



**Larry Hogan**, Governor  
**Boyd Rutherford**, Lt. Governor  
**Mark Belton**, Secretary  
**Joanne Throwe**, Deputy Secretary

January 10, 2017

The Honorable Larry Hogan  
Governor  
State House  
Annapolis, MD 21401

The Honorable Michael E. Busch  
Speaker, Maryland House of Delegates  
H101 State House  
Annapolis, MD 21401

The Honorable Thomas V. Mike Miller  
President, Senate of Maryland  
H107 State House  
Annapolis, MD 21401

The Honorable Ben Grumbles  
Chair, Maryland Commission on Climate Change  
Maryland Department of Environment  
1800 Washington Avenue  
Baltimore, MD 21230

**Re:** Submission of Report on the State's Greenhouse Reduction Efforts  
**Agency:** Maryland Department of Natural Resources  
**Report Authority:** State Environment Article § 2-1305(c) (MSAR 10580)

Dear Governor, President, Speaker and Secretary Grumbles:

On behalf of the Maryland Department of Natural Resources, I am pleased to submit the *2016 Annual State Agency Report* for the department, developed in accordance with the State Environment Article §2-1305, as defined in House Bill 514 from 2015.

Please find the department's update on the programs that support the State's Greenhouse Gas Reduction Efforts, which will be incorporated as a section of the larger State Agency Report being coordinated by the Maryland Department of the Environment.

This annual requirement under the law that governs the Maryland Commission on Climate Change asks that numerous state agencies submit annual reports on the progress surrounding the implementation of climate change programs to both the Governor and the Commission in accordance with § 2-1246 of the State Government Article.

Sincerely,

Mark Belton  
Secretary

Enclosure

cc: Sarah Albert, Department of Legislative Services (5 hard copies)

# Maryland Department of Natural Resources

## Greenhouse Gas Reduction Programs

### I. Forestry and Sequestration

#### I.1<sup>1</sup> Managing Forests to Capture Carbon

##### Program Description

Managing forests to capture carbon will promote sustainable forestry management practices in existing Maryland forests on both public and private lands. The enhanced productivity resulting from enrolling unmanaged forests into management regimes will increase rates of carbon sequestration in forest biomass, increase amounts of carbon stored in harvested, durable wood products which will result in economic benefits, and increased availability of renewable biomass for energy production. Enhanced forestry management in Maryland should contribute to a 1.8 MMtCO<sub>2</sub>e reduction in the State's GHG emissions by 2020. The goals of this program are to improve sustainable forest management on 30,000 acres of private land annually and on 100 percent of State-owned resource lands, and ensure 50 percent of State-owned forest lands will be third-party certified as sustainably managed. This program is performing as designed.

##### Program Objectives

###### **GHG Emission Reductions in 2020**

The potential emission reductions from the Managing Forests to Capture Carbon program in 2020 are estimated to be 1.80 MMtCO<sub>2</sub>e. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

##### Implementation Milestones

###### **Public Lands:**

- Since 2006, 211,000 acres of State Forests have been certified with Dual Third Party Certification for Forest Sustainability to the Sustainable Forestry Initiative (SFI) and Forest Sustainability Certification (FSC) standards.

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<sup>1</sup> Headings correspond to the Maryland Greenhouse Gas Reduction Plan Update (2015)

- DNR is working to develop similar sustainable forest management practices on State parkland and wildlife management areas.
- Dual Third Party Certification for Forest Sustainability on State Forests
- WMAs and Parks (e.g., early successional habitat)
  - Currently working with WHS on several projects.
  - Currently developing Forest Stewardship plans on several WMAs
- Accelerated Pace of Silvicultural Activity
  - Audit Received: Savage River State Forest will increase the number of sales from 14 to 20. DNR is continuing to work to decrease the backlog of timber sales.
- State Forest Annual Workplans
  - Include a planned 2,200 acres of harvests for FY17, that will be naturally regenerated.

#### Private Lands:

- Since 2006-
  - **183,607** acres of Stewardship Plans,
  - **113,907** acres of Sediment Control
  - **88,709** acres of forest stand improvements (“Tree Planting”, “Timber Stand Improvements”, and “Wildlife Habitat”)
  - Total of **386,223** acres have been implemented on private lands.
- DNR is currently on track to meet their goal by 2020.

#### Technical Assistance – Forest Stewardship Plan Preparation

- Forest Stewardship Plan Implementation – Expanded Special Rivers Project
- Financial Assistance – State and Federal Cost Sharing
- Woodland Incentive Program
- Healthy Forests/Healthy Waters (Currently working on developing the next round of projects)
- Backyard Buffer Program
- Environmental Quality Incentive Program
- Conservation Reserve Enhancement Program

- TAXMOD – expanded eligibility (as of 10/27/14, 3 applicants from the expanded eligibility)
- Forest Conservation and Management Program
- Woodland Assessment Program
- Development and application of the UMCP remote sensing capability for forest carbon assessment – Completed
- Launch of NASA, USDA and DOE climate science project for remote sensing, modeling, and field-based measurements to quantify the carbon consequences of alternate development and management plans across rapidly changing forests in Maryland. – Pending funding approval
- DNR with other partners, including USFS, UMCES and UMD Extension to release topic related fact sheets and technical guidance on woodland and climate change stewardship principles. – Completed

### **Estimated Emission Reductions for CY 2015**

Forest management on private land in Maryland reduced carbon emissions by 0.19 MMtCO<sub>2</sub>e.

Forest management on public land in Maryland reduced carbon emissions by 0.20 MMtCO<sub>2</sub>e. Both exceed yearly reduction goals.

