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Memorandum

To: MARC/SEPTA Rail Connection Working Group Partners

From: Dave Gula
Principal Planner
WILMAPCO

Date: August 29, 2017

RE: MARC/SEPTA Commuter Rail Service Extension Ridership Analysis, August 21, 2017

The purpose of this working group was to complete the MARC/SEPTA Commuter Rail Service Extension Ridership Analysis for a direct connection between the MARC commuter train service and the SEPTA commuter train service. MARC trains on the Penn Line currently provide service between Washington D.C. and Perryville, MD. The SEPTA Wilmington/Newark Line provides service between Newark, DE and Philadelphia. There is a twenty-mile gap between these commuter services, which is currently served only by Amtrak. However, the Amtrak Northeast Regional trains do not provide scheduled stops between these two stations to fill that gap. This is the only such commuter rail gap on the 460 miles of the Northeast Corridor (NEC) between Spotsylvania, VA and New London, CT.

The working group was tasked to complete the attached ridership modeling study to project ridership demand and to complete a feasibility analysis for the concept of a new commuter rail service to fill this gap. The service delivery concept has not been fully defined, so three different scenarios were considered in the modeling process, in addition to a no-build scenario. The first build scenario assumed doubling the MARC and SEPTA train frequencies during peak hours. This was done solely for testing purposes to determine the upper limit for potential demand, as these frequencies are infeasible based on current capacity restrictions. The second build scenario uses current schedule times and assumes transfers at Newark. The third build scenario is based on a proposed new schedule with transfers at Newark. The proposed station locations (including the addition of the unbuilt Elkton Train Station) and information, service headways, fare structures, and site information that were necessary for the study were provided to WILMAPCO by MDOT MTA, SEPTA, DTC and their associated partners. See table 4 in the attached *MARC/SEPTA Commuter Rail Service Extension Ridership Analysis, August 21, 2017* for full information.

The results of the sketch-level ridership forecast show greater growth for the overall service than the 2040 No-build: an additional 10% for the First Build Scenario, 6% for the Second Build Scenario, and 3% for the Third Build Scenario. It is important to note that the No-Build growth in the model may also be unfeasible: the Perryville Station could not support 480 riders due to parking limitations of approximately 200 spaces. Other stations may face similar challenges. This information is shown in (Table 6) the attached memorandum. The projected ridership results support the goal of connecting the MARC and SEPTA commuter rail services.

Table 6

MARC/SEPTA Station	Base Year	2040 No-Build	2040 Build Scenario		
			Scenario 1	Scenario 2	Scenario 3
Stations between Washington Union Stations and Aberdeen	23,800	31,100	33,900	33,280	31,550
Perryville	180	480	260	230	140
Elkton	0	0	440	190	430
Newark	790	860	800	1050	780
Churchmans Crossing	590	500	590	550	540
Wilmington	1,860	1,850	2,340	2,040	2,200
Claymont	1,180	1,400	1,740	1,510	1,630
Stations between Marcus Hook & University City	5,800	6,300	6,500	6,380	6,350
Total	**34,200**	**42,490**	**46,570**	**45,150**	**43,620**
Growth (2015-2040)		**24%**	**36%**	**32%**	**28%**
Difference between the Build and No-Build			**10%**	**6%**	**3%**

The working group recommends that the implementing agencies (DelDOT, DTC and MDOT MTA) create a Memorandum of Agreement towards developing a service connection for MARC and SEPTA. There is currently no timetable in place to create the commuter service connection. There are currently no funds in place to operate the service or to construct any necessary infrastructure needs. The MOU would be to formalize the goals of: developing a service schedule; creating an operating agreement; and prioritizing a list of infrastructure improvements that would be needed to create a rail service connection between the MARC Penn Line and SEPTA's Wilmington/Newark Line.

Whitman, Requardt & Associates, LLP
Engineers · Architects · Environmental Planners Est. 1915

MEMORANDUM

Date: Aug 21st, 2017
To: Dave Gula, WILMAPCO
From: Scott Thompson-Graves, WRA
cc:

Work Order Number: 32068
Contract Number: 16.13.15-4
Project: MARC/SEPTA Commuter Rail Service Extension Ridership Analysis

The purpose of this memorandum is to provide additional documentation regarding the data sources and how they were used in the MARC/SEPTA model process to evaluate the extension of service. The previous memorandum provided by WRA on June 29, 2016 .provided an overview of the model structure and preliminary results. This memorandum provides additional information on the model structure and development and results of additional scenarios.

