Review of the Economic Benefits Analysis for the Proposed Baltimore-Washington Maglev Project

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EXECUTIVE SUMMARY

This report provides results of an independent review conducted by the University of Maryland Center for Environmental Science, Environmental Economics lab (UMCES-EE) of an economic impacts report prepared for the Baltimore-Washington Rapid Rail (BWRR) by environmental economic contractors. The Maryland Department of the Environment (MDE) requested the review of the BWRR report to use as a reference in aiding MDE in its decision as to whether BWRR met the necessary conditions to adequately complete the Antidegradation (Tier II) Review, which includes justifying the project's environmental impacts to Tier II waters on an economic basis. To conduct the independent review, UMCES-EE evaluated model assumptions and construction methods, recreated the economic analysis using the same input data and modeling software, and conducted a quality assessment of the model outputs. This report compares the BWRR economic impact results to several alternative modeling scenarios for estimating economic impacts but does not recommend which modeling scenario MDE should use when making its determination. As required by the Code of Maryland Regulations (COMAR) 26.08.02.04-2, the Tier II Review is occurring concurrently with the Nontidal Wetlands permit application (AI No. 170244 /20-NT-1398 /202061983) for the Baltimore-Washington Maglev (BW Maglev) rail project proposed by BWRR. The Tier II review is also required for the 401 Water Quality Certification environmental review for the same Maglev project.

The BW Maglev project has been proposed for a route between Washington, DC and Baltimore, MD. This specialized type of high-speed rail will require new tunnels and maintenance structures and is expected to generate substantial new economic activity during the 7-year construction period and ongoing future operations and maintenance. Capital spending on the project is expected to be about $13.8 billion in the U.S. during the construction phase. Annual operations and maintenance (O&M) activities were projected by BWRR to generate 1,740 direct jobs with $118 million in employee compensation and $82 million in other spending (e.g., electricity, infrastructure maintenance).

Overall, UMCES-EE found the contractor's approach to calculating economic impacts of the construction and O&M phases of the project (Scenario 1a) using IMPLAN analysis software to be an appropriate application, although several concerns were noted. The economic impact results in the BWRR report were largely replicated by UMCES-EE using the data inputs described by BWRR (Scenario 1b). Although the UMCES-EE version of the BWRR impact analysis did not generate identical results, differences can largely be explained by UMCES-EE limiting the study area to Maryland and DC (where direct spending occurred) rather than using BWRR's approach of including all counties in the Washington-Baltimore-Arlington Combined Statistical Area (CSA) economic zone. Both choices of study area are justifiable given that the CSA is defined by data on economic interactions but UMCES-EE restricted the geography (in consultation with MDE) to align areas of economic and environmental impacts. In accordance with COMAR, MDE requested an analysis that could show varying scales of impact within the State of Maryland. Despite the replicability of BWRR's analysis, some concerns were identified about how analytic choices appear to have inflated some of the economic impacts, as described below. UMCES-EE further suggested that construction phase job results could be clarified by reporting the estimated 31,798 average annual jobs instead of only reporting the 222,587 total person-years of employment in the Local Study Area (LSA), because person-years can easily be misinterpreted.

The primary concern with the BWRR analysis that was identified by UMCES-EE was that the economic impacts of the construction phase appeared higher than average, due to some data anomalies in the construction sector of the model year (2018) that was used in analysis. The O&M phase impacts were not similarly affected because the economic industries in that analysis did not have the same anomalies as the construction sector. UMCES-EE ran the construction phase economic analysis using a data year of 2019 that was more representative of long-term average conditions than 2018, and held everything else within the model constant (Scenario 2). The change in data year resulted in employment estimates that were 39-49% lower and total economic output that was 8-23% lower than estimates in the UMCES-EE baseline model (Scenario 1b).

The O&M economic impact estimates were replicable with respect to the effects of $200M in annual spending and employee compensation. However, information was insufficient to independently evaluate BWRR's estimates of direct jobs and employee compensation or assess the potential for double-counting of jobs by adding these estimates of direct jobs to the modeled jobs that were output from IMPLAN as a result of direct O&M spending. Nonetheless, if the job estimates are realistic, BWRR used methods that produced a lower or more conservative estimate of economic impacts than impacts that would have resulted from modeling the direct jobs as inputs to an IMPLAN model.

The BWRR economic projections were compared with other high speed rail and local infrastructure projects using three economic ratio metrics of 1) the output multiplier (total project output divided by total project spending), 2) jobs per billion in spending (total person-years of employment divided by total project spending), and 3) average income per job. Compared to a large infrastructure project in the Washington DC area (I-495 & I-270 Toll Lanes and New American Legion Bridge), the BW Maglev output multipliers were slightly lower (1.9 vs 2.1) but the jobs/billion in spending are considerably higher (16,150 vs 7,230). The higher jobs appears to reflect the impact of using the anomalous 2018 IMPLAN data to generate employment estimates.

Another concern with the BWRR analysis that was explored was whether some of the direct spending of the project would be met by businesses outside the region being modeled. Although it is typical to model economic impacts as if 100% of direct spending would be absorbed locally, a portion of purchases are likely to come from non-local businesses, particularly when projects are large and impacts are evaluated for small or specialized economies. Using an alternative model specification that applies historic data of purchasing patterns to move some direct spending outside of the LSA (Scenario 3), resulted in an additional 6-11% reduction in total economic output in the LSA, relative to the 2019 (Scenario 2) results. Scenario 3 reveals some of the uncertainty of economic impact estimates for the local scale and could be used to represent economic impacts as ranges, rather than single values.

1 INTRODUCTION

A Superconducting Maglev rail project has been proposed for a route between Washington, DC and Baltimore, MD. This specialized type of high-speed rail will require new tunnels and maintenance structures and is expected to generate substantial new economic activity during the 7-year construction period and ongoing economic activity associated with operations and maintenance.

Baltimore-Washington Rapid Rail (BWRR) is the permit applicant for the Baltimore-Washington Maglev (BW Maglev) project and their economic contractor estimated the expected magnitude of economic impacts of the construction phase and ongoing operations, if the DC-MD rail line moves forward. This report provides results from an independent review of that economic impact report by an environmental economics team at the University of Maryland Center for Environmental Science (UMCES-EE). UMCES-EE conducted a review of the economic modeling by evaluating assumptions and methods used, recreating the economic analysis, and conducting a quality assessment of the results. Using the same expected spending provided by the applicants and the same IMPLAN software tool, UMCES-EE estimated the economic impacts of the planning, construction and annual maintenance of the BWRR project in terms of jobs, activity, and taxes collected.

1.1 IMPLAN OVERVIEW

All economic analyses by BWRR and UMCES-EE were conducted using IMPLAN data and software, a common tool for economic impact analysis. IMPLAN is an economic model built on data aggregated from multiple sources to represent an area's economic structure and is used to analyze effects of new economic activity, such as a new construction project. The model uses local data on the size and type of businesses in a region and interactions (purchases, taxes and transfers) among business (or industry) sectors, governments and households, as the basis for modeling economic impacts. To model impacts, new spending (or new job creation) is distributed to the appropriate economic sectors (546 industry categories are available), resulting in increased output (or employment). This new spending on activities such as planning, constructing or managing a project increases industry-specific activity that, in turn, necessitates increased purchases of inputs from other businesses (goods and services) and households (labor). Resulting economic impacts are classified in IMPLAN as Employment (jobs created), Labor Income, Value Added, Total Output, and tax revenues (Figure 1 and Glossary). These impacts represent the various ways that economic activity is stimulated as a result of new spending or new hiring.

Economic impacts are generated through direct, indirect and induced effects. Direct effects are those that result from purchases associated with the project. Indirect effects are associated with purchases and sales by businesses that supply inputs to the businesses that are directly impacted by project spending, and additional rounds of new spending that propagate through the economy. Induced effects are generated when households spend new income to purchase goods and services at businesses that are unrelated to project construction. The indirect and induced effects are often referred to as *multiplier effects* and their magnitude is a function of the economic structure of the region used in analysis. For example, if the businesses within the study region can meet the demands for needed inputs, the economic activity will occur locally and increase the multiplier effects. However, if the local economy cannot meet the demand, some spending will "leak" out of the region (i.e., occur elsewhere). This results in lower multiplier effects in the region because the indirect and induced effects generated by

the leaked direct spending occur elsewhere. In the IMPLAN model, any direct spending to businesses outside the defined region will not generate any indirect or induced effects in the local study area. Regional Purchase Coefficients (RPCs) in IMPLAN determine the proportion of industry spending that is estimated to occur locally, based on available data. Multi-region models are used to evaluate effects within the area receiving the direct spending and also include the indirect and induced effects within a broader region that includes businesses and households that interact with businesses in the region of direct spending.

Figure 1. Nested components of IMPLAN outputs
Components in bold are the primary IMPLAN economic impact results. The figure shows how terms in lower rows are summed to create terms in higher rows. For example, output is the broadest category because it is the sum of all other categories shown. See Glossary for definitions of each term.

<table>
<tr><td colspan="4">Output</td></tr>
<tr><td colspan="3">Value Added</td><td rowspan="2">Intermediate Inputs</td></tr>
<tr><td colspan="2">Labor Income</td><td rowspan="2">Taxes on Production and Imports</td><td rowspan="2">Other Property Income</td></tr>
<tr><td>Employee Compensation</td><td>Proprietor Income</td></tr>
</table>

1.2 Model Scenarios and Study Areas

This section describes how the IMPLAN model was specified by BWRR, how UMCES-EE replicated that base scenario, and alternative scenarios that were run by UMCES-EE to test model specifications (Table 1). The rationale for the alternative scenarios was based on concerns about the BWRR results that will be explained in the next section. UMCES-EE defined the study area differently from the BWRR study area to isolate effects for Maryland while still accounting for the direct spending that occurs in Washington, DC. Because of this difference in the study region, alternative scenarios are compared to the UMCES-EE baseline when evaluating changes in model specifications to isolate changes in economic impacts due to the scenario.

The BWRR baseline model (Scenario 1a) includes expected spending by economic sector (IMPLAN industries) for the construction and operations and maintenance (O&M) phases of the project across multiple nested economic regions. The construction phase is expected to last 7 years and create new spending in the new nonresidential construction, insurance carriers, legal services, architecture and engineering, marketing and management industries. The O&M phase was modeled for a single year but represents ongoing future economic impacts associated with operating the BW Maglev system. The ongoing operations are expected to generate direct spending in the electric power transmission and distribution, infrastructure maintenance, and rail transportation industries.

The primary area of the BWRR analysis was the Local Study Area (LSA), representing the jurisdictions where the majority of the spending is expected to occur, including Washington DC and four Maryland counties (Anne Arundel, Baltimore, Baltimore City and Prince George's).[1] In addition, BWRR also modeled and reported impacts for the rest of the Washington-Baltimore-Arlington Combined Statistical

[1] Baltimore City is treated as a county in Maryland.

Area (CSA),[2] the State of Maryland, the Commonwealth of Virginia, and the United States. In contrast, UMCES-EE analyzed the same LSA but only added the rest of Maryland to the multi-region analysis, rather than the full CSA. This study area was chosen in consultation with MDE to closely align the area of environmental impacts with the area of economic impacts as is required by COMAR.