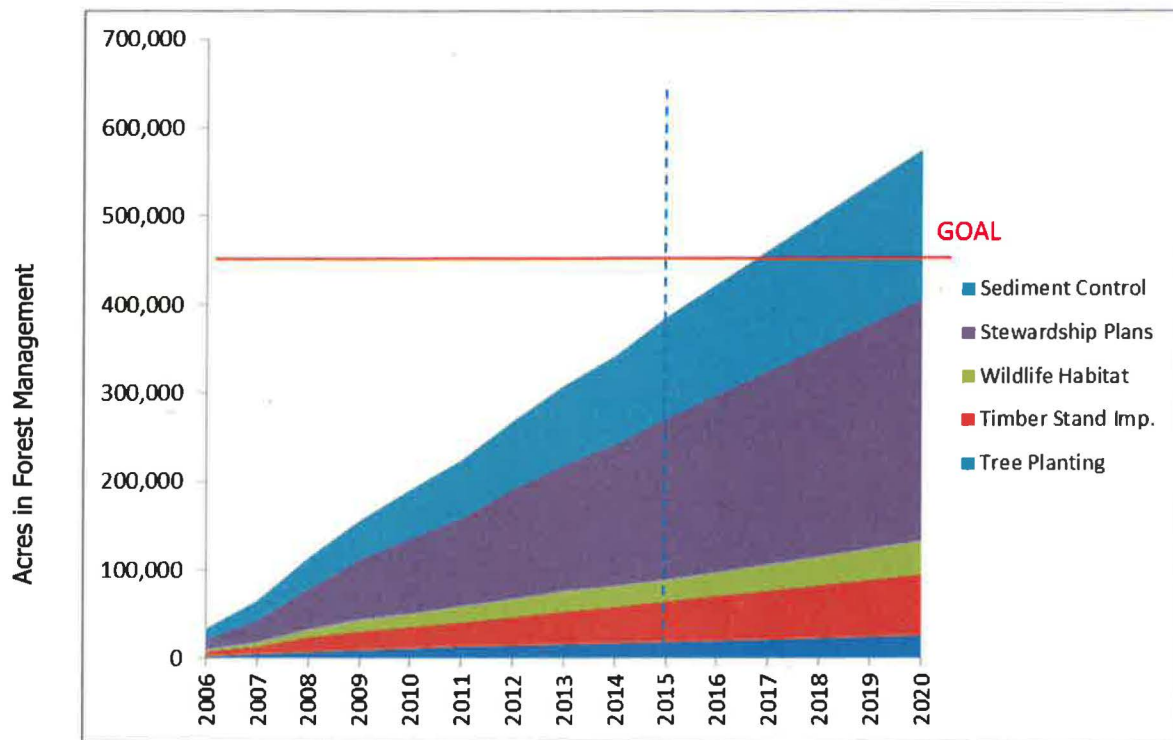
**Table I.1 Forest Management Programs**

<b>Year</b>	<b>Stewardship Plans</b>	<b>Sediment Control</b>	<b>Tree Planting</b>	<b>Timber Stand Imp.</b>	<b>Wildlife Habitat</b>	<b>Acres</b>
2006	12,106	11,580	3,082	4,796	2,196	33,760
2007	13,630	9,799	2,661	3,300	2,456	31,846
2008	20,657	13,060	2,286	8,519	3,760	48,282
2009	22,228	9,037	2,234	4,188	4,327	42,014
2010	16,895	11,249	1,497	3,542	1,835	35,018
2011	14,866	10,479	2,428	2,778	3,149	33,700
2012	24,640	11,167	1,151	4,607	2,489	44,054
2013	17,822	13,252	1,166	5,171	2,627	40,038
2014	17,651	10,310	1,237	3,850	528	33,576
<b>2015</b>	<b>23,112</b>	<b>13,974</b>	<b>1,196</b>	<b>5,374</b>	<b>279</b>	<b>43,935</b>



2016	18,000	11,000	1,500	4,500	2,800	37,800
2017	18,000	11,000	1,500	4,500	2,800	37,800
2018	18,000	11,000	1,500	4,500	2,800	37,800
2019	18,000	11,000	1,500	4,500	2,800	37,800
2020	18,000	11,000	1,500	4,500	2,800	37,800
<b>Total</b>	<b>273,607</b>	<b>168,907</b>	<b>26,438</b>	<b>68,625</b>	<b>37,646</b>	<b>575,223</b>
Average Annual 2006-2015	11,391	1,894	4,613	2,365	38,622	18,361

(Red indicates projections)



**Figure I.1** Managing Forests to Capture Carbon. DNR is promoting sustainable forestry management practices in Existing Maryland forests on Public and private land through a suite of efforts, policies and programs.

### Enhancement Opportunities

Current programming appears to be meeting targeted goals.

## **Funding**

The Woodland Incentive Fund is the progenitor of much of the activity on private lands. This Fund receives revenues from a number of sources, including revenues collected by the Department from the payment of charges imposed for Department assistance in implementation of an approved practice, money distributed from the Chesapeake and Atlantic Coastal Bays 2010 Trust Fund under § 8-2A-04 of § 5-307; and subject to approval by the Secretary and the Board of Public Works, a portion of the revenues derived from the forestry practices on designated lands owned and managed by the Department, but particularly important is the portion received from property tax transfer of forest lands (up to \$200,000 per year).

## **Challenges**

The Department will need to mix, match, and layer funding to complete projects and supplement the Woodland Incentive Fund.

