PRESTO

PROSPECTS FOR REGIONAL SUSTAINABILITY TOMORROW

Numerous forces will disrupt our future in the region. At the least, changes in technology and energy costs and in how we address these, ensure some unpredictability. One way to plan for uncertainty is to create plausible future scenarios and assess their impacts. PRESTO creates four distinct scenarios for the Baltimore-Washington region, each very different than a simple continuation of current trends, policies and forces. PRESTO's interconnected models test the impact of these scenarios on a range of quality of life factors. None of these impacts are inevitable. But identifying them can spur strategies and policies that produce a more resilient and sustainable future for the region.

Engaging the Future

Baltimore-Washington 2040

Table of Contents

April 2018

Letter from our Executive Director

Thanks for your interest in our PRESTO project. To our knowledge PRESTO is the first attempt to address the long-term sustainability of the Baltimore-Washington region using advanced modeling and scenario analysis techniques. The seeds of this project were planted in 2005 when we helped the Washington chapter of the Urban Land Institute conduct a Reality Check on growth. The exercise engaged over 300 DC-area citizens in a conversation about the future of the metropolitan area using Lego blocks on table-sized maps. This exercise, and the four that followed across the state of Maryland, raised the profile of growth and development issues and made clear that there is no organization undertaking a serious analysis of the sustainability of the Baltimore-Washington region, and that doing so would require a significant investment in analytical infrastructure.

The seminal investment in analytical infrastructure was provided by the Maryland State Highway Administration, which funded the development of Maryland State Transportation Model. This model, developed in partnership with Parsons Brinckerhoff, was built on the foundations of the Washington and Baltimore metropolitan planning organizations' and was the first model to integrate two major metropolitan areas in a single and comprehensive travel model. To support and extend this regional travel model we subsequently coupled it with land use, land cover, nutrient loading and air emissions models. Combined, these models now produce a wide range of sustainability measures for the greater Baltimore-Washington region showing how firms, individuals and households respond to changes in external forces.

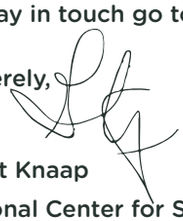
Major contributors to our model-building effort include the US Environmental Protection Agency, the Federal Highway Administration, the Maryland Department of Transportation, the US Geological Survey, the National Socio-Environmental Synthesis Center (SESYNC), and others. But the principal funder and longstanding supporter of our efforts has been the Town Creek Foundation. Stuart Clarke and the Town Creek board recognized the tremendous potential of integrating a suite of advanced models, and their value in analyzing and promoting sustainability in the Baltimore-Washington region. We remain exceptionally grateful for their support.

We are also grateful for the support of many individual scientists and stakeholders who have lent their expertise along the way. Early on we formed a Scientific Advisory Committee that helped us identify forces that would shape the future of our region and from which we developed a baseline and four alternative scenarios. These scenarios are not forecasts of the future but internally consistent and plausible outcomes that could occur if certain external trends and internal policy decisions were to occur. They demonstrate quite clearly that the future is uncertain and that without careful consideration and deliberate policy making, we could find ourselves in a future that is neither desirable nor sustainable.

While the release of these scenarios is an important milestone, and we hope they will stimulate a useful dialog, the project doesn't end here. These scenarios reveal the critical importance of how we handle the coming revolution in transportation technology, conduct land use policy, manage energy supplies, and invest in transportation infrastructure. But how best to actually make these decisions in an increasingly uncertain environment is the question to which we turn next—and we invite your participation.

To stay in touch go to www.umdsmartgrowth.org/projects/presto and click on Keep in Touch.

Sincerely,

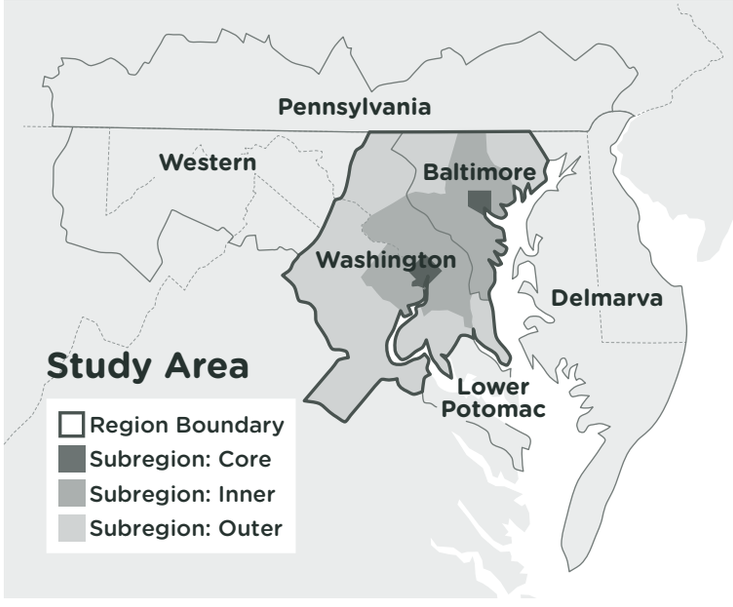


Gerrit Knaap
National Center for Smart Growth

Overview

Engaging the Future contrasts four plausible futures against a trend-based future, called the baseline, which projects the effects of current plans, policies and driving forces. We first describe the baseline in broad strokes, then provide a quick overview of the four scenarios, before presenting the specific, numeric assumptions used to model the scenarios. We then describe the various models deployed to implement the scenarios and see their impacts. With this foundation, we show how the 2040 baseline differs from the year 2015 (existing conditions), focusing on household, job, environment, mobility and equity measures. Each of the four scenarios is then compared to the baseline (2040) using the same measures. We conclude by comparing and contrasting all the scenarios and draw out lessons learned from the analysis to date.

This project focuses attention on the combined Baltimore -Washington region, shown in a bold outline in the map (Region Boundary). Our models, however, include indicators for many areas surrounding the region (the irregular line that includes adjacent states). This larger geography allows us to capture the ripple effects of our region-focused scenarios on the Delmarva peninsula, Lower Potomac, portions of Pennsylvania and areas west of the region. In this document we call this area "outside the region." Within the region, we present results for various subregions: the core, representing the cities of Baltimore and Washington (including both Arlington County and Alexandria City); the six inner suburban counties, around the cores; and the eleven outer suburban counties.



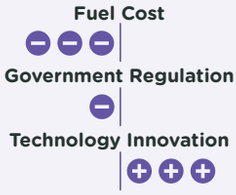
The Baseline

Maryland, Washington, DC, Virginia and their component jurisdictions already possess a complex array of laws, plans and regulations for the management of growth, transportation and environmental impacts. Developing a scenario that assumes a laissez-faire future for the region fails to acknowledge that all future driving forces must necessarily interact with how our region presently does business. As such, the baseline scenario for 2040 incorporates key current state and local assumptions about and plans for the future.

Transportation and land use inputs for the baseline have their basis in the long range plans of the two metropolitan planning organizations and the plans for surrounding jurisdictions. Planning inputs include the baseline highway and transit network for 2040, as well as projections for the growth of households and employment by small area geographies called Transportation Analysis Zones. These projections are part of the metropolitan planning organizations' Constrained Long Range Plans (CLRPs), which are the basis for selecting future facility investments. Transportation network investments in the baseline include the completion of the Silver and Purple lines in the Washington suburbs as well as many highway projects throughout the region. More details and maps, including household and job projections, can be found in the baseline scenario section of this document.

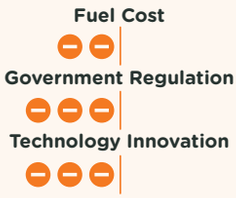
Another important plan included in the baseline assumptions is Maryland's 2009 Greenhouse Gas Emissions Reduction Plan (GGRP), which aims to reduce emissions 25 percent by 2020. The state extended its goals to achieve a 40 percent reduction by 2030, but is still developing this plan. Thus it cannot yet be modeled for this effort. As the state intends to build upon existing plans in their 2030 planning effort, the 2009 GGRP remains the most valid plan to model state action on climate. This project models greenhouse gas emissions for the road transportation sector and also from commercial and residential buildings. The input assumptions of the climate action plan were prepared by Dr. Timothy F. Welch as part of his dissertation at the University of Maryland. More details of the greenhouse gas planning assumptions can be found in Dr. Welch's dissertation, available on the UMD website.

The Four Scenarios



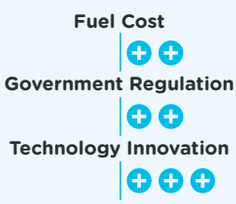
Revenge of the Nerds (RON)

shows how a combination of low fuel prices, limited government regulation, and rapid technological change profoundly impacts regional development patterns, travel behaviors and the environment. For many, the adoption of autonomous vehicles confers new opportunities and choices in where to live, work and invest. Most strikingly, despite large increases in miles traveled, the increase in road capacity created by vehicle autonomy yields an equally dramatic decrease in road congestion. Transit ridership declines significantly. The widespread decentralization and growth of new housing consumes more farm and forest land, but since suburban development can produce lower nutrient loadings than farming and some best management practices (BMP) are implemented, nutrient runoff is similar to the baseline. Greenhouse gas and local air pollutants increase.



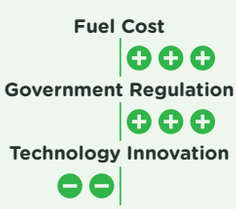
Free for All (FFA)

shows how the region might respond to lower fuel prices, significant increases in road capacity, and much less restrictive development controls. The resulting suburbanization of many households into the agricultural preserves of Baltimore, Montgomery, Howard, Prince George's, and Fairfax Counties also improves housing affordability throughout the region. This development pattern reduces farm and forest land more than the baseline despite less population growth. Transit ridership falls as a consequence of lower fuel prices and decentralized development patterns. Despite the significant increase in road capacity, miles of travel by automobile remains relatively unchanged from the baseline but congestion declines significantly. Greenhouse gas emissions and other forms of air pollution rise, and nutrient loadings increase due to the failure to implement Watershed Implementation Plans (WIPs).



Blue Planet (BP)

portrays a region with characteristics commonly viewed as more sustainable: increased development capacity in the inner suburbs, major transit investments, rapid adoption of zero-emission vehicles, and growth in green technologies. Rising fuel costs discourage automobile travel and the implementation of WIPs decrease nutrient loading. Many of the expected benefits are realized: auto use and congestion are significantly reduced as are associated emissions and pollutants, new jobs and housing co-locate more than in the baseline scenario, and transit use increases notably. Surprisingly, this scenario also increases forest loss as increasing growth leapfrogs the agricultural preserves. Housing prices remain similar to baseline due to additional building capacity in the inner suburbs. However, capacity is still severely depleted, deflecting some growth outside the region.



Last Call at the Oasis (LCO)

depicts a region facing rising scarcity in energy resources that limits economic growth. Increased fuel costs and tighter development regulations have dramatic impacts on location decisions and travel behavior. High transportation costs lead to core and inner suburban development, less travel by automobile, and more rail transit ridership. This scenario has the least adverse environmental impacts. Fewer miles traveled means less pollution from automobiles and clustered growth, and the aggressive implementation of best management practices leads to lower nutrient loads. Slow economic growth, tighter land supplies in the outer suburbs, and increased capacity in the inner suburbs combine to reduce housing costs slightly below the baseline, except in downzoned rural areas.

Scenario Inputs

The four scenarios just presented provide coherent stories illustrating a range of possible futures our region may face. Beyond the narratives, however, rigorous scenario planning requires translating scenario concepts and narratives into measures that can be used in a range of models to assess their impact. But models have limitations, and sometimes focus attention narrowly on what they can measure or produce. As modeling efforts go, the PRESTO suite incorporates a substantial number of sophisticated and tested models that are acknowledged in their respective fields, making it one of the leading-edge efforts in the US to simulate future conditions. Nevertheless, the model inputs (and outputs) are not comprehensive and one must remain aware of issues not considered.

The adjacent chart lists 33 selected model inputs and their percent differences from the baseline values by scenario. These drive the direction of the model outputs and thus deserve close attention. The inputs (and outputs) were developed by the research team and vetted by the project's Scientific Advisory Committee and other outside experts.

Some actions and interventions cannot be modeled directly but must be modeled through a variety of parameters. Autonomous vehicles, for example, are modeled via adjustments to roadway lane capacity, value of time, parking cost, trip and work distance limitations, and behavioral parameters.

Scenario Inputs Relative to Baseline

	RON	FFA	BP	LCO
Mobility				
Vehicle Operating Cost	-75%	-50%	100%	300%
Zero Emission Vehicle Fleet %	38%	-37%	265%	158%
Travel Distance Cap	100%	0%	0%	0%
Value of Time	-50%	0%	0%	0%
In-Vehicle Time & Operating Cost Coefficient	-50%	0%	0%	0%
Parking Cost	-50%	0%	0%	0%
Transportation Network				
Rail Miles	0%	0%	56%	29%
Rail Stations	0%	0%	65%	45%
Limited Access Highway Miles	0%	12%	0%	0%
Highway Lane Capacity	50%	0%	0%	0%
Employment				
Total Employment	1%	-1%	2%	-1%
Core Employment	-1%	-4%	4%	1%
Inner Suburban Employment	2%	-3%	4%	0%
Outer Suburban Employment	5%	0%	-1%	-6%
Outside Region Employment	6%	2%	1%	-5%
Household Location				
Household Distance to Work	100%	0%	0%	0%
Development Capacity	23%	498%	10%	-13%
Core Development Capacity	0%	25%	0%	136%
Inner Suburban Development Capacity	2%	223%	20%	13%
Outer Suburban Development Capacity	24%	587%	11%	-25%
Outside Region Development Capacity	38%	699%	6%	-56%
Energy				
Max HVAC Age	-25%	100%	-50%	-50%
Max Building Renovation Age	-20%	100%	-50%	-50%
Percent of Buildings Renovated Early	25%	-50%	100%	50%
Nutrient Loading				
Nitrogen Loading Rate from Forests	-3%	65%	-17%	-7%
Phosphorous Loading Rate from Forests	-6%	67%	-34%	-11%
Sediment Loading Rate from Forests	-10%	10%	-43%	-21%
Nitrogen Loading Rate from Farms	-16%	48%	-58%	-32%
Phosphorous Loading Rate from Farms	-17%	64%	-57%	-34%
Sediment Loading Rate from Farms	-12%	85%	-53%	-25%
Nitrogen Loading Rate from Development	-13%	66%	-43%	-26%
Phosphorous Loading Rate from Development	-12%	70%	-49%	-25%
Sediment Loading Rate from Development	-20%	100%	-54%	-41%

The lowest numbers are shown in red and the highest in green.

The PRESTO Modeling Suite

The PRESTO modeling suite includes six principal models: the Simple Land Use Orchestrator (SILO) developed by Parsons Brinckerhoff, the Maryland State Transportation Model (MSTM) developed by NCSG and Parsons Brinckerhoff, the Chesapeake Bay Land Cover Model (CBLCM) developed by USGS and the Chesapeake Bay Program, the Mobile Emissions Model (MEM) developed by the EPA and the Building Emissions Model (BEM) developed by Dr. Welch/ NCSG, and the Nutrient Loading Model (NLM) also developed by USGS and the Chesapeake Bay Program. The baseline demographic and employment projections are from the Constrained Long Range Plan (CLRP) forecasts of the Baltimore and Washington metropolitan planning organizations and other government sources. Each of the models has been individually calibrated and validated in the process of their development.

