Linking Transportation and Land Use Goals through Scenario Planning: A Case Study of the Metropolitan Washington Region

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ABSTRACT

The federal MAP-21 transportation legislation provides Metropolitan Planning Organizations (MPO) with a framework for developing and evaluating scenarios for consideration in metropolitan transportation planning. Scenario planning will be an important tool as the National Capital Region Transportation Planning Board (TPB), the MPO for the Metropolitan Washington region, works to develop a Regional Transportation Priorities Plan.

The TPB has a long history of scenario planning work. This paper discusses the TPB's "CLRP Aspirations Scenario Study," completed in October 2011, which combines, for the first time, significant changes in land use with an extensive network of variably priced lanes (VPL) and high quality bus rapid transit (BRT) service into an integrated scenario. Two variations of this scenario were developed as sensitivity tests: (1) to analyze the impact of land use changes without the VPL and BRT components; and (2) to analyze a variation of the scenario that included a lower-cost "streamlined" VPL network that would require less new construction and more conversion of general purpose lanes to VPLs.

This paper describes the development and results of the analysis of the three scenarios with respect to future baseline forecasts for land use and transportation. Additionally, this paper compares the CLRP Aspirations Scenario Study to the recommendations outlined in the MAP-21 legislation for scenario development and analysis to evaluate how well the current TPB scenario planning process aligns with the new legislation and how the process can be improved in the future.

INTRODUCTION

The metropolitan Washington region faces a similar challenge to many other areas in the United States: providing adequate transportation infrastructure for anticipated future population and employment growth while meeting environmental and other social goals. As the Metropolitan Planning Organization (MPO) for the Washington region (which includes the District of Columbia, Northern Virginia, and suburban Maryland), the National Capital Region Transportation Planning Board (TPB) is responsible for maintaining the Financially Constrained Long-Range Transportation Plan, or CLRP, which is required by federal planning regulations and includes all regionally significant transportation projects and programs that are planned in the region over at least the next 20 years. *(1)* The CLRP only includes projects for which funding is "reasonably expected to be available", which limits the ability of the CLRP to address all of the region's transportation challenges. *(1)*

Like many MPOs, the TPB uses scenario planning to study the potential impact of future development and transportation plans. The TPB completed its most recent scenario study, the CLRP Aspirations Scenario Study, in October 2011 and will expand its use of scenario planning as it works to develop a Regional Transportation Priorities Plan (RTPP) to identify transportation strategies that offer the greatest contributions toward addressing regional challenges above and beyond what is contained the CLRP. *(2)* Moving Ahead for Progress in the 21st Century Act (MAP-21), the new federal transportation authorization legislation signed into law in July 2012, provides MPOs with a framework for "optional scenario development" to identify potential regional investment strategies and consider future distributions of population and employment to assist in the development of metropolitan transportation plans. *(3)* MAP-21 also emphasizes performance-based planning and performance targets for state and metropolitan transportation planning. *(3)*

The process for developing and evaluating the scenarios in CLRP Aspirations Scenario Study provides the opportunity to see how well the TPB's scenario planning process aligns with the new federal legislation. The MAP-21 legislation recommends six components for MPOs to consider when developing scenarios: (1) "potential regional investment strategies for the planning horizon;" (2) "assumed distribution of population and employment;" (3) maintains baseline condition performance measures to the "maximum extent possible;" (4) "improves the baseline conditions for as many of the performance measures identified…as possible;" (5) "revenue constrained scenarios based on the total revenues expected to be available over the forecast period of the plan;" and (6) "estimated costs and potential revenues available to support each scenario." *(3)* The legislation promises the establishment of performance measures for the evaluation of scenarios; allows for additional evaluation of scenarios "using locally-developed measures;" and provides MPOs with the national goals for the federal transportation

program: safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, and reduced project delivery delays. *(3)*

The TPB's CLRP Aspirations Scenario Study was developed to integrate the best components of previous TPB scenario studies into a comprehensive scenario that could offer a promising path forward for the region. Previous TPB studies have provided meaningful conclusions about effective regional strategies for improving travel conditions, but those studies focused either on issues of land use or on transportation, but not both. The Aspirations Scenario combines a land use scenario of denser and more transit-oriented development as compared to current projections of the future; a regional network of variably price lanes (VPLs); and high quality bus rapid transit (BRT) and circulator bus service focused on supporting the alternative land use plan. The findings from the Aspirations Scenario study offer a useful starting point for the TPB as it works to develop a Regional Transportation Priorities Plan.