Travel Demand Models for the Baltimore Metropolitan Council (BMC), the Metropolitan Washington Council of Governments (MWCOG), Delmarva Peninsula (from the Delaware Department of Transportation, DelDOT), and the Delaware Valley Regional Planning Commission (DVRPC) were combined. In conjunction with a pivot analysis, this combined model was used to test an extension connecting MARC and SEPTA commuter rail services. This extended rail service would provide a vital alternative for commuters along the congested I-95 corridor connecting Philadelphia, Baltimore, and Washington, DC.

MARC / SEPTA Extension Ridership Analysis Model

The MARC / SEPTA extension ridership analysis model or sketch model that was developed is not a traditional travel demand model with the four steps of trip generation, trip distribution, mode choice, and traffic assignment. The sketch model estimates demand using source model data, American Community Survey (ACS) Journey to Work (JTW) data, and other information from the models and includes a simplified mode split process to obtain a transit trip table that summarizes ridership at each rail stop.

Because of the large model area and limited project budget, the model relies upon personal trip tables from each model area instead of relying upon the creation of a combined model for all steps. The mode split process divides traffic analysis zone (TAZ)-to-TAZ personal trips into private vehicle and public transit mode based on the travel cost and utility. Similarly, the transit cost skim was also derived from MPO source model outputs. Highway cost skims are sourced from the Delmarva Freight Model, which covers the Delmarva Peninsula and DVRPC, Delmarva Peninsula, BMC, MWCOG, Richmond, and Hampton Roads MPO areas.

The mode split input, and output data and process is shown in Figure 1. Table 1: MPO Models Used provides a list of the source models and corresponding versions or release dates.

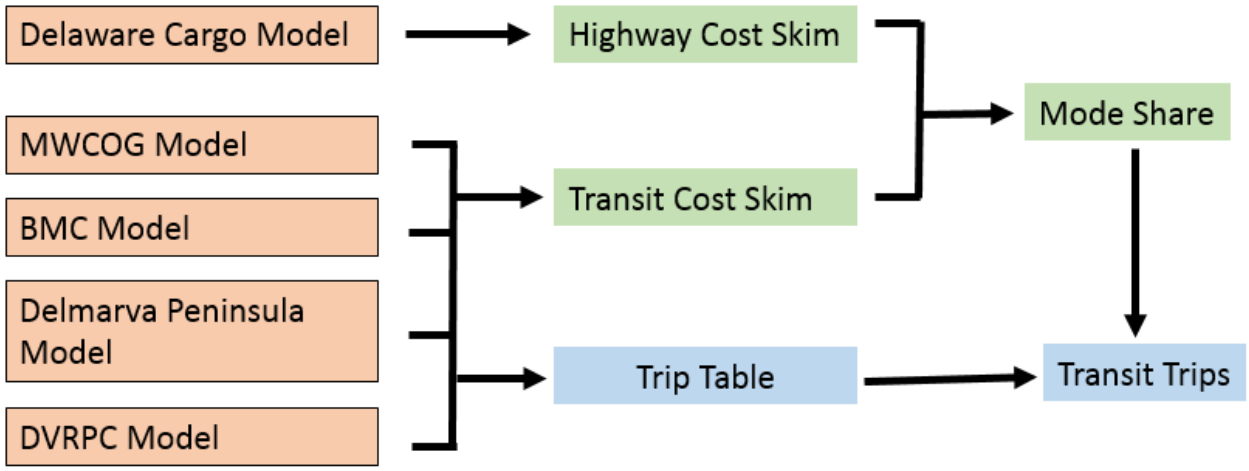

Figure 1: Mode Split Process

Table 1: MPO Models Used

Region	Model Version	Base Year	Future Year
MWCOG	Version 2.3 (Build 57)	2015	2040
BMC	Version 3.3	2010	2035
Delmarva Peninsula	Most updated	2015	2040
DVRPC	TIM 1.0	2010	2035

Trip Table Development

The MARC/SEPTA Model has two trip types, home-based work (HBW) and OTHER. All personal trips other than HBW trips from each of the MPO models were combined together to make up the OTHER trips. Since each MPO model only covers a subarea of the studied railroad service area, no long distance trips with detailed origination/destination (OD) information were available directly from the source models. The external-external (EE), external-internal (EI), and internal-external (IE) trips from each MPO model were utilized to derive long distance trips.