Limiting the study area to Maryland and Washington, DC results in a somewhat more conservative estimate of economic impacts for the LSA and the state of Maryland, relative to the BWRR analysis. The modestly lower impacts (5-9%, see Section 3.1.1) result from not including the indirect and induced effects that occur when new spending (by businesses or households) is used to purchase goods and services from companies outside of Maryland that buy inputs from Maryland companies. Further, the household spending induced by these lost purchases from Maryland companies is not accounted for in results. As an example, if a rail project employee buys a chicken dinner at a restaurant in Virginia and that restaurant buys its chicken from a Maryland chicken processing company, the amount of money that was received by the Maryland chicken processor from the Virginia business will not be included in the economic output for Maryland. The other economic effects of that money flow to the processor (e.g., a portion of labor income and employee spending effects) will also be excluded from impact results.

In the three UMCES-EE scenarios, the region and direct spending per industry were held constant and only model specifications varied. UMCES-EE replicated the BWRR analysis omitting portions of Virginia (Scenario 1b) and this scenario was used as the baseline for evaluating changes due to other scenarios. Two additional scenarios were created to analyze results. An "Alternative data year" scenario (Scenario 2) was created using a more recent economic data year (2019) than the year used by BWRR (2018) and was otherwise the same as Scenario 1b. The "Alt data year + leakage" model (Scenario 3) was the same as Scenario 2 but enabled a model feature in which direct spending is not constrained to the initial jurisdiction but instead adjusts to account for local economic spending patterns.

Table 1. Model scenarios used to evaluate economic impacts

Number	Model Scenario	Data Year	Phases Modeled	Differences from BWRR model
1a	BWRR Base	2018	Construction & O&M	None
1b	UMCES-EE Base	2018	Construction & O&M	Same as 1a but only LSA and rest of MD modeled as multi-region, rather than the entire CSA (which includes some VA, WV, and PA counties)
2	Alternative data year	2019	Construction & O&M	Same as Scenario 1 but economic data from 2019 used
3	Alt data year + leakage	2019	Construction	Same as Scenario 2 but some direct effects leak from the study region, based on RPCs

[2] The LSA falls entirely within the Washington-Baltimore-Arlington CSA. The rest of the CSA comprises some cities and counties in Maryland, Washington, DC and Virginia, as well as several Metropolitan Statistical Areas (MSA) in Maryland, Virginia, Pennsylvania and West Virginia.

The remainder of this report is organized as follows. Section 1 describes the inputs to the BWRR base scenario. Section 2 presents BWRR results, a comparison of BWRR results to similar projects and the rationale for the UMCES-EE alternative scenarios. Section 3 provides the results of UMCES-EE's independent analysis of the three scenarios (1b, 2 and 3). Section 4 synthesizes results, includes a quantitative comparison of all scenarios and an assessment of other modeling choices. Section 5 provides conclusions. In the main body of the report, results tables show a subset of model outputs for primary areas of interest: Washington DC, Prince George's County (where any Tier II impacts would occur), the LSA and the state of Maryland. Results for all modeled geographies and scenarios are included in Appendix A.

1.3 Estimated Project Spending

UMCES-EE developed estimates of direct spending for the BW Maglev project by industry and by jurisdiction from the BWRR report (WSP 2021) and from information requests to BWRR (Appendix B). Two impact phases were modeled, 1) the initial 7-year construction phase and 2) the annual O&M phase. All direct spending is expected to occur within the LSA, therefore the use of different study areas by BWRR and UMCES-EE does not affect the total direct spending used in analysis.

1.3.1 Construction Phase

The BWRR report (WSP 2021) estimates a total of $15.3 billion in 2020 dollars (2020$) in project spending for the construction phase, 90% ($13.8 billion) of which will be spent in the United States and generate multiplier effects (WSP 2021, page 7). The remainder of spending is for a tunnel boring machine that will be purchased from outside the United States. The $13.8 billion in spending will go towards construction and non-construction or soft costs (i.e., design, marketing, legal services, etc.). As consistent with FHWA guidelines (US DOT FTA 2022), the initial cost estimate of ($10.6 billion) was increased to include a 30% contingency (recommended at 45% design stage) to represent factors that may increase costs beyond initial projections. Because cost estimation methods were consistent with federal guidance, the UMCES-EE analysis also included the contingency spending in all scenarios.

BWRR distributed the total spending (%) among specific industries (Table 2) which UMCES-EE used to estimate direct spending (dollars) per industry (Table 3). BWRR also distributed spending to jurisdictions in the LSA (Table 4), which was then used to estimate spending for each industry in each jurisdiction. Following the approach used in the BWRR report, all scenarios modeled estimated spending during the 7-year project construction phase as a single event. The BWRR analysis used the data year 2018, which they reported to be the most current IMPLAN data at the time of the analysis, and this choice was replicated in UMCES-EE base Scenario 1b.

Table 2. Construction phase spending estimates generated with information provided by BWRR

IMPLAN Industry		% direct spending*
#	Name	
56	Construction of new nonresidential structures	79%
469	Management of companies and enterprises	5%
457	Architectural, engineering and related services	5%
455	Legal services	5%
444	Insurance carriers, except direct life	4%
468	Marketing research and all other miscellaneous professional, scientific, and technical services	2%
		100%

* Numbers may not sum due to rounding

Table 3. Direct construction phase spending by industry estimated by BWRR and used in all scenarios

Industry	Estimated Spending ($M)	Plus 30% contingency* ($M)
Construction	$8,374	$10,886
Management	$530	$689
A&E	$530	$689
Legal	$530	$689
Insurance	$424	$551
Marketing	$212	$275
Total	$10,600	$13,780

* Numbers may not sum due to rounding

Table 4. Distribution of construction-phase project spending in the LSA from BWRR
Per industry spending for each jurisdiction was estimated by multiplying the % of direct spending shown here by the estimate of construction phase spending by industry (Table 3).

County	% Direct Spending
Washington, DC	22%
Anne Arundel	41%
Baltimore City	10%
Baltimore	2%
Prince George's	24%
Total *	100%

* Numbers may not sum due to rounding

1.3.2 Operations and Maintenance (O&M) Phase

When the BW Maglev system is operational, annual O&M is projected by BWRR to require 1,740 direct annual jobs with $118 in associated Employee Compensation (EC). In addition, annual post-construction O&M spending is projected to include $82 million in direct spending in 3 industries. The BWRR economic impact analysis combined their independent estimates of jobs and EC with the output from an IMPLAN model that applied the EC and the direct spending (a total of $200 million annually) as inputs (Table 5). In IMPLAN, the direct industry spending inputs generate total (i.e., direct, indirect and induced) impacts including new jobs, while the Employee Compensation input generates only induced impacts (effects of household spending). The BWRR results added together the 1,740 direct jobs, the $118 million in

Employee Compensation plus induced effects, and the total effects of the estimated industry spending. With this approach, it is not possible to verify whether the jobs created by the direct spending were fully distinct from the direct jobs.

At the request of UMCES-EE, BWRR provided an allocation of annual O&M spending for the three industries per region (Table 6; Correspondence details in Appendix B) that was used by UMCES-EE to independently estimate O&M impacts. O&M spending is expected to occur in Washington, DC (24%) and the four Maryland counties in the LSA (76%). The jurisdiction spending patterns were reported to be based on the percentage of the project footprint within that jurisdiction (WSP 2021), but, unlike construction phase modeling, impacts by individual jurisdiction (county) were not reported.

Table 5. BWRR methods used to generate economic impacts for O&M

The table shows which independent estimates of jobs and employee compensation were added to which IMPLAN model results to generate total economic impacts by category.

Result	Impact Category	BWRR Estimates	Inputs to IMPLAN	IMPLAN Outputs	BWRR Reported Results
A	Employment	1,740 direct jobs	NA	NA	A (direct jobs) + B (induced jobs) + C (total jobs)
B	Labor Income	$118M in direct Employee Compensation (EC)	$118M in EC	Induced effects (jobs, labor income, total output, etc.)	B (direct and induced income) + C
C	Industry Output	$82M direct spending in 3 industries	$82M	Direct, indirect and induced effects (jobs, labor income, total output, etc.)	B (direct and induced output) + C

Table 6. Annual O&M spending estimates derived from BWRR information

From Contractor			Derived by UMCES-EE		
IMPLAN Industry					
#	Name	%	Estimated Spending ($M)	Spending in DC (24%) ($M)	Spending in MD LSA* (76%) ($M)
62	Maintenance and repair construction of highways, streets, bridges, tunnels	11%	$22.00	$5.28	$16.72
47	Electric power transmission and distribution	10%	$20.00	$4.80	$15.20
415	Rail transportation	20%	$40.00	$9.60	$30.40
	Labor Income	59%	$118.00	$28.32	$89.68
		100%	$200.00	$48.00	$152.00

* MD LSA refers to the Maryland portion of the LSA without DC

2 BWRR IMPLAN ANALYSIS (SCENARIO 1A) RESULTS

Scenario 1a represents the results presented in the BWRR economic report (WSP 2021) and not IMPLAN output generated by UMCES-EE. Results in this section were primarily drawn from the BWRR report, however, some details that were not in the report were recreated by communicating with BWRR (Appendix B). Only four of the study regions presented in the BWRR report are provided in the body of this report because they are considered the most relevant to MDE's decision making. Additional region results are provided in Appendix A. The economic impact terms shown for each scenario are defined in the Glossary.

The study areas used in the BWRR report (Section 1.2) are consistent with economic flows in the region and will allow many indirect and induced effects to be included. In particular, the high proportion of Maryland residents employed in Washington, DC and the economic diversity of the DC economy make the inclusion of DC in the LSA useful for thoroughly capturing regional economic impacts.

2.1 IMPACTS OF CONSTRUCTION PHASE SPENDING

The BWRR analysis suggests that project-related construction phase spending will result in significant economic impacts in the LSA. For the four MD counties and DC that make up the LSA, the analysis projects about 222,600 jobs and over $26.5 billion in Output. For Maryland as a whole (without DC), the total impacts (sum of direct, indirect and induced impacts) are projected to be about 193,300 jobs, $13 billion in Labor Income, and $24 billion in Output (Table 7; Table Appendix A-1). Impacts within Prince George's County, where the Tier II watersheds are located, include over 54,000 person-years of employment (over 7 years) and almost $6 billion in Output. All dollar figures in the BWRR and UMCES-EE analyses are reported in 2020 dollars.

Table 7. BWRR construction phase total impacts for primary study regions (Scenario 1a)
Derived from Figure 7 in WSP (2021)
Prince George's County economic impacts are shown because it contains the Tier II watershed (Beaverdam Creek 2) where any project impacts would occur.

	Employment (Jobs)*	Labor Income ($M)	Value ($M)	Output ($M)
Washington, DC	42,372	$3,456	$2,524	$4,788
Prince George's	54,365	$3,401	$2,939	$5,980
LSA total	222,587	$15,827	$13,905	$26,532
Maryland Total**	193,329	$13,166	$12,845	$24,168

* Person-years of employment

** Values lower than LSA because DC is included in LSA

2.2 IMPACTS OF OPERATIONS AND MAINTENANCE PHASE SPENDING

In contrast with the fixed duration of economic impacts from planning and construction, annual O&M spending generates ongoing economic impacts for the lifespan of the railway. Overall, direct employment and annual spending on O&M was projected in the BWRR analysis to generate almost 2,700 annual jobs, about $181 million in Labor Income, and about $289 million in Output in the LSA. In the state of Maryland, annual O&M activities were estimated to produce about 2,200 jobs, about $145

million in Labor Income, and about $248 million in Output (Table 8, Appendix A Table A-8), assuming the regional economic structure of 2018.

