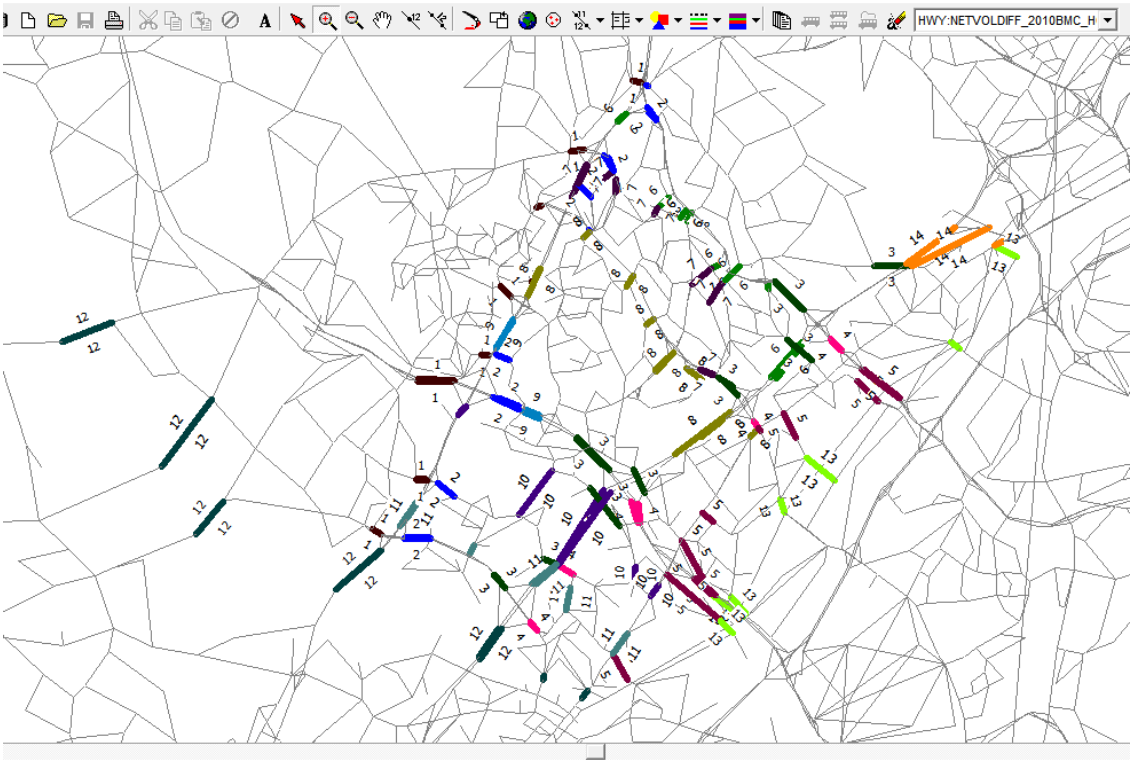

Figure 5 Howard County Model Screenlines

Table 8 Screenline Summary

Screenline		BMC 4.3 2010 Daily Volume	HoCo 2010 Daily Volume	Difference	% Difference
1	West of US 29	245106	250481	5375	2.2%
2	East of US 29	297370	293281	-4089	-1.4%
3	West of I-95	307415	313625	6210	2.0%
4	East of I-95	258292	267137	8845	3.4%
5	East of Route 1	206234	210066	3832	1.9%
6	South of MD 100	437056	436520	-536	-0.1%
7	South of MD 108	210088	214495	4407	2.1%
8	South of MD 175	409673	426173	16500	4.0%
9	South of Broken Land Pkwy	165476	166611	1135	0.7%
10	South of MD 32	340634	340846	212	0.1%
11	North of MD 216	328365	331051	2686	0.8%
12	South Howard County Line	363503	365258	1755	0.5%
13	East Howard County Line	212288	224145	11857	5.6%
14	North Howard County Line	237537	240647	3110	1.3%

Table 9 provides a comparison of the daily transit ridership by line from the transit assignments of the two models. There is an overall drop in boardings which can be attributed to better representation of the percent walk and access along the corridors (smaller zones). Transit assignment is known to have flip flops where there are several choices for taking different lines because it is not an equilibrium assignment with feedback. While there is an over assignment to the Howard County Silver Line in the BMC Model this is reduced in the HoCo model, but it still significant. The most notable finding from the assignment comparison, is the while the HoCo model may better represent the access choice, all of the

commuter service to the DC area is below expectations. This is due to how the BMC 4.3 model represents transit service in the DC area to Downtown DC but not to the suburban markets such as Silver Spring, Bethesda, or College Park. We are still exploring how to address this in the build alternatives.