The EE, EI, and IE trips were first grouped into HBW and OTHER trips based upon the MPO source model outputs. If the specific model did not disaggregate external demand into HBW and OTHER, the distribution of trips from the model was used to define the percentages. Figure 2 below demonstrates the creation of long distance trips in the MARC/SEPTA Model based on an example MPO area (Delmarva Peninsula).

The blue line represents the internal-internal (II) trips for Delmarva Peninsula. These trips were directly aggregated to MARC/SEPTA model TAZs. The green lines represent EI or IE trips and the red lines are EE trips. The trip ends outside M2 were allocated by the DVRPC model and BMC model external trip OD pattern. After locating M2 external trips, the model combined the Delmarva Peninsula trips that end outside BMC model and BMC model external trips,

removed duplicated trips, and applied the same process to locate them to MWCOG or outside MWCOG according to the MWCOG external station trip OD pattern. This process was applied to both base year and future year MPO trip tables.

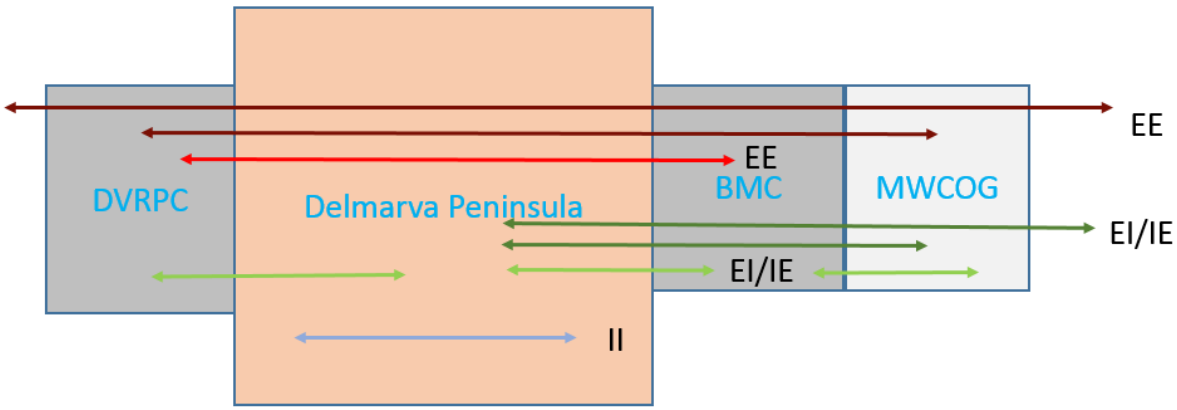

Figure 2: Long Distance Trip Structure

The HBW purpose was modeled based on developing a base year trip table for the entire model study area using the ACS JTW data disaggregated to the TAZs based on the source model area distributions of trips from the ACS geography to the TAZ. The resulting trip table was then converted to origin-destination (OD) format. The base trip table was then forecasted based on source model growth rates at the zone-to-zone interchange level. The OTHER purpose was based upon the MPO source model trip tables and used directly in the mode split process for the base and forecast years.

Transit and Highway Cost Skim Development

To code a complete highway and transit network for the model area would require significant effort and cost, so an alternative method was developed. Similar to the trip table development, the source MPO models were used to provide accurate transit cost skims. The MPO source models commuter rail transit cost skims were used to produce long transit costs for the long distance trips. The transit cost between TAZs within the same MPO model area use the transit cost from MPO model directly. For transit cost between TAZ pair crossing the MPO model boundary, the rail stops at the adjacent point of MPO models area were identified and the MPO model TAZ closest to the rail stop data were assumed to be the cost to/from the rail station. In vehicle time from MPO models were added up to get the transit time between TAZs in different MPO model area. The access/egress time, wait time, transfer times, other local transit time and fare were derived from MPO model transit cost skim and refined. The MARC/SEPTA Model relies on this method for both the peak and off peak period skims.

Congested highway cost skims were output from the Delmarva Freight Model. The Delmarva Freight Model highway network was created by relating directly with MPO network links. It uses MPO scenario year highway congested speeds when skimming the zone to zone travel times. This network was used to then estimate personal vehicle time as input to the mode split process.

Figure 3 below depicts the process used for the transit and highway skimming.