Table 8. UMCES-EE O&M phase impact analysis for primary study regions (Scenario 1a)
Derived from WSP (2021) Figure 9

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)
Washington, DC	548	$39.83	$43.09	$53.98
4 MD counties	2,109	$141.45	$171.03	$235.28
LSA total	2,657	$181.28	$214.12	$289.26
Maryland Total	2,168	$145.36	$178.46	$247.85

2.3 Comparison of BWRR Results to Similar Projects

BWRR and UMCES-EE each compared the BWRR economic impact results to those of large railway or other transportation projects in the US. The UMCES-EE set of studies included those described in the BWRR report (except one for which the report could not be found) and 3 additional studies. Two of the additional studies were for Maglev and high speed rail projects from around the US and one was a DC-area infrastructure (highway and bridge) project. Project spending and impacts varied considerably over the diverse projects analyzed (see Appendix Table C-2). Some project differences make comparisons difficult such as variation in project durations (1 – 16 years) and year of analysis (2009 to 2022). Dollars were not converted to a consistent dollar year because many reports did not specify the analysis year used. Therefore, because prices rise over time, project comparisons will tend to make projects in older studies appear less expensive and potentially have lower economic impacts, when compared to projects using more current dollars.

To aid in comparing projects of different size and duration, the UMCES-EE analysis used several ratio metrics. These metrics take different project outcomes and divide by project spending or total employment. The metrics used were total multiplier effects (Output divided by direct spending), jobs per billion dollars in direct spending, and average income (total Labor Income divided by total person-years of employment). The input values used in Table 9 ratio calculations differ somewhat from the BWRR report. In particular, BWRR estimated jobs per billion spending on total capital costs ($15.3 billion) rather than the expected spending within the LSA ($13.8 billion) or state of Maryland ($10.7 billion). Additional economic impacts and comparisons can be found in Appendix C.

Report-derived data were sufficient to calculate and compare multiplier effects for 8 studies, generating a range from 1.08 to 4.12 (Table 9). Excluding these low and high values, which were outliers, the range was 1.51 to 2.37 and the average multiplier was about 1.92. This value falls within the range of multiplier effects estimated from the BWRR analysis of construction spending (Scenario 1a), which ranged from 1.79 for Prince George's County to 2.25 for the state of Maryland (Table 9).

Similar to the BWRR report, UMCES-EE found that the estimated jobs per $1B spending for the construction phase of the BW Maglev project (about 16,000 to 18,000) were somewhat higher than for similar projects. In the set of comparison studies, jobs per billion dollars in spending ranged from about 6,050 for to as high as 20,680 (Table 9). The range for the comparison projects, after excluding the low and high values, was about 7,200 to 19,700 with an average value of 11,500. This average across 8 studies is about 40-56% lower than the values calculated from the BWRR analysis.

Comparing average income (Labor Income divided by person-years of employment) across projects must be done cautiously since the cost of living, which influences wage rates, varies geographically and older project values will appear lower than recent values since dollar years were not standardized due to data constraints. The BWRR average wage estimates were lower than two recent studies. The California High Speed Rail analysis estimated average annual income in recent fiscal years in the $78-$86,000 range and the Maryland project upgrading I-495, I-270 and the American Legion Bridge estimated $68-77,000 in average annual income. Both estimates were somewhat higher than the $63-$71,000 range estimated from the BWRR analysis (Table 9).

Only one project, Cascadia, included an analysis of the economic impacts from O&M spending. Output multipliers could not be compared because Cascadia output estimates were not included, but jobs per $1B spending were similar between the two projects (14,000 for Cascadia, 13,000 for BWRR). Average wages for the Cascadia project ($83,000) were substantially higher than for the BWRR project ($68,000).

Table 9. Comparison of economic impact metrics from similar projects

Year of publication is shown when dollar years (e.g., 2020$) were not specified. Spending and impacts were not converted from native dollar years because years were specified.

Study	Analysis Year (publication date or dollar year)	Region	Output Multiplier[1]	Jobs/$1B in spending	Average Income[2]
CA High Speed Rail – FY19/20	2021	State of California	1.85 - 1.89	8,210 – 8,460	$78,100 - $80,200
CA High Speed Rail – FY20/21	2022		1.96	8,860	$83,200
CA High Speed Rail – FY21/22	2023		1.93	8,200	$85,800
CA High Speed Rail – 2006-22	2023		1.53 – 1.63	7,560 – 8,180	$75,500 - $81,800
Cascadia – Construction	2015$	Vancouver-Seattle-Portland	NA	9,380	$76,300
Cascadia – O&M	2015$		NA	14,290	$83,300
IL High Speed Rail	2013	Chicago-St Louis-Indianapolis	2.37	19,710	$48,300
Purple Line	2014$	Montgomery + PG + Washington DC	4.12	11,910	$48,500
Capital Beltway HOT Lanes	2009	Fairfax County, VA	1.51	8,620	$34,000
		DC Metro Area	1.73	20,680	$25,800
		Virginia	2.25	18,970	$32,000
I-495 & I-270 Toll Lanes and New American Legion Bridge	2022$	DC Metro Area	2.10	7,230	$76,600
		Maryland Suburbs	1.08	6,050	$67,700
BWRR – BW Maglev	2020$	Prince George's County	1.79	16,320	$62,600
		LSA	1.93	16,150	$71,100
		State of Maryland	2.25	17,990	$68,100
BWRR – BW Maglev O&M	2020$	Local Study Area	1.45	13,290	$68,200
		LSA	1.24	10,840	$67,000
Average[3]			1.92	11,550	$81,700

[1] Output divided by spending,

[2] Labor income divided by estimated person-years employment

[3] Averages calculated after excluding low and high values for each metric. To allow comparison, average values do not include BWRR metrics. Note that the average wage calculation is based on a variety of dollar years.

2.4 Rationale for Additional UMCES-EE Scenarios

Two additional scenarios were developed for evaluating the BWRR economic impact analysis, based on concerns identified by examining their results. Scenario 2 explores using a different year of data to inform the model calculations. Scenario 3 explores the uncertainty of whether the businesses within local jurisdictions are likely to have the capacity to absorb all direct spending.

2.4.1 Scenario 2 Rationale: Anomalous Industry Data for 2018

The relatively high ratio of jobs per $Billion dollar spent in the BWRR results compared to similar projects (Table 9) was investigated by evaluating the IMPLAN model data and specifications. A deep inspection of the construction-phase impacts in the BWRR IMPLAN analysis revealed an unusual result: a large negative value (i.e., profit loss) for Other Property Income (OPI) in the non-residential construction industry (Industry 56). This negative value had the effect of dramatically increasing the projected labor-related economic impacts in this industry, compared to projections using other recent years. UMCES-EE found that 2018 had an atypical large and negative OPI of -$1.2 billion for Industry 56 in Maryland (Table 10). This value was a significant outlier compared to the consistently positive range of OPI values of about $100 to $200 million in years 2015-2021. This negative value implies that spending greatly exceeded revenues in the construction of new nonresidential structures industry in 2018. Due to how the economy is represented in IMPLAN, this negative OPI has a disproportionate effect on Employment and Labor Income, but relatively little effect on Output or TOPI.

Table 10. Industry detail for Industry 56 in the state of Maryland, 2015-2021

Year	Output ($M)	Labor Income ($M)	TOPI ($M)	OPI ($M)	Total Employment (Jobs)
2015	$2,490	$1,026	$20	$97	17,048
2016	$2,739	$1,102	$21	$127	18,140
2017	$2,776	$1,147	$22	$114	17,852
2018	$2,606	$2,234	$22	-$1,231	34,606
2019	$2,914	$1,227	$24	$132	18,275
2020	$2,928	$1,227	-$84	$186	18,361
2021	$2,959	$1,196	-$20	$211	16,654

IMPLAN collects data annually from a variety of federal sources, makes conversions and estimates as needed, and performs quality checks against other data sources to ensure accuracy (IMPLAN 2022b). As a result, IMPLAN data represents all the quirks of a given year, rather than a moving window average of many years, as might be preferred for an analysis intended to represent multiple future years. To address this anomalous data year, the Alternative data year model using 2019 data (Scenario 2) was created and results in several substantial differences. Note that the year 2019 was preferred to 2020 or 2021 due to perturbations due to the pandemic, as recommended by IMPLAN (2021).

2.4.2 Scenario 3 Rationale: Accounting for purchases likely to be made outside the LSA

Not all goods and services purchased to create a local project will come from the jurisdiction in which the project is located. Specifying the local share of spending is a major source of uncertainty of economic input-output modeling and is affected by supply constraints and leakage out of the study

region. The smaller the region being analyzed, the higher the likelihood that local businesses will not have capacity to meet the full demand nor produce the exact good or service being demanded (e.g., local architectural firms may specialize in residential design rather than industrial design). Some demands, such as in the construction sector, are commonly represented in economic input-output models as being met by businesses within the local economy (i.e., an industry output in IMPLAN). However, for some industries, it may be more appropriate to consider the proportion of demand that has historically been met by businesses outside the local economy.

To evaluate the potential loss of direct spending (and associated multiplier effects) within the LSA, the IMPLAN model was specified to allow the non-construction soft costs of the BW Maglev project to leak out of the local jurisdiction. Spending estimates for each of the industries associated with soft costs were modeled as "commodity outputs" instead of "industry outputs" in IMPLAN. In this specification, the model uses RPCs based on actual spending patterns (by industry and jurisdiction) to represent the proportion of spending that the data suggest would typically be retained by that industry in that jurisdiction. For example, the RPC for the insurance industry in Prince George's County is about 0.17, meaning that, on average, only 17% of the demand for insurance policies in the county is met by insurance companies there. As a result, a portion of the demand (i.e., spending) in this industry is likely to be met by businesses in other jurisdictions.

A limitation of this model specification is that the IMPLAN model does not assign the lost direct demand to nearby counties or the state of Maryland, so the direct, indirect and induced effects that leak from an individual jurisdiction are completely lost and not counted as economic impacts in any part of the region. This limitation is especially pronounced when small geographies (e.g., individual counties) are modeled, but combining multiple counties into a region yields a larger and more diverse economy for modeling purposes. Modeling a multi-county region would tend to mitigate the leakage somewhat because a larger proportion of goods and services necessary for the project would be available for purchase within the larger region (i.e., the RPCs of the multi-county region would likely be larger than the RPCs of the individual counties). Therefore, Scenario 3, which models each county separately, represents a sensitivity analysis that can suggest the proportion of spending susceptible to loss from a given jurisdiction (e.g., Prince George's County). However, given the diversity of the Maryland-DC economy, and the likelihood that the region as a whole could meet much of the project's demand, this specification could also underestimate impacts at the broad region scale.

3 UMCES-EE INDEPENDENT IMPLAN ANALYSIS

This section describes methods and results of the UMCES-EE scenarios: Scenario 1b (recreation of BWRR's baseline economic analysis), Scenario 2 (alternative data year) and Scenario 3 (accounting for leakage).

3.1 UMCES-EE IMPLAN SCENARIO 1B RESULTS

3.1.1 Impacts of Construction Phase Spending

The results of the UMCES-EE analysis for Scenario 1b (the UMCES-EE base model) are generally consistent with the results presented in the BWRR report. Overall, the UMCES-EE analysis of the 7-year

construction phase estimated that in the LSA, about 211,000 jobs would be created with almost $15 billion in Labor Income and over $24 billion in total Output (Table 11). These Employment and Labor Income estimates are about 5% lower than the LSA estimates in Scenario 1a, while total Output is about 8% lower than Scenario 1a (Table 12). For the state of Maryland, the Scenario 1b model estimated about 180,000 jobs, just over $12 billion in Labor Income and almost $22 billion in Output (Table 11). These values are 7-10% lower than the values in Scenario 1a.