The initial report for the CLRP Aspirations Scenario Study was completed and presented to the TPB in September 2010. (*4*) This paper discusses the performance of the Aspirations Scenario and two variations on the Aspirations Scenario developed as sensitivity tests: the Land-Use Only Scenario that contained the land use component of the Aspirations Scenario with no changes to the transportation network, and the "Streamlined" VPL Network Scenario based on Aspirations Scenario with a scaled-back version of the VPL network. The results of the Aspirations and Land-Use Only scenarios were presented in the September 2010 report. The Streamlined Scenario was presented to the TPB in October 2011. *(5)*

PREVIOUS TPB SCENARIO STUDIES

In 2000, the TPB launched the Regional Mobility and Accessibility Study (RMAS) to examine land use and transportation improvements beyond the 2000 CLRP that would "improve mobility and accessibility among and between regional activity centers." (*6*) The RMAS evaluated five different alternative land use scenarios for the year 2030: shifting more households into the region; moving projected household growth from the outer jurisdictions to the inner jurisdictions; moving job growth from the inner jurisdictions to the outer jurisdictions; moving job growth from the western side of the region to the eastern side; and moving projected job and household growth closer to transit. (*6*) All of the scenarios had supporting transportation improvements, most of which were improvements to transit. All of the scenarios produced positive results, as compared to the CLRP, in slowing anticipated growth in congestion and driving and, in most cases, in increasing transit use. (*4*)

In 2006, the TPB launched a federally funded study to analyze the potential effects of a variably priced lane (VPL) network in the Washington region. Three different components were studied: (1) adding capacity to the region's freeways and arterials in the form of VPLs; (2) pricing selected existing roadways in the District of Columbia; and (3) pricing the region's parkways. *(7)* The results of this study

demonstrated that toll rates would vary significantly by direction, time period, and facility in order to maintain free-flow conditions. (*4*) A financial analysis of the scenarios showed that a scenario which incorporated all of those options was the only one in which total toll revenues approximately equaled the costs of constructing and operating the VPL network. Work related to this study was presented at the 88th Annual Meeting of the Transportation Research Board. (*8*)

DEVELOPMENT OF THE CLRP ASPIRATIONS SCENARIO STUDY

The main elements of the CLRP Aspirations Scenario Study are the CLRP Aspirations Scenario itself and a Baseline against which the performance of the Aspirations Scenario could be compared. Two additional scenarios were developed – a Land Use-Only Scenario and a Streamlined VPL Network Scenario – for the purpose of conducting sensitivity tests to evaluate the performance of individual components of the Aspirations Scenario. The analysis year for all of the scenarios is 2030.

Baseline

The land use component of the Baseline is the Round 7.2 Cooperative Forecast developed by the Metropolitan Washington Council of Governments' (COG) Metropolitan Development Policy Committee and approved by the COG Board of Directors in 2009. The Cooperative Forecasts provide household, population, and employment forecasts that are used as an input to the TPB's travel forecasting model. *(4)* The transportation component for the Baseline is the 2008 CLRP, which contains all of the highway and transit projects adopted by the TPB in 2008 to be built through 2030. The 2008 CLRP includes two express lane corridors in Virginia: I-95/I-395 from the District of Columbia line to VA 610 in Stafford County; and I-495 (Capital Beltway) from just south of the American Legion Bridge (Maryland Line) to the I-95/I-395 interchange. There is one all-VPL facility in Maryland, the Intercounty Connector (ICC).

CLRP Aspirations Scenario

Land Use Component

The land use component of the Aspirations Scenario focuses on shifting projected household and employment growth into "targeted growth areas" near transit in an effort to make the transportation system more efficient. The areas designated as targeted growth areas are a combination of: (1) Regional Activity Centers and Clusters previously identified by COG through extensive collaboration with local jurisdictions in the region as places where it would be desirable for future growth to occur; and (2) other areas near existing or planned transit infrastructure. In the scenario, a portion of the residential and employment growth anticipated in the region between 2015 and 2030 was shifted into the targeted growth

areas to make those areas supportive of transit and mixed use development, and to make them walkable, while still reflecting local-level planning realities. *(4)*

Because local jurisdictions in the Washington region have primary responsibility for comprehensive land-use planning and zoning, determining how much development could realistically be shifted into targeted growth areas required a collaborative process much like that used by COG to compile its Cooperative Forecasts of residential and employment growth. After MPO staff developed the basic framework for the land use component of the Aspirations Scenario, local jurisdictions were asked to provide realistic estimates of how much growth could take place in areas identified as targeted growth areas. *(4)* In the development of the land use component, there was a certain recognition that redistribution of jobs and households will benefit individual jurisdictions as well as the region. Many jurisdictions sought to improve the balance between jobs and households within their jurisdictions. Another common interest was to improve utilization of the existing transportation network by shifting growth away from areas where the network is forecasted to be overburdened, and adding growth to less developed areas such as areas around those Metrorail stations that are not currently meeting their development potential.