The economic projections for the various scenarios are the product of a Delphi process with several experts at all scales of economic geography drawn from the region's university-based think tanks.

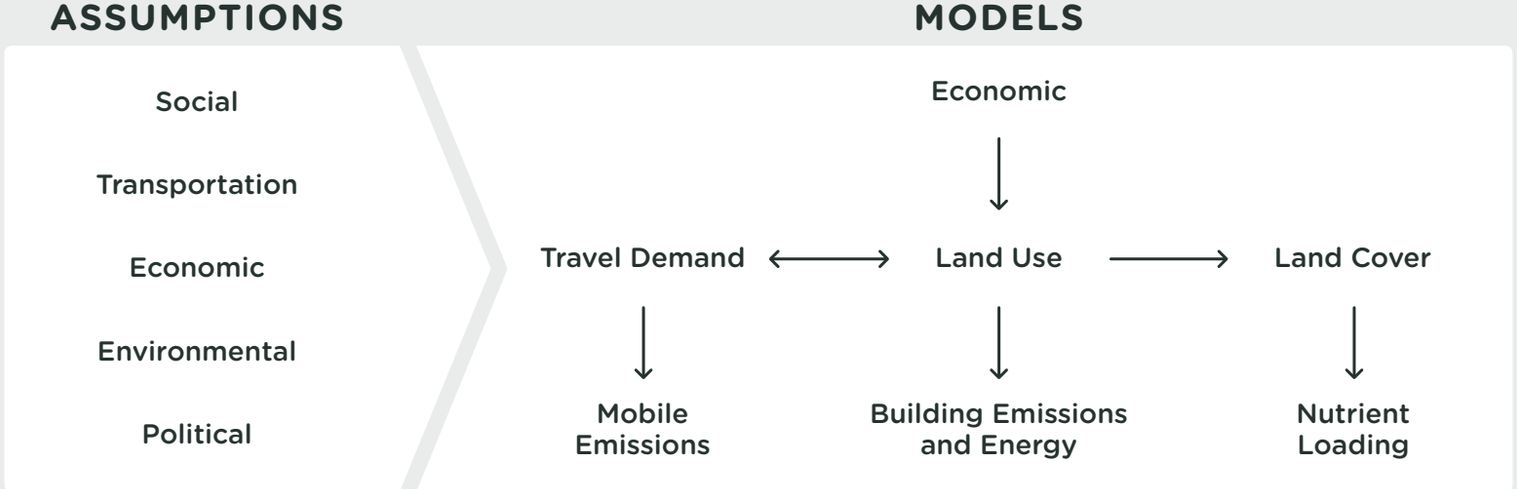
In the baseline, the CLRP employment projections are entered into the SILO model, which micro-simulates the decisions of individuals, developers, and households within the region, based primarily on housing costs, transportation costs and household budget tradeoffs. The result allocates housing units and households throughout the study area. SILO is particularly useful because it models real constraints in travel time to work and in household budgets.

Notably, PRESTO's implementation of SILO also includes existing preferences about racial segregation, school quality, crime, and development constraints enforced by zoning. Within the scenarios, parameters that vary include employment levels and location as determined by the Delphi process, household sensitivity to accessibility, development capacity (zoning), and distance to work preferences.

The Maryland State Highway Administration and Department of Transportation have used MSTM for statewide projections and analysis for the past several years. In the PRESTO effort, SILO iterates with MSTM to capture the primary feedback dynamic between transportation and location choice, i.e., balancing housing options against travel options. Within the scenarios, critical changes to MSTM include changes to transportation networks and vehicle operating cost in addition to growth in population and employment. Within PRESTO, MSTM is only run for the evening peak and all results reflect this time period.

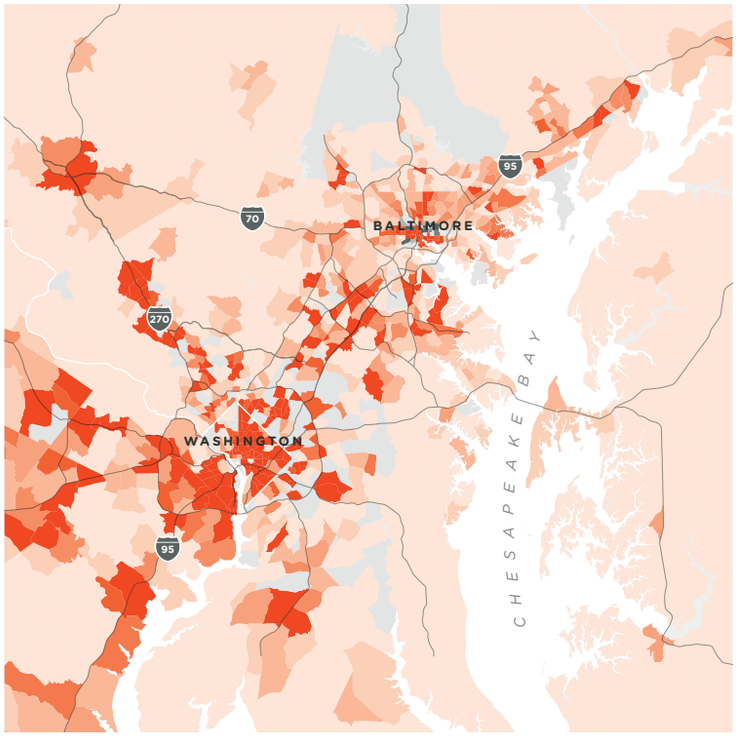
Also using SILO allocations, CBLCM models the conversion of forest and farm land for new development. Finally, the NLM applies nutrient loading coefficients by county to land cover projections to determine pollutants running into streams, rivers and the Bay. Reducing nutrient loads, particularly nitrogen, is well recognized as key to restoring the health of the Bay. The scenarios vary the nutrient loading coefficients based on scenarios derived from the Maryland Assessment Scenario Tool (MAST), a web-based tool built to estimate loading rates from various land uses under different best management practices.

MEM, a customized application of the US EPA's Motor Vehicle Emissions Simulator (MOVES) to MSTM, estimates transportation emissions by applying emissions coefficients from the MOVES model to MSTM-generated traffic flows. BEM uses SILO allocations to estimate energy use and emissions from residential and commercial buildings. Parameters in MEM include the extent of zero-emission vehicle adoption and parameters in BEM include home renovation frequency and the energy efficiency of new buildings.



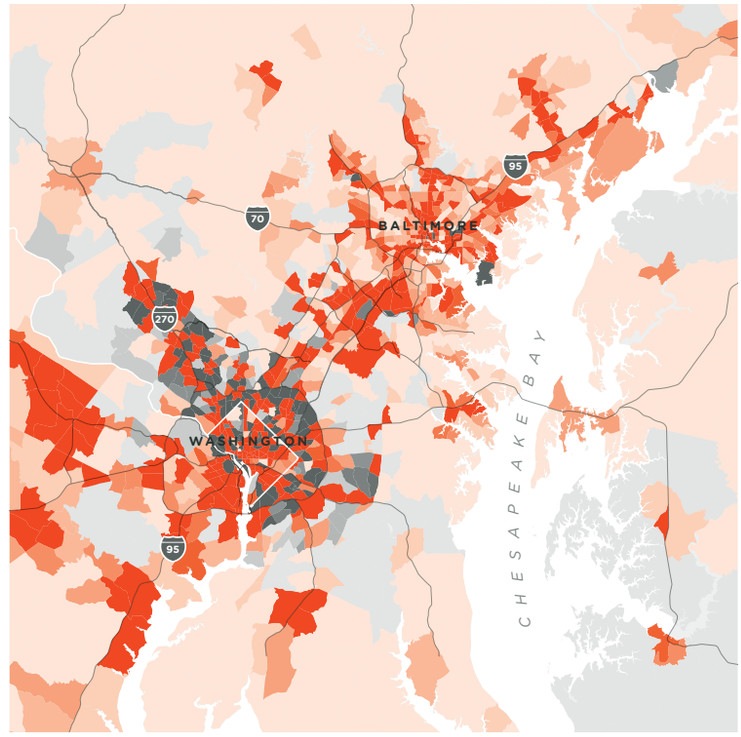
Existing Conditions and Baseline

The region is projected to grow by 616,000 households and 1,451,000 jobs from 2015 to 2040. An additional 312,000 households will locate outside the region, many of whom will commute into the region. Nearly 45 percent of employment growth will occur in the inner suburbs, driven by strong growth in education, health care and scientific/technical services. Household growth follows, with 54 percent growth in the inner suburbs. Generally growth continues to occur in existing corridors until the development capacity of the inner suburban jurisdictions is fully consumed, pushing growth both inward toward the city cores and further outward to outer counties.



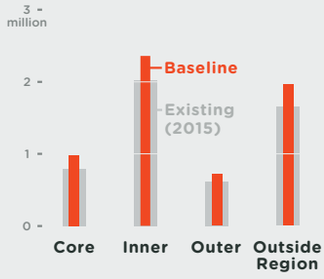
Households

More households per sq. mile in 2015 — More households per sq. mile in Baseline (2040)



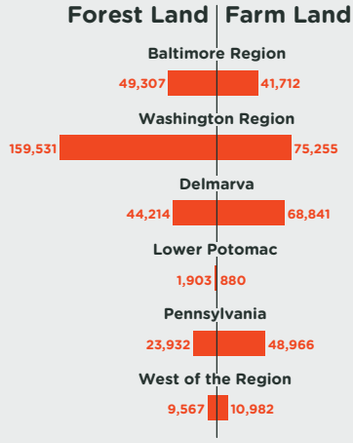
Jobs

More jobs per sq. mile in 2015 — More jobs per sq. mile in Baseline (2040)



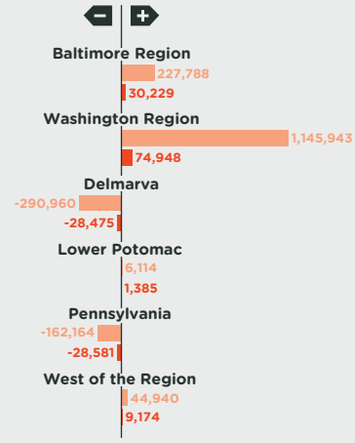
Households

Growth results in substantial farm and forest loss. Nitrogen loading worsens in areas where forests are displaced; however, loading decreases when polluting farms give way to development.



Acreage Lost Since 2015

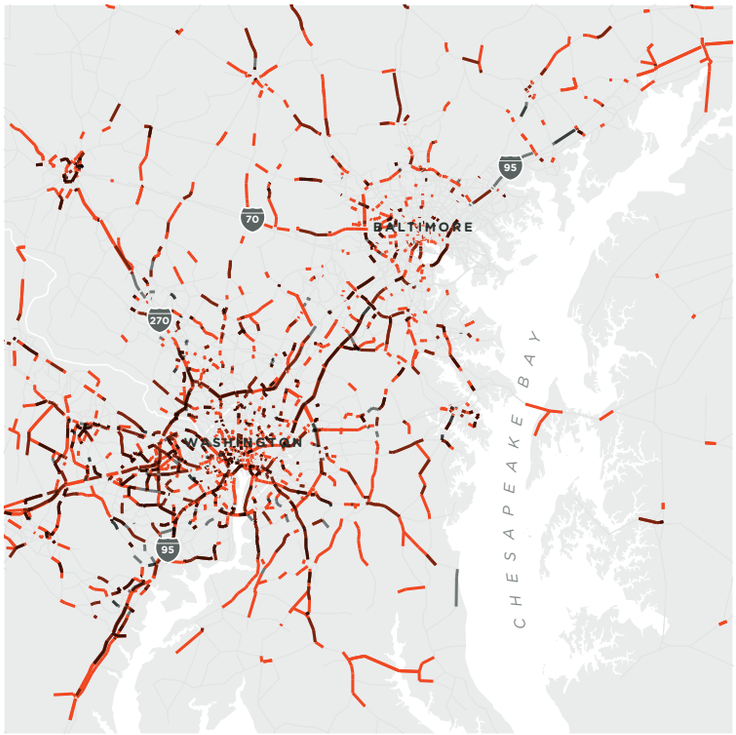
= Baseline (2040)



Nutrient Loading

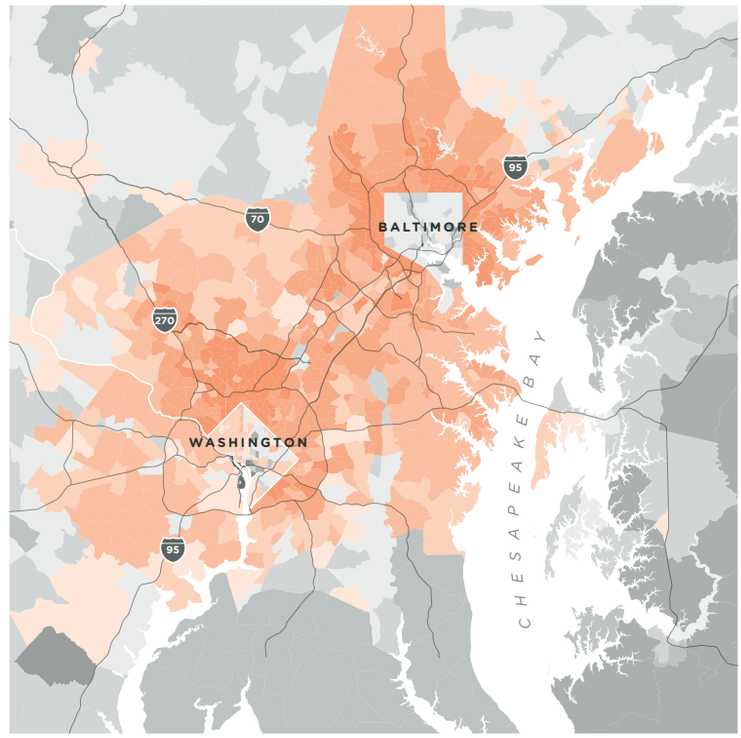
difference in loading lbs 2015 to 2040

= Nitrogen = Phosphorous



Severe Traffic Congestion

= Existing (2015) = Existing and Baseline = Baseline (2040)



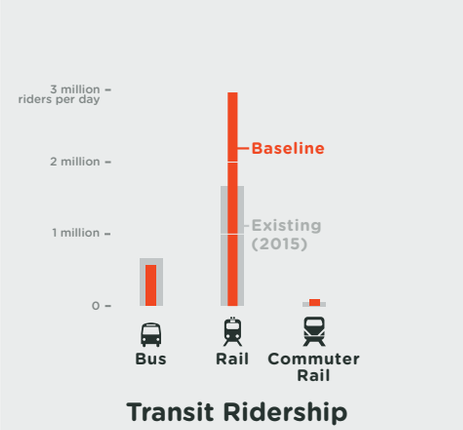
Housing Prices

More expensive in 2015 — More expensive in Baseline (2040)

Vehicle Impacts

Two of the most tangible impacts of continued regional growth are increased housing prices and worsening congestion. Housing prices increase substantially throughout the inner suburban jurisdictions, particularly those with strong growth restrictions such as Baltimore and Montgomery Counties. As those jurisdictions exhaust locations for growth, prices rise in adjacent jurisdictions such as Washington DC, Arlington, Fairfax and Anne Arundel Counties.