The discrepancy in baseline scenarios (Scenarios 1a and 1b) is likely to be largely explained by the exclusion of CSA counties outside of Maryland and DC from the UMCES-EE study region and may also have been affected by the use of different software versions. All direct project spending occurs in Maryland and DC in both baselines. However, the smaller study region used by UMCES-EE means that indirect and induced impacts that would have occurred outside of Maryland are not included. Further, the economic impacts of businesses and households in these areas purchasing goods and services from Maryland or DC would not have been captured. As a result of these two types of losses, the overall impacts in the state of Maryland would be expected to be somewhat lower. In addition, the UMCES-EE analysis uses IMPLAN Version 7, released in December 2022, whereas BWRR used an earlier version of the software that may have handled multi-region models and regional spending (RPCs) somewhat differently (IMPLAN 2022a).

Table 11. UMCES-EE construction phase impact analysis for primary study regions (Scenario 1b)
Prince George's County economic impacts are shown because it contains the Tier II watershed (Beaverdam Creek 2) where any project impacts would occur.

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)
Washington, DC	41,590	$3,388	$2,420	$4,631
Prince George's	51,666	$3,227	$2,705	$5,579
LSA total	210,805	$14,991	$12,632	$24,417
Maryland Total	179,632	$12,217	$11,351	$21,711

Table 12. Differences between Scenario 1a and Scenario 1b construction phase results
Values in Table 7 and Table 11 were compared to calculate the values shown. Negative values indicate UMCES-EE Scenario 1b values were lower. See Appendix A, Table A-3 for differences across all modeled geographies.

	Employment		Labor Income		Value Added		Output	
	Diff	% Diff	Diff ($M)	% Diff	Diff ($M)	% Diff	Diff ($M)	% Diff
Washington, DC	-782	-2%	-$68	-2%	-$104	-4%	-$157	-3%
Prince George's	-2,699	-5%	-$174	-5%	-$234	-8%	-$401	-7%
LSA total	-11,782	-5%	-$836	-5%	-$1,273	-9%	-$2,115	-8%
Maryland Total	-13,697	-7%	-$949	-7%	-$1,494	-12%	-$2,457	-10%

3.1.2 Impacts of O&M Phase Spending

UMCES-EE estimated O&M economic impacts using Scenario 1b model specifications and estimated somewhat higher impacts than those in Scenario 1a, across all impact categories and geographies. For the LSA, the UMCES-EE Scenario 1b model estimated just over 2,700 jobs, almost $193 million in Labor Income and almost $320 million in Output (Table 13). These values are 2%, 6% and 11% higher than the analogous values in Scenario 1a (Table 14). For the state of Maryland, the total impacts were somewhat lower than the LSA with about 2,200 jobs expected, $152 million in Labor Income, and $269 million in

Output. These values are 1%, 4%, and 9% higher, respectively, than the values in the BWRR report (Scenario 1a). Results for all modeled geographies are shown in Appendix A, Table A-9. As with Scenario 1b construction phase impacts, these small differences in BWRR and UMCES-EE results may be explained by slightly different study regions and the use of different model versions.

Table 13. UMCES-EE O&M phase impact analysis for primary study regions using Scenario 1b

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)
Washington, DC	585	$44.65	$44.32	$62.89
4 MD Counties	2,133	$148.07	$177.82	$256.78
LSA total	2,717	$192.73	$222.14	$319.68
Maryland Total	2,193	$151.96	$185.35	$269.45

Table 14. Differences between Scenario 1a and Scenario 1b results for the O&M phase
Values in Table 8 and Table 13 were compared to calculate values shown. Negative values indicate UMCES-EE O&M Scenario 1b values were lower. See Appendix A Table A-10 for differences across all modeled geographies.

	Employment		Labor Income		Value Added		Output	
	Diff	% Diff	Diff ($M)	% Diff	Diff	% Diff	Diff ($M)	% Diff
Washington, DC	37	7%	$4.82	12%	$1.23	3%	$8.91	17%
4 MD Counties	24	1%	$6.62	5%	$6.79	4%	$21.50	9%
LSA total	60	2%	$11.45	6%	$8.02	4%	$30.42	11%
Maryland Total	25	1%	$6.60	5%	$6.89	4%	$21.60	9%

3.2 UMCES-EE IMPLAN Scenario 2 (2019 Data) Results

3.2.1 Impacts of Construction Phase Spending

The effect of changing the IMPLAN data year lowered impacts across all economic impact categories. Results from Scenario 2 (2019 data year) estimated substantially lower employment and labor income and modest reductions in other economic impacts, compared to Scenario 1b.[3] In the LSA, estimates of Employment (116,000 jobs) and Labor Income ($8.5 billion) were reduced about 45% and 43% relative to Scenario 1b (Table 15 and 16). Value Added ($12 billon) and Output ($21.5 billion) had more modest decreases of 6% and 12% compared to Scenario 1b (Table 15 and 16). Results for the state of Maryland showed similar reductions with employment about 34% lower, Labor Income 33% lower, and Output 30% lower (Table 16).

[3] Scenarios 1b and 2 are compared (rather than 1a and 2) because the model version and all inputs other than model data year are identical.

Table 15. UMCES-EE construction phase impact analysis for primary study regions using Scenario 2
Prince George's County economic impacts are shown because it contains the Tier II watershed (Beaverdam Creek 2) where any project impacts would occur.

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)
Washington, DC	21,054	$1,904	$2,501	$4,263
Prince George's	28,678	$1,847	$2,565	$4,952
LSA total	115,982	$8,538	$11,852	$21,489
Maryland Total	101,779	$7,043	$10,141	$18,571

Table 16. Differences between Scenario 1b and Scenario 2 construction phase results
Values in Table 11 and Table 15 were compared to calculate values shown. Negative values indicate UMCES-EE Scenario 2 values were lower. See Appendix A, Table A-5 for differences across all modeled geographies.

	Employment		Labor Income		Value Added		Output	
	Diff	% Diff	Diff ($M)	% Diff	Diff	% Diff	Diff ($M)	% Diff
Washington, DC	-20,536	-49%	-$1,484	-44%	$81	3%	-$368	-8%
Prince George's	-22,988	-44%	-$1,380	-43%	-$140	-5%	-$627	-11%
LSA total	-94,823	-45%	-$6,453	-43%	-$780	-6%	-$2,928	-12%
Maryland Total	-77,853	-34%	-$5,174	-33%	-$1,210	-31%	-$3,140	-30%

3.2.2 Impacts of O&M Phase Spending

O&M impacts were estimated with the 2019 data year for consistency with the construction phase analysis. However, the industries included in O&M spending do not include the nonresidential construction industry (56), which was the source of the 2018 data anomaly. Therefore, as expected, Scenario 2 results appear similar to and slightly lower than Scenario 1b results. In the LSA, the Scenario 2 model estimates 2,550 jobs, about $182 million in Labor Income, and about $312 million in Output (Table 17). These values are all within 6% of the values in Scenario 1b (Table 18), representing the general variability of annual economic data. The O&M differences for Scenario 2 compared to 1b at the scale of the state of Maryland were proportionally similar to the LSA (Table 18). .

Table 17. UMCES-EE O&M phase impact analysis for primary study regions using Scenario 2

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)
Washington, DC	553	$43.33	$44.76	$63.46
4 MD Counties	1,997	$138.94	$175.72	$248.35
LSA total	2,550	$182.27	$220.48	$311.81
Maryland Total	2,052	$142.77	$183.41	$261.19

Table 18. Differences between Scenario 1b and Scenario 2 results for the O&M phase
Values in Table 13 and Table 17 were compared to calculate values shown. Negative values indicate UMCES-EE O&M Scenario 1b values were lower. See Appendix A, Table A-12 for differences across all modeled geographies.

	Employment		Labor Income		Value Added		Output	
	Diff	% Diff	Diff ($M)	% Diff	Diff	% Diff	Diff ($M)	% Diff
Washington, DC	-32	-5%	-$1.32	-3%	$0.44	1%	-$1.44	1%
4 MD Counties	-136	-6%	-$9.13	-6%	-$2.10	-1%	-$0.87	-3%
LSA total	-168	-6%	-$10.45	-5%	-$1.66	-1%	-$2.32	-2%
Maryland Total	-141	-6%	-$9.19	-6%	-$1.95	-1%	-$0.67	-3%

3.3 UMCES-EE IMPLAN Scenario 3 (Leakage) Results

3.3.1 Impacts of Construction Phase Spending

The Scenario 3 model that allowed the spending on soft costs (non-construction industries) to leak out of the LSA, resulted in a reduction of all economic impacts (see Section 2.4.2 for scenario rationale). The project's direct spending was reduced in the IMPLAN model by about $950 million in Maryland, reflecting the sum of purchases made outside each MD county (Table 19). This reduction is 7% of total direct spending or 33% of direct spending on soft costs. The loss of direct spending reduces the total economic impacts by 6-9% for the LSA (Table 20 and 21). Total job estimates in the LSA in Scenario 3 are about 108,600, a decrease of about 6% from Scenario 2.[4] Total Output in the LSA is almost $20 billion which is about 8% lower than when leakage is not factored in. In the state of Maryland, job estimates in Scenario 3 are about 94,500, a decrease of about 7% relative to Scenario 2, while Output ($17 billion) is about 9% lower (Table 20 and 21).

In general, the larger the study area, the greater the likelihood that purchaser needs will be met within the region, instead of being lost to leakage. In all construction phase results presented so far, counties were modeled individually and economic results were subsequently aggregated to the region. To better represent regional leakage, the four Maryland counties in the LSA were combined and run as a single region, allowing leakage from one county to be partially absorbed by neighboring counties. In this regional model, the amount of direct spending that leaked decreased from $950 million to about $570 million.

[4] Scenarios 2 and 3 are compared (rather than 1b and 3) because the only difference is the model specification that allows leakage. The model version, all inputs and model data year are identical.

Table 19. Direct spending lost to other regions in Scenario 3

	Institutional Commodity Sales* ($M)	Purchases outside of Region ($M)
Washington	$0.60	$137.47
Prince George's	$1.34	$372.06
LSA total	$3.77	$1,084.70
Maryland Total	$3.17	$947.23

* Sales of commodities produced by the government

Table 20. UMCES-EE construction phase impact analysis for primary study regions using Scenario 3
Prince George's County economic impacts are shown because it contains the Tier II watershed (Beaverdam Creek 2) where any project impacts would occur.

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)
Washington, DC	20,352	$1,799	$2,326	$4,009
Prince George's	26,164	$1,677	$2,256	$4,384
LSA total	108,571	$7,920	$10,766	$19,665
Maryland Total	94,511	$6,496	$9,166	$16,895

Table 21. Differences between Scenario 2 and Scenario 3 results
Values in Table 15 and Table 20 were compared to calculate values shown. Negative values indicate UMCES-EE Scenario 3 values were lower. See Appendix A, Table A-7 for differences across all modeled geographies.