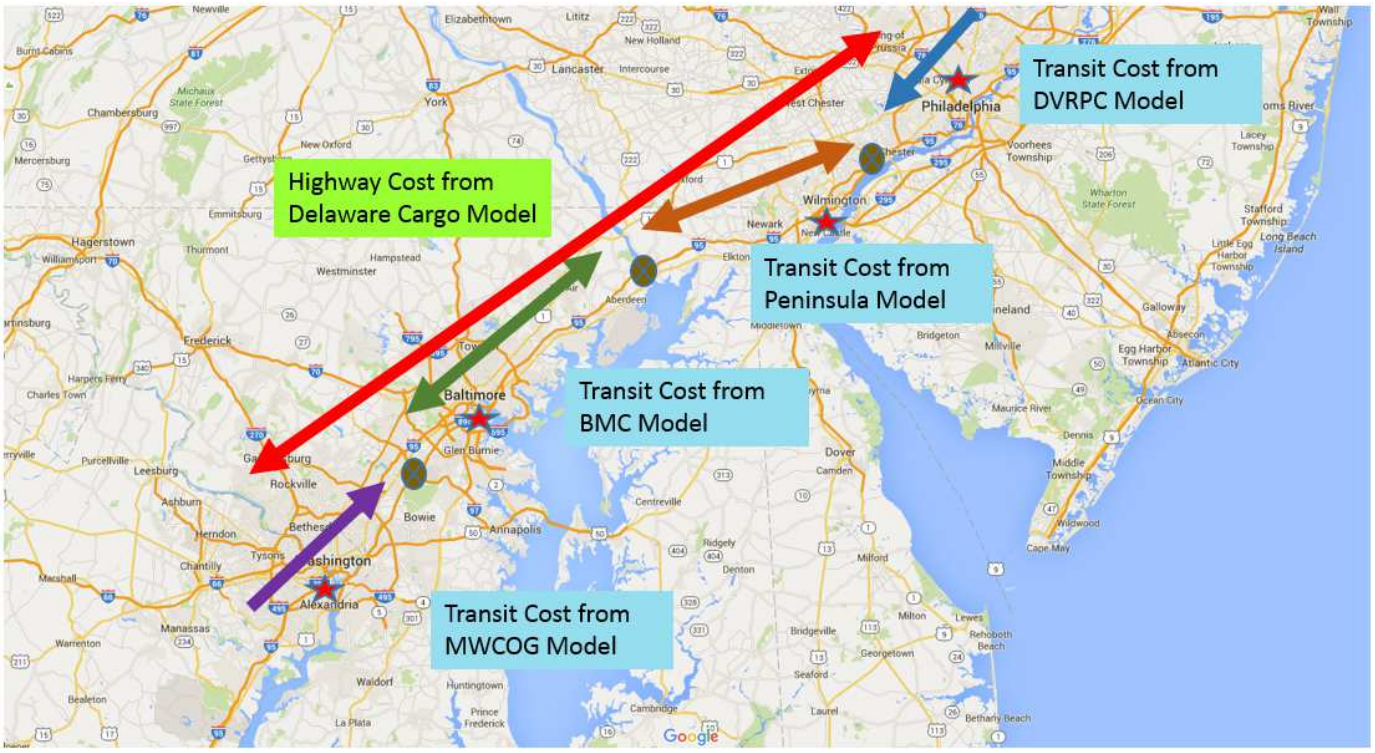

Figure 3: Transit and Highway Cost Skim MPO Sources

Model Calibration

Ridership data for 2014 and 2015 was received from several sources including MARC station ridership data, SEPTA ridership data at Newark, Churchmans, Wilmington and Claymont, from WILMAPCO, and transit on-board survey data from DVRPC. Additional SEPTA station ridership was found in SEPTA's "Fiscal Year 2016 Annual Service Plan". Table 2 below provides detailed ridership data by source agency that was used for model calibration.

Table 2: Daily Station Boarding Count Data by Source Agency

Stations	2014/2015 Boarding	Data Source
Washington	10,607	WILMAPCO
New Carrollton	973	
Seabrook	425	
Bowie	703	
Odenton	2,803	
BWI	1,885	
Halethorpe	1,460	
West Baltimore	787	
Penn Station	3,665	
Martins Airport	393	
Edgewood	269	
Aberdeen	225	
Perryville	167	
Newark	793	WILMAPCO
Churchmans Crossing	591	
Wilmington	1,859	
Claymont	1,179	
Marcus Hook	605	SEPTA Fiscal Year 2016 Annual Service Plan
Highland Ave	83	
Chester	314	
Eddystone	63	
Crum Lynne	80	
Ridley Park	291	
Prospect Park	196	
Norwood	308	
Folcroft	193	
Glenolden	210	
Sharron Hill	127	
Curtis Park	118	
Darby	102	
University City	3,091*	

* University City station count includes Newark/Wilmington, Airport, and Media/Elwyn lines

Ridership data from the model was based upon aggregation of trips by mode after applying the Mode Choice process. The service area for each stop was based on the walk and drive access distance and travel time. The Mode Choice process was applied to both the HBW and OTHER purposes. The calibration of the model focused on the overall mode split by purpose between AUTO and TRANSIT and then boardings at the specific stations. Extra attention was paid to the suburban and rural stations where limited or no other transit service was available.