Congestion in the region, already bad, worsens significantly. In spite of large increases in rail ridership, vehicle miles traveled and hours traveled increase substantially. Traffic worsens nearly everywhere, but particularly on the Beltways and on the highways connecting Baltimore and Washington. This results in nearly quadrupling the hours of delay. As the baseline only assumes modest adoption of electric vehicles, greenhouse gas from vehicles increases 24 percent. Nitrous oxide and volatile organic compounds increase even more.



Transit Ridership

Revenge of the Nerds

This first of four scenarios explores a future of rapid economic growth driven by low carbon fuel prices, rapid adoption of new technologies—including autonomous vehicles—and a retreat from government regulation in the face of economic success. Combined, these factors increase the capacity of existing expressways, dramatically reduce the cost of travel by gas-powered automobiles, and make travel time more productive. In this radically different landscape of access and housing costs, jobs and households move to smaller, more distant cities and towns, as well as outside the region. These small towns expand capacity to accommodate this growth, but this does not lower housing prices in general.

While advances in technology ripple through the economy, low fuel prices increase the demand for autonomous, gas-powered vehicles. Complementary investments in autonomous vehicle technology (self-driving cars) by state and federal agencies accelerate their adoption, which does not occur for electric vehicles. The resulting increase in capacity on existing roadways significantly increases vehicle miles traveled but massively reduces congestion, even on the Baltimore and Washington Beltways. Ridership on transit plummets, however, as lower driving costs dramatically reduce the demand for public transportation for those with access to vehicles.

The impacts on the environment are mixed. Although fuel efficiency rises and fewer hours are spent in traffic, greenhouse gas emissions and other pollutants rise, in large part due to the continuing reliance on low-cost fossil fuels.

The dispersion of household growth increases development on farmland and forest lands by over 10 percent. This additional land development, however, is offset by modest improvements in nutrient management, resulting in nutrient loads below the baseline scenario.

Inputs

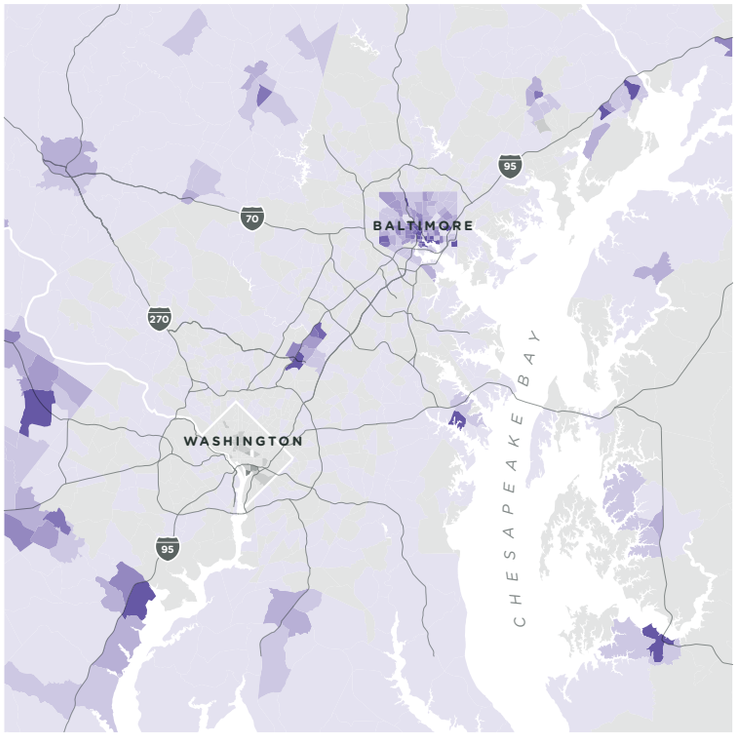
As with all modeling efforts, estimated impacts (outputs) are determined by the assumptions regarding how the model is structured and the assumptions (inputs) entered into the model. Key inputs include:

- employment grows 10 percent faster than in baseline scenario
- buildings are renovated 25 percent more frequently than baseline (using newer, cleaner technology)
- development capacity in and around small towns doubles
- vehicle capacity on expressways increases by 50 percent
- vehicle operating expenses fall by 75 percent
- employment disperses somewhat throughout the region
- nutrient loading rates fall with new technologies; nitrogen loading decreases three percent on forests, 16 percent on farm land, and 13 percent on developed land

Footloose

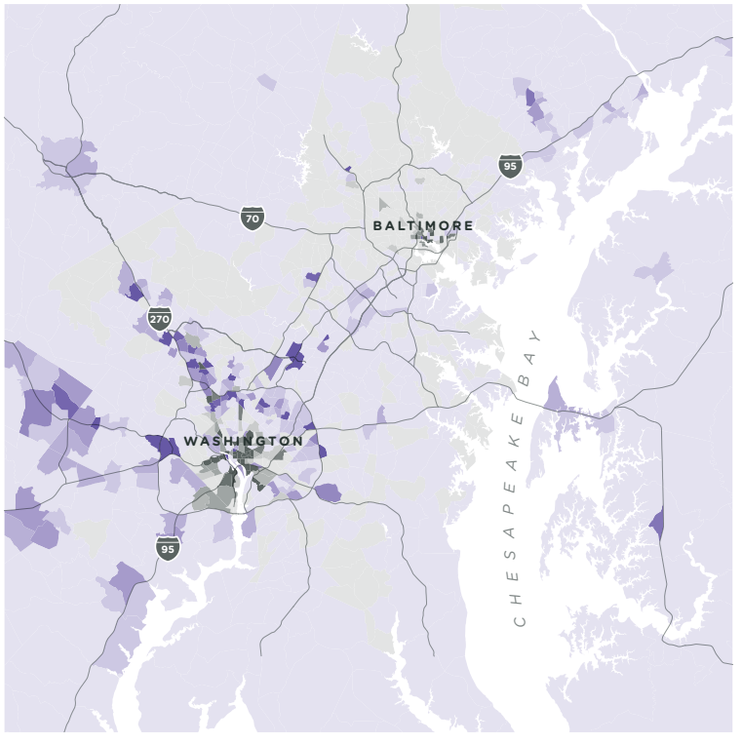
Many households and some jobs decentralize

Cheap fuel and autonomous vehicles weaken the attraction of Baltimore City and Washington, DC. Local governments relax long-held development restrictions on rural towns and their surrounding areas. Households move to rural areas and small towns, and outside the region. To a lesser degree, businesses also move to suburban and exurban job centers, and outside the region.



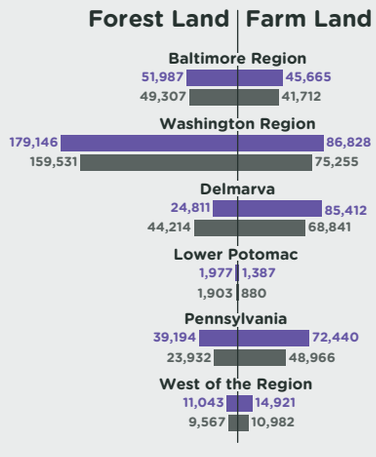
Households

More households per sq. mile in Baseline — More households per sq. mile in Revenge of the Nerds



Jobs

More jobs per sq. mile in Baseline — More jobs per sq. mile in Revenge of the Nerds



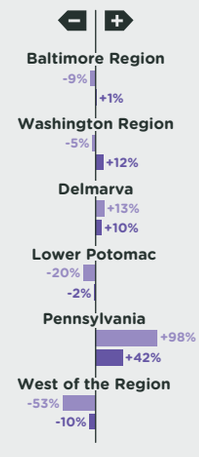
Acreage Lost Since 2015

● = Revenge of the Nerds (2040)

● = Baseline (2040)

More forest and farms developed but nutrient loading declines

This scenario sees an increase of more than one million new households in the study area and weak restrictions on development in and around towns and rural areas. This change leads to a loss of farm and forest land throughout the region, and even more farm land lost outside the region. Compared with the baseline scenario, this causes nitrogen loadings to decrease in many rural areas as farms in Delmarva and west of the region develop and some improvements in urban nutrient management take hold.



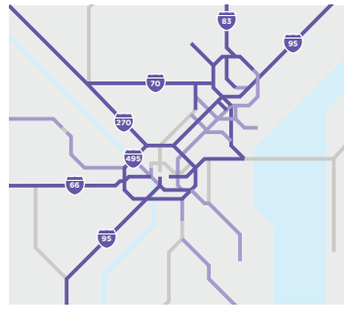
Nutrient Loading

% difference between Revenge of the Nerds and Baseline

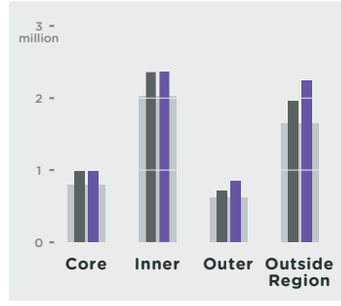
● = Nitrogen ● = Phosphorous

The open road

The widespread use of autonomous vehicles increases highway capacity by 50 percent, which dramatically reduces congestion compared to the baseline. As residents decentralize, vehicle miles traveled increase but vehicle hours traveled actually decrease as time spent in traffic and vehicle hours of delay fall dramatically.



TRANSPORTATION NETWORK
No new highways, but autonomous vehicles create more capacity
= 50% increase = 25% increase



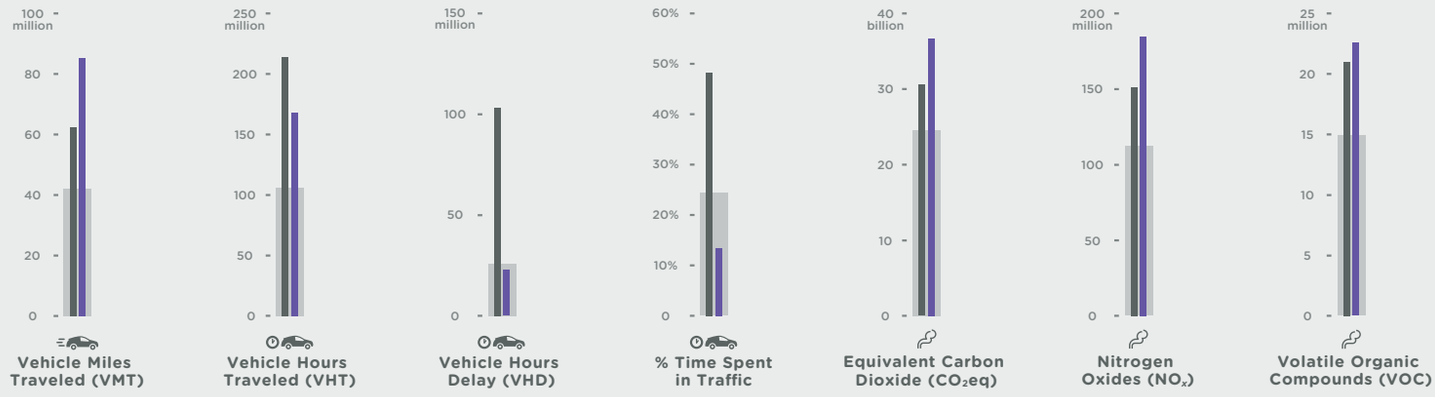
HOUSEHOLD LOCATIONS
= Revenge of the Nerds
= Baseline
= Existing (2015)

BASELINE SCENARIO

REVENGE OF THE NERDS SCENARIO

Traffic Volume and Congestion

= Severely congested = Free flowing
Wider lines = Higher roadway volumes



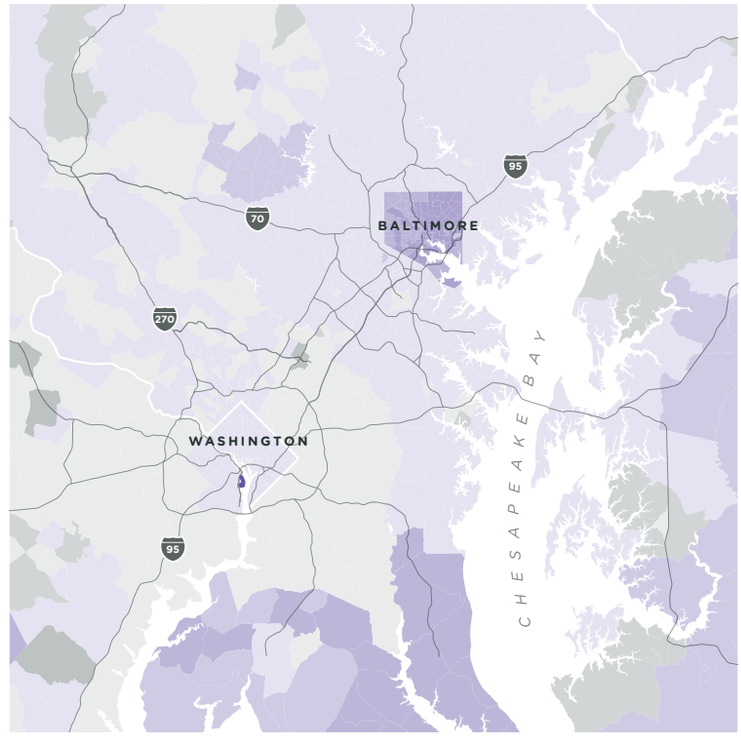
TRAVEL BEHAVIOR **EMISSIONS**

Vehicle Impacts

Baseline
Revenge of the Nerds
Existing (2015)

A new world of tradeoffs between housing and transportation costs

The decline in the cost of driving alters accessibility to jobs and housing affordability. In general, the demand for housing in the suburbs and outside the region rises while the demand for housing in core areas decline. This is reflected in widespread but modest rises in housing prices throughout the region. Baltimore City is an exception. Baltimore has ample development capacity, unlike Washington, DC, but Baltimore's housing prices increase since the region's suburban development capacity is exhausted and some development is pushed inward. Some development is also pushed outward toward Charles and Calvert Counties, which also have development capacity, and experience a consequent rise in housing prices.

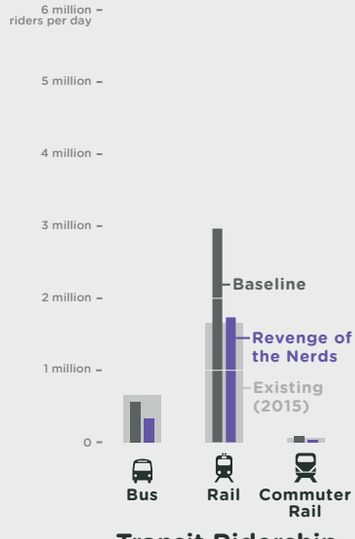


Housing Prices

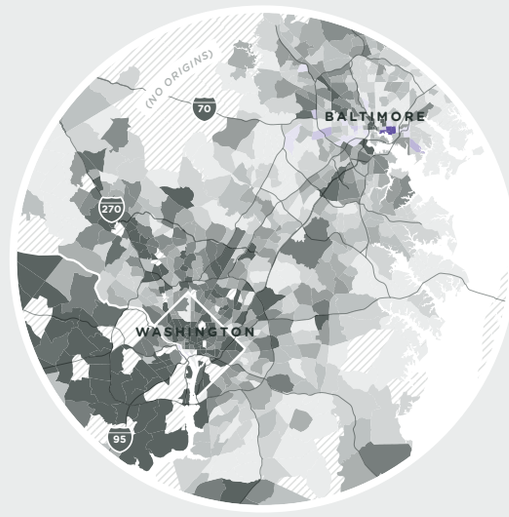
More expensive in Baseline — More expensive in Revenge of the Nerds

Transit ridership declines precipitously

The widespread adoption of autonomous vehicles causes a marked decline in bus and rail ridership, as transit's advantages of convenience and personal productivity dissipate. Decentralized development patterns, difficult to serve by transit, further discourage transit ridership.