## **Relevant Information**

Towson's Regional Economic Studies Institute (RESI) 2015 Study estimated that the Managing Forests to Capture Carbon program, once fully operational, would support a total of 268 jobs by 2020, \$28,564,453 in net economic output and \$28,137,209 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **I.2 Planting Forests in Maryland**

### **Program Description**

Planting trees expands forest cover and associated carbon stocks by regenerating or establishing healthy, functional forests through practices such as soil preparation, erosion control, and supplemental planting, to ensure optimum conditions to support forest growth. By 2020, the implementation goal of this program is to achieve the afforestation and/or reforestation of 43,030 acres in Maryland. Achieving the 43,030 acre target should reduce GHG emissions in the State by 1.79 MMtCO<sub>2e</sub> by 2020. This program is performing as designed.

### **Program Objectives**

The potential emission reductions from the Planting Forests in Maryland program in 2020 are estimated to be 1.79 MMtCO<sub>2e</sub>. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

### **Implementation Milestones**

DNR is implementing this program through a suite of efforts, policies, and programs, including:

Public Lands:

- State Forest System Annual Workplan Implementation

Private Lands:

- Technical Assistance
  - Forest Stewardship Plan Implementation
  - FCA Implementation

This program is performing as designed.

- Financial Assistance – Rural Lands: State and Federal Cost Sharing
  - Woodland Incentive Program (WIP –MD Forest Service)
  - TAXMOD (MD Forest Service; as of 10/27/14, 3 applicants from the expanded eligibility)
  - Environmental Quality Incentive Program (EQIP – Federal/NRCS)

- Conservation Reserve Enhancement (CREP – Federal/NRCS)
- Financial Assistance – Urban Lands: Public/Private Partnerships
  - Tree-Mendous/Arbor Day
    - 4,003 trees (40.3 acres) planted in 2015
  - Marylanders Plant Trees/Private Nurseries
    - Reimbursed coupons for 4,432 trees (44.3 acres) in 2015
  - Lawn to Woodland (e.g. National Arbor Day Foundation, etc.)
    - Kicked off in spring 2014 with 4.3 acres planted.
    - 100.73 acres on 84 sites planted in spring 2015
- Maryland Urban & Community Forestry Council Grants
  - Small Community UTC Grants (Possibly Spring 2015)
  - This program is performing as designed.

### **Estimated Emission Reductions for CY 2015**

On track with previous years, reductions totaled 0.10 MMtCO<sub>2</sub>e for 2015.

**Table I.2 Acres of Forest Planted in Maryland**

<b>Year</b>	<b>Afforestation</b>	<b>Reforestation</b>	<b>Riparian Buffers</b>	<b>Private Natural</b>	<b>Total (acres)</b>
2006	558	2,104	420	1,400	4,482
2007	334	1,991	336	1,400	4,061
2008	415	1,596	275	1,400	3,686
2009	531	1,497	206	1,400	3,634
2010	566	403	528	1,400	2,897
2011	1,231	639	558	1,400	3,828
2012	330	607	214	1,400	2,551

2013	286	602	278	1,400	2,566
2014	342	544	334	1,400	2,620
<b>2015</b>	<b>586</b>	<b>550</b>	<b>258</b>	<b>1,400</b>	<b>2,794</b>
2016	400	700	400	1,400	2,900
2017	400	700	400	1,400	2,900
2018	400	700	400	1,400	2,900
2019	400	700	400	1,400	2,900
2020	400	700	400	1,400	2,900
<b>Total</b>	<b>7,179</b>	<b>14,033</b>	<b>5,407</b>	<b>21,000</b>	<b>47,619</b>

(Red indicates projections)

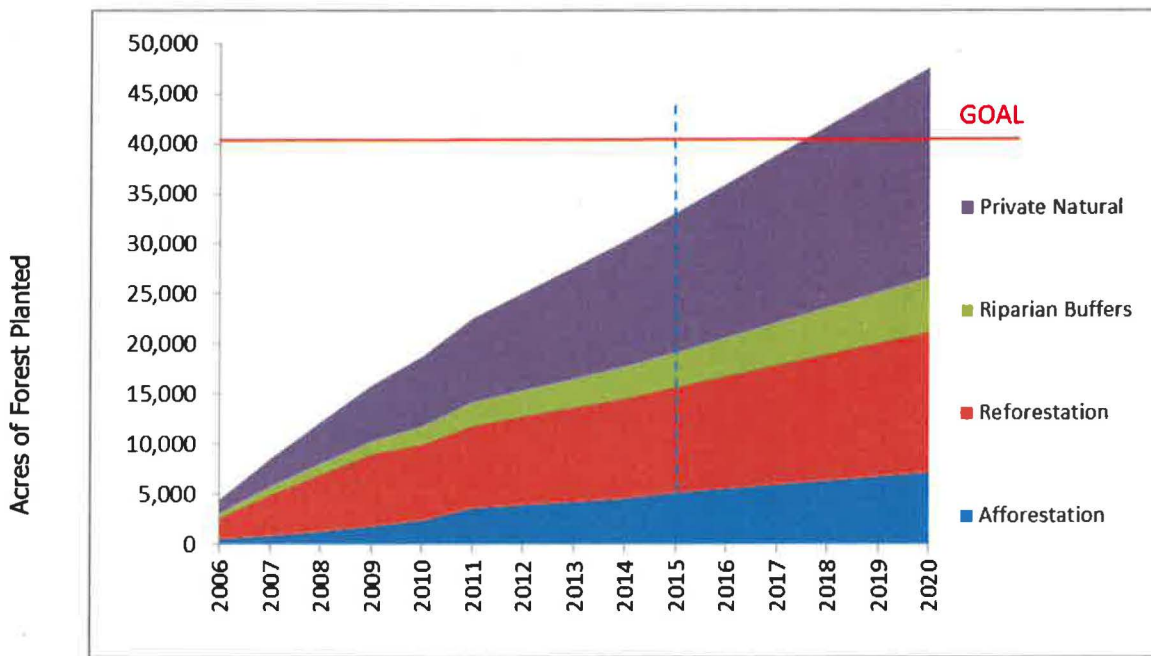


Figure I.2 Planting Forests in Maryland.

