MONTGOMERY COUNTY PLANNING BOARD
THE MARYLAND-NATIONAL CAPITAL PARK AND PLANNING COMMISSION

March 1, 2022

The Honorable Gabe Albornoz
Council President
Montgomery County Council
Council Office Building
100 Maryland Avenue, 4th Floor
Rockville, Maryland 20850

Re: **Planning Board Comments on Bill 3-22, Legislative Branch – Climate Assessments - Required**

Dear Council President Albornoz:

On February 24, 2022, Montgomery County Planning Department staff briefed the Montgomery County Planning Board on Bill 3-22, Legislative Branch – Climate Assessments – Required. Given that this bill would create a new requirement for the Office of Legislative Oversight (OLO) to produce climate assessments of zoning text amendments, master plans and master plan amendments, which fall under the Planning Board's review as land use advisors to the Council, Planning staff asked the Planning Board to provide comments on the bill in time for the public hearing on March 1, 2022.

The Planning Board and Planning Department have a strong commitment to addressing climate change through innovative recommendations in Thrive Montgomery 2050, our master plans, regulatory reviews of development projects, environmental guidelines, and other planning initiatives. However, the Board is concerned that a new requirement for OLO to produce climate assessments for master plans is duplicative of an existing statutory requirement for the Planning Board to produce carbon footprint analysis for master plans. Since 2008, Montgomery County Code Section 33A-14 requires the Planning Board to assess a master plan's potential impact on greenhouse gas emissions in the County, including a carbon footprint analysis; to consider ways to reduce vehicle miles traveled (VMT) and to consider options that would minimize greenhouse gas (GHG) emissions. The Planning Board includes a carbon footprint analysis and recommendations for reducing VMT and GHG emissions in each master plan transmitted to County Council since 2008.

Montgomery Planning staff perform carbon footprint analysis for master plans using a GHG emissions modeling spreadsheet created by King County, WA and adjusted for use in Montgomery County. The model estimates GHG emissions from embodied energy, building energy use, and transportation used by residents and workers in the master plan area. The model then compares estimated emissions from master plan recommendations for land use, zoning, development density and transportation systems against a baseline estimate using existing conditions. Attached to this letter are examples of carbon footprint analysis produced for the following plans: Thrive Montgomery 2050; Corridor Forward; and Silver Spring Downtown and Adjacent Communities Plan.

We rely on the expertise of environmental planners already on staff and their ongoing collaborations with the Department of Environmental Protection to both inform the development of master plan recommendations to reduce climate impacts and to conduct the carbon footprint analysis. The Board is concerned that adding an OLO climate assessment requirement to ZTAs and master plans will both duplicate effort and potentially cause delays in the Council's review process. The Board points to the experience of how the Council's request for OLO to produce a racial equity and social justice impact statement for Thrive Montgomery resulted in further delay of the start of the full Council's review of this critical plan.

Another question the Board identified is whether an assessment tool designed for a targeted legislative action such as a bill or ZTA is appropriate to apply to a more policy- and long-range-oriented product such as a master plan. The Board notes the example of the fiscal impact statement produced for Thrive Montgomery 2050. The FIS ultimately was less useful in identifying the fiscal impacts of this 30-year plan which primarily contains long-range, high-level policies and not specific actions that can be easily quantified in terms of fiscal impact. The Board feels a tool that is not calibrated to assess the kinds of recommendations made in a master plan could cause confusion in evaluation of impacts and potentially delay implementation.

If the Council chooses to create a new OLO role in climate review, the Council may want to consider whether to apply it to the capital improvements process. Construction of infrastructure, schools and other facility projects have direct impacts on the built and natural environment, so a consideration of the climate impacts of those projects may also be appropriate.

The Planning Board recommends that, rather than creating a duplicative climate assessment process conducted by another agency, the Council adopt the more efficient process of having only one agency responsible for producing climate assessments for master plans and ZTAs. The Board offers the following options for how to structure this alternative process:

1) Rely on existing Montgomery Planning expertise to produce climate assessments for master plans and ZTAs and OLO can review the assessments for adequacy; or
2) Require OLO to contribute analysis to Montgomery Planning's carbon footprint/GHG/VMT assessments already required by law, which would then be transmitted to the Council at the same time; or
3) Remove the County Code requirement for the Planning Board to produce carbon footprint analysis for master plans and rely solely on OLO to produce climate assessments for master plans and ZTAs.

Regardless of which option the Council chooses, the Planning Board strongly encourages the Council to avoid duplication in evaluating the climate impacts of land use plans and zoning actions. The Planning Board looks forward to further discussion of these recommendations.

Sincerely,

Casey Anderson
Chair

Attachments:
Thrive Montgomery 2050 Carbon Footprint Analysis
Corridor Forward I-270 Transit Plan Carbon Footprint Analysis
Silver Spring Downtown and Adjacent Communities Master Plan Carbon Footprint Analysis

cc: Montgomery County Planning Board
Gwen Wright, Director, Montgomery Planning
Tanya Stern, Deputy Planning Director, Montgomery Planning
Christine Wellons, Montgomery County Council
Chris Cihlar, Director, Office of Legislative Oversight
Montgomery County Council

Carbon Footprint Analysis

Thrive Montgomery 2050--Planning Board Draft Plan

October 12, 2021

Introduction

Since 2010, the Planning Board has included a carbon footprint analysis and recommendations to reduce vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions in each of the county's master plans to satisfy the requirement of Montgomery County Code Chapter 33A, Section 33A-14. Specifically, the law requires that the Planning Board must:

(a) Assess the Plan's potential impact on greenhouse gas emissions in the County, including a Carbon Footprint Analysis;
(b) Consider ways to reduce vehicle miles traveled in the County;
(c) Consider options that would minimize greenhouse gas emissions; and
(d) Consider the impact of the plan on racial equity and social justice in the County (as defined in Section 2-64A).

What is carbon footprint

Carbon footprint is the amount of carbon dioxide including "direct emissions, such as those that result from fossil-fuel combustion in manufacturing, heating, and transportation, as well as emissions required to produce the electricity associated with goods and services consumed. In addition, the carbon footprint concept also often includes the emissions of other greenhouse gases, such as methane, nitrous oxide, or chlorofluorocarbons (CFCs). [A] carbon footprint is usually expressed as a measure of weight, as in tons of CO2 or CO2 equivalent per year.".[i]

Carbon Footprint Analysis

A typical carbon footprint analysis measures only the direct emissions generated by fossil fuel consumption for transportation, manufacturing and building energy use. In conducting a carbon footprint analysis, the Planning staff has generally relied on a spreadsheet model that uses existing and projected square feet of non-residential development, numbers of existing and projected single family and multi-family residential units, current and future VMT, pavement, and population changes to estimate the change in both total and per capita emissions that may occur as a result of the Master Plan recommendations. Some functional Master Plans, such as the Bicycle Master Plan and Countywide Transit Corridors Functional Master Plan, have used a modified approach focused exclusively on changes in VMT in the carbon footprint analysis, since those plans did not include specific land use recommendations (such as zoning) that would generate data on projected square feet of non-residential development or numbers of residential units.

Unlike the county's typical master or countywide functional plans, Thrive Montgomery 2050 is a high-level policy document with a 30-year horizon that focuses on long-range planning and policies to guide the physical development of the county, including where and how land will be preserved or developed for housing, office buildings, parks, agriculture, recreation, and transportation infrastructure. These decisions have a major influence on GHG emissions, carbon sequestration, and adaptation to climate

change. But the Plan does not propose specific zoning changes or other recommendations that can be used to generate specific data on projected square feet of commercial development, residential units, and specific infrastructure improvements. Therefore, this analysis is mainly a qualitative assessment of possible reductions in GHG emissions that can be attributed to Thrive's policy recommendations. But it also includes a quantitative section that estimates potential reduction in VMT based on a transportation analysis conducted to test the impacts of Thrive's land use and transportation recommendations on three different growth scenarios.

Major recommendations of Thrive Montgomery 2050 (or Thrive) include compact, corridor-focused growth, Complete Communities and an emphasis on walking, biking and public transit. The GHG reduction benefits of these recommendations will be a combined result of reductions in VMT, building energy savings from reduced residential and commercial development footprints, and the reduction in forest and tree canopy loss in the areas outside of the targeted growth areas. All three of these sources of reduced GHG emissions are influenced by how we plan and build our communities. And, until we consume all energy generated by renewable sources, we must employ all strategies to reduce the amount of energy used in our buildings and transportation system and take emissions out of the atmosphere through sequestration.

This analysis therefore estimates the impacts of the Plan's policy recommendations on GHG emissions for the following three areas:

- Reductions in new GHG emissions by reducing vehicle miles travelled
- Reduction in new GHG emissions through more compact and energy efficient buildings
- Sequestration through increased forest and tree canopy

While some estimates can be made for the contributions to GHG reductions from reduced VMT and increased protection and expansion of forests and tree canopy, the variability of specific development footprints, building materials, etc. makes Montgomery county-specific estimates of building energy savings from compact growth difficult and impractical.