Transit Ridership



Transit Origins

More origins per sq. mile in in Baseline — More origins per sq. mile in Revenge of the Nerds

Free for All

This second of four scenarios portrays a future with very little government regulation and a slow but steadily growing economy aided by relatively low fossil fuel prices, but with limited technological innovation. With low fuel prices there are no major investments in transit, but public-private partnerships invest in new tolled outer beltways and an additional bridge to the Eastern Shore. Widespread relaxation of development regulations enables development on agricultural preserves in the inner suburbs.

The fossil fuel industry booms, while growth in the technology sector fails to materialize. Compared to the baseline, both job and household growth slow somewhat. Lack of government enforcement allows water quality best management practices to backslide to 2010 levels.

As development regulations are relaxed, employment disperses somewhat and households fill the formerly protected agricultural preserves of the inner suburbs, especially in Montgomery, Prince George's and Baltimore Counties. Growth that would have deflected to the region's outer suburbs and outside the region itself, shifts to areas once known for their bucolic qualities but now in rural subdivisions adjacent to developed areas. Housing prices are far lower than in the baseline scenario, except on the Delmarva peninsula, where the new bridge increases accessibility and development pressure.

Low fuel prices and major investments in road capacity stimulate only a very slight increase in auto travel, since decentralizing households and jobs appear to both shorten and change commuting patterns. Congestion levels decline significantly compared to baseline conditions despite new tolled highways being underused. Transit ridership falls significantly.

More forest land remains undeveloped than in the baseline and there is only a small increase in farmland developed region-wide. Nevertheless, without an active federal government, nutrient loading regulations backslide, allowing huge spikes in nitrogen and sediment loadings. With little public support for zero-emission or autonomous vehicles, most travel occurs in gas-powered automobiles. This causes significant increases in GHG emissions and air pollutants.

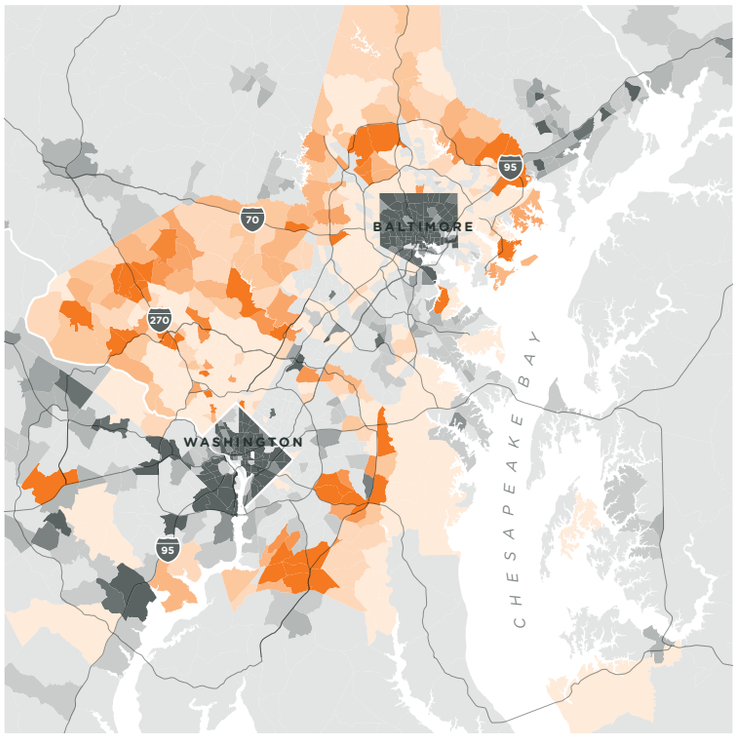
Inputs

As with all modeling efforts, estimated impacts (outputs) are determined by the assumptions about how the model is structured and the assumptions (inputs) entered into the model. Key inputs include:

- employment grows 10 percent slower than baseline scenario
- vehicle operating costs are half those of the baseline scenario
- zero-emission vehicles have only a modest penetration of 12 percent
- limited access highway lane miles increase by almost 500 miles
- development capacity increases 25 percent in urban and suburban areas and ten times in agricultural areas
- HVAC upgrades and house renovations decrease by half
- nutrient loading rates backslide to 2010 levels; nitrogen loading increases 65 percent on forests, 48 percent on farm land, and 66 percent on developed land

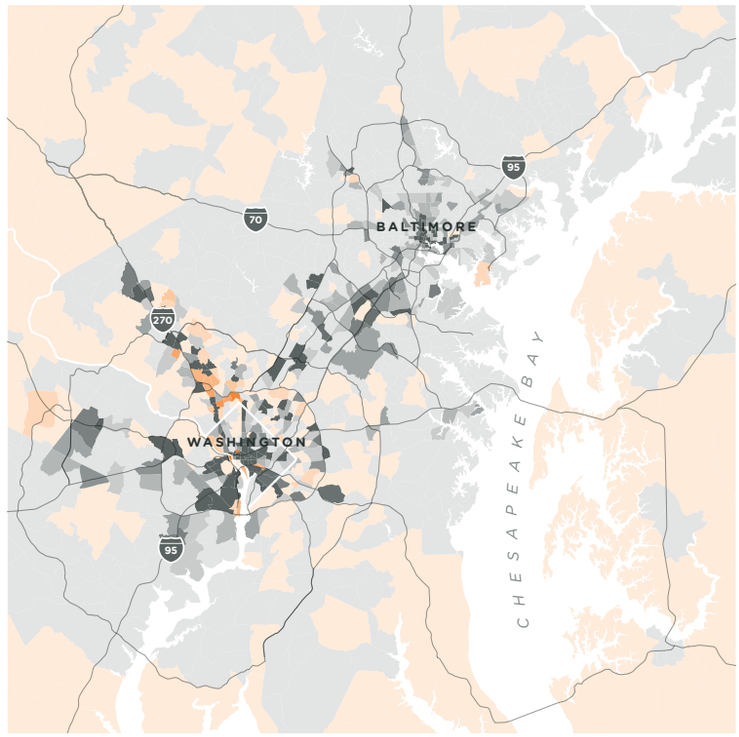
If you let them suburbanize, they will

Despite the relaxation of development restrictions almost everywhere, most new residential development locates in the formerly rural areas of Montgomery, Baltimore, Prince George's, and Howard Counties. This growth pattern results from much relaxed development controls, reinforced by some decentralization of employment.



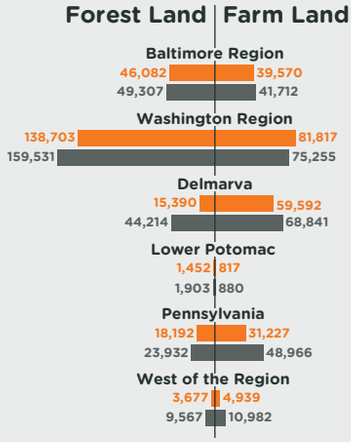
Households

More households per sq. mile in Baseline — More households per sq. mile in Free for All



Jobs

More jobs per sq. mile in Baseline — More jobs per sq. mile in Free for All

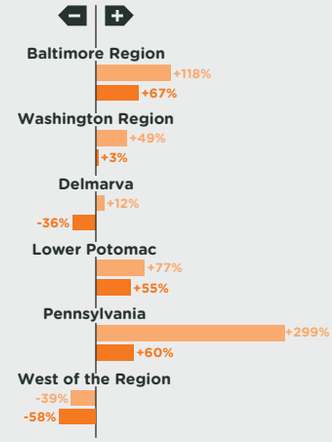


Acreage Lost Since 2015

= Free for All (2040)
= Baseline (2040)

More forest land saved but nutrient loadings spike

In the Baltimore-Washington region, the concentration of new growth in the inner suburbs displaces less forest land and slightly more farm land than in the baseline scenario. Because of a reversion to lax nutrient loading regulations, the net effects of this pattern are severe: there is a considerable increase in nitrogen and sediment runoff compared to the baseline, although less in phosphorus.



Nutrient Loading

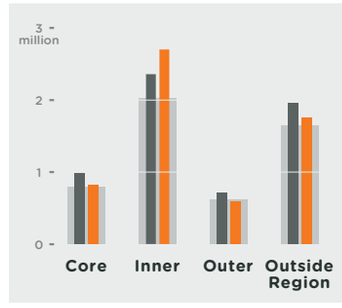
% difference between Free for All and Baseline

= Nitrogen = Phosphorous

Same miles but less congestion

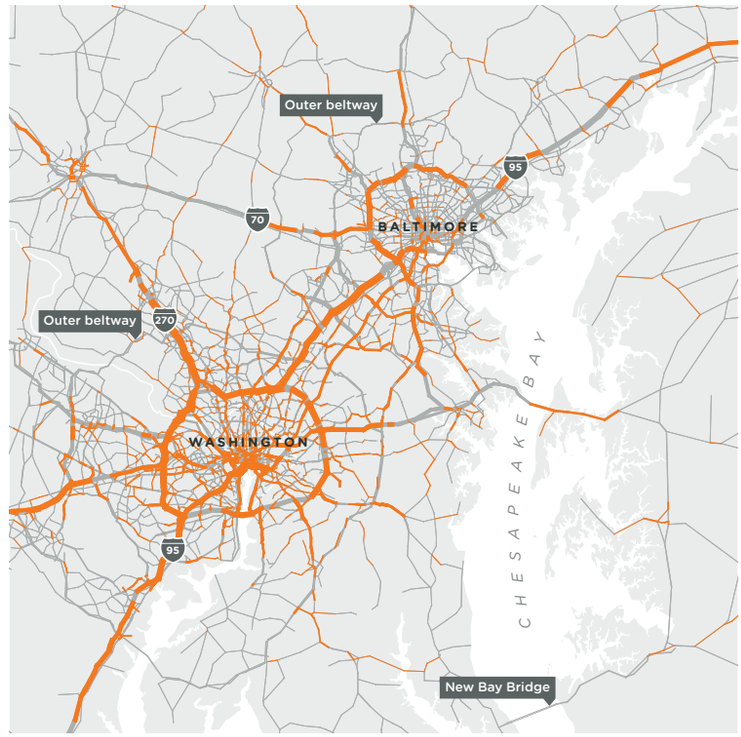
Surprisingly, vehicle miles traveled remain almost the same as in the baseline despite massive investments in highway capacity. Less surprisingly, vehicle hours of delay are much lower. This occurs for two reasons: first, because the new outer beltways are tolled, they do not get congested; second, the suburbanization of both households and jobs improves the jobs-housing balance and lowers commute distances.

NEW HIGHWAY INFRASTRUCTURE



HOUSEHOLD LOCATIONS
= Free for All
= Baseline
= Existing (2015)

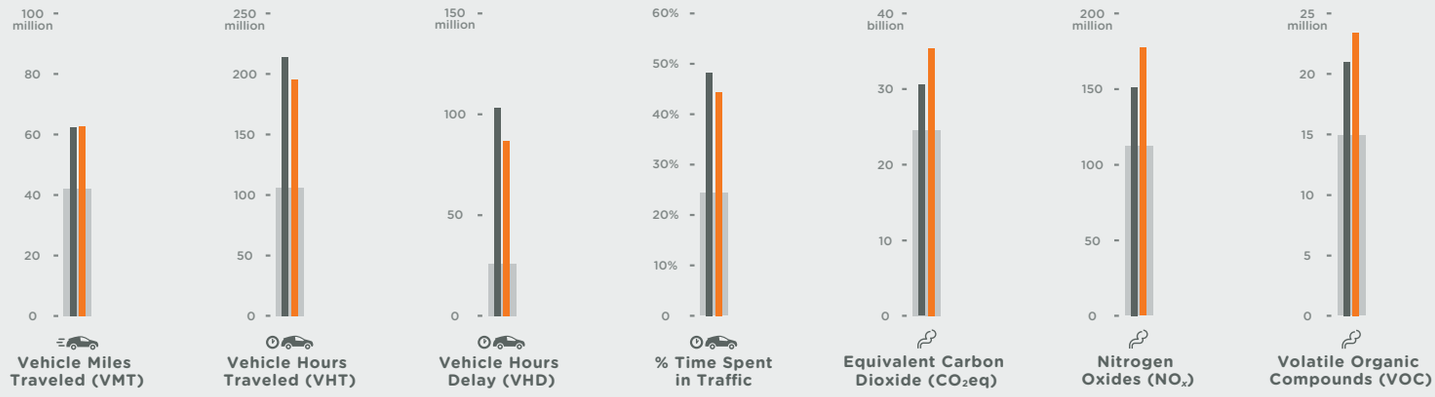
BASELINE SCENARIO



FREE FOR ALL SCENARIO

Traffic Volume and Congestion

= Severely congested = Free flowing
Wider lines = Higher roadway volumes



TRAVEL BEHAVIOR

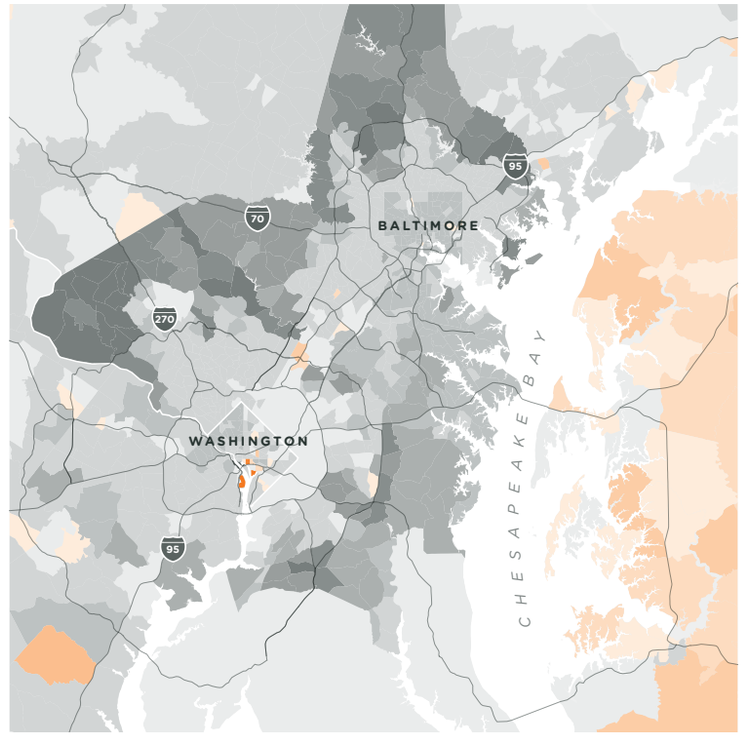
EMISSIONS

Vehicle Impacts

Baseline
Free for All
Existing (2015)

Weaker development controls enable increases in housing supplies, which increases housing affordability

The pervasive relaxation of development constraints lowers housing prices significantly in nearly all parts of the region. Relative to the baseline, they are lowest in the Washington suburbs where the baseline's strong development constraints are relaxed in the areas of highest demand. Consequently, much less development is deflected outside the region than in the baseline. Prices are higher than baseline in a few exurban areas and on the Delmarva peninsula, where an additional bridge stimulates development demand. Though Delmarva housing prices are higher than in the baseline, they remain generally lower than 2015 levels. The construction of a new Bay bridge as well as some employment dispersal increases the accessibility and relative value of locations east of the Chesapeake Bay.