### Enhancement Opportunities

Provide dedicated staff to identify landowners interested in participating in programs like “Lawn to Woodland” and “Marylanders Plant Trees”.

## **Funding**

See below.

## **Challenges**

The Department will need to mix, match, and layer funding to complete projects and build upon the “Lawn to Woodland” and “Marylanders Plant Trees’ programs.

## **Relevant Information**

RESI’s 2015 Study estimated that the Planting Forests in Maryland program, once fully operational, would support a total of 92 jobs by 2020, \$11,077,882 in net economic output and \$14,862,060 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **I.3 Creating and Protecting Wetlands and Waterway Borders to Capture Carbon**

### **Program Description**

In addition to forests, wetlands and marshlands are known to be very efficient at sequestering carbon. Therefore, DNR is planting forested stream buffers and pursuing the creation, protection and restoration of wetlands to promote carbon sequestration through several means, including undertaking on-the-ground wetland restoration projects through its Natural Filters Program which restores wetlands and buffers on state and public lands to meet its water quality goals, the Coastal Wetlands Initiative whose objective is to restore natural tidal marsh hydrology to coastal wetlands through ditch plugging practices, the development of a terrestrial carbon sequestration protocol, and the Sea Level Affecting Marshes Model.

The goals of the Natural Filters Program are restoring 1,142 acres of wetlands on state and public land and planting 645 acres of streamside forest buffers on state and public lands based on the State's Watershed Implementation (WIP) Goals for state and public lands.

In addition, DNR is including another best practice for terrestrial carbon sequestration through its Shoreline Conservation Service projects to install Living Shorelines. These are additional coastal wetland restoration practices that function to sequester carbon.

This Natural Filters Program is exceeding the established goals.

### **Program Objectives**

The potential emission reductions from the Creating and Protecting Wetlands and Waterway Borders to Capture Carbon program in 2020 are estimated to be 0.43 MMtCO<sub>2e</sub>.

### **Implementation Milestones (have they been met?)**

On the ground wetland and waterway restoration projects:

Natural Filters Program: To date, 1,486 acres of wetlands have been restored and 868 acres of streamside buffers planted.

Coastal Wetlands Initiative Program: To date, 505.6 acres of coastal wetlands have been restored by plugging existing drainage ditches to restore these drained wetlands.

Living Shorelines through the Shoreline Conservation Service: To date, 12.21 acres of Living Shoreline have been implemented since 2006.



**Table I.3 Shoreline and Marsh Creation in Maryland**

<b>Year</b>	<b>Linear Feet of Shoreline</b>	<b>Square Feet of Marsh Created/Restored</b>	<b>Acres Created/Restored</b>
2006	2,901	55,779	1.28
2007	2,920	119,210	2.74
2008	2,485	87,670	2.01
2009	8,935	46,660	1.07
2010	1,944	37,871	0.87
2011	2,100	31,497	0.72
2012	None		
2013	2,000	24,000	0.55
2014	3,000	63,115	1.45
2015	None		
2016	3,100	66,000	1.52
<b>Total</b>	<b>29,385</b>	<b>531,802</b>	<b>12.21</b>

*Studies and Protocols*

A Tidal and Seagrass protocol has been developed in partnership with Restore America’s Estuaries and the Verified Carbon Standard Program. The protocol provides a default value of 1.46 MG Carbon sequestered/hectare/year for tidal wetland restoration projects if more detailed and precise accounting methodologies are not applied.

The Sea Level Affecting Marsh Model has been completed for Maryland coastlines and is being actively used for a variety of wetland management practices including:

- Targeting DNR’s land acquisition efforts to areas that may provide a future wetland benefit through inland marsh migration resulting from sea level rise.
- Developing new easement opportunities for landowners that own land within these wetland adaptation area transition zones.
- Identifying the value of current and future wetlands for protecting communities and infrastructure from coastal flooding and shoreline erosion through the Department’s Coastal Resiliency Initiative.

Future work will address using the SLAMM model to determine the potential loss of tidal wetlands, and the potential gain to provide input to the GGRA plan in understanding the effect of sea level rise on carbon storage pools in current and future wetlands.

**Estimated Emission Reductions for CY 2015**

The Verified Carbon Standard has accepted default values for carbon sequestration for tidal wetland restoration. Restoration gains from both the Coastal Wetland Initiative and the Shoreline Conservation Service total 517.81 acres since 2006. However, more information is needed before applying this default value. A significant factor in determining the net greenhouse gas benefit of tidal wetland restoration is the quantification of methane

emissions. Methane emissions vary according to salinity levels. Current research (pers. communication, Brian Needelman, University of Maryland) is ongoing and may soon be ready in form that the State can use to more accurately reflect the greenhouse gas benefits once methane emissions are considered.

## **Enhancement Opportunities**

The new protocol for Tidal and Seagrass restoration opens up opportunities to account for the greenhouse gas benefits of carbon sequestration through Submerged Aquatic Vegetation restoration and re-establishment.

Restore America's Estuaries and the Verified Carbon Standards program will be pursuing additional carbon sequestration accounting protocols for tidal wetland conservation. This protocol will provide justification for projects that prevent the degradation of tidal wetlands. Living Shorelines projects will prove to yield greater benefit through this new protocol as a result of the protection these buffers provide to tidal wetlands landward from the shoreline restoration project.