Findings

The results of this analysis indicate that Thrive Montgomery 2050 will help reduce our GHG emissions and the county's overall carbon footprint due to reductions in VMT; reductions in the use of energy in buildings and infrastructure; and sequestration of carbon in the atmosphere through reduction in tree loss, increases in tree cover, and protection of forested areas.

Reductions in Daily VMT and Annual GHG Reductions

To get a true picture of the Thrive Montgomery 2050's contribution in reducing VMT and GHG emissions it is important to compare the impacts of Thrive to a no-Thrive situation. As part of developing the policy recommendations for Thrive, Planning staff conducted a transportation analysis[ii] that estimated daily VMT in the year 2050 based on current trends, and how much that figure could change due to the recommendations in Thrive Montgomery 2050. The analysis compared the results of the three scenarios with the existing conditions in the year 2015 as the base year: "Business as Usual," "On the Road," and "Home Alone Together."

A Business-as-Usual scenario assumed continuation of our current planning framework without any significant disruption in by external factors outside of our control (e.g., a fully autonomous travel network, a different economic structure, etc.) in the way we live, work, and travel, and related changes in how we plan our land use, infrastructure and public and private services and amenities. An On-the-Road scenario assumed mass adoption of autonomous vehicles and where employment growth was focused on specific industries concentrated in a few locations leading to substantially higher numbers of vehicle trips, vehicle miles traveled (VMT) and travel times by automobile, compared to 2015 baseline levels. Conversely, a Home-Alone-Together scenario assumed the mass adoption of teleworking and e-commerce and where employment growth was focused broadly on a wide variety of jobs and locations resulting in fewer vehicle trips, reductions in VMT and fewer trips by automobile, compared to the 2015 baseline levels.

The transportation analysis showed that, although per capita VMT will be reduced in each case, the overall amount of VMT will be higher in two of the three scenarios compared to the 2015 baseline levels. However, the application of relevant Thrive policies yielded reductions in VMT in all three scenarios.

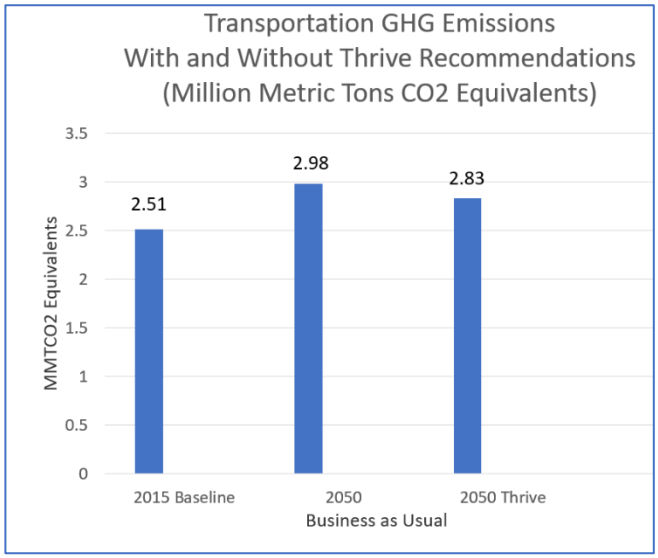
Planning staff used the results of the transportation analysis to calculate the changes in GHG emissions for the same three scenarios. Staff used the same modeling approach used for the Bicycle Master Plan and the Countywide Transit Corridors Functional Master Plan to convert projected VMT into estimated metric tons of CO2 equivalents and compared emissions for 2050 against 2015 as baseline levels. Under the "Business-as-usual" scenario, our VMT, and therefore, GHG emissions in 2050 are forecast to increase over 2015 baseline levels, but they are reduced by 5.0 percent when Thrive policies are applied to this scenario. In the "On the Road" scenario, overall VMT are projected to be higher than the 2015 baseline levels, but they are reduced by 3.6 percent when Thrive policies are applied to this scenario. "Home Alone Together" is the only scenario that projects a reduction in VMT over the 2015 base levels, which are further reduced by 3.7 percent when the Thrive Montgomery 2050 policies are added.

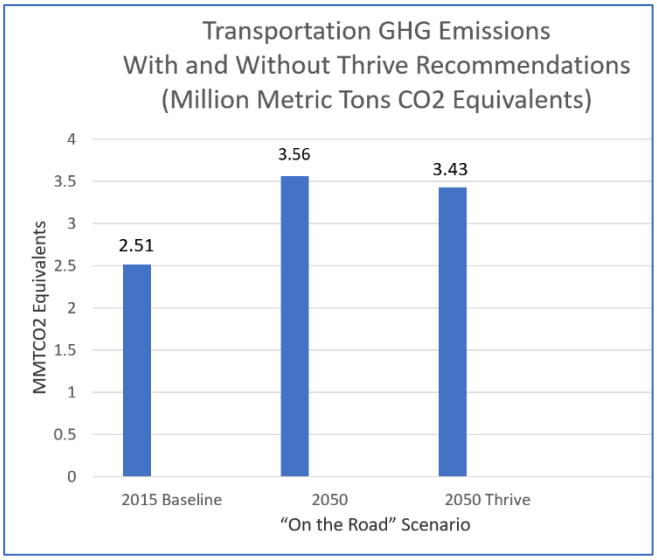
The following table summarizes the VMT projections based on the transportation modeling analysis and then translates those VMTs into GHG emissions. It compares the 2015 baseline levels against the three scenarios with and without the impacts of Thrive in 2050:

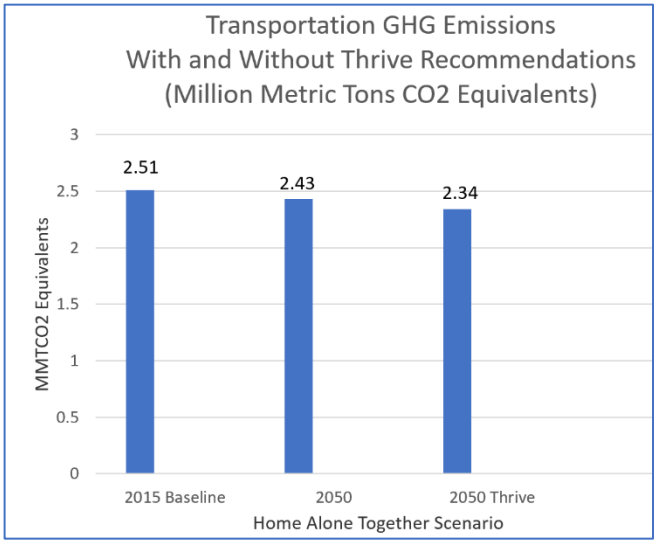
Table 1: Estimates of VMT and GHG emission in 2015 and 2050

Daily Vehicle Miles Traveled (VMT) for Trips Beginning or Ending in Montgomery County (millions)			
	Business-As Usual	**On the Road**	**Home Alone Together**
2015 Baseline levels	20.2	20.2	20.2
2050 no-Thrive	24.0	28.6	19.6
2050 with Thrive	22.8	27.6	18.8
Reduction in VMT attributed to Thrive	**1.2** (~ 5% reduction)	**1.0** (~ 3.5% reduction)	**0.8** (~ 4% reduction)
Annual Emissions--Metric Tons of CO2 Equivalent (millions except as noted)			
2015	2.51	2.51	2.51
2050 no-Thrive	2.98	3.56	2.43

2050 with Thrive	2.83	3.43	2.34
Reduction in GHG emissions attributed to Thrive	**0.15** (~150,000 metric tons)	**0.13** (~128,000 metric tons	**0.09** (~93, 800 metric tons)
Percent reduction over 2050 No-Thrive scenario	**5.0%**	**3.6%**	**3.7%**
Note: The numbers have been rounded off for simplicity. See Appendix C for full numbers			







GHG Reduction Through More Energy Efficient Buildings

Reducing building energy emissions is an important goal of Thrive Montgomery 2050, the county's Climate Action Plan, and of other county programs and initiatives, such as the International Green Construction Code. Thrive contributes to the implementation of this goal through recommendations in various chapters of the Plan. Notable recommendations that will help reduce building energy emissions

are included in the Design, Arts and Culture chapter, especially under the goal to "Promote design strategies and retrofits to make new and existing buildings more sustainable and resilient to disruption and change." This section includes recommendations to:

- encourage net-zero building design, biophilic design and on-site energy generation for new public buildings and large private developments on sites across the county;
- promote cost-effective infill and adaptive reuse design strategies to retrofit single-use commercial sites such as retail strips, malls, and office parks into mixed use developments;
- incentivize the reuse of historic buildings and existing structures to accommodate the evolution of communities, maintain building diversity, preserve naturally occurring affordable space, and retain embodied energy of structures; and
- implement policies to ensure that new buildings and parking structures are adaptable to changing technologies and market preferences and are able to mitigate effects of climate change over time. While it is difficult to quantify the emissions reductions from these actions, their implementation is important to reducing the County's carbon footprint.

