Organics Management Plan, including Siting, Technology and Capacity Planning, for Montgomery County, Maryland

Prepared for

Montgomery County Department of Environmental Protection
Under Contract to Maryland Environmental Service
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LIST OF ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
µm	Micrometer(s)
AASHTO	American Association of State Highway and Transportation Officials
AD	Anaerobic digestion
AR	Agricultural Reserve
ASP	Aerated static pile
BMP	Best Management Practice
BSM	Bioretention soil mix
C:N	Carbon to nitrogen
CH_4	Methane
CO_2	Carbon dioxide
CO2eq	Carbon dioxide equivalent
Coker	Coker Composting and Consulting
COMAR	Code of Maryland Regulations
County	Montgomery County
CSTR	Continuous-stirred tank reactor
CY	Cubic yard(s)
DEP	Department of Environmental Protection
EA	EA Engineering, Science, and Technology, Inc., PBC
EPA	U.S. Environmental Protection Agency
ESD	Environmental Site Design
ft	Foot (feet)
FY	Fiscal year
GHG	Greenhouse gas
GIS	Geographic information system
IH	Heavy industrial
ILSR	Institute for Local Self-Reliance
in.	Inch(es)
kg	Kilogram(s)
M-NCPPC	Maryland-National Capital Parks and Planning Commission
MCYTCF	Montgomery County Yard Trim Composting Facility
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
mg/kg	Milligram(s) per kilogram

MTCO2e	Metric tons of carbon dioxide equivalents
MDOT	Maryland Department of Transportation
MEP	Maximum Extent Practicable
MES	Maryland Environmental Service
mm	Millimeter(s)
mmhos/cm	Millimhos per centimeter
MP	Microplastic
MS4	Municipal separate storm sewer system
MSF	1,000 square feet
MSW	Municipal solid waste
nm	Nanometer(s)
NRAES	Natural Resource, Agriculture, and Engineering Service
O&M	Operation and maintenance
P	Phosphorus
PFAS	Per- and polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PH	Persistent herbicide
ppb	Part(s) per billion
ppt	Part(s) per thousand
psi	Pound(s) per square inch
RNG	Renewable natural gas
RRF	Resource Recovery Facility
RRMD	Recycling and Resource Management Division
RRS	Resource Recycling Systems
SCA	Sugarloaf Citizens Association
SF	Square foot (feet)
SHA	State Highway Administration
Shady Grove TS	Shady Grove Processing Facility and Transfer Station
SSO	Source-separated organics
SWM	Stormwater Management
TPY	Ton(s) per year
USDA	U.S. Department of Agriculture
v/v	Volume per volume
VOC	Volatile organic compound
WARM	EPA Waste Reduction Model

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EXECUTIVE SUMMARY

EA Engineering, Science, and Technology, Inc., PBC (EA) and its team, including Coker Composting and Consulting and Amplify for Change, were contracted by the Maryland Environmental Service for Montgomery County to prepare this organics siting study plan to evaluate the siting, technology, and capacity planning for a County-owned organics processing facility in Montgomery County to meet the food scrap, non-recyclable paper, and yard trim diversion needs of the County for the next 20 years. The EA Team completed the evaluation as outlined below.

SOURCE SEPARATED ORGANIC MATERIAL FEEDSTOCK PROJECTIONS

The County has a long-standing yard trim diversion program, capturing around 90% of the yard trim generated, and processing up to the processing limit of 77,000 tons of yard trim per year at the Montgomery County Yard Trim Composting Facility (MCYTCF). In contrast, food waste and non-recyclable paper present organic waste streams with significant opportunity to improve upon historically low capture rates.

Projections for capture of food waste and non-recyclable paper were developed based on eight scenarios considering the potential of low, medium, high, and mandatory participation by single-family, multi-family, and non-residential sectors in the county. Survey response data were used to inform the projections for single-family households, by creating an understanding for the potential for future public engagement. In four of the scenarios, decentralized processing strategies, including backyard, community, and on-farm composting, were considered to understand the extent to which these pathways may process food scraps and offset the processing capacity required by the County. Projected food scrap capture quantities varied from 8,800 to 65,800 tons per year in low to mandatory scenarios, and up to 58,300 tons per year captured where diversionary measures through decentralized processing were in place. The food scrap capture projections are shown in Table ES-1.

Table ES-1. Projected Food Scraps Capture (Tons) by Year

Scenario	2025	2030	2035	2040	2045
1	4,600	5,700	6,700	7,700	8,800
2	6,400	10,700	15,100	19,600	24,100
3	7,300	18,500	30,000	41,900	54,000
4	7,300	35,500	45,300	55,400	65,800
5	4,600	5,700	6,700	7,700	8,800
6	4,800	7,600	11,900	16,500	21,100
7	5,700	15,400	26,900	38,800	51,000
8	3,500	28,100	37,700	47,900	58,300

SOURCE SEPARATED ORGANICS PROCESSING OPTIONS

Organics processing technologies were reviewed, focusing on the current state-of-practice technologies and their potential to support municipal-scale processing of food scrap and yard trim. Several aerobic processing technologies were evaluated in this study, including aerated static pile (ASP); enclosed in-vessel tunnel reactors; rotating drums; and agitated bed composting systems. In addition, anaerobic processing technologies were evaluated, including wet (low-solids) continuous-stirred tank reactor (CSTR) anaerobic digestion (AD), high-solids dry fermentation AD, and high-solids plug flow AD. Technology review included discussion of pre- and post-treatment processing; pollutants of concern, including per- and polyfluoroalkyl substances, microplastics, and persistent herbicides; and greenhouse gas emissions assessment. To discern the most suitable organics processing technology, the EA Team used a weighted matrix approach to rank each technology with County input on 20 evaluation criteria considering systems factors, operations, end products, and environmental concerns. The technologies were ranked as shown in Table ES-2.

Table ES-2. Technology Ranking Summary Table

Technology	Weighted Score
ASP	269.8
Tunnel Reactor	253.5
Agitated Bed	227.5
Dry Fermentation	225.9
Rotating Drum	212.9
High Solids Plug Flow	201.5
Wet (low-solids) CSTR	185.3

RECYCLED ORGANICS PRODUCT USAGE OPTIONS

As all organics processing end products must have viable end markets to be successful, a review of the end products and potential capacities of end markets in the county to absorb recycled organics products from aerobic and anaerobic organics processing technologies was conducted. End products reviewed included compost, biogas, and digestate. Market capacity by sector was considered for landscaping, agriculture, and stormwater management for new construction/redevelopment, with an estimated market capacity of 276,600 cubic yards (CY) per year, or 69,800 CY per year for the County's market share. Although not quantified, additional emerging discussion included erosion and sediment control applications, development of soil organic matter content, and climate sequestration and climate action plans.

SITING EVALUATION

To support an organics processing facility, a site must meet the needs to receive, process, and distribute organic feedstocks and finished products. The siting evaluation examined the feasibility of using County-owned property for the development of an organics management facility, including review of the Shady Grove Processing Facility and Transfer Station (TS), the MCYTCF at Dickerson, and the tract of land known as Site 2 in Dickerson. To discern the most suitable site, the EA Team used a weighted matrix to rank each technology with County input, using 17 evaluation criteria for evaluating each site, including site characteristics that may affect site development, conditions local to each site, and community considerations. The sites were ranked as shown in Table ES-3.

Table ES-3. Site Ranking Summary Table

Technology	Weighted Score
MCYTCF	267.0
Shady Grove TS	236.0
Site 2	219.8

In addition, the EA Team performed a desktop analysis based on publicly available geographic information system data to determine whether any additional County-owned parcels merit further review as potential locations for facility siting. From the initial desktop analysis, EA identified 101 parcels meeting evaluation criteria for County ownership over 25 acres and outside of the presence of wetlands and floodplains. However, with further County review and refined selection criteria, all sites were removed from consideration due to current use or accessibility. A preliminary desktop evaluation was done with non-County-owned sites over 25 acres, but further consideration and discussion would be needed to identify if the sites were viable and merit the additional costs of land acquisition.

EVALUATION OF ALTERNATIVES

The projections, the technology evaluation, and the siting study were combined into five alternatives for consideration. While other combinations of technology and siting may be viable, these five alternatives were prioritized based on rankings previously developed in this report. Additional combinations of technology and siting beyond those represented as Options 1 through 5 are discussed in Chapter 6 with additional cost considerations.

The five alternatives presented considered a phased processing facility development, with adequate capacity to process up to 97,400 tons (273,500 CY) of yard trim and food scrap in Phase I, and to meet the future processing capacity needs identified in the mandatory program and some high capture scenarios in Phase II. Conceptual capital and operation and maintenance costs were developed for the purposes of comparing alternatives. To discern the preferred alternative, the EA Team used a weighted matrix to rank each alternative, with County input, using eight evaluation criteria important for facility development. The alternatives were ranked, with pros and cons for each alternative summarized, as shown in Table ES-4.

Table ES-4. Alternatives Ranking Summary Table

Alternative	Weighted Score	Pros	Cons
Option 1 – ASP Composting at MCYTCF	103.8	• Technology process controls optimize material processing • Established technology familiar to regulators	• Material receiving requires transport from Shady Grove TS • Site upgrades to MCYTCF required • Management of contact water required

Alternative	Weighted Score	Pros	Cons
Option 3 – Agitated Bed Composting at Site 2	92.0	• Effective system for large-scale operations • Indoor processing yields little to no contact water • High degree of process control	• Significant capital costs for equipment and building • Material receiving requires transport from Shady Grove TS and would require additional road access from RRF to Site 2
Option 2 – In-Vessel Tunnel Reactor Composting at Shady Grove TS and Product Finishing at MCYTCF	75.3	• Minimal contact water generation • High degree of process control to minimize odors and optimize material processing	• Significant capital costs for equipment and concrete construction • Shady Grove TS at capacity with existing operations, requiring relocation of current activities or acquisition of adjacent parcels • Material receiving and processing at Shady Grove TS with curing off-site with significant transportation cost
Option 5 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF	71.5	• Enclosed system yields little to no contact water • No MCYTCF upgrades required	• Material receiving and processing at Shady Grove TS with curing off-site • Shady Grove TS at capacity with existing operations, requiring relocation of current activities or acquisition of adjacent parcels • Unclear permitting pathway and unfamiliar to regulators • End products include digestate and biogas which require additional management
Option 4 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF via Tunnel Reactor Composting	64.0	• Enclosed system yields little to no contact water	• Material receiving and processing at Shady Grove TS with curing off-site • Shady Grove TS at capacity with existing operations, requiring relocation of current activities or acquisition of adjacent parcels • Unclear permitting pathway and unfamiliar to regulators • End products include digestate and biogas which require additional management • MCYTCF upgrades required

CONCLUSION

The County has a demonstrated need for organics processing capacity to meet the yard trim and food scrap generation and capture projected over the planning period. Final alternatives provide the outline of facility site development alternatives that utilize proven organics processing technologies at County-owned sites. Achieving food scrap diversion at low, medium, or high capture levels will continue to require rigorous program development and public engagement.

While all alternatives presented rely on a centralized processing approach concentrating processing capacity at a single site, it is noted that a distributed processing approach merits further evaluation by the County, including identification of suitable land area for development. While pursuing a distributed processing approach would require further study, it may provide the County with an avenue to address its already burdened solid waste management facilities. Moreover, implementation of decentralized processing approaches may be effective for geographic regions of the County, while a centralized processing option located at an existing County facility may also be an effective systems approach. Further, where diversionary measures such as expanded backyard, community, and on-farm composting are utilized, the viable capacity life of proposed organics processing alternatives developed in this study may be extended beyond the planning period.

1. INTRODUCTION

The EA Engineering, Science, and Technology, Inc., PBC (EA) Team, including Coker Composting and Consulting (Coker) and Amplify for Change, was contracted by the Maryland Environmental Service (MES) to conduct a study for the development of a Montgomery County (County)-owned organics processing facility to meet the food scrap, non-recyclable paper, and yard trim diversion needs of the County for the next 20 years.

Currently, the County manages the collection by contractor of recyclables, yard trim, and scrap metal for approximately 222,000 households, and the collection by contractor of refuse for approximately 92,000 households. The remaining 130,000 households arrange for private collection individually or through their homeowner's association. This study considers the organics captured from single-family residences located in Subdistricts A and B, municipalities; multi-family and commercial sectors (e.g., businesses, non-profits, institutions, and federal, state, and local government offices) within Montgomery County.

1.1 METHODOLOGY

The intent of this study is to evaluate the potential for organic waste processing separately from the municipal solid waste (MSW) stream currently managed through waste to energy. The feasibility of diverting organic waste and processing by other methods was evaluated as follows:

- **Source Separated Organic Materials Feedstock Projections (Chapter 2)** – Projections for organic waste generated and captured from residential, commercial, industrial, and agricultural sectors were estimated over the planning period, to assess the organic waste processing capacity that may be required over the planning period.

- **Source Separated Organics Processing Options (Chapter 3) –** A review of the state-of-practice of organics processing technologies in the country was evaluated and the capabilities and costs of organics processing options were outlined, including compost and anaerobic digestion technologies.

- **Recycled Organics Product Usage Options (Chapter 4)** – Potential uses of recycled material produced during organics processing were assessed, including end products from compost and anaerobic digestion, including compost, biogas, and digestate.

- **Siting Evaluation (Chapter 5)** – Three County-owned sites and a geographic information system (GIS)-based review of additional County-owned sites were evaluated for their characteristics to support an organics processing facility and ranked according to feasibility of development.

- **Development and Evaluation of Alternatives (Chapter 6)** – Five final alternatives were evaluated, based on the highest-ranking organics processing technologies and sites, and are reviewed in detail for capital and operation and maintenance costs.

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2. SOURCE SEPARATED ORGANIC MATERIAL FEEDSTOCK PROJECTIONS

Based on organic waste projected to be generated over the planning period 2025 to 2045 and levels of capture considered, this chapter is developed to understand the processing capacity necessary for a County organics processing facility. Projections considered herein are based on what may enter a County processing system and independent of existing processing capacity.

2.1 ORGANIC WASTE GENERATION

2.1.1 Overview of Data Sources

The EA Team examined publicly available and County-provided data sources providing critical context for County organic waste generation. A summary of select sources is presented below.

2.1.1.1 Montgomery County's Comprehensive Solid Waste Management Plan 2020–2029

Developed and updated at least every 3 years in accordance with Title 9, Subtitle 5 of the Environment Article of the Annotated Code of Maryland Regulation (COMAR) and COMAR 26.03.03.03, the plan provides a thorough review of current generation and collection systems, identifies needs of current systems, and highlights a plan of action for moving waste diversion forward, including outlining potential future efforts to improve organics diversion. In calendar year 2021, over 1.57 million tons of waste was generated within the county, including approximately 910,900 tons of County-managed MSW (Montgomery County Department of Environmental Protection [DEP] 2021a, 2023c). The organic fraction of County-managed MSW is the focus of this report.

2.1.1.2 Montgomery County's Solid Waste Capture Model

The County's Capture Model provides a spreadsheet-based analysis of waste within the County, including waste tracking by material type, and tonnages generated and captured in single-family, multi-family, and non-residential sectors. For consistency with County tracking and available data, organics material types including yard trim, food scrap, non-recyclable paper, manure, and animal protein are considered in this report. For the organics material types noted, the Capture Model identifies that County-managed MSW included over 339,800 tons of organic waste in calendar year 2021 (Montgomery County DEP 2023c).

2.1.1.3 County's Waste Composition Studies

The County regularly performs waste characterization studies to identify the composition of their disposed waste and to understand where material diversion from disposal can be improved. The most recent study examined waste data collected from 300 samples of the as-disposed waste stream across all four seasons. This study, which the County uses to inform its Capture Model for waste disposed, estimates that compostable organics accounted for approximately 23.4% of the solid waste disposed, comprised of 16.6% food waste and 6.9% non-recyclable paper (SCS Engineers 2023). The County's Capture Model shows that this represented 130,400 tons of food waste and non-recyclable paper disposed in calendar year 2021 (Montgomery County DEP 2023c).

2.1.2 Projected Household and Population Growth

The Montgomery County Planning Department, the Maryland-National Capital Park and Planning Commission (M-NCPPC), maintains growth forecasts for the County developed in the Round 9.2 Cooperative Forecasts (Metropolitan Washington Council of Governments 2022). Population projections utilize 2020 census data and econometric model projections for employment, population, and households, to develop population projections in 5-year increments. Montgomery County DEP utilizes these data to develop projections for the total number of households in the County, including single-family households in the County's Subdistricts A, B and municipalities, and multi-family households. The resulting housecount projections are utilized for County solid waste and recycling collections planning.

Over the planning period, population projections show an increase of 14.7% and a total housecount increase of 15.8% (Montgomery County DEP 2023b), as shown in Table 2-1. Figure 2-1 shows a percentage breakdown of housecount by subgroup. The EA Team utilized housecount projections to estimate organic waste generation within the single-family and multi-family sectors, and to consider participation in future organics diversion efforts tailored to the waste generation characteristics of the County's Subdistrict A, B, and municipalities.

Table 2-1. Population and Housecount Projections, 2025–2045

Parameter	2025	2030	2035	2040	2045	Percent Change Over period
Population	1,090,000	1,130,000	1,170,000	1,210,000	1,250,000	14.7%
Employment (no. of jobs)	573,000	605,000	627,000	650,000	673,000	17.5%
Housecount – Single Family Subdistrict A	93,200	95,500	97,900	100,300	102,700	10.2%
Housecount – Single Family Subdistrict B	129,800	133,000	136,300	139,700	143,100	10.2%
Housecount – Municipalities	39,900	40,900	41,900	43,000	44,000	10.3%
Housecount – Multi-Family	147,400	158,000	167,100	176,300	185,400	25.8%
Housecount Total	410,300	427,300	443,300	459,200	475,200	15.8%

Source: Montgomery County DEP 2023b.

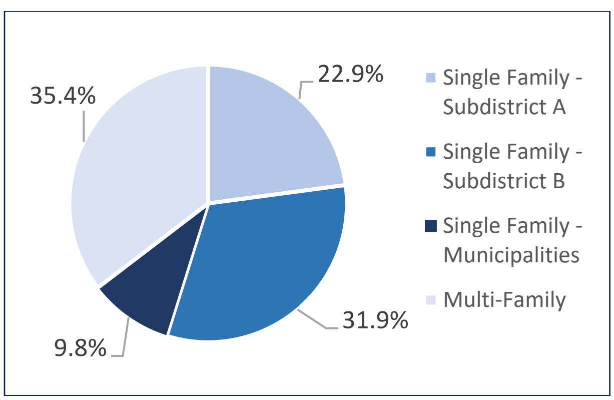

Figure 2-1. Housecount by Subgroup

2.1.3 Organic Waste Generation Projections (Baseline)

To develop organic waste generation projections over the planning period, the EA Team utilized County data for organic waste generation coupled with housecount and employment projections previously discussed. This approach was utilized in lieu of population-based projections, as it provides a more accurate representation of residential food scrap generation between County Subdistricts A, B, and municipalities. For non-residential waste generation, the County's employment data are utilized to account for commercial waste generated in-County, including that generated by those working in the County that are not County residents. Of the total 910,900 tons of County-managed MSW generated in calendar year 2021, organic waste represented 37.3%, or 339,800 tons, as shown in Figure 2-2. Of the organic waste considered for diversion in this report, the breakdown of generated material by type is shown in Figure 2-3.

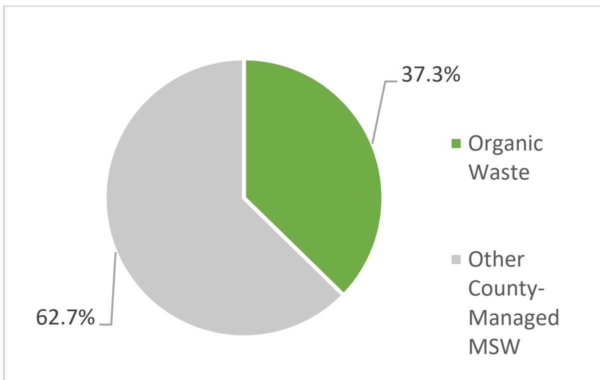

Figure 2-2. Organic Waste Fraction of County-Managed MSW, Calendar Year 2021

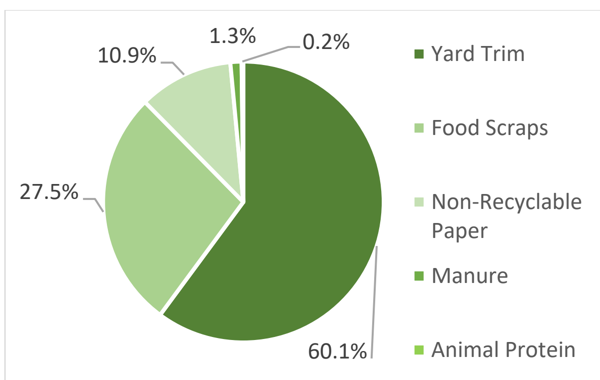

Figure 2-3. Organic Waste Generation by Material Type

A summary of organic waste generation projections by material type is included in Table 2-2, with complete projections included in Appendix A. Projections consider that organic waste generation increases proportionally with the number of households and employment, respectively, for the target organic waste material types considered in this report.

Table 2-2. Organic Waste Generation Projections, 2025-2045 (tons)

Group	Calendar Year 2021 (Actual)	2025	2030	2035	2040	2045
Yard Trim	204,293	223,700	226,900	230,100	233,300	236,500
Food Scraps	93,418	102,300	103,700	105,200	106,700	108,200
Non-Recyclable Paper	37,002	40,500	41,100	41,700	42,300	42,800
Manure	4,386	4,800	4,900	4,900	5,000	5,100
Animal Byproducts	697	760	770	780	800	810
Total	**339,795**	**372,100**	**377,400**	**382,700**	**388,100**	**393,400**

Projections present the baseline of organics generation and serve as a reference point for the organics capture projections presented later in this chapter. These baseline projections are based on historical data through calendar year 2021, with actual calendar year 2021 data shown for reference, and do not reflect reductions in organics generation resulting from more recent County initiatives for waste reduction and diversion in the residential and commercial sectors; emerging trends affecting organics diversion are considered later in this chapter.

2.2 ORGANIC WASTE CAPTURE IN COUNTY SYSTEMS

2.2.1 Calendar Year 2021 Organic Waste Capture

In calendar year 2021, the organic waste captured by material type is shown in Figure 2-4. Generation and capture of yard trim was very high, demonstrating the already successful efforts by the County to meet the State mandate of diverting these materials from disposal. Capture of manure and animal protein was near 100%; however, only *de minimis* amounts were generated. In contrast, capture of food scraps and non-recyclable paper generated was low. Capture varied by single-family, multi-family, and non-residential sectors, as demonstrated in Table 2-3. Given the tons of food scrap and non-recyclable paper generated with relatively little capture across all sectors, these organic materials present a significant opportunity for capture going forward.

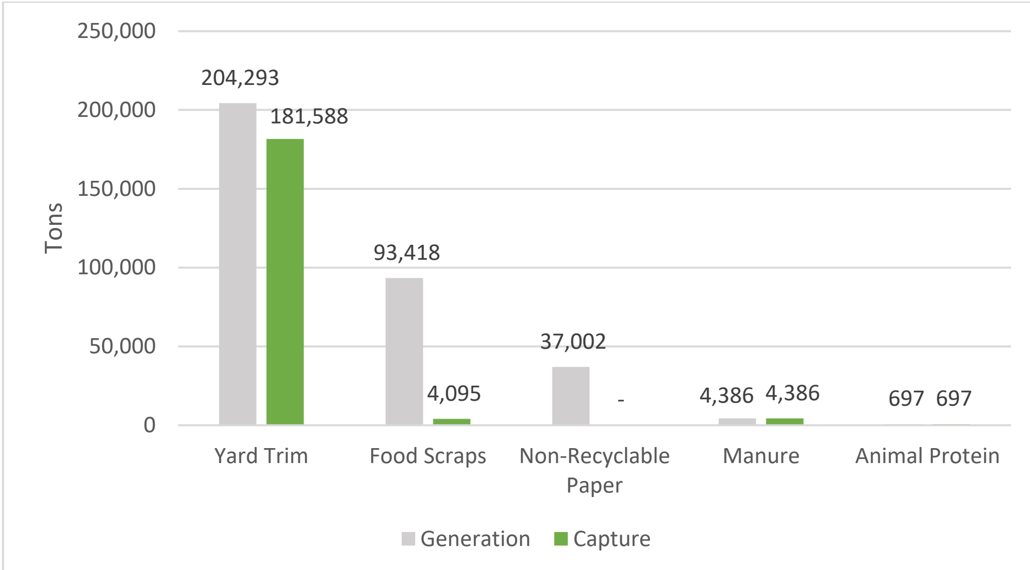

Figure 2-4. Organic Waste Capture by Material Type

Table 2-3. Calendar Year 2021 Organic Waste Capture by Sector and Material (tons)

Parameter	Single-Family	Multi-Family	Non-Residential	Total
Yard Trim	63,900	2,000	115,700	181,600
Food Wate	1,400	30	2,700	4,100
Non-Recyclable Paper	-	-	-	-
Manure	-	-	4,400	4,400
Animal Byproducts	-	-	700	700
Total	**65,300**	**2,030**	**123,500**	**190,800**

2.2.2 Historical Trends in Organic Waste Capture

Based on review of the County's available Capture Model data from 2018 through 2021, food scrap capture in single-family and multi-family sectors increased steadily, albeit modestly, while food scrap capture in the non-residential sectors decreased, as shown in Figure 2-5. The positive trend in residential (single-family and multi-family sectors) food scrap capture may suggest public awareness of food scrap diversion in the general population has increased in step with both local and national environmental awareness. Capture trends observed within the County seem to mirror solid waste generation trends observed during the COVID-19 pandemic, whereby residential food and packaging waste generation increased relative to pre-pandemic levels, while industrial, commercial, and institutional waste generation decreased.

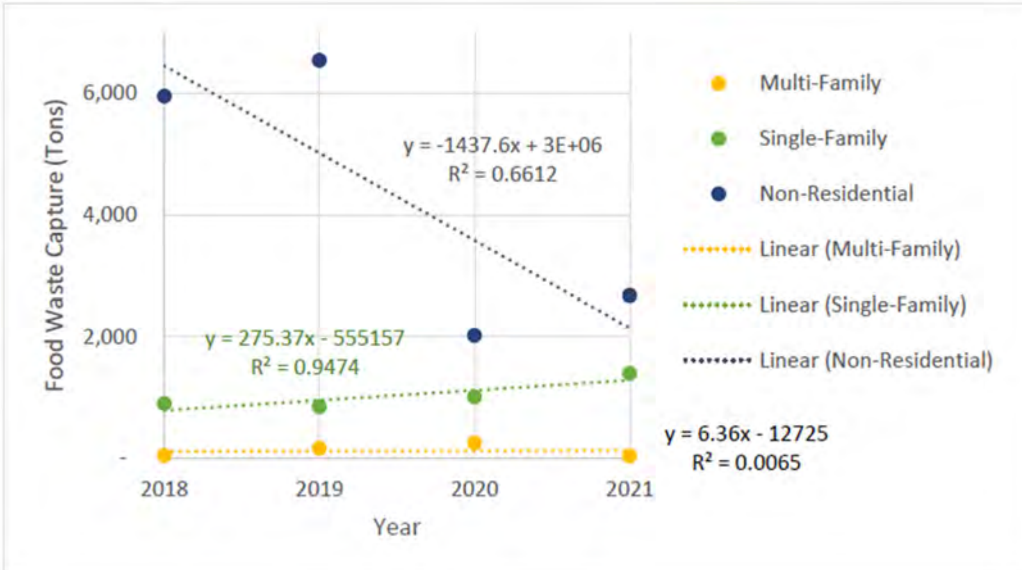

Figure 2-5. Historical Food Scrap Capture Trends

2.2.3 Organic Waste Capture Scenarios

To estimate the food scrap capture potential, the EA Team developed projections over the planning period for food scrap capture with voluntary participation in diversion programs considering low, medium, and high capture scenarios. In addition, projections considered capture in a mandatory diversion requirement scenario. The assumptions of each capture scenario are summarized below, and associated projections detailed in this section.