## **Funding**

**Natural Filters Program:** In 2007, the Maryland General Assembly created the Chesapeake and Atlantic Coastal Bays Trust Fund (Trust Fund) to provide the financial assistance necessary to advance Chesapeake Bay restoration. A portion of this funding is targeted to the installation of natural filters on public lands which includes forested buffers, reforestation, wetland restoration, stream and floodplain restoration, stormwater retrofits, and other bioremediation projects. In FY17, \$6,000,000 was requested.

**Coastal Wetlands Initiative (CWI):** There are no dedicated funds currently allotted to CWI. Funding is typically acquired through a competitive grant process which in the past have used State transportation and other federal funding sources.

**Shoreline Conservation Services:** This program is funded through the Shore Erosion Control Revolving Loan.

**DNR/SHA Memorandum of Understanding:** The Maryland Department of Natural Resources has partnered with the State Highway Administration in an effort to lead by example in restoring the Chesapeake Bay and local waters. State Parks have initially been targeted to provide opportunities for SHA to implement restoration projects required by their Federal Stormwater Permit (MS4) and their nutrient and sediment reduction goals required under the Bay Total Maximum Daily Load (TMDL). A Memorandum of Understanding was signed in 2013 to initiate this program and is currently being updated to provide additional guidance. This MOU will increase the rate of restoration projects on state and public lands.

## **Challenges**

While wetland restoration, in both inland, freshwater and tidal environments, are practices that significantly contribute to terrestrial carbon sequestration rates throughout the State, the highly variable rate of methane emissions has a marked effect on net greenhouse gas benefits. Research at state, regional, national and global scales continues to evolve and narrow in on more precise methods to evaluate the greenhouse gas benefits of wetland restoration.

Measures of success for the various Coastal Wetland Initiative projects are currently being monitored. In some cases, ditch plugging has been very effective in establishing sheet flow across the marsh and allowing sediment to naturally fill the plugged ditches. In other areas, the ditch plugging has resulted in excessive water pooling, creating a drowned marsh effect. Ongoing monitoring of these projects will improve the design, best practices and success of future efforts.

### **Relevant Information**

RESI's 2015 Study estimated that the Creating and Protecting Wetlands and Waterway Borders to Capture Carbon program, once fully operational, would support a total of 62 jobs by 2020, \$28,717,043 in net economic output and \$15,045,166 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **I.4 Biomass for Energy Production**

### **Program Description**

Maryland is working to promote the use of locally produced woody biomass for generation of thermal energy and electricity. Energy from forest by-products can be used to offset fossil fuel-based energy production and associated GHG emissions. There are many end users that could potentially benefit from such a program, including Maryland's public schools which could enjoy wood heating and cooling; hospitals which could utilize wood as primary heating/cooling source; municipalities which could utilize local fuel markets as key component of their urban tree management programs; and all rural landowners which would have access to a wood fuel market.

The goal of this program is to develop policies that recognize wood as a preferred renewable energy source, recognize wood as the largest source of energy consumption in Maryland, and offer incentives to utilize locally produced wood to meet thermal energy needs.

This program is performing as designed.

### **Program Objectives**

#### **Revised 2015 Estimate**

The potential emission reductions from the Biomass for Energy Production program in 2020 are estimated to be 0.33 MMtCO<sub>2</sub>e. Appendix C of this report provides a more detailed description of the process used to quantify GHG reductions

### **Implementation Milestones**

- Working with partners MES, MEA, COMMERCE and US Forest Service to facilitate installation of wood energy systems
- Various projects in earliest stages of investigation in Baltimore County and Baltimore City
- Both Ft. Meade and Andrews Air Force Base are evaluating the opportunities for incorporating wood systems in their overall green energy transformations
- MEA offers grant opportunities for feasibility studies of biomass to energy facilities, with implementation funds available pending a favorable finding

- MEA's Combined Heat and Power grant program encourages technologies that leverage biogas/biomass as a fuel source in industrial and critical infrastructure facilities.

### **Estimated Emission Reductions for CY 2015**

None.

### **Enhancement Opportunities**

An analysis of "woodsheds" where the available wood resource is quantified would help to raise confidence in the ability of an area to support industrial scale biomass to energy would help to raise confidence in the feasibility of industrial scale biomass to energy. Additional educational outreach on the feasibility of biomass to energy to state agencies, academic institutions, and the business community would likely help to establish this program.

### **Funding**

Maryland Energy Administration (MEA) administers two grant programs for biomass to energy. The Commercial Wood Boiler Program will have \$1 million of funding and will provide up to \$500,000 toward a commercial biomass boiler project. The funds can be used for capital costs or feasibility studies and they must be matched 1:1. The project must have a feasibility study and be in operation by January 2019.

MEA's Combined Heat & Power Program has \$4 million in funding, including a \$1 million carveout for biomass and biogas projects. There is a \$500,000 cap on a project and the amount funded will depend on the kilowatts produced. A feasibility study is required and the project must be in operation by January 2019.

### **Challenges**

Awareness of wood energy technology is the primary barrier to this program. Actions needed include:

1. Educate State agency leadership
2. Develop policy supporting THERMAL energy
3. Recognize wood as a preferred renewable energy source, on par with solar, geothermal, and wind

### **Relevant Information**

RESI's 2015 Study estimated that the Biomass for Energy Production program, once fully operational, would support a total of 51 jobs by 2020, \$24,871,827 in net economic output and \$12,756,348 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **I.6 Increasing Urban Trees to Capture Carbon**

### **Program Description**

Trees in urban areas directly impact Maryland's carbon budget by absorbing GHG emissions from power production and vehicles, reducing heating and cooling costs and energy demand by moderating temperatures around buildings, and slowing the formation of ground level ozone as well as the evaporation of fuel from motor vehicles. Implementation is supported by several other Maryland laws and programs that include outreach and technical assistance for municipalities to assess and value their urban tree canopy goals, and plant trees to meet those goals.

