

Building Maryland's Future

The Potential of Transit-Friendly Neighborhoods to Protect Open Space and Reduce Global Warming Pollution



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Cover Photos: Baltimore light rail: Matthew Johnson; development along light rail line and people in rail station: Reconnecting America; Arlington transit-oriented development, Coalition for Smarter Growth.

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Executive Summary

Sprawling development threatens Maryland's last remaining open spaces, while global warming threatens to inundate parts of Maryland's Chesapeake Bay waterfront over the next century and create major disruptions to agriculture, natural systems and human health across the state.

Transit-oriented development – the creation of compact, walkable, mixed-use neighborhoods around transit stations – can contribute to addressing both of these difficult challenges. Transit-oriented development can consume less land than traditional forms of development, reducing the pressure to pave over open spaces. And residents of transit-oriented developments drive much less than residents of sprawling suburban areas, reducing global warming pollution, easing our dependence on oil, and reducing traffic on our roads.

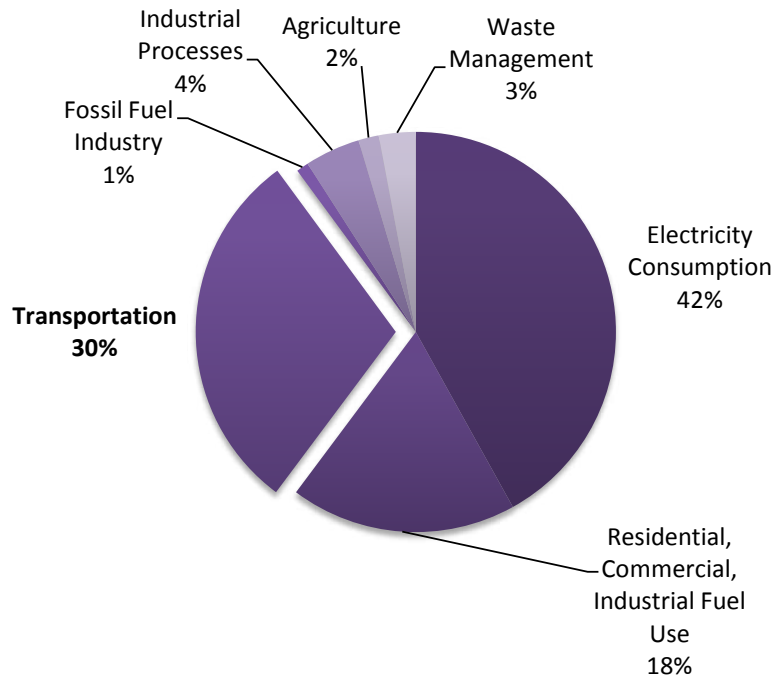
An aggressive strategy to promote transit-oriented development could reduce global warming pollution by at least 740,000 metric tons per year, helping the state to reduce its contribution

to global warming while easing development pressure on Maryland's remaining open spaces.

Sprawling development and global warming are among the most profound threats facing the future of Maryland's environment.

- Since the beginning of 1998, Maryland has converted about 3 percent of its total land area – an area three times the size of Baltimore City – to new residential and commercial development. Virtually all of that development has taken place in previously undeveloped open space.
- Sprawl threatens Maryland's environment in several ways: reducing water quality in the Chesapeake Bay, adding to water supply problems, and damaging Maryland's wildlife and ecosystems.
- The effects of global warming are already visible in Maryland. The state's average temperature has risen

Figure ES-1. Global Warming Emissions in Maryland by Sector, 2007¹



more than 1 degree over the past century. Sea level near Baltimore has risen 7 inches in the past 100 years.

- Without action to reduce emissions, the number of days in Maryland with temperatures higher than 90° F could quadruple over the next century, reaching more than 100 days per year. Sea level is expected to rise 2 feet over the next century – causing more than 350,000 acres statewide to be submerged at high tide. Precipitation is expected to increase by an average of 20 percent, and the intensity of severe storms is expected to worsen.
- Pollution from cars and trucks is a major contributor to global warming in Maryland. In 2005, Maryland’s transportation sector generated 30 percent of the state’s total global warming emissions.

Transit-oriented development (TOD) – the creation of pedestrian-friendly communities built around transit stops – can help to both preserve open space and reduce global warming pollution from transportation.

- TOD uses much less land per resident than sprawl, while providing a higher quality of life. A residential or commercial space can have a footprint up to 90 percent smaller in a compact community than the same square footage in a sprawling development.
- Through a forward-thinking TOD plan, more than 20,000 new residential units have been built in Arlington County in Virginia since 1970 in its Metro corridor, all on redeveloped land. Building the same amount of housing in Maryland, using the current average acreage per new residence, would have required at least 18,000 acres of land.



The planned expansion of rail transit in Maryland would create new opportunities for transit-oriented development. Photo: Reconnecting America

- Focusing new growth in TOD can save hundreds of thousands of acres of forests and agricultural lands. The Delaware Valley Regional Planning Commission in the Philadelphia area estimated that an aggressive strategy to encourage transit-oriented development on existing land could reduce the amount of open space needed for new development by 2035 by 97 percent compared with continuation of current development trends.
- Academic research shows that individuals and families who live in transit-oriented developments drive 20 to 40 percent fewer miles annually than those living in traditional suburban developments – dramatically reducing global warming pollution from transportation.

An aggressive strategy to promote transit-oriented development in Maryland could reduce emissions of global warming pollutants by at least 740,000 metric tons per year – the equivalent of taking more than 140,000 of today’s cars off the road.

- Maryland’s population is projected to grow by nearly 1 million residents, or almost 16 percent, between 2010 and 2030. The Maryland Department of Transportation projects that vehicle travel will increase 34 percent over the same period, producing approximately 3 million metric tons of additional global warming pollution annually by 2030, in a business as usual scenario.
- If 75 percent of new residents in high-growth counties take up

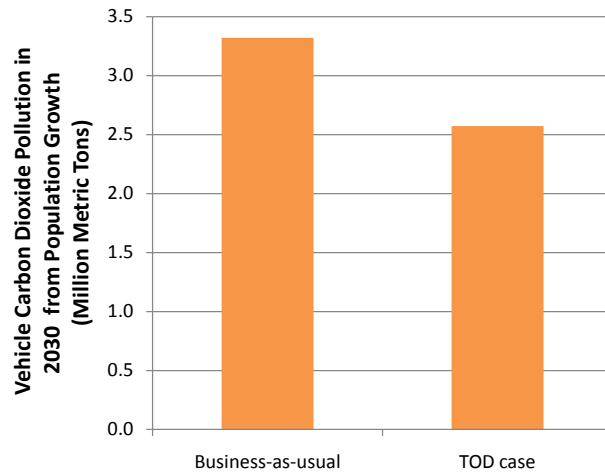
residence in transit-oriented developments between now and 2030, Maryland could:

- Reduce vehicle travel and global warming pollution from these new residents by at least 22.5 percent.
 - Help consumers save least \$300 million per year at the gas pump, and avoid burning 80 billion gallons of gasoline.
 - Reduce traffic congestion on Maryland highways and reduce the pressure to pursue highway expansion projects that contribute to sprawl.
- These benefits do not include the emission reductions and avoided costs that would result from expanding and improving transit service in already-developed areas of the state. Transit expansion, coupled with the development of new centers of activity around transit stations, would provide new transportation options that would enable residents of existing Maryland communities to reduce their driving and curb global warming pollution.
 - Residents want to live in neighborhoods that include elements of transit-oriented development. National demand for compact, walkable development with good access to public transportation is already underserved, and projected to rise well above supply.

To help Marylanders find alternatives to driving, local governments, transit agencies and state government should work together to:

- **Fund transit-oriented development.** Maryland should spend less money on new roads and highways

Figure ES-2. Transit-Oriented Development Can Reduce Vehicle Emissions of Global Warming Pollution from Population Growth in Maryland's 13 Fastest-growing Counties²



In 2030, transit-oriented development would reduce annual car and truck emissions among new residents 22.5 percent against a business-as-usual development baseline.

and provide more resources for the public transportation infrastructure that is part and parcel of transit-oriented development.