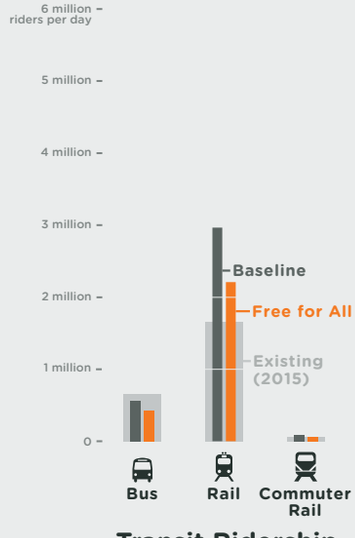


Housing Prices

More expensive in Baseline — More expensive in Free for All

Significant transit ridership losses

Because lower fuel prices reduce the cost of driving, travel by all types of transit declines. The dispersed pattern of household growth in the inner suburbs and some job dispersal further causes rail transit ridership to fall most precipitously.



Transit Ridership

Transit Origins

More origins per sq. mile in in Baseline — More origins per sq. mile in Free for All

Blue Planet

This third of four scenarios represents a future that is perhaps the most sustainable overall. High fuel prices double vehicle operating costs and stimulate investments in transit and renewable energy. Strong price signals, intentional public policy, and growing preferences for urban lifestyles stimulate additional growth in Baltimore City, and in transit-served areas of the inner suburbs.

Economic growth increases as advancements in technology—especially green technology—overpowers the drag of rising fossil fuel prices. High-technology clusters expand throughout the region, particularly the I-270, Dulles, and Washington-Baltimore corridors.

Local governments accommodate growth by substantially increasing residential capacity in the inner suburbs and somewhat in the outer suburbs, especially around the expanding transit network. The housing market responds modestly with additional development in Baltimore, the inner suburbs, and in the outer suburbs around new transit stations. The dispersal of both jobs and housing along these same employment corridors improves the jobs-housing balance. The net effect on housing prices overall is minimal, with price decreases in the inner suburbs offset by increases in both cores. Insufficient development capacity in the region also results in the substantial deflection of growth outside the region.

As the price of renewable energy falls, zero-emission vehicles become affordable and popular. Stronger economic growth, more employment and households than in the baseline, and high gas prices enable major investments in rail transit infrastructure. Changes in travel behavior are dramatic—growth of vehicle miles traveled rises, congestion is much reduced and transit ridership increases compared to the baseline. These factors yield very large reductions in auto-related emissions and pollution.

Slightly more farm land and more forest lands are developed due to higher overall growth. In particular, forest land is lost as development capacity is exhausted in the region and households move farther out. Nevertheless, nutrient loading is substantially reduced as advances in best management practices and manure-to-energy systems go beyond the effects of Watershed Implementation Plans.

Inputs

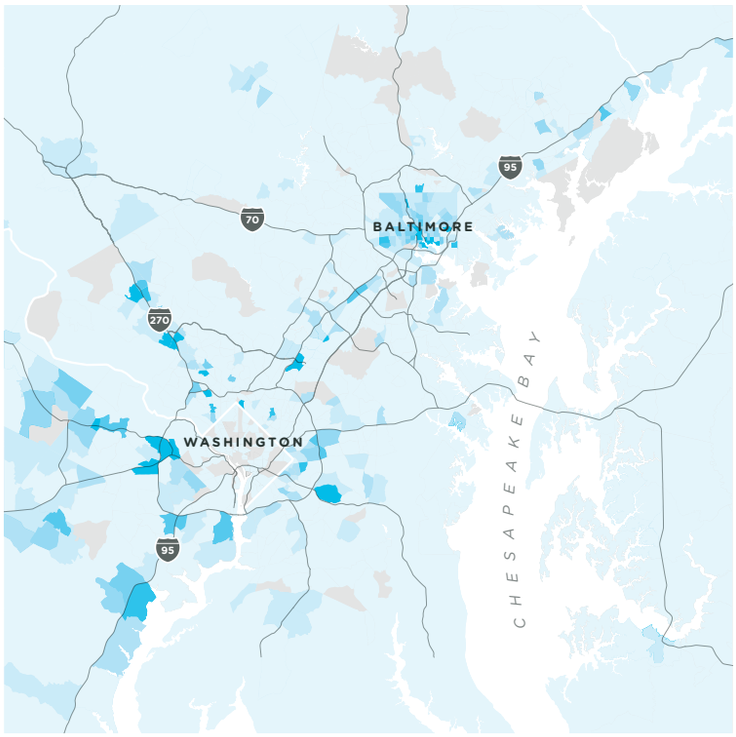
As with all modeling efforts, estimated impacts (outputs) are determined by the assumptions about how the model is structured and the assumptions (inputs) entered into the model. Key inputs include:

- 10 percent more employment growth
- vehicle operating costs double
- ownership of zero-emission vehicles reaches 72 percent
- core employment increases four percent
- development capacity increases 25 percent in existing inner and outer suburban communities
- transit rail miles and number of stations increase 56 percent and 65 percent, respectively
- HVAC replacement and building renovations double
- aggressive best management practices are implemented beyond WIPs; nitrogen loading rates decrease 17 percent on forests, 58 percent on farm land and 43 percent on developed lands

High gas prices + job concentration + much more transit =

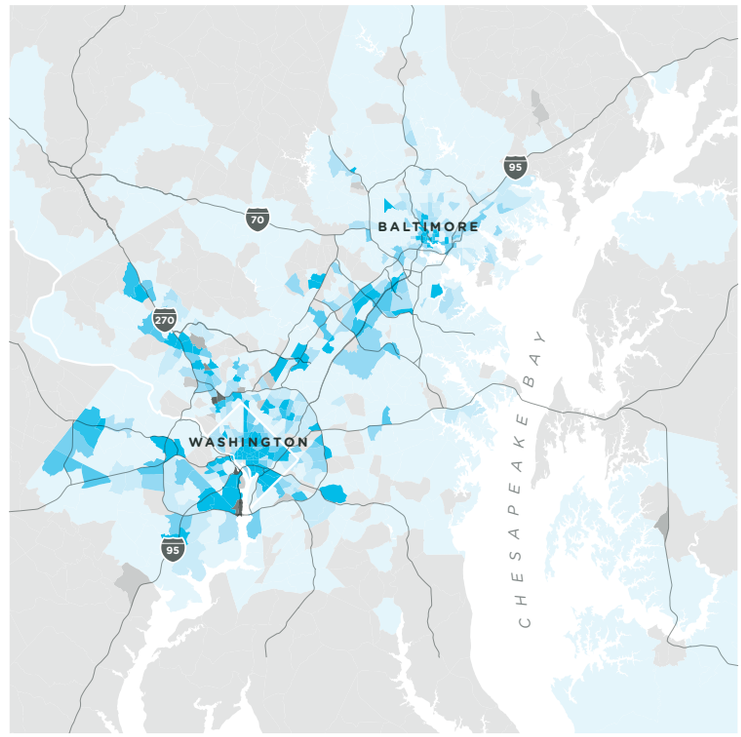
more compact corridors

New jobs are located within the beltways and along existing major job corridors.
New housing follows suit in Baltimore and inner suburbs, especially the Washington suburbs.
Both jobs and housing, now better served by expanded transit, are much more concentrated than in the baseline.



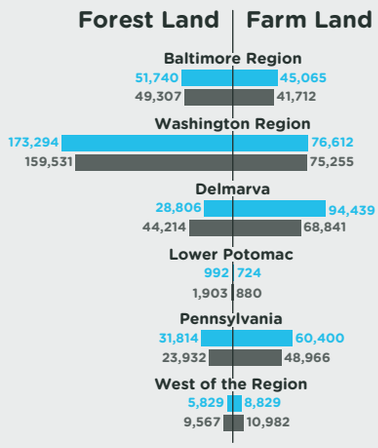
Households

More households per sq. mile in Baseline — More households per sq. mile in Blue Planet



Jobs

More jobs per sq. mile in Baseline — More jobs per sq. mile in Blue Planet

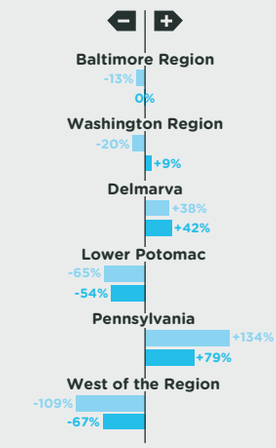


Acreage Lost Since 2015

= Blue Planet (2040)
= Baseline (2040)

Despite faster growth and some forest land loss, best management practices save the day

Faster growth increases land development compared to the baseline, despite a more compact overall growth pattern. In the Baltimore-Washington region, farmland loss increases somewhat, particularly around Washington as the inner suburbs exhaust capacity. Forest loss is greater, as growth leapfrogs preserved farmland into forested areas beyond. Nevertheless, technological advances in nutrient management allows for implementing best management practices beyond the watershed implementation plans, reducing nitrogen and phosphorous substantially, and sediment loading even more.

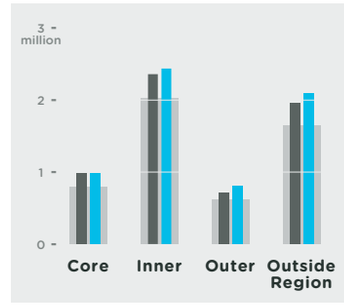


Nutrient Loading

% difference between Blue Planet and Baseline
= Nitrogen = Phosphorous

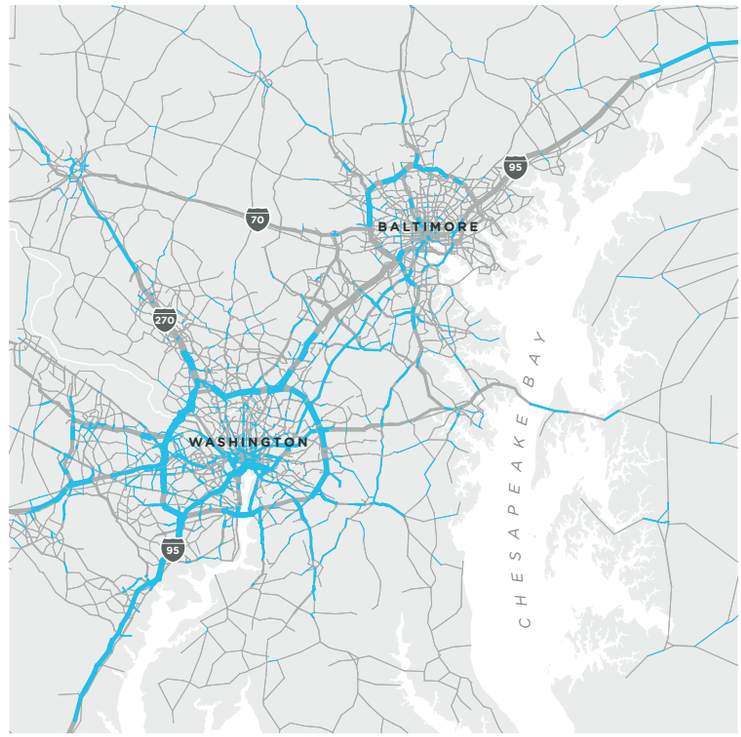
The road less traveled

Doubling travel costs and concentrating jobs along regional corridors shortens vehicle trips, reduces the overall miles and hours traveled, and significantly reduces delays and congestion. Since almost three-fourths of the automobile fleet is zero-emission vehicles, related air pollution declines precipitously. This scenario assumes autonomous vehicles are not adopted before 2040.



HOUSEHOLD LOCATIONS
- = Blue Planet
- = Baseline
- = Existing (2015)

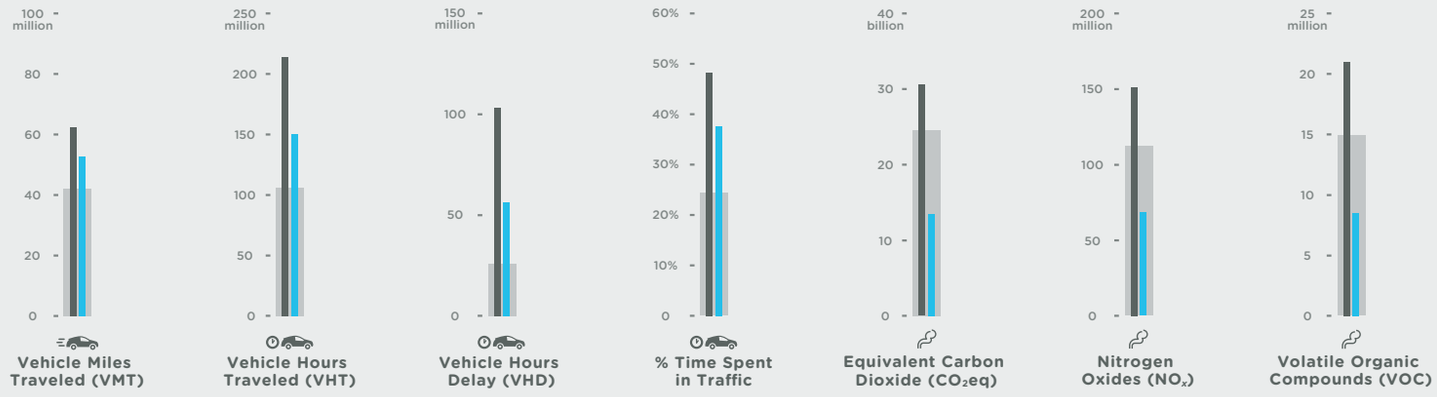
BASELINE SCENARIO



BLUE PLANET SCENARIO

Traffic Volume and Congestion

= Severely congested = Free flowing
Wider lines = Higher roadway volumes



TRAVEL BEHAVIOR **EMISSIONS**

Vehicle Impacts

Baseline
Blue Planet
Existing (2015)

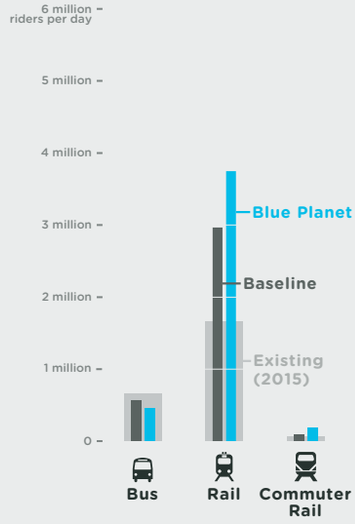
Housing supply constraints negate affordability benefits of more concentrated development

Compared with the baseline, the Blue Planet scenario expands housing capacity significantly in inner suburbs and developing outer suburbs, but not in the cores. The market response is to locate in inner suburbs, but the depletion of the region's core and inner suburban capacity by 2040 drives growth to the outer suburbs. The net effects on housing prices is neutral overall but prices increase in the cores and decrease in the inner suburbs, following standard supply-demand principles.