	Employment		Labor Income		Value Added		Output	
	Diff	% Diff	Diff ($M)	% Diff	Diff ($M)	% Diff	Diff ($M)	% Diff
Washington, DC	-703	-3%	-$104	-5%	-$175	-7%	-$254	-6%
Prince George's	-2,514	-9%	-$170	-9%	-$309	-12%	-$568	-11%
LSA total	-7,411	-6%	-$618	-7%	-$1,086	-9%	-$1,824	-8%
Maryland Total	-7,268	-7%	-$547	-8%	-$975	-10%	-$1,676	-9%

3.3.2 Impacts of O&M Phase Spending

The effects of leakage (Scenario 3) were not modeled for BW Maglev O&M phase spending. The commodities produced by the industries involved in annual O&M (i.e., electric power transmission and distribution, maintenance of infrastructure and rail transportation) have generally high RPCs and are not appropriate to run as commodity output events.

4 SYNTHESIS OF BWRR AND UMCES-EE ANALYSES

This section includes a summary of the key similarities and differences between the BWRR and the UMCES-EE economic impact analysis and an assessment of the effects of the choice to model construction spending as a single event.

4.1 Summary Comparison of BWRR and UMCES-EE IMPLAN Scenario Results

A simultaneous comparison of the IMPLAN outputs for the three UMCES-EE scenarios and the BWRR scenario demonstrates the relative magnitude of effects resulting from the different model specifications. A primary result is that Scenarios 2 and 3 generally show smaller impacts than the two baseline scenarios (Figure 2). Reductions in Employment and Labor Income for Scenarios 2 and 3 were most pronounced.

The differences between Scenario 2 and 3 construction phase results, which range from 3-12% (Table 21), could be mitigated by modeling larger regions or combinations of jurisdictions to lower leakage from the study region. When all four Maryland counties in the LSA are modeled as a single region, instead of as individual counties, it lowered leakage of direct spending from $950 to $570 million (Section 3.3.1). When project spending leaks out of the region (i.e., Scenario 3), less money is available to be spent locally, and all economic impacts are lower.

In contrast to the construction spending, the impacts of O&M phase jobs and spending are similar across scenarios 1a, 1b and 2. Only small differences between Scenario 1a and 1b (BWRR and UMCES-EE baselines) were found, likely explained by the smaller study region used by UMCES-EE (See Section 1.2).The differences between Scenario 1b and Scenario 2 (2018 and 2019 model year) appear to reflect typical year-to-year economic variation.

Figure 2. Economic impacts of Construction Phase spending by model scenario

The MD LSA total is shown in this figure instead of Prince George's County to allow easier comparison between Figures 2 and 3.

Results show large differences between Scenario 1b and Scenarios 2 and 3 for some impacts and jurisdictions, particularly Employment and Labor Income. Small differences between scenarios 1a and 1b are due to modeling differences.

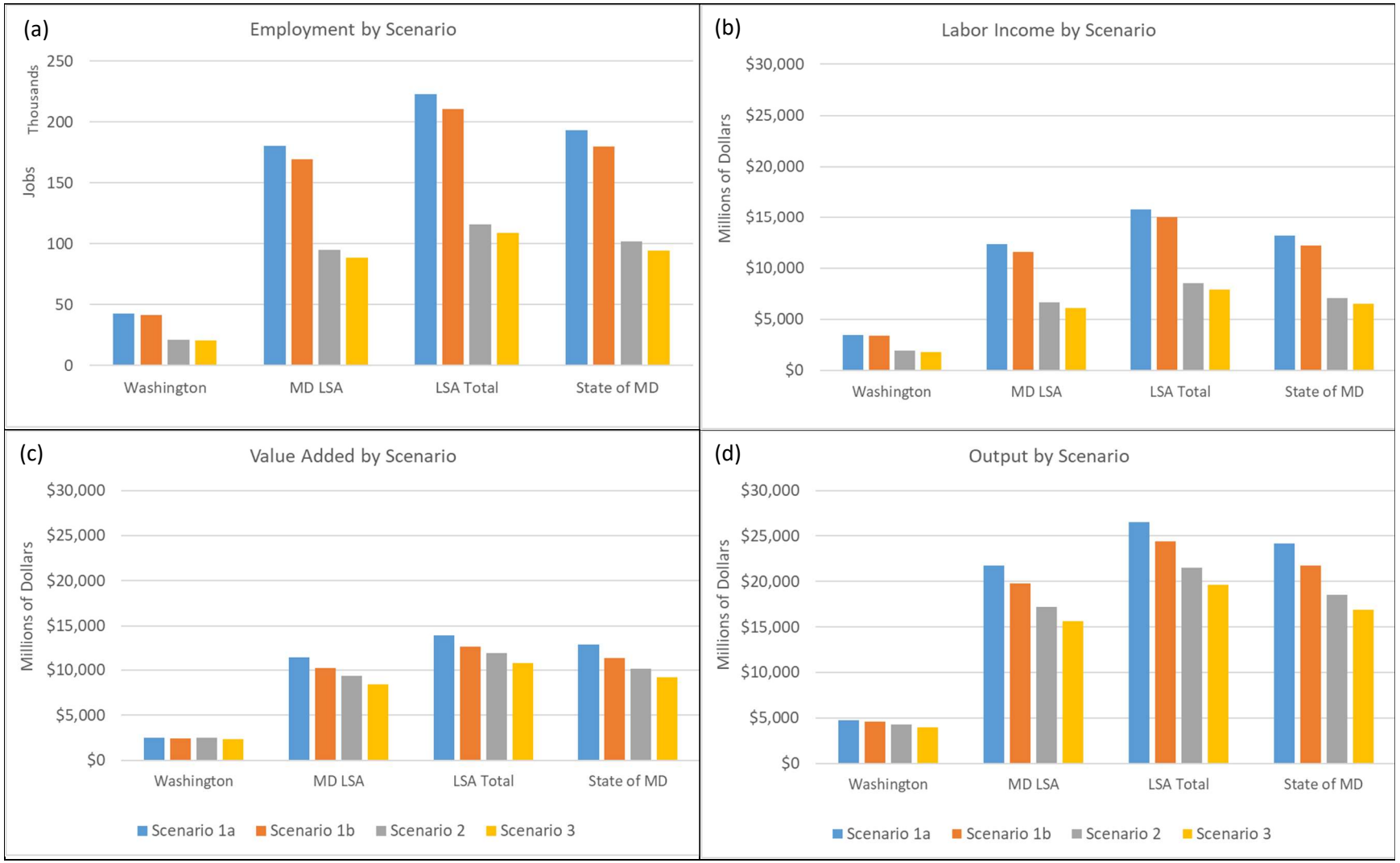
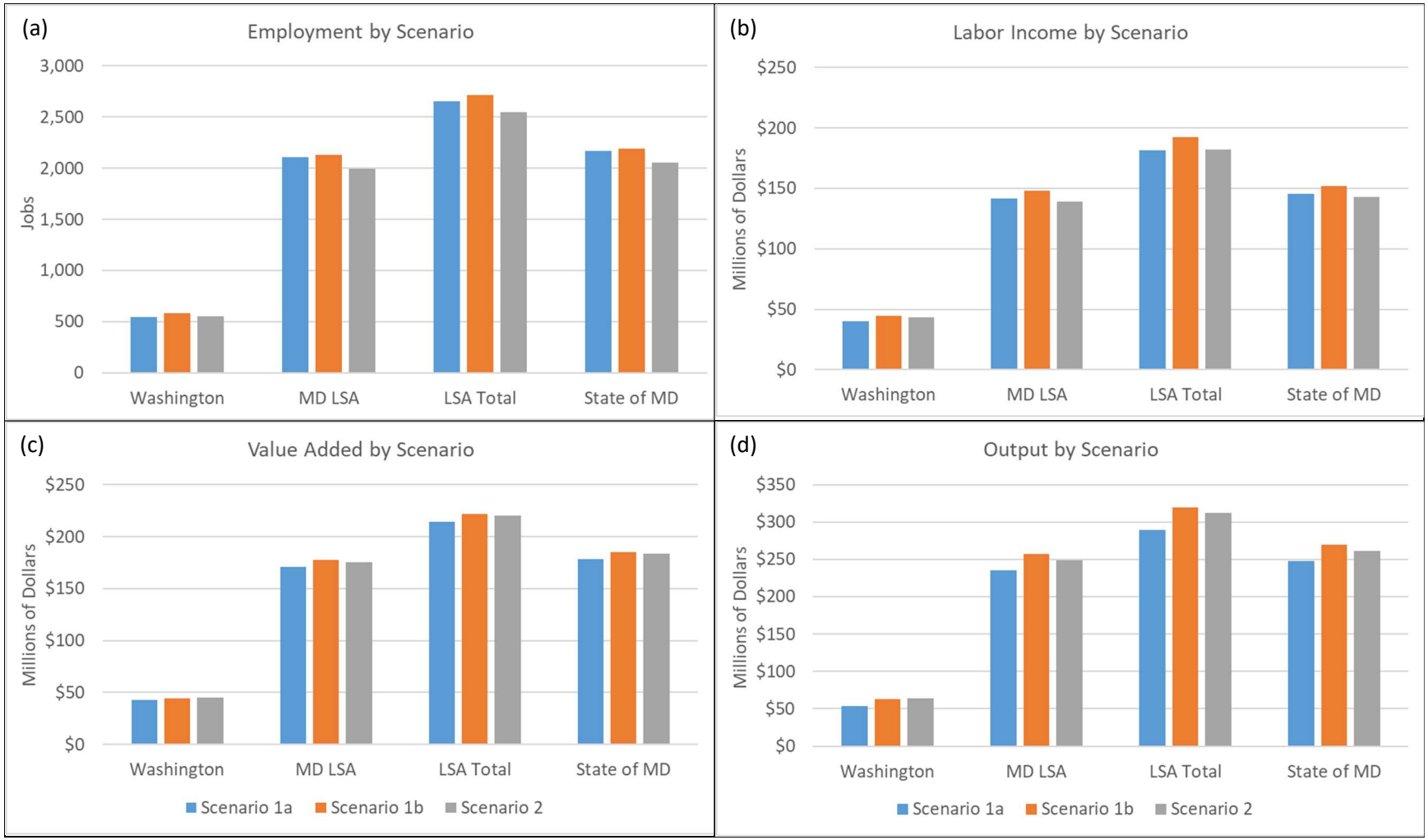


Figure 3. Economic impacts of Operations and Maintenance phase spending for each model scenario
Comparison shows that Scenarios 1a, 1b and 2 are similar.



4.2 Comparison of Ratio Metrics Across Scenarios

UMCES-EE compared three ratio metrics of output multiplier, jobs per $1B spending and average income, for Scenario 1b (2018 data) and Scenario 2 (2019 data) to further document the effect of using the anomalous 2018 data year. The output multiplier values were consistently lower for Scenario 2 than for 1b (Table 22), but these values are still generally within the range of values found in other studies (see Table 9). Jobs per $1 billion in spending for Scenario 2 were similar to values for California High Speed rail, but much lower than the values in Scenario 1b and other projects. Average wages in Scenario 2 were similar to those in Scenario 1b. Scenario 3 was not included in the table to ease interpretation and because the effects to Maryland's economy may have been exaggerated by modeling at the county, rather than regional, scale. Overall, leakage effects for Scenario 3 showed 0-11% reductions in impact ratios.