- **Plan for transit-oriented development.** TOD should be widely included in plans for the future, whether in transit system planning, city and regional planning, or locating a new state agency building. Establishing and empowering TOD coordinators to shepherd station-area development at state and local levels of government can help make TOD a reality. Increasing funding for public transportation would expand opportunities for transit-oriented development.
- **Offer incentives** for infrastructure that strengthens TOD communities, such as public transportation,

bike paths and pedestrian streets and walkways.

- **Update zoning laws** to emphasize the mixed-use, residential and commercial zoning that is a core element of transit-oriented development.
- **Strengthen and better enforce smart growth laws**, such that the laws encourage transit-oriented development and incorporate TOD into standards for priority funding areas statewide.
- **Integrate TOD principles into the BRAC planning process.** A significant part of Maryland's growth in the coming decades will come from the base realignment and closure process, and planning to build these new communities with TOD in mind should begin immediately.
- **Consolidate land parcels near transit stations** to provide adequate land for planned TOD projects.
- **Reduce minimum parking space requirements.** Not only does TOD reduce driving need, but maintaining large numbers of parking spaces in TOD communities encourages driving and is counterproductive.
- **Support and coordinate with community members and developers** to provide the education, technical assistance and resources that will make TOD projects more straightforward.
- **Share expertise**, such as the experience the Maryland Department of Transportation has developed in planning for TOD and coordinating discussions among multiple government agencies, planners and developers.
- **Lead by example.** By requiring state and local offices to be transit-accessible, Maryland could help better concentrate development near transit stations.

Introduction

The phrase “everything is connected” has become an environmental cliché. But as with most clichés, it is usually true.

Consider sprawling development and global warming – two areas of big concern to Marylanders. One issue is about preserving Maryland’s remaining open spaces from runaway development, the other about forestalling a global catastrophe that would change life in Maryland as we know it forever.

But there are ways that Maryland can address both of these challenges at the same time – while also improving our transportation system and our quality of life. One of the best ways is through the use of transit-oriented development – a form of development that results in compact, vibrant communities with access to transit.

Transit-oriented development has been talked about for decades and already exists in several locations in Maryland. But its full potential can be seen just across the Potomac River from Washington, D.C., in Arlington, Virginia. There, in the 1970s, city leaders had the

foresight to use the planned expansion of the Washington Metro transit system as a catalyst for development in existing business districts rather than as just a conduit for taking suburban commuters to and from D.C. In 1980, Arlington adjusted its zoning standards to promote mixed residential and commercial development around the downtown areas of Rosslyn and Ballston – with compact development patterns near the Metro stations sloping down to traditional, single-family suburban development further away.³

The result has been a boom in development along the corridor – with a quadrupling in the number of jobs and a tripling in the number of residential units. Such focused growth has reduced the already intense pressure to build new, sprawling development in the D.C. exurbs.⁴ But it has also driven changes in traveling behavior that are curbing global warming pollution. Residents of Arlington’s Metro corridors are eight times more likely to take transit to work than the average American and twice as likely to walk.⁵ Fewer than half of the corridors’ residents drive to work or to complete non-work

“The lesson for Maryland is that the state can grow in ways that preserve our quality of life, reduce sprawl, and reduce global warming pollution from transportation, while supporting a healthy economy.”

tasks. All those avoided automobile trips add up to substantial reductions in global warming pollution.

And incredibly, given the fact that the recent growth in Arlington has left

the county with more office space than downtown Dallas or Pittsburgh, automobile traffic on several key streets in the city has actually gone *down* over the last decade.⁶

The lesson for Maryland is that the state can grow in ways that preserve our quality of life, reduce sprawl, and reduce global warming pollution from transportation, while supporting a healthy economy. Promoting transit-oriented development isn't the only thing Maryland needs to do to reduce the impact of transportation on global warming – improving and expanding transit service, among other things, is also critically important. But it can play a key role in Maryland's overall efforts to save our open spaces, curb global warming pollution, deal with congestion, and improve our quality of life.



Walkable and transit-oriented development in Arlington County, Virginia, has spurred growth and kept driving low. Photo: Coalition for Smarter Growth

Land Consumption and Global Warming: Two Threats to Maryland's Future

As Maryland's population grows, sprawling development is consuming vast amounts of land in the state. This inefficient development is eating up cherished open spaces. It also harms Maryland's environment in a number of other ways, and lowers Marylanders' quality of life.

At the same time, Maryland is already beginning to experience the effects of global warming. Science tells us that, unless we take immediate action to reduce our emissions of global warming pollution, those impacts will become increasingly severe over time.

Sprawling Development Is Consuming Our Agricultural and Forest Lands

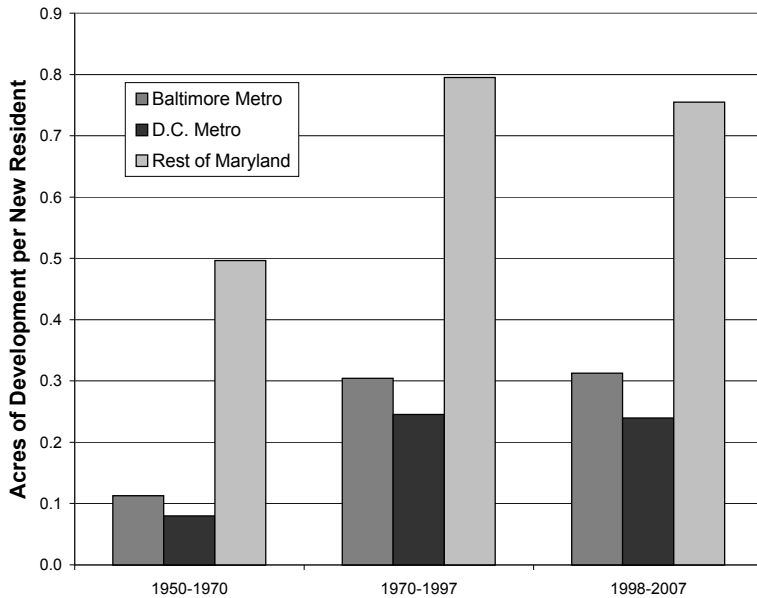
Over the past few decades, Maryland has accommodated our growing population by building outward – creating sprawling new residential and commercial

developments that have consumed vast amounts of open space.

In the past decade, more than 175,000 acres have been consumed for residential or commercial development – an area three times as large as Baltimore City.⁷ In other words, since the beginning of 1998, Maryland has converted about 3 percent of its total land area to new residential and commercial development. Almost all new residential and commercial development in Maryland currently occurs in open space; very few new projects are redevelopment efforts in urban or suburban areas.

Population growth has contributed to this loss of land, but the bigger problem is that Maryland is consuming far more land per person for new development than we did in decades past. Between 1950 and 1970, new residential and commercial development used 0.12 acres per new resident. Since the 1970s, however, new development has averaged about three times as much land, with over 0.34 acres

Figure 1. Land Developed per New Maryland Resident Has Grown Over the Past Half Century⁹



developed per new Marylander between 1970 and 2007.⁸

By 2030, Maryland’s population is projected to grow by about 1 million residents.¹⁰ If growth continues in current development patterns, between 2005 and 2030 Maryland will have lost about 390,000 additional acres of land to development.¹¹

Reduced agricultural land and forests is an emotional loss for Marylanders – many can name a favorite local viewpoint that has been altered due to sprawling development. But sprawling development also has a number of direct and indirect impacts on the environment.