Sequestration Through Increased Forest and Tree Canopy

In addition to reducing emissions, increases in the effects of Climate Change can be mitigated by drawing down excess carbon in the atmosphere. While technological solutions, such as engineered systems for carbon capture and storage, are being explored, they have not yet been developed to the point where they can be practically implemented on a large scale. Natural climate solutions are available now and are cost-effective and practical to implement. These solutions primarily focus on protecting existing forest and tree canopy and expanding the coverage of these resources. Protection and planting of forests and tree canopy also have numerous co-benefits for human health, recreational opportunities, energy conservation, water quality improvement and runoff reduction, and provision of critical habitat.

In July 2020, the Montgomery County Department of Environmental Protection (MCDEP) released a report titled "*Examining the Role of Forests and Trees in Montgomery County's Greenhouse Gas Inventory*." The report, which was coordinated for Montgomery County by MCDEP, was authored by investigators from the World Resources Institute, the Climate and Land Use Alliance, and the Woods Hole Research Center (now called the Woodwell Climate Research Center). Staff from the Montgomery County Planning Department provided input on the study and development of the approach to quantifying the contribution of forests and trees in mitigating Montgomery County's GHG emissions.

Among the key findings of the report are the following points (page 2 of the report):

- Roughly one third of Montgomery County's land base is forest. Many areas outside of forests are also covered by trees, including an average of nearly 50 percent tree canopy in developed areas.
- In the period 2011-2016, average annual emissions were less than in the period 2001-2011 due to a reduction in the loss of forests and trees.
- The County's tree canopy also increased during the 2011-2016 period, which resulted in higher annual removals of CO2 compared to 2001-2011.

- Between 2005 and 2015, overall (i.e. all sectors) emissions in Montgomery County dropped 14%. When including the impact of forests and trees, this emission reduction increases to 16%.
- Montgomery County's net GHG emissions could be lower if additional forests and trees were added to its land base, or if losses of these resources were reduced further.

The reduction in emissions from forest loss between 2001 and 2016 corresponds with a move away from greenfield development toward infill and redevelopment as the availability of greenfield development areas in Montgomery County diminished and the large forest losses associated with those developments declined. This underscores the importance of the Compact Growth recommendations in Thrive Montgomery 2050 for protecting and expanding forests and tree canopy.

It is also important to note from this report that forest and tree removals constitute a net increase in emission of GHGs. This is because most of the forest and trees removed for development are not converted into wood products that continue to store carbon, but instead decompose and release the stored carbon back into the atmosphere. The study estimates that approximately 41 million metric tons of CO2 were stored in the standing stock of Montgomery County's forests and trees in 2016. About 30 million metric tons of CO2 were bound up in Montgomery County's forests, and the remaining 11 million metric tons of CO2 were stored in trees outside of forests. The trend at that time was that both figures were increasing.

Spreadsheets accompanying the report include carbon removal rates for forests and trees outside of forests in the County. The county's deciduous forests, for example, remove approximately 6.7 metric tons of CO2 equivalents per hectare per year from the atmosphere. The actions in the Appendix B to this carbon footprint analysis include Thrive recommendations to develop forest cover and tree canopy goals for different land uses and locations in the County. These sequestration factors can be used to estimate the sequestration of potential increases in forest cover and tree canopy to help understand the effects of different forest and canopy cover recommendations.

Planning staff updated the information in the MDEP report using the county's Geographic Information System. The updated information was used to generate some estimates of the amount of carbon dioxide stored and the amount of greenhouse gases sequestered annually, expressed in carbon dioxide equivalent measures, by the county's forests and trees outside of forests. These figures are presented in the table below.

Table 2: Forest and Trees Outside of Forest Carbon Storage and Sequestration

	Carbon Stored--Metric Tons of CO2 (Millions)	**Annual Sequestration--Metric Tons of CO2 Equivalents**
Forest	30	296,174
Trees Outside of Forest	11	285,064
Total	**61**	**581,238**

Implementing Thrive's recommendations and action items should increase the carbon capture and storage from these natural systems and reduce the county's carbon footprint.

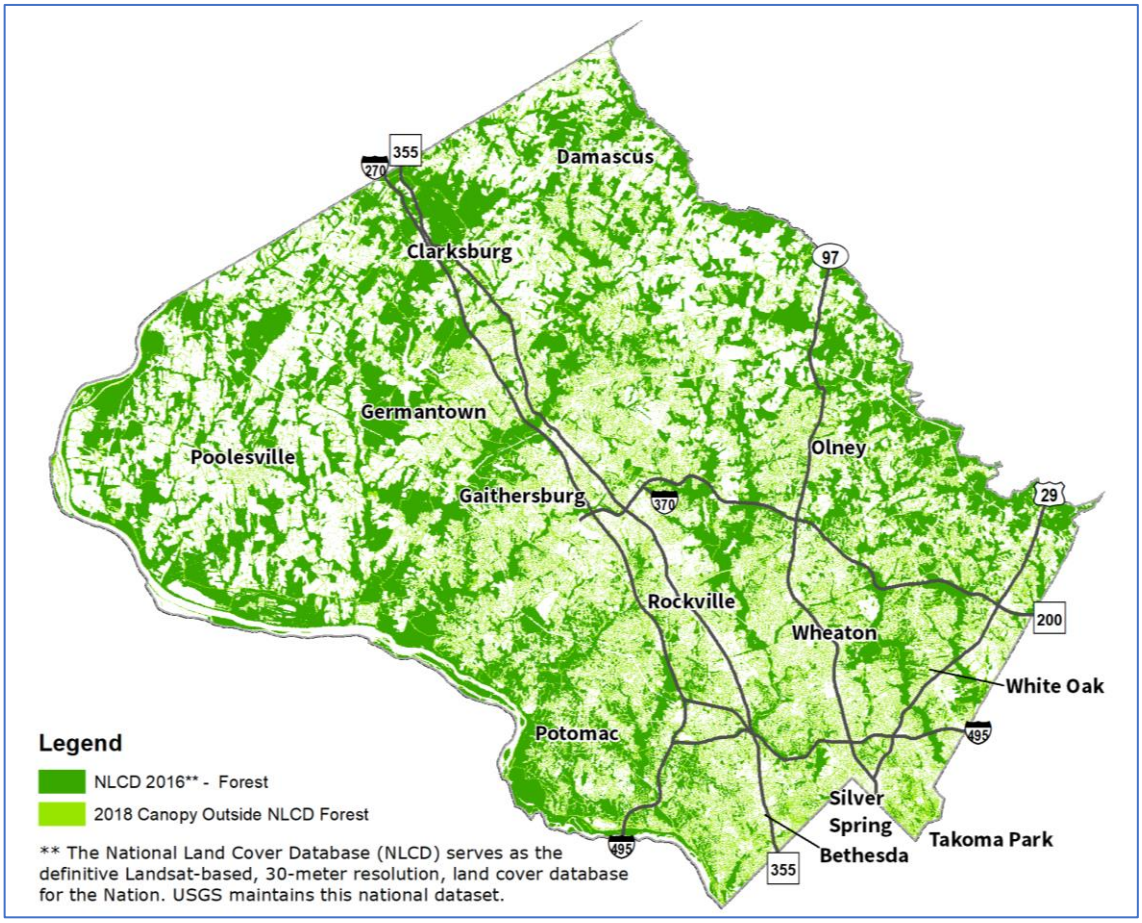


Figure 1: Forest and Tree Canopy Cover in Montgomery County

Thrive Montgomery 2050's Role in Combatting Climate Change

Thrive Montgomery 2050 builds upon the framework established by the 1964 Wedges and Corridors Plan and subsequent master plans and functional countywide plans that have focused growth into more compact areas around major transit hubs and transportation corridors, and preserved areas of lower density development, open spaces and agricultural lands that protect natural resources critical to climate mitigation, sequestration, and resilience.

Thrive Montgomery 2050 includes recommendations that focus on the critical land use component of our efforts to reduce and draw down excess carbon in the atmosphere, and ultimately help achieve the county's goal of eliminating all GHG emissions by 2035. It recommends that future development in the county be compact, bikeable and walkable, and served by public transit. It also recommends transforming our existing neighborhoods into complete communities across the county. Compact growth focused around transit stations and along major corridors in Complete Communities is the Plan's most important strategy in reducing VMT, reducing imperviousness and saving our environmental

resources that dovetail with the increasing preference across age groups to live in mixed-use and diverse walkable places.