- Low Capture – Assumes historical trends in the County's capture of food scrap continue as is through the planning period. No additional processing capacity is required.

- Medium Capture – Assumes historical capture trends are improved by the implementation of new County diversion programs. Existing processing capacity may not be adequate to process material captured in this scenario, and securing additional processing capacity in the future may be required.

- High Capture – Assumes historical capture improved by new program implementation and increased public participation. Existing processing capacity is not adequate to process material captured in this scenario, and securing additional processing capacity in the future will be required.

- Mandatory Diversion – Assumes implementation of a mandatory County program, requiring food scrap diversion in all sectors. Existing processing capacity is not adequate to process material captured in this scenario, and securing additional processing capacity in the future will be required.

2.2.4 County Diversion Programs

In accordance with the Montgomery County Council Bill 28-16 “Strategic Plan to Advance Composting, Compost Use, and Food Waste Diversion” passed in 2016 as an amendment to Chapter 48 of the County Code, DEP was required to develop a strategic plan to achieve the objectives of the bill. In response, the DEP Recycling and Resource Management Division (RRMD) developed the Strategic Plan to Advance Composting, Compost Use, and Food Scraps Diversion in Montgomery County, Maryland (Montgomery County DEP 2018a), organizing over 215 stakeholders to provide recommendations for food scrap diversion over six focus areas:

- Reducing Wasted Food/Channeling Food to Others
- In-Home, Backyard, and Community-Scale Composting
- On-Site Institutional and On-Site Business Composting
- On-Farm Composting
- Composting in Montgomery County
- Strategies to Maximize Food Scrap Collection at the Curb

Based on the plan of action outlined within each focus area, the DEP RRMD proceeded with developing, implementing, and managing programs, education and outreach initiatives, and other efforts to improve single-family residential, multi-family residential and commercial food scrap diversion. As of April 2023, DEP RRMD food scrap programs and initiatives are noted below and highlighted in Appendix B. Program data, where available, are utilized to inform the medium capture scenarios developed for single-family, multi-family, and non-residential sectors, as discussed by sector in the following section.

- Backyard Composting – *Total backyard composting bins distributed, total backyard composting events hosted, and total event attendees from calendar year 2018 to 2022.*

- Single-Family Residential Food Scraps Curbside Recycling Collection Pilot Program – *Total tons collected from Potomac and Silver Spring (Phase I) from December 2021 through April 2023.*

- Multi-Family Residential Food Scraps Recycling Program – *Total tons collected from participating properties provided from calendar year 2014 to 2021.*

- Commercial Food Scraps Recycling Partnership Program – *Total tons collected from June 2020 through April 2023.*

- Edible Food Recovery Program

- “Food Is Too Good To Waste” Wasted Food Reduction Program

In addition, the County is currently conducting a Pay as You Throw program study and pilot implementation. This may affect future organic waste generation and capture efforts.

2.2.5 Public Participation

For food scrap capture projections, it is critical to understand public interest in food scrap reduction and diversion initiatives. To gain this insight, the EA Team developed a survey distributed by SurveyMonkey link and QR code to single-family households in the County, accessible in English and Spanish. Disseminated through existing County communications channels, including by email, social media, community newsletters, and in-person events attended by DEP, the survey invited a wide base of respondents representing a diversity of viewpoints on the County's solid waste management. From over 900 responses received from County residents in Subdistrict A, Subdistrict B and municipalities with a 95% confidence level and 5% margin of error, over 80% of respondents indicated they had an interest in participating in a curbside food scrap collection program, and over 35% of respondents indicated they would be interested in participating in backyard composting programs, as shown in Figure 2-6.

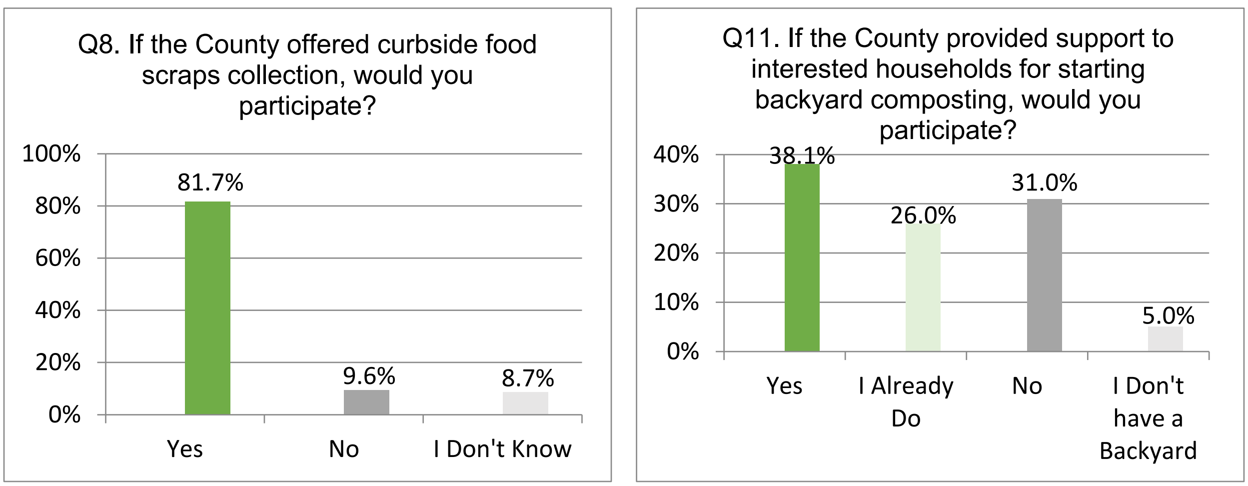

Figure 2-6. Public Interest in Participating in County Food Scrap Diversion Programs

Survey responses obtained were considered, along with additional comments providing anecdotal and situational insights from County residents, to qualitatively inform high capture projections for single-family households. Considering this information in developing projections for future planning creates a more realistic basis for estimating the rate of future program adoption based on the expression for which organic waste diversion approaches constituents already engage in or may have interest in engaging in. The complete report of survey results is included in Appendix C, including survey questions and response data, and distribution channel details.

2.2.6 Food Scrap Capture by Sector

2.2.6.1 Single-Family Households

Based on the historical trend of food scrap capture from single-family households, the low capture scenario projects that capture of food scraps from single-family households will increase by about 0.3% annually, from approximately 3.6% of food scrap generated in 2025 to 9.3% by 2045 or capture of approximately 5,200 tons in 2045. The medium capture scenario builds on this by considering participation trends in pilot programs for curbside collection of food scraps active into 2023. As of 31 July 2023, the pilot in Silver Spring (Subdistrict A) demonstrated participation (enrollment) by 35% of the 2,053 eligible households, generating an average of 8.5 pounds of food scraps (including non-recyclable paper) collected per participating household per week with a weekly setout rate of 90%; the pilot in Potomac (Subdistrict B) demonstrated participation by 19% of the 1,909 eligible households, generating an average of 10.1 pounds of food scraps per household per week with a 74% weekly setout rate; and the pilot in Bethesda (Subdistrict B) demonstrated participation by 18% of the 2,053 eligible households, generating an average of 11.6 pounds per household per week with a 72% weekly setout rate (Montgomery County DEP 2023e). Given these factors, the medium capture scenario projects that capture of food scrap from single-family households will increase by about 1.4% annually, from approximately 6.0% of food scrap generated in 2025 to 33.3% by 2045 or capture of approximately 18,900 tons in 2045.

The high capture scenario was estimated based on low and medium capture factors, as well as survey respondents' interest in participating in curbside collection food scrap programs. While over 80% of respondents noted they would participate in a County program, there are examples of curbside collections programs nationwide struggling to achieve higher than 50–60% participation, and some recent studies suggesting upper limits at 20–30% participation. Factoring in high interest with actual program participation across the country, the high capture scenario projects an initial spike of food scrap capture from single-family households reaching 28.7% by 2035, and thereafter increasing by approximately 2.1% annually to reach a voluntary program maximum of 50% by 2045, or approximately 28,300 tons.

The final capture scenario considers implementation of a mandatory diversion program implemented in 2025. Like the high capture scenario, the mandatory capture scenario projects an initial spike of food scrap capture from single-family households reaching 41.7% by 2035, and thereafter increasing by approximately 1.8% to reach 60% program participation by 2045 or capture of approximately 34,000 tons. In practice, the participation and capture from mandatory programs is strongly linked with program design and enforcement measures.

Table 2-4. Single-Family Food Scrap Tons Captured Scenarios

Scenario	2025	2030	2035	2040	2045
Generation (tons)	*54,000*	*54,400*	*55,000*	*56,000*	*57,000*
Low Capture (%)	3.6%	5.1%	6.5%	7.9%	9.3%
Medium Capture (%)	6.0%	12.9%	19.7%	26.5%	33.3%
High Capture (%)	7.5%	18.1%	28.7%	39.4%	50.0%
Mandatory Program (%)	7.5%	32.6%	41.7%	50.9%	60.0%
Low Capture (tons)	1,900	2,800	3,600	4,400	5,200
Medium Capture (tons)	3,200	7,000	10,900	14,800	18,900
High Capture (tons)	4,000	9,800	15,800	22,000	28,300
Mandatory Program (tons)	4,000	17,700	23,000	28,400	34,000

2.2.6.2 Multi-Family Households

The multi-family sector in the County, defined as residential buildings with 7 or more dwelling units (Montgomery County 2016), includes over 730 multi-family properties with over 145,000 dwelling units (Montgomery County DEP 2018b), with the greatest growth potential in this sector over the planning period as shown in Table 2-1. However, barriers to growth in multi-family food scrap collection include property manager concerns around vectors, contamination, and the space and personnel to manage on-site food scrap collections (Montgomery County DEP 2017). As previously noted, historical and projected organics tonnages and program participation presented in this section refers to the Multi-Family Residential Food Scraps Recycling Program and available program data from calendar year 2014 to 2021.

Based on the historical trend of food scrap capture from multi-family households, the low capture scenario projects that capture of food scraps from multi-family households will increase by about 0.04% annually, from approximately 0.8% of food scraps generated in 2025 to 1.5% by 2045 or capture of approximately 280 tons in 2045. This capture scenario reflects that historically, capture from multi-family households has been very limited. The medium capture scenario builds on the low capture scenario by examining emerging participation trends in multi-family food scrap diversion. Multi-family buildings enrolled in the program and reporting data as of 2022 represented approximately 2,000 dwelling units, contributing 30 tons of food scraps (Montgomery County DEP 2023d). Based on program participation trends, the medium capture scenario projects that capture of food scraps from multi-family households will increase by about 0.8% annually, from approximately 1.4% of food scraps generated in 2025 to 3.1% by 2045 or capture of approximately 590 tons in 2045.

The high capture scenario was estimated based on these factors and the results of a survey distributed to property managers of over 700 multi-family properties in 2017 (Montgomery County DEP 2017), with over 14% of respondents noting food scrap recycling as viable in the future for their property. Factoring this potential for future participation with current program participation rates, the high capture scenario projects that capture of food scraps from multi-family households will increase by approximately 0.7% annually, reaching a voluntary diversion program maximum of 17.1% by 2045 or capture of approximately 3,260 tons in 2045.

The final capture scenario considers implementation of a mandatory diversion program implemented in 2025. Like the high capture scenario, steady 1.7% increases will reach 35% multi-family property participation by 2045 or capture of approximately 6,690 tons. The participation and capture from mandatory programs is strongly linked with program design and enforcement measures. To support improvements to multi-family food scrap diversion, resources and support for program development at individual residential buildings will be critical.

Table 2-5. Multi-Family Food Scrap Tons Captured Scenarios

Scenario	2025	2030	2035	2040	2045
Generation (tons)	*18,100*	*18,300*	*18,600*	*18,900*	*19,100*
Low Capture (%)	0.8%	1.0%	1.2%	1.3%	1.5%
Medium Capture (%)	1.4%	1.9%	2.3%	2.7%	3.1%
High Capture (%)	2.7%	6.3%	9.9%	13.5%	17.1%
Mandatory Program (%)	1.4%	12.7%	20.1%	27.6%	35.0%
Low Capture (tons)	150	180	220	250	280
Medium Capture (tons)	260	340	420	510	590
High Capture (tons)	490	1,150	1,840	2,550	3,260
Mandatory Program (tons)	260	2,320	3,740	5,210	6,690

2.2.6.3 Commercial Sector

The non-residential sector in the County is estimated to include over 2,800 industrial, commercial and institutional food scrap generators in the County, including over 1,400 restaurants and food service businesses (U.S. Environmental Protection Agency [EPA] 2023a,b). While the County is not required by Code to provide waste disposal capacity for the non-residential sector, organic capture from this sector represents a significant waste tonnage for organics diversion.

Based on the historical trend of food scrap capture from the non-residential sector, the low capture scenario projects that capture of food scraps will increase by about 0.09% annually, from approximately 8.3% of food scraps generated in 2025 to 10.0% by 2045 or capture of approximately 3,200 tons in 2045. In addition to these factors, the medium capture scenario considers participation trends in commercial food scrap diversion programs; as of 2022, 32 businesses participating in the program contributed 352 tons of food scraps (Montgomery County DEP 2023f). Based on program participation trends since 2018, the medium capture scenario projects that capture of food scraps from the non-residential sector will increase by about 0.3% annually, from approximately 9.8% of food scraps generated in 2025 to 15.5% by 2045 or capture of approximately 5,000 tons in 2045.

For the non-residential sector, both the high capture and mandatory program scenarios were estimated to capture food waste tonnages based on the current State diversion mandate for large food waste generators in effect as of 1 January 2023 codified in HB264/SB483. Based on review of the Excess Food Opportunities Map database (EPA 2023a), 29 large generators (excluding exempted restaurants and food service businesses) were estimated to meet the generation threshold of 2 tons per week, generating over 8,000 tons per year of food waste. As of 1 January 2024, the diversion threshold of 1 ton per week is estimated to require 27 total businesses to divert (excluding exempted restaurants and food service business), generating an additional 3,000 tons per year of food waste. Both the high capture and mandatory program scenarios assume the addition of a 0.5 ton per week threshold requiring diversion in 2029 with no generators exempted, that could be implemented as part of a County mandate or further State-wide legislation. This would require a total of 139 businesses to divert, generating an additional 5,000 tons per year of food waste. Table 2-7 summarizes the breakdown by sector of businesses generating food waste in excess of the threshold requiring diversion. Figure 2-7 presents the distribution of food waste generators within the County.

Table 2-6. Non-Residential Food Scrap Tons Captured Scenarios

Scenario	2025	2030	2035	2040	2045
Generation (tons)	*31,000*	*31,000*	*31,000*	*32,000*	*32,000*
Low Capture (%)	8.3%	8.7%	9.1%	9.6%	10.0%
Medium Capture (%)	9.8%	11.3%	12.7%	14.1%	15.5%
High Capture (%)	9.8%	26.7%	43.7%	60.6%	77.6%
Mandatory Program (%)	9.8%	49.7%	59.0%	68.3%	77.6%
Low Capture (tons)	2,600	2,700	2,800	3,100	3,200
Medium Capture (tons)	3,000	3,500	3,900	4,500	5,000
High Capture (tons)	3,000	8,300	13,500	19,400	24,800

Scenario	2025	2030	2035	2040	2045
Mandatory Program (tons)	3,000	15,400	18,300	21,900	24,800

Table 2-7. Large Food Waste Generators by Sector

Sector	No. of Large Generators as of 1 January 2023 (>2 tons/week)	No. of Large Generators as of 1 January 2024 (>1 tons/week)	No. of Large Generators in future (>1 tons/week)
Correctional Facilities	1	0	2
Educational Institutions	2	5	21
Food Manufacturers	6	5	17
Food Wholesale	16	14	9
Restaurants and Food Service	17*	29*	84
Hospitality	1	1	4
Healthcare Facilities	3	2	2
Total	29	27	139

Notes:
1. Restaurants and food service businesses are exempt from diversion requirements of HB264. In 2023 and 2024, the estimated number of large food waste generators in this category is not included in totals as denoted with ‘*’. However, these have been included in estimates for future regulations.

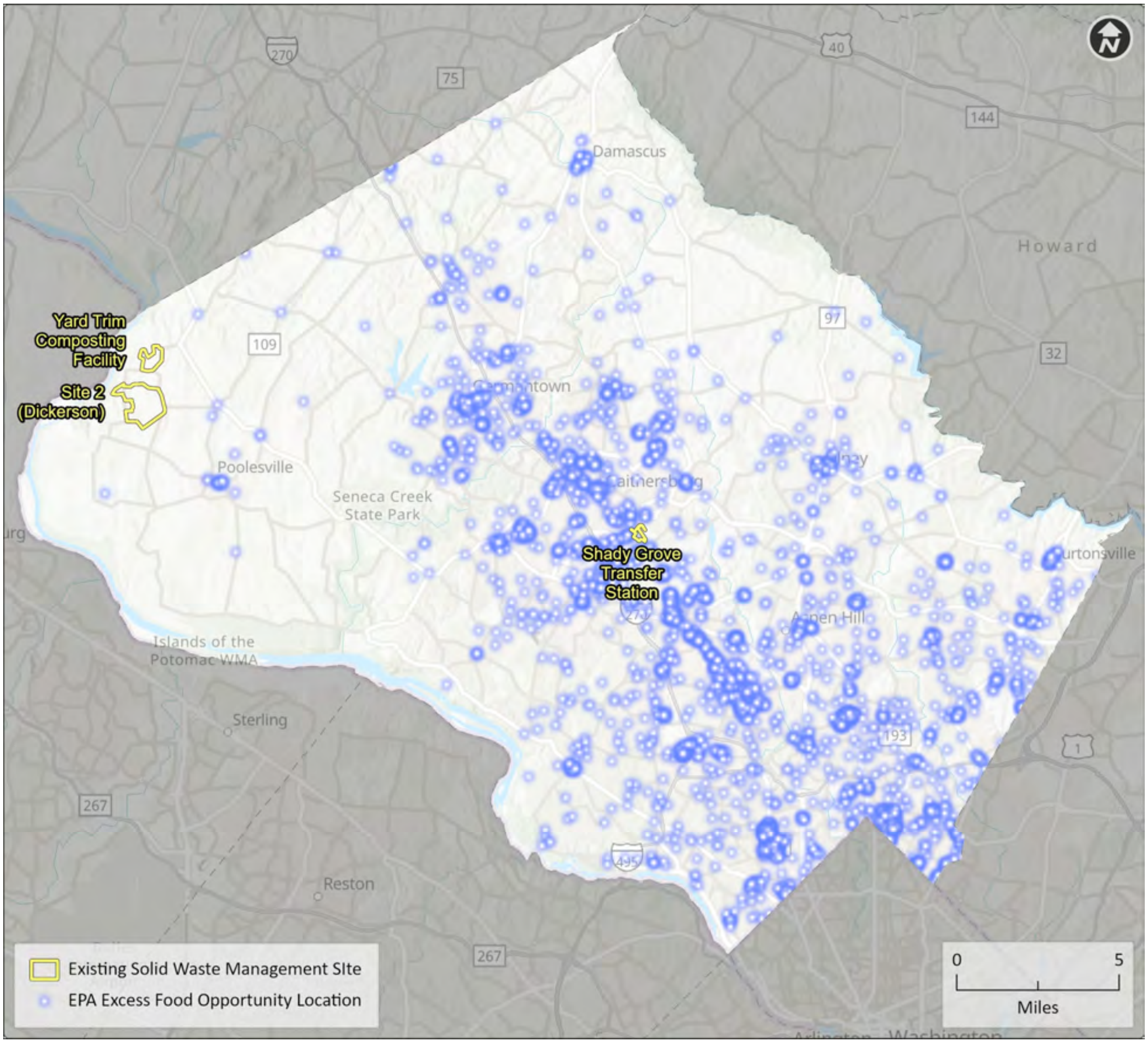

Figure 2-7. Large Food Waste Generators

2.2.7 Yard Trim and Non-Recyclable Paper Capture

Captured tons of food scraps will be processed in combination with yard trim and non-recyclable paper. As noted previously, generation and capture of yard trim has historically been near 90% and was projected to continue at this level throughout the planning period, with growth in tons attributable to population growth, as shown in Table 2-8.

Table 2-8. Yard Trim Tons Captured

Material	2025	2030	2035	2040	2045
Generation (tons)	*223,700*	*226,900*	*230,100*	*233,300*	*236,500*
Capture (%)	90%	90%	90%	90%	90%
Capture (tons)	201,300	204,200	207,100	210,000	212,900

Capture of non-recyclable paper, including tissues, paper towels, napkins, cardboard paper, food-soiled paper that cannot be recycled, and other non-recyclable paper, was projected in low, medium, and high scenarios, as shown in Table 2-9. Since historical capture of this waste stream was at or near zero, the projected scenarios mimic the food waste capture projections, as non-recyclable paper can be handled similarly. In practice, it will require outreach and education to ensure residents are aware of which types of materials constitute non-recyclable paper, and that they are acceptable for disposal along with food waste in organics collection bins.

Table 2-9. Non-Recyclable Paper Tons Captured Scenarios

Scenario	2025	2030	2035	2040	2045
Generation (tons)	*40,500*	*41,100*	*41,700*	*42,300*	*42,800*
Low Capture (%)	4.4%	5.4%	6.2%	7.3%	8.2%
Medium Capture (%)	6.4%	10.5%	14.6%	18.7%	22.7%
High Capture (%)	7.2%	17.8%	28.5%	39.2%	50.0%
Low Capture (tons)	1,800	2,200	2,600	3,100	3,500
Medium Capture (tons)	2,600	4,300	6,100	7,900	9,700
High Capture (tons)	2,900	7,300	11,900	16,600	21,400

2.2.8 Other Capture Considerations

2.2.8.1 Local and Regional Diversion Programs

While mandatory diversion programs have been considered in the development of food scrap projections, there are many local and regional examples of voluntary and mandatory programs presented for the County's consideration. The following recent and relevant examples are provided giving both regulatory framework and program design considerations. Moreover, these programs are continuing to drive public awareness and understanding of the importance of food scrap diversion across the region.

Many jurisdictions have targeted large commercial food waste generators in their initial diversion program efforts. To date, state-wide commercial food waste diversion mandates have been developed in many states, including California, Connecticut, Maryland, Massachusetts, New Jersey, New York, and Rhode Island. Many of these mandates have set food waste generation thresholds, above which a business or facility is required to divert food waste from landfill when alternative organics reduction or recycling options are available within a 25– to 35-mile radius. In addition to state-wide mandates, jurisdictions are also pursuing similar legislation at the local level:

- Washington, District of Columbia – The District of Columbia passed the Zero Waste Omnibus Amendment Act of 2020 requiring some of the largest industrial, commercial, and institutional food scrap generators to begin source separating food scraps for diversion (D.C. Law 23-211 2021). D.C. estimates that of 5,600 commercial entities generating food scraps in the district, including hundreds of large generators, these entities contribute more than 85,000 tons of food scraps to the district's waste stream annually, 42,000 tons of which are produced by large generators (Zero Waste DC Plan 2023). The implementation plan is currently being developed to identify which commercial entities will be required to divert and when. An early draft of the Plan called for required non-residential diversion of food scraps if an organics processing facility were located within 35 miles of the Capitol Dome, demonstrating the need for additional regional organics processing capacity.

To improve food waste diversion in the residential sector, curbside collection programs have been developed with voluntary sign-up, standard offering (all residents receive a collection bin but can opt out of participating), and, more recently, mandatory program models:

- Boston, Massachusetts – In addition to a drop-off program known as Project Oscar, where citizens can drop off food waste for processing at one of 15 sites in the city, a new voluntary sign-up curbside collection program serving 10,000 participating households (with another 8,000 households on the waiting list) launched in August 2022. Boston's program covers buildings with six units or less and prioritizes enrollment from residents in environmental justice communities. The curbside diversion program collected 510 tons of food waste between August and December 2022, in addition to 226 tons collected at Project Oscar sites (Coker 2023).

- Arlington County, Virginia – In 2017 the County began planning for a food scrap diversion program, as neighboring Prince William County was developing a facility upgrade to its yard trim composting facility in Manassas to process food scraps. That expanded and upgraded the Prince William County facility operated by Free State Farms which came online in September 2020, and Arlington County began its food scrap diversion program on 1 July 2021. Single-family dwelling units in Arlington County currently utilize a three-cart system—trash, conventional recyclables, and yard trim. Food scraps have been integrated into the current collections of 33,000 households by allowing co-mingled yard trim and food waste. The County is focusing on food scraps first and may add non-recyclable paper to the program in the future (Coker 2020).

- City of Laurel, Prince George's County, Maryland – Based on the ordinance recently passed by the City Council, the separation of organics at all single-family and multi-family residences is required as of 1 July 2025. A pilot program is currently underway for volunteers, giving residents a 2-gallon countertop bin with carbon filter, a locking 35-gallon large curbside bin, and biodegradable composting bags, with weekly curbside compost collection (City of Laurel, Maryland 2023). As of the 2020 census, there were over 11,000 households in the City of Laurel.

- New York City, New York – The Zero Waste Act is a set of five bills passed in June 2023 that codifies mandatory residential organics curbside collection and food scrap drop-off sites, among other efforts to achieve the City's zero waste goals. Residential curbside collection of separate yard trim and food scraps is expected to be phased in by borough across the city, with service available citywide by October 2024 and participation mandatory by April 2025. Curbside collection will be provided weekly by the Department of Sanitation. For organic waste drop-off sites, the Department of Sanitation is required to establish a minimum number of sites per borough, making access to food scrap diversion equitable and accessible across the city (New York City Council 2023).

Developing diversion programs and mandates that encompass both the commercial and residential sectors has been tackled in Vermont, Oregon, and Washington. These established programs have grown over time and provide examples of successful long-term programs for consideration. The Vermont program is highlighted here, considered most relevant to the development of other East Coast diversion programs.

- Vermont – As a regional hallmark, the State of Vermont passed the Universal Recycling Law in 2012 to divert recyclables and organics, including yard trim and food scraps, from landfill. The law phased diversion in over time, requiring first commercial diversion from large institutions with successively restrictive tiers of entities required to divert, and in 2020, phased in mandatory residential food scrap diversion. The law requires facilities that offer trash collection to also offer recycling and food scrap collection. Food scrap drop-off is also available at many transfer stations. Prior to the enactment of residential organics diversion, it was estimated that organic waste made up 30% of a typical Vermont family’s waste (Vermont Agency of Natural Resources 2023).