In the end, the scenario assumed an 11% increase in the number of jobs and a 42% increase in the number of households in the targeted growth areas compared to the land use assumptions associated with the Baseline. The projections were based on an assumption that all of the growth in the region expected to occur before 2015 was already "in the pipeline" and unable to be shifted. The remaining growth that was expected to occur between 2015 and 2030, which represented approximately 15% of all the jobs and households expected to be on the ground in 2030, was considered "movable," but only half was shifted into targeted growth areas. In addition to these shifts, some forecast growth in jobs and households expected outside the region was also shifted to targeted growth areas inside the region, reflecting a strategy examined as part of the RMAS. *(4)*

All of the changes in the land use component of the scenario take place in the TPB Planning Area (the District of Columbia, Montgomery, Prince George's, Frederick, and Charles Counties in Maryland; and Arlington, Fairfax, Prince William, Loudoun Counties and the City of Alexandria in Virginia), and in Calvert County, Maryland, and Stafford County, Virginia. Figure 1 shows the TPB Planning and Modeled Areas. Table 1 shows the percentage difference in households, population, and employment between the Baseline and the Aspirations Scenario by jurisdiction. The first five, listed in italics, are considered the "inner jurisdictions" which are more urbanized.

Figure 1: TPB Planning and Modeled Areas

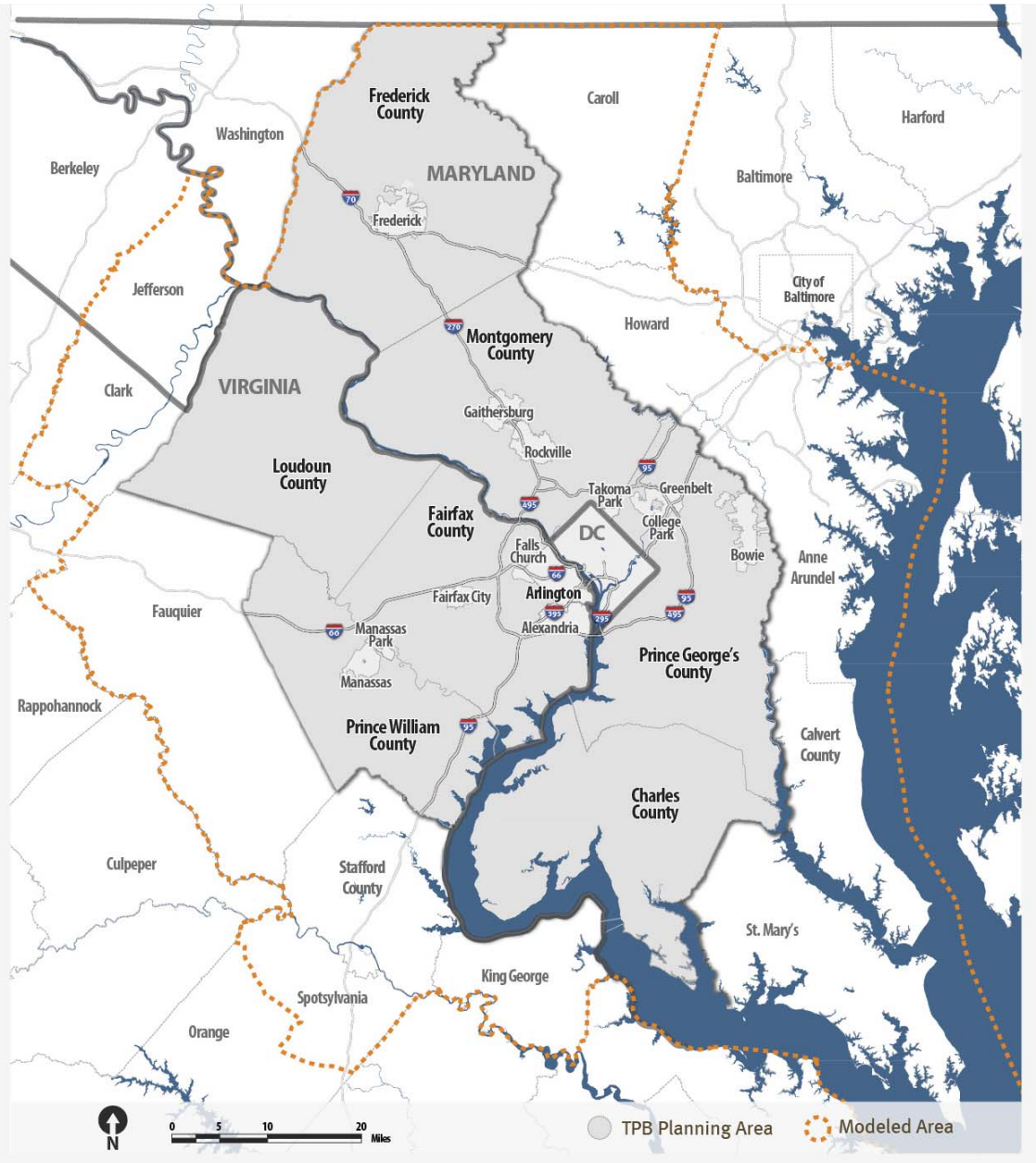

Table 1: Change in Households, Population and Employment between Baseline and Aspirations, Year 2030

	Households		Population		Employment	
	Change from Baseline		Change from Baseline		Change from Baseline	
Jurisdiction	Number	Percentage	Number	Percentage	Number	Percentage
District of Columbia	23,159	6.9%	50,155	6.8%	9,840	1.1%
Montgomery County, MD	-6,208	-1.4%	-25,024	-2.2%	-13,350	-2.0%
Prince George's County, MD	26,108	7.1%	123,815	12.7%	17,013	3.7%
Arlington County VA	10,294	8.5%	30,818	12.6%	7,822	2.9%
City of Alexandria, VA	6,854	8.0%	16,695	10.0%	-11,078	-7.1%
Fairfax County, VA	43,312	9.0%	125,376	9.8%	36,035	4.1%