Compact Growth

This emphasis on compact growth is based on the idea that the efficient use of land through compact corridor-focused growth complemented by a rural pattern outside of the growth corridors is the best land use strategy to make development more environmentally sustainable and to reduce GHG emissions. Staff has found that overwhelming body of research provides evidence that compact growth reduces VMT over conventional sprawl, which causes more vehicle miles traveled simply because destinations are farther apart and generally accessible only by motor vehicles. A 2008 study, *Growing Cooler*[iii], published by the Urban Land Institute and partially funded by EPA, concluded that compact development alone can reduce vehicle miles traveled by 20 to 40 percent compared to conventional development. Based on the amount of new development and the percentage of that development that could reasonably be expected to be compact infill, the study estimated that compact development could reduce carbon dioxide (CO2) emissions by 7 to 10 percent in 2050. A subsequent study by ULI in 2009, *Moving Cooler*[iv], found that a combination of more compact development and investments in transit and other transportation options could reduce greenhouse gas emissions from transportation by 9 to 15 percent by 2050.

Compact growth also leads to smaller homes which produce energy savings. A December 2019 BBC report[v] on climate change stated that, "Though the differences are not huge, on average, homes in large towns emit slightly less CO2 per person than their more rural counterparts. They tend to be smaller, denser and easier to heat. One of the biggest differences in carbon emissions comes from transport, with CO2 emissions per head 66% higher away from cities. This is probably because more people drive private cars and make longer journeys for work and leisure."

Complete Communities and 15-minute Living

Thrive Montgomery 2050 further reinforces the concept of compact growth by adding Complete Communities and 15-minute living as organizing principles for making our neighborhoods more walkable and sustainable. Complete Communities include a mix of uses, infrastructure, diverse housing types suitable for different household types and income levels, and services and amenities within walking or biking distance.

Many of our existing amenity-rich neighborhoods near transit are not affordable to low-income households forcing them to live farther away from job centers in places that are not well-served by Transit. This in turn causes them to drive longer distances resulting in higher VMTs. Thrive Montgomery proposes reimagining these neighborhoods as Complete Communities to provide more diverse housing through infill and redevelopment to make them affordable to low-income families who are more likely to use transit resulting in reductions in VMT.

The related concept of 15-minute living is another way of reimagining existing communities to maximize their attractiveness and efficiency by mixing housing, offices, and retail uses in each neighborhood or district as much as feasible so services, infrastructure, facilities, and amenities to serve the daily needs of people who live or work there or are within walking distance. The ideas of compact growth, 15-

minute living and Complete Communities are not just for urban areas. Although more people living near mid- to high-density centers in downcounty and midcounty areas will be able to walk to their daily needs, but even in the low-density suburban and rural locations people will be able drive to a well-connected, compact town center, park their vehicles once and walk to stores and other destinations instead of driving from store to store.

Many of Thrive recommendations will help reduce our carbon footprint, but the following recommendations play a more direct role in reducing our VMT and GHG emissions:

- Concentrate new growth in a limited number of places that already have the infrastructure and service to support additional new growth.
- Allow appropriate densities needed to support the efficient provision of transit service along growth corridors.
- Improve the environmental sustainability of growth by encouraging infill and redevelopment to curb sprawl and improve storm water management and sustainability in older neighborhoods built long before current environmental standards.
- Create complete communities to provide more options for people to reach their daily needs by walking, biking or rolling in as many places as possible in all parts of the county.
- Apply flexible approaches to accommodate infill and redevelopment that improve access to amenities, active transportation, parks, and open spaces, and a broader range of housing types at the neighborhood scale
- Make existing and new public facilities more reachable to the surrounding neighborhoods through active transportation improvements that prioritize walking, biking, rolling, and transit use.
- Create mixed-use employment clusters with retail, amenities, and transit, and integrate them into the surrounding communities.
- Develop a convenient and attractive transit system to reduce our reliance on automobiles.
- Ensure safe and comfortable access to transit stations via walking, rolling, and bicycling.
- Stop planning or constructing new highways or major road widenings for cars.
- Provide safe, comfortable, and attractive sidewalks, bikeways, roadway crossings, and other improvements to support walking, bicycling, and transit.
- Encourage the proliferation of non-polluting vehicles by upgrading government fleets and requiring appropriate infrastructure.
- Incentivize residential infill, redevelopment, and repositioning of office parks, shopping malls, and other underutilized properties.
- Facilitate the development of a variety of housing types in every part of the county but especially in areas near transit, employment, and educational opportunities.
- Integrate park trails and paths into transportation planning and better use them to connect residents to jobs and centers of activity.
- Acquire additional land to protect sensitive natural resources and increase tree cover, along with other environmental goals.
- Create a resiliency plan to improve the ability of park and recreation facilities and natural resources to withstand the effects of climate change.

Additional Contributions from Thrive Montgomery 2050

The Compact Growth chapter also contains recommendations to ‘‘Preserve and enhance the Agricultural Reserve and manage it to maintain a rural pattern of development for the benefit of the entire county,” including a recommendation to “Maximize the benefits of the Agricultural Reserve through policies designed to ensure the continued viability of farming as an economically productive and sustainable activity, discourage sprawl, facilitate a broad range of outdoor recreation and tourism activities, conserve land and natural resources, and promote practices that advance environmental quality.” The existence of the Agricultural Reserve and the original “Wedges and Corridors” approach to land use has helped focus Montgomery County’s growth into more compact forms along transportation corridors. The continued preservation and use of the Agricultural Reserve to discourage sprawl and maintain large areas of forest and pastureland through the recommendations of Thrive Montgomery 2050 presents the county with a resource that enables the continued storage and sequestration of large amounts of carbon and contributes to the county’s resilience. Actions related to the implementation of this recommendation can improve the productivity of agricultural soils while also enhancing their ability to store carbon.

The Parks and Recreation chapter contains recommendations for the continued stewardship of natural resources in our award-winning Park system, including recommendations to “selectively acquire additional land where needed to protect sensitive natural resources, improve water quality, increase tree cover, enhance wildlife corridors, curb invasive species, and achieve other environmental goals,” and to” create a resiliency plan to improve the ability of park and recreation facilities and natural resources to withstand the effects of climate change.” As discussed previously in the section on sequestration, these actions will increase the ability of our Park system to capture and store carbon while providing many additional benefits.

Relationship Between Thrive Montgomery 2050 and the Climate Action Plan

In December 2017, Montgomery County adopted Resolution 18-974 committing to reduce the county’s GHG emissions of 80 percent by 2027 and reaching 100 percent elimination by 2035. In June 2021, the county released a Climate Action Plan (CAP) that details the effects of climate change on Montgomery County and includes strategies to achieve the goals of Resolution 18-974.

Thrive Montgomery 2050 was drafted in coordination with the CAP, which outlines ways to reduce the county’s net greenhouse gas emissions to zero by 2035. The CAP also recommends approaches to deal with the hazards of climate change predicted for Montgomery County: extreme heat, extreme precipitation, high winds, and drought. The Planning Department staff worked with executive branch representatives to ensure that the goals, policies, and actions recommended by Thrive Montgomery 2050 and the CAP are complementary rather than duplicative.

Thrive Montgomery 2050 is a high-level document that focuses on long- range planning and policies to guide the physical development of the county, including where and how land will be preserved or developed for housing, office buildings, parks, agriculture, recreation, and transportation infrastructure. These kinds of decisions have a major influence on greenhouse gas emissions, carbon sequestration, and

adaptation to climate change. The CAP, on the other hand, recommends specific actions to be taken in the near-term to achieve the goal of eliminating greenhouse gas emissions by 2035 and to mitigate or adapt to the effects of climate change. Thrive Montgomery 2050 incorporates a wide range of recommendations related to climate change and its connection to land use, transportation, and parks, and the Planning and Parks Departments will implement recommendations in the CAP that are within the scope of the M-NCPPC's responsibilities. Together these plans will create a comprehensive approach to climate change at the local level.

Building Capacity to Improve GHG Modeling, Help Track Progress

Planning staff recognizes that estimating the effects of Thrive Montgomery 2050's recommendations and tracking the progress of implementation will require new tools and additional efforts in the coming years. In addition to our existing tools there are newer, better tools and approaches being developed that will help us to better address and track progress in climate change mitigation, sequestration and resilience moving forward. One of the actions that maybe considered for Thrive's implementation is to create or choose tools to evaluate the effect of land use options on greenhouse gas reduction goals. Like other agencies, the Montgomery County Planning Department will be considering ways to build our capacity to address the many issues and challenges we will encounter as we seek to reduce our carbon footprint and find ways to adapt and become more resilient in the face of climate change.

Appendix A: Thrive Montgomery 2050—Recommendations Related the VMT and GHG Emissions Reduction

(Note: these recommendations are from the Planning Board Draft and may be modified during the PHED Committee or the full Council review).

Compact Growth chapter

Concentrate growth in centers of activity and along corridors through compact, infill development and redevelopment to maximize efficient use of land.