2.3 ORGANIC WASTE CAPTURE IN NON-COUNTY SYSTEMS

2.3.1 Private Collections

The private sector has played a role in collecting food scraps from commercial and institutional sources for about 25 years, with a rapid rise seen more recently in subscription services for residential food scraps collection and/or drop-off (Goldstein 2021b). Collection services vary in type and scale, from micro-haulers collecting by bicycle and niche collectors utilizing customized trailers, both including non-profit and worker-owned operations; to commercial haulers with dedicated organics collection routes. According to DEP’s website, private organics collection in Montgomery County is currently provided by several companies, including Compost Cab, Compost Crew, EnviRelation, Key Compost, Organic Agriculture Recycling, LLC, Organic Waste Haulers, and Veteran Compost (Montgomery County DEP 2023a). Based on a review of all company websites, published prices for weekly subscription services for curbside collection of food scraps were generally found to range from $30 to $40 per month (Compost Cab n.d., Compost Crew n.d., Key Compost n.d.).

Based on available data for tonnage collected by private organics haulers from Hauler Reports and other sources, private collection is estimated at 2,500 tons of food scraps in calendar year 2022, collected from residential and commercial sources. Of the companies noted, only Veteran Compost had a currently permitted operating facility; it is assumed the other collection companies noted currently process collected organics at a municipal or commercial processing facility. As a note, Compost Crew did have a planned and permitted facility in the County at the time of this report, but it is not yet operational. Although companies may continue to enter and exit the market, private collections may continue to provide an avenue for collection and processing of commercial and institutional food scrap sources, particularly if additional processing capacity is developed by the private sector.

For the purposes of the capture projections, private collections are projected to increase at 4% year on year in the low capture scenario, 6% year on year in the medium capture scenario, and 8% year on year in the high capture scenario, as summarized in Table 2-10 with projections over the planning period presented in Table 2-11.

Table 2-10. Private Collections Capture Scenarios Basis

Scenario	Annual Tonnage Captured Growth Rate (%)
Low Capture	4.0
Medium Capture	6.0
High Capture	8.0

Table 2-11. Private Collections Tons Captured Scenarios

Scenario	2025	2030	2035	2040	2045
Low Capture (tons)	2,780	3,380	4,110	5,000	6,090
Medium Capture (tons)	2,940	3,940	5,270	7,050	9,440
High Capture (tons)	3,110	4,570	6,720	9,870	14,510

2.3.2 Decentralized Processing

2.3.2.1 Backyard Composting

Backyard composting has a critical role for developing homeowner understanding and know-how around food scrap diversion. The County began providing outreach, education and training on grasscycling and backyard composting of yard trim in 1991, initially including recommendations for homeowners on purchase of compost bins, and later distributing compost bins for yard trim. The most recent five years of backyard composting program data in Table 2-12 shows that backyard composting bins have been distributed to nearly 14,000 households, and events attended by over 2,300 County residents, with a slowdown to these efforts during the COVID-19 pandemic (Montgomery County DEP 2023g). In addition, the County has guidance on its website for materials appropriate for backyard composting with the grass and leaves bin (e.g., dry leaves, straw, wood chips [browns], flowers, pruning materials, grass clippings [greens], no food scraps, etc.) (Montgomery County DEP 2023h).

Table 2-12. County Backyard Composting Outreach

Year	Backyard Composting Bins Distributed	Education Events Hosted	Total Event Attendees
2018	2,460	9	620
2019	3,030	9	690
2020	1,860	6	250
2021	2,420	4	190
2022	4,070	11	550
Total	13,840	39	2,300

In 2022, the County began testing of two models of enclosed backyard compost bins for rodentproof attributes and effectiveness in backyard composting of food scraps.

Low, medium, and high capture scenarios for backyard composting of food scraps by single-family households over the planning period were developed by applying estimations for weekly diversion rate (pounds per household) and percentage of households participating, as summarized in Table 2-13. Based on a review of recent program data and backyard composting studies looking at both local cities, such as Baltimore and Cheverly, Maryland (Resource Recycling Systems [RRS] and Institute for Local Self-Reliance [ILSR] 2019; Platt and Fagundes 2018), and national examples (Hoover 2017), weekly generation varied from 8.7 to 12.0 pounds of food scraps per household per week. Given average generation in the County's curbside collection program for food scraps of 8.5 pounds per household per week, the diversion rates for low, medium, and high scenarios were assumed to range from 5.0 to 8.5 pounds per household per week. Participation for a low capture scenario was developed assuming 5% participation of single-family households, medium capture assuming 10% participation, and high capture assuming 15% participation. Survey results from over 900 respondents to the single-family survey noted that 25% are already participating in backyard composting, suggesting program uptake may reach higher levels in interested groups within the County. Based on the assumptions noted, tonnages captured through backyard composting over the planning period are summarized in Table 2-14.

Table 2-13. Backyard Composting Capture Scenarios Basis

Scenario	Diversion Rate (pounds/household/week)	Percentage of Single-Family Households Participating
Low Capture	5.0	5%
Medium Capture	6.75	10%
High Capture	8.5	15%

Table 2-14. Backyard Composting Tons Captured Scenarios

Scenario	2025	2030	2035	2040	2045
Low Capture (tons)	1,710	1,750	1,790	1,840	1,870
Medium Capture (tons)	4,610	4,730	4,850	4,970	5,060
High Capture (tons)	8,720	8,930	9,150	9,380	9,560

2.3.2.2 Community Composting

The definition of community composting can be broadly interpreted as various small-scale, local, and diverse composting practices led by communities to engage, empower, and educate people in recycling organic materials and recovering resources (ILSR 2023). Community composting can be located in and supported by neighborhoods, housing associations, schools, or in community gardens, with site areas of tens to hundreds of square feet, up to an acre. A nationwide census of community composters conducted in 2022 revealed there are operations in 33 states in the U.S., with the annual average growth of new community composting programs at 21.6% between 2010 and 2021 (Libertelli et al. 2023). Locally, a site-based community composting network in Washington, D.C. called the Community Compost Cooperative Network, hosts 50 cooperative compost sites. The D.C. Parks and Recreation Department has one full-time program staff member to manage the program, who supports identifying a local champion at each site and ensures necessary three-bin systems are available. Each site diverts around 12 tons of material a year and is supported by around 100 active composters (Department of Parks and Recreation n.d.). With a more mature community composting network, New York City has built a successful community program from the founding of the NYC Compost Project in 1993 to a program now boasting over 200 community sites processing up to a ton of feedstock monthly; 250 smart composting bins across the city; and 7 larger hub sites processing up to 1,000 tons per year (Biocycle 2013; Department of Sanitation New York 2023).

To develop capture scenarios for community composting over the planning period, estimations for the number of active sites consider model programs in Washington, D.C., New York City, and other cities; areas of population density and land use that may support a community composting model; and the 14-site community garden network managed by the M-NCPPC Community Gardens Program in Montgomery County providing residents park land for food production (Montgomery Parks 2023). Based on a review of self-reported processing capacities at various community composting sites, the average processing capacity at each site was assumed to be 8 tons per site per year (RRS and ILSR 2019). The basis for the capture scenario projections is summarized in Table 2-15. Based on the assumptions noted, tonnages captured through community composting over the planning period are summarized in Table 2-16.

Table 2-15. Community Composting Capture Scenarios Basis

Scenario	Number of Active Composting Sites	Site Processing Capacity (tons per year)
Low Capture	5	8.0
Medium Capture	15	8.0
High Capture	30	8.0

Table 2-16. Community Composting Organics Diversion Scenarios (Tons)

Scenario	2025	2030	2035	2040	2045
Low Capture (tons)	41	42	44	45	46
Medium Capture (tons)	122	126	131	134	137
High Capture (tons)	243	252	261	268	274

2.3.2.3 On-Farm Composting

Maryland Department of the Environment laws surrounding composting on-farm are complex, allowing various exemptions for production of compost on-farm in the state. The exemptions depend on the feedstock and the size of the compost processing area. If a farm utilizes feedstock material from the farm and does not intend to sell or use the compost in any location besides the farm, there are no restrictions. If the farm intends on selling the compost, and the non-food feedstock is from the farm and off-site sources, the compost processing area is limited to 40,000 square feet (SF). In 2023, for feedstocks including food scraps, the passage of SB262/HB253 in the Maryland state legislature increased the compost processing area from 5,000 SF to 10,000 SF for farms intending on selling the compost. At the County level, the Agricultural Reserve Zoning Amendment of 2021 increased the percentage of off-site materials farmers are allowed to include in their compost or mulch. Now, 50% of the feedstock can come from off-site sources and be incorporated into on-farm compost. These complexities make it important to define how composting on farms is measured.

After review of publicly available data for on-farm composting at two farms in Montgomery County, Butler's Orchard (Compost Crew 2022) and Koiner Farm (Charles Koiner Conservancy for Urban Farming 2023), and accounting for average farm size, tons of organic waste diverted to composting per acre per month was estimated for the low, medium, and high capture scenarios, at 0.01, 0.05, and 0.07 tons per acre per month (Israel 2022, Brolis 2023, Biocycle 2022, DEP Division of Solid Waste Services 2018). Of 48,500 acres of cropland in Montgomery County (U.S. Department of Agriculture [USDA] 2017), the County Office of Agriculture provided additional information that 3,540 acres of farmland is operated by farmers who are likely to be currently participating in on-farm composting, estimated from around 30 vegetable farms with an average size of 118 acres. The basis for the capture scenario projections is summarized in Table 2-17. Based on the assumptions noted, tonnages captured through on-farm composting over the planning period are summarized in Table 2-18, with no year on year increases to composting rate nor participating acreage assumed.

Table 2-17. On-Farm Composting Capture Scenarios Basis

Scenario	Composting Rate (tons / acre / month)	Acreage of Farms Participating
Low Capture	0.01	3,540
Medium Capture	0.05	3,540
High Capture	0.07	3,540

Table 2-18. On-Farm Composting Tons Captured Scenarios

Scenario	2025	2030	2035	2040	2045
Low Capture (tons)	430	430	430	430	430
Medium Capture (tons)	2,120	2,120	2,120	2,120	2,120
High Capture (tons)	2,970	2,970	2,970	2,970	2,970

2.4 ORGANIC WASTE CAPTURE SCENARIOS

2.4.1 Food Scraps

Based on the capture projections presented, Scenarios 1 through 4 in Table 2-19 consider the potential food scrap capture of the low, medium, high, and mandatory capture conditions as shown. In these scenarios, private collection occurs at the low condition and is recognized to offset County-managed waste tonnages above the low condition only. Decentralized waste processing, through backyard, community, and on-farm composting, are not considered in these scenarios. In contrast, Scenarios 5 through 8 consider the offset to County-managed waste that can be provided through decentralized channels.

Captured tons of food scraps over the planning period are summarized in Table 2-20. Given the scenarios developed, this summary shows that capture of food scraps in 2045 could range from 9,000 tons per year in the low condition (Scenario 1) to 51,000 to 54,000 tons per year in the high condition (Scenarios 3 and 7), with a mandatory diversion program potentially reaching capture of 58,300 to 65,800 tons per year (Scenarios 4 and 8).

Estimated food scrap capture varies widely across the scenarios, suggesting that the County's investment in developing food scrap diversion programs will ultimately drive the food scrap diversion achieved. Decentralized processing provides a noteworthy offset to County-managed waste; developing these channels will support the overall success of the County's organics diversion efforts and are critical to developing a more resilient waste management system in the County. In addition, these approaches contribute to increased awareness and education of residents around composting and could begin to influence household disposal habits.

Table 2-19. Food Scrap Capture Scenarios

Scenario	County Processed			Outside Processing and Decentralized			
	SF	MF	NR	Private	Backyard	Community	On-Farm
1	Low	Low	Low	Low	None	None	None
2	Med	Low	Med	Med	None	None	None
3	High	Med	High	High	None	None	None
4	Mandatory	Mandatory	Mandatory	Mandatory	None	None	None
5	Low	Low	Low	Low	Low	Low	Low
6	Med	Low	Med	Med	Med	Med	Med
7	High	Med	High	High	Med	Med	Med
8	Mandatory	Mandatory	Mandatory	Mandatory	High	High	High

Table 2-20. Food Scraps Capture (Tons) by Year

Scenario	2025	2030	2035	2040	2045
1	4,600	5,700	6,700	7,700	8,800
2	6,400	10,700	15,100	19,600	24,100
3	7,300	18,500	30,000	41,900	54,000
4	7,300	35,500	45,300	55,400	65,800
5	4,600	5,700	6,700	7,700	8,800
6	4,800	7,600	11,900	16,500	21,100
7	5,700	15,400	26,900	38,800	51,000
8	3,500	28,100	37,700	47,900	58,300

2.5 ORGANIC WASTE PROCESSING

2.5.1 Yard Trim Processing Capacity Limitations

While captured yard trim is projected at up to 212,900 tons (Table 2-8), captured non-recyclable paper projected at up to 21,400 tons (Table 2-9) and captured food waste is projected at up to 65,800 tons (Table 2-20), not all material will be processed by the County.

Yard trim received and processed at the Shady Grove Processing Facility and Transfer Station (TS) has historically been only a fraction of the yard trim captured. This is due in part to the yard trim receiving and processing operation at the Shady Grove TS being constrained by site operations and available area on-site for material processing. Since yard trim is an important carbon-rich feedstock providing the bulk of volume in a compostable mix, organics processing will be limited by the availability of yard trim feedstock. Table 2-21 summarizes the yard trim processed at Shady Grove TS from fiscal year (FY) 2019 to FY23.

Table 2-21. Yard Trim Processed and Transported to Montgomery County Yard Trim Composting Facility (MCYTCF) (Tons), FY19-23

Scenario	FY19	FY20	FY21	FY22	FY23
Generation (tons)	*223,700*	*226,900*	*230,100*	*233,300*	*236,500*
Capture (tons)	201,300	204,200	207,100	210,000	212,900
Capture (%)	90%	90%	90%	90%	90%
Processed (tons)	67,900	63,400	60,900	55,800	59,700
Processed (%)	34%	31%	29%	27%	28%

Given this, facility sizing developed later in this report will consider that a County-owned organics processing facility will be limited by processing of yard trim at approximately 70,000 tons per year, consistent with the material historically received and processed at the Shady Grove TS. While yard trim capture exceeds this limit, processing additional yard trim by the County will require significant changes in centralizing the receiving and processing operation currently housed at the Shady Grove TS, and is beyond the scope of this report.

2.5.2 Food Scrap and Yard Trim Collection

Collection of food scrap and yard trim feedstocks is another variable that will impact processing of diverted organic waste by the County. Currently, yard trim is collected separately from refuse, and placed in brown paper yard trim/lawn bags or other non-plastic reusable containers or bundled by residents for curbside collection.

Co-collection of yard trim and food scrap would require making collection carts adequate for the waste stream available to single-family households throughout the County, such as a 65-gallon cart with latching lid. While the cost of supplying carts would be a significant capital cost, this would allow existing yard trim collection routes to be maintained. However, processing of co-collected yard trim and food scrap material may yield an organic waste stream with higher contamination, requiring additional pre-processing.

As an alternative, separate collection of food scrap and yard trim could be achieved by maintaining current yard trim collection at curbside and adding a food-scrap-only collection route. The costs of an additional collection route are based on average monthly per household costs for the County's current yard trim collection (Montgomery County DEP 2023i). Thirty-five-gallon food scrap bins similar to those used currently in the County's pilot program could be provided to single family households for curbside food scrap collection. Separately collected food scraps would likely have less contamination, and could be pre-processed as separate streams, then combined in mix ratios for optimal processing. However, separate collection would increase hauling traffic and associated greenhouse gas (GHG) emissions, along with greater safety considerations for both truck drivers and pedestrians.

Estimated costs for each collection approach are summarized in Table 2-22, with costs developed for a standard offering (e.g., provided standard to all single-family households) or voluntary sign-up (e.g., households opt-in). Estimated costs do not include any fleet upgrades, and assumed bagged yard trim can be collected by the same trucks as co-collected food and yard trim.

Table 2-22. Estimated Food Scrap and Yard Trim Collection Costs

Scenario	FW + YT Co-Collection		Separate FW + YT Collection	
	Standard Offering	Voluntary Sign-Up	Standard Offering	Voluntary Sign-Up
Existing Yard Trim Collection	$9,458,000	$9,458,000	$9,458,000	$9,458,000
Additional Collection Cost	$-	$-	$14,186,000	$5,151,000
65-gallon cart for Co-mingled FW + YT	$4,500,000	$1,090,000	$-	$-
35-gallon cart for FW only	$-	$-	$3,335,000	$808,000
1.8-gallon countertop bin	$1,334,000	$323,000	$1,334,000	$323,000
Total	$15,292,000	$10,871,000	$28,313,000	$15,740,000

Notes:
FW = Food waste
YT = Yard trim

Both models are used in food scrap programs nationwide.

2.5.3 Compost Recipe

Composting of source-separated organics (SSO) is a volumetric materials handling and processing endeavor, but it starts with a mass (weight)-based recipe. Composting recipes are used in facility design and are based on tonnages of anticipated feedstocks and laboratory analyses of the compostability parameters of those feedstocks. Composting recipes balance, at a minimum, carbon-to-nitrogen ratios (C:N) which should be between 25:1 and 30:1 on a weight basis, and moisture content, which should be between 50% and 55% for turned windrow operations (like the MCYTCF) or 55% to 60% for ASP systems. Recipes can also be used to balance volatile solids and predicted free air space. These mass-based recipes are converted to volumetric recipes using the bulk density measurements of the feedstocks.

For the purposes of this analysis, the compost recipe to be used in sizing alternatives is assumed to be four parts carbon-rich feedstock to one part nitrogen-rich feedstock on a volumetric basis. This 4:1 volumetric ratio is higher than the traditional 3:1 ratio commonly found in backyard composting instruction manuals, as it takes into consideration the fact that the lignin content of carbon-rich wood chips, brush, etc. is not available to the bacteria responsible for organics conversion to compost in active composting (lignaceous carbon is more easily degraded by the fungi found in compost curing and storage piles).

In addition, bulk densities can vary widely based on feedstock materials, contamination, moisture, etc. For the purposes of recipe planning, we have utilized the EPA Guide (EPA 2016) to represent general industry-accepted material bulk densities. It is important to acknowledge that these values may differ considerably across various materials, prompting the annotation of a range of observed bulk densities obtained from diverse sources, including vendor information and research studies like the one conducted for Hennepin County, which found the bulk density of SSO food scraps to be 1,163 pounds/calendar year (Coker 2019). In future facility development, analysis can be tailored to the unique characteristics of the County's organic waste stream. Bulk densities utilized and observed ranges are summarized in Table 2-23.

Table 2-23. Bulk Density Summary Table

Feedstock	EPA (pounds/cubic yard)	Range (pounds/cubic yard)
Food Scraps[1]	1,000	1,000-1,400
Yard Trim (Ground)[2]	640	640-1,500
Non-Recyclable Paper[3]	323	---

Source: EPA 2016
Notes:
1. Category "source separated organics – commercial."
2. Category "Mixed Loose Paper."
3. Category "source separated organics – commercial."
4. Mixed Loose Paper, source separated organics – commercial, compacted mixed yard trim.

For an organics program developed based on co-collection of food waste and trim, processing based on a mass-based recipe may be more difficult to implement. While carbon sources (e.g., yard trim) may be sufficient, it is typical that co-collected material may not have sufficient nitrogen (e.g., food waste). To optimize the co-collected material for processing, addition of a nitrogen-rich amendment may be required, such as grass clippings, commercial food processing residuals, or other high-nitrogen inoculant. Processing co-collected material without the use of high-nitrogen amendment may extend the processing time.

2.5.4 Processing Capacity Basis for Facility Planning

Based on the County's current yard trim processing capacity, recommended compost recipe processing feedstocks in a volumetric ratio of four parts carbon-rich feedstock to one part nitrogen-rich feedstock, and bulk densities utilized, the following recipe is developed to establish the processing capacity that will be the basis for Phase I facility planning later in this report, as summarized in Table 2-24.

Table 2-24. Organics Processing Capacity Basis

Feedstock	Tons	Cubic Yards
Yard Trim	70,000	218,800
Food Scrap	27,400	54,700
Total	97,400	273,500

Based on food scrap capture scenarios outlined in Table 2-20, the County will have adequate processing capacity for food scraps captured in all scenarios except mandatory scenarios 4 and 8, and some high scenarios. These scenarios were utilized as the basis for Phase II facility planning. However, alternatives to centralized material receiving and processing at the Shady Grove TS will be required to meet processing capacity for these scenarios, in addition to the facility planning proposed herein.

3. SOURCE SEPARATED ORGANICS PROCESSING OPTIONS (TASK 2)

Organics processing technologies vary widely from traditional windrows to sophisticated anaerobic digesters, all involving biological, chemical, and physical transformation of organic material into end-products such as finished compost, digestate, and biogas.

This review of organics processing technologies focuses on the current state-of-practice technologies, including evaluation of their potential to support centralized municipal-scale processing. Organics processing technologies evaluated in this section include aerobic and anaerobic processing approaches that are capable of processing up to or greater than 100,000 tons per year (TPY) of organic waste. Additional technologies with smaller processing capacities (under 30,000 TPY), such as modular static and agitated containers, although well proven for organics processing, are less appropriate for processing organic wastes anticipated to be generated at the County-wide scale, and therefore are excluded from evaluation herein.

Due to concerns around GHG emissions, lack of proven commercial-scale operations, and opposition to existing, local incineration efforts, technologies relying on thermal processing of organic matter, such as waste gasification and pyrolysis, are not evaluated in this study. In addition, passive processing methods poorly suited for putrescible wastes that will generate odors, such as unturned open or covered windrows, are not included in this study.

3.1 AEROBIC PROCESSING TECHNOLOGIES

Aerobic processing technologies evaluated include aerated static pile (ASP) and extended aeration composting, enclosed (in-vessel) composting (such as tunnel reactors and rotating drums), and agitated bed reactors. Each processing technology is discussed in detail in this section, and considerations including land area requirements, processing and feedstock considerations, public benefits and concerns, and equipment costs are summarized in Table 3-1.

3.1.1 Aerated Static Pile (ASP)

ASP composting is the second-most popular method of aerobic composting of source-separated organics (behind turned windrows) but is gaining in popularity due to the growth in food scrap composting in the United States. Developed in the early 1970s, ASP composting utilizes forced aeration to accelerate decomposition of organic matter placed in large piles, thereby improving compost process control and increasing facility throughput over a fixed area.

Forced air is typically delivered beneath piles, with installations varying in sophistication from at-grade perforated piping to in-ground trenches or ductwork with integrated process controls. Aeration can be delivered in positive (pushing), negative (pulling) or reversing regimes. ASP configurations include material placement in stand-alone piles (like windrows), within walls or bunkers, or in extended bed configurations where each new pile is constructed immediately adjacent to the previously built pile. Each of these configurations (see Figure 3-1) yields increasing material processing density (i.e., increased processing tons per square foot (SF) of composting area), thereby decreasing the land required for each layout.

Figure 3-1. ASP alternatives in windrow (left), bunker (center), and extended ASP (right) configurations. Photos courtesy of Coker Composting and Consulting.

ASP composting is well suited for processing food scraps, yard trim, and manure; however, attentive management is required to maintain optimal material biodegradation. Recipe development is recommended and should consider specific feedstocks and any seasonable variability in materials. ASP composting does require achieving balanced C:N ratios (>25:1) and maintaining optimum moisture (50–55%), volatile solids (>80%) and free air space (40–60%) to optimize air flow throughout the pile (Platt et al. 2014). Moisture demand can be considerable in warm/arid climates. ASP composting is not well suited for processing large quantities of animal byproducts or grease from food processing industries (EPA 2023). To minimize odor concerns, piles can be covered with compost (known as biolayers) or fabric covers, and/or aeration air can be directed through a biofilter. Use of fabric covers (Figure 3-2) provides additional means of controlling temperature, oxygen, and moisture within compost piles, and allows the collection and treatment of the process air prior to venting. Use of fabric covers has the additional benefit of minimizing contact water production, as the Maryland Composting regulations codified in COMAR 26.04.11 dictate that water coming into contact with the fabric cover can be handled as stormwater. ASP systems utilizing biocovered material must collect and manage any stormwater coming into contact with the pile as contact water, potentially requiring tanks for contact water collection and holding, or recirculation systems to collect and reuse contact water for material wetting prior to material placement within bunkers. However, the labor effort required to remove and reinstall fabric covers is considerable.

Figure 3-2. Fabric-covered ASPs. Photos courtesy of Coker Composting and Consulting.

ASP composting performs optimally when material is well ground, reducing particle size and thereby increasing surface area for material degradation, and well mixed, to achieve the proper process design properties noted above, prior to placement in piles. The active composting phase can vary in material handling requirements, from installations requiring no pile turning (low handling); remixing halfway through active composting to re-establish free air space and ensure even temperature distribution throughout the pile (medium handling); or the placement of fabric covers either via specialized mechanical winders or use of other on-site equipment for cover placement (high handling). Secondary curing is typically necessary after the active composting phase to improve compost maturity. ASPs typically produce compost within 3–6 months including active composting and secondary curing (EPA 2023).

3.1.2 Enclosed (In-Vessel) Composting

Like ASP composting, enclosed or in-vessel composting utilizes forced aeration; however, it differs from the ASP in-bunker configuration by fully enclosing the compost pile. In-vessel systems are available in multiple configurations, including storage-style tunnel reactors and rotating drums discussed further in this section.

3.1.2.1 Tunnel Reactor

Tunnel reactors, which are better-suited to the larger processing volumes of centralized composting, utilize a long, narrow, cast-in-place concrete enclosure resembling a self-storage garage. Enclosures are typically designed for entry by front-end loaders for material placement, with gasketed doors to ensure an airtight seal when doors are closed. Tunnel composting can utilize positive aeration via in-ground aeration systems or exhaust process air in the headspace of the tunnel, or both. The fully enclosed active composting area coupled with complex aeration and process controls provides even greater control over material degradation. Land area requirements for enclosed composting are like ASP bunkers and can be installed in indoor and outdoor settings. Tunnel systems may require management as confined spaces with appropriate personal protective equipment to ensure adequate worker health and safety.

While enclosed or in-vessel composting facilities can process smaller volumes, the higher capital cost for cast-in-place concrete tunnel construction lends itself to facilities processing higher volumes of organics. The process is well suited for composting of separated municipal organic waste, commercial food scraps, yard trim, digestate from anaerobic digestion, and biosolids from wastewater treatment and manure. For optimal composting, material is ground prior to placement in reactors, reducing particle size and thereby increasing surface area for material degradation. The high degree of process air containment minimizes odor concerns, and the enclosed system lends itself to improved moisture management and leachate production.

3.1.2.2 Rotating Drum

Rotating drum composting systems utilize mechanical agitation to achieve material aeration, although some systems do also utilize auxiliary air injection systems to meet process air requirements. Vessels can vary in size and capacity; however, they generally require significantly less land area than windrow composting. Large-scale drums typically consist of a steel drum with diameter up to 16 feet (ft) and length between 100 and 250 ft, positioned on an incline less than 5% (Figure 3-3). Drum rotation at 0.5–5 revolutions per minute moves material down the drum in a corkscrew pattern. Process air containment within the drum does minimize odor concerns.

Figure 3-3. Rotating Drum Composting. Photo of XACT Systems, Trenton, Ontario, Canada.

This technology can accommodate virtually any type of organic waste (e.g., meat, animal manure, biosolids, food scraps); however, skilled operators are required to ensure attentive process management throughout the short active composting window. Drum loading/unloading does introduce mechanical complexity in comparison to other enclosed or in-vessel composting. In addition, drive train components may need regular calibration and servicing, requiring a skilled operator and/or mechanic be available to minimize system downtime.