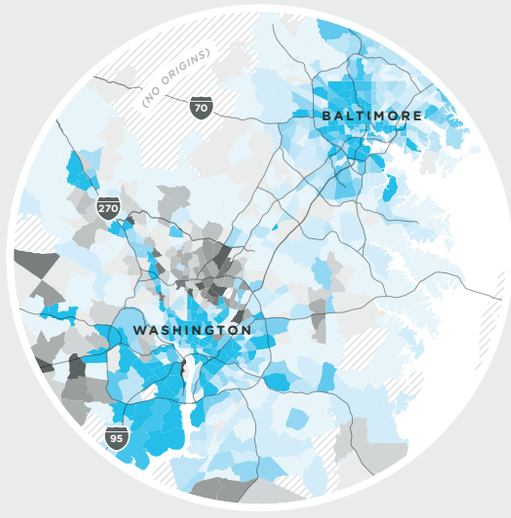
Housing Prices

More expensive in Baseline — More expensive in Blue Planet

Transit Infrastructure



Transit Ridership



Transit Origins

More origins per sq. mile in in Baseline — More origins per sq. mile in Blue Planet

Massive transit investments, diminishing returns

Transit ridership increases 21 percent over the baseline; about half due to the expanded network and half due to high fuel prices. Unlike the baseline, many more transit trips originate in the cores and inner suburbs, with a substantial increase in reverse commutes to transit-accessible inner suburb locations. But there is little new ridership in outlying areas, even with new rail links in Annapolis, Ellicott City, Charles County and Columbia.

Most of the increased ridership is on heavy and light rail, which increase by twenty-six percent over the baseline. Despite high-cost transit expansion and considerable new housing at rail stations, transit mode share only increases to ten percent from the baseline's eight percent. Models might show a further reduction in auto travel, if they included complementary bus feeder networks, a level of detail not captured in our models.

Last Call at the Oasis

This fourth scenario envisions a future defined by scarcity. Declining world oil reserves quadruples gas prices, slows economic growth, lowers real incomes, and dramatically increases the cost of driving. Governments respond with investments in core transit and electric vehicle infrastructure and tighter development controls. Jobs and households grow mostly in already developed areas and near the cores.

The changing structure of the economy, rising gas prices, and strict land use controls direct growth to near the two cores of the region. Both households and jobs concentrate near transit stations with jobs more concentrated in Baltimore City and Washington, DC, with households favoring the inner suburbs. Housing prices decline modestly overall and roughly equally within core, inner suburban, and outer suburban areas but rise outside the region due to strong development restrictions in currently rural areas.

Changes in travel behavior are dramatic. Quadrupled gas prices, the concentration of growth near transit stations, and the continuing investment in rail transit combine to slash auto travel and congestion, including on the Baltimore and Washington beltways. Transit ridership increases significantly. The share of zero-emission vehicles in the automotive fleet rises as local governments offer subsidies and invest in charging stations throughout the region.

Zero-emission vehicles and increased transit ridership dramatically lower greenhouse gas emissions. Considerably less forest land and farm land is developed than in the baseline. This, combined with slower growth and sustained implementation of stormwater regulations, lowers nutrient loadings. Smaller houses, government support for energy efficiency, and more solar energy reduce emissions from buildings.

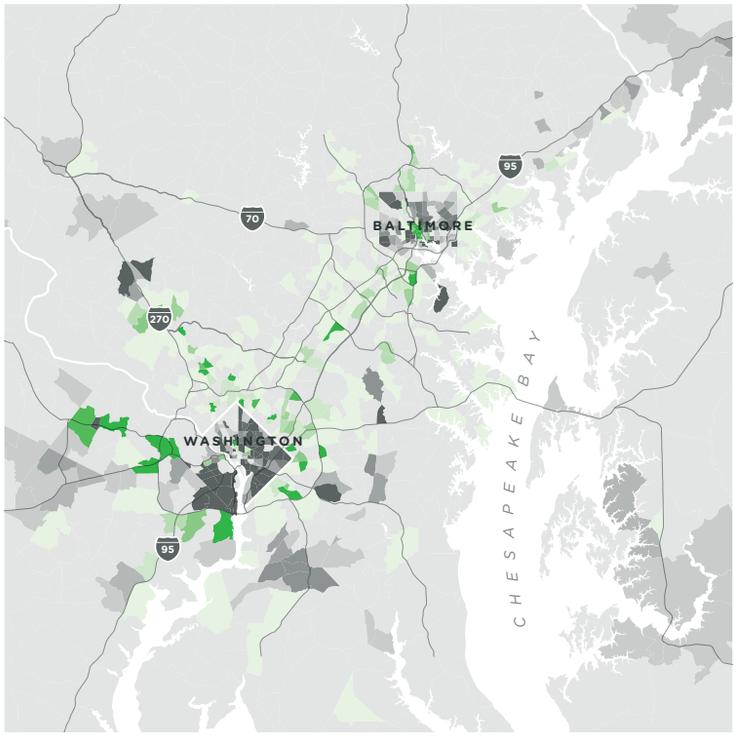
Inputs

As with all modeling efforts, estimated impacts (outputs) are determined by the assumptions about how the model is structured and the assumptions (inputs) entered into the model. Key inputs include:

- 10 percent slower employment growth
- vehicle operating costs are fourfold those of the baseline
- zero-emission vehicles have a substantial penetration of 51 percent
- employment growth is more concentrated in core areas
- no new highway capacity is built, but rail transit miles and stations increase inside the beltways
- development capacity doubles at Metro stations and in the core, but is cut by 75 percent in rural areas
- HVAC upgrades and house renovations to conserve energy occur twice as frequently as in baseline
- jurisdictions fully implement WIPs; nitrogen loading rates decrease seven percent on forest land, 32 percent on farm land, and 26 percent on developed land

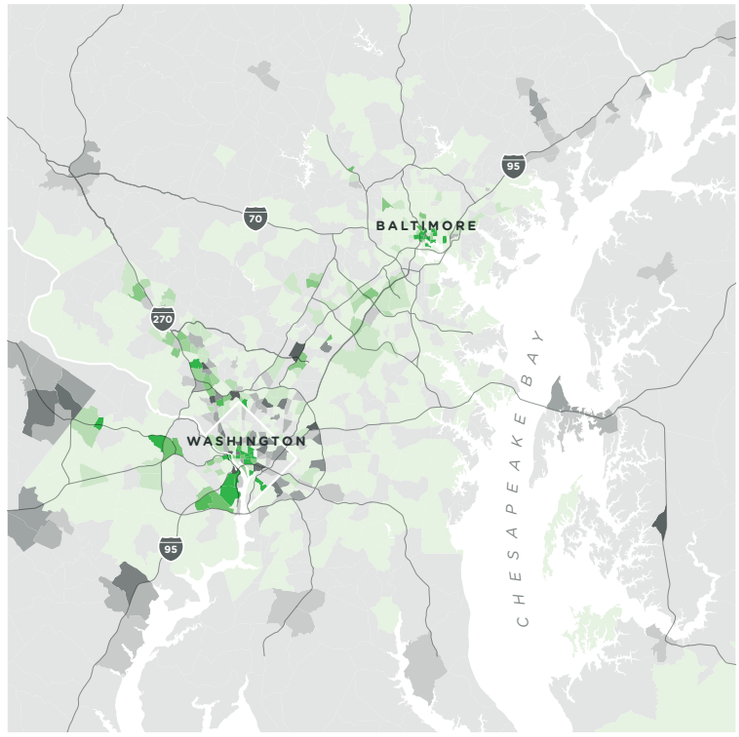
Follow the money

When vehicle operating costs quadruple, travel behavior, and ultimately land use, change in expected ways. Households cluster in the inner suburbs, close to employment and services, and near existing and new rail transit stations. Somewhat surprisingly, households do not cluster in Baltimore City or Washington, DC, despite a significant increase in employment and loosening of development constraints. These core areas fare poorly in competition with transit-accessible inner suburbs with better schools and less crime. Low income household location choices are particularly sensitive to fuel prices.



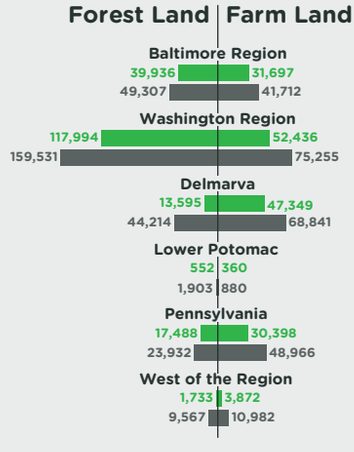
Households

More households per sq. mile in Baseline — More households per sq. mile in Last Call at the Oasis



Jobs

More jobs per sq. mile in Baseline — More jobs per sq. mile in Last Call at the Oasis



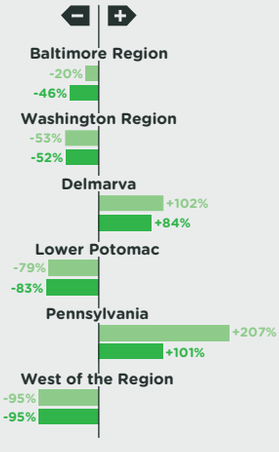
Acreage Lost Since 2015

● = Last Call at the Oasis (2040)

● = Baseline (2040)

Less impact on forest, farms, and water

Because this scenario has six percent fewer households than the baseline, human impacts on the environment are generally lower. Along with fewer households, development in the inner suburbs, rather than in the outer suburbs, significantly reduces forest and farm land development below the baseline in both the region and its surrounding areas. Reduced water pollution from nitrogen, phosphorus, and sediment is widespread and significant.



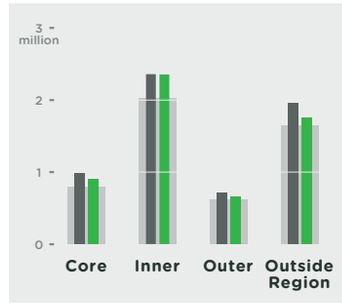
Nutrient Loading

% difference between Last Call at the Oasis and Baseline

● = Nitrogen ● = Phosphorous

Fewer and shorter trips mean much less traffic

Travel behavior is profoundly affected by the fourfold increase in fuel costs, the lack of autonomous vehicles, and the concentration of households in suburban corridors. Vehicle miles and hours traveled fall significantly. Vehicles hours of delay, time spent in traffic, and congested lane miles fall even more rapidly. Despite the modest proportion of zero-emission vehicles in the automobile fleet, auto-related pollution declines by a third compared to the baseline. In the inner suburbs, where most new households locate, emissions decrease slightly. Home heating and cooling efficiencies are significantly improved and building emissions are also reduced.



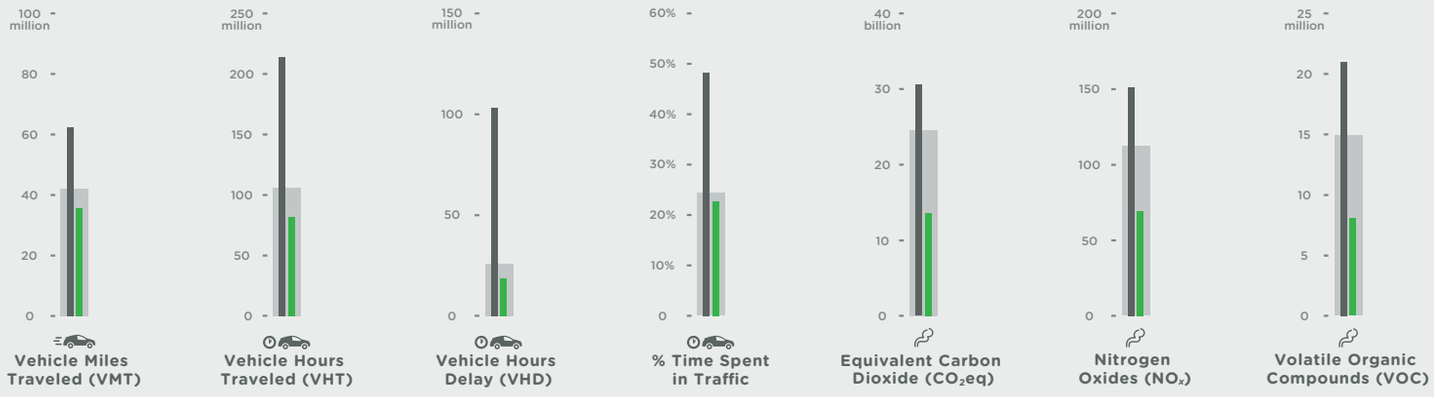
HOUSEHOLD LOCATIONS
= Last Call at the Oasis
= Baseline
= Existing (2015)

BASELINE SCENARIO

LAST CALL AT THE OASIS SCENARIO

Traffic Volume and Congestion

= Severely congested = Free flowing
Wider lines = Higher roadway volumes



TRAVEL BEHAVIOR

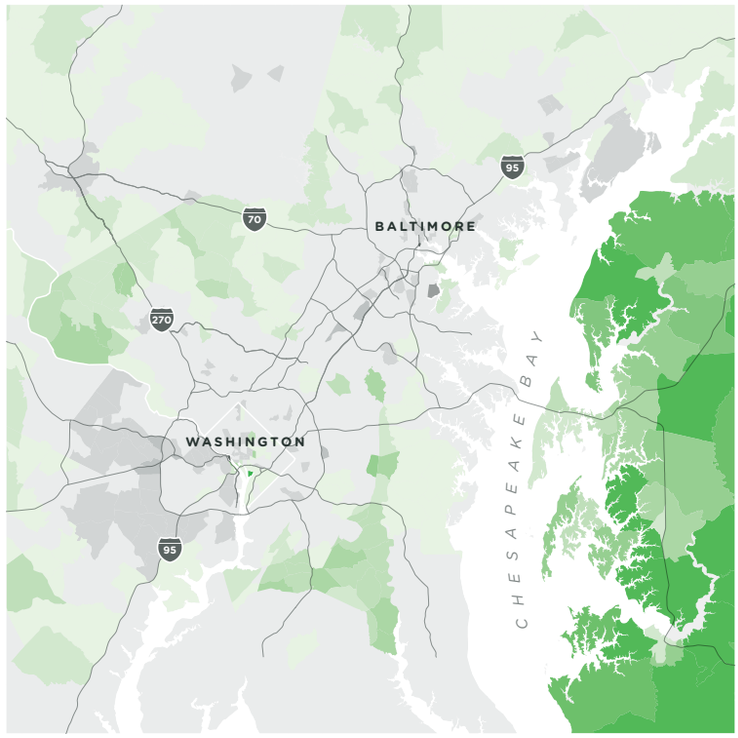
EMISSIONS

Vehicle Impacts

Baseline
Last Call at the Oasis
Existing (2015)

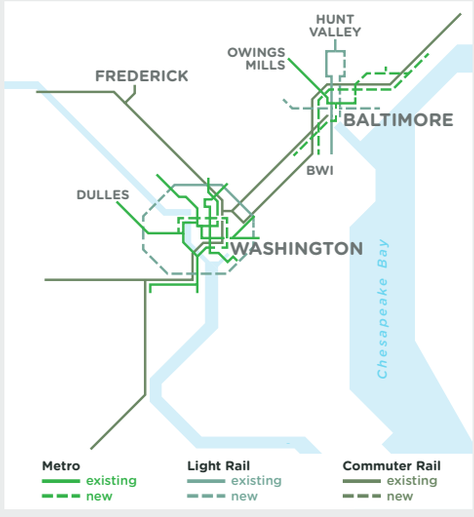
Modest increases in affordability

Housing prices in the region are slightly reduced below the baseline as capacity is increased in the desirable inner suburbs, except in the downzoned outskirts of Montgomery, Prince George's, Howard and Fairfax Counties. Higher housing prices on the Delmarva peninsula reflect demand spilling across the Bay Bridge as development regulations limit the supply of developable land.