Water Quality

Development increases stormwater runoff into the bay. Development replaces natural pollution filters, such as forests and wetlands, with hard surfaces. Rooftops, parking lots and roadways channel water and pollutants – together known as stormwater – into the streams and

rivers that feed the bay.¹² From 1990 to 2000, development added 250,000 acres of rooftops, parking lots and roadways, a 41 percent increase in impervious surface area in the Chesapeake Bay region.¹³ According to the Chesapeake Bay Program, a multi-state partnership that studies the bay, stormwater runoff is the fastest growing source of bay pollution.¹⁴

Water Availability

When rain and melting snow rush directly into the Chesapeake Bay instead of seeping into the ground, not only does water quality in the bay suffer but drinking water supplies are also not replenished. In addition, sprawling growth increases water consumption – for example, larger lawns are being watered. The water level in the Magothy aquifer that serves southern Maryland has dropped by 90 feet beneath Charles County since 1975.¹⁵ The Maryland Geological Survey estimates that by 2030, the aquifers beneath Charles County will not be able to supply enough water to meet the needs of new homes.¹⁶

Habitat Degradation

Low-density development, and the road network that supports it, breaks up forests, wetlands and meadows, with negative impacts on the number and diversity of plant and animal species. Approximately 60 percent of forestland in the Chesapeake Bay region is fragmented by development.¹⁷ Fragmented habitat means less protection for many animals, especially ground-nesting birds, and increases the likelihood that bird species will disappear from an area.¹⁸ It also makes migration more difficult, and slows regeneration in burned forests and damaged wetlands. Fragmented wetlands also are less effective at improving water quality, flood control, and increasing groundwater supplies.¹⁹

Global Warming Pollution

Poorly planned, spread-out residential and commercial development forces residents to drive everywhere – to take the kids to school, to buy ingredients for dinner, or to get to work – rather than walking or using transit for some trips. Thus, low-density development is one of the factors that results in the long commutes that reduce residents' quality of life and contribute to global warming.

The number of miles Marylanders drive per year has already increased in the past decade, and is projected to continue to grow. From 1997 to 2007, per-capita miles driven per year grew by almost 10 percent, from 9,200 to 10,100.²⁰ By 2030, the number of miles driven per capita in the state is projected to grow to almost 13,000.²¹ To fuel all that travel, Marylanders must consume more gasoline, contributing to a range of problems from increased emissions of global warming pollutants to smog to increased dependence on oil.

Global Warming Threatens Maryland's Future

Marylanders are keenly aware of the impact sprawling development has had on our open spaces and quality of life. Global warming threatens even more dramatic changes in the decades to come if we do not act now to reduce our emissions of global warming pollutants.

The Impact of Global Warming in Maryland

Maryland has already begun to experience the effects of global warming. For example:

- **Maryland is getting hotter and wetter.** From 1908 to 2003, the

average recorded temperature at a weather station in Waldorf rose by more than a degree.²² In other places in the state, even greater increases have occurred. The average temperature in College Park, for example, has risen by 2.4° F in the past 100 years.²³

- **Sea level is rising.** Sea level near Baltimore has risen 7 inches in the past 100 years.²⁴ The net effect of the rising sea and sinking land has been a 1-foot increase in water level in the past 100 years, causing the loss of 260 acres of land each year.²⁵
- **Maryland is suffering more severe storm damage.** Higher water levels in the Chesapeake Bay allow water to be pushed farther inland, causing greater flooding damage, and also increase the strength of waves. In the relatively shallow bay, a 1-foot increase in water level produces a 40 percent increase in wave power.²⁶

If Maryland, the United States and the world continue to emit large amounts of global warming pollution, the state will likely face further, dramatic impacts, including:

- **Temperature and precipitation changes.** The number of days with temperatures higher than 90° F could quadruple, reaching 100 or more per year.²⁷ This could increase the number of heat-related deaths in Maryland by 50 percent during summer heat waves.²⁸ Precipitation is projected to increase by an average of 20 percent.
- **Further sea level increases.** Sea level could rise by more than 2 feet by the end of this century – or up to 4 feet if portions of the ice sheet on Greenland rapidly disintegrate. Statewide, an estimated 380,000

acres of land are less than five feet above sea level and are vulnerable to complete submersion or to inundation during high tides.²⁹

- **Declining water quality.** Through increased precipitation and runoff, global warming may trigger a decline in water quality in the Chesapeake Bay, harming fish and crab populations. Already, nutrient pollution causes algal blooms and areas of oxygen depletion covering more than one-third of the bay each summer.³⁰
- **Loss of plant and animal species.** Higher temperatures and changes in precipitation will alter the mix of plants and animals that can survive in Maryland. Forested areas may shrink or become less dense. Insect populations may thrive as temperatures increase. As plant types change, birds and other animals may have to move northward to find suitable habitat, including the Baltimore Oriole, the state bird.³¹
- **Declining agricultural production.** Higher temperatures and increased precipitation would affect Maryland's \$1.3 billion agriculture industry. Higher temperatures would decrease corn and hay production, while soybean and wheat production could rise or fall, depending on precipitation changes.³²

The precise effects of global warming will be unpredictable and may be sudden. Rising sea level may gradually erode shoreline for years, or a hurricane aimed straight up the bay may create an unprecedented storm surge that destroys land and property not typically considered at risk. An unusually dry and hot year could wreak havoc on the state's drinking water supplies and force the development of expensive alternatives. In other words, the

impacts of global warming will include severe and unforeseen events, not merely a gradual change in current conditions.

The Development-Transportation-Global Warming Connection

Science tells us that in order to avoid the worst impacts of global warming, we must reduce global warming pollution by at least 20 percent from 2006 levels by 2020 and at least 80 percent by 2050. Maryland has wisely committed to a 25 percent reduction by 2020 with the Greenhouse Gas Emission Reduction Act of 2009. In order to meet this short-term target – and the more stringent targets that will be necessary in the long run – Maryland must implement policies that will reduce the state's emissions.

Maryland's transportation system is a major source of the pollution that causes global warming, contributing close to one-third of the state's total carbon dioxide emissions.³³ Implementing strategies to cut pollution from transportation will play a key role in curbing global warming pollution in our state. (See Figure 2.)

The state has also already implemented several transportation policies that will help make significant progress towards reducing global warming emissions. The state's Clean Cars Program, for example, requires automakers to make increasingly cleaner cars and trucks, including some with low to zero emissions such as electric cars. The law will help the state cut projected transportation sector emissions in 2012 by 4 percent, and, because the program's benefits increase over time, by 28 percent (relative to a 2012 baseline) in 2025.³⁵ National fuel efficiency laws and the state's public transportation infrastructure also cut Maryland's transportation emissions.

These steps alone, however, will not provide the kind of transportation-sector

pollution reductions that the state needs to achieve to hit its 2020 goal. Maryland must do more to cut car-related emissions, and one way to accomplish that is simply to help residents drive less.

Population growth in the coming years will present a challenge in Maryland's efforts to control its emissions of global warming pollution. By 2030, the state's population is projected to grow 16 percent, reaching 6.7 million residents. Each resident will need a place to live and a way to get around his or her community, which will require building new communities and transportation infrastructure.

Under current development patterns, the Maryland Department of Transportation expects that population growth by 2030 will cause vehicle travel on state roads and highways to jump to 85.6 billion vehicle-miles in 2030, an increase of 34 percent.³⁶ While population statewide is projected to grow by 16 percent between 2005 and 2030, vehicle-miles traveled (VMT) is expected to rise more than twice as quickly.³⁷ (See Figure 3.) Such an increase in VMT would seriously erode the emission reductions that will be delivered by programs such as the Clean Cars Program, making it that much more difficult for Maryland to do its part in the fight against global warming.

By building compact communities in which driving a car is an option, not a requirement, Maryland can reduce the growth in vehicle travel over the next several decades. A small but growing number of projects in Maryland and elsewhere use the principles of transit-oriented development to deliver these benefits and interest in TOD is growing: the Maryland Department of Transportation is exploring options to implement transit-oriented development at transit stations around the state.³⁹ But to achieve the lasting, long-term reduc-

tions in emissions Maryland will need, compact and transit-oriented development must become the norm rather than the exception.