Loudoun County, VA	-309	-0.2%	-10,730	-2.5%	-3,568	-1.3%
Prince William County, VA	-1,375	-0.6%	22,514	3.7%	-15,258	-6.3%
Frederick County, MD	13,546	11.0%	22,625	6.7%	11,441	6.8%
Charles County, MD	-5,342	-7.0%	605	0.3%	5,802	7.5%
Calvert County MD	-5,653	-14.7%	-9,096	-8.7%	-13,199	-28.0%
Stafford County, MD	-16,822	-23.2%	-38,109	-17.5%	-12,638	-19.3%

Transportation Component

Due to funding limitations, the region is focusing a majority of future funding on operations and maintenance of the existing transportation system rather than on expansion, despite forecasts of significant increases in congestion through 2030. *(2)* Planning for new capacity that consists of priced lanes can provide revenue for construction and maintenance as well as managing the volume of new traffic. The region saw its first VPL facility, the ICC, open in November 2011 and variably priced Express Lanes on I-495 in Virginia are scheduled to open in November 2012.

The transportation component of the Aspirations Scenario contains three elements: a regional network of priced lanes; an extensive BRT network; and selected transit projects identified by the RMAS. The scenario's transportation component focuses on supporting the land use component by providing "increased accessibility to the targeted growth areas, specifically for transit riders, carpools, and those willing to pay tolls to drive low-occupant vehicles on variably priced lanes." (*4*) The first element, a regional network of priced lanes, is based on the 2006 VPL study. The following general guidelines went into developing the network: (1) all freeways in the region have two VPLs in each direction with 24/7 operation (all high-occupancy vehicle [HOV] lanes are converted to VPLs and new lanes are added as needed to meet that goal); (2) major arterials have one VPL added in each direction outside of the

Beltway, (3) all Potomac and Anacostia River crossings are tolled; and (4) existing lanes of parkways (operated by the National Park Service) are tolled. Some additional facilities are tolled as needed to alleviate chokepoints and create connectivity amongst the corridors. The priced lane network creates a total of 1,740 miles of VPLs in the region, with 959 of those being new lane-miles of construction.