The goals of this program are to plant 12.5 million trees in urban areas through the Forest Conservation Act, Marylanders Plant Trees, Tree-Mendous Maryland, and 5-103 State Highway Reforestation Act planting programs.

This program is performing as designed.

### **Program Objectives**

#### **Revised 2015 Estimate**

The potential emission reductions from the Increasing Urban Trees to Capture Carbon program in 2020 are estimated to be 0.02 MMtCO<sub>2</sub>e. Appendix C of this report provides a more detailed description of the process used to quantify GHG reductions.

### **Implementation Milestones**

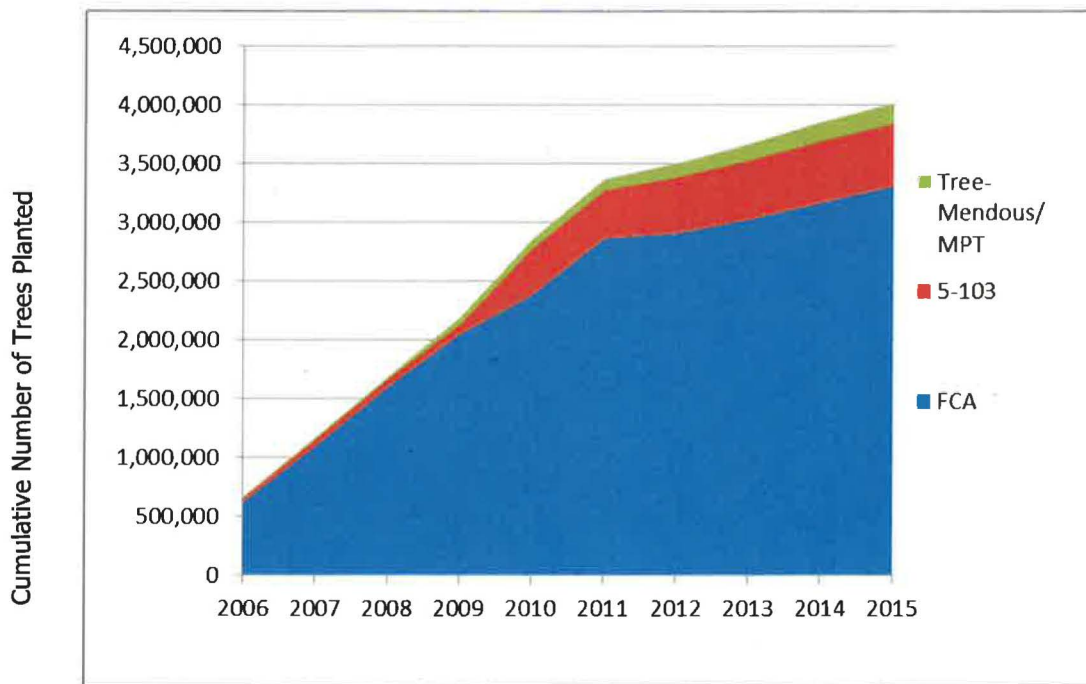
To date, 5,371,863 trees have been planted from 2006 to 2015 (total for this program and Planting Forests in Maryland).

### **Estimated Emission Reductions for CY 2015**

Urban tree plantings are estimated to sequester 0.002 MMtCO<sub>2</sub>e in 2015.

**Table I.4. Urban Tree Planting (number of trees).**

Year	FCA	5-103	Tree-Mendous/MPT	Totals
2006	623,700	33,750	8,178	665,628
2007	473,400	27,000	6,057	506,457
2008	499,500	9,900	2,160	511,560
2009	450,900	13,950	39,020	503,870
2010	337,950	308,250	23,000	669,200
2011	481,050	15,750	17,200	514,000
2012	42,300	68,850	21,700	132,850
2013	119,250	23,850	23,800	166,900
2014	140,580	24,615	21,500	186,695
<b>2015</b>	<b>142,875</b>	<b>6,251</b>	<b>8,435</b>	<b>157,561</b>
Totals	3,311,505	532,166	171,050	4,014,721



**Figure I.3 Increasing Urban Trees to Capture Carbon.**



## **Enhancement Opportunities**

The MD Department of Natural Resources – Forest Service (MD Forest Service) developed two new tree planting assistance programs that reach landowners within the urban/suburban areas of Maryland. The new programs target the 1.1 million acres of turf statewide. Each targets different lot size and different available planting space.

- The “Lawn to Woodland” program, a partnership with the Arbor Day Foundation, targets the small lot with 1-5 acres of plantable space or turf. The Foundation does outreach while MD Forest Service handles the tree planting at no cost to the lot owner. In Spring of 2014, a pilot was done with 14 acres planted on 12 lots. In Spring of 2015, the program planted 100.73 acres on 84 sites statewide.
- The other program, the “Marylanders Plant Trees” program, is a \$25 coupon reimbursement program targeting individuals wishing to plant a tree. It enables very small lot owners to purchase a tree valued at \$50 or more, and reduce the cost by the use of the \$25 coupon. There are 85 participating nurseries across the state. From the program’s inception in FY09 to FY15, 33,324 coupons have been reimbursed.

## **Funding**

The “Lawn to Woodland” program utilized all its funding with the 2016 spring planting. No current future funding source has been identified. The “Marylanders Plant Trees” program funding source is limited and expected to end in the next year.

## **Challenges**

As funding through the “Lawn to Woodland” and “Maryland Plant Trees” is expected to end in the next year, the Department will investigate opportunities to mix, match, and layer funding to complete projects. This will include various state and federal grants and low interest loan programs, private and non-profit grants, and tax incremental financing.