Since drums provide effective mixing and agitation of feedstocks and amendments, material pre-treatment is limited to material grinding only. Rotating drum composting typically produces compost within 1–3 months including active composting and secondary curing. Due to the high mechanical agitation, the active composting phase typically lasts 7–10 days. Once the compost comes out of the drum, however, several more weeks or months are required in secondary composting and in curing for the microbial activity to stabilize the organics and mature the compost.

3.1.3 Agitated Bed

Equipped with forced aeration like ASP and enclosed (in-vessel) systems, agitated beds utilize large beds of material placed at depths up to 10 ft, enclosed within perimeter walls in long narrow bays. Material is mechanically turned in individual bays every 1–3 days, with mechanical agitation achieved via an auger riding on perimeter wall rails or suspended from a bridge crane that can reach all areas of the bed (Figure 3-4). As the auger mixes and moves the compost along the axis of the bed, a certain amount of stable (but immature) compost is exhausted for further processing and an empty space is created at the upstream end of the bed to allow new mixed feedstocks to be emplaced. Agitated bed systems are an effective use of land area, as space requirements per ton of capacity are lower than other configurations. In addition, agitated beds are typically installed within buildings, allowing a higher degree of odor control. The high use of automation in agitated bed systems does require high capital cost but reduces the labor effort necessary.

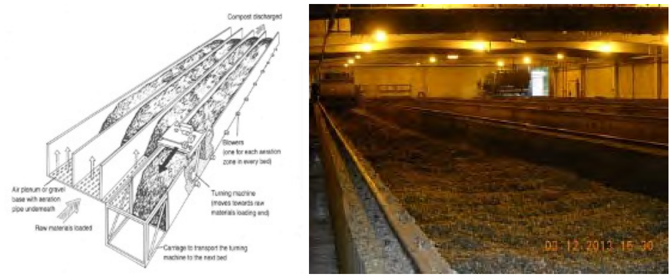

Figure 3-4. Agitated Bed Composting NRAES-54. Photo courtesy of Coker Composting and Consulting.

Processing by agitated bed system is appropriate for food scraps and yard trim and is well suited for handling large volumes of material. While material grinding is required prior to processing and additional agitation is provided during active composting, the preparation of feedstocks and amendments prior to active composting is critical. Due to the high degree of automation, material handling requirements during the active composting phase are low. Front-end loaders or conveyors are typically used to place material at the receiving end of an agitated bed, with material moved along beds by the turning auger throughout active composting. Augured compost is discharged onto the bed floor or a conveyor belt for further processing at the completion of the active composting phase. Agitated bed composting typically produces compost within 2–4 months including active composting and secondary curing. Due to mechanical agitation, the active composting phase typically lasts 3–4 weeks. Additional secondary curing is typically required.

3.1.4 Aerobic Processing Technologies Summary Table

A summary of aerobic processing technologies discussed in this section is included in Table 3-1.

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Table 3-1. Compost Technology Alternatives – Centralized Aerobic Processing

Compost Technology	General Description	Land Area Requirements	Feedstock Considerations	Processing Considerations and Timeline	Public Benefits and Concerns	Cost
Aerobic Processing Technologies						
Aerated Static Pile (ASP)	Forced aeration system which utilizes at-grade (low tech) or in-ground (high tech) piping to provide positive, negative, or reversing aeration to mixed organic waste piles. Piles can be managed with biocovers or fabric covers. Contact water can be minimized through use of fabric covers, or captured for reuse with biocovers. Systems may utilize temperature and moisture probes for continuous pile management and optimization.	Low to Moderate Controlled aeration supply allows construction of large piles (e.g., 30 ft wide × 100 ft long × 10 ft high), with ASP requiring less land than windrow composting. Configurations for ASP can be standalone piles, in-bunker, or extended aeration, with processing density increasing for each and decreasing land area. Low difficulty to add piles but requires cost of additional aeration equipment.	1,000 to >100,000 TPY Appropriate for large volumes of food scraps, yard trim, and manure. "Recipe" development considering specific and seasonal availability of feedstocks. Recommended for achieving balanced C:N ratio (>25:1), optimum moisture (50–55%), volatile solids (>80%) and free air space (40–60%) (Coker 2014). Moisture demand can be considerable in warm/arid climates. Not well suited for processing animal byproducts or grease from food processing industries (EPA 2023).	2–6 months Pre-Treatment Material grinding/mixing prior to placement in piles. Active Composting Fan aeration. No mechanical agitation required. Depending on facility configuration and level of technology, material handling can be ***Low*** (no pile turning during active composting), ***Medium*** (one pile rebuild), or ***High*** (use of fabric pile covers). Typically, 2–8 weeks. Post-Processing Secondary curing/maturation.	Public Benefits Reduced processing facility footprint and size. Reduced volatile organic compound (VOC) emissions compared to turned windrows. Public Concerns ***Odor*** – Requires process design and attentive management of moisture and temperature throughout process. Can also be optimized through use of aeration regime, pile covers, and biofilters.	Moderate Significant cost and technical assistance to purchase, install, and maintain aeration equipment (e.g., blowers, piping and ductwork, process controls).
Enclosed (In-Vessel) Tunnel Reactor	Forced aeration system with compost processed in a fully enclosed structure, typically a long, narrow, cast-in-place concrete enclosure resembling a tunnel. Positive aeration via an in-ground aeration system and/or process air can be exhausted from the headspace of the tunnel. Complex aeration and control systems provide increased control over optimizing material degradation. Tunnel can be entered by front-end loader for material placement, and gasketed door sealed during composting creates an airtight enclosure.	Low to moderate Land area requirement like ASP bunker facility configurations. Can be installed in indoor and outdoor settings.	25,000 to >100,000 TPY Composting of separated municipal organic waste, commercial food scraps, yard trim, digestate from anaerobic digestion, biosolids from wastewater treatment and manure. While facilities can process smaller volumes, the higher capital costs for tunnel construction lend use of this technology to facilities processing higher volumes of organics.	2–4 months Pre-Treatment Material grinding/mixing prior to placement in enclosed system. Active Composting Fan aeration. No mechanical agitation required. Depending on the facility processing approach, material handling can be ***Low*** (no pile turning during active composting) or ***Medium*** (one pile rebuild). Typically, 2–4 weeks. Post-Processing Secondary curing.	Public Benefits Reduced processing footprint and reduced processing size. Reduced VOC emissions compared to turned windrows. Public Concerns ***Odor*** – High degree of process air containment minimizes odor concerns. ***Worker Health and Safety*** – Tunnel systems may require management as confined spaces with appropriate personal protective equipment.	Moderate to High Cast-in-place concrete for tunnel systems increases construction costs. Significant cost and technical assistance to purchase, install, and maintain complex aeration equipment and process controls.
Enclosed (In-Vessel) Rotating Drum	Rotating drum systems utilize mechanical agitation to achieve material aeration, rotating organic material in large-scale drums at 0.5–5 revolutions per minute, moving material down the drum in a corkscrew pattern. Air is typically injected into drums to meet process air requirements.	Low to Moderate Vessels can vary in size and capacity; however, they generally require significantly less land area than windrow composting. Large-scale systems typically consist of a steel drum with diameter up to 16 ft and length between 100 and 250 ft, positioned on an incline less than 5%.	1,000 to 100,000 TPY Can accommodate virtually any type of organic waste (e.g., meat, animal manure, biosolids, food scraps).	1–3 months Pre-Treatment Material grinding only. Drums provide effective mixing and agitation of feedstocks and amendments, minimized pre-treatment needs. Active Composting ***Low*** material handling. Drum loading/unloading introduces mechanical complexity in comparison to other enclosed or in-vessel composting. Typically, 7–10 days. Additional active composting may be required. Post-Processing Secondary curing.	Public Benefits Reduced processing footprint. Public Concerns ***Odor*** – Process air containment minimizes odor concerns.	Moderate to High High cost of equipment and technical expertise may be required to support operations.
Agitated Bed	Equipped with forced aeration like ASP and enclosed (in-vessel) systems, agitated beds utilize large beds of material placed at depths up to 10 ft, enclosed within perimeter walls. Material mechanically turned in individual bays every 1–3 days. Mechanical agitation can be achieved with an auger suspended from a bridge crane spanning across the bed floor, which can reach all areas of the bed.	Low Effective use of land area; space requirements per ton of capacity are low.	50,000 to >100,000 TPY Appropriate for food scraps and yard trim. While facilities can process smaller volumes, the technology is well suited for handling large volumes of material.	2–4 months Pre-Treatment Material grinding. Preparation of feedstocks and amendments critical. Additional mechanical mixing during active composting. Active Composting High degree of automation requires ***Low*** material handling. Front-end loaders or conveyors are used to place material at bed receiving ends. Material moved across bays and discharged on floor or conveyor belt after processing. Typically, 3–4 weeks. Post-Processing Secondary curing.	Public Benefits Reduced processing facility footprint and size. Reduced VOC emissions compared to turned windrows. Public Concerns ***Odor*** – Agitated beds are typically installed within buildings, allowing a higher degree of odor control.	High High use of automation requires high capital cost.

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3.2 ANAEROBIC PROCESSING TECHNOLOGIES

Anaerobic processing technologies rely on the decomposition of organic materials in the absence of oxygen in either wet (low-solids) or dry (high-solids) digesters. The anaerobic digestion (AD) technology evaluated herein includes traditional wet continuous-stirred tank reactor (CSTR) and high-solids configurations including dry fermentation and plug flow. Each processing technology is discussed in detail in this section, and considerations including land area requirements, processing and feedstock considerations, public benefits and concerns, and equipment costs are summarized in Table 3-2. An analysis of biogas yield potential from a high-solids AD technology is included in Appendix D.

3.2.1 Wet (Low-Solids) CSTR Anaerobic Digestion

As AD was developed in the U.S. for handling sewage sludges at wastewater treatment plants, most AD systems are wet (low-solids) digesters, and were some of the first digester designs used for processing residential food scraps. Wet (low-solids) systems have moisture content greater than 80% and conversely, dry matter content of 20% or less. Typically requiring water addition, feedstocks are dissolved or suspended in a liquid form and are handled as a liquid. Based on this processing approach, a high level of pretreatment is required, including removal of floatables and settleables; removal of large, fibrous materials that could interfere with the stirring and mixing mechanisms; and size reduction, such as shredding, to achieve higher surface area for effective degradation and render the slurry pumpable. This processing approach is best-suited for low-solids feedstocks. Some examples of low-solids feedstocks include dairy manure and food processing residuals such as from juice, cheese whey, and spoiled milk.

Wet (low-solids) can be operated under mesophilic (86 to 100 degrees Fahrenheit [°F]) or thermophilic (122 to 144°F) temperature regimes, in single-, dual-, or multi-stage digesters. A typical single-stage CSTR digester can process up to 250,000 TPY with a typical material retention time of 14–40 days. Anaerobic digestion also produces biogas, primarily methane and carbon dioxide, that can be used on-site or sold to provide energy, although it has the lowest net energy output per ton of input feedstocks relative to other AD systems presented in this section (Environment Canada 2013). Due to the high (70–90%) moisture content of digestate, the low-solids, nutrient-rich liquid digestate requires significant dewatering, typically done with filter/screw presses, centrifuges, or other techniques. Digestate typically requires additional processing, such as composting, although processing time is reduced due to the decomposition partially achieved during digestion. Up to 45% of the moisture fed into the digester for processing may be discharged as effluent during digestate dewatering.

With the enclosed digester vessels, there is a high degree of odor control with AD processing. AD processing facilities require high capital and site development costs to establish the pre-processing, dewatering, and composting areas in support of the digester vessels and process equipment required and would not be suitable for organics diversion programs developed around co-collection of food waste and yard trim. AD can be expensive compared to traditional aerobic composting systems.

3.2.2 High-Solids Dry Fermentation Anaerobic Digestion

Dry fermentation AD is a batch process well suited for high-solids material, including commercial and residential food scraps. In the batch process, the digester is filled with a mix of fresh organic matter—screened of materials too large for digestion and mixed with a bulking agent to facilitate the free air space necessary for percolation—then closed with a gas- and liquid-tight seal. The digester remains closed until the end of the desired retention time, up to 30 days. It is then emptied and filled with new material, often a mixture of partially digested material that was just removed and fresh, undigested material to seed the digestion process. Digesters can be operated under mesophilic or thermophilic conditions, in single- or dual-stage systems to optimize digestion.

Anaerobic microorganisms require a moist environment in which to thrive. A dry system is not moist enough to foster this, so a liquid "percolate" is typically sprayed into the fermenter over the digesting feedstocks, filling the biomass pore spaces with liquid, and shifting the bacterial activity to anaerobic decomposition, producing biogas (see Figure 3-5). An organic waste mix with free air space for effective percolation typically requires roughly equal volumes of food scraps and bulking agent. The percolate has already been through an active digester; therefore, it contains anaerobic microorganisms. As percolate is recycled in the process, little water addition is necessary throughout the process, and minimal process effluent is produced. Once a fermenter has been re-seeded, and percolate has been sprayed in, gas production begins almost immediately. Over the retention time of the digester, the percolate is repeatedly drained and re-sprayed onto the fermenting mass.

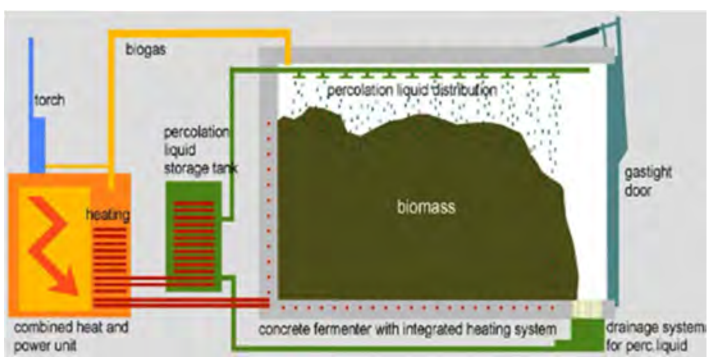

Figure 3-5. Cross Section through Dry Fermenter. Illustration courtesy of P. Lutz, BEKON Technologies.

3.2.3 High-Solids Plug Flow Anaerobic Digestion

Plug flow reactors are, like the wet (low-solids) CSTR reactors, continuous systems. The digester contents are not completely mixed but move as a plug through the reactor from the feed port to the exit. This process requires heavy process equipment that can handle dry, viscous material that does not flow freely. High solids plug flow digesters are typically operated at a moisture content of 60–80% by weight, maintaining at least 20% solids in the tank. This digester type can accommodate a wider variety of materials than dry fermentation AD, including large volumes of wet materials, and residential and commercial food scraps. In addition, these digesters are more robust regarding acceptance of non-biodegradable material, such as glass, metals, or plastic contamination, that may be present in feedstocks. Feedstock quality could necessitate complex pre-treatment, including size reduction, mixing, and slurry pumping. Digesters are typically managed at mesophilic temperature regimes, in vertical silo or horizontal tank configurations, through one or more processing stages.

One vertical plug-flow configuration uses vertical steel tanks with a central baffle that extends two-thirds of the way through the center of the tank. The material is forced to flow around the baffle from the inlet to reach the outlet port on the opposite side, creating a plug flow in the reactor. These tanks can operate between 25% and 35% total solids. A biogas mixing system is used to create local mixing in the tank. The biogas mixing provides adequate interaction between fresh product and mature digestate. As a result, fresh feedstock does not necessarily require inoculation with finished product or leachate outside the tank prior to feeding.

A horizontal plug flow reactor is a horizontal steel tank with slowly rotating axial mixers that assist in conveying the material from the inlet to the outlet, keep heavy solids in suspension, and degas the thick digestate (Figure 3-6). The total solids in the reactor are held in the range of 23–28% to facilitate flow. Recycled digestate is mixed with the feed stream to inoculate the material and process water may be added to reduce the solids content.

Figure 3-6. Horizontal Plug Flow Digester. Photo courtesy of BioCycle CONNECT LLC.

3.2.4 Anaerobic Processing Technologies Summary Table

A summary of anaerobic processing technologies is included in Table 3-2.

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Table 3-2. Anaerobic Digestion Technology Alternatives – Centralized Anaerobic Processing

AD Technology	General Description	Land Area Requirements	Feedstock Considerations	Processing Considerations and Timeline	Public Benefits and Concerns	Cost
Anaerobic Processing Technologies						
Wet (low-solids) CSTR Anaerobic Digestion	Closed vessel system that utilizes wet (low-solids) organic material and maintains a high moisture content (more than 80%) slurry for processing. Microorganisms digest the slurry within the anaerobic system to create a digestate. Up to 45% of the moisture fed into the digester for processing may be discharged as effluent during digestate dewatering.	Moderate to High Digesters can be single-, dual-, or multi-stage to optimize digestion. Processing equipment required for pre-processing, dewatering, and composting.	3,000 to 250,000 TPY Best suited for high-liquids/low-solids organic waste (e.g., dairy manure, and food processing residuals such as from juice, cheese whey, and spoiled milk). Yard trim can be resistant to digestion at typical processing temperatures and is not well suited for processing via AD.	14–40 days digester retention time, additional digestate processing time <u>Pre-Treatment</u> ***High*** Material grinding for particle size reduction and to render pumpable slurry. Floatables and settleables removal. Addition of moisture as necessary to achieve 80% water content. No addition of bulking material necessary. <u>Digestate Management</u> ***High*** Due to the high (70–90%) moisture content of digestate, the low-solids, nutrient-rich liquid digestate requires significant dewatering, typically done with filter/screw presses. Additional processing typically required, such as composting.	<u>Public Benefits</u> ***Energy Production*** – Biogas produced can be used for on-site power and heating or sold for off-site use with appropriate gas transmission infrastructure. Lowest net energy output per ton of input feedstocks. <u>Public Concerns</u> ***Odor*** – Enclosed digester minimizes odor concerns during processing. Odor may be present from digestate.	High High capital cost for digester vessel and related pre-processing, digestate dewatering and composting equipment. Technical expertise required to support operation of digester and maintenance of flare and biogas monitoring. Significant site development costs for processing and administrative facilities and access roadways. Biogas sold for energy can provide system revenue to offset operating costs.
High-Solids Dry Fermentation Anaerobic Digestion	Dry fermentation AD is a batch process in which the digester is filled with a mix of fresh organic matter and partially digested material from a previous batch to seed digestion, then closed with a gas- and liquid-tight seal for a retention time, up to 30 days. Digestate recycle rates vary between manufacturer's systems, varying from 20% to 50% for dry fermentation batch systems. Liquid percolate is sprayed over the digesting feedstocks, shifting the bacterial activity to anaerobic decomposition, producing biogas. As percolate is recycled in the process, little water addition is necessary throughout the process, and minimal process effluent is produced.	Moderate to High Digesters can be single- or dual-stage systems to optimize digestion. Processing equipment required for pre-processing, dewatering, and composting.	3,000 to 250,000 TPY Well suited for high-solids material, including commercial and residential food scraps.	14–30 days digester retention time, additional digestate processing time <u>Pre-Treatment</u> ***Medium*** Material screening for removal of materials too large for digestion. Material mixing with bulking agent in equal quantity as organic waste to facilitate the free air space necessary for percolation. Material shredding is limited, to prevent rendering the organic matter into slurry. <u>Digestate Management</u> ***Medium*** Additional active composting typically required for digestate.	<u>Public Benefits</u> ***Energy Production*** – Biogas produced can be used for on-site power and heating or sold for off-site use with appropriate gas transmission infrastructure. Medium net energy output per ton of input feedstocks. <u>Public Concerns</u> ***Odor*** – Enclosed digester minimizes odor concerns during processing. Odor may be present from digestate.	High High capital cost for digester vessel and related pre-processing. Technical expertise required to support operation of digester and maintenance of flare and biogas monitoring. Significant site development costs for processing and administrative facilities and access roadways. Biogas sold for energy can provide system revenue to offset operating costs.
High-Solids Plug Flow Anaerobic Digestion	Plug flow reactors are not mechanically mixed, but process digester contents as a plug through the reactor from the feed port to the exit. This process requires heavy process equipment that can handle dry, viscous material that does not flow freely. High solids plug flow digesters are typically operated at a moisture content of 60–80% by weight, maintaining at least 20% solids in the tank. Digesters are typically managed at mesophilic temperature regimes.	Moderate to High Reactors in vertical silo or horizontal tank configurations, through one or more processing stages. Processing equipment required for pre-processing, dewatering and composting.	10,000 to 100,000 TPY Can accommodate a wider variety of materials than dry fermentation AD, including large volumes of wet materials, and residential and commercial food scraps. In addition, these digesters are more robust regarding acceptance of non-biodegradable material, such as glass, metals, or plastic contamination, that may be present in feedstocks.	14–30 days digester retention time, additional digestate processing time <u>Pre-Treatment</u> ***Medium*** Feedstock quality could necessitate complex pre-treatment, including size reduction, mixing, and slurry pumping. <u>Digestate Management</u> ***Medium*** Additional active composting typically required for digestate.	<u>Public Benefits</u> ***Energy Production*** – Biogas produced can be used for on-site power and heating or sold for off-site use with appropriate gas transmission infrastructure. High net energy output per ton of input feedstocks. <u>Public Concerns</u> ***Odor*** – Enclosed digester minimizes odor concerns during processing. Odor may be present from digestate.	High High capital cost for digester vessel and related pre-processing, dewatering, and composting equipment. Technical expertise required to support operation of digester and maintenance of flare and biogas monitoring. Significant site development costs for processing and administrative facilities and access roadways. Biogas sold for energy can provide system revenue to offset operating costs.

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3.3 SUPPORTING PROCESSING INFRASTRUCTURE

3.3.1 Pre-Treatment

Pretreatment, or pre-processing, is usually needed to optimize feedstocks for processing by either aerobic or anaerobic means. The most common pretreatment steps are particle size reduction, contaminant removal, and mixing. Particle size reduction is usually done by mechanical shredding or grinding of woody materials like yard trim. Contaminant removal can be done manually with a sorting line or mechanically with a depackager. Mixing feedstocks is needed to optimize proportions for the composting or digestion “recipe” and to homogenize the feedstocks.

Grinding is normally done with either horizontal or tub grinders (high-speed rotary hammermills), although slow-speed, high-torque shredders are increasing in popularity as they can process large-diameter tree trunks and root balls. Figure 3-7 shows a tub grinder at work. Currently the County utilizes a grinder at the Shady Grove TS to reduce yard trim and land-clearing debris particle size.

Figure 3-7. Tub Grinder. Photo courtesy of BioCycle CONNECT LLC.

Contaminant removal is necessary for wet (low-solids) digestion and is increasingly of concern for composting and high-solids anaerobic digestion facilities. Contaminant removal conducted manually or robotically via a sorting line may be required for food waste material co-collected with yard trim or with high contamination rates, however staffing manual removal operations and maintaining removal rates over time can be key obstacles. Facilities such as the Prince William County/Freestate Farms yard trim and food scrap composting facility in Manassas, Virginia that previously staffed a sorting line for manual contaminant removal, and the Atlas Organics facility in San Antonio which previously utilized robotic equipment to mechanize contaminant removal in sorting lines have both abandoned the practices due to the challenges noted.

Depackaging is used for both contaminant removal and for opening packaged food products, although is not typically designed to work with co-collected food scraps and yard trim. Mechanical depackagers are available from multiple sources in the U.S. and abroad (Coker 2021a,b). Most depackaging systems operate by pressing the organics against a rigid screen (Figure 3-8) with the extract being the recovered food materials and the rejects consisting of more rigid materials like plastics and metals. However, the depackaging pressures often lead to plastics fracturing and creating microplastics and nanoplastics (see Section 3.4 for additional discussion on pollutants of concern). Depackagers used in contaminant removal for wet (low-solids) digestion often use added water to create a pumpable slurry of 5–15% total solids. One depackaging machine in the U.S. market uses 70 gallons per minute of water to make a digestible slurry.

Figure 3-8. Mechanical Depackager. Photo courtesy of Dupps Mavitec.

Mechanical mixers (Figure 3-9) are often used in ASP composting to ensure good particle size homogeneity (turned windrow operations like the MCYTCF mix by turning the windrows). Most mixers are horizontal counter-rotating shaft configurations that can blend pre-processed materials together efficiently to create an optimum composting environment (Figure 3-10).

Figure 3-9. Mechanical Mixers. Photo courtesy of Coker Composting and Consulting.

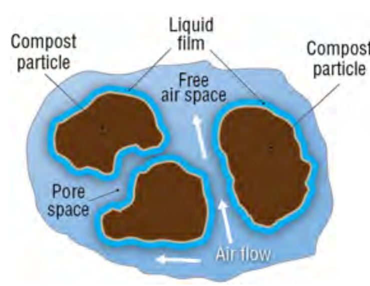

Figure 3-10. Optimum composting environment. Graphic courtesy of BioCycle CONNECT LLC.

3.3.2 Post-Treatment

Even with thorough pre-treatment steps there is often a need for further refinement of the compost or high-solids digestate product following processing (liquid digestates from wet [low-solids] digesters have all contaminants removed prior to processing). The simplest form of post-treatment is simple mechanical screening, which most yard trim and food scrap composting facilities utilize to make the product more "market-ready," including removal of oversized woody particles and some larger-scale contaminants like plastics. Mechanical screens can be equipped with magnets on the discharge conveyor to remove ferrous metal contaminants such as nails, and/or can be equipped with vacuum-extraction systems to remove film plastics. Harder, denser contaminants like stones, metal, and broken glass can be removed by taking advantage of the differences in densities between the compost or high-solids digestate and the contaminants. These removal systems include ballistic separators and densimetric tables (Figure 3-11).

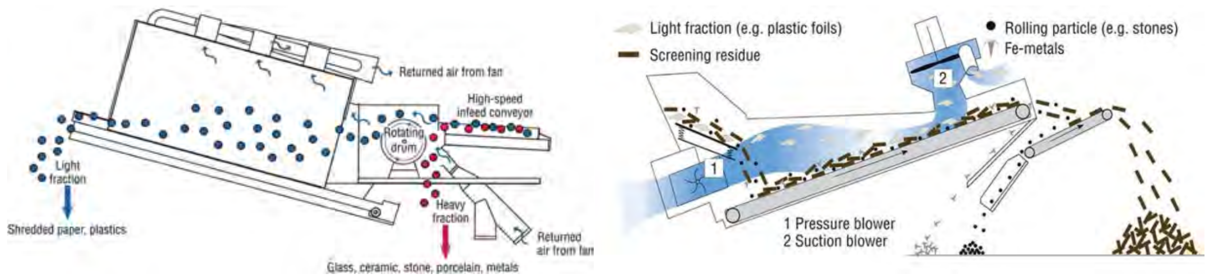

Figure 3-11. Post-treatment separators including drum-style ballistics separator (left) and densimetric separators (right). Graphics courtesy of BioCycle CONNECT LLC.

3.4 POLLUTANTS OF CONCERN

Even with pre- and post-processing controls, contamination is increasingly a concern for organics processing facilities. Contaminants can include glass, metal, hard plastic, and film plastics. In particular, the County has noted a particular issue with scrap metal in yard trim feedstocks received for processing. Contamination in source-separated organics feedstocks destined for composting or digestion can be reduced significantly with public education and outreach, using educational missives like "Compost It Right!" which educate the public about what is, and what is not, suitable for organics recycling. Additional discussion on education and outreach is included later in this report.

This section provides additional discussion on emerging contaminants in composting and digestion procession, per- and poly-fluoroalkyl substances (PFAS), and microplastics, as well as persistent herbicides, which have been long-present in organics processing.