The second element, a high-quality, 500 mile BRT network, operates on the free-flowing VPL network and is integrated with the region's Metrorail system. Buses run every 10 minutes during peak hours and every 20 minutes during off-peak hours. The BRT network provides service to new BRT stations in the regional activity centers, and makes connections to Metrorail stations and existing park-and-ride lots. The ability of the buses to travel on the VPL network provides travel time reliability, which makes the system more attractive to riders. Additionally, some revenue from the VPL network can go to pay for the BRT network. The BRT network is complemented by 140 miles of circulator bus service.

The third element comprises selected projects from the RMAS study that were added to fill in missing links in the transit network. (*4*)

Sensitivity Tests

After the CLRP Aspirations Scenario analysis was completed, two sensitivity tests were conducted to separately study the effects of land use changes and variable pricing of highway lanes.

Land Use-Only Scenario

A land use-only scenario was developed for the purpose of conducting a sensitivity test to evaluate the impact of land use changes alone on the performance of the transportation network. The land use-only scenario used the highway and transit networks from the Baseline, and the land use component of the Aspirations Scenario.

"Streamlined" VPL Network Scenario

A "streamlined" VPL network scenario was developed for the purpose of conducting a sensitivity test to evaluate the effect of including fewer new interchanges and fewer new lane-miles of priced highways in order to reduce costs. The goal of the Streamlined Scenario was that each of the states should be able to pay for its own capital costs with revenue collected in that state while still providing an effective, integrated transportation network.

Many of the highway corridors in the region have been the subject of previous pricing studies. These studies were referred to in designing the VPL network in the Streamlined Scenario. On freeways, the Streamlined Scenario used an "add-a-lane/take-a-lane" approach by constructing one new lane and tolling one general purpose lane in order to maintain two VPLs in each direction. On major arterials, the

volume-to-capacity ratio of the toll lanes in the Aspirations Scenario network was used to identify corridors in which the demand could be satisfied by directional, as opposed to bi-directional, toll lanes. The number of new interchanges to be constructed was reduced from 155 to 97, keeping only those which provided access to activity centers or allowed for connectivity within the priced lane network. The Streamlined Toll Network reduced the number of new lane-miles of construction by 30% and the number of interchanges constructed by 33% as compared to the Aspirations Scenario, thereby reducing the overall cost of the network by 32%.

METHOD FOR ANALYSIS

The Version 2.2 TPB Travel Forecasting Model was used to evaluate the travel implications for the different scenarios for forecast year 2030, which was TPB's planning horizon at the start of the study. The TPB maintains a four-step transportation planning model that is used to evaluate transportation plans and programs, including air quality planning, in accordance with federal requirements. (*9*) The modeled area includes all of the jurisdictions shown in Figure 1.

There are two types of toll facilities in the TPB model – fixed toll facilities where the tolls do not change by time of day and are expressed in the model as a monetary value, and variably priced facilities where tolls change by time of day and are modeled as equivalent minutes that are added to the highway time. (*9*) Toll rates on VPLs result in a demand that does not degrade the prevailing speed, which in turn ensures that high-occupancy vehicle travel is not adversely impacted on the VPLs. (*9*) In the CLRP Aspirations study, a base rate of $0.20 per mile is applied to variably priced facilities and a toll update algorithm is then applied to gradually raise the tolls on congested facilities until a free-flow volume-to-capacity (v/c) ratio, generally in the range of 0.6 to 0.8, is achieved (*7*). In Virginia, high-occupancy vehicles with three or more persons (HOV3+) are allowed to travel in the VPLs free of charge. In Maryland and the District of Columbia, only buses are permitted to use the VPLs without charge. (*7*) While there were no VPL facilities open in the Washington region when the model was calibrated, the tolls generated by the model compare reasonably to other VPLs in place elsewhere in the country. (*10*)

MAJOR FINDINGS

A regional analysis was conducted for the modeled area comparing the performance of the Aspirations, Land Use-Only, and Streamlined scenarios with the Baseline. Performance measures were developed to evaluate the differences in regional travel, roadway congestion, mode share, and air quality.

Regional Travel Indicators

Table 2 summarizes the differences in regional travel indicators. (For reference, the Baseline has 197 million average weekday vehicle-miles traveled (VMT), 24.25 VMT per capita, 27 million total vehicle trips, 1.58 million transit trips, and an average vehicle trip length of 7.23 miles.)