## **Relevant Information**

RESI’s 2015 Study estimated that the Increasing Urban Trees to Capture Carbon program, once fully operational, would support a total of 375 jobs by 2020, \$288,146,970 in net economic output and \$93,017,577 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **I.7 Geological Opportunities to Store Carbon**

### **Program Description**

Geological carbon sequestration differs from other discussed sequestration methods as it captures carbon at the source, transports it to the sequestration site, and then sequesters it. Maryland is one of eight partner states in the Midwest Region Carbon Sequestration Partnership whose role is to identify, locate, and characterize potential geologic storage opportunities. More than 10 gigatonnes of storage capacity has been identified to be available within the terrestrial portion of Maryland (103 years of storage capacity at current CO<sub>2</sub> estimated production rate of 97 million metric tons per year). An unquantified, but estimated larger in magnitude potential amount of storage is located in the offshore of Maryland.

The goal of this program is to identify and assess geologic storage opportunities. However, no quantification target has been assigned.

This program is performing as designed.

### **Program Objectives**

The potential emission reductions from the Geological Opportunities to Store Carbon program have been aggregated with the estimated emission reductions from the Terrestrial Sequestration bundle (Forestry and Wetlands).

### **Implementation Milestones**

DNR's Resource Assessment Service (RAS) has completed or is currently working on the following implementation milestones.

- Total organic carbon content in Maryland black shales (e.g., Marcellus) is being evaluated as a precursor for determining the viability of these as storage units for carbon dioxide. This data is incorporated into regional and national databases for various integration projects. Projected completion date is December 2019.
- The potential for offshore carbon sequestration is being evaluated in partnership with Harvard University, Battelle, US Department of Energy, Rutgers University, University of Texas, and the surrounding Mid-Atlantic States. Focus areas of this study include geologic characterization, capacity evaluations, injectability, and risk analyses. This project will provide foundation knowledge and an assessment of potential

for carbon sequestration offshore in the Baltimore Canyon Trough. Projected completion date is December 2017.

- The potential of saline aquifers located under the Coastal Plain in Maryland as a target for carbon sequestration is being evaluated in cooperation with multiple State Geological Surveys.
- Baseline data has been collected to provide the foundation for conducting risk analyses for potential development of stray gas migration into potable aquifers.
- Research is ongoing to assess the CO<sub>2</sub> chemical adsorption capacity of power plant combustion by-products and the organic shales and clays in the closest geologic formations.

Other RAS program notes include:

- Site testing (Carbon capture, transport, and storage) continues in Michigan and Ohio (Regional partners to Maryland in CO<sub>2</sub> sequestration projects) and has been completed in Kentucky. These programs are being evaluated at a national level and the results are positive at this time.
- Depleted gas fields present the most immediate option for permanent storage of carbon dioxide in western Maryland.
  - RAS is currently assessing the potential of utilizing black shales (e.g., Marcellus) as permanent sequestration locations as a logical reutilization of natural gas infrastructure, should it be permitted.
  - A methane emissions study of the Deer Park Anticline by the Western Maryland Regional GIS Center has ruled out using this Anticline for structural storage of CO<sub>2</sub> due to observed methane leaks primarily from the old Mountain Lake Park Gas Field. It could still have potential for chemical adsorption of CO<sub>2</sub>.

### **Estimated Emission Reductions for CY 2016**

None

### **Enhancement Opportunities**

The Taylorsville Formation is closest to the majority of Maryland's coal and gas fired power plants. An investigation focused on the CO<sub>2</sub> chemical adsorption capacity of this formation could best serve the Maryland electric power industry. RAS is leveraging funds from Battelle to analyze the exposed Gettysburg-Cullpepper Basin as a proxy for the Taylorsville Basin. This study was begun in 2016.

## **Funding**

Most of the funding for Geological Carbon Sequestration is coming from the US Department of Energy, organized and administered through Battelle. Twenty thousand dollars per year is provided through the State's Environmental Trust Fund.

## **Challenges**

The cost of capturing CO<sub>2</sub> using current technologies involves a parasitic loss of approximately 25% at the generation site. This cost has decreased over the last 5 years by 5%. It is anticipated this will decline to an 18% parasitic loss unless a vastly improved technology is identified. This cost, under the current carbon economic climate is cost-prohibitive for implementation at a grand scale. Thus, regardless of location and method of CO<sub>2</sub> sequestration, there must be an order of magnitude reduction in its cost of capture or development of sequestration methods or a change in carbon policy.

## **Relevant Information**

RESI's 2015 Study estimated that the Geological Opportunities to Store Carbon program, once fully operational, would support a total of 217 jobs by 2020, \$312,011,719 in net economic output and \$62,194,826 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **J. Ecosystems Markets**

### **J.1 Creating Ecosystems Markets to Encourage GHG Emissions Reductions**

#### **Program Description**

Increased attention to the benefits and cost efficiencies that ecosystem markets could provide has spurred evaluation of the potential its programs and policies may have for fostering carbon market development. Maryland's Forest Conservation Act and Critical Area Act require mitigation for natural resource impacts generated through land development, and mitigation banking is an option to address these mitigation requirements

The goal of this program is the establishment of ecosystem markets, creation of a tracking mechanism and the development of protocols to assess/quantify GHG benefits of individual markets. However, no quantification target has been assigned.