Table 3 below provides count and estimated ridership data for the base year. The model estimation of ridership between West Baltimore and Marcus Hook is 10,060, which is close to the 2015 count of 10,230.

Table 3: Ridership Calibration for 2015

Stations	2014/2015 Count	2015 Estimation
MARC Penn Line Union Station – Halethorpe	**8,192**	
West Baltimore	797	1,165
Penn Station	3,136	2,614
Martin	344	275
Edgewood	237	113
Aberdeen	199	97
Perryville	177	137
Segment Total	**4,890**	**4,401**
Newark	793	801
Churchmans crossing	591	1,310
Wilmington	1,859	2,213
Claymont	1,179	523
Segment Total	**4,422**	**4,847**
Marcus Hook	918	812
Segment Total	**918**	**812**
Subtotal between West Baltimore and Marcus Hook	**10,230**	**10,060**
SEPTA Newark/Wilmington Highland Avenue - Temple University	**2,584**	

Model Results

An underling assumption for all future build scenarios was no additional transit improvements other than the ones that were included in MPO models as they were the source of the underlying time and cost skims. Using this assumption, the impact of the scenarios for the MARC/SEPTA extension could be evaluated.

Build Scenario 1, 2 & 3

In addition to the 2040 no-build scenario, three build scenarios were evaluated. The first build scenario is based on information provided by MTA which assumed doubling the frequencies of the Penn Line during peak hours for testing purpose only. This scenario was used to determine an upper limit for the potential demand for the corridor, although operating at this increased frequency would be infeasible based on current capacity restrictions. Comparing the transit headways coded in the MWCOG, BMC, and DVRPC models, the proposed schedule reduces the headway by 50% and off peak headways are unchanged. Standard practice is to assume wait time is to be half of headways. The

wait time was reduced by half between TAZ pairs served by the extension for peak periods. This build scenario assumes the rail route is connected but does not account for the speed differences between MARC and SEPTA.

The second build scenario differs by assuming transfers at Newark for both peak period and off peak period. The transfer time is added by identifying the arrival and departure times for MARC and SEPTA service. Additional boarding time was added to TAZ pairs that are served by the extensions that use the Newark station.

The third build scenario is based on the new schedule "MARC Exercise #1a – schedule with express service.xlsx" provided by WILMAPCO. The new schedule was compared with the first build scenario and additional wait time was added to the TAZ pairs crossing through the Newark station. The seven- to eight-minute transfer time at Newark in the daily last run for both northbound and southbound was not accounted for due to model limitations. The detailed headways for all scenarios can be found in Table 4.

Table 4: Headways by Scenario and Service Area

Headway (minutes)			MARC		SEPTA	
			SB	NB	SB	NB
Current Schedule		Peak	30/60*	27.5/110*	30	25
		Off-Peak	60/240*	60/240*	60	60
Model Base Year	**MWCOG**	Peak	30	20		
		Off-Peak	60	60		
	BMC	Peak	45/60*	45/60*		
		Off-Peak	60/240*	60/240*		
	DVRPC	Peak			30	40
		Off-Peak			60	60
Future NB	**MWCOG**	Peak	30	20		
		Off-Peak	60	60		
	BMC	Peak	29	29		
		Off-Peak	38	38		
	DVRPC	Peak			30	40
		Off-Peak			60	60
Build 1		Peak	15	15	15	20
		Off-Peak	50	50	60	60
Build 2 (transfer)		Peak	65	75	65	80
		Off-Peak	122	180	132	190
Build 3		Peak	30/125*	25/55*		
		Off-Peak	50/450*	50/615*		

*Headways between Washington D.C. and Baltimore / Baltimore to Perryville

The growth in demand in the model was compared against growth rates from the input model demographics and against ridership growth for the no build scenario. The 2040 no-build scenario forecasts a 24% growth over the entire

route, with 31% growth at stations in the MWCOG and BMC areas, 10.7% growth on the Delmarva Peninsula, and 8.6% growth in the DVRPC region. The overall growth is reasonable when compared to general socio-economic growth around the MARC/SEPTA service area. The MWCOG model included 20% population growth and 31% employment growth around the MARC Penn Line service area, the BMC model included 16% population growth and 32% employment growth, and the Delmarva Peninsula included 23% population growth and 14% employment growth. The DVRPC model included 1% employment growth in Delaware County and Philadelphia. Table 5 provides detailed socio-economic data.