Figure 2. Global Warming Emissions in Maryland by Sector, 2007³⁴

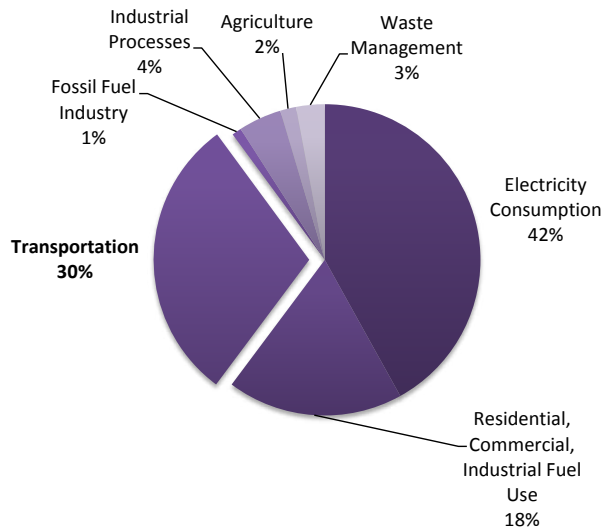
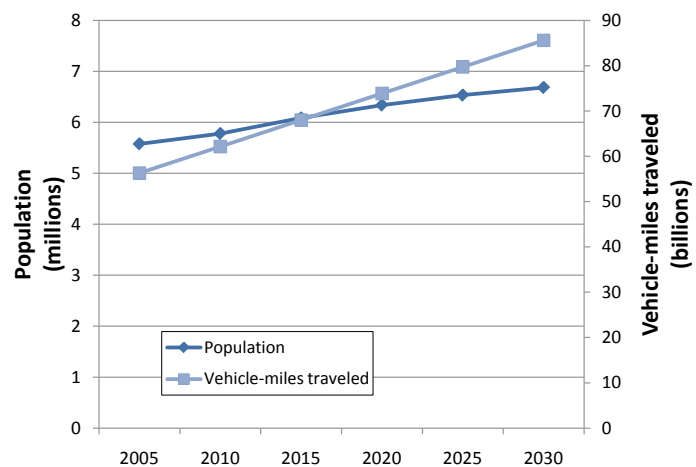


Figure 3. Projections of Population and Vehicle-miles Traveled in Maryland, 2005-2030³⁸



Population and vehicle travel are both expected to rise in Maryland over the next two decades; however, vehicle travel is projected to rise more quickly.

Transit-Oriented Development: Protecting Open Space and Addressing Global Warming

Maryland is growing and will continue to do so over the coming decades. Transit-oriented development is an alternative to sprawl that saves open space and cuts global warming pollution. Transit-oriented development will be an important tool for preserving agricultural land and forests and curbing global warming pollution in Maryland as the state grows.

What Is Transit-Oriented Development?

The economic and social benefits of transit-oriented development, or TOD, have long been valued in Maryland: many older towns and neighborhoods that grew up around trolley lines, such as Bethesda and Chevy Chase, are essentially transit-oriented development. Other Maryland cities, such as Silver Spring, have used some aspects of TOD to redevelop in recent years. But today,

transit-oriented development is poised to add further value to the state as a tool to combat the global warming pollution that threatens Maryland's environment and economy alike.

Transit-oriented development is a familiar sight to many Marylanders. TOD constructed near rail stations can include residential, office and retail space and has a design that offers multiple travel options, including walking, driving and transit. Closest to the rail station are small shops – a grocery store, a dry cleaner, a bookstore or flower shop – and restaurants, often on the ground floor of office or apartment buildings. Beyond this nucleus are townhouses or free-standing homes on small lots. In the broader neighborhood beyond are often traditional, single-family suburban developments.

Living in a transit-oriented development has become an increasingly popular choice for people tired of long commutes or the relative isolation of



Areas such as Silver Spring have used their proximity to public transportation to fuel the redevelopment of formerly struggling downtown areas. Photo: Bill Holmes

traditional suburban developments. The popularity of transit-accessible neighborhoods with shops and services within easy walking distance of homes is demonstrated through lower vacancy rates and increased home sale prices. A widely respected forecast of real estate investment predicts that “markets served with mass-transportation alternatives and attractive close-in neighborhoods” will be increasingly desirable “as people strive to make their lives more convenient.”⁴⁰

Transit-oriented development benefits towns and cities, too. As the population has shifted to outlying areas, the tax base in older towns and cities has declined, making it harder for those places to support schools, maintain parks and libraries, and provide basic city services. Attractive urban places draw retailers and residents, increasing economic activity and boosting property values. Moreover, TOD can

save state and municipal dollars, since sprawling development also raises the cost of infrastructure (such as sewer lines and streets) 20 to 40 percent above infrastructure costs of denser development.⁴¹

Maryland already has rail transit – the Metro in areas surrounding Washington, D.C., the light rail and subway in Baltimore, and commuter rail between the two cities – but too many train stations are surrounded by parking lots and empty space rather than serving as centers of neighborhood activity. Local and county governments can seize the opportunity presented by these stations. Growth plans that envision development near rail stations, zoning to facilitate that vision, and assistance for developers in creating a community with housing, offices, and shops are among the steps that can lead to more than just parking lots near rail stations.

Population Growth: A Problem and an Opportunity

Maryland is growing today, and is expected to grow even more in the coming years. In just two decades, between 2010 and 2030, the state's population is projected to grow by nearly 1 million residents, or roughly 16 percent.⁴² Moreover, 84 percent of this growth is expected to happen in just 13 of Maryland's 24 counties, primarily on the western shore of the Chesapeake Bay, and around metropolitan areas such as Annapolis, Baltimore and Washington, D.C. These counties include: Anne Arundel, Baltimore City, Baltimore, Carroll, Cecil, Charles, Frederick, Harford, Howard, Montgomery, Prince George's, St. Mary's and Washington counties.⁴³ Growth will be largest in Montgomery, Frederick and Prince George's counties, where new residents will account for nearly 40 percent of statewide population gain.

With the prospect of concentrated population growth, Maryland has an important opportunity to refocus the way that it develops. Rather than continuing down the road of wasteful, polluting and unhealthy sprawl, new, smarter growth can help make communities more sustainable – and more enjoyable for their residents. By anticipating large growth in specific jurisdictions, the state and its counties can plan new communities around town centers using principles of transit-oriented development, including mixed-use zoning and public transportation. Doing so will save open space and reduce global warming pollution, as well as yield additional benefits to Marylanders.

Moreover, the compact neighborhoods that characterize transit-oriented development are popular today, and demand for them is expected to rise even higher in the near future. A 2007 study by researchers at the University of Maryland's National Center for Smart Growth and the Urban Land Institute, for example, shows that 55

percent of Americans would prefer to live in compact, walkable communities if given the choice between that and conventional sprawling developments. The study further shows that demand for attached housing and housing on small lots will rise to more than double the 2003 stock of those houses by 2025.⁴⁴

Adopting Transit-Oriented Development Can Protect Land in Maryland

Emphasizing transit-oriented development could save thousands of acres of Maryland's open space.

One important way in which transit-oriented development reduces land consumption is by reducing the amount of space that must be dedicated to automobiles. Because they have other choices for getting around, residents of TOD communities own fewer cars. People living and working in smart growth areas own 10-20 percent fewer cars and make 20-40 percent fewer vehicle trips.⁴⁵ That means less space devoted to sprawling parking lots and roads.

In residential development, the combination of multi-story buildings with fewer parking spaces and driveways adds up to a significant reduction in the area used to house people. The footprint of comparably sized buildings, such as a 1,250 square-foot residential building – including the building, driveway, and parking space – is 29-88 percent smaller in a compact community than in a sprawling development.⁴⁶ Reduced space between buildings and narrower roads lower TOD's land use impact even further.