#### **Program Objectives**

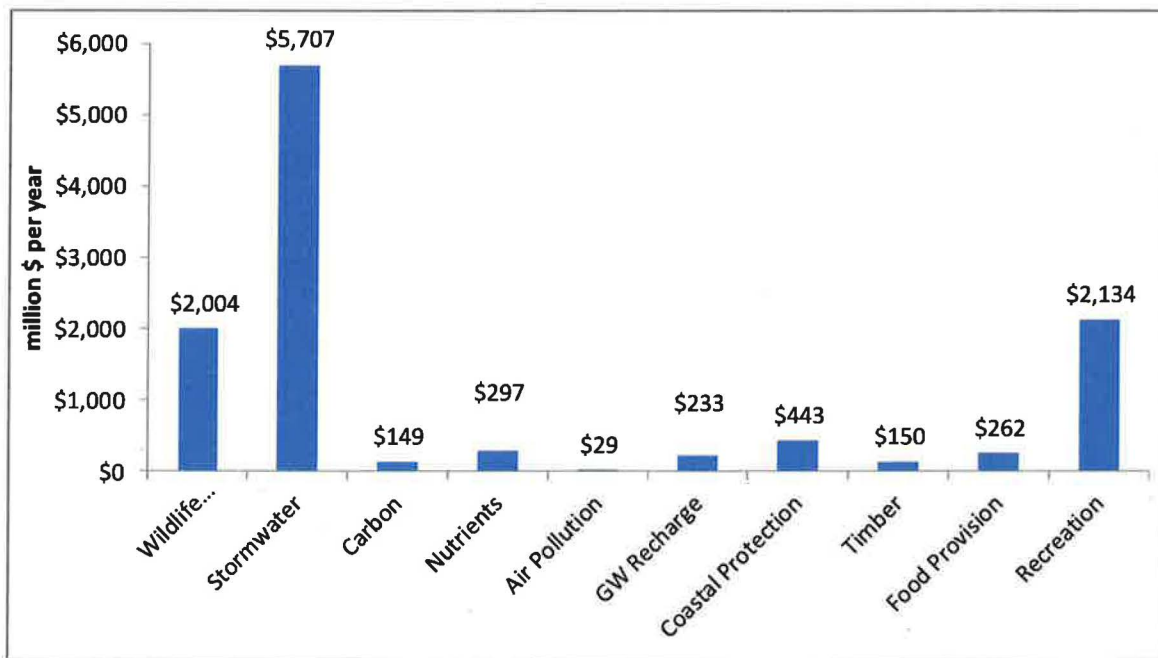
Revised 2015 Estimate

The potential emission reductions from the Creating Ecosystems Markets to Encourage GHG Emission Reductions program in 2020 are estimated to be 0.11 MMtCO<sub>2</sub>e. Appendix C of this report provides a more detailed description of the process used to quantify GHG reductions.

#### **Implementation Milestones**

- DNR has initiated a study to economically value a suite of ecosystem services for select habitats along an urban to rural gradient.
- The net effect will be conservation of natural lands and reduction of GHG emissions.
- Ecosystem services from forests, wetlands, cropland, and pasture land have been spatially quantified across the state of Maryland.

- Spatial models for coastal ecosystem services have been initiated, to be completed in FY2017
- Ecosystem service assessment of Charles County, Maryland has been completed, indicating that ecosystems provide over \$500 million of value every year to county residents.
- The preliminary assessment for the State of Maryland estimates a total value of \$11.4 billion of benefits from natural lands provided every year (see figure).
- The Nontidal Wetlands Mitigation Banking bill passed in 2016 removes barriers to mitigation banking in Maryland, with the goal of reducing cost for meeting mitigation requirements in an ecologically beneficial way.
- Forest Conservation Act (FCA) banking. Several counties in Maryland allow off-site mitigation for forest loss through purchasing credits in a forest bank. Over 2000 acres of forest loss have been mitigated in this way over the past 15 years.



**Figure J.1** Creating Ecosystem Markets to Encourage GHG Emission Reductions Preliminary Results.

### **Enhancement Opportunities**

As currently functioning ecosystem markets in Maryland are not designed to meet the goals of climate change mitigation. Banking for forests and wetlands could prioritize habitat types that have high potential for carbon sequestration, like forested wetlands or deciduous forests. If mitigation were to be required on more acreage than is impacted it is likely there will be net carbon sequestration. Adoption of ecosystem service valuation for restoration activities, state land acquisition, or best management practice implementation (i.e. to meet WIP water

quality goals) would optimize for the greatest net ecosystem service benefit. In particular, the GHG impact of certain BMP's could be calculated and preference given to practices with greater GHG reductions but similar cost per quantity of nutrients reduced. A cap-and-trade program for carbon would stimulate a carbon market in the state, but this would likely have to be initiated at the federal level.

## **Funding**

Was the state to require, or create incentives for, forest and wetland mitigation activities or nutrient reduction BMP's with greater carbon sequestration potentials it may reduce costs relative to conducting nutrient and carbon reduction programs independently. These savings could be put towards subsidizing actions that reduce both carbon and nutrients. Results from the Accounting for Maryland's Ecosystem Services assessment indicate that investing in preservation or restoration of green infrastructure is often more cost effective than "grey" infrastructure alternatives, when factoring in the multiple benefits of green infrastructure, including sequestering carbon. This has potential implications for funding of various state programs and is currently the subject of a state funded study by the University of Maryland's Environmental Finance Center.

## **Challenges**

Without a cap and trade program on the national level the voluntary carbon market in the United States has largely failed. Working within the boundaries of currently functioning ecosystem marketplaces for wetlands, forests, and habitat presents limited opportunities for generating net carbon reductions. While economically valuing ecosystem services in Maryland is an important first step, we must translate these values to greater investment in conservation and restoration of natural lands to create a positive trend in ecosystem services provided (including the sequestration of carbon).

## **Job Creation and Economic Benefits**

### **Revised 2015 Estimate**

RESI's 2015 Study estimated that the Geological Opportunities to Store Carbon program, once fully operational, would support a total of -1,758 jobs by 2020, \$423,431,394 in net economic output and \$358,169,556 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.