- Focus future land use and public infrastructure planning on growth corridors so as to direct development in ways that facilitate the emergence of Complete Communities. Evaluate appropriate land uses, transportation facilities, and community design that will encourage and enable full use of centers of activity and creation of Complete Communities. (Ec, Env, EQ)
- Amend land use, design, and zoning regulations, including the Zoning Ordinance and Subdivision Regulations, to support corridor-focused compact development. Appropriate densities will vary but should be sufficient to support, at a minimum, the efficient provision of transit service along these corridors. (Ec, Env, Eq)
- Improve the environmental sustainability of growth by encouraging infill and redevelopment to curb sprawl and bring areas built out in an era with little or no environmental regulations up to robust standards for stormwater management and other state-of-the-practice environmental standards. (Env)

Promote and prioritize public investment in infrastructure along growth corridors and leverage it to attract future private investment in a compact form.

- Establish high-quality transit infrastructure along growth corridors through capital investment and ensure reliable, frequent service through operational investment. (Ec, Env, Eq)
- Leverage federal, state and local incentive programs, publicly owned land and land investment opportunities for corridor infill development and redevelopment. (Ec, Env, Eq)

Limit growth beyond corridors to compact, infill development and redevelopment in Complete Communities to prevent sprawl. Apply principles of urbanism at an appropriate scale along a rural-to-urban transect as outlined in the Complete Communities chapter. (Env, Eq)

- Sustainably manage land outside growth corridors and Complete Communities to increase biodiversity, improve the health of natural habitats, preserve privately owned forests, protect watersheds and aquifers, and improve water quality while providing expanded opportunities for outdoor recreation, including vigorous physical activity. (Env, Eq)

Preserve and enhance the Agricultural Reserve and manage it to maintain a rural pattern of development for the benefit of the entire county.

- Maximize the benefits of the Agricultural Reserve through policies designed to ensure the continued viability of farming as an economically productive and sustainable activity, discourage sprawl, facilitate a broad range of outdoor recreation and tourism activities, conserve land and natural resources, and promote practices that advance environmental quality. (Ec, Env)

Complete Communities chapter

Identify and integrate elements needed to complete centers of housing, retail, and office development and plan to make 15-minute living a reality for as many people as possible.

- Promote zoning allocations and standards to encourage the integration of varied uses, building types and lot sizes. (Ec, Env, EQ)
- Apply flexible approaches to accommodate infill and redevelopment that improve access to amenities, active transportation, parks, and open spaces, and a broader range of housing types at the neighborhood scale. (Ec, Env, EQ)
- Prioritize neighborhood-level land use planning as a tool to enhance overall quality of community life and avoid reinforcing outdated land use patterns. (EQ)
- Allow sufficient densities to make a wide range of uses economically viable in Complete Communities. Encourage densities sufficient to support convenience retail and other local-serving amenities at the neighborhood level. Provide guidance for accommodating additional density in a context-sensitive manner. (Ec, Env, EQ)
- Ensure that Complete Communities are integrated into their surroundings and supported by a public realm that encourages walking, biking and rolling, as well as social interaction through the configuration of sidewalks, paths, landmarks, and gathering spaces. (Ec, Env, EQ)

Encourage co-location and adjacency of all essential and public services, especially along growth corridors and in Complete Communities.

- Maximize the utility of public facilities by locating them in places that promote integration with other public and private uses and infrastructure. (Env, EQ)
- Promote active transportation improvements that prioritize walking, biking, rolling, and transit use to enhance public access to these co-located facilities. (Env, EQ)
- Develop standards for colocation of public facilities that promote mixing of uses or services and compact development strategies. Encourage public-private partnerships and ensure they promote social interaction and physical activity. (Ec, Env, EQ)

Retrofit centers of activity and large-scale older facilities such as shopping centers, abandoned federal campuses, office parks, and other single-use developments to include a mixture of uses and diversity of housing types and to provide a critical mass of housing, jobs, services, and amenities for vibrant, dynamic Complete Communities.

- Ensure employment uses in economic clusters develop in a mixed-use format along with housing, retail, amenities, and transit, and ensure they are integrated into the surrounding communities. (Ec, Env, EQ)
- Allow creation of co-located housing, discussed further in the Affordable and Attainable Housing Chapter, including for industries that employ large numbers of employees (permanent or seasonal). (Ec, Env, EQ)
- Encourage higher density economic and housing cooperatives (live/work areas such as home occupations, artist villages, farmers' market/villages, tech/life-science startup incubators). (Ec, Env, EQ)

Design, Arts and Culture chapter

Use design-based tools to create attractive places with lasting value that encourage social interaction and reinforce a sense of place and inclusion.

- Design buildings, streets, and parking to prioritize the pedestrian scale and encourage walking and bicycling through smaller blocks, narrower streets, buffered bike lanes and sidewalks. Slow vehicle speeds and minimize surface parking while adequately accommodating automobiles. (Eq, Env)
- Adopt rules for alternative housing types such as tiny houses, cottages, courtyard clusters, duplexes, multiplexes, small apartment buildings; shared housing, co-housing and accessory dwelling units (ADUs). (Eq, Env)

Promote design strategies and retrofits to make new and existing buildings more sustainable and resilient to disruption and change.

- Encourage state-of-the-practice sustainability features such as net-zero/carbon-positive buildings, biophilic design and on-site energy generation for new public buildings and large private developments on sites across the county. (Env)
- Promote cost-effective infill and adaptive reuse design strategies to retrofit single-use commercial sites such as retail strips, malls, and office parks into mixed use developments. (Ec, Env)
- Incentivize the reuse of historic buildings and existing structures to accommodate the evolution of communities, maintain building diversity, preserve naturally occurring affordable space, and retain embodied energy of structures. (Eq, Env)
- Implement policies to ensure that new buildings and parking structures are adaptable to changing technologies and market preferences and are able to mitigate effects of climate change over time. (Env)

Transportation and Communications Network chapter

Develop a safe, comfortable and desirable network for walking, biking, and rolling.

- Expand the street grid in downtowns, town centers, transit corridors, and suburban centers of activity to create shorter blocks. (Ec, Env)
- Stop proposing new four+ lane roads in master plans. (Env)
- Do not give priority to construction of new four+ lane roads or major road widenings for cars. (Env)
- Convert existing traffic lanes and on-street parking to create space for walkways, bikeways, and street buffers with landscaping and street trees. (Env)
- Prioritize the provision of safe, comfortable, and attractive sidewalks, bikeways, roadway crossings, and other improvements to support walking, bicycling, and transit usage in capital budgets, development approvals and mandatory referrals. (Env)

Build a world-class transit system.

- Build a network of rail, bus rapid transit, and local bus infrastructure and services that make transit the fastest, most convenient and most reliable way to travel to centers of economic, social and educational activity and opportunity. (Ec, Eq, Env)
- Convert existing general purpose traffic lanes to dedicated transit lanes, as consistent with other county policies. (Ec, Eq, Env)

- Ensure safe and comfortable access to transit stations via walking, rolling, and bicycling. (Eq, Env)

Adapt policies to reflect the economic and environmental costs of driving alone. (Eq, Env)

- Employ pricing mechanisms, such as congestion pricing or the collection and allocation of tolls to support walking, rolling, bicycling, and transit. (Env)
- Manage parking efficiently by charging market rates and reducing the supply of public and private parking. (Ec, Env)
- Encourage the proliferation of non-polluting vehicles by upgrading government fleets and requiring appropriate infrastructure. (Env)

Develop and extend advanced communications networks

- Support teleworking by accelerating deployment of information and communications technology and making working from home easier by facilitating Complete Communities. (Ec, Env)

Attainable and Affordable Housing chapter

Encourage the production of more housing to better match supply with demand

- Expand opportunities to increase residential density, especially along major corridors and in locations where additional housing can assist in the development of Complete Communities. (Ec, Eq, Env)
- Increase regulatory flexibility to incentivize residential infill, redevelopment, and repositioning of office parks, shopping malls, and other underutilized properties. (Ec, Eq, Env)
- Provide financial incentives such as Payment in Lieu of Taxes to boost housing production for market rate and affordable housing, especially near transit and in Complete Communities. (Ec, Eq, Env)

Plan for a wide range of housing types and sizes to meet diverse needs

- Facilitate the development of a variety of housing types in every part of the county but especially in areas near transit, employment, and educational opportunities. (Ec, Eq, Env)
- Support creative housing options including personal living quarters and/or micro units; “missing middle” housing types such as tiny houses, cottages, duplexes, multiplexes, and small apartment buildings; shared housing, co- housing, accessory dwelling units (ADUs), social housing and cooperative housing to help meet housing needs and diversify housing options. (Ec, Eq, Env)
- Encourage provision of multi-bedroom units suitable for households with children in multifamily housing. (Eq, Env)

Parks and Recreation chapter

Focus on creating high quality urban parks

- Prioritize acquisition of land for parks in urban centers and other intensively developed places along growth corridors and in Complete Communities using the Legacy Urban Space CIP commitment and the Energized Public Spaces Functional Master Plan (EPS Plan) as a starting point. (Ec, Eq, Env)

Maintain high standards of environmental stewardship in park management and operations

- Selectively acquire additional land where needed to protect sensitive natural resources, improve water quality, increase tree cover, enhance wildlife corridors, curb invasive species, and achieve other environmental goals. (Env)
- Create a resiliency plan to improve the ability of park and recreation facilities and natural resources to withstand the effects of climate change. (Env)

Integrate parks/rec/public spaces into economic development strategies and land use planning to attract employers and workers, build social connections, encourage healthy lifestyles, and create vibrant places, especially as part of Complete Communities. (Ec, Eq, Env)

Appendix B: Thrive Montgomery 2050-- Proposed Actions Related to GHG Emissions Reduction

Compact Growth: Corridor-Focused Development

G-4. Implement recommendations in the county's Climate Action Plan (CAP) within the authority of the M-NCPPC in order to achieve the climate change goals and related objectives of both the CAP and Thrive Montgomery 2050.