The same is true for commercial development and office space in TOD communities. Multi-story buildings take up less room while providing the same amount of business space. In mixed-use

developments near transit stops, employees and shoppers are more likely to walk, bike, or take transit to businesses, and the remaining cars are often parked more efficiently in structures or underground lots. A 1,000 square-foot commercial space in a medium-density urban area has a footprint 33-90 percent smaller than one located in an area of sprawl.⁴⁷

The reduced footprint of transit-oriented developments can add up to quite a lot of land preserved.

The Delaware Valley Regional Planning Commission (DVRPC) projected land use in eight counties surrounding Philadelphia under three scenarios through 2035 – one that emphasized transit-oriented development in areas that had been previously built-up, one that continued current trends, and one with accelerated rates of sprawl.⁴⁸

They found that development patterns would have an enormous impact on land use in the Delaware Valley, with the same projected population and employment numbers. Under the “trends” scenario, 169,000 acres of land would be newly developed between 2005 and 2035. In the “sprawl” scenario, development would be even more extreme – 478,000 acres would be developed in the 30-year period. Under the “recentralization” scenario, however, only 5,800 acres would be developed during this time period.⁴⁹

Arlington County in Virginia has already demonstrated TOD’s effectiveness at saving space while encouraging new development. Since 1970, almost 20,000 housing units have been built in Arlington’s Metro corridor – in addition to over 15 million square feet of office space, which accommodates almost 70,000 new jobs. All of this development has occurred on previously developed land.⁵⁰

Arlington’s residents also own far fewer cars than residents of more sprawling counties. In neighboring Fairfax County, 96 percent of residents own at least one

“The reduced footprint of transit-oriented developments can add up to quite a lot of land preserved.”

car, and 67 percent own two or more. In Arlington, 88 percent of residents own at least one car, and fewer than 40 percent own two or more.⁵¹

If these housing units had instead been built as single-family homes with the average parcel size Maryland has seen over the past decade, this development would have eaten up at least 18,600 acres of open space.⁵² This doesn’t include additional area for less well-planned commercial development, as well as additional roads and parking spaces.

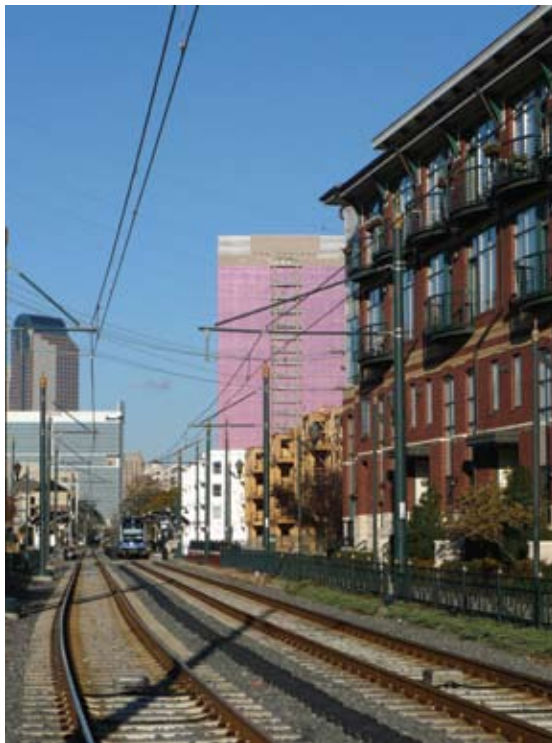
Compact communities with a mix of shops, housing, schools, and businesses where residents can easily walk, bike, or take transit wherever they regularly go are more than just nice places to live. Encouraging this sort of growth can save large areas of forest and farm land that would otherwise have been bulldozed to make way for sprawling suburbs, strip malls and parking lots.

Adopting Transit-Oriented Development Can Cut Global Warming Pollution in Maryland

Since a significant portion of Maryland’s global warming pollution comes from fossil fuel-burning automobiles, providing transportation options that don’t require the use of cars is an essential tool for cutting global warming

“Transit-oriented development cuts vehicle travel by changing the type of transportation that consumers demand, emphasizing public transit, walking and biking as opposed to car travel.”

pollution. Transit-oriented development cuts vehicle travel by changing the type of transportation that consumers demand, emphasizing walking, biking and public transit as opposed to car travel.



Cities such as Charlotte have encouraged compact, mixed-use development adjacent to new light-rail lines, creating attractive new transit-oriented neighborhoods. Photo: Reconnecting America

TOD Reduces Dependence on Cars

In a community built as transit-oriented development, demand for automobiles shrinks for several reasons. First, residents' homes are closer to the businesses, schools and offices that they frequent, allowing them to walk or bike back and forth in a timely way, rather than get in their cars for short trips around town. Wider sidewalks, as well as bike lanes and bike paths, encourage residents to use nonmotorized options. To the extent that residents still have to drive, the locations they travel to are, by and large, closer.

Second, homes are also closer to public transportation services, providing cost-effective and time-saving ways to travel longer distances. Longer-distance subway, light rail service, or express buses, for example, can also be combined with local-route buses to provide convenient mobility to residents in a wider area. Finally, residents of denser, transit-oriented developments tend to own fewer cars per household.⁵³

The benefits of TOD have been documented since the early 1990s, and a number of studies have quantified the driving reductions that result from transit-oriented development in various communities around the country. A 1994 study of four different metropolitan areas and one rural county in California, for example, showed that families living in a community twice as dense as a “baseline” community reduced their driving by an average 25-30 percent per household. The study assumed that households in denser areas had access to the amenities of dense development: shorter distance to shopping centers, better public transportation, and “a more pedestrian-friendly environment.”⁵⁴

In a different study, the California Department of Transportation found that TOD reduced vehicle travel by 20-

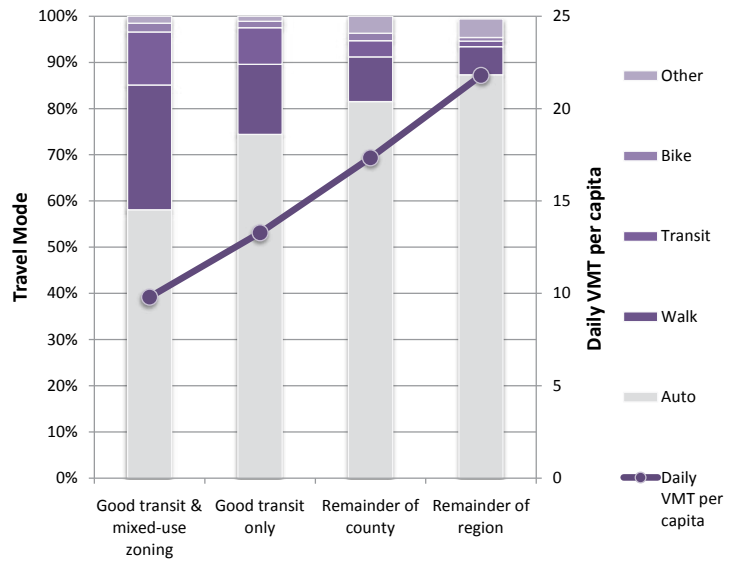
40 percent annually, per household, for people who lived, worked or shopped near transit stations.⁵⁵ For residents of TOD neighborhoods, TOD resulted in a 25 to 30 percent VMT reduction per household.⁵⁶ A 2003 meta-study examining the collective results of other TOD studies found that VMT decreases by between 15 and 30 percent when the density of a community doubles.⁵⁷

Additionally, the California study found that TOD can result in a 5 percent decrease in regional VMT.⁵⁸ The availability of public transit in TOD neighborhoods, in other words, changes the travel behavior of more people than just TOD residents alone. Some residents of outlying communities will be willing to drive to public transit to save time and money on longer commutes, while visitors will use transit to get to the community, for instance to go shopping. TOD can thus result in additional, region-wide vehicle travel reductions as well.