3.4.1 PFAS

PFAS are a large group of synthetic chemicals that are ubiquitous in the environment due to their widespread production and use since the 1940s. Many PFAS do not easily break down and therefore persist in the environment for a long time, earning them the nickname "forever chemicals." Because of their persistence, many PFAS also accumulate in the human body. There is a growing body of evidence that, at certain levels, some have carcinogenic effects and adverse effects on the immune system, endocrine system, reproductive system, and liver. The two most studied PFAS are perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS).

PFAS have been used in a large number of commercial products and industrial processes due to their ability to repel water and oils, chemical and thermal stability, and other properties.

Commercial products that may contain PFAS include stain-resistant carpets, furniture, food packaging materials, personal care products, non-stick cookware, waterproof clothing, electronics, building materials, fire-fighting foams, and many more.

The likely source of PFAS in any compost or digestates made from residential and commercial food scraps is the food packaging that is erroneously included in a source-separated organics (SSO) collection bin. As SSO diversion in Montgomery County increases, the County should develop educational outreach materials about the need to keep food packaging out of the diverted SSO stream.

Although this study is not considering a County-wide organics processing facility to accept biosolids, there have been some recent findings and actions around biosolids with detectable PFAS levels. In December 2022, the town of Poolesville reported that PFAS were detected in the town's drinking water wells and disconnected the two wells with the highest levels. Believing a possible cause to be the application of biosolids on land overlying the local aquifer, in January 2023 two non-profit groups petitioned the County government to ban the application of biosolids on county agricultural fields, golf courses, and public land. Biosolids are produced by the Blue Plains Wastewater Treatment Plant in Washington, D.C., and dewatered biosolids are marketed under the brand name "Bloom." Bloom has been tested for PFAS and found to contain 42 parts per billion (ppb).

Although the Montgomery County Office of Agriculture does not currently have regulatory authority over the land-application of fertilizers, biosolids, and other nutrient sources on private properties (the Maryland Department of Agriculture does), the Office of Agriculture has recommended that County farmers voluntarily suspend the application of all biosolids on their fields until additional information is available. If PFAS are found to be present in compost or digestate from a County organics processing facility, this could have an impact on potential end markets of finished compost or digestate for agricultural uses. This concern may inform any limits to feedstocks that are accepted for County processing and provide a focus for public education and outreach efforts.

3.4.2 Microplastics

Microplastics (MPs) are small plastic fragments that are less than 5 millimeters (mm) in size — slightly larger than one-eighth inch. A subcategory of microplastics is nanoplastics, synthetic polymers with dimensions ranging from 1 nanometer (nm) to 1 micrometer (μm). For perspective, a compost bacterium is about 1,000 nm in size and the width of a single human hair is 20 to 200 μm.

MPs can be introduced to agricultural soils through products engineered to be small, such as plastic-coated controlled release fertilizers, treated seeds, and capsule suspension plant protection products. They can be introduced via plastic mulching, contaminated soil amendments, irrigation water, atmospheric deposition, roads, and litter. MPs can also be formed during and because of food scrap depackaging, a pre-treatment approach previously discussed.

The research on the health effects of MP has focused, to date, on direct exposure, with inhalation and ingestion being the two primary exposure pathways. Inhalation causes physical damage to the lungs and ingestion is thought to have potential impacts on the immune system, liver, energy metabolism, and reproduction. There are no comprehensive studies of MPs in the diet, although MPs have been found in seafood/fish, salt, beer, honey, milk, rice, sugar, and seaweed. MPs in composts and digestates used as soil amendments are a secondary pathway of exposure, which has not yet been studied to any extent.

MPs are categorized as emerging persistent pollutants that occur widely in various ecosystems. A recent U.K. study (Brown 2023) evaluated MPs in wastewater, finding that raw plastics recycling wash waters were estimated to contain microplastic counts between 5.97×10^6 and 1.12×10^8 MPs per cubic meter, which they suggested was due to the grinding and washing of waste plastics for recycling. MP measurements reported in the literature are tens to thousands of particles per dry kilogram (kg) of agricultural soils, similar to levels found in composts and digestates. MPs' impacts on terrestrial plants (particularly crops) are poorly understood. Given the persistence and widespread distribution of MPs in the soil, they have potential impacts on terrestrial plants. Due to their small size and high adsorption capacity, MPs can adhere to the surfaces of seeds and roots, and thus inhibit seed germination, root elongation, absorption of water and nutrients, and ultimately inhibit plant growth.

Maryland has taken steps to ban single-use plastics and does regulate the inert and film plastics content of composts (and, by extrapolation, digestates); however, there are currently no known plans to regulate MPs. The transition from regulating inert content in finished composts and digestates to regulating the MP content of those products is mind-boggling in its complexity. Good policy and regulation should always be based on good science, and with MPs, good science is currently lacking in conformity of testing and reporting procedures, analysis procedures, and even in certification of laboratories in analyzing MPs. These scientific shortfalls will be addressed over time. As with PFAS and food packaging, microplastic concerns may inform public outreach and education efforts to reduce plastics erroneously included in SSO diversion streams, and thereby reduce sources of MPs in compost and digestates.

3.4.3 Persistent Herbicides

Approximately 15 years ago, composters became aware that a certain class of weed killers was showing up in finished compost in a way that affected some plants. These weed killers are known as persistent herbicides (PHs). Chemically, these weed killers are picolinic acids designed to target many broadleaf plants. The picolinic acid family includes aminocyclopyrachlor, aminopyralid, clopyralid, and picloram as active ingredients included in numerous retail herbicide products—PHs and products familiar to the composting industry. Composters have come to understand that concentrations as low as 1 ppb may negatively affect some plants. For perspective, 1 ppb is equal to ½ teaspoon of product in an Olympic-sized swimming pool. The persistence, decay rate, and safe concentrations of commonly used herbicides that may be found in compost feedstocks and compost are shown in Table 3-3.

Table 3-3. Persistent Herbicides Commonly Found in Organics Feedstocks

Herbicide	Trade Name	Reported Half-Life in Soils (days)	Estimated Composting Half-Life (days)	Plant Safe Concentration in Soils (ppb)
2,4-D	Weed-B-Gon, Hi-Dep®, Weedar® 64, Weed RHAP A-4D®, Weed RHAP A	7	7–14	500
Aminocyclopyrachlor (PH)	Imprelis®, Streamline®	3–112	No data	No data
Aminopyralid (PH)	Capstone™, Chaparral™, CleanWave®, Forefront®, GrazonNext®, Milestone®, Opensight®, PasturAll®, and Sendero™	32–533	No data	No data
Atrazine	Aatrex®, Atratol®, Atrazine	100–300	21–50	No data
Clopyralid (PH)	Stinger®, Reclaim®, Transline®. Confront, Curtail, Millenium Ultra	15–287	1–2 years	3
Diazinon	Basudin, Dazzel, Gardentox, Kayazol, Knox Out, Nucidol, Spectracide, Diazinon	14–28	1–2	Not applicable
Dicamba	Banvel®, Banex®, Trooper®	7–42	No data	50
Glyphosphate	Roundup®, Rodeo®, Accord®	3–130	No data	No data
Mecoprop (MCPP)	Kilprop, Mecopar, Triester-II, Mecomin-D, Triamine-II, Triplet TriPower, Trimec-Encore, U46 KV Fluid	< 60	No data	600
Pendimethalin	Prowl, AC 92553, Accotab, Go-Go-San, Herbadox, Penoxalin, Sipaxol, Stomp and Way-Up.	90	7-14	100
Picloram (PH)	Tordon®, Grazon®, Access®, Pathway	20–300	No data	10

As the majority of the PH problems in composts have been documented in composting facilities handling manures from herbivorous animals, and, as none of the known PHs are on the list of allowable pesticides in Montgomery County, the risk of PH contamination in Montgomery County organics feedstocks for may be minimal.

3.4.4 Summary Table

A summary of pollutants of concern in organics processing is included in Table 3-4.

Table 3-4. Pollutants of Concern in Organics Processing

Pollutant of Concern	Sources in Source Separated Organics	Measured Levels in Recovered Organic Products	Related Regulatory Standards in Maryland
Per- and Polyfluoroalkyl Substances PFAS PFOA PFOS	Non-stick cooking tools Food packaging Paper products	PFOA • Food scrap/yard trim compost – 2.73–10.31 ppt[1] • Yard trim compost – 0.48 ppt[1] • Backyard compost – 1.05 ppt[1] PFOS • Food scrap/yard trim compost – 0.35–1.53 ppt[1] • Yard trim compost – 1.2 ppt[1] • Backyard compost – 1.69 ppt[1] PFAS • Food scrap digestates – 3.9–4.1 ppt[2]	EPA National Primary Drinking Water Regulations • PFOA – Maximum Contaminant Level (MCL) = 4.0 ppt • PFOS – MCL = 4.0 ppt EPA Health Based Water Concentration • PFHxS – 9.0 ppt • PFNA – 10 ppt • PFBS – 2,000 ppt • HFPO-DA – 10 ppt Maryland Department of Health Advisory • PFHxS – 140 ppt
Microplastics	Food packaging Food service utensils Compostable bags/servingware[3]	• Food scrap/yard trim compost – 0.001–0.1358% wwb[4] • Yard trim compost – 0.00024-1.0% wwb • Food scrap digestate – 0.01–0.25% wwb	COMAR 15.18.4 • Film plastic > 4 mm (0.16 in.) – 2% dwb • Man-made inerts > 4 mm, < 13 mm (0.5 in.) – 2% dwb
Persistent Herbicides Aminocyclopyrachlor Aminopyralid Clopyralid Picloram	Landscaping debris/residuals Herbivorous animal feed	Numerous examples of phytotoxicity at < 1 ppb	None are included on the Montgomery County List of Approved Pesticides[5]

Notes:
1. Choi, Y.J., et.al. 2019. Perfluoroalkyl acid characterization in U.S. municipal organic solid waste composts. *Environ. Sci. Technol. Lett.* 6:372−377.
2. O'Connor, J., et.al. 2022. Physical, chemical and microbial contaminants in food waste management for soil application: A review. *Environ. Pollut.* 300.
3. Compostable packaging/servingware complies with ASTM 6800 if 90% of the compostable plastic disintegrates within 180 days in an industrial composting facility.
4. Porterfield, K., et.al. 2023. Microplastics in composts, digestates, and food wastes: A review. *J. Environ. Qual.* 1–16.
5. Montgomery County DEP. 2023. *What Pesticides Are Allowed.* https://www.montgomerycountymd.gov/lawns/law/allowed-pesticides.html. Accessed on 16 May 12023.

dwb = dry weight basis
HFPO-DA = Hexafluoropropylene oxide – dimer acid
in. = inch(es)
mm = Millimeter(s)
PFBS = Perfluorobutanesulfonic acid
PFHxS = Perfluorohexane sulfonic acid
PFNA = Perfluorononanoic acid
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctanesulfonic acid
ppb = Part(s) per billion
ppt = Part(s) per trillion
wwb = wet weight basis

3.5 GREENHOUSE GAS (GHG) IMPACTS

The EA Team utilized the EPA Waste Reduction Model (WARM) to assess the mitigation potential of GHG emissions from organics processing technologies presented in this chapter. While assessment by specific technology is beyond the capability of the WARM model, it was utilized to provide a high-level assessment of the reduction in GHG emissions between processing via composting and anaerobic digestion (wet and dry).

The scenarios evaluated estimate the mitigation in metric tons of carbon dioxide equivalents (MTCO2e) from diversion of one ton of mixed organics from combustion, in the County's current disposal practice, to processing via composting or anaerobic digestion. Model assumptions were utilized to reflect current combustion practices and controls, and transportation distances of feedstocks to their respective processing locations. The models' 'mixed organics' categorization was deemed appropriate to consider the County-reported disposal of yard trim, food scrap, nonrecyclable paper, manure, and animal products appropriate for processing in an organics recycling facility.

Table 3-5. GHG Emissions Mitigation Per Ton of Diverted Organic Material

Scenario Evaluated	Avoided Metric Tons of Carbon Dioxide Equivalents
Currently combusted mixed organics diverted to composting	0.08 MTCO2e avoided
Currently combusted mixed organics diverted to wet (low-solids) anerobic digestion (excluding yard trim), assuming process digestate is land applied	0.14 MTCO2e avoided
Currently combusted mixed organics diverted to dry anerobic digestion, assuming process digestate is land applied	0.08 MTCO2e avoided

The model results estimate that utilizing composting or dry anaerobic digestion for diverted organics processing provides comparable GHG emissions reductions, while processing via wet anaerobic digestion provides marginally improved emissions reductions. Note that the scenario modeling anaerobic digestion assumes that the digestate is land applied. If instead, that digestate was composted or disposed of in another way, this would decrease emissions reduction; however, this reduction was not possible to quantify using the WARM model. Also of note is that any emissions reductions are only applicable to tonnages diverted from combustion, but not to organics tonnages that are already diverted, such as yard trim currently processed at the MCYTCF, or food scraps processed at the Prince George's Organics Composting Facility.

3.6 ANALYSIS

Aerobic and anaerobic organics processing technologies are assessed and ranked in this section using the weighted criteria decision matrix approach evaluating alternatives based on specific evaluation criteria, weighted by the importance of each criterion. This decision-making tool treats each criterion independently, which helps avoid bias or emphasis on a specific criterion. Additional discussion of methodology and analysis outcomes are discussed in the subsequent sections.

3.6.1 Technology Evaluation Criteria

To discern the most suitable organics processing technology for a County facility, the EA Team and the County developed 20 criteria against which to evaluate each technology, organized into categories including systems factors, operations, end products, and environmental concerns. After determining on the criteria most salient to the County, personnel across the DEP in management, planning, and operational roles assigned weighting factors on a scale of 1 to 5 to indicate the relative importance of each criterion. The weighting factors presented below represent an average of all responses received from County personnel and are applied in the weighted matrix discussed later in this section.

Among respondents, considerations regarding end-product usage, potential to produce odor, and solid wastes produced from processing were the most heavily weighted evaluation criteria.

Table 3-6. Organics Processing Technologies – Evaluation Criteria

Criteria	Definitions	Weighting Factor (Scale of 1-5)
System Factors		
1 – Relative Costs	A technology with lower capital and operating costs will score higher.	3.25
2 – Ease of Construction	A technology that is easily constructed will score higher. This includes consideration of the County management of site development and processing technology installation.	3.25
3 – Proven Experience	A technology with more current North American installations will score higher.	4
4 – Reliability	A technology that minimizes process downtime of mechanical components will score higher.	4.75
5 – Adaptability	A technology that is easily adaptable in layout to fit the site area, and expandable to process additional feedstock intake, will score higher.	4.25
6 – Permitting	A permitting pathway that has greater definition and clarity of requirements will score higher. This considers permitting at the state and local level for site development around a given technology.	3.5
Operations		
7 – Ease of Operation	A technology that is easy to operate will score higher. This includes consideration of material handling for loading/unloading and during material processing.	3.75
8 – Energy Utilization	A technology with lower net energy consumption will score higher.	3.5
9 – Process Stability	A technology that has reliable microbial processing will score higher. A technology that is more susceptible to microbial upset will score lower.	4.5
10 – Ease of Maintenance	A technology that is easier to maintain and repair will score higher. This includes consideration of repairs that can be conducted on-site, whether specialized subcontractors will be needed to conduct repairs, or if equipment must be sent off-site for repair.	4.5

Criteria	Definitions	Weighting Factor (Scale of 1-5)
11 – Feedstocks Processing Capability	A technology that accepts more feedstocks (e.g., food scraps, yard trim, manure, etc.) or that has more tolerance to seasonal changes in materials will score higher. A technology that accepts only one type or other limitation in feedstock acceptance will score lower.	4.25
12 – Co-collection of food and yard trim collection	A technology that allows co-collection of multiple feedstocks (e.g., food scraps and yard trim) will score higher. A technology that requires separate collections of feedstocks will score lower.	4.25
13 – Bulking Agents	A technology with greater need for external bulking agent will score lower. This includes consideration of amount of bulking agent required and County's ease in securing the appropriate supply.	2.5
End Products		
14 – End product usage	A technology that produces end products (e.g., compost, biogas) with proven usage in Montgomery County will score higher.	5.0
15 – Ability of the end product to produce renewable energy	A technology whose byproducts can be used to generate renewable energy will score higher.	4.0
16 – Byproducts	A technology that produces byproducts (e.g., digestate, effluent) requiring additional management will score lower.	4.75
Environmental Concerns		
17 – Air Quality – Odor	A technology with greater potential to produce odors will score lower. This includes consideration of odor generation during material processing and in end products. A technology with controls to prevent odors will score higher.	5.0
18 – Air Quality – GHG Emissions	A technology with less potential for GHG emissions will score higher.	3.75
19 – Contact Water Produced	A technology that produces less contact water requiring treatment will score higher.	4.5
20 – Solid waste produced	A technology with a higher reject rate for non-processable contaminants would score lower.	5.0

3.6.2 Technology Scoring

To provide an independent assessment of each organics processing technology, the EA Team scored each technology against the evaluation criteria, independent of facility size, siting, or other detailed County considerations. Based on the EA Team's organics industry experience and familiarity with organics processing facilities utilizing installations of all technologies presented, a score was assigned to each technology reflecting the merits and challenges of each technology. Annotations for each score are provided in Table 3-7 to provide additional information underlining each assigned score.

Table 3-7. Technology Scoring

Criteria	Aerobic Processing Technologies				Anaerobic Processing Technologies		
	ASP	**Tunnel Reactor**	**Rotating Drum**	**Agitated Bed**	**Wet (low-solids) CSTR**	**Dry Fermentation**	**High-Solids Plug Flow**
System Factors							
1 – Relative Costs	4 – Some electrical and concrete capital costs	3 – Higher electrical and concrete capital costs	3 – Higher electrical and concrete capital costs	2 – Building, electrical, concrete capital costs	2 – Building, electrical, concrete and process equipment capital costs	3 – Higher electrical and concrete capital costs	2 – Building, electrical, concrete and process equipment capital costs
2 – Ease of Construction	4 – County/MES experience with ASP construction	3 – More complicated construction	3 – More complicated construction	3 – More complicated construction	2 – Very complicated construction	3 – More complicated construction	2 – Very complicated construction
3 – Proven Experience	5 – Established technology with many installations	4 – Fewer than 10 U.S. Installations	2 – Limited U.S. installations	3 – Fewer than 5 U.S. Installations	5 – Most U.S. AD installations are Wet (low-solids) CSTR	2 – Limited U.S. installations	2 – Limited U.S. installations
4 – Reliability	5 – Stable process with fewer mechanical components / equipment	4 – Stable process with somewhat more mechanical components / equipment	3 – Stable process with more mechanical components / equipment	3 – Stable process with more mechanical components / equipment	2 – Easily upset process with more mechanical components / equipment	4 – Stable process with somewhat more mechanical components / equipment	3 – Stable process with more mechanical components / equipment
5 – Adaptability	3.5 – Flexible system layout potential, expandable with additional piles / bunkers	3.5 – Flexible system layout potential, expandable with additional tunnels	2 – Limited layout flexibility and expandability	3 – Less flexible system layout, expandable with additional bays	3 – Somewhat flexible on layout and not expandable	3.5 – Somewhat less flexible on layout but expandable	3 – Somewhat flexible on layout and not expandable
6 – Permitting	5 – Clear permitting pathway and Maryland Department of the Environment (MDE) experience with ASPs	4 – Clear permitting pathway, limited MDE technology experience	4 – Clear permitting pathway, limited MDE technology experience	4 – Clear permitting pathway, limited MDE technology experience	3 – Unclear permitting pathway but MDE experienced with technology	2 – Unclear permitting pathway and no MDE experience with technology	2 – Unclear permitting pathway and no MDE experience with technology
Operations							
7 – Ease of Operation	5 – Requires handling during material loading/unloading, limited labor during material processing	5 – Requires handling during material loading/unloading, limited labor during material processing	2 – More effort required during loading/unloading and some material management needed throughout processing	3 – More complex operations due to longitudinal agitator and moving agitator from one bed to the next	3 – Complex process management with strong need for highly skilled operator	5 – Requires handling during material loading/unloading, limited labor during material processing	3 – More complex operations due to horizontal agitator
8 – Energy Utilization	4 – Electrical consumption needed, could be met with solar	3 – Electrical consumption needed	3 – Electrical consumption needed, including need for drum insulation	2 – Electrical consumption for blowers and agitator	4 – Electrical consumption needed, can be met with parasitic energy usage	4 – Electrical consumption needed, can be met with parasitic energy usage	4 – Electrical consumption needed, can be met with parasitic energy usage
9 – Process Stability	5 – Aerobic composting very process-stable	5 – Aerobic composting very process-stable	5 – Aerobic composting very process-stable	5 – Aerobic composting very process-stable	2 – Process can be easily upset by ammonia and volatile fatty acids	4 – High-solids AD less susceptible to process upsets	4 – High-solids AD less susceptible to process upsets
10 – Ease of Maintenance	4 – On-site repairs and maintenance generally feasible	3 – On-site repairs and maintenance generally feasible	2 – More mechanically complex systems, may need specialized subcontractors	2 – More mechanically complex systems, may need specialized subcontractors	2 – More mechanically complex systems, may need specialized subcontractors	3 – Somewhat less mechanically complex systems, although may need specialized subcontractors	2 – More mechanically complex systems, may need specialized subcontractors
11 – Feedstocks Processing Capability	4.5 – ASP very flexible regarding feedstocks and contamination	4.5 – Very flexible regarding feedstocks and contamination	4 – Flexible regarding feedstocks and contamination; less flexible to volume surges	4.5 – Very flexible regarding feedstocks and contamination	1 – Can't handle yard trim, volume surges could upset process	4 – Flexible regarding feedstocks and contamination; less flexible to volume surges	4 – Flexible regarding feedstocks and contamination; less flexible to volume surges
12 – Co-collection of food and yard trim collection	5 – Can process co-collected food scraps and yard trim	5 – Can process co-collected food scraps and yard trim	4.5 – Can process co-collected food scraps and yard trim (mostly smaller materials)	5 – Can process co-collected food scraps and yard trim	1 – Cannot process yard trim	5 – Can process co-collected food scraps and yard trim	5 – Can process co-collected food scraps and yard trim
13 – Bulking Agents	3 – Food scrap composting optimal with 3:1 volume per volume (v/v) bulking agent ratio	3 – Food scrap composting optimal with 3:1 v/v bulking agent ratio	3 – Food scrap composting optimal with 3:1 v/v bulking agent ratio	3 – Food scrap composting optimal with 3:1 v/v bulking agent ratio	5 – No bulking agent needed	4 – Some bulking agent necessary for adequate material porosity for percolate	3 – Food scrap processing via has similar C:N requirements to aerobic composting

Criteria	Aerobic Processing Technologies				Anaerobic Processing Technologies		
	ASP	**Tunnel Reactor**	**Rotating Drum**	**Agitated Bed**	**Wet (low-solids) CSTR**	**Dry Fermentation**	**High-Solids Plug Flow**
End Products							
14 – End product usage	5 – Compost use well-established in County	5 – Compost use well-established in County	5 – Compost use well-established in County	5 – Compost use well-established in County	3 – Some County experience with biogas	3 – Some County experience with biogas	3 – Some County experience with biogas
15 – Ability of the end product to produce renewable energy	1 – Renewable energy production not possible, some heat recovery potential	1 – Renewable energy production not possible, some heat recovery potential	1 – Renewable energy production not possible, some heat recovery potential	1 – Renewable energy production not possible, some heat recovery potential	5 – Biogas can be used for electricity generation or renewable natural gas (RNG) or hydrogen production	5 – Biogas can be used for electricity generation or RNG or hydrogen production	5 – Biogas can be used for electricity generation or RNG or hydrogen production
16 – Byproducts	5 – No byproducts produced	5 – No byproducts produced	5 – No byproducts produced	5 – No byproducts produced	2 – Digestate post-processing for non-thermophilic AD	2 – Digestate post-processing for non-thermophilic AD	2 – Digestate post-processing for non-thermophilic AD
Environmental Concerns							
17 – Air Quality – Odor	4 – Odor minimization with biolayers, fabric covers, and/or biofilters	4.5 – Enclosed processing, typically equipped with biofilters to minimize odors	3 – Odor potential from material requiring additional curing post-processing	4.5 – Processing within building, typically equipped with biofilters to minimize odors	4 – Enclosed air-tight process, however digestate has odor potential	4 – Enclosed air-tight process, however digestate has odor potential	4 – Enclosed air-tight process, however digestate has odor potential
18 – Air Quality – GHG Emissions	4 – Less GHG emissions than AD	3.5 – Less GHG emissions than AD, although more mechanized system utilizes more energy	3.5 – Less GHG emissions than AD, although more mechanized system utilizes more energy	3 – Less GHG emissions than AD, although more mechanized system utilizes more energy	2 – Potential for methane leakage	2 – Potential for methane leakage	2 – Potential for methane leakage
19 – Contact Water Produced	3 – Contact water may be generated, requiring on-site management	5 – Enclosed system yields little to no contact water	3.5 – Drum enclosed, however some risk of contact water generation during compost curing	5 – Enclosed system yields little to no contact water	5 – Enclosed system yields little to no contact water	5 – Enclosed system yields little to no contact water	5 – Enclosed system yields little to no contact water
20 – Solid waste produced	4 – Aerobic composting can handle contaminants without rejects	4 – Aerobic composting can handle contaminants without rejects	4 – Aerobic composting can handle contaminants without rejects	4 – Aerobic composting can handle contaminants without rejects	1 – Poor tolerance for contaminants and therefore a high reject rate	2 – Can handle somewhat less contaminants without rejects	2 – Can handle somewhat less contaminants without rejects

3.6.3 Technology Ranking

Organics processing technologies ranked using a weighted criteria decision matrix technique are detailed in Table 3-9 and summarized in Table 3-8. To develop the weighted score, the score of each technology was multiplied by the evaluation criteria weighting factor. The weighted score was totaled across all evaluation criteria for each technology. The scores for each technology are then compared to create a ranking among alternatives.

Table 3-8. Technology Ranking Summary Table

Technology	Weighted Score
ASP	269.8
Tunnel Reactor	253.5
Agitated Bed	227.5
Dry Fermentation	225.9
Rotating Drum	212.9
High Solids Plug Flow	201.5
Wet (low-solids) CSTR	185.3

Based on the technologies presented and ranked applying the County’s evaluation factors with the EA Team’s technology scoring, the weighted matrix approach identifies multiple aerobic processing technologies and one anaerobic processing technology as meriting additional consideration. The EA Team will proceed with consideration of ASP, Tunnel Reactors, Agitated Beds, and Dry Fermentation AD in future tasks evaluating program alternatives for a County-wide organics processing technology. Consideration of technology in conjunction with other County-specific factors will be detailed later in this report.