G-8. Create or choose tools to evaluate the effect of land use options on greenhouse gas reduction goals.

G-9. Evaluate opportunities for siting alternative energy production and storage systems.

G-11. Research and create guidance for innovative development, retrofit and construction designs, and techniques that minimize imperviousness.

G-17. Identify for protection forests and other natural areas with high value for climate mitigation, resilience, and biological diversity.

G-18. Establish appropriate forest and non-forest canopy goals and strategies to protect plant and wildlife diversity and human health while accommodating and complementing land use policies such as redevelopment and infill in areas identified as appropriate for growth.

G-21. Develop a long-range forest quality management plan to address fragmentation, deer pressure, invasive threats, and the forest's capacity to withstand and mitigate climate impacts.

G-22. Develop recommendations to improve the vitality and survivability of planted forests and trees.

Design, Arts and Culture chapter

D-7. Update the Historic Preservation Ordinance, the zoning code, and Historic Resources Preservation Tax Credit program to incentivize and facilitate adaptive reuse and/or repurposing of existing buildings.

D-8. Develop a sprawl repair manual to promote cost-effective design strategies and establish regulatory approaches to accommodate retrofitting of single-use commercial sites such as retail strips, malls and office parks into mixed-use developments that are more energy efficient.

D-9. Develop guidelines and standards for climate-sensitive design principles and materials for new public and private development projects. Ensure these standards include strategies to maximize greenhouse gas reductions in the built environment, including generating clean renewable energy and reducing heat island effect.

Transportation and Communications Network chapter

T-2. Remove master-planned but unbuilt highways and road widenings that are not consistent with this plan, add dedicated transit lanes, upgrade transitways to median running, and repurpose general-purpose lanes and on-street parking for sidewalks, bikeways, transit lanes, street buffers, street trees, and stormwater management.

T-8. Create guidelines for prioritizing transportation projects to improve walking, bicycling, and transit in Equity Focus Areas.

T-17. Develop short-term and long-term bus transit plans to extend local and regional bus service to underserved communities in Montgomery County, improve reliability, frequency, and span of service and restructure local and regional bus service to integrate with existing and planned rail and Bus Rapid Transit (BRT).

T-19. Expand commuter rail capacity on the MARC Brunswick Line to provide additional station locations in Montgomery County and provide frequent bidirectional all-day service, seven days a week.

T-21. Eliminate motor vehicle parking minimums for new development projects in downtowns, town centers, rail and BRT corridors and adjacent communities to encourage travel by walking, bicycling, and transit.

T-24. Develop an implementation plan for transitioning to zero emission fueling in residential and commercial development and public facilities and spaces.

T-25. Update all county fleets and contracted fleet providers to zero emission vehicles.

T-26. Develop county incentives to accelerate conversion of privately-owned fleets to sustainable, zero emission vehicles.

Appendix C: VMT and GHG Emissions Projections

Daily Vehicle Miles Traveled (VMT) For Trips Beginning or Ending in Montgomery County			
	Business-As Usual	On the Road	Home alone Together
2015	20,228,973	20,228,973	20,228,973
2050 no-Thrive	24,012,055	28,639,289	19,583,130
2050 with Thrive	22,808,430	27,604,428	18,827,231
Reduction in VMT attributed to Thrive	**1,203,625**	**1,034,861**	**777, 899**

Annual Emissions (Metric Tons of CO2 Equivalent)			
2015	2,511,431	2,511,431	2,511,431
2050 no-Thrive	2,981,101	3,555,573	2,431,249
2050 with Thrive	2,831,671	3,427,001	2,337,404
Reduction in emissions attributed to Thrive	**149,430**	**128,572**	**93,845**
% reduction over 2050 no-Thrive scenario	**5.01%**	**3.61%**	**3.86%**

Endnotes

[i] https://www.britannica.com/science/carbon-footprint

[ii] https://montgomeryplanning.org/wp-content/uploads/2021/10/FINAL-Thrive-Montgomery-Transportation-Analysis-Report.pdf

[iii] https://www.nrdc.org/sites/default/files/cit_07092401a.pdf

[iv] https://www.issuelab.org/resources/10329/10329.pdf

[v] https://www.bbc.com/news/science-environment-49639003

APPENDIX 5: CARBON FOOTPRINT ANALYSIS

Since 2010, the Planning Board has included a carbon footprint analysis and recommendations to reduce vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions in each of the county's master plans to satisfy the requirement of Montgomery County Code Chapter 33A, Section 33A-14. Specifically, the law requires that the Planning Board must:

(a) Assess the Plan's potential impact on greenhouse gas emissions in the County, including a Carbon Footprint Analysis;
(b) Consider ways to reduce vehicle miles traveled in the County;
(c) Consider options that would minimize greenhouse gas emissions; and
(d) Consider the impact of the plan on racial equity and social justice in the County (as defined in Section 2-64A).

In addition, Montgomery County completed its Climate Action Plan in June 2021, committing to cut greenhouse gas emissions by 80 percent by 2027 and 100 percent by 2035. he Climate Action Plan details the effects of a changing climate on Montgomery County and includes strategies to reduce GHG emissions and climate-related risks to the County's residents, businesses, and the built and natural environment. The Climate Action Plan focuses on seven pillars to reduce greenhouse gas emissions and climate change impacts: clean energy; buildings; transportation; carbon sequestration; climate adaptation; climate governance; and public engagement, partnerships, and education.

WHAT IS CARBON FOOTPRINT?

Carbon footprint is the amount of carbon dioxide including "direct emissions, such as those that result from fossil-fuel combustion in manufacturing, heating, and transportation, as well as emissions required to produce the electricity associated with goods and services consumed. In addition, the carbon footprint concept also often includes the emissions of other greenhouse gases, such as methane, nitrous oxide, or chlorofluorocarbons (CFCs). [A] carbon footprint is usually expressed as a measure of weight, as in tons of CO2 or CO2 equivalent per year".[1]

CARBON FOOTPRINT ANALYSIS

A typical carbon footprint analysis measures only the direct emissions generated by fossil fuel consumption for transportation, manufacturing, and building energy use. Some functional master plans, such as the 2018 *Bicycle Master Plan* and 2013 *Countywide Transit Corridors Functional Master Plan*, have used a modified approach focused exclusively on changes in VMT in the carbon footprint analysis, since those plans did not include specific land use recommendations (such as zoning) that would generate data on projected square feet of non-residential development or numbers of

[1] https://www.britannica.com/science/carbon-footprint

residential units. Corridor Forward: The I-270 Transit Plan (Corridor Forward) employs a similar approach to those functional master plans.

RESULTS

The results of the VMT analysis are included in **Table 1**, which includes the daily totals for four different geographies: the entire metropolitan Washington region, Montgomery County, Equity Focus Areas (EFAs) within Montgomery County, and the areas of Montgomery County not designated as an EFA (non-EFAs). The analysis was conducted for several scenarios, including an existing condition, a future "no build" baseline condition, the six transit options selected for detailed study, and the three transit network packages (which are a combination of the transit options, with some modifications).

The carbon footprint analysis, included in **Table 2**, is built off the VMT analysis. For each scenario, a factor was applied to the VMT results to calculate each type of emissions (CO_2 emissions, hydrocarbons, etc.). As a result, the relationship between each scenario is the same for the VMT and carbon footprint analysis. For ease of explanation, only the VMT analysis results are described below. However, the findings and relationship between each scenario is the same for the VMT and carbon footprint analysis.

Consistent with the anticipated population and employment growth in the region and Montgomery County between 2015 and 2045, VMT is anticipated to rise in the coming decades. Each of the transit options and networks evaluated would reduce VMT from the "no build" baseline, but that reduction is relatively small. At the regional level, VMT reductions do not exceed 0.2%, and reductions within Montgomery County do not exceed 1% of "no build" VMT.

VMT reductions for the network packages exceed the VMT reductions for the individual options, indicating that a combination of transit options is more effective at reducing emissions than a singular transit project. The recommended transit network includes elements from Network Package 2 and Network Package 3, discussed in greater detail in Appendix 3 – Metrics and Performance.