Importantly, it is the three-way combination of mingling residential and commercial zoning (“mixed-use zoning”) and providing more and better public transportation options and making communities more pedestrian-friendly that makes transit-oriented development unique and useful in cutting VMT. Not only have studies shown that TOD reduces driving, but they also show that TOD is more effective in cutting vehicle-miles traveled

“TOD is more effective in cutting vehicle-miles traveled (VMT) than either mixed-use zoning or access to transit alone.”

Figure 4. Land Use Impacts on Travel Mode Share and Vehicle Travel in Portland, Oregon⁶⁰



Residents of transit-oriented neighborhoods tend to drive significantly less and rely more on walking and public transit than residents of other neighborhoods.

than either mixed-use zoning or access to transit alone.

For example, a study of Portland, Oregon, by Gloria Ohland and Shelley Poticha of Reconnecting America demonstrated that public transportation alone can reduce daily VMT, while a combination of mixed-use development and public transportation caused daily VMT to decrease even further. (See Figure 4.) In the study, access to public transit caused a 23 percent decrease in daily VMT, while a combination of public transit and mixed-use zoning led to a total daily VMT decrease of 43 percent.⁵⁹

TOD Can Cut Global Warming Pollution in Maryland

Adopting transit-oriented development on a broad scale in Maryland can make a significant contribution toward achieving the state’s goals for reducing

global warming pollution. If, for example, a large majority of the new residents in Maryland's fastest growing counties found housing in transit-oriented developments between 2010 and 2030, the state could reap key pollution savings.

Transit-oriented developments could easily accommodate the 800,000 new residents expected in these counties by 2030. The Center for Transit-Oriented Development estimates that transit-oriented developments in suburban neighborhoods typically have at least 12 housing units per acre of land, and good policy can ensure this level of density persists for a radius of roughly ½ mile around each transit stop.⁶¹ The development experiences of Arlington, Virginia, and Silver Spring indicate that this level of development is possible over the two decades between today and 2030.⁶² The potential density of housing in urban transit-oriented development is even higher.

Currently, there are approximately 109 transit stations in Maryland.⁶³ As of 2004, more than 430,000 Marylanders lived in census "block groups" (a geographic area smaller than a census tract containing up to several thousand residents) within a half-mile radius of a transit station.⁶⁴ Assuming that transit-oriented development could achieve an average density of 12 housing units per acre, these areas could theoretically accommodate an additional 600,000 residents at Maryland's average of 2.41 people per housing unit.⁶⁵

With plans for at least three major transit lines (Red Line, Purple Line and Corridor Cities Transitway) underway, it is possible that roughly 50 new stations will be added in Maryland by 2030.⁶⁶ Some of these will be located in densely developed areas, but many will be placed in suburban neighborhoods or the centers of commuter towns. The areas around these new stations could accommodate as many as 725,000 residents. Assuming that



The proposed expansion of Maryland's transit networks – including the Baltimore light rail system – creates new opportunities for transit-oriented development.

Credit: Matthew Johnson

these areas have the same potential for population growth as those around existing transit stations (a very conservative assumption), TOD in new station areas could accommodate more than 400,000 new residents.

In total, Maryland's current and existing transit stops could house roughly 1 million new residents, more than the total expected population growth in the state's 13 fastest growing counties – in transit-oriented developments. This estimate is a rough cut at the potential of transit-oriented development to house new residents in Maryland, but it clearly demonstrates that an aggressive program of transit expansion and TOD creation can accommodate future growth.

Assuming that 75 percent of the projected new residents of Maryland's 13 fastest-growing counties are accommodated in transit-oriented developments – and that the average resident of a new TOD would drive 30 percent less than they otherwise would – the impact of a policy to encourage TOD would be significant.

Each of Maryland’s 13 largest-growth counties would experience a 22.5 percent reduction in driving by new residents – reducing congestion on highways and curbing demand for highway expansion projects that would be costly and lead to more sprawl.

By 2030, Maryland would reduce carbon dioxide pollution by at least 740,000 metric tons annually – the rough equivalent of taking more than 140,000 of today’s cars off Maryland’s roads.⁶⁸

While these savings are appreciable, they also represent savings for just one year. Community planning begins to have an impact on people’s habits as soon as communities are built and inhabited – changes which will begin to happen long before 2030, and which will continue to accrue benefits long after 2030.

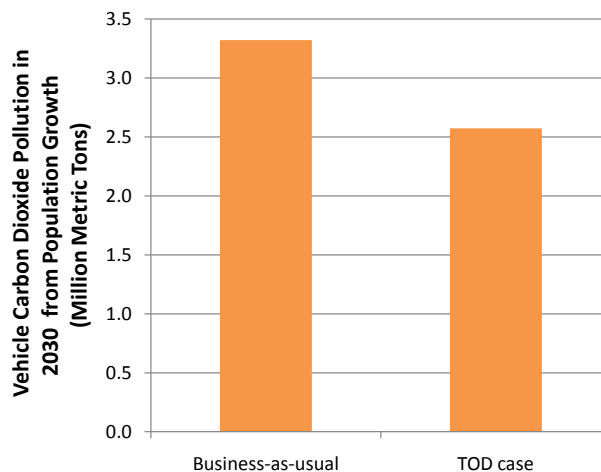
Moreover, these calculations underestimate global warming pollution savings in several ways:

1. They assume a 30 percent reduction in VMT for individuals living in transit-oriented development. Some studies show that this percentage could actually be 44 percent or higher, yielding significantly greater emission reductions.
2. They include only the emission reductions generated by new *residents* of TODs. In fact, compact growth near transit stations and better access to more transportation options have the potential to impact the travel habits of *all* the residents of a given county, and even beyond. This happens for several reasons:
 - Residents of existing developments near new TODs will likely find more jobs, services, entertainment and travel options within walking distance or a short drive from their homes.⁶⁹ Longer-term residents of existing communities are thus also likely to reduce their

driving. This impact is difficult to quantify accurately given existing data sets, so it has been omitted from this analysis. However, the driving reductions – and therefore global warming pollution savings – that result from TOD are likely to be far greater than these figures convey.

- Commercial development near TOD reduces commute-related VMT for non-residents of the area. One California-based study, for example, found that workers whose offices were located within a half mile of a transit stop were three times more likely to use transit when compared to a regional average.⁷⁰ In other words, by locating more jobs near transit lines, more workers will have the option of using transit for their commutes, regardless of where

Figure 5. TOD Can Reduce Vehicle Emissions of Global Warming Pollution from Population Growth in Maryland’s 13 Fastest-growing Counties⁶⁷



In 2030, transit-oriented development would reduce annual car and truck emissions among new residents by 22.5 percent compared with a business-as-usual development baseline.

they live in a given metropolitan area.

3. They assume relatively constant costs of driving over time. Living in a TOD community may become more appealing as a result of an increase in driving costs, and more long-term Maryland residents may elect to move into transit-oriented developments.
4. They do not account for the impacts of transit expansion. Expanding transit service reduces VMT whether or not it occurs as a part of transit-oriented development (see Figure 4, page 21), and would lead to reductions in global warming pollution, as some residents of existing communities trade in their car commutes for the opportunity to take transit.

Transit-oriented development is therefore likely to produce significantly greater global warming pollution savings than predicted in this report, and to be a useful contributor to overall global warming pollution mitigation for Maryland.

Additional Benefits of TOD

Beyond cutting global warming pollution, the reduced driving that results from transit-oriented development also provides a series of additional benefits for consumers, public health and the economy.

For example, driving reductions that could result from TOD in Maryland's 13 fastest growing counties by 2030 would also reduce other tailpipe emissions from cars, improving air quality and cutting emissions that lead to respiratory illnesses in children and adults.