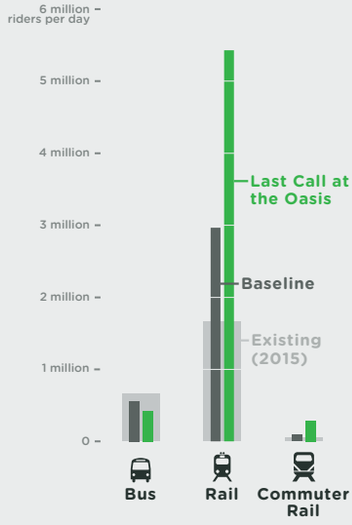


Housing Prices

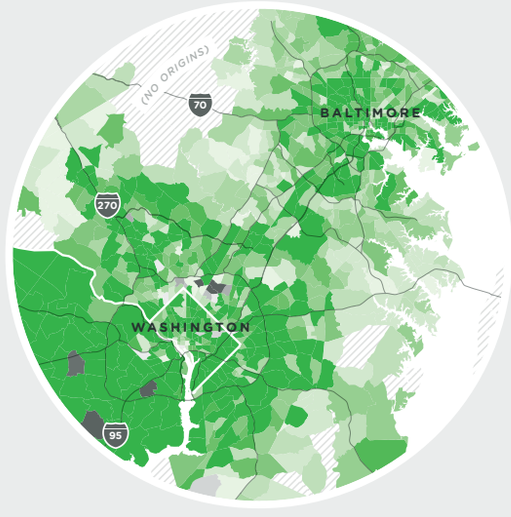
More expensive in Baseline — More expensive in Last Call at the Oasis



Transit Infrastructure



Transit Ridership



Transit Origins

More origins per sq. mile in in Baseline — More origins per sq. mile in Last Call at the Oasis

The rail more traveled

Sustained high fuel prices are the main driver behind a considerable increase in transit ridership—especially by rail. This reflects both the rising cost of driving and bus service and increases in rail and commuter rail transit infrastructure.

Impacts at a Glance

The adjacent table presents 26 scenario outcomes based on key indicators, organized by land use change, mobility, equity, and environment. Most of this information is presented in the individual scenario sections, but seeing the information together, and expressed as percentage change from the baseline, allows comparison and generalization. The scenario footprint diagrams (page 24) present a simplified comparative picture using selected impact indicators.

Total employment and households vary by scenario because their economic assumptions vary. These variations should be borne in mind because they help explain the extent of some of the impacts.

In the tables, Revenge of the Nerds and Free for All are side by side, followed by Blue Planet and Last Call. This sequence reflects their similarities in two of the three scenario drivers. They should thus be expected to show some similar outcomes.

The highest (green) and lowest (red) values across scenarios do not always mean better or worse outcomes. For example, lower greenhouse gas emissions, in red, is a better outcome; but lower transit use, also in red, is a worse outcome. The results should be interpreted carefully. Further, not all gains or losses are comparable. For example, affordable housing advocates may believe that Free for All's significantly lower housing prices would outweigh its downsides. We are in the realm of values and tradeoffs. That said, there are some obvious and overall comparisons among the scenarios.

Last Call at the Oasis has the lowest impacts on most of the indicators, the result of assumptions about quadrupled fuel costs, greater regulatory controls, and slower growth. But the benefits come with costs, given the way this scenario was constructed. At the other end of the spectrum, Revenge of the Nerds has greater air quality impacts than other scenarios, driven by assumptions about low fuel cost and autonomous vehicles. But these vehicles also imply a greater degree of personal autonomy than the other scenarios. As a result, Revenge of the Nerds has the highest household employment and growth rates.

Free for All stands out as generating the least growth beyond the inner suburbs, where most growth is now absorbed due to increased development capacity. Housing prices fall accordingly. This reduction in outward growth can only occur with the development of currently protected farmland.

In Blue Planet, set up to favor a growing green economy, the assumptions of higher fuel prices and zero-emission vehicles produce huge drops in vehicle pollutants. But this scenario also has the second highest farm and forest land impacts, as well as mixed nutrient loading impacts, due to strong regional economic growth.

We next highlight impacts by category.

Impacts

(2040 impacts by scenario vs. baseline)

	RON	FFA	BP	LCO
Total Employment (PRESTO Area)	2%	-2%	3%	-2%
Total Households (PRESTO Area)	7%	-3%	5%	-6%
Land Use Change				
Households in Cores	1%	-17%	1%	-8%
Households in Inner Suburbs	0%	14%	3%	0%
Households in Outer Suburbs	17%	-16%	12%	-7%
Growth outside the region	14%	-11%	7%	-11%
Land Cover				
Forest Loss (1,000s acres)	11%	-12%	8%	-24%
Farmland Loss (1,000s acres)	13%	4%	4%	-28%
Targeted Ecological Acres Developed Upon	10%	-8%	-2%	-25%
Mobility				
Vehicle Miles Traveled	37%	0%	-15%	-43%
Vehicle Hours Traveled	-21%	-8%	-30%	-62%
Vehicle Hours Delay	-78%	-16%	-45%	-82%
Transit Ridership Total	-42%	-26%	21%	70%
Time in Traffic	-72%	-8%	-22%	-53%
Transit Mode Share	-41%	-20%	22%	84%
Equity				
Housing Prices	1%	-23%	0%	-5%
Share Low Income on High Capacity Transit	-2%	-8%	56%	49%
Daily Travel Cost for Low Income Persons	-54%	10%	-70%	100%
Emissions				
Vehicle Greenhouse Gases (lbs of CO2EQ)	20%	16%	-56%	-56%
Nitrous Oxide (lbs)	22%	17%	-55%	-54%
Volatile Organic Compounds (lbs)	8%	12%	-59%	-61%
Building Based Greenhouse Gases (million metric tons)	1%	2%	2%	-2%
Building Based Energy Use (MBTU)	1%	1%	4%	-3%
Nutrient Loading				
New Nitrogen Loading (lbs)	-6%	60%	-24%	-44%
New Phosphorous Loading (lbs)	9%	22%	-27%	-27%
New Sediment Loading (lbs)	-24%	96%	-52%	-74%

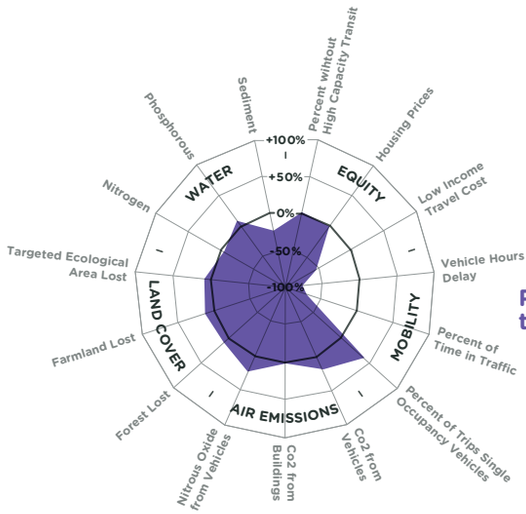
Land Use Change: The SILO model uses land use capacity inputs for both jobs and housing. Job inputs were generated by a Delphi panel of experts on the national and regional economies. Housing inputs were set as percentage increases or decreases in capacity by sub-area, consistent with assumptions about the role of government in each scenario. The models then distribute households and jobs spatially.

All scenario results show that future zoning assumptions direct the location and amount of development capacity and future growth throughout the region. If additional development capacity is opened up in the region's most attractive areas—the inner suburbs that balance strong employment accessibility with good schools and low crime—this capacity will almost certainly be absorbed. In three scenarios, significant new capacity is absorbed by new development in the inner suburbs. This is true both within the developed corridors (as in Blue Planet and Last Call at the Oasis) and in areas that are currently preserved for rural uses (Free for All). Free for All experiences the greatest growth in the inner suburbs by opening up rural preserves to low density development. Though this growth removes farms and forests and provides poor access to transit, it also forestalls leapfrog growth to even more remote locations.

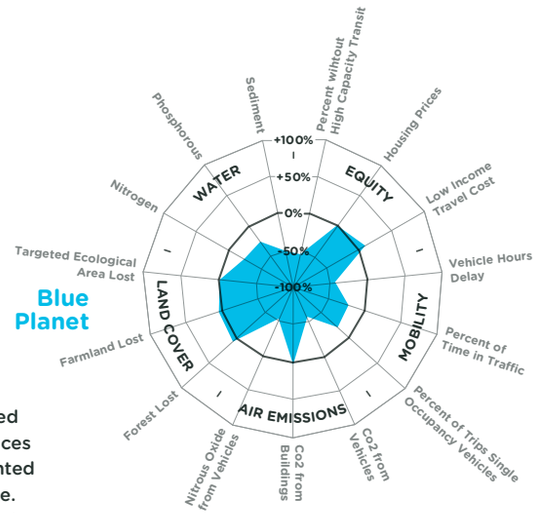
The insufficient capacity within inner suburban jurisdictions directs growth either inward or outward. In both Blue Planet and Revenge of the Nerds, which have higher rates of growth, the outer suburbs and areas outside the region experience significantly higher growth. Revenge of the Nerds has a similar growth trajectory, but one that is more balanced because employment also decentralizes. Blue Planet, however, projects more employment growth in the region's core, creating a problematic mismatch with leapfrogging household development.

Mobility: Autonomous vehicles, vehicle operating cost, and additional transit all have significant impacts on VMT, VHT, VHD, and transit mode share. Revenge of the Nerds shows the most dramatic changes, due to the combination of the lowest operating costs, additional roadway capacity, and behavioral changes from autonomous vehicles. Unsurprisingly residents throughout the region commute farther to work and travel significantly farther overall. But congestion and delays decrease due to the dramatic increase in road capacity.

Unlike Revenge of the Nerds, mobility impacts in the other scenarios are more in line with current transportation patterns, related directly to infrastructure investment and pricing. Sensitivity testing shows that the higher auto operating costs in Blue Planet and Last Call are stronger influences on ridership than additional investments in the transit network. In fact, Last Call induces more transit ridership and lower VMT, despite less transit expansion than



Revenge of the Nerds

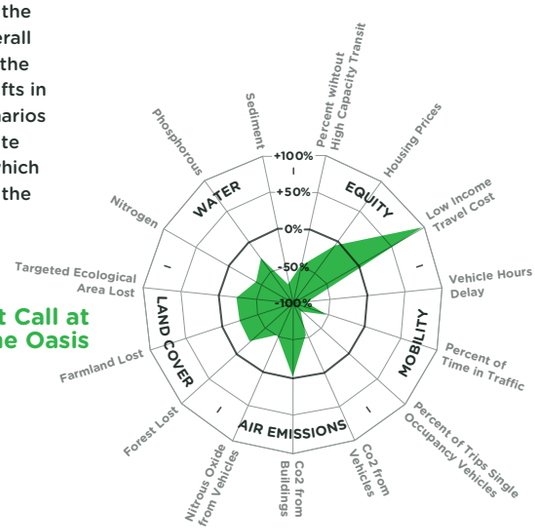


Blue Planet

Scenario Footprints

The four diagrams show 15 selected key impacts as percentage differences from the baseline, which is represented by the darker zero percentage line. This line separates the "plus" or greater impact of any given indicator from the "minus" or lesser impact. As an overall shape, the smaller the footprint of the scenario, the less its impacts. The shifts in percentage within and between scenarios is relatively modest visually, despite strongly contrasting assumptions, which testifies to the difficulty of moving the needle on impacts in a large, mature urban region.

Free for All



Last Call at the Oasis

Blue Planet. In both, the addition of transit is not immaterial, particularly in the region's cores. But Blue Planet's linear expansion of transit outside the beltways only has a modest impact on ridership.

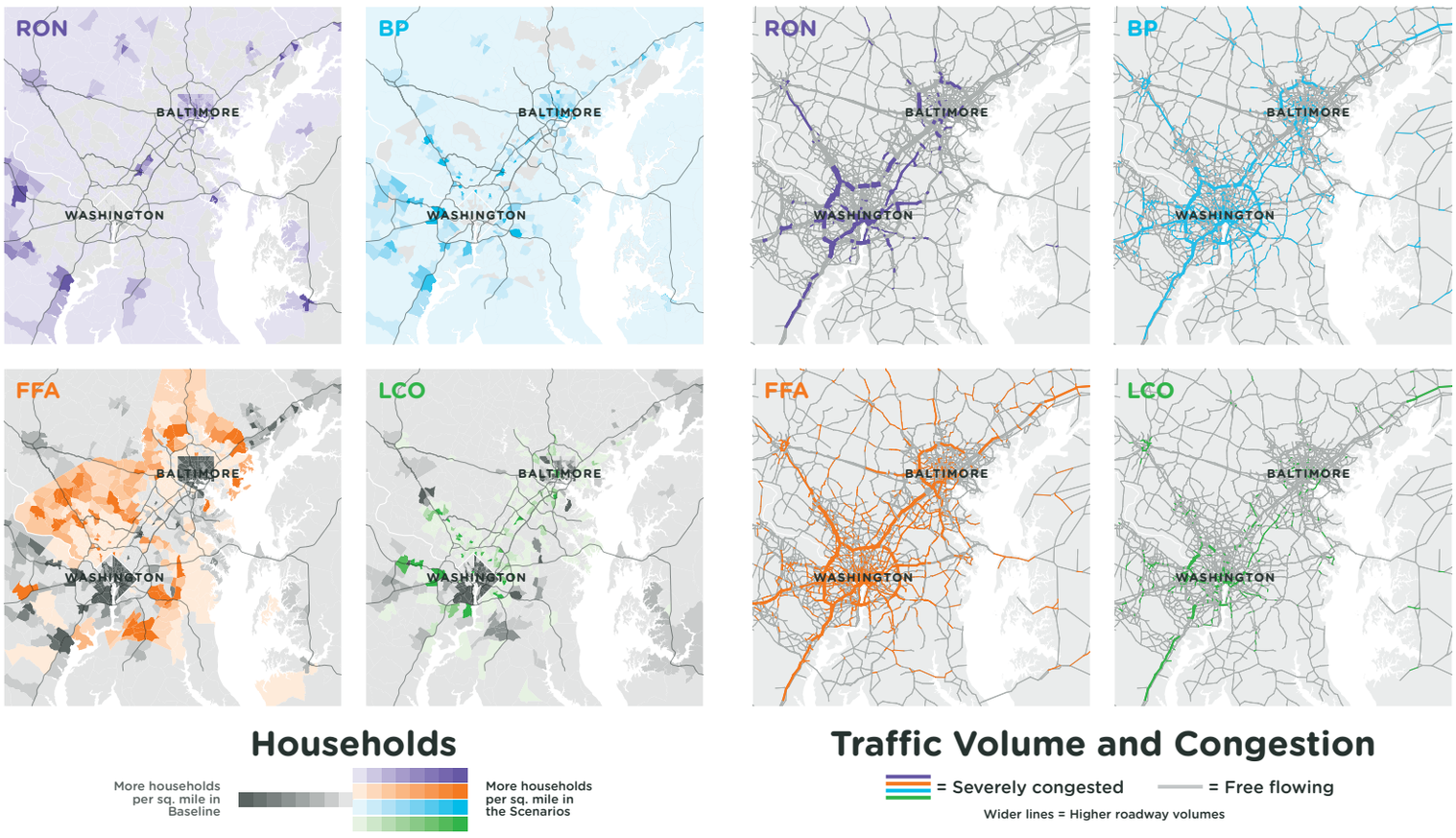
The physical expansion of highway infrastructure also has a limited impact on land use and travel behavior. The over 500 lane miles of additional toll road construction in Free for All expands capacity, but still pales in comparison with the potential capacity increase that autonomous vehicles create. VMT remains similar to the base, increasing only slightly per capita, and congestion is reduced, due to land use patterns that open rural preserves to development. The new toll roads in less populated areas attract few new trips given the ubiquitous un-tolled system.