Table 5: Socioeconomic Growth

Socio-economic		Total Households	Total Population	Total Employment
MWCOG	2015	1,901,075	4,944,859	3,249,768
	2040	2,339,270	5,932,696	4,249,378
	Growth Factor	23%	20%	31%
BMC	2010	2,039,965	5,332,303	3,242,833
	2035	2,477,792	6,206,240	4,275,520
	Growth Factor	21%	16%	32%
Delmarva peninsula	2015	546,339	1,414,505	673,077
	2040	688,847	1,735,736	766,744
	Growth Factor	26%	23%	14%
DVRPC	2015	817,797	2,095,622	1,041,351
	2040	873,326	2,200,571	1,107,700
	Growth Factor	7%	5%	6%

*MWCOG data include DC, Montgomery, Prince George's, Arlington, Alexandria, Fairfax, Howard, and Anne Arundel Counties.
**DVRPC data include Philadelphia and Delaware County, DVRPC data has been updated to the most recent information available

The results of the model, when applied to the three build scenarios, indicates additional growth compared with the no-build scenario as shown in Table 6. Perryville and Newark produce negative growth from no-build to the build scenarios, due to the additional stop added at Elkton. In the second scenario, all trips are supposed to transfer at Newark; the boarding at Newark counts the first boarding passenger but does not account for the transfer boardings. The increased boardings at Newark is a shift from other stations due to the additional waiting time and boarding.

Table 6: Boardings by Station

MARC/SEPTA Station	Base Year	2040 No-Build	2040 Build Scenarios		
			Build Scenario 1	Build Scenario 2	Build Scenario 3
Stations between Washington Union Stations and Aberdeen	23,800	31,100	33,900	33,280	31,550
Perryville	180	480*	260*	230*	140
Elkton	0	0	440	190	430
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Stations between Marcus Hook & University City	5,800	6,300	6,500	6,380	6,350
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Growth (2015-2040)		**24%**	**36%**	**32%**	**28%**
Difference between the Build and No-Build			**10%**	**6%**	**3%**

*number of riders will exceed the existing parking supply of approximately 200 spaces on four different lots

Additional reasonableness checks were done by comparing with MPO model ridership forecasting for routes included in the MARC/SEPTA Model. MWCOG includes the MARC Penn Line coded from Union Station to Baltimore-Washington International Airport (BWI). The BMC model covers the whole MARC Penn Line, and the Peninsula Model covers the four stations of the SEPTA Newark/Wilmington Line within Delaware. The DVRPC Model covers all of the SEPTA Newark/Wilmington line in Pennsylvania.

The source MPO models reveal the following results:

- The MWCOG model predicts about 47% growth along the studied rail line
- The BMC model predicts 22% growth in the rail mode ridership
- The Peninsula model forecasts a 3% growth among the 4 stations in Delaware
- The DVRPC model shows 6.2% growth

The MARC/SEPTA Model predicts an overall 24% growth from base year to future year for the no-build scenario, which is generally in line with the MPO model forecasting. More detailed growth by segment can be found in Table 7.

Table 7: Transit Ridership Forecasting from MPO Models Compared to MARC/SEPTA Model Output

Segments	MPO Model Output				MARC/SEPTA Model Output
	MPO Model	Base Year Ridership	Future Year Ridership	Growth Factor	
MARC Penn Line Union Station-BWI	MWCOG	15,728	23,086	46.8%	
MARC Penn Line	BMC *	112,801	137,133	21.6%	31.7%
SEPTA Newark/Wilmington Stations in DE	Peninsula Model	470	484**	3.0%	4.3%
SEPTA Newark/Wilmington Stations in PA	DVRPC	8,176	8,682	6.2%	8.6%

*BMC shows negative ridership growth along the Penn Line. Review of the model found that the existing drive access leg to some stations was removed in the future year modeling. The data list in the table is overall rail trips.

** The Peninsula model only covers the Delmarva Peninsula, so ridership is between the stations in Delaware.