A second impact of reduced driving is reduced roadway congestion. Data from the latest INRIX National Traffic Score-

card show that a small decrease in driving produces a large drop in congestion: in 2008, a 3 percent drop in national highway travel resulted in a 30 percent drop in peak-hour congestion, and a 36 percent drop in off-peak congestion.⁷¹ By helping to reduce driving, transit-oriented development could also help Maryland address the congestion problems that have given its residents some of the longest commute times in the nation and waste more than a billion dollars every year.⁷²

Further, transit-oriented development can diminish our dependence on oil and help consumers save money at the gas pump. In 2030, for example, TOD could help the new residents of Maryland's 13 largest-growth counties avoid burning more than 80 billion gallons of gasoline, saving over \$300 million.⁷³

Transit-oriented development builds healthier communities, cuts pollution and saves consumers money. But, while these many additional benefits are certainly attractive for the short-term, the benefits of transit-oriented development for cutting sprawl and reducing global warming pollution may well prove to be the most valuable.

Benefits of Transit-Oriented Development

- Reduces land consumption
- Reduces global warming pollution
- Cuts traffic congestion
- Decreases oil dependence
- Saves consumers money

Policy Recommendations

Maryland has great potential for transit-oriented development and should pursue the creation of projects that capitalize on the state's full potential. Capturing this potential, however, will require concentrated efforts by local governments, the state, and transit agencies. Each has a role to play in promoting TOD, in ensuring that TOD is as straightforward for a developer to pursue as a typical single-use suburban fringe development, and in shaping projects to achieve the greatest benefit from valuable transit stations.

Recommendations for Local Governments

Because of their power to establish zoning, draft growth plans, and allocate funds, Maryland's towns and counties can play a crucial role in promoting TOD.

Create a TOD Coordinator

Planning and completing a TOD project involves coordinating the work of many public agencies and requires community involvement. A TOD ombudsman – someone within local government who has experience in planning, development, finance, and public participation – can help developers surmount the many hurdles that accompany unusual or complicated projects. The coordinator would also help resolve community concerns and ensure that the completed project is integrated into surrounding neighborhoods.

Incorporate TOD into Growth and Spending Plans

A town or county's growth plan should incorporate TOD into the area surrounding each transit station. The first steps include identifying the TOD potential at each station and creating a general vi-

sion for what development should occur at which station. Later versions can include a specific vision for what should be included near the station, establish a review process for approving a development plan, and identify priority components of the project. This will help ensure the rail station is connected to the immediate area, not isolated by parking lots or heavily-traveled roads, and that the TOD neighborhood fits in with the larger community.

Another aspect of planning for TOD is to include TOD in spending proposals. Counties can anticipate funding requirements of roads and other public infrastructure. Budgeting should include elements necessary to support TOD, such as sidewalks, public buildings, and open space. Federal funds such as from the Congestion Mitigation and Air Quality program may be available to help.

In 2009, local governments gained the power to use tax-increment financing for TOD projects. They should actively seek opportunities to use that authority.

Zone for TOD

County governments can adjust zoning regulations to promote good development near rail stations. While zoning itself cannot ensure that the best use is made of land near transit, it can clear the way and rule out less-beneficial projects. Land near transit stations should be zoned for more development than property several miles away. Regulations should allow neighborhoods to contain a variety of retail and residential options and perhaps commercial office space. Vertical mixing – residential units built above ground-floor stores – allows the greatest integration of the different uses. By establishing zoning standards conducive to building TOD, counties signal their willingness to support TOD and reduce potential delays for developers who would otherwise have to seek variances to land use guidelines.

Reduce Parking Requirements

An especially important aspect of zoning regulations is parking. Typically, suburban zoning regulations establish a minimum number of spaces that must be provided with each 1,000 square feet of retail or office space or per bedroom in residential units; regulations do not cap the number of spaces. The situation near rail stations is very different from a car-oriented setting and parking minimums can be counterproductive. Further, a development with intermingled homes, shops, and offices can reduce parking needs by relying on shared parking, in which spaces are used by residents at night and shoppers during the day.

Mandating that developers include extensive parking in any project near a rail station creates several obstacles. First, parking is costly. Surface parking can cost \$1,500-\$3,000 per space and garage parking \$12,000-\$20,000 per space. This drives up the price of the development, a problem for both the developer and for people seeking affordable housing.⁷⁴ Second, it can increase vehicle traffic around the station, making it more hazardous and less appealing for people to walk to the station. Abundant parking may encourage people to drive to the station even when they could walk and thus the availability of transit will not help reduce traffic congestion or air pollution. Finally, the land nearest to a rail station is the most valuable. Filling it with a parking structure does not capture the full value of that space.

Though developers and lenders initially may be reluctant to reduce the amount of parking at a site, fearing it will deter customers, they will soon learn that with good transit options nearby there is less need for extensive parking.

Recommendations for Transit Agencies

Transit agencies like the Washington Metropolitan Area Transit Authority (WMATA), in Washington, D.C., and the Maryland Transit Administration, which operates Baltimore's light rail, subway and buses, can promote TOD through a number of approaches. Each has already undertaken elements of the recommendations below but should do much more.

Plan for TOD

TOD should be included in all plans for system expansion, from consideration of where a line is placed to consultations with local governments to shape land-use regulations. Such advance planning will ensure that a mix of jobs, housing, and retail is available at stops throughout the transit system and will boost ridership.

Assist with Land Assembly

Transit agencies can help provide adequate land near a transit stop for a planned TOD project. Many agencies own extensive amounts of land. If agency land is not available, the authority can help assemble multiple properties into one piece. WMATA, for example, operates a public/private joint development program to encourage development on WMATA-owned land.⁷⁵

An alternative to purchasing dozens of small parcels to create space for the development is to form a partnership of all current landowners who would be affected. A partnership allows current community members and building owners to benefit from development of the station area and gives them a voice in how their community will change. It can also encourage creation of a shared vision, simplifying decision-making on development plans.

Adopt TOD-Consistent Policies

Once land is available, adopting TOD-friendly policies for agency-owned property reduces barriers for good private development projects. Requiring extensive commuter or retail parking at transit stations, for example, makes projects more expensive for the developer and harder for pedestrians to navigate. Policies that allow for less than full replacement of parking lost to development may make a project more economical for the developer while enhancing the transit-oriented nature of the neighborhood.

Recommendations for the State

Steer Funding to TOD

Recent legislation has cleared the way for the state to help facilitate the construction of TOD projects. In 2008, the General Assembly approved a bill to allow the Maryland Department of Transportation to use money from the Transportation Trust Fund for improvements of all sorts that help to realize transit-oriented developments. Now it is time to follow through on that authority and fund planning and engineering, streetscape improvements, roadway modifications, and other projects that make individual developments possible.

MDOT should also make adjustments to the system for transportation funding allocation decisions. Entities seeking state funds should be required to demonstrate that their proposals adhere to smart growth principles. TOD and other smart growth developments should be the norm, not the exception, for the use of limited state dollars.

Methodology

A main goal of this report was to calculate the amount of global warming emissions in Maryland that could be avoided by the use of transit-oriented development. We made this calculation confined by a set of limitations and using a set of assumptions designed to yield reasonable yet conservative savings projections. These limitations and assumptions are detailed by category in the sections that follow.

Broadly, however, we had to make two key decisions: 1) Over what time frame would we calculate emissions savings, and 2) for which portion of Maryland's population?

First, we calculated savings for a "snapshot" year, 2030. We assume that TOD in Maryland would be phased in over time, providing benefits well before 2030 and well after. The year 2030 was chosen both because it is at the end of the time horizon for the Maryland Department of Planning's population projections and because it provides enough time to fairly capture the impacts of the long-term changes in

development patterns that would result from expansion of TOD.