Table 9 Daily Transit Ridership by Line

Daily Boardings				
Route	BMC 4.3 2010 Base	HOCO 2010	Difference	% Differer
BWIACC	434.67000	200.12	-234.55	-53.96%
CTCC	210.78000	146.64	-64.14	-30.43%
CTCE	810.03000	617.47	-192.56	-23.77%
CTCJ	1248.58000	1172.23	-76.35	-6.11%
CTCK	868.90000	523.95	-344.95	-39.70%
HTBRWN	588.86000	515.78	-73.08	-12.41%
HTGOLD	861.37000	732.19	-129.18	-15.00%
HTGREE	423.56000	161.02	-262.54	-61.98%
HTORAN	361.76000	159.22	-202.54	-55.99%
HTPURP	818.71000	482.43	-336.28	-41.07%
HTRED	434.83000	347.31	-87.52	-20.13%
HTSILV	2061.56000	1468.69	-592.87	-28.76%
HTYELL	918.08000	812.82	-105.26	-11.47%
MARCC	806.49000	638.36	-168.13	-20.85%
MCE150	734.98000	714.00	-20.98	-2.85%
MCE311	79.09000	56.84	-22.25	-28.13%
MCE320	39.67000	27.90	-11.77	-29.67%
MCE915	192.74000	129.27	-63.47	-32.93%
MCE929	267.57000	211.52	-56.05	-20.95%
MCE995	256.02000	248.51	-7.51	-2.93%

Next Steps:

A significant milestone has been reached in implementing the model with 166 additional zones and adjusting it to maintain consistency with the original model. But, there is still much work to be done for the study. The next forecasting steps, therefore, include:

- Implementing an Extra Work Order to continue the study
- Carrying out a 2035 Nobuild forecast and comparing the results to the BMC 4.3 model results
- Further exploration and implementation of a method to better represent the transit markets to/from Howard County and the Study Corridors and the suburban locations in Montgomery and Prince George's County.
- Additional coordination with the Montgomery County US/29 RTS study that the US 29 Howard County BRT may use, or coordinate with.
- Coding and running the initial 2035 Howard County BRT Phase II alternatives.

Appendix 1

Screen Line Summaries Embedded (click to expand)

Howard County BRT PH 2											
Year 2010			Screenline:	1	West of US 29						
					BMC		HOCO_SWA 1/13/2015				
Model Network								HOCO-BMC			
A	B		Facility	Vol24	Congspd	Congtime	Vol24	Volume	Congspd	Congtime	Count 2010
Node	Node	Tag	Identification					Diff			
26130	26143		MD 103	9,382	28	0.3264	9,762	380	28	0.3264	4,611
26143	26130		MD 103	6,415	28	0.3264	6,666	251	28	0.3264	4,611
26367	26166		MD 108	20,134	33	0.4440	18,699	-1,435	33	0.4440	0
26166	26368		MD 108	20,830	27	0.2821	19,648	-1,182	27	0.2821	0
26269	26280		MD 175	19,266	27	0.2422	19,494	228	27	0.2422	0
26280	26269		MD 175	18,194	27	0.2422	17,761	-433	27	0.2422	0
26291	26292		S Entrance Rd	6,782	14	0.1804	8,732	1,950	14	0.1804	0
26292	26291		S Entrance Rd	6,286	14	0.1804	7,289	1,003	14	0.1804	0
26302	26309		Broken Land {kwy	14,879	27	0.6340	15,355	476	27	0.6340	0
26324	26302		Broken Land {kwy	14,714	27	0.4917	14,249	-465	27	0.4917	0
26314	26739		Seneca Dr	2,846	28	0.2777	5,390	2,544	28	0.2777	0
26739	26314		Seneca Dr	3,935	28	0.2777	5,575	1,640	28	0.2777	0
26601	26189		MD 32	37,993	55	0.6814	38,686	693	55	0.6814	36,768
26190	26602		MD 32	39,355	55	0.6561	37,557	-1,798	55	0.6561	36,768
26202	27204		John Hopkins	4,042	38	0.7741	4,458	416	38	0.7741	0
27204	26202		John Hopkins	6,321	38	0.7741	6,777	456	38	0.7741	0
26193	26646		MD 216	6,530	38	0.3009	6,657	127	38	0.3009	9,108
26646	26193		MD 216	7,202	38	0.3009	7,726	524	38	0.3009	9,108
	Links: 0		TOTALS	245,106			250,481	5,375			100,974