Table 2: Change in Regional Travel Indicators with respect to Baseline for the TPB Modeled Area, 2030 Average Weekday

Travel Indicators	Land Use	Aspirations	Streamlined
VMT	-0.5%	3.1%	2.2%
VMT per capita	-4.1%	-0.7%	-1.5%
Average Trip Length	-2.5%	1.8%	1.0%
Total Vehicle Trips	2.2%	1.3%	1.3%
Vehicle Hours of Travel	0.5%	-6.1%	-6.1%
Vehicle Hours of Delay	1.0%	-11.9%	-11.4%
Bike/Pedestrian Work Trips	16.5%	16.3%	16.3%
Total Transit Trips	10.5%	13.9%	13.9%
HOV3+ HBW Person Trips	-2.4%	108.9%	105.5%

The main conclusions drawn from these results are:

- In all three scenarios, there are more jobs and households than in the Baseline which results in an increase in total vehicle trips in all three scenarios.
- The Aspirations and Streamlined scenarios have a larger share of these new trips as HOV3+ trips than the land use scenario.
- For both the Aspirations and Streamlined scenarios, the VMT increases as available road capacity increases. The Land Use-Only Scenario shows a small decrease in overall VMT from the Baseline.
- The VMT per capita in the modeled area decreases in all three scenarios.
- The average trip length increases in both the Aspirations and Streamlined scenarios, but decreases in the Land Use-Only Scenario.

Roadway Congestion

Vehicle hours of travel (VHT) and vehicle hours of delay (VHD) are measures of congestion on the road network. VHD are calculated as the difference between vehicle-hours of travel under congested conditions and vehicle-hours of travel under free flow conditions (*10*).

- VHT decrease by the same percentage in both the Aspirations and Streamlined scenarios, while increasing slightly in the Land Use-Only Scenario.
- The Land Use-Only Scenario shows a slight increase in VHT and VHD over the Baseline as vehicle trips are increased, but no additional highway capacity is added.
- The Aspirations and Streamlined scenarios both show a notable decrease in VHD in the modeled area as compared to Baseline. Notably, the Streamlined Scenario achieves almost the same amount of congestion reduction with far fewer lane miles of new construction and reductions in GPLs.

Volume-to-capacity (v/c) ratio is another indicator of congestion, although it is not directly related to VHD. Table 3 shows the change in the percent of highly congested lane miles by facility in the afternoon peak period for each of the scenarios as compared to the Baseline. For this analysis, highly congested is defined by having a v/c ratio over 1.0.

Table 3: Percent of Congested Lane Miles by Facility Type

Scenario	Freeways and Expressways	Major and Minor Arterials	Collectors	All Facilities
Baseline	35%	34%	17%	31%
Land Use-Only	34%	35%	16%	31%
Aspirations	23%	33%	15%	27%
Streamlined	24%	33%	15%	28%

For all scenarios, there is a decrease in the percentage of congested lane miles when looking at all facilities. The Land Use-Only Scenario has fewer lane miles of congestion on freeway facilities, but more congested miles on lower level facilities. Both the Aspirations and Streamlined scenarios have significantly lower percentages of congested lane miles on freeways where additional capacity was added. Comparing the Streamlined to the Aspirations Scenario, the Streamlined has more congestion on all facility types.

Mode Share

One of the goals of the scenario is to show a shift away from low-occupancy auto trips to non-motorized, transit, and HOV trips. Non-motorized travel (ie bicycle, pedestrian) is reflected only in the home-based work (HBW) trip rates in the model and is extracted from the total trip ends prior to trip distribution (*9*). Thus, non-motorized trips are influenced heavily by land use. Non-motorized trips increase in all three scenarios by over 16% as jobs and households are moved closer together in the land use assumptions.

Transit trips increase in all scenarios, significantly more so in the Aspirations and Streamlined scenarios which have a regional BRT and circulator network that serves activity centers and makes connections to other existing transit (i.e. subway, commuter rail). Since there was no change in the transit network between the Baseline and Land Use-Only scenarios to support the new land use assumptions, the increase in transit for the Land-Use Only Scenario can be largely attributed to the land use shifts as well as increases in congestion for automobile trips.

The model reports HOV3+ trips only for the HBW purpose, and if the trip takes place on a designated HOV facility (all VPLs) and saves at least five minutes by taking the HOV facility. (*9*) There are significantly fewer eligible HOV facilities in the Land Use-Only Scenario as compared to both of the VPL scenarios resulting in a higher share of low occupancy vehicle trips. The number of HBW HOV3+ trips more than doubled from the Baseline in both the Aspirations and Streamlined scenarios.