Second, we applied global warming pollution savings only to residents of 13 counties: Anne Arundel, Baltimore City, Baltimore, Carroll, Cecil, Charles, Frederick, Harford, Howard, Montgomery, Prince George's, St. Mary's and Washington counties. We selected these counties because the Maryland Department of Planning projects that they will experience the largest growth by far over the 2010 to 2030 period: each county is expected to grow by at least 30,000 residents. Each of the remaining counties in Maryland is expected to grow by an average of approximately 8,300 residents, with the largest growth by far in Wicomico County (growth of 21,450 residents). These counties were also chosen because they possess existing transit infrastructure or could be reasonably anticipated to have significant transit service in the foreseeable future.

Third, we attributed global warming emissions savings from TOD to *new* resi-

dents of TODs in the 13 counties. TOD will also deliver emission reductions by reducing driving among residents of existing Maryland communities. However, the broader regional impact of TOD has been less thoroughly studied than the impact on TOD residents. As a result, the broader impact of TOD for residents of existing communities – while likely very significant – was not included in this analysis.

Finally, we assumed that TODs would accommodate a number of residents (roughly 800,000 people) equivalent to 75 percent of the population growth in each of the 13 counties described above between now and 2030.

Baseline Assumptions

In order to create a reference scenario against which we could compare savings, we estimated the global warming emissions from automobiles driven by new residents of the 13 counties in the year 2030. To derive this number, we used vehicle-miles traveled (VMT) projections, made assumptions about the fuel economy of cars in 2030, and used a standard emission rate of carbon dioxide pollution per gallon of burned gasoline.

VMT Projections

Maryland does not project VMT on a per-county basis, but rather estimates a statewide VMT figure. It arrives at this number, 85.6 billion miles in 2030, by “extending the line”; that is, by calculating the historical rate of year-to-year VMT increase and applying it to each year through 2030.

We created county by county per-capita VMT projections by applying the statewide rate of VMT per-capita increase between 2005 and 2030 to 2005 VMT data by county.

Fuel Economy

In order to calculate emissions, we had to determine how much fuel would be used, which is dependent on the fuel economy of vehicles. The Energy Information Administration of the federal Department of Energy projects a national average light-duty fleet fuel economy of 28.87 miles per gallon in 2030.

Emissions from Gasoline

To calculate the global warming (carbon dioxide) emissions that would be generated by new Maryland residents’ vehicle travel in 2030, we used the Environmental Protection Agency’s emissions rate of 19.6 pounds of carbon dioxide per gallon of gasoline.

We did not include emissions of other global warming pollutants, such as nitrous oxide, in our analysis because carbon dioxide makes up by far the largest proportion of global warming emissions from tailpipes.

Gasoline Costs

We calculated gasoline cost baseline and savings based on the federal Energy Information Administration’s 2009 national price forecast for motor gasoline in 2030, which is \$3.88 per gallon in 2007 dollars. Given that gasoline prices rose far above this in 2008, have been somewhat volatile since, and are likely to continue to rise as world oil demand increases faster than world oil supply, the gasoline cost savings presented here are likely to grossly underestimate actual possible savings in 2030.

Emissions Savings as a Result of TOD

Based on a review of existing TOD studies (presented in the body of this

report), we concluded that residents of TOD communities in Maryland would be likely to reduce their VMT by 30 percent. Several studies demonstrate reductions of 40 percent or more, and, with thoughtful and rigorous implementation, further reductions seem likely. A 30 percent re-

duction is therefore conservative.

We applied a 30 percent reduction to the total projected VMT in 2030 of the 13 counties' new residents, and performed the same calculation as described for the base-case above to arrive at an emissions figure.

Appendix

Projected population growth, vehicle-miles traveled and automobile-based carbon dioxide emissions from new population in Maryland's 13 fastest-growing counties, baseline and TOD case, in 2030.

County	Projected population growth, 2010 to 2030	Projected vehicle-miles traveled by new residents in 2030, baseline case	Carbon dioxide emissions from cars and light trucks of new residents in 2030, baseline case (metric tons)	Projected vehicle-miles traveled of new residents in 2030, TOD case	Carbon dioxide emissions from cars and light trucks of new residents in 2030, TOD case (metric tons)	Emission reductions due to TOD, 2030 (metric tons)
Anne Arundel	52,500	753,770,656	232,081	584,172,258	179,863	52,218
Baltimore City	32,850	236,538,948	72,829	183,317,685	56,442	16,386
Baltimore	47,250	634,744,034	195,434	491,926,626	151,461	43,973
Carroll	34,800	344,411,941	106,042	266,919,254	82,183	23,860
Cecil	51,150	840,359,996	258,741	651,278,997	200,525	58,217
Charles	59,250	702,852,823	216,404	544,710,938	167,713	48,691
Frederick	98,100	1,713,243,200	527,497	1,327,763,480	408,810	118,687
Harford	35,150	429,094,366	132,115	332,548,133	102,389	29,726
Howard	42,150	756,067,489	232,788	585,952,304	180,411	52,377
Montgomery	175,000	1,795,371,262	552,783	1,391,412,728	428,407	124,376
Prince George's	98,000	1,306,431,710	402,242	1,012,484,576	311,738	90,504
St. Mary's	46,100	506,398,163	155,917	392,458,576	120,835	35,081
Washington	40,500	764,313,771	235,327	592,343,172	182,379	52,949
TOTAL	812,800	10,783,598,359	3,320,201	8,357,288,728	2,573,156	747,045

Notes

1. Includes in-state emissions and emissions from out-of-state created by consumption in Maryland, such as emissions from electricity consumption. Maryland Commission on Climate Change, *Climate Action Plan*, 27 August 2008, Appendix C.
2. Assumes 75 percent of growth per county will use principles of transit-oriented development, yielding 30 percent vehicle-miles traveled reductions in these areas. Assumes 19.6 lbs CO₂ emitted per gallon of burned gasoline. For detailed information, see Methodology. Population data: Maryland Department of Planning, Planning Data Services, *Historical and Projected Total Population for Maryland's Jurisdictions, Revisions*, December 2008. VMT data: Maryland Department of Transportation, *2009 State Transportation Plan*, January 2009, 6. Car and light truck fuel economy projections from U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2009, Table 59 Light Duty Vehicle Miles per Gallon by Technology Type*, December 2008. Available at www.eia.doe.gov/oiaf/aeo/supplement/index.html, Transportation Demand Sector.
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48. Delaware Valley Regional Planning Commission, *Making the Land Use Connection: Regional What-If Scenario Analysis*, September 2008.

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51. Ibid.

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53. See note 44.

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60. Ibid.

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62. In Arlington, the Rosslyn-Ballston corridor added roughly 5,000 housing units per transit station between 1970 and the present; Silver Spring added 2,700 TOD

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63. Based on geospatial data from U.S. Department of Transportation, Bureau of Transportation Statistics, *National Transportation Atlas Database 2009*, downloaded from [www.bts.gov/publications/national_transportation_atlas_database/2009/National Transportation Atlas](http://www.bts.gov/publications/national_transportation_atlas_database/2009/National%20Transportation%20Atlas), 9 December 2009.

64. Based on population data contained in ESRI, ArcMap 9.2.

65. 2.41 people per housing unit from U.S. Census Bureau, *State & County Quick-Facts: Maryland*, downloaded from www.census.gov, 9 December 2009.

66. The Red Line is expected to produce anywhere between 13 and 25 stations; the Purple Line will likely create roughly 11 stations in Maryland, and plans for the Corridor Cities Transitway include 25 possible stations. From Sarah Payne, et al., Maryland PIRG Education Fund, *Making Tracks: The Case for Building a 21st Century Public Transportation Network in Maryland*, April 2009. TOD integration at 75 existing transit stations from Maryland Department of Transportation, *2009 State Transportation Plan*, 21 January 2009.

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71. INRIX National Traffic Scorecard, *2008 Annual Report*, February 2009. Available at scorecard.inrix.com/scorecard/pdf/INRIX%20NTSC08%20Executive%20Summary.pdf.

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