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Table 3-9. Technology Weighted Matrix

Criteria	Weighting Factor	Aerobic Processing Technologies								Anaerobic Processing Technologies					
		ASP		Tunnel Reactor		Rotating Drum		Agitated Bed		Wet (low-solids) CSTR		Dry Fermentation		High-Solids Plug Flow	
		Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
System Factors															
1 – Relative Costs	3.25	4	**13.0**	3	**9.8**	3	**9.8**	2	**6.5**	2	**6.5**	3	**9.8**	2	**6.5**
2 – Ease of Construction	3.25	4	**13.0**	3	**9.8**	3	**9.8**	3	**9.8**	2	**6.5**	3	**9.8**	2	**6.5**
3 – Proven Experience	4	5	**16.3**	4	**13.0**	2	**6.5**	3	**9.8**	5	**16.3**	2	**6.5**	2	**6.5**
4 – Reliability	4.75	5	**16.3**	4	**13.0**	3	**9.8**	3	**9.8**	2	**6.5**	4	**13.0**	3	**9.8**
5 – Adaptability	4.25	3.5	**11.4**	3.5	**11.4**	2	**6.5**	3	**9.8**	3	**9.8**	3.5	**11.4**	3	**9.8**
6 – Permitting	3.5	5	**16.3**	4	**13.0**	4	**13.0**	4	**13.0**	3	**9.8**	2	**6.5**	2	**6.5**
Operations															
7 – Ease of Operation	3.75	5	**16.3**	5	**16.3**	2	**6.5**	3	**9.8**	3	**9.8**	5	**16.3**	3	**9.8**
8 – Energy Utilization	3.5	4	**13.0**	3	**9.8**	3	**9.8**	2	**6.5**	4	**13.0**	4	**13.0**	4	**13.0**
9 – Process Stability	4.5	5	**16.3**	5	**16.3**	5	**16.3**	5	**16.3**	2	**6.5**	4	**13.0**	4	**13.0**
10 – Ease of Maintenance	4.5	4	**13.0**	3	**9.8**	2	**6.5**	2	**6.5**	2	**6.5**	3	**9.8**	2	**6.5**
11 – Feedstocks Processing Capability	4.25	4.5	**14.6**	4.5	**14.6**	4	**13.0**	4.5	**14.6**	1	**3.3**	4	**13.0**	4	**13.0**
12 – Co-collection of Food and Yard Trim Collection	4.25	5	**16.3**	5	**16.3**	4.5	**14.6**	5	**16.3**	1	**3.3**	5	**16.3**	5	**16.3**
13 – Bulking Agents	2.5	3	**9.8**	3	**9.8**	3	**9.8**	3	**9.8**	5	**16.3**	4	**13.0**	3	**9.8**
End Products															
14 – End Product Usage	5	5	**16.3**	5	**16.3**	5	**16.3**	5	**16.3**	3	**9.8**	3	**9.8**	3	**9.8**
15 – Ability of the End Product to Produce Renewable Energy	4	1	**3.3**	1	**3.3**	1	**3.3**	1	**3.3**	5	**16.3**	5	**16.3**	5	**16.3**
16 – Byproducts	4.75	5	**16.3**	5	**16.3**	5	**16.3**	5	**16.3**	2	**6.5**	2	**6.5**	2	**6.5**
Environmental Concerns															
17 – Air Quality – Odor	5	4	**13.0**	4.5	**14.6**	3	**9.8**	4.5	**14.6**	4	**13.0**	4	**13.0**	4	**13.0**
18 – Air Quality – GHG Emissions	3.75	4	**13.0**	3.5	**11.4**	3.5	**11.4**	3	**9.8**	2	**6.5**	2	**6.5**	2	**6.5**
19 – Contact Water Produced	4.5	3	**9.8**	5	**16.3**	3.5	**11.4**	5	**16.3**	5	**16.3**	5	**16.3**	5	**16.3**
20 – Solid Waste Produced	5	4	**13.0**	4	**13.0**	4	**13.0**	4	**13.0**	1	**3.3**	2	**6.5**	2	**6.5**
TOTAL WEIGHTED SCORE			**269.8**		**253.5**		**212.9**		**227.5**		**185.3**		**225.9**		**201.5**

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4. RECYCLED ORGANICS PRODUCT USAGE OPTIONS (TASK 3)

All organics processing technologies produce recycled organics that must have viable end markets to be successful. To avoid processing disruptions, outgoing product volumes should equal incoming feedstock volumes. This chapter examines the potential capacities of markets in Montgomery County to absorb recycled organics products from aerobic and anaerobic organics processing technologies.

4.1 RECYCLED ORGANICS PRODUCTS

4.1.1 Product Types

Based on technologies investigated in the previous chapter, end products from aerobic and anaerobic processing are examined. Composting end products reviewed include compost, and compost-based soil blends. Review of these product end markets has been limited to compost produced with food scrap feedstocks. However, it is noted that the influence of recycled organics products produced from non-food scrap sources, such as biosolids compost and yard trim-based mulch products, should be considered for these product end markets in the future.

Anaerobic digestion produces methane, which can be utilized as biogas, and carbon dioxide, and trace gases; liquid and solid residuals from digestion, known as digestate; and the wastewater from percolate used in dry fermentation AD systems and from dewatering of liquid digestates, known as effluent. Based on these products, markets for anaerobic digestion end products examined in this chapter include digestate, biogas for pipeline injection, biogas for electricity generation, and biogas for production of fleet vehicle fuel. Although both compost and digestate can be utilized as soil conditioners, they are discussed separately for the purposes of this discussion. Additional discussion of byproducts is included as necessary.

4.1.2 Product Requirements – Compost End Products

4.1.2.1 Maryland Department of Agriculture

Federal authority under EPA for regulating compost end products is delegated to the states; in Maryland, this lies with the Maryland Department of Agriculture (MDA). MDA defines compost in COMAR 15.18.04.01 as "a stabilized organic product produced by the controlled aerobic decomposition process in such a manner that the product may be handled, stored, and applied to the land or used as a soil conditioner in an environmentally acceptable manner without adversely affecting plant growth." MDA identifies testing limits for contaminants in compost depending on its use in general, limited, or restricted capacities, with the general use standards being most stringent. Any compost distributed for public use must meet the general use requirements in accordance with COMAR 15.18.04.05. In addition, when compost feedstocks include anything other than agricultural or yard trim, such as food scraps, a material testing plan describing monitoring, sampling, and analysis plans for quality assurance and quality control must be approved by MDA. A summary of parameters and their MDA limits for general use compost is included in Table 4-1.

Table 4-1. MDA Parameter Limits for General Use Compost

Parameters[1]	Parameter Limit	Units
pH	6.0–8.0	scale
Metals		
Arsenic (As)	41	mg/kg dry wt.
Cadmium (Cd)	39	mg/kg dry wt.
Chromium	1,200	mg/kg dry wt.
Copper (Cu)	1,500	mg/kg dry wt.
Lead (Pb)	300	mg/kg dry wt.
Mercury (Hg)	17	mg/kg dry wt.
Molybdenum (Mo)	18	mg/kg dry wt.
Nickel (Ni)	420	mg/kg dry wt.
Selenium (Se)	36	mg/kg dry wt.
Zinc (Zn)	2,800	mg/kg
Polychlorinated biphenyls	5	ppm
Man-made inerts >4 mm, <13 mm	2	% dry wt.
Film plastic >4 mm	2	% dry wt.

Notes:
1. Material requirement to pass Process to Further Reduce Pathogens is applicable only to compost from MSW or manure, and therefore not included herein.

mg/kg = milligram(s) per kilogram
mm = millimeter(s)
ppm = parts per million

4.1.2.2 Maryland State Highway Administration

Where compost is applied for achieving water quality improvements, the Maryland Department of Transportation (MDOT) State Highway Administration (SHA) has materials specifications for bioretention soil mix (BSM) and soil amendments used on its projects. Where compost produced from food scraps has moderate to high levels of phosphorus, a known water quality inhibitor in the Chesapeake Bay Watershed, these products are not suitable for use as soil amendments. In its *Standard Specifications for Construction and Materials* (MDOT SHA 2023), the products with potential for integrating compost include and are summarized below. Compost types for use as a soil amendment are summarized in Table 4-2:

- Furnished Topsoil, Section 920.01.02 – Provides for the use of compost to raise the topsoil's organic matter content in accordance with an applicable Nutrient Management Plan.

- BSM, Section 920.01.05 – Specifies that BSM composed of sand, furnished topsoil, and hardwood mulch may include approved soil amendments, such as compost.

- Compost Use as a Soil Amendment, Section 920.02.05 – Specifies the moisture content, material bulk density, and other parameters per compost type. Compost Type A is composed primarily of biosolids, manure, and similar compost source materials with low carbon-to-nitrogen ratios. Type B is composed primarily of tree leaves, lawn clippings, and similar compost source materials with high carbon-to-nitrogen ratios. Type C is composed primarily of chipped, ground or granulated wood, bark, and similar compost source materials with very high carbon-to-nitrogen ratios. All compost types shall be biologically mature and no longer able to reheat to thermophilic temperatures per DeWar Self Heating > 5 stable; a moisture content of 30 to 55%; and a weight of 1,400 pounds per cubic yard (CY) or less when delivered.

Table 4-2. MDOT SHA Compost Types – Physical Properties

<table>
<tr><th colspan="3">Type A and B Compost</th><th colspan="2">Type C Compost</th></tr>
<tr><td colspan="3">Type A and Type B Compost shall have pH of 6.0 to 7.5; shall have soluble salt concentration less than 10.0 mmhos/cm; shall have a moisture content of 30 to 55%; and shall be screened as follows.</td><td colspan="2">Type C Compost shall have pH of 5.0 to 8.0; shall have soluble salt concentration less than 4.0 mmhos/cm; shall have a moisture content of 30 to 55%; and shall be screened as follows.</td></tr>
<tr><th colspan="2">Sieve</th><th>Passing by Volume</th><th>Sieve Size</th><th>Passing by Volume</th></tr>
<tr><th>Size</th><th>mm</th><th>mg/kg</th><td>6 in.</td><td>100 % minimum</td></tr>
<tr><td>0.5 in.</td><td>12.5</td><td>100 % minimum</td><td>¾ in.</td><td>75 % minimum</td></tr>
<tr><td>No. 4</td><td>4.75</td><td>90 % maximum</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>No. 40</td><td>0.425</td><td>25 % maximum</td></tr>
<tr><td>No. 200</td><td>0.075</td><td>2.2 % maximum</td></tr>
</table>

Notes:
in. = inch(es)
mg/kg = milligram(s) per kilogram
mm = millimeter(s)
mmhos/cm = millimhos per centimeter

4.1.2.3 Maryland Department of the Environment

Where compost is utilized in stormwater management Best Management Practices (BMPs), the Maryland Department of the Environment (MDE) includes specifications for filtering media and planting soil in its Stormwater Design Manual (MDE 2000). For use in micro-bioretention, rain gardens, landscape infiltration, and infiltration berms, the use of compost in facility media is intended to improve the stormwater filtering capacity. The filtering media and planting soil must meet the following criteria:

- Soil Component – Loamy Sand or Sandy Loam (USDA Soil Textural Classification).
- Organic Content – Minimum 10% by dry weight (ASTM D 2974). In general, this can be met with a mixture of loamy sand (60% to 65%) and compost (35% to 40%) or sandy loam (30%), coarse sand (30%), and compost (40%).
- Clay Content – Media shall have a clay content of less than 5%.
- pH Range – Should be between 5.5 and 7.0. Amendments (e.g., lime, iron sulfate plus sulfur) may be mixed into the soil to increase or decrease pH.

4.1.2.4 County Agency Requirements and Incentives

In addition to the MDE BMP specifications for compost use in stormwater management, the County Department of Permitting Services has modified some specifications for infiltration practices, including bioswales, biofiltration, and micro-bioretention facilities, and landscape infiltration, to require that "high grade compost free of stones and partially composted woody material" make up one-third of the planting medium (Montgomery County Department of Permitting Services 2012). The DEP has a RainScapes Rewards Rebate Program that awards residential and commercial/multi-family/institutional participants. There are a variety of techniques, and all guidelines must be followed to qualify for the rebate. For rain gardens, soil must be amended with 2 inches (in.) of compost to qualify for a residential rebate up to $7,500 per parcel or a commercial/multi-family/institutional rebate of up to $20,000 per parcel.

4.1.3 Product Requirements – Anaerobic Digestion End Products

4.1.3.1 Maryland Department of Agriculture

Digestate retains most of the nutrients present in the feedstocks being digested in a more concentrated form; solid digestates are usually composted prior to beneficial reuse, and liquid digestates are often land-applied to cropland, to capitalize on that nutrient value.

For use as a fertilizer or soil conditioner, digestates are regulated in Maryland by MDA under COMAR 15.18.03, including requirements for product registration, distribution, testing, and reporting. To register digestate as a commercial fertilizer, the distributor must include a legal claim of the digestate's minimum percentages of plant nutrient content; these percentages cannot change after registration. To register digestate as a soil conditioner, the distributor must only include a statement of digestate composition. MDA's State Chemist Section regulates fertilizer and soil conditioner sale and distribution, requiring annual registration of each brand and grade of commercial fertilizer or each product name of soil conditioners, in accordance with COMAR 15.18.03.02. MDA regulations also include testing and classification, labeling, and recordkeeping requirements. Distributors must submit a semiannual report on the tons of digestate distributed in the state and pay a 25-cent fee per ton of digestate distributed.

Effluent from digestate dewatering, also subject to MDA requirements, can be either land-applied on cropland or discharged to a sanitary sewer. However, percolate generated in dry fermentation digestion is typically recycled internally to seed the continuance of anaerobic processing, so this processing option in particular yields little effluent.

4.1.3.2 Biogas

While biogas itself is not regulated by the State of Maryland, standards dictated by uses for pipeline injection as renewable natural gas (RNG), direct use for on-site electricity generation, and as hydrogen fuel for fleet vehicles, are presented in this section. In addition, the flammable nature of biogas requires all processing of end products to be completed in gas-tight systems.

4.1.3.2.1 Biogas Standards for Pipeline Injection as RNG

Increasingly, AD systems are exploring converting biogas to RNG either for pipeline injection or for use as vehicle fuel in engines converted to run on natural gas. For biogas use as RNG, gas impurities, such as carbon dioxide (CO_2), must be removed, and the methane content concentrated to 97–98%. The removed CO_2 is either released to the atmosphere, or, in some cases, can be reused in greenhouse crop production. Typical specifications for RNG require considerable cleanup of biogas to meet maximum concentrations for oxygen, hydrogen sulfide, sulfur, and moisture content.

While biogas itself is not regulated by the State of Maryland, standards of the natural gas utility accepting the biogas are relevant. In Montgomery County, illustrative gas quality considerations for the local utility Washington Gas are summarized in Table 4-3. Currently, Washington Gas' first RNG interconnection project is currently under construction at the WSSC Water Piscataway Wastewater Treatment Facility in Accokeek, Maryland, as part of a larger bioenergy project at the Piscataway facility. Product competition for biogas end markets is less salient for discussion in this chapter than access to RNG transmission pipelines for biogas injection, to be discussed in later chapters of this report.

Table 4-3. Illustrative Gas Quality Considerations for RNG Injection

Gas Quality Term	Generally Acceptable Limit
Heating Value	≥960 Btu/SCF
Sulfur (including dimethyl sulfur and hydrogen sulfide)	Total S: ≤20 grains/CCF, H_2S: ≤0.25 grains CCF
Carbon Dioxide, CO_2	≤ 3.0%, by volume
Nitrogen, N_2	≤ 4.0%, by volume
Oxygen, O_2	≤ 0.4%, by volume
Ammonia	≤ 0.001%, by volume
Siloxanes	≤ 1 mg/m^3
Temperature	32 to 140°F
Moisture	< 7 lb/MMSCF

Notes:
Btu/SCF = British thermal units per standard cubic foot
CCF = one hundred cubic feet
H_2S = hydrogen sulfide
lb/MMSCF = pounds per million standard cubic feet
mg/m3 = milligram(s) per cubic meter
Source: ICF Resources, LLC 2020

4.1.3.2.2 Biogas Standards for On-Site Electricity Generation

Many AD systems (including landfill gas extraction systems) use biogas (55–60% methane [CH_4], 30–35% CO_2) as fuel for combined heat and power engines to generate electricity. This use requires the gas be condensed to remove moisture and filtered through a charcoal filter to remove hydrogen sulfide. While not a biogas quality standard, MDE air emissions permits may be required for combined heat and power electrical generators burning biogas.

4.1.3.2.3 Biogas Standards for Hydrogen Fuel for Fleet Vehicles

Another recycled organic product that could be produced from biogas is hydrogen fuel for fleet vehicles. While it is not yet clear which hydrogen-forming technologies will be most cost-effective in the future, the Department of Energy continues to support development of hydrogen technologies to identify a pathway for near-term hydrogen production. In addition, while some consider the carbon intensity of biogenic hydrogen fuel, such as that generated from biogas, to be carbon negative, there is uncertainty around how the carbon intensity will be recognized for pursuing federal incentives and whether waste and biomass may potentially be excluded by these rulemakings (Schill 2023).

Most hydrogen produced today in the United States is made via steam-methane reforming, a mature production process in which high-temperature steam (700–1,000 degrees Celsius) is used to produce hydrogen from a methane source, such as natural gas. In steam-methane reforming, methane reacts with steam under 3–25 bar pressure (1 bar = 14.5 pounds per square inch [psi]) in the presence of a catalyst to produce hydrogen, carbon monoxide, and a relatively small amount of carbon dioxide. Steam reforming is endothermic; heat must be supplied to the process for the reaction to proceed. Subsequently, in what is called the "water-gas shift reaction," carbon monoxide and steam are reacted using a catalyst to produce carbon dioxide and more hydrogen. In a final process step called pressure-swing adsorption, carbon dioxide and other impurities are removed from the gas stream, leaving essentially pure hydrogen. Steam reforming can also be used to produce hydrogen from other fuels, such as ethanol, propane, or even gasoline (U.S. Department of Energy 2023).

Steam-methane reforming reaction

$$CH_4 + H_2O \text{ (+ heat)} \rightarrow CO + 3H_2$$

Water-gas shift reaction

$$CO + H_2O \rightarrow CO_2 + H_2 \text{ (+ small amount of heat)}$$

Once the biogas has been upgraded to RNG by removing the carbon dioxide and water vapor, a steam/methane reformer is used to split the hydrogen molecules (H_2) from the methane in the biogas to get the final product. The recovered hydrogen is compressed to 10,000 psi for vehicle fuel. With a carbon capture system to reuse or recycle the CO_2 from the pressure-swing adsorption system, instead of releasing the CO_2 to atmosphere, it may be possible to make a hydrogen fuel that is carbon negative. Another method of making hydrogen fuel for vehicles is by the electrolysis of water molecules, essentially splitting H_2 from H_2O. Additional analysis of hydrogen yield from recycled organic sources in the County will be necessary to ensure the feedstocks available for processing will produce a beneficial volume of end product. An estimate of hydrogen gas yields are included in Appendix D.

4.1.4 Product Competition

This section investigates compost product sales through bulk and bagged markets by competitor food scrap compost products. The geographic area of influence for sale of bulk compost and soil products is typically considered a 1-hour hauling travel time from production location for manufacturing compost. While travel time is a function of road network capacity and quality, this analysis assumes a 50-mile radius for bulk sales. However, for parts of Montgomery County near interstate 95 or other high-speed corridors, this radius for bulk sales could reach 75 to 100 miles in practice. Bagged product sales have a considerably longer reach of +200 miles. However, the added cost of bagging is often a challenge for start-up and first-stage expansion facilities. Compost produced by small-scale entities that do not enter commercial markets, such as compost produced by community composters, is not currently considered in this analysis.

Figure 4-1. Typical Radii for Bulk (50-mile) and Bagged (200-mile) product sales.

In an aerated static pile compost facility co-located at the Alpha Ridge Landfill in Marriottsville, Maryland, Howard County, produces compost from food scrap, yard trim, and manure, marketed as HoCoGro. The facilities' finished product, available as compost or blended topsoil, is registered with MDA and is tested six times per year under the US Composting Council's Seal of Testing Assurance program. The HoCoGro products are sold primarily in a bulk market at the unit prices noted In Table 4-4. Wholesale sales to private entities make up over 80% of the products' sales, with some bulk sales to residents and some use on County projects at public schools and through the Department of Recreation and Parks.

The Prince George's Organics Composting Facility produces compost in an aerated static pile compost facility utilizing fabric covers, located in Upper Marlboro, Prince George's County. The finished product from residential food scraps and yard trim is marketed under the brand name Leafgro GOLD® by MES and is available as a finished compost product primarily in bulk markets at the unit prices noted in Table 4-4. The Leafgro GOLD® products are sold exclusively in Prince George's County under the same trade name (MES 2022), with the majority of product sales to private landscapers and lawn and garden shops, and sales to commercial landscapers increasing. Bulk compost sales do include sales of up to 5 CY to residents available at the County facility. Product sales to third parties that bag products and market in or out-of-county under other trade names are not included in this analysis. Note that the facility also produces

Leafgro® from grass clippings and leaves through windrowing; however, the market influence of the Leafgro® product is not considered in this analysis.

Veteran Compost, a privately and veteran-owned company, produces compost from residential and commercial food scrap, and wood chips; processed via vermicomposting or aerated static piles systems. Finished compost products are typically sold for bulk pickup, but bagged products are available for nationwide shipping. Pricing available from the producer website, along with estimated annual product sales, are included in Table 4-4.

Table 4-4. Food Scrap Compost Products Produced and Sold in Maryland

Product, Producer	Compost (Bulk) ($/CY)	Compost (Bagged) ($/CY)	Compost-Based Soil Blends ($/CY)	Annual Product Sales (CY/year)
HoCoGro, Howard County Compost Facility	24[1]	N/A	28[1]	23,000[3]
Leafgro GOLD®, PG Organics Composting Facility	16[2]	N/A	N/A	50,000
All-Natural Compost, Veteran Compost	39	67.50	175	25,000-30,000[4]
Estimated Total Food Scrap Compost Product Sales				98,000-103,000

Notes:
1. Prices effective as of 1 January 2022. Price includes sales tax.
2. Average sale price, given pricing tiers by volume for 0-1,000 CY, 1,000–5,000 CY and >5,000 CY. Price increase to $16.30/CY anticipated fall 2023.
3. Volume of compost removed from the facility in calendar year 2021.
4. Production not available at time of reporting. Product sales estimated based on permitted facility capacity (MDE 2023).
CY = Cubic yard

As composting expands, public and private entities within Maryland may pursue developing processing facilities yielding a competing product in compost end markets. Within Maryland, this includes growing municipal composting programs in the City of Baltimore and Frederick County. Outside of Maryland, Freestate Farms is a privately run compost operation processing food scraps and yard trim for the Prince William County, Virginia, government at a site in Manassas, Virginia. Currently the 88,000 ton/year facility is within the 50-mile radius considered viable for bulk compost markets; however, traffic and location west of the Potomac River make this finished product less competitive in the Maryland market. Lastly, private processors such as WeCare Denali, currently producing only yard trim-based products for Carroll County, have expressed interest in expanding operations to include food scrap feedstocks (WeCare Denali 2023). While these are not products that have yet entered the market, they are programs that have the potential to enter the production market in the short to medium term.

4.2 RECYCLED ORGANICS PRODUCT MARKETS

Markets for compost and compost-based soil blends can be classified as traditional and emerging. Traditional markets are those in which a product is considered well defined and has customers with well-developed buying patterns and established customer loyalty, while emerging markets are those in which the benefits of a product are still being defined. Based on review of competing products currently on the market, traditional markets for compost and compost-based soil blends in Maryland include stormwater management for new construction/ redevelopment, landscaping, and agriculture. Emerging markets for compost and compost-based soil blends with high potential for new product sales are commercial landscaping and erosion and sediment control.

Markets are also characterized in this section as "dollar" markets and "volume" markets. Dollar markets can be described as those with higher unit price potential, but lower volume sales expectations. Conversely, volume markets are those with the capacity to support large product volumes but exhibit a lower unit cost and willingness-to-pay. The distinctions between volume and dollar markets are not definitive, and potential compost markets can fluctuate between both dollar and volume markets depending on project size. For example, a small commercial landscaping job might be considered a dollar market but landscaping the grounds of a new shopping mall would be considered a volume market.

Traditional and emerging and dollar and volume recycled organics product markets are summarized in Table 4-5.

Table 4-5. Recycled Organics Product Market Types

Market Type	Dollar	Volume
Traditional	**Stormwater Management for New Construction/Redevelopment** **Residential Landscaping (small projects)**	**Residential Landscaping (large projects)** **Agriculture** Agriculture (specialty) Containerized Horticulture Engineered Soils
Emerging	Commercial Landscaping Green Roofs Sports Turf	Erosion and Sediment Control Carbon sequestration/climate action plans Development soil organic matter programs Local gov't sustainability programs

4.2.1 Market Capacity By Sector

4.2.1.1 Landscape Market

Landscaping represents a traditional market for recycled organics products, appropriate for use of compost and compost-based soil blends. Based on their ability to fortify soil health and structure, improve nutrient and water retention, and encourage microbial activity, these products are advantageous for use in planting beds and for turfgrass growth. Potential methods of compost use are incorporation into the top 6 to 8 in. of soil, incorporation into plant backfill material, loosely spread on the surface of turf as a topdressing, and (more rarely) as a 2- to 3-in. mulch layer. This landscaping market has been the main outlet for the compost produced by MCYTCF to date.

The landscape market has several potential sectors including design professionals (landscape architects and consulting engineers), landscape contractors (installation/maintenance), wholesalers/retailers of landscape soil amendment products, and homeowners/gardeners.

Wholesale landscape material supply yards mainly serve contractors and large residential markets. As such, these businesses often stock bulk inventories of compost-based soils (i.e., manufactured topsoil), rootzone mixes, mulches, gravels, stones, and other similar bulk supplies.

Homeowners and gardeners represent a significant market share for bulk compost sales, with much of Montgomery County's current production of yard trim-based products oriented toward this market. While many residential customers appreciate the convenience of bagged products, there are still a significant number of "pick-up truckload" (up to 5 CY per purchase) buyers willing to travel some distance to capture cost efficiencies associated with bulk compost purchases. Given that, timely small-scale deliveries and local distribution through wholesale and retail outlets are important considerations to sales growth in this market sector. The retail landscape material supply distribution chain is heavily dominated by "big box" stores and generally serves smaller residential customers. These businesses are commonly more interested in bagged products. This is evidenced by the local lawn and garden centers increasingly converting the use of their limited space from bulk materials to bagged merchandise.

To estimate the landscape market capacity within the county, the EA Team considered the single-family home as the most significant user of recycled organics products. While multi-family, commercial, and other property types within the county have landscaping needs, the number of single-family households in the County was considered a reasonable proxy for the overall residential compost need. Future study efforts could refine these assumptions.

Based on review of average lot sizes across the county, and minimum lot sizes and maximum building coverage area in each residential zoning codes (Zoning Montgomery 2023), average planting bed and turf grass areas were assumed to be 3% and 50%, respectively, of the average lot size. For every 1,000 square feet (MSF) of planting bed or turfgrass area, an application rate of compost was assumed in cubic feet per year. The annual total compost usage was calculated by multiplying application rate, landscaping area, by the total number of housing units in the County, and by the percentage of households estimated to apply recycled organics products. Based on the comparable recycled organics products available on the market, as discussed previously in the product competition section of this report, a 25% market share was assumed. Achieving this market share will require the development of detailed business plans and marketing strategies in the future. The market sector analysis is summarized in Table 4-6.

Table 4-6. County Landscape Market Capacity

Single-Family Households	259,300
Average Lot Size	18,880 SF/household
Average Planting Bed Area	800 SF/household
Compost Application Rate	3 CY/MSF/year
Households Applying Compost	8%
Compost Usage	49,800 CY/year
Average Turf Grass Area	10,000 SF/household
Compost Application Rate	1.5 CY/MSF/year
Households Applying Compost	4%
Compost Usage	155,600 CY/year
Landscape Market Capacity	**205,400 CY/year**
County Market Capture	25%
County Market Share	**52,000 CY/year**

4.2.1.2 Agriculture Market

While compost has been used in agricultural applications for centuries, the practice of using recycle-based composts made off-site for farm applications in lieu of that generated from on-farm sources (i.e., manures), such as row-crop agriculture, is a more recent trend. Compost use in organic agriculture is a well-established tendency and is becoming a larger phenomenon in conventional agriculture. The supporting research on compost addition to agricultural soils has been developed for the past 10 to 15 years, and results consistently point to improved crop yields, improved crop quality, reduced incidences of root-rot-type diseases, and reduced demand for fertilizers, herbicides, and fungicides.