Table 4 shows the mode split for the Baseline and all three scenarios for work trips. All three scenarios have a lower mode share for low-occupancy vehicle trips than the Baseline.

Table 4: Mode Share for Work Trips

Trip Type	Baseline	Land Use-Only	Aspirations	Streamlined
LOV* Auto Person	79.3%	78.0%	74.5%	74.6%
Transit	13.4%	14.2%	14.7%	14.7%
HOV3+ Auto Person	2.6%	2.5%	5.4%	5.3%
Non-motorized HBW trips	4.7%	5.3%	5.3%	5.3%

*LOV - Low occupancy vehicle

Air Quality

The Washington region is in non-attainment for ozone (VOC and NOx) and particulate matter (PM2.5 and Pre-cursor NOx). (*11*) Emissions for criteria pollutants were estimated for the respective non-attainment areas, shown in Map 1, using the most recently adopted air quality planning assumptions for the air quality assessment of the 2010 CLRP and the 2011-2016 Transportation Improvement Program which include vehicle fleet data collected in 2008 (*11*). Emissions for the criteria pollutants were developed using the Environmental Protection Agency's (EPA) Mobile 6.2 model. Emissions for carbon dioxide (CO2), the primary greenhouse gas, were estimated for the modeled area using a speed curve developed by University of California, Riverside (*12*). The air quality analysis demonstrates adherence to both the 8-hour ozone and PM2.5 budgets that have been submitted to EPA. (*11*). There is currently no federal requirement for CO2 reporting. Future emissions forecasts for scenario work will use the EPA's MOVES model as the TPB transitions to MOVES for air quality conformity modeling.

Table 5 shows the results from the emissions analysis.

Table 5: Emissions Analysis, Year 2030

Pollutant	Baseline Emissions	Percent Difference from Baseline: Land Use-Only	Aspirations	Streamlined
VOC (tons/day)*	38	1.54%	2.10%	1.74%
Nox (tons/day)*	33	0.47%	5.45%	4.39%
PM2.5 (tons/year)**	721	0.26%	4.93%	3.77%
Precursor Nox (tons/year)**	11,714	0.67%	6.13%	5.01%
CO_2 (,000 tons/year)***	26,911	-0.26%	2.77%	2.16%

* Emissions estimated for the 8-hour Ozone non-attainment area

** Emissions estimated for the PM2.5 non-attainment area

*** Emissions estimated for the modeled area

FINANCIAL ANALYSIS

A sketch level analysis was completed to determine whether the toll scenarios would be financially feasible. As part of the cost analysis three categories of VPLs were identified: new variably priced lane miles to be constructed, HOV lane miles converted to VPLs and general purpose lane (GPL) miles converted to VPLs. In addition, the number of new interchanges to be constructed was identified. For the BRT network, the analysis included operating and capital costs, and farebox revenue. Cost information for the VPL network was obtained from the state DOTs in Maryland and Virginia for new construction and conversion of existing lanes, and regional unit costs per lane mile and per interchange in 2010 dollars were developed. (*7*) It is assumed that an additional 1% of the capital cost would be needed on an annual basis for maintenance of the facility, administration, and other expenses, based on the revenue and expenditure analysis of Virginia's Capital Beltway HOT Lane Project. (*13*)

The regional travel forecasting model output was used to develop revenue estimates for weekday and afternoon peak periods. It was assumed that 50% of the peak period traffic would use the VPLs during the off-peak period, and during weekends and holidays. Since HOV3+ do not pay toll on VPLs in Virginia, they were excluded in the revenue estimation.

Table 6 shows the lane miles (new VPL, conversion from HOV to VPL, and conversion from to GPL to VPL), number of interchanges, and annualized cost information over 20 years for both the Aspirations and Streamlined scenarios. Under the Aspirations Scenario the annual revenue is forecasted to cover approximately 81% of the annual cost. The financial analysis of the Streamlined Scenario indicates that the annual revenue generated would be sufficient to meet the capital and operating expenses of the variably priced lanes and transit.