Table 22. Comparison of economic impact metrics for Scenario 1b and Scenario 2

Region	Output Multiplier[1]		Jobs/$1B in spending		Average Wages[2]	
	Scenario 1b	Scenario 2	Scenario 1b	Scenario 2	Scenario 1b	Scenario 2
Prince George's County	1.67	1.49	15,500	8,610	$62,500	$64,400
LSA	1.77	1.56	15,300	8,420	$71,100	$73,600
State of Maryland	2.02	1.73	16,700	9,470	$68,000	$69,200

[1] Total output divided by direct spending,

[2] Labor income divided by estimated person-years employment

4.3 Assessment of Employment Reporting Units

A small change in how jobs are reported would improve clarity of the BWRR economic impact results. Jobs are reported in tables as person-years, summed over all 7 years of construction-phase spending in BWRR's results tables. These units obscure the fact that some jobs are held for multiple years and would not employ additional people. The average annual jobs can be included in results tables to clarify how many people are likely to be employed or the spending can be modeled as a sequence of individual years, so that the duration of jobs can be represented (IMPLAN 2019). With this approach, a single job that was held for all 7 years of construction would be represented as one job and not 7 person-years during the construction phase.

A secondary concern is that jobs are not reported as full-time equivalent (FTE) jobs. IMPLAN counts full-time, part-time and temporary positions in the total jobs number and offers a conversion to FTEs which tends to reduce job estimates between 5-10%. Using the simple assumption that jobs are spread equally across the 7 years and are counted as FTEs, the 221,000 total person-years estimated in Scenario 1b would be reported as to 30,000 annual FTEs (Table 23). Although the construction phase is likely to offer direct jobs of different durations, rather than all jobs persisting for 7 years, it may be useful to represent average annual FTEs as an addition to total job or FTE-years, to clearly convey the magnitude of job creation during construction. Although FTEs may be easier to interpret, the common practice of reporting jobs, rather than FTEs, can be followed to allow results to be easily compared across economic impact analyses.

Table 23. Employment impacts converted to FTEs and average annual FTEs (Scenario 1b)

Region	Total Employment (Jobs)	Average Annual Jobs*	Total FTEs	Average Annual FTEs*
Washington, DC	41,590	5,941	39,750	5,679
Anne Arundel County	86,447	12,350	81,866	11,695
Baltimore City	20,967	2,995	19,911	2,844
Baltimore County	10,135	1,448	9,391	1,342
Prince George's County	51,666	7,381	49,088	7,013
Rest of Maryland	10,417	1,488	9,374	1,339
Total	**221,222**	**31,603**	**209,380**	**29,911**

*Assuming spending is spread equally over 7 years

5 CONCLUSIONS

Overall, the economic contractor's approach to estimating economic impacts from the proposed BWRR project was appropriately applied but appears to have overestimated jobs created in the construction phase, compared to average economic conditions. The primary concern revealed by the UMCES-EE analysis was that year-to-year fluctuations in the underlying economic data used to create the IMPLAN model may have inflated the economic impacts for the construction phase. Using the 2018 model data, reported to be the most recent data available at the time of their analysis, amplified some data anomalies. By using a more representative data year of 2019, the UMCES-EE Scenario 2 analysis finds somewhat lower economic impacts than the BWRR model (Scenario 1a) across all categories (Table 24). Some of the largest differences were in the Employment and Labor Income categories, which were reduced by as much as 48% (116,000 vs 223,000 jobs in Scenario 2 vs Scenario 1a). In addition, the ratio of jobs per $1B of spending was reduced from 16,200 to 8,400 jobs and the lower ratio was consistent with the ongoing California High Speed Rail project. Otherwise, the economic impact multipliers were generally consistent with the average multiplier effects of similar transportation projects.

Another concern with the construction phase analysis was that the uncertainty of economic impacts at the county scale was not well represented, given that direct spending is not typically fully absorbed by small and specialized economies. When non-construction spending was allowed to leak out of a jurisdiction, consistent with data on typical purchasing patterns, the total economic impacts were reduced by 9-12% in Prince George's County, and to a lesser or comparable degree in other jurisdictions. These results (Scenario 3) characterize the uncertainty in the default assumption that all spending will be retained locally and generate local impacts. However, the improved estimates of economic impacts at the county scale from including leakage can have the side effect of exaggerating direct spending losses to the region or state, due to how leakage is treated under this model specification. It may be more appropriate to model leakage for large multi-county regions, or the state as a whole, to avoid underestimating regional impacts.

The O&M economic impacts were replicable and appeared appropriate. Although the job estimates could not be fully evaluated due to BWRR's use of proprietary data on Maglev employment, the ratio metric of jobs/$1Billion in direct spending was consistent with (and lower than) a similar transportation project (Table 9). Given the challenges of representing the new Maglev technology in IMPLAN, job

estimates based on observed data, as reported, are potentially more accurate than the IMPLAN values that are based on the existing rail industry. If the direct job estimates are realistic and the addition of direct spending did not double-count jobs, then the BWRR method could result in conservative impacts since their methods omitted the indirect and some induced impacts when they modeled Employee Compensation, rather than jobs as model inputs.

Overall, the majority of model specifications for construction and O&M phases appear appropriate but some changes could improve the representativeness and clarity of results. The study area designation choices were appropriate for reflecting the economic flows in the region and the decision to use a 30% contingency on spending is consistent with Federal guidance (US DOT FTA 2022). Using the same model specifications, UMCES-EE was able to largely replicate all results. However, the BWRR report could be improved by using a more representative data year and by adding annual average jobs or FTEs to the results tables. If average annual jobs had been reported (using the preferred data year of Scenario 2), 16,600 average annual jobs or about 15,700 average annual FTEs in the LSA would have been presented instead of 222,587 person-years of jobs reported.

Table 24. Construction-phase economic impacts comparison for the LSA across all scenarios*

Impact Category	Scenario 1a (BWRR report)	Scenario 1b (2018 data)	Scenario 2 (2019 data)	Scenario 3 (2019 data + leakage)	Average Annual (Scenario 2)
Employment (jobs)	222,587	210,805	115,982	108,571	16,569
Employment (FTEs)	NA	200,006	109,886	102,948	15,698
Labor Income ($M)	$15,827	$14,991	$8,538	$7,920	$1,220
Value Added ($M)	$13,905	$12,631	$11,852	$10,766	$1,693
Output ($M)	$26,532	$24,417	$21,489	$19,665	$3,070
State & County Gov ($M)	$951	$1,087	$832	$733	$119
Federal Gov ($M)	$2,486	$2,169	$1,388	$1,278	$198

* With the exception of FTE and average annual estimates, data in each column is the same as the LSA row in Tables 7, 11, 15 and 20.

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7 GLOSSARY

Definitions of IMPLAN components (derived from IMPLAN)

Term	Part of	Definition
Total Output	NA	Gross value of industry production, or sales plus net inventory change
Value Added	Output	Output less Intermediate Inputs Reflects an enhancement made to a product or service before offering it for sale to a customer Equivalent to an industry's contribution to Gross Domestic Product (GDP) Sum of Labor Income, TOPI and OPI
Intermediate Inputs	Output	Purchases of non-durable goods and services (e.g., energy) that are used for the production of other goods and services, rather than for final consumption
Labor Income	Value Added	All forms of employment income The sum of total payroll paid to employees (Employee Compensation) and payments received by self-employed individuals and/or unincorporated business owners (Proprietor Income)
Employee Compensation	Labor Income	Wages, salaries and benefits received by employees
Proprietor Income	Labor Income	Payments received by self-employed individuals and/or unincorporated business owners
Taxes on Production and Imports (TOPI)	Value Added	Sales and excise taxes, customs duties, property taxes, motor vehicle licenses, severance taxes, other taxes and special assessments Government subsidies are included and thereby reduce TOPI Taxes are evaluated at the sub-county, county, state and federal levels.
Other Property Income (OPI)	Value Added	Gross operating surplus less proprietor income Negative OPI generally means that an industry spent more than it brought in as revenues for the year
Employment	NA	Mix of full-time, part-time and seasonal employment expressed as jobs. Jobs are not equivalent to full time equivalents (FTEs)

APPENDIX A – IMPLAN ANALYSIS RESULTS TABLES

CONSTRUCTION PHASE SPENDING IMPACTS

Table A-1. Economic Impacts from construction in BWRR Scenario 1b

Derived from WSP (2021) Figure 7; Impacts shown are total impacts (sum of direct, indirect and induced impacts).

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)	State & County Gov ($M)	Fed Gov ($M)
LSA:						
Washington	42,372	$3,456	$2,524	$4,788	$0	$440
Baltimore City	22,503	$1,747	$1,566	$2,912	$56	$279
Baltimore	11,381	$722	$962	$1,714	$102	$138
Anne Arundel	91,966	$6,501	$5,914	$11,138	$543	$1,093
Prince George's	54,365	$3,401	$2,939	$5,980	$250	$536
LSA total	222,587	$15,827	$13,905	$26,532	$951	$2,486
Rest of Maryland*	13,114	$795	$1,464	$2,424	$160	$155
Maryland Total	193,329	$13,166	$12,845	$24,168	$1,111	$2,201

* Calculations in this row were made by UMCES-EE. Row values were calculated by subtracting the values for the 4 MD counties in the LSA from the Maryland total.

Table A-2. Results of UMCES-EE construction phase impact analysis using Scenario 1b (2018 IMPLAN data)

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)	State & County Gov ($M)	Fed Gov ($M)
LSA:						
Washington	41,590	$3,388	$2,420	$4,631	$164	$430
Anne Arundel	86,447	$6,116	$5,295	$10,103	$493	$931
Baltimore City	20,967	$1,621	$1,381	$2,613	$102	$234
Baltimore	10,135	$639	$830	$1,491	$88	$112
Prince George’s	51,666	$3,227	$2,705	$5,579	$240	$462
LSA total	210,805	$14,991	$12,632	$24,417	$1,087	$2,168
Rest of Maryland	10,417	$614	$1,139	$1,925	$137	$123
Maryland Total*	179,632	$12,217	$11,351	$21,711	$1,060	$1,861

* Values in this row were not part of the IMPLAN output and were added to be comparable with BWRR report. Row values were calculated by summing values for the 4 MD counties in the LSA and the Rest of Maryland.

Table A-3. Percent difference between BWRR Scenario 1a and UMCES-EE Scenario 1b results

Values in Table A-1 and Table A-2 were compared to calculate percent change in Construction phase spending. Negative values indicate UMCES-EE Scenario 1b values were lower.

	Employment	Labor Income	Value Added	Output	State & County Gov	Fed Gov
LSA:						
Washington	-2%	-2%	-4%	-3%	NA	-2%
Anne Arundel	-6%	-6%	-10%	-9%	-9%	-15%
Baltimore City	-7%	-7%	-12%	-10%	82%	-16%
Baltimore	-11%	-11%	-14%	-13%	-14%	-19%
Prince George's	-5%	-5%	-8%	-7%	-4%	-14%
LSA total	-5%	-5%	-9%	-8%	14%	-13%
Rest of Maryland	-21%	-23%	-22%	-21%	-14%	-21%
Maryland Total	-7%	-7%	-12%	-10%	-5%	-15%

Table A-4. Results of UMCES-EE construction phase impact analysis using Scenario 2 (Alternative Data year (2019))

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)	State & County Gov ($M)	Fed Gov ($M)
LSA:						
Washington	21,054	$1,904	$2,501	$4,263	$137	$278
Anne Arundel	48,507	$3,474	$4,852	$8,860	$373	$592
Baltimore City	11,519	$922	$1,280	$2,262	$77	$150
Baltimore	6,225	$392	$653	$1,151	$62	$74
Prince George's	28,678	$1,847	$2,565	$4,952	$183	$295
LSA total	115,982	$8,538	$11,852	$21,489	$832	$1,388
Rest of Maryland	6,851	$408	$790	$1,345	$104	$87
Maryland Total	101,779	$7,043	$10,141	$18,571	$800	$1,197

Table A-5. Percent difference between Scenario 1b and Scenario 2 results

Values in Table A-2 and Table A-4 were compared to calculate percent change in Construction phase spending. Negative values indicate UMCES-EE Scenario 2 values were lower.