Potential agricultural uses for compost include incorporation into soil as an amendment prior to planting, surface-applied mulch layers for weed control, and distilling compost into a water-based extract (compost “tea”) for use as a foliar spray or in root drench applications. The benefits of compost use in agriculture are improved soil organic matter, increased soil water-holding capacity (resulting in reduced irrigation demand), increased soil microbial activity (one of the reasons for improved disease suppression), long-term slow-release of plant nutrients, and improved soil pH buffering. The main drawbacks to its use in agriculture are the cost of transport to the fields and a historically low willingness-to-pay by farmers. Consequently, many compost professionals use agricultural markets as “relief valves” to clear space at their composting facility for other uses.

Product to be used as an agricultural soil amendment need not be as mature and stable as compost used in landscaping or in container mixes as it is often incorporated into soils after crop harvest and allowed to “winter over” until the following spring planting season. Application rates are dependent on local soil testing for organic matter but rates of approximately 20 tons per acre per year are typical (Natural Resource, Agriculture, and Engineering Service [NRAES] 1999). This application rate typically achieves a planted soil organic matter content of 3 to 5% over a 3- to 5-year period. Sandy soils, generally along and east of I-95 in Maryland, receive greater benefit from organic matter addition than loam or clay soils. Farmers in sandy soil regions have a higher willingness-to-pay for compost amendment. Compost is also used in agriculture as a weed-control mulch and has been shown to be more effective when immature due to its phytotoxic effects on weeds (Ozores-Hampton 2001). It was shown to be effective as a weed control agent in 3-in.-thick layers (approximately 10 CY per 1,000 SF per year). One concern that has been voiced about compost use in agriculture is that some composts contribute to a build-up of phosphorus (P) in farm soils, which can constrain agricultural use in future years. In addition, as more regulations are developed surrounding PFAS and MP in soil application to crops, maintaining a high quality of organic feedstock will be important to keep organics products competitive in the market.

Agricultural applications represent a potentially major market for compost, where Montgomery County protects 93,000 acres of County land in Agricultural Reserve. The land use categories sourced from the 2017 Census of Agriculture (USDA 2019) show approximately 65,500 acres were used for agricultural purposes, including 74% in cropland and 12% in pastureland considered in this analysis. To estimate the compost market for agricultural use, compost application rates for each agricultural purpose were assumed to be applied to 2% of farming acreage in each use category. Based on other compost products currently available, the potential share of compost sale for agricultural use was estimated at 25%. The market sector analysis is summarized in Table 4-7.

Table 4-7. County Agriculture Market Capacity

	Cropland	Pastureland	Total
Agricultural Reserve (acres)			93,000
Farming Area (acres)	48,400	7,800	56,200
Farms Applying Compost	2%	2%	
Farm Area Using Compost (acres)	900	150	
Compost Application Rate (Tons/acre/year)[1]	30	20	
Agricultural Market Capacity (CY/year)	49,100	5,300	54,400
County Market Capture	25%	25%	
County Market Share (CY/year)	12,300	1,300	**13,600**

Note:
Application rates from the US Composting Council 2001.

4.2.1.3 Stormwater Management for New Construction/Re-development Market

In Maryland, the Stormwater Management Act of 2007 outlines the stormwater management strategy entitled Environmental Site Design (ESD) to the Maximum Extent Practicable (MEP), which prioritizes smaller-scale solutions that mimic local and natural hydrology, to control runoff and improve stormwater quality. New development or re-development activities that result in more than 20% of new impervious surface across a site require the implementation of ESD to the MEP to address stormwater management. Implementation of bioretention and micro-bioretention facilities, rain gardens, bioswales, landscape infiltration, and infiltration berms can utilize compost as facility media or in amended soils, to carry out the ESD to the MEP strategy. Design and sizing of facility ESD BMPs, including selection of practice media, reflect site drainage areas, rainfall, slope, soil type, and other factors. Implementation of designed stormwater BMPs removes non-point-source pollutants in stormwater runoff through filtration, absorption, adsorption, and in some cases microbial degradation (i.e., total petroleum hydrocarbons from road and parking lot runoff). The pollutant removal efficiencies of these systems are dependent upon the physical, chemical, and biological quality of the substrate used to grow vegetation within each practice.

To estimate the capacity of the compost market for stormwater management in new construction and/or redevelopment projects in the county, the EA Team applied assumptions about the total developable land area in the county of 223,800 acres, or the total land area of 316,800 acres minus area in agricultural reserve of 93,000 acres. Based on the Residential Development Capacity Analysis performed by the County, the annual county acreage for new construction/re-development was estimated at 5% of the total area for development. If 50% of parcels under development require stormwater management, the total area for construction requiring stormwater management is expected to be 5,600 acres per year. Applying an annual compost usage of 3 CY per year for stormwater management, based on historical project experience, and a county market share of 25%, market capacity for compost sales in the county for stormwater management for new construction/redevelopment is estimated to be 4,200 CY per year. The market sector analysis is summarized in Table 4-8.

Table 4-8. Stormwater Management (SWM) for New Construction/Re-Development Market Sector Analysis

Total Land Area in Montgomery County	316,800 acres
Total Land Area in Agricultural Reserve	93,000 acres
Total Land Area for New Development/Re-Development	223,800 acres
Assume 5% Land Area for Annual New Construction/Re-development	11,190 acres
Assume 50% of New Construction/Re-development Parcels Require SWM	5,600 acres/year
Average SWM Compost Application Rate	3 CY/acre
SWM for New Construction/Re-Development Market Capacity	**16,800 CY/year**
County Market Capture	25%
County Market Share	**4,200 CY/year**

4.2.1.4 Market Capacity Summary

Based on review of the markets for compost use in landscape, agriculture, and stormwater management for new construction/redevelopment within the County, the market capacity is estimated to support use of 276,600 CY per year. This is a conservative estimate, given that only the traditional use markets are quantified, and application is considered only within the County.

The estimate of 69,800 CY per year represents a 25% market share for the County. Given that there are three similar and competing products produced from food scraps currently on the market, this estimate reflects current conditions; however, as noted, additional products or other conditions have the potential to shift market dynamics. In addition, non-food-scrap recycled organic products, such as biosolids compost or mulch products may influence the market and should be further considered in the future.

The market capacity by sector is summarized in Table 4-9.

Table 4-9. Market Capacity Summary

Market	Market Capacity	County Market Share
Landscape	205,400 CY/year	52,000 CY/year
Agriculture	54,400 CY/year	13,600 CY/year
SWM for New Construction/Re-Development	16,800 CY/year	4,200 CY/year
Total	**276,600 CY/year**	**69,800 CY/year**

4.2.1.5 Emerging Markets

While not quantified in this analysis, emerging markets for recycled organics products within the county include increased used of compost for erosion and sediment control, development of soil organic matter content, and enhanced carbon sequestration to support climate action plans. These markets are discussed below and can be considered in future market planning efforts.

4.2.1.5.1 Erosion and Sediment Control

MDE has regulatory authority over erosion and sediment control under COMAR 26.17.01 and requires erosion and sediment control plans for projects disturbing 5,000 SF or more of land or 100 CY or more of soil. Although MDE does not explicitly name compost as a soil amendment in its specifications for erosion and sediment control (MDE 2011), it is addressed in the 2023 update to the *Standard Specifications for Construction and Materials*, signaling a shift toward increasing use of compost in erosion and sediment controls. In practice, this may include future controls such as compost filter berms, compost filter socks, and compost blankets. Erosion and sediment control incentives and requirements may be initiated at the local and state levels to promote increased compost use in the future.

4.2.1.5.2 Development Soil Organic Matter Content

Several states and municipalities have adopted ordinances to require minimum soil organic matter content in new development. As compost-amended soils hold more water, less irrigation is needed, driving such ordinances in western states and other arid locations. As compost-amended soils reduce runoff by improving infiltration and water retention in soil pores, water quality improvements affecting the salmon industry in the Columbia River watershed in Washington state are the driver. To restore soil porosity and improve soil health, the Fairfax County Department of Public Works and Environmental Services published guidance for homeowners defining a soil compost amendment applying a minimum of 2 to 5 in. of compost incorporated 6 to 10 in. below the surface to deeply till compacted soils and backfill terraced slopes to slow down runoff and improve infiltration (Fairfax County 2014). Howard County notes that addition of compost into its blended topsoil product raises the organic matter content in the soil to 5–9% and adds billions of soil-enhancing microbes (Howard County, Maryland 2023) critical to improving soil health.

In Washington, the state’s stormwater manuals and local codes require 3 in. of compost to be tilled 8 in. into the soil for planting beds, and 1.75 in. of compost tilled in 8 in. deep for turf areas. Alternatively, a “calculated rate” can be used to meet the organic matter content requirements, which are 8 in. of settled soil at 10% organic content for planting beds, and 5% organic content for turf. The soil must be scarified an additional 4 in. to achieve a total depth of 12 in. of uncompacted soil after the calculated amount of amendment is added. Scientific trials in Washington and elsewhere have shown that these simple soil BMPs can reduce stormwater runoff by 50% or more, and reduce the summertime need for landscape irrigation by 50%—which pays for the amendments in 3 to 5 years.

Fort Collins, Colorado, adopted a land use code in 1998 requiring use of compost at new building and development sites and expanded the rule to the municipal code in 2003. The ordinance requires building permit holders to incorporate soil amendments into at least 6 in. of soil in any turfed or landscaped area, at a minimum rate of 3 CY per 1,000 SF of area to be planted. Other cities in the state—including Greeley, Boulder, Castle Rock, Colorado Springs, and Westminster—have followed suit.

Voluntary programs encouraging homeowners to retrofit their landscaping—with an eye to increasing organic matter content in soil even where there is no development taking place—have also been on the rise in the Metropolitan D.C. region. This largely follows on the success of Montgomery County's (Maryland) RainScapes program, which offers technical assistance and financial incentives to homeowners who install a RainScapes project on their property to reduce stormwater runoff volume and improve water quality. Projects include use of compost and rain barrels, and installation of rain gardens and conservation landscaping. Financial assistance is given in the form of RainScapes Rewards Rebates—a maximum of $7,500 per parcel for residential properties and $20,000 per parcel for commercial, multi-family, and institutional properties.

4.2.1.5.3 Carbon Sequestration and Climate Action Plans

Carbon dioxide, a potent GHG, is taken up by soil as a natural part of the carbon cycle, with increased organic content of soil improving carbon uptake. The Intergovernmental Panel on Climate Change has assessed soil carbon mitigation to be a stepping stone in the path to addressing climate change and has set forth the goal of 0.4% additional absorption of carbon per year. As carbon uptake, or sequestration, in soils is improved, atmospheric GHG mitigation is improved. Researchers at the University of California at Davis recently published a study examining the effect of compost amendment on carbon sequestration during 19 consecutive years of adding compost at the University's Russell Ranch Sustainable Agriculture Facility. They found that repeated use of compost amendments increased the stockpile of soil organic carbon by 12.6% (or 0.7% annually) to a depth of 78.4 in. (Tautges et al. 2019).

In addition, local governments and regional institutions are engaged in developing climate action plans to address potential impacts from GHG. King County in Washington state has developed estimates of carbon dioxide equivalent (CO2eq) emissions reductions through the use of organic amendments in agriculture. The County land applied its biosolids compost product and calculated that application of the biosolids to farmland resulted in a projected decrease in CO2eq emissions of 1.55 metric tons per metric ton of biosolids applied (Brown and Beecher 2019b). Using that same methodology, researchers calculated that a new residential lawn using compost in lieu of fertilizer would reduce CO2eq emissions by 1.2 metric tons per metric ton of compost used (Brown and Beecher 2019b). A compost product branded and marketed to promote CO2eq reductions in residential landscaping could be successful.

4.3 INFLUENCE OF COUNTY POLICY

The County should consider policy decisions that will stimulate demand and enhanced use of recycled organics products. Recommendations are included for development of specifications, enactment of ordinances, consideration of incentives, and support through technical assistance resources. Note some recommendations have been presented previously to the County through zero waste and waste diversion planning in other efforts.

Specifications

- Require US Composting Council Seal of Testing Assurance-registered compost for all County projects that include landscaping.
- Consider adopting a tree-planting media specification for urban trees that includes compost.

Ordinances

- Modify Chapter 59-3 of the Montgomery County Zoning Ordinance to allow "Agricultural Processing" (which includes composting) as a Permitted Use rather than as a Conditional Use.
- Adopt a New Construction Development Ordinance that specifies a minimum soil organic matter content of 5% to promote rainfall infiltration and reduce stormwater runoff (Coker 2021a)
- Consider a program similar to Arlington County, Virginia, for restoration of the soil profile for developed sites undergoing substantial reconstruction, to enhance rainfall infiltration and reduce stormwater runoff (Coker 2021b)
- Examine municipal separate storm sewer system (MS4) plans in other jurisdictions (e.g., Fairfax County) that have adopted compost use as a soil amendment to be part of their MS4 program.

Incentives

- Consider property tax credit for compost use on residential properties (ornamentals and turf grass).
- Expand the Office of Agriculture's Soil Amendment Program to provide up to five 40-CY loads of County-produced food scrap compost to interested farms at no cost annually.

- Encourage compost-based alternatives for erosion control measures (e.g., compost filter socks instead of silt fence or compost blankets instead of erosion control blankets). MDOT SHA Type C Compost is specified for use in manufactured products for sediment and erosion control.

- Encourage Sustainable Building Practices in all County projects.

Technical Assistance

- Consider providing a certified nutrient management planner to support farmers.

- Support research into stormwater nutrient credits for compost use in soils, specifically how long the infiltration and stormwater benefits last.

- Work with the USDA Natural Resources Conservation Service to allow pilot-testing of Conservation Practice 336, Soil Carbon Amendment, on farms in Maryland and in Montgomery County.

Procurement

- Require County agencies and all municipalities in the County with land holdings, to purchase and use recycled organics products. An agency or jurisdiction can comply by directly procuring recovered organic waste products for use or giveaway, and/or requiring, through a written contract or agreement, that a direct service provider to the agency or jurisdiction procure recovered organic waste products.

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5. SITING EVALUATION (TASK 4)

To support an organics processing facility, a site must meet the needs to receive, process, and distribute organic feedstocks and finished products. This chapter examines the feasibility of utilizing County-owned property for the development of an organics management facility, including review of, at the direction of the County, the Shady Grove TS, the MCYTCF at Dickerson, and the tract of land known as Site 2 in Dickerson. In addition, the EA Team performed a desktop analysis based on publicly available GIS data to determine whether any additional County-owned parcels merit further review as potential locations for facility siting. Site development and permitting requirements are reviewed later in the chapter.

5.1 SHADY GROVE PROCESSING FACILITY AND TRANSFER STATION

The Shady Grove TS is a 52.5-acre site zoned IM-2.5, located at 16101 Frederick Road in Derwood, Maryland. This site hosts material receipt, processing, homeowner drop-off, and Material Recovery Facility operations. The Shady Grove TS is the central point for solid waste collection in the County, accepting trash, recycling, scrap metal, yard trim, household hazardous waste, bulk trash, and construction and demolition waste from permitted solid waste collectors and haulers operating in the County, and from residents at public drop-off areas. The transfer station is currently served by public water and sewer services from WSSC Water and has three-phase power available on-site. The transfer station has been in operation since 1982, with rail haul of combustible waste to a Resource Recovery Facility (RRF) since 1995. The Processing Facility and Transfer Station Permit 2022-WPT-0617 granted by MDE allows the facility to process 821,500 tons of waste per year (MDE 2023a). Site improvements conducted in 2008 included the expansion of the transfer station building and tipping floor area, site road upgrades, installation of new scales, and the construction of a small vehicle drop-off center (Montgomery County DEP 2021). Site improvements currently underway include upgrades to the scale house (Montgomery County DEP 2023a). The site is shown in Figure 5-1.

Shady Grove TS is bordered to the northeast by the Washington Metropolitan Area Transit Authority and Shady Grove Rail Yard and Metro Station (both zoned IM-2.5); to the north by a CarMax dealership (zoned IM-0.5) and Maryland Route 370; to the northwest by two undeveloped parcels totaling 13.4 acres (zoned CR-1.5) privately owned by the Eugene Casey Foundation; to the southwest by a mix of retail and multi-family housing, including the King Farm residential development; and to the south by an institutional/community facility (zoned CR-2.25). Residents of the King Farm development across Frederick Road are the nearest residents to the transfer station, located within 400 ft. Across Maryland 370 is a residential area (zoned RP-T) of the City of Gaithersburg, and in the parcel adjacent to the rail yard east of the transfer station, new multi-family residential buildings are currently under construction. Given the mix of commercial and residential activity and proximity to the Shady Grove TS, odor and noise are prominent considerations for any organic waste receiving and/or processing considered for this location.

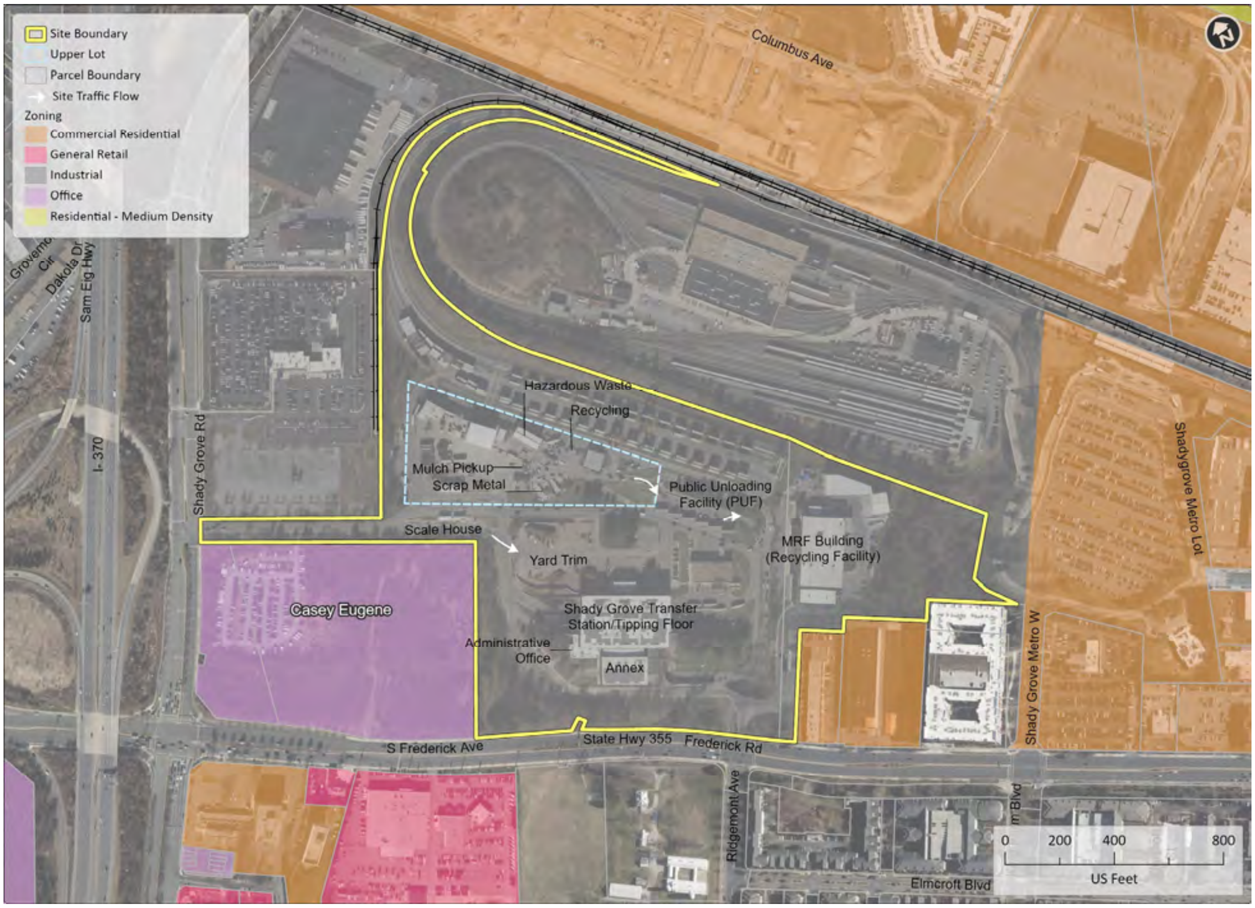

Figure 5-1. Shady Grove Processing Facility and Transfer Station.

5.1.1 Current Site Operations

On average, the facility receives 2,100 tons of waste daily, transported by collection trucks and personal vehicles (Montgomery County DEP 2023a). Based on visual observation of the site, there are significant logistical challenges from commercial trucks and personal vehicles accessing various loading and unloading areas of the site. Traffic queues from truck trailers entering the transfer station building to unload at the tipping floor and vehicles at the scale house exiting the facility regularly cause backups that impact the access and free movement of other site areas. This is further complicated by foot traffic from the public in material unloading areas and site operations personnel directing site activities. Given the daily volume of material handling and vehicular traffic from private haulers, public drop-off, and rail delivery, the transfer station is an active site with attentive traffic and operations management critical for safely conducting daily activities. Recommendations have been made from various County-commissioned planning studies for the relocation of operations currently sited at Shady Grove TS to other locations; however, in lieu of available alternate site locations, there are no active plans to relocate yard trim processing, Material Recovery Facility activities, or other on-site processing activities.

A significant source of organics currently processed on-site is yard trim, which is managed by the County in an approximately 2-acre lot adjacent to the transfer station building. Yard trim and recycling are collected separately from other residential waste by County and private haulers on a weekly basis across the County-designated areas Subdistrict A, Subdistrict B, and municipalities located within the County. Yard trim and leaves from residential curbside collection are sorted, processed, and loaded for transport from Shady Grove TS to the MCYTCF for composting, while brush from residential curbside collection is ground and chipped into mulch and sold to commercial mulch companies. Existing site grinders process yard trim at up to 500–600 CY per hour; storage for ground material is limited within the processing area.

In calendar year 2021, approximately 578,000 tons of MSW were transported off-site for disposal at the RRF, and 60,900 tons of ground yard trim were transported off-site for windrow composting at the MCYTCF (Montgomery County DEP 2023c, 2023j). Material is transported off-site from the Shady Grove TS by rail or truck. Rail haul is utilized Monday through Saturday, with enough containers available to facilitate daily roundtrips between the Shady Grove TS and the RRF. Rail containers hauling yard trim are transferred at the RRF from train cars to truck beds, then driven approximately 0.5 mile to MCYTCF and over the scales before being discharged from the tipping chassis at a location near the active windrow building area.

5.1.2 Considerations for Future Site Use

Given the daily volume of material handling and vehicular traffic currently at the Shady Grove TS site, changes to site operations that would increase the volume of material for daily processing and/or increase vehicle traffic at the site are not considered feasible without modifications to existing site operations. Any organic waste processing activities conducted on-site would require prioritizing these activities over current operations and relocating current processing activities elsewhere. An assessment of site adequacy for material processing is considered for various technologies as summarized in Table 5-1, where a darkened circle connotes that the processing area is sufficiently sized to accommodate the process noted and an open circle connotes that the area is insufficient. Technologies reviewed include the four highest-ranked technologies identified in the processing technologies analysis (Chapter 3) and site areas reviewed include the Upper Lot and adjacent Eugene Casey Foundation parcels (which would require acquisition by the County).

Table 5-1. Site Adequacy Assessment – Shady Grove TS

Materials Handling Processes		Aerated Static Pile		Tunnel Reactor		Agitated Bed		Dry Fermentation	
		Upper Lot Only	Upper Lot + Casey Parcels	Upper Lot Only	Upper Lot + Casey Parcels	Upper Lot Only	Upper Lot + Casey Parcels	Upper Lot Only	Upper Lot + Casey Parcels
1 – Feedstock Receipt by Truck		●	●	●	●	●	●	●	●
2 – Feedstock Receipt by Rail		○	○	○	○	○	○	○	○
3 – Feedstock Pre-Processing (e.g., grinding, mixing)		●	●	●	●	●	●	●	●
4 – Active Processing		●	●	●	●	●	●	●	●
5 – Material Transport by Truck		●	●	●	●	●	●	●	●
6 – Material Transport by Rail		●	●	●	●	●	●	●	●
7 – Secondary Curing		○	●	○	●	○	●	○	●
8 – Screening		○	●	○	●	○	●	○	●
9 – Material Storage	Compost	○	○	○	○	○	○	N/A	N/A
	Biogas	N/A	N/A	N/A	N/A	N/A	N/A	○	○
	Digestate	N/A	N/A	N/A	N/A	N/A	N/A	○	○
10 – Product Post-Processing	Compost	○	○	○	○	○	○	N/A	N/A
	Biogas	N/A	N/A	N/A	N/A	N/A	N/A	○	○
	Hydrogen	N/A	N/A	N/A	N/A	N/A	N/A	○	○
	Digestate	N/A	N/A	N/A	N/A	N/A	N/A	○	○
11 – Finished Product Transport/Distribution by Truck	Compost	○	○	○	○	○	○	N/A	N/A
	Biogas	N/A	N/A	N/A	N/A	N/A	N/A	○	○
	Hydrogen	N/A	N/A	N/A	N/A	N/A	N/A	○	○
	Digestate	N/A	N/A	N/A	N/A	N/A	N/A	○	○
12 – Finished Product Transport/Distribution by Rail	Compost	○	○	○	○	○	○	N/A	N/A
	Biogas	N/A	N/A	N/A	N/A	N/A	N/A	○	○
	Hydrogen	N/A	N/A	N/A	N/A	N/A	N/A	○	○
	Digestate	N/A	N/A	N/A	N/A	N/A	N/A	○	○

As the centralized waste collection point within the County, the Shady Grove TS currently receives yard trim and MSW, among other waste streams. An expanded waste diversion program within the County would aim to reduce food scrap in MSW. Food scrap could be managed either co-collected with yard trim, or collected separately, as discussed in Section 2.5.2. For the purposes of this study, it is assumed that waste receiving of yard trim and food scraps remains centralized at the Shady Grove TS.

The approximately 7-acre Upper Lot of the Shady Grove TS could provide an area sufficient for feedstock pre-processing and active processing with various technologies, if this processing activity is prioritized for the site and current procession operations are relocated elsewhere. However, this area alone would be insufficient to also support secondary curing, material storage, or product post-processing. Any material handling conducted at the Upper Lot would require relocating the hazardous waste drop-off, scrap metal and other recycling activities that currently take place in this area. The two Eugene Casey Foundation parcels immediately adjacent to the transfer station site present an additional opportunity for supplementary organics processing area, with the potential for up to 8 acres of additional processing area. These parcels are currently assessed at $6 million (Maryland Department of Assessments and Taxation 2023), and with market value anticipated to be $10 million or greater, land acquisition of these parcels would be costly. The presence of an existing stream channel through the parcels could trigger additional permitting and mitigation requirements prior to any site development in this area.

The highest levels of organic waste capture projected at high or mandatory program levels (Chapter 1) would require additional site area for materials handling processes beyond that which both the Upper Lot and Eugene Casey Foundation parcels could provide; however, low and medium organic waste volumes projected through the planning period could be accommodated as described.

Based on the EA Team review of the site, the pros and cons regarding the development of the site for supporting organics processing are summarized in Table 5-2.