EQUITY ANALYSIS

In addition to understanding emissions regionwide and countywide, an additional analysis was conducted to evaluate the how VMT reductions are distributed across the county, specifically between EFAs and non-EFAs. Approximately one quarter of the county's population lives in EFAs, yet in all scenarios, about a third of trips are generated by EFAs.

This overrepresentation of VMT associated with EFAs represents a disparity – residents of EFAs experience more VMT (and the resulting emissions) per capita than non-EFAs. This disparity is because EFAs – in addition to hosting a concentration of low-income households, people of color, and residents with limited English proficiency – also represent some of the county's job centers, such as Wheaton, Rockville, and Silver Spring. This disparity does not mean that people living in EFAs generate more VMT, but instead that the mix of uses present in EFAs generate more VMT. Residents of EFAs do not drive more than residents elsewhere in the county, but EFAs tend to be areas of greater

activity, and therefore the VMT in those areas are disproportionately high relative to other parts of the county (see Appendix 6 – Equity Assessment for additional information).

Similar to the regionwide and countywide results, the greatest VMT reductions in EFAs are associated with the network packages. However, it is important to note that for all scenarios, non-EFAs experience a greater reduction in VMT than EFAs (as a percent of “no build” VMT), indicating that the existing emissions disparity will not be mitigated by the recommended transit network. In addition to the provision of new transit infrastructure and service, other interventions could be considered to evaluate how VMT and disparities can be reduced, such as lane repurposing, parking management, travel pricing, and travel demand management strategies.

Table 1. Daily Vehicle Miles Traveled

Region											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
Value	178,017,268	218,640,994	218,567,959	218,483,583	218,611,629	218,596,499	218,481,570	218,530,978	218,357,797	218,355,996	218,347,324
Change from No Build	-	-	-73,035	-157,410	-29,365	-44,495	-159,424	-110,016	-283,196	-284,997	-293,670
% Change	-	-	-0.04%	-0.09%	-0.02%	-0.02%	-0.09%	-0.06%	-0.16%	-0.16%	-0.16%
Montgomery County											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
Value	19,445,335	22,515,296	22,482,035	22,431,609	22,491,971	22,503,393	22,462,035	22,468,730	22,368,362	22,365,431	22,377,158
Change from No Build	-	-	-33,261	-83,687	-23,325	-11,903	-53,261	-46,566	-146,934	-149,865	-138,138
% Change	-	-	-0.17%	-0.43%	-0.12%	-0.06%	-0.27%	-0.24%	-0.76%	-0.77%	-0.71%
Montgomery County - Equity Focus Area											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
Value	6,556,666	7,622,522	7,616,998	7,595,923	7,618,222	7,620,587	7,610,288	7,611,713	7,586,231	7,581,613	7,585,779
Change from No Build	-	-	-5,524	-26,600	-4,300	-1,936	-12,235	-10,810	-36,291	-40,910	-36,744
% Change	-	-	-0.08%	-0.41%	-0.07%	-0.03%	-0.19%	-0.16%	-0.55%	-0.62%	-0.56%
Montgomery County - Non-Equity Focus Area											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
Value	12,888,668	14,892,774	14,865,037	14,835,687	14,873,749	14,882,806	14,851,748	14,857,017	14,782,131	14,783,818	14,791,379
Change from No Build	-	-	-27,737	-57,087	-19,025	-9,967	-41,026	-35,757	-110,643	-108,956	-101,395
% Change	-	-	-0.22%	-0.44%	-0.15%	-0.08%	-0.32%	-0.28%	-0.86%	-0.85%	-0.79%

Table 2. Emissions Associated with Daily Vehicle Miles Traveled (kilograms)

Region											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
CO_2 Emissions	71,918,976	88,330,961	88,301,455	88,267,368	88,319,098	88,312,985	88,266,554	88,286,515	88,216,550	88,215,823	88,212,319
Hydrocarbons	107,344	131,841	131,796	131,746	131,823	131,814	131,744	131,774	131,670	131,669	131,663
Exhaust Carbon Monoxide	1,086,795	1,334,803	1,334,357	1,333,842	1,334,624	1,334,532	1,333,830	1,334,132	1,333,074	1,333,063	1,333,010
Exhaust Nitrogen Oxides	244,774	300,631	300,531	300,415	300,591	300,570	300,412	300,480	300,242	300,239	300,228
Exhaust PM2.5	7,121	8,746	8,743	8,739	8,744	8,744	8,739	8,741	8,734	8,734	8,734
Breakwear PM2.5	712	875	874	874	874	874	874	874	873	873	873
Tirewear PM2.5	356	437	437	437	437	437	437	437	437	437	437
Montgomery County											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
CO_2 Emissions	7,855,915	9,096,180	9,082,742	9,062,370	9,086,756	9,091,371	9,074,662	9,077,367	9,036,818	9,035,634	9,040,372
Hydrocarbons	11,726	13,577	13,557	13,526	13,563	13,570	13,545	13,549	13,488	13,486	13,493
Exhaust Carbon Monoxide	118,714	137,456	137,253	136,945	137,313	137,383	137,131	137,172	136,559	136,541	136,613
Exhaust Nitrogen Oxides	26,737	30,959	30,913	30,843	30,926	30,942	30,885	30,895	30,756	30,752	30,769
Exhaust PM2.5	778	901	899	897	900	900	898	899	895	895	895
Breakwear PM2.5	78	90	90	90	90	90	90	90	89	89	90
Tirewear PM2.5	39	45	45	45	45	45	45	45	45	45	45

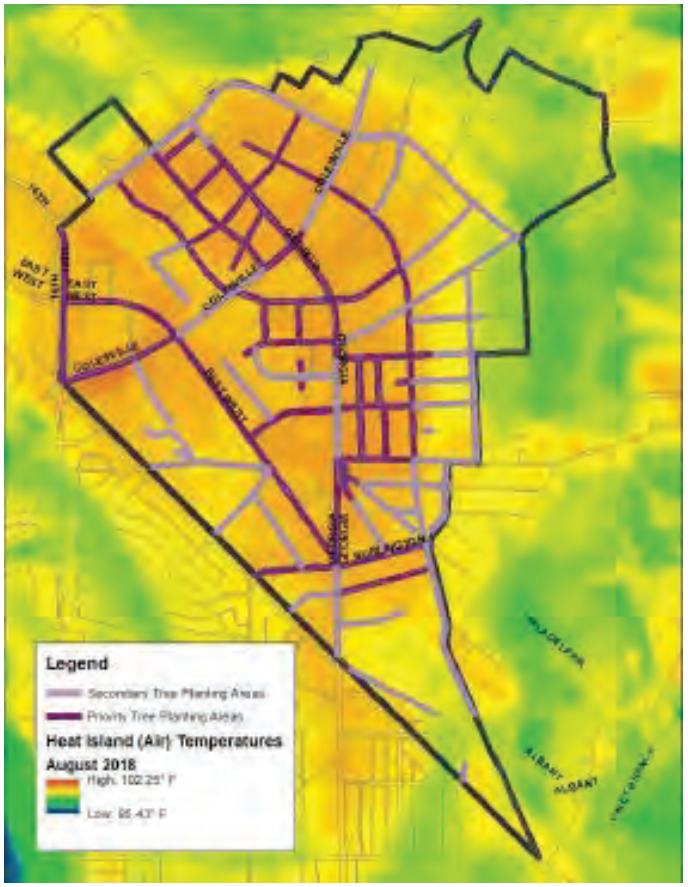
Table 2. Emissions Associated with Daily Vehicle Miles Traveled (kilograms) - Continued

Montgomery County - Equity Focus Areas											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
CO_2 Emissions	2,648,893	3,079,499	3,077,267	3,068,753	3,077,762	3,078,717	3,074,556	3,075,132	3,064,837	3,062,972	3,064,655
Hydrocarbons	3,954	4,596	4,593	4,580	4,594	4,595	4,589	4,590	4,574	4,572	4,574
Exhaust Carbon Monoxide	40,028	46,535	46,502	46,373	46,509	46,524	46,461	46,470	46,314	46,286	46,311
Exhaust Nitrogen Oxides	9,015	10,481	10,473	10,444	10,475	10,478	10,464	10,466	10,431	10,425	10,430
Exhaust PM2.5	262	305	305	304	305	305	304	304	303	303	303
Breakwear PM2.5	26	30	30	30	30	30	30	30	30	30	30
Tirewear PM2.5	13	15	15	15	15	15	15	15	15	15	15
Montgomery County - Non-Equity Focus Areas											
	Existing (2015)	**No Build (2045)**	**Enhanced MARC**	**Red Line Ext**	**CCT**	**Purple Line Ext**	**Rail to Frederick**	**Enhanced Commuter Bus**	**Network Package 1**	**Network Package 2**	**Network Package 3**
CO_2 Emissions	5,207,022	6,016,681	6,005,475	5,993,617	6,008,994	6,012,654	6,000,106	6,002,235	5,971,981	5,972,662	5,975,717
Hydrocarbons	7,772	8,980	8,964	8,946	8,969	8,974	8,956	8,959	8,914	8,915	8,919
Exhaust Carbon Monoxide	78,685	90,920	90,751	90,572	90,804	90,860	90,670	90,702	90,245	90,255	90,301
Exhaust Nitrogen Oxides	17,722	20,478	20,439	20,399	20,451	20,464	20,421	20,428	20,325	20,328	20,338
Exhaust PM2.5	516	596	595	593	595	595	594	594	591	591	592
Breakwear PM2.5	52	60	59	59	59	60	59	59	59	59	59
Tirewear PM2.5	26	30	30	30	30	30	30	30	30	30	30

The right-of-way is an opportunity area for bolstering carbon sequestration, cooling the streetscape and community, and proving enhanced ecological benefits that bring nature back to the urban landscape. Green infrastructure is a network of nature-based solutions such as stormwater management, trees and vegetation, and porous pavements. Its components provide multiple ecological benefits to cool streets and communities, improve air and water quality, beautify the landscape, and provide vegetation that supports the survival of animal and insects as they live and migrate through the community. These affordable elements are integral for designing a resilient, healthy, safe, and economically viable future in the face of climate change.