	Employment	Labor Income	Value Added	Output	State & County Gov	Fed Gov
LSA:						
Washington	-49%	-44%	3%	-8%	-17%	-35%
Anne Arundel	-44%	-43%	-8%	-12%	-24%	-36%
Baltimore City	-45%	-43%	-7%	-13%	-25%	-36%
Baltimore	-39%	-39%	-21%	-23%	-29%	-34%
Prince George's	-44%	-43%	-5%	-11%	-24%	-36%
LSA total	-45%	-43%	-6%	-12%	-23%	-36%
Rest of Maryland	-43%	-42%	-11%	-14%	-25%	-36%
Maryland Total	-34%	-33%	-31%	-30%	-24%	-29%

Table A-6. Results of UMCES-EE construction phase impact analysis using Scenario 3 (2019 data and leakage)

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)	State & County Gov ($M)	Fed Gov ($M)
LSA:						
Washington	20,352	$1,799	$2,326	$4,009	$124	$261
Anne Arundel	45,194	$3,207	$4,392	$8,092	$329	$542
Baltimore City	11,013	$871	$1,188	$2,112	$71	$141
Baltimore	5,848	$366	$604	$1,068	$58	$69
Prince George's	26,164	$1,677	$2,256	$4,384	$150	$264
LSA total	108,571	$7,920	$10,766	$19,665	$733	$1,278
Rest of Maryland	6,291	$375	$726	$1,240	$98	$80
Maryland Total	94,511	$6,496	$9,166	$16,895	$706	$1,096

Table A-7. Percent difference between Scenario 2 and Scenario 3 results

Values in Table A-4 and Table A-6 were compared to calculate percent change in Construction phase spending. Negative values indicate UMCES-EE Scenario 3 values were lower.

	Employment	Labor Income	Value Added	Output	State & County Gov	Fed Gov
LSA:						
Washington	-3%	-5%	-7%	-6%	-9%	-6%
Anne Arundel	-7%	-8%	-9%	-9%	-12%	-8%
Baltimore City	-4%	-5%	-7%	-7%	-7%	-6%
Baltimore	-6%	-7%	-8%	-7%	-7%	-7%
Prince George's	-9%	-9%	-12%	-11%	-18%	-10%
LSA total	-6%	-7%	-9%	-8%	-12%	-8%
Rest of Maryland	-8%	-8%	-8%	-8%	-6%	-8%
Maryland Total	-7%	-8%	-10%	-9%	-12%	-8%

Operations and Maintenance Phase Spending Impacts

Table A-8. Economic impacts from BWRR Scenario 1a O&M

Derived from WSP (2021) Figure 9

	Employment (Jobs)*	Labor Income ($M)	Value Added ($M)	Output ($M)	State & County Gov Receipts ($M)	Federal Gov Receipts ($M)
LSA:						
Washington	548	$39.83	$43.09	$53.98	$0.00	$1.70
4 MD counties	2,109	$141.45	$171.03	$235.28	$8.64	$9.62
LSA total	2,657	$181.28	$214.12	$289.26	$8.64	$11.33
Rest of Maryland**	59	$3.91	$7.43	$12.57	$0.00	$0.00
Maryland Total	2,168	$145.36	$178.46	$247.85	$8.64	$9.62

* Person-years of employment

** Calculations in this row were made by UMCES-EE. Row values were calculated by subtracting the values for the 4 MD counties in the LSA from the Maryland total.

Table A-9. Results of UMCES-EE O&M phase impact analysis using Scenario 1b (2018 IMPLAN data)

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)	State & County Gov ($M)	Fed Gov ($M)
LSA:						
Washington	168	$16.33	$16.00	$34.57	-$1.32	$2.06
4 MD Counties	813	$58.39	$88.14	$167.10	$8.43	$10.73
LSA total	980	$74.73	$104.14	$201.68	$7.11	$12.79
Rest of Maryland	60	$3.89	$7.53	$12.67	$1.11	$0.79
Maryland Total	873	$62.28	$95.67	$179.77	$9.53	$11.52

Table A-10. Percent difference between BWRR IMPLAN and UMCES-EE Scenario 1b results for the O&M phase

Values in Table A-8 and Table A-9 were compared to calculate percent change. Negative values indicate UMCES-EE O&M Scenario 1b values were lower.

	Employment	Labor Income	Value Added	Output	State & County Gov	Fed Gov
LSA:						
Washington	-69%	-59%	-63%	-36%	NA	21%
4 MD Counties	-61%	-59%	-48%	-29%	-2%	12%
LSA total	-63%	-59%	-51%	-30%	-18%	13%
Rest of Maryland	3%	-1%	1%	1%	NA	NA
Maryland Total	-60%	-57%	-46%	-27%	10%	20%

Table A-11. Results of UMCES-EE O&M phase impact analysis using Scenario 2 (2019 IMPLAN data)

	Employment (Jobs)	Labor Income ($M)	Value Added ($M)	Output ($M)	State & County Gov ($M)	Fed Gov ($M)
LSA:						
Washington	553	$43.33	$44.76	$63.46	-$2.76	$1.95
4 MD Counties	1,997	$138.94	$175.72	$248.35	$7.55	$9.70
LSA total	2,550	$182.27	$220.48	$311.81	$4.79	$11.65
Rest of Maryland	55	$3.83	$7.69	$12.84	$1.31	$0.82
Maryland Total	2,052	$142.77	$183.41	$261.19	$8.86	$10.52

Table A-12. Percent difference between Scenario 1b and Scenario 2 results for the O&M phase

Values in Table A-9 and Table A-11 were compared to calculate percent change. Negative values indicate UMCES-EE O&M Scenario 1b values were lower.

	Employment	Labor Income	Value Added	Output	State & County Gov	Fed Gov
LSA:						
Washington	-5%	-3%	1%	1%	110%	-5%
4 MD Counties	-6%	-6%	-1%	-3%	-10%	-10%
LSA total	-6%	-5%	-1%	-2%	-33%	-9%
Rest of Maryland	-8%	-2%	2%	1%	18%	4%
Maryland Total	-6%	-6%	-1%	-3%	-7%	-9%

APPENDIX B – SUMMARY OF COMMUNICATIONS BETWEEN UMCES-EE AND BWRR

Some of the data used in the UMCES-EE analysis came directly from the BW Maglev Economic Analysis, but to fully replicate and review that analysis, additional information was required and solicited from BWRR. All communication between UMCES-EE and BWRR was passed through MDE. The table below summarizes the communications between UMCES-EE and BWRR.

Question and Response #	Date	From	Request/Response
1	July 2022	UMCES-EE	Requested information on how construction and operations and maintenance (O&M) spending was apportioned to IMPLAN industries
	August 2022	BWRR	Responded to data request and provided a spreadsheet that distributed Construction and Operations and Maintenance (O&M) spending to IMPLAN Industries (MDE_request_Econ_Sectors_082522.xlsx)
2	February 2023	UMCES-EE	Submitted questions about the model inputs, specifically asked about for information on the allocation of spending for construction and O&M phases of impacts analysis among counties, a timeline of construction spending
	Mach 2023	BWRR	Provided responses to UMCES-EE questions with breakdown of spending per county for construction and O&M
3	March 2023	UMCES-EE	Found discrepancy between BWRR allocation of construction spending to counties and IMPLAN results, so requested clarification
	March 2023	BWRR	Provided corrected construction spending allocations to Maryland counties
4	March 2023	UMCES-EE	Submitted follow-up question (from February request) regarding O&M spending allocation between Washington DC and Maryland counties in the LSA. Specifically, BWRR had provided the percentage of spending in each Maryland county, but no estimate for DC. In their economic analysis, impacts were shown for DC and the four Maryland counties as a group, so UMCES-EE asked for the MD/DC breakdown.
	April 2023	BWRR	Provided the requested allocation of O&M spending between DC and the MD counties in the LSA
5	May 2023	UMCES-EE	Sought clarification on BWRR O&M inputs because UMCES-EE's O&M IMPLAN analysis results were significantly lower than BWRR's. UMCES-EE shared IMPLAN inputs and outputs for BWRR's review.
	May 2023	BWRR	Noted the omission of an estimate of direct jobs in the UMCES-EE O&M analyses that may account for different results

6	May 2023	UMCES-EE	Attempted to run a revised O&M IMPLAN impacts analysis which included direct jobs. However, direct jobs must be assigned to specific industries in IMPLAN (which weren't provided), so UMCES-EE followed up requesting the number of jobs per industry
	May 2023	BWRR	Provided estimates of the number of jobs per job description (e.g., head office, station operations)
7	June 2023	UMCES-EE	Was unable to match job descriptions with IMPLAN industries, so requested clarification
	June 2023	BWRR	Indicated that direct jobs were not distributed to specific industries
8	June 2023	UMCES-EE	Was unable to reconcile information about direct jobs with IMPLAN results. Specifically, adding direct jobs to original UMCES-EE O&M IMPLAN output yields a close match with BWRR results, but other economic impacts (Labor Income, Value Added, Output) still too low. Requested a brief phone/web meeting
	June 2023	BWRR	Contractor met with UMCES-EE to discuss O&M impact modeling. Clarified Labor Income differences. Contractor will look back to see how VA and Output were handled and follow up with UMCES-EE
	June 2023	BWRR	Contractor indicated that Employee Compensation estimates were added to Labor Income, Value Added and Output impact results

APPENDIX C – COMPARISON OF SIMILAR PROJECTS

This appendix provides additional details about the comparison of economic impacts across large transportation projects that is summarized in the main report (section number).

OVERVIEW AND METHODS

UMCES-EE compared BWRR estimated economic impacts to those of similar projects to evaluate consistency of results. UMCES-EE conducted a web search for new or recent Maglev or high-speed rail projects in the US. Studies from other countries were excluded due to substantially different labor rates, tax structures and other factors that would make comparison of results difficult. Through this search, UMCES-EE identified 5 rail projects, only 4 of which had web-accessible economic impact studies (Table C-1). An additional 6 major transportation projects (highways, bridges, subways) were identified in the Washington, DC region through a second web search but only 3 had economic impact studies available (Table C-1).

The BWRR report included a comparison to other US transportation projects, using 4 high speed rail or highway projects. All of those projects were identified through the UMCES-EE search but the Intercounty Connector economic impact report that was referenced by BWRR could not be found. The available economic impact studies are described in the next section, and economic output results are combined into a table to show project sizes and impacts (Table C-2).

UMCES-EE evaluated project costs and estimated economic impacts and then calculated ratios that enable different sized projects to be meaningfully compared. The ratios were total economic impacts (output) generated per unit of direct spending, jobs per unit of direct spending, and average annual wages. These ratios are presented and discussed in Section 2.3. The output multiplier is the ratio of estimated total economic output to direct project spending. A multiplier value of 2.25 suggests that every $1 in spending generates an additional $1.25 in economic impacts (indirect and induced). Jobs per unit spending is the ratio of total person-years of employment to total direct spending (in billions of dollars). Average annual wages are the ratio of total labor income to total person-years of employment. Tax impacts of projects are not included in the summary table due to the inconsistency of reporting but are included in project descriptions, when available.