Table 6: Financial Analysis of Aspirations VPL Network versus Streamlined VPL Network

Scenario	Annualized Cost (millions)	Annual Revenue (millions)	Revenue/Cost
Aspirations Scenario	$ 3,799	$ 3,082	0.81
Streamlined Scenario	$ 2,688	$ 2,997	1.11

The analysis completed as part of this scenario study is not a substitute for a detailed financial analysis. It should also be noted that there is a great deal of uncertainty associated with forecasting toll revenue on VPLs. According to Mwalwanda, the elasticity for determining optimum toll rates "is 4.0. i.e. a small 10% change in traffic can result in 40% change in revenues" (*14*).

CONCLUSIONS

The results of the CLRP Aspirations Scenario Study and its related sensitivity tests show what can happen when land use, highway, and transit planning are designed in a synergistic way in the metropolitan Washington region. The CLRP Aspirations Scenario Study demonstrated a process for regional land use planning that balances regional goals with the planning responsibilities and priorities of local jurisdictions.

In developing the scenarios, the TPB addressed all six recommendations for scenario development included in MAP-21. The CLRP Aspirations Scenario Study considered potential regional investment strategies in the VPL network and BRT system, compared assumed (Baseline) and alternative (Aspirations) population and employment distributions, developed scenarios that met or improved upon baseline conditions in terms of transportation network performance, and demonstrated that the revenues estimated can support one of the scenarios (Streamlined). However, new MAP-21 requirements on maintaining the number of toll-free non-HOV lanes will require a reexamination of the VPL networks assumed in both the Aspirations and Streamlined Scenarios.

In evaluating the scenarios, the CLRP Aspirations Study addressed three of the six outcome-oriented national goals specified by MAP-21: congestion reduction, environmental sustainability, and system reliability. In terms of congestion reduction, the analysis showed that both of the scenarios with VPL networks reduced congestion in the modeled area. However, as the results in Table 3 indicate, further analysis is needed on localized areas of congestion, such as adjacent GPLs, facilities parallel to

VPLs, and arterials near targeted growth areas. The TPB has access to INRIX archived Vehicle Probe Project data as an affiliate member of I-95 Corridor Coalition that can be used to identify areas of congestion that should be addressed when developing scenarios. (*15*)

In terms of environmental sustainability, emissions modeling was completed and the scenarios demonstrated adherence to submitted criteria pollutant budgets. Despite the lack of a federal mandate to report greenhouse gas emissions, the TPB, like other MPOs, has chosen to model and report CO2 emissions. All of the scenarios showed an increase in CO2 emissions compared to baseline conditions that the region would need to mitigate to achieve the goal of environmental sustainability.

For system reliability, the VPL network provides travel time reliability for vehicles, including BRT vehicles, traveling in the VPLs. The aforementioned INRIX data can be used to analyze historic travel time reliability on the roadway network as a basis for future forecasts. TPB staff is planning to use benefit cost analysis, similar to that used in its Transportation Investment Generating Economic Recovery (TIGER) grant applications, to better evaluate scenarios with variably priced lanes. Such analysis would help to quantify benefits of travel time predictability along with other benefits and costs that have not been previously quantified in TPB scenario studies.

NEXT STEPS

The CLRP Aspirations Scenario Study used sketch level planning, and did not address all of the realities of planning a regional VPL network including, the new MAP-21 requirements on maintaining the number of toll-free non-HOV lanes, the challenge of planning a network that spans a tri-state area, operational issues, and the public perception of variably priced lanes. On the last point, the TPB, in partnership with the Brookings Institution, is completing a study to investigate issues related to the public acceptability of road-use pricing under a grant from the Federal Highway Administration's Value Pricing Pilot Program. Findings from this research project will help inform future scenario work related to variably priced lanes.

The CLRP Aspirations Scenario Study provides three examples of alternative planning futures for the region and offers a useful starting point for defining regional transportation and land use priorities as part of the TRB's Regional Transportation Priorities Plan (RTPP), which includes analysis of near-term, on-going, and long-term strategies. Long-term strategies will cover the entire planning period, which now extends to 2040, and can include significant changes in both transportation and land use that can be informed through the use of scenario planning. As part of the public outreach effort for the RTPP beginning in Fall 2012, a series of long-term scenarios, including components of the CLRP Aspirations Scenario Study, will be presented to illustrate long-term transportation and land use strategies. Participants will be asked to consider those scenarios and suggest additional scenarios for consideration.

The MAP-21 legislation provides guidance for developing scenarios and taking a performance-based approach to evaluating scenarios. The TPB plans to consider all of the national goals for the federal transportation program as outlined in MAP-21 in its future scenario work, and to use the development of the RTPP as an opportunity to establish locally-derived performance measures.

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