Air pollution outcomes are determined jointly by changes in travel behavior and the adoption of zero-emission vehicles. Both Blue Planet and Last Call have dramatic positive impacts on all air emissions though for different reasons. In Blue Planet, gas prices are similar to peak US prices in the last decade, but the significant number of zero-emission vehicles reduces emissions. In Last Call, gas prices are similar to European highs, which, combined with a moderate adoption of zero-emission vehicles, also reduces emissions.

In Revenge of the Nerds, emissions are higher than in the baseline, due to increased VMT and despite some zero-emission vehicle adoption. However, reduced congestion mitigates air pollution impacts somewhat. Free for All has similar VMT levels as the baseline but in more polluting vehicles, which predictably increases emissions.

Equity: PRESTO's models incorporate limited measures of equity. Housing prices, produced by SILO, are the key measure. In each scenario, housing prices fall or remain level with the baseline because of changes in development capacity. Additional capacity in the inner suburbs is particularly important for housing prices and has cascading impacts throughout the region. This is particularly illustrated by the different outcomes in Revenge of the Nerds and Last Call. While Revenge of the Nerds increases overall development capacity, much of that capacity is in the outer suburbs and areas outside the region. This allows prices to continue to increase overall at levels similar to the baseline. On the other hand, Last Call provides less capacity than the baseline, but more within the inner suburbs. As a result, prices increase in the downzoned areas outside the region but increased capacity holds down prices slightly in both the inner and outer suburbs. Free for All assumes a dramatic increase in development capacity in the inner suburbs, and has the most beneficial impact on general housing affordability.

Scenarios that increase fuel prices, like Blue Planet and Last Call, also have a regressive impact. This is evident in



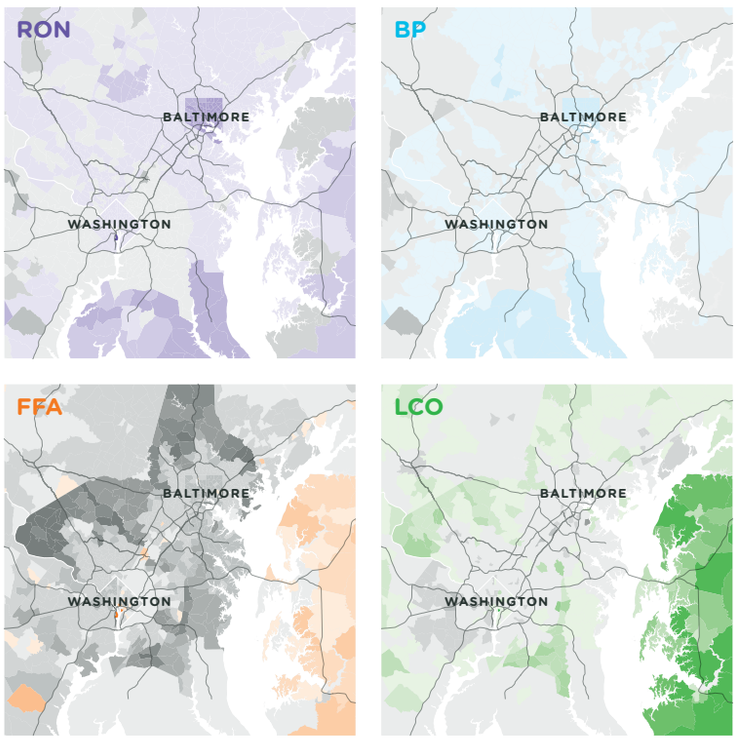
the measure of low income travel costs where Revenge of the Nerds and especially Free for All, have significant equity benefits.

Transit access, as an equity measure, looks at the generation of transit trips from low income households by scenario. Unsurprisingly, Blue Planet, with the greatest investment in transit, results in the highest percentage of low income households living on high capacity transit corridors. Nevertheless, Last Call, with a more core oriented transit expansion, approaches similar transit access levels for low income households.

Environment: Each scenario's growth rate impacts farm and forest land. Both Revenge of the Nerds and Blue Planet have higher overall growth and experience more development on farm and forest land. This is particularly troubling in Blue Planet, which concentrates more growth in already developed inner suburbs, but also induces significant leapfrog growth once capacity in those areas is exhausted. Revenge of the Nerds has a more predictable result, with autonomous vehicles and slightly dispersed employment growth encouraging growth beyond the region's currently developed areas. In spite of their exurban development, both scenarios have mixed nutrient loading impacts. Revenge of the Nerds assumes limited adoption of best management practices which, along with farm land conversion into less polluting suburbs, mitigate the worst nutrient loading impacts. Blue Planet achieves a notable reductions in nitrogen and phosphorus loading with its aggressive implementation of best management practices. These outweigh the detrimental impacts of additional development on forest land.

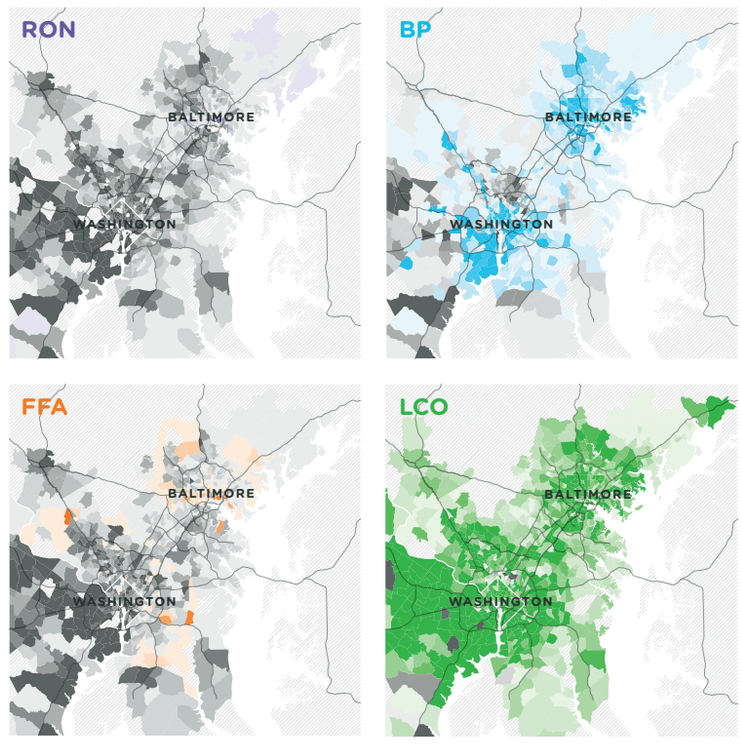
With less overall growth, both Free for All and Last Call highlight the region's critically different paths if best management practices are fully implemented. With less growth on forest land and more growth in rural preserves, Free for All should outperform the baseline. However, its assumption about the failure to execute WIPs results in nutrient loading rates at 2010 levels, causing much higher nitrogen and phosphorous loads. In Last Call, reduced loss of forest land encourages the successful completion of the WIPs, cutting loads from nitrogen and phosphorous in half.

Building-based energy emissions vary by no more than roughly four percent across scenarios. Because more than 80 percent of the 2040 built environment already exists, retrofitting existing structures reduces emissions more than building more efficient new buildings. As such, Blue Planet experiences higher overall emissions and energy use, a result of additional growth, in spite of increased efficiency efforts. Last Call performs the best with slower growth and more frequent building and HVAC renovations.



Housing Prices

More expensive in Baseline — More expensive in the Scenarios



Transit Origins

More origins per sq. mile in in Baseline — More origins per sq. mile in the Scenarios

Implications for Action

What have we learned from these four scenarios that can help us plan for the future?

First and most important is that the region could grow in significantly different ways. The future is uncertain, but also not forgone. Policy matters.

Parsing cause and effect through scenarios with many moving and interacting parts requires extensive sensitivity testing, with some items held constant so that the effect of others can be seen. This kind of testing has not yet been done in a systematic way, but is the next step. However, at this stage, we see that the following factors are truly influential in the analysis.

Development capacity. Because so many regional jurisdictions are close to building out their planned growth areas, decreases or increases in housing capacity by jurisdiction are very influential. Opening development capacity within inner suburban jurisdictions has beneficial impacts on housing prices and the natural environment at a regional scale, at the expense of currently preserved farm land. The diagram opposite illustrates the effects of each scenario on development capacity.

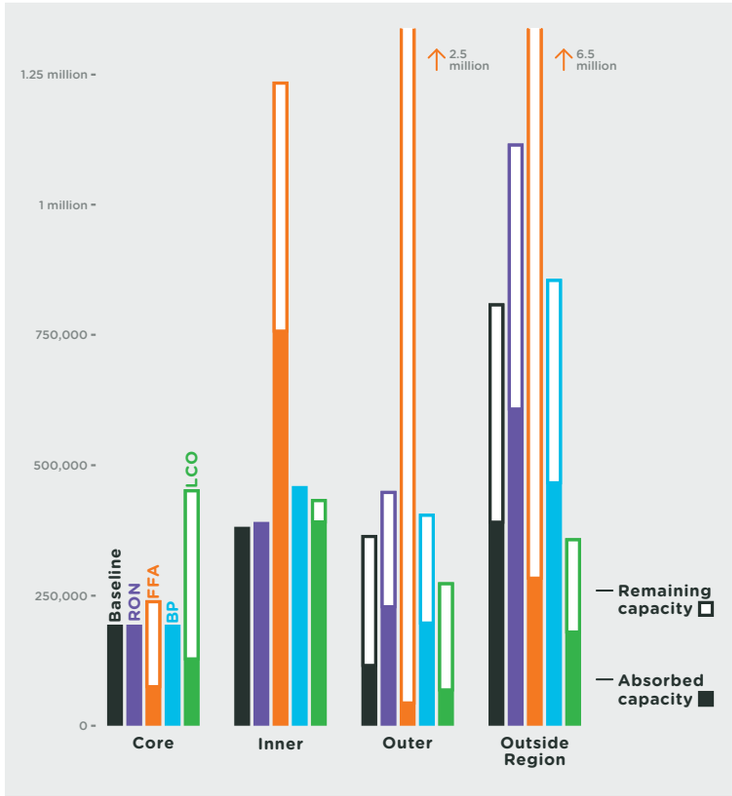
Autonomous vehicles. Aptly termed a disruptive technology, autonomous vehicles could contribute to a very large drop in transit ridership. But before adopting policies in response, it is important to note that PRESTO modeling assumed that all current car owners would own autonomous vehicles without any increase or decrease in car ownership. This means that the potential to share vehicles is not reflected in the outcomes. Similarly, autonomous transit fleets are not included in the modeling. Managing the adoption of autonomous vehicles is a crucial strategic option for managing growth.

Highway and transit investment. The advent of autonomous vehicles raises questions about the logic of massive road investments. Even when funded and tolled by the private sector, as in Free for All, their mere provision doesn't result in heavy use. Similarly, as we have seen, the mere provision of more transit doesn't guarantee more ridership; additional investment in core transit increases ridership but investments outside the beltways are less impactful.

Nutrient loading. Favoring forest land protection over farm land protection reduces nutrient runoff, but here the policy lessons become more complex. Only Last Call dramatically reduces both forest and farm land losses, but it relies on slow growth and more growth controls to achieve these outcomes. Free for All moves in this direction, preserving more forest land and allowing some modest farm land loss as growth moves into the agricultural preserves within the inner suburbs.

Air pollution. We might assume that aggressively implementing zero-emission vehicles will have air quality benefits, but PRESTO doesn't account for the environmental impacts of the additional electricity required or any associated generating technologies. While zero-emission vehicles are cleaner than current internal combustion engines, achieving carbon neutrality will depend on transitions in the energy sector away from the current fuel mix.

Building emissions. As the region continues to grow moderately, retrofitting existing structures will be more critical to managing building emissions than constructing new green buildings, though that should also be pursued.



Development capacity is a measure of the number of dwelling units that can be built in an area. The graph shows the relationship between absorbed vs. remaining capacity by scenario.

PRESTO Team

Uri Avin
Fred Ducca
Dan Engelberg
Sevgi Erdogan
Nicholas Finio
Gerrit Knaap
Rolf Moeckel
Harutyan Shahumyan
And numerous graduate and undergraduate assistants

PRESTO was funded by grants from the Town Creek Foundation and National Socio-Economic Synthesis Center (SESYNC).

The project team would like to thank the following individuals (whose affiliations may have since changed) who provided feedback or advice as a member of our Scientific Advisory Committee or in some other capacity. The project team alone, however, is responsible for all interpretations, opinions and errors.

Marty Baker, Maryland Department of Transportation

Charles Baber, Baltimore Metropolitan Council

Peter Bishop, University of Houston

Don Boesch, University of Maryland Center for Environmental Science

Jamie Bridges, Baltimore Metropolitan Council

Antonio Busalacchi, UMD Earth System Science Interdisciplinary Center

Elliot Campbell, Maryland Department of Natural Resources

Peter Claggett, US Geological Survey, Chesapeake Bay Program

Richard Clinch, Jacob France Institute

Terry Clower, George Mason University

Ted Cochin, Environmental Protection Agency

Christine Conn, Maryland Department of Natural Resources

Paul DesJardin, Metropolitan Washington Council of Governments

Brian Gardner, US Department of Transportation

Mark Goldstein, Maryland Department of Planning

Rachel Healy, Washington Metropolitan Area Transit Authority

Seema Iyer, Jacob France Institute

Mary Kendall, Maryland Department of Housing and Community Development

Todd Lang, Baltimore Metropolitan Council

Jeff Lemieux, UMD Inforum, Interindustry Forecasting

Lewis Linker, US Environmental Protection Agency, Chesapeake Bay Program

Kevin Lucas, Maryland Energy Administration

Arjun Makhijani, Institute for Energy and Environmental Research

Douglas Meade, UMD Inforum, Interindustry Forecasting

Chris Nelder, Rocky Mountain Institute

John Papagni, Maryland Department of Housing and Community Development

Joe Tassone, Maryland Department of Planning

Timothy F. Welch, Georgia Institute of Technology

Jeffrey Werling, UMD Inforum, Interindustry Forecasting

Sean Williamson, UMD Environmental Finance Center

DATA VISUALIZATION + GRAPHIC DESIGN: PASTE IN PLACE

The National Center for Smart Growth Research and Education is a non-partisan center for research and education on smart growth in Maryland, in metropolitan regions around the nation, and around the world. The Center's independent, objective, interdisciplinary research uses the diverse resources of the University of Maryland and a network of national experts to explore issues related to land use and the environment, transportation and public health, housing and community development, and international urban development.

The Center, with the support of the Town Creek Foundation, has developed PRESTO, a futures testing framework to inform citizens, advocacy groups and decision-makers about the major forces that will affect the region's development over the next 25 years. By examining these forces and combining them into scenarios, PRESTO provides a picture of their potential impact, individually and in combination.

For more information on the PRESTO project, data and the models:
www.umdsmartgrowth.org/projects/presto

UNIVERSITY OF MARYLAND

A. James Clark School of Engineering
School of Public Policy
College of Agriculture and Natural Resources
School of Architecture, Planning and Preservation

NCSG