Table C-1. Results of web searches

Project Type	Project	State(s)	Status	Rationale for exclusion (if excluded)
High Speed Rail in US	CA High Speed Rail*	CA	Under construction	
	Cascadia Ultra High Speed Ground Transportation	OR-WA-BC, Canada	Proposed	
	Texas Central High Speed Rail	TX	Proposed	
	Illinois High Speed Rail	IL-IN-MO	Proposed	
	Atlanta to Charlotte Passenger Rail	GA-SC-NC	Proposed	Economic impact report not available

Regional major transportation infrastructure project	Purple Line*	MD-DC	Under construction	
	Capital Beltway HOT Lanes*	VA	Constructed	
	I-495 & I-270 Toll Lanes and New American Legion Bridge	MD	Proposed	
	Intercounty Connector*	MD	Constructed	Economic impact report not available
	Metro Silver Line	VA	Under construction	Economic impact report not available
	Transform 66 Outside the Beltway	VA	Under construction	Economic impact report not available

* Included in BWRR report

PROJECTS EVALUATED

Economic impacts are described in this section for two project types 1) US high speed rail projects and 2) DC Metropolitan area transportation projects.

Maglev and High Speed Rail Projects

Of the 4 rail studies identified with available economic impact reports, one evaluated economic impacts of using Maglev technology and three evaluated proposed or in-development high speed rail projects. These projects are found in rail corridors in seven states in the West, South and Midwest US (Table C-1). One project (Texas Central) was excluded from further analysis because only an executive summary was available and it lacked sufficient detail to compare to other studies.

California High Speed Rail

The California High Speed Rail Authority is currently planning, designing and building a high-speed rail system in California that will connect "mega-regions" in the state with an expected completion date of 2034. Economic impacts associated with spending during the past fiscal year, and cumulatively, are estimated using IMPLAN and updated annually (CAHSRA 2021, 2022, 2023). For the past three years, the spending retained in California has been around $1.2 billion and used to estimate Employment, Labor Income and Output (Table C-2). Results in the report are presented at the state level, the regional level (Central Valley, Sacramento, Bay Area, Southern California), and county level (for eight counties with largest impacts) and include projections to 2034. The report does not provide an estimate of tax impacts.

Cascadia Innovation Corridor Ultra High Speed Ground Transportation

The proposed Cascadia project would connect the cities of Vancouver, BC, Seattle and Portland (Cascadia megaregion) with either high speed rail (steel wheel) or Maglev technology. Several corridors have been proposed (CH2M 2018) but economic impact analysis was presented for only a single Maglev alternative. Capital costs for the Maglev scenario were estimated at $40.5 billion with a 10-year construction period. O&M costs were estimated at $210 million annually. Construction and O&M impacts on Employment and Labor Income were estimated with IMPLAN (Table C-2), and no tax impacts were reported.

Texas Central High Speed Rail

Texas Central is a proposed high speed rail project that would connect the cities of Dallas and Houston using all private funding. A 2015 economic impact analysis of the project used BEA multipliers to estimate impacts (Insight Research Corporation 2015). The cost of the project was estimated at $10.9 billion for land acquisition, construction, equipment and maintenance facilities, and is expected to generate about $4.3 billion in annual construction impacts over 4 years (2018-2021). The report also indicated that the project would generate $2.5 billion in direct tax revenues (i.e., paid by rail company) between 2015 and 2040 with an additional $608 million in indirect tax revenues. This analysis was not included in UMCES-EE's summary of other projects because only the Executive Summary was available online and details provided were insufficient for comparing results. Specifically, land acquisition costs were not separated from other spending, as needed for comparing the economic impacts to other projects.

Illinois High Speed Rail

A Preliminary Feasibility Study examined high speed (220 mph) rail alternatives along the Chicago to St Louis and Chicago to Indianapolis corridors, with two dedicated electrified tracks (UIUC and UIC 2013). Depending on the corridor and type of infrastructure (elevated track or retained fill track), capital costs ranged from $22 to $50 billion. Using a regional economic model for Illinois, output, labor income and employment impacts for construction (Table C-2) (UIUC and UIC 2013). No tax impacts were reported.

Metropolitan DC Region Projects

Purple Line Light Rail

Construction on the Purple Line Metro in Washington, DC and Montgomery and Prince George's counties in Maryland began in 2017, and it is expected to open in 2026. Economic impacts were estimated prior to construction. Capital costs were projected to be $1.9 billion with construction costs making up $1.7 billion of that total (TEMS 2015). Construction was expected to take five years. Economic impacts of construction were estimated using the RIMS II (Regional Input-Output Modeling System) from the Bureau of Economic Analysis (BEA). Employment, regional output and personal income impacts were presented for the District of Columbia, Montgomery and Prince George's counties (Table C-2). The report notes that the project is expected to generate $541 million in tax benefits (federal, state, local and sales tax) in the study area and $635 million in tax impacts overall.

Capital Beltway HOT Lanes

The impacts of spending were evaluated prior to construction of the projected 6-year construction phase of the Capital Beltway HOT Lanes in Fairfax County, Virginia, the Washington metropolitan area and the Commonwealth of Virginia. The project developed high occupancy toll lanes along the Capital Beltway from Springfield, VA north to the Dulles Toll Road. Construction on this project began in 2008, and the lanes opened in late 2012. However, all economic analyses were conducted prior to construction. The total cost of the project was estimated at $1.98 billion with $1.54 billion in direct construction spending (Fuller 2009). BEA RIMS II was used to estimate economic impacts of construction for Fairfax County, VA, the Washington Area, and the Commonwealth of Virginia (Table C-2). No tax impacts were reported.

I-495 and I-270 Toll Lanes and New American Legion Bridge

The proposed project includes construction of 37 miles of new managed toll lanes along I-495 and I-270 in Maryland, as well as a new American Legion Bridge. The project would be within Montgomery and Frederick counties in Maryland (CRA 2022). IMPLAN was used to model the impacts from $6 billion in spending in the Washington DC Metropolitan Statistical Area and the Maryland suburbs of the DC Metro Area (Montgomery, Frederick, Charles, Calvert, and Prince George's counties) (Table C-2). Project duration was not reported, so average annual jobs were not estimated. State and local jurisdiction tax revenues were reported for both geographies. For the DC Metro Area, state tax impacts were estimated to be about $155 million and local jurisdiction revenue was estimated at about $195 million. For the five counties in the Maryland suburbs, state tax revenues were estimated at almost $131 million, and local jurisdiction revenues were estimated at about $138 million.

Table C-2. Economic impacts analysis results

Spending and impacts were not converted from native dollar years.

Study[1]	Duration analyzed (years)	Analysis Year (publication date or dollar year)[2]	Spending ($M)	Jobs (person-years)	Jobs (Average Annual)	Total Labor Income ($M)	Total Output ($M)
CA High Speed Rail (FY19/20)	1	2021	$1,170	9,600 – 9,900	9,600 – 9,900	$750 - $770	$2,160 - $2,210
CA High Speed Rail (FY20/21)	1	2022	$1,140	10,100	10,100	$840	$2,230
CA High Speed Rail (FY21/22)	1	2023	$1,180	9,670	9,670	$830	$2,280
CA High Speed Rail (2006-2022)	16	2023	$9,800	74,070 – 80,170	4,630 – 5,010	$5,590 - $6,060	$14,980 - $15,940
Cascadia – Construction	10	2015$	$40,500	380,000	38,000	$29,000	Not reported
Cascadia – O&M	1	2015$	$210	3,000	3,000	$250	Not reported
IL High Speed Rail – Chicago-St Louis-Indianapolis at-grade (IL segments only)	5	2013	$20,700	408,000	81,600	$19,700	$49,100
Purple Line	5	2014$	$1,700	20,240	4,050	$981	$7,009
Capital Beltway HOT Lanes (Fairfax County)	6	2009	$1,540	13,280	2,210	$452	$2,330
Capital Beltway HOT Lanes (Washington Area impacts)			$1,540	31,840	5,300	$821	$2,669
Capital Beltway HOT Lanes (Virginia)			$1,540	29,210	4,870	$934	$3,466
I-495 & I-270 Toll Lanes and New American Legion Bridge (DC Metro Area)	Not reported	2022$	$6,000	43,406	Not reported	$3,326	$12,589
I-495 & I-270 Toll Lanes and New American Legion Bridge (MD suburbs)			$6,000	36,281	Not reported	$2,456	$6,481
BWRR – BW Maglev (PG Co)	7	2020$	$3,330	54,370	7,770	$3,401	$5,980
BWRR – BW Maglev (LSA)			$13,780	222,590	31,800	$15,827	$26,532
BWRR – BW Maglev (MD)			$10,750	193,330	27,620	$13,166	$24,168
BWRR – BW Maglev O&M (LSA)	1	2020$	$200	2,657	2,657	$181	$289
BWRR – BW Maglev O&M (MD)			$200	2,168	2,168	$145	$248

[1] All project studies are for the construction phase unless labeled O&M.

[2] Dollar signs indicate that the dollar year was specified; Years without dollar signs are the report publication date

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APPENDIX D – SUGGESTIONS FOR FUTURE ECONOMIC IMPACT ANALYSES OF TIER II PERMIT SEEKERS

1. UMCES-EE recommends that all model inputs and details necessary to replicate the model results be provided in economic impact reports. These inputs would include all direct inputs (i.e., spending, jobs) distributed to the appropriate economic sectors (with sector number/code and name) and to geographic regions. How the region is specified, should also be described. UMCES-EE recommends providing information about the data year used in analysis and the years in which dollar estimates were made.
2. The economic data year used in the input-output analyses should be evaluated for representativeness of long term average conditions. Data anomalies can occur for a wide variety of reasons and may be specific to a small region or representative of major disruptions, such as those created by COVID-19. If data anomalies are found, selection of a data year that is typical of the long-term average may be appropriate. If using IMPLAN, UMCES-EE particularly recommends inspecting Other Property Income (OPI), which, if negative, can have a disproportionate effect on estimates of Employment and Labor Income.
3. Reporting job impacts as person-years of employment may lead to misinterpretation. Including average annual jobs (or annual jobs as a timeline) in employment reporting, including summary tables, is encouraged. Including an additional estimate of full-time equivalents (FTEs) is also desirable.
4. UMCES-EE recommends including multi-county and Maryland state regions for comparison with county-specific impacts.
5. Including leakage effects, by specifying commodity impacts in IMPLAN or through alternative methods of applying Regional Purchase Coefficients or similar data, can be useful for documenting the variability or uncertainty of local economic impact projections. Leakage or the loss of direct spending in a given jurisdiction or region is often based on historic spending patterns but can also be developed by evaluating the degree of match between project needs and local business capabilities. Such effects may be appropriately modeled at a regional or Maryland state scale to provide likely levels of leakage of direct spending across the regional economy.
6. UMCES-EE recommends comparing ratio metrics of project results to similar projects. Ratio metrics are economic outputs divided by the total spending or total employment, as appropriate to compare differently-sized projects. Similar projects may be selected from similar types (i.e., transportation, accommodation and food, residential), in the same or similar regions of the country, and projects of similar size or scale.