Recommendations

- Provide streets and open space through the planting of native canopy trees prioritizing lower income areas, the Green Loop, and the hottest streetscape areas (see map).
- During street renovations and routine replacements consider installing smart street elements such as: solar lighting, solar metering, solar crosswalks, LED lighting, electric vehicle charging portals, and/or other technologies that emerge.
- Implement cooling strategies into all streetscape plans during the site planning process, and street renovation and improvement projects. Cool Streets Recommendations will be included in the Design Guidelines.
- Encourage car-free, flexible, and car-lite streets through flexible streets, road diets, alternative modes of transportation, and bike/vehicle sharing programs.
- Encourage more vehicle charging stations than currently required on private property and within the right-of-way (ROW) where appropriate to support a growing electric vehicle demand.



Greenhouse Gas Modeling

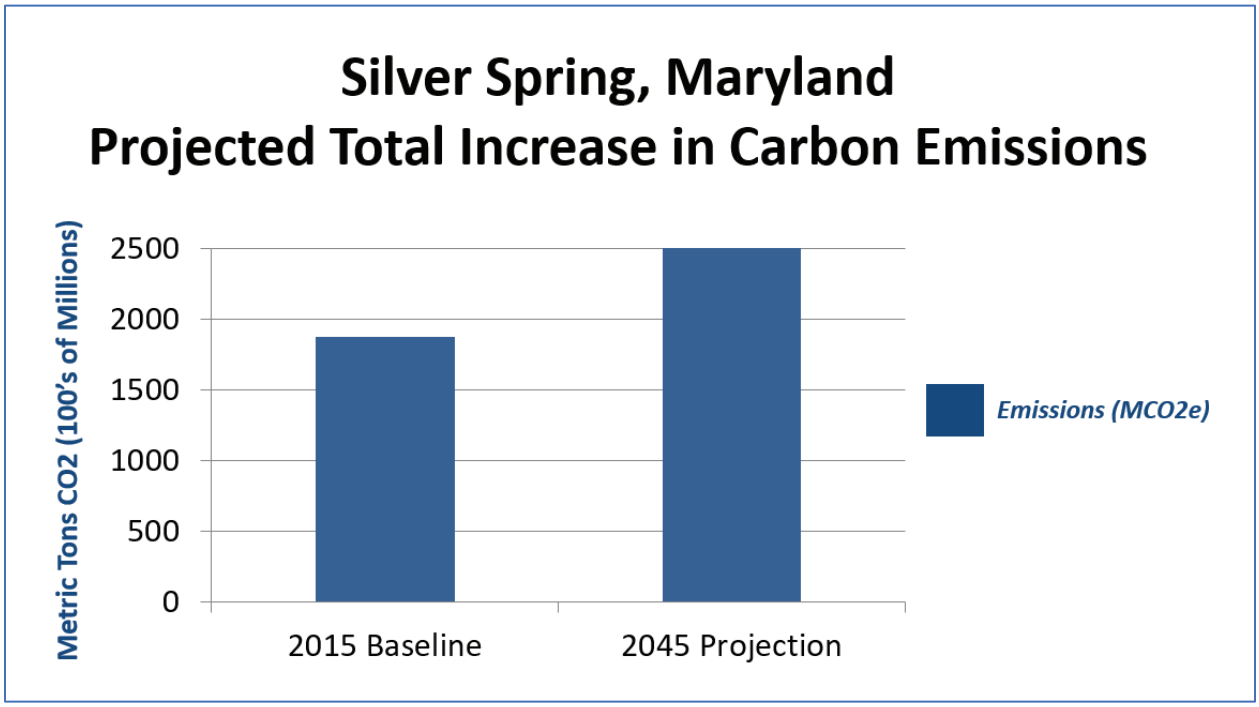
Montgomery County Code Chapter 18A-15 requires the Planning Board to model the carbon footprint of planning areas as part of Sector Plans. Another law (Montgomery County Code Chapter 33A-14) requires the Planning Board to estimate the carbon footprint of areas being master planned, and to make recommendations for carbon emissions reductions. Carbon footprint is calculated by estimating the greenhouse gas (GHG) emissions from construction and operation of the projected development.

There are three main components to greenhouse gas emissions: embodied energy emissions, building energy emissions and transportation emissions in projecting total emissions for an area. Embodied emissions are emissions that are created through the extraction, processing, transportation, construction and disposal of building materials, as well as emissions created through landscape disturbance (by both soil disturbance and changes in above ground biomass). Building energy emissions are created in the normal operation of a building, including lighting, heating cooling and ventilation, operation of computers and appliances, etc.

Transportation emissions are released by the operation of cars, trucks, buses, motorcycles, etc. Results are given for the total life of the development from construction to demolition and are given in metric tons of carbon dioxide equivalents (MTCO2e).

The Sector Plan focuses on areas that are most likely to redevelop which will increase the numbers of housing units and non-residential spaces. Population and use are intended to increase, smart growth policies such as increased density, transit options, and the construction of energy efficient buildings will be constructed. However, the model being used today was developed in King County, Washington in 2007. It is outdated and does not take into consideration new energy efficient building materials and requirements, the rise of electric vehicles, and energy efficient non-electric vehicles. Therefore, we need to state that the numbers shown do not reflect true carbon forecasting. Forecasting and carbon modeling have become quite complex and can often take months if not years of full staff dedication. The forecast below may or may not reveal actual carbon outputs. The results of the carbon analysis show an increased greenhouse gas emission above the existing conditions. However, when considered population increases the carbon emissions per capita will likely decline.

Recommendations for reducing energy demand and use are woven throughout the content of the Sector Plan. Some significant carbon reduction recommendations include building efficiencies, increased alternative modes of transportation, increased density, and increased tree and vegetation to sequester carbon and reduce heat island effect.



Carbon Analysis Methodology

MNCPPC currently uses a greenhouse gas model developed by King County, Washington. The inputs are derived from national averages, and wherever possible we have substituted Montgomery County data obtained by the Planning Department's Research and Technology and the Transportation Division. The results are reported in terms of the equivalent effect of a given volume of carbon dioxide ("carbon dioxide equivalents").

To project total emissions for the Silver Spring Sector Plan, the spreadsheet model considered embodied energy emissions, building energy emissions, and transportation emissions. The model documentation defines embodied emissions as “emissions that are created through the extraction, processing, transportation, construction and disposal of building materials as well as emissions created through landscape disturbance (by both soil disturbance and changes in above ground biomass). Building energy emissions are created in the normal operation of a building including lighting, heating cooling and ventilation, operation of computers and appliances, etc. Transportation emissions are released by the operation of cars, trucks, buses, motorcycles, etc.

Inputs for Silver Spring Sector Plan include the numbers and types of housing units and the square footage of different categories of retail, commercial, and public buildings. The model was run once using 2015 data to establish baseline results. The model was run again using housing units, and commercial and retail space projected to develop under the sector plan (2045) to estimate future greenhouse gas emissions. The model estimates emissions over the life of the development, and results are given in metric tons of CO2 equivalents. The actual outcome of the model is higher than the reality due to continuous changes in technology, energy efficiencies, and alternative energy sources.

To project total emissions for an area, the spreadsheet model also considered embodied energy emissions, building energy emissions, and transportation emissions. The model documentation defines embodied emissions as “emissions that are created through the extraction, processing, transportation, construction and disposal of building materials as well as emissions created through landscape disturbance (by both soil disturbance and changes in above ground biomass). Building energy emissions are created in the normal operation of a building including lighting, heating cooling and ventilation, operation of computers and appliances, etc. Transportation emissions are released by the operation of cars, trucks, buses, motorcycles, etc.

The emissions model does not calculate and future carbon offsets from either best management practices, vehicle and/or building efficiencies or conversions to electric, or other unknown carbon reductions. The estimates from the existing methodology assume “business as usual” when projecting emissions.