Table 5-2. Shady Grove Transfer Station Pros and Cons for Site Development

Pros	Cons
• Shady Grove TS is centrally located and connected via rail, reducing costs for haulers • Existing water and sewer service exists on-site, although service upgrades may be required • Limited groundwater concerns in Shady Grove TS area	• Residents' proximity to the site necessitates attentive process control to minimize odor and vector issues • Existing site infrastructure for internal access roads, traffic flow already constrained • Limited site area to support all material handling on-site • Shady Grove TS already receives food scrap on-site co-mingled with MSW; however, pending the food scrap collection pursued (e.g., separate or co-collected with yard trim), the processing burden will shift to the yard trim or other to-be-determined area. • Use of Upper Lot and land acquisition of Eugene Casey Foundation parcels would allow more processing of organic waste on-site; however, organics capture at high and mandatory scenarios projected would require additional site area for processing • Use of Upper Lot would require relocation of existing materials processing currently conducted in that area • Electrical service exists on-site, although major service upgrades will be required

5.2 YARD TRIM COMPOSTING FACILITY AT DICKERSON (MCYTCF)

The MCYTCF is a 118-acre site zoned Agricultural Reserve (AR), located at 21210 Martinsburg Road, Dickerson, Maryland. This site hosts a yard trim windrow composting operation processing yard trim and leaves to manufacture a high-quality soil amendment marketed under the brand name Leafgro® sited on a 48-acre bituminous pavement pad, using open-air windrows with mobile windrow turners. In addition, the site includes an 80,000-square-foot pavilion for screening and bagging finished compost, an office/scale house, a maintenance building, a storage building, a pumphouse, and three stormwater management ponds. Public sewer and water service is not available at this site; however, on-site water supply and septic systems are present. The parcel was originally an interim sewage sludge composting facility (1981–1982) and was converted by the County in 1983 to be used for yard trim composting. The General Composting

Facility Permit issued by MDE on 2 June 2021 is based on the current site capability for processing up to 77,000 tons of waste per year (MDE 2023b). The MCYTCF is currently operated by MES (Figure 5-2) under an agreement with the County. The finished product, Leafgro®, is sold to landscapers and homeowners. The site is shown in Figure 5-2, including the RRF shown within the site boundary.

MCYTCF is surrounded almost entirely by land zoned AR, with the exception of adjacent RRF and power plant zoned IH-2.5 for use by utilities. Additional neighboring parcels are the Dickerson Conservation Park, deeded to M-NCPPC, to the west; and privately owned parcels to the east owned by the Evans James B Trust; to the southeast by the Sugarloaf Citizens Association, Inc. (SCA), a local citizens group; and to the south by GenOn, owner of the Westlands Ash Management Landfill.

The SCA is sensitive to the impacts of MCYTCF on nearby sensitive receptors and in 1996 entered into an agreement with the County to cap yard trim handled at the MCYTCF at 77,000 tons per year. The agreement restricts facility operations to the existing asphalt pads and buildings and prohibits the County from increasing the area of impervious surfaces of the facility beyond 48 acres of existing asphalt surfaces. The County is prohibited from adding additional buildings or expanding existing buildings; however, repair and replacement of existing buildings and impervious surfaces is allowed. Production of bagged compost at the site is limited to 650,000 bags per year. Any changes to the methods of operations, such as the use of new types of machinery, must be approved by the SCA. In 2018, SCA agreed to the County establishing a residential food scrap composting pilot program at MCYTCF. The pilot program must be conducted with the consent of SCA and in accordance with requirements of the agreement. However, to establish a permanent operation at the MCYTCF, SCA requires the County to close the RRF, operate a 1-year food scrap composting pilot outside of the Montgomery County Agricultural Reserve, and agree to abandon Site 2 as a landfill option while providing SCA control over the future use of the 815-acre property.

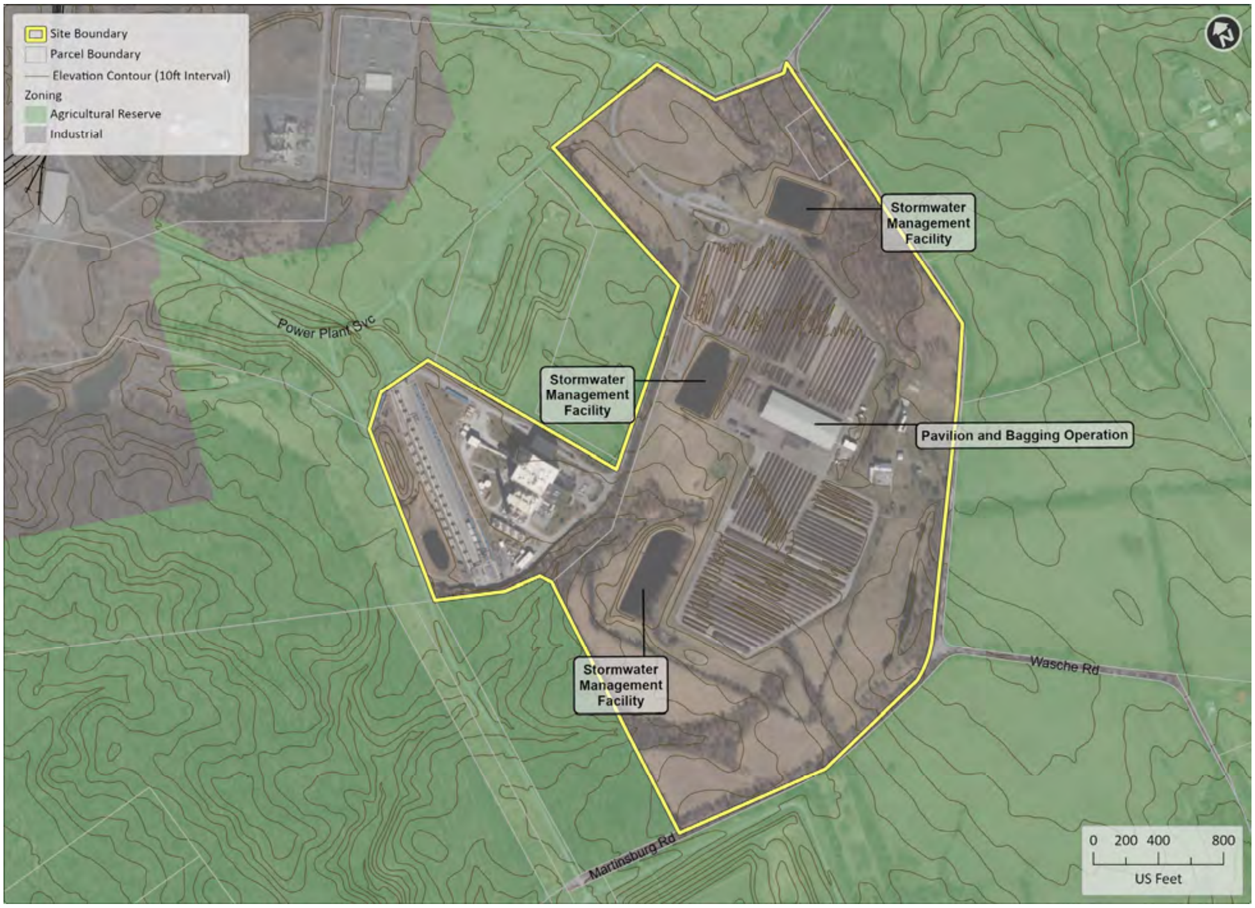

Figure 5-2. MCYTCF at Dickerson.

5.2.1 Current Site Operations

Yard trim is transported via rail and truck from the Shady Grove TS to the MCYTCF year-round, and leaves are trucked directly from the Department of Transportation's Silver Spring Depot during the County's vacuum leaf collection program where they capture the fall leaf surge. Transport of yard trim by rail is prioritized when possible, to reduce truck traffic on Maryland Route 28 and other roads near the MCYCTF. Table 5-3 shows the total tons of yard trim received at MCYTCF by mode (Montgomery County DEP 2023c).

Table 5-3. Yard Trim (Tons) Received at MCYTCF by Mode

	Fiscal Year			
Tons by Mode	**2020**	**2021**	**2022**	**2023**
Rail	21,600	26,700	16,700	13,900
Truck	41,700	33,800	40,700	44,900
Total	63,300	60,500	57,400	58,800

Upon receipt on-site, the material is windrowed, and using windrow turners, piles are turned as needed based on material moisture and temperature. Material is typically composted on-site over a 9-month period, before being screened and prepared for bulk sale and bagged distribution. Eleven MES full-time staff manage daily site operations.

An ongoing structural maintenance program continues at MCYTCF for the maintenance of existing site infrastructure, which includes scheduled replacement of portions of the paved pad, regular inspections, and preventative maintenance and as-needed repairs to its on-site stormwater management system. Additional recommendations have been made regarding additional improvements that could be undertaken to improve site operations.

5.2.2 Considerations for Future Site Use

The MCYTCF is a natural site to consider for hosting additional organics processing capacity, as it currently hosts the County's yard trim processing in windrows. At 20-25 miles from the Shady Grove TS by truck, the site can receive material by both rail and truck. Given its location in an agricultural area, concerns regarding odor and vectors are less common. Assessment of site adequacy for material processing is considered for various technologies and site areas as summarized in Table 5-4, where a darkened circle connotes that the processing area is sufficiently sized to accommodate the process noted and an open circle connotes that the area is not sufficient. Technologies reviewed include the four highest ranked technologies identified in the processing infrastructure analysis (Chapter 3). As shown, the site is considered to provide adequate processing area for the technologies noted, including at the highest levels of organic material capture projected at high or mandatory program levels (Chapter 1).

Table 5-4. Site Adequacy Assessment – MCYTCF

Materials Handling Processes		Aerated Static Pile	Tunnel Reactor	Agitated Bed	Dry Fermentation
1 – Feedstock Receipt by Truck		●	●	●	●
2 – Feedstock Receipt by Rail		●	●	●	●
3 – Feedstock Pre-Processing (e.g., grinding, mixing)		●	●	●	●
4 – Active Processing		●	●	●	●
5 – Secondary Curing		●	●	●	●
6 – Screening		●	●	●	●
7 – Material Storage	Compost	●	●	●	N/A
	Biogas	N/A	N/A	N/A	●
	Digestate	N/A	N/A	N/A	●
8 – Product Post-Processing	Compost	●	●	●	N/A
	Biogas	N/A	N/A	N/A	●
	Hydrogen	N/A	N/A	N/A	●
	Digestate	N/A	N/A	N/A	●
9 – Product Transport/Distribution by Truck	Compost	●	●	●	N/A
	Biogas	N/A	N/A	N/A	●
	Hydrogen	N/A	N/A	N/A	●
	Digestate	N/A	N/A	N/A	●
10 – Product Transport/Distribution by Rail	Compost	●	●	●	N/A
	Biogas	N/A	N/A	N/A	●
	Hydrogen	N/A	N/A	N/A	●
	Digestate	N/A	N/A	N/A	●

The EA Team estimates that the existing infrastructure at MCYTCF can accommodate up to 100,000 tons of organic waste utilizing windrow processing, with one option being to add food scraps to the open windrows. Under a new organics diversion program, food scraps could be co-collected with yard trim and ground/processed at the Shady Grove TS complex (although coarser screening would be needed to offset the free air space problem currently experienced), and then composted in the existing windrows. Adding food scraps would lower the C:N ratio and speed up the processing time. Higher quantities of food waste and yard trim could be handled by converting the composting operation to ASP, the methodology used when the facility was operated as an interim sewage sludge composting facility, or other technologies as noted.

The Montgomery County DEP would also need to pursue permit amendments to incorporate food scraps at the proposed capacity into their General Compost Facility Permit. Under COMAR, this would entail updates to the stormwater management system, specifically separation and containment of contact water and repair of the forebays on the ponds. Retrofitting MCYTCF to accept food scraps would require renegotiation of the existing use agreement with the SCA.

Based on the EA Team review of the site, the pros and cons regarding the development of the site for supporting an organics processing facility are provided in Table 5-5.

Table 5-5. MCYTCF at Dickerson Pros and Cons for Site Development

Pros	Cons
• Large site area with few constraints/limited traffic for development of additional processing approach • MCYTCF can be configured to accept food waste with less capital and operational expense for an expanded operation, given the current site infrastructure available • Existing compost equipment available on-site that may be reusable, including windrow turners, screens, and bagging equipment • Material can be transported to site by rail and truck from the Shady Grove TS • Equipment for material bagging and distribution operation already exists at the site	• MCYTCF requires larger hauling distances than the Shady Grove TS • Requires renegotiation of the SCA agreement conditions around material type, processing capacity limits, bagging, infrastructure, and other terms that would impede optimal site operations • Upgrades to stormwater management infrastructure would be required • Electrical upgrades would likely be necessary if converting to aerated static pile or extended aerated static pile • Located in an area identified by EPA as a Sole Source Aquifer system, which may require additional review or permitting effort during site development.

5.3 SITE 2 (DICKERSON)

Montgomery County owns 810 acres of land zoned AR known as "Site 2" between Martinsburg Road and Wasche Road in Dickerson, Maryland. The site holds MSW landfill permit 2019-WMF-0237 expiring 23 July 2024, permitting landfilling on 125 acres of the site (MDE 2023a). While a landfill is not currently constructed at this site, the area is held in reserve in case out-of-County waste disposal becomes infeasible due to economic conditions, changes in the law, or other circumstances. To begin development of a landfill, the County would need to submit a notice to proceed 1 year in advance of starting construction at the site (Montgomery County DEP 2021). The site is shown in Figure 5-3.

Site 2 is surrounded almost entirely by other land zoned AR. The parcel to the east, the Woodstock Equestrian Park, is deeded to M-NCPPC; the parcel to the north by GenOn, owner of the Westlands Ash Management Landfill. Privately owned parcels surround the site to the west, south, and southeast. The nearest parcel zoned for residential (low density) is 0.5 mile to the west. As with the MCYTCF, the SCA is sensitive to the impacts on nearby sensitive receptors.

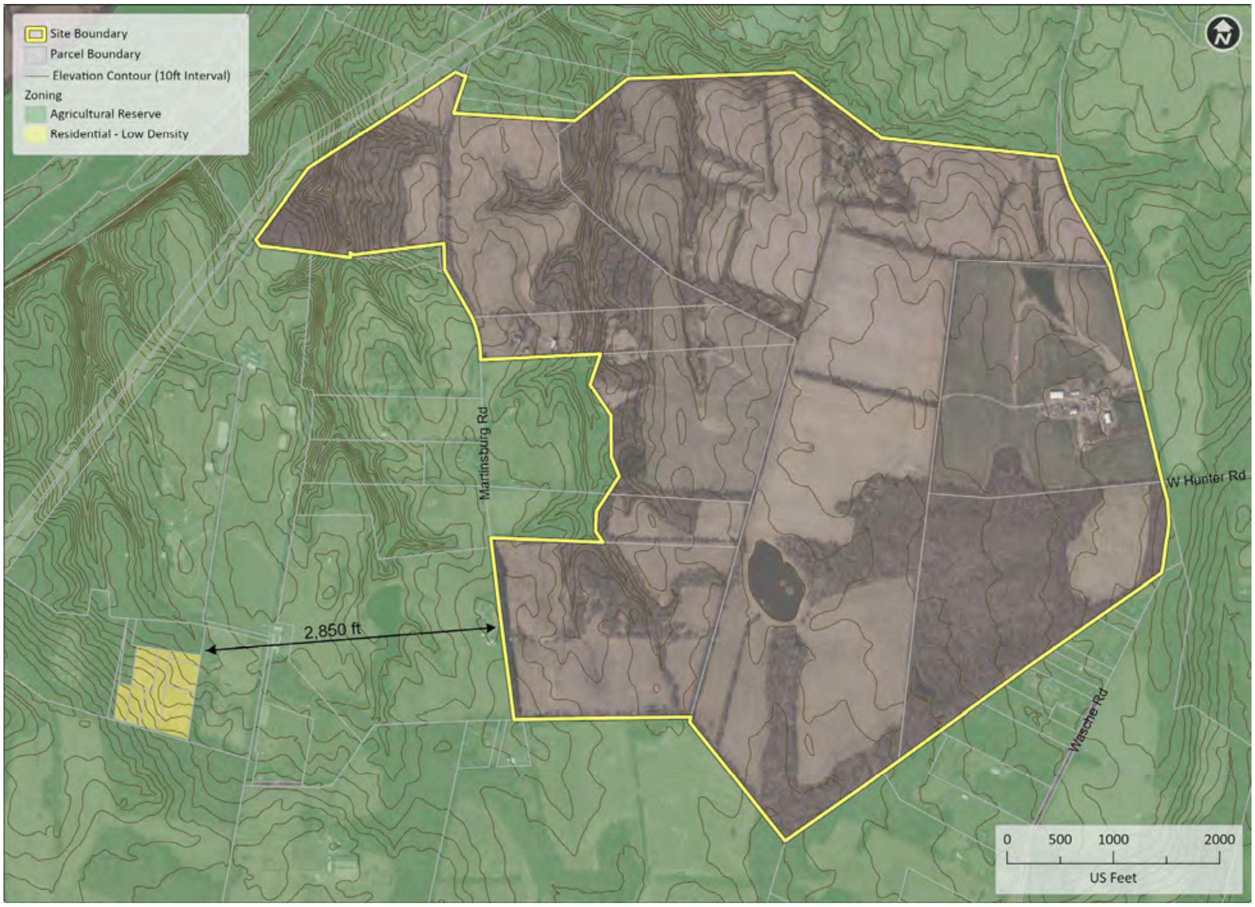

Figure 5-3. Montgomery County Site 2 at Dickerson.

5.3.1 Current Site Operations

Site 2 is currently leased to local farmers for crop production purposes. There is no solid waste infrastructure currently at Site 2. There are two test wells installed by adjacent parcel owner GenOn to monitor groundwater quality surrounding the Westlands Ash Management Facility. A plume from the Westlands Ash Landfill has impacted a key aquifer in this portion of the County; therefore, residents are concerned about any activities that could cause additional impact to groundwater quality.

5.3.2 Considerations for Future Site Use

Assessment of site adequacy for material processing is considered for various technologies and site areas as summarized in Table 5-6, where a darkened circle connotes that the processing area is sufficiently sized to accommodate the process noted and an open circle connotes that the area is not sufficient. Technologies reviewed include the four highest ranked technologies identified in the processing infrastructure analysis (Chapter 3). As shown, the site is considered to provide adequate processing area for the technologies noted, including at the highest levels of organic waste capture projected at high or mandatory program levels (Chapter 1).

Table 5-6. Site Adequacy Assessment – Site 2

Materials Handling Processes		Aerated Static Pile	Tunnel Reactor	Agitated Bed	Dry Fermentation
1 – Feedstock Receipt by Truck		●	●	●	●
2 – Feedstock Receipt by Rail		●	●	●	●
3 – Feedstock Pre-Processing (e.g., grinding, mixing)		●	●	●	●
4 – Active Processing		●	●	●	●
5 – Secondary Curing		●	●	●	●
6 – Screening		●	●	●	●
7 – Material Storage	Compost	●	●	●	N/A
	Biogas	N/A	N/A	N/A	●
	Digestate	N/A	N/A	N/A	●
8 – Product Post-Processing	Compost	●	●	●	N/A
	Biogas	N/A	N/A	N/A	●
	Hydrogen	N/A	N/A	N/A	●
	Digestate	N/A	N/A	N/A	●
9 – Finished Product Transport/Distribution by Truck	Compost	●	●	●	N/A
	Biogas	N/A	N/A	N/A	●
	Hydrogen	N/A	N/A	N/A	●
	Digestate	N/A	N/A	N/A	●
10 – Finished Product Transport/Distribution by Rail	Compost	●	●	●	N/A
	Biogas	N/A	N/A	N/A	●
	Hydrogen	N/A	N/A	N/A	●
	Digestate	N/A	N/A	N/A	●

As there is no existing solid waste infrastructure at the site, there is a need to construct water, electricity, and sewer lines on the property. In addition, due to concerns about potential impacts on the aquifer under Site 2, impermeable composting/processing areas, a lined stormwater pond and leachate collection and recycling system will likely need to be constructed.

The conditions of the county roads between Site 2 and the RRF rail yard are an additional infrastructure limitation. The portion of Martinsburg Road between the RRF and Whites Ferry Road is classified as an Exceptional Rustic Road due to its historic and scenic character that reflects the agricultural, rural origins of the county. According to the Rustic Roads Functional Master Plan, rustic roads must maintain narrow widths and follow natural historic alignments to "encourage slower speeds and increase safety" (M-NCPPC 2023). In addition, MDOT and SHA are instructed to "maintain the current surface of a rustic road to preserve the character of the road to the extent practicable" and most rustic roads do not have storm drains and ditches (Montgomery Planning 2023). Finally, Martinsburg Road has a gross vehicle weight limit of 10,000 pounds, which further limits what kinds of vehicles can use it. The haul road between the RRF rail yard and Site 2 would also require significant investment before it could accommodate increased traffic. However, this would allow transportation on internal access roads not relying on the public roadways adjacent to the site.

While Site 2 is being held in reserve for use as a landfill, construction of a compost or AD facility at Site 2 should not impact the landfill permit so long as at least 125 acres and additional setbacks are left for landfill development. Effort for permit review and modification will be required with MDE.

The Montgomery County Executive has expressed interest in developing an agrivoltaics system on the property. Agrivoltaics is the use of land for both solar photovoltaic energy generation and food production. Agrivoltaics systems maximize land use and the solar panels and crops offer symbiotic cooling benefits. Montgomery County's Department of General Services is in conversations with a solar power company which has speed grid access to lease part of Site 2 for solar installations. MDE would need to review the future landfill permit to determine the potential impact of solar collectors.

Based on the EA Team review of the site, the pros and cons regarding the development of the site for supporting an organics processing facility are provided in Table 5-7 below.

Table 5-7. MCYTCF at Dickerson Pros and Cons for Site 2 Development

Pros	Cons
• Large site area could provide adequate space for all facility operations • Some effort to obtain compost facility permit; however, effort may differ siting on a permitted solid waste management facility • Limited residential receptors nearby	• Roadway access limitations, rustic roads between RRF and Site 2 • No existing solid waste infrastructure or electricity, water, or sewage—high up-front costs • Located on key aquifer, groundwater protection infrastructure and systems would be needed

5.4 GIS REVIEW

To evaluate additional potential siting locations for an organics processing facility within the County, the EA Team performed a GIS-based desktop review of County-owned parcels based on publicly available data.

As initial screening criteria, County-owned parcels not containing floodplains nor Chesapeake Bay Critical Areas and greater than 25 acres in size were considered suitable for further consideration. Parcels already owned by the County were deemed to be an important initial screening criterion, as using an existing County-owned parcel would reduce facility development costs. Privately owned parcels requiring County purchase for development were not included in this desktop review. Exclusionary criteria for floodplains and critical areas were applied based on COMAR 26.04.11.08, Composting Facility Siting and Design Requirements, which notes that a composting facility may not be in a floodplain nor in conflict with critical areas. In addition, with County agreement, a minimum size of 25 acres was deemed necessary to support processing facility site operational needs. Parcels previously considered by the County for potential organics facility development were included in the initial evaluation, subject to the initial screening criteria noted (Montgomery County DEP 2015). Initial screening criteria yielded a listing of 101 parcels for further review, as shown in Figure 5-4.

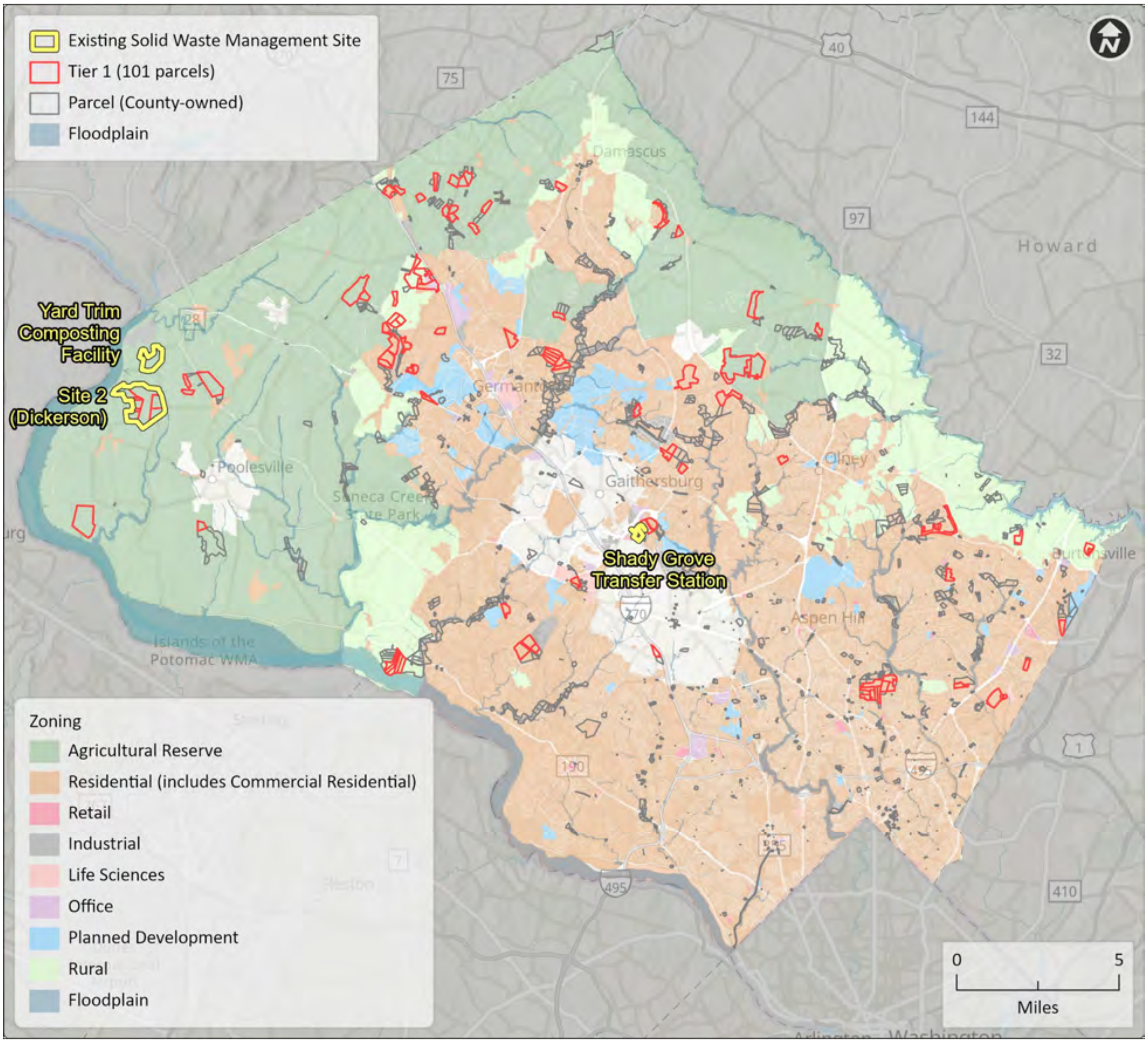

Figure 5-4. GIS Desktop Findings from Initial (Tier 1) Screening

Secondary screening criteria were then applied to further refine the parcel search, including the application of zoning criteria. Based on correspondence with the County's Office of Law, the County is not subject to the zoning code in developing its owned land (Montgomery County 2015). However, the County would be affected by public opinion from residents in proximity to the proposed facility development project. Given that, any parcels from the initial screening that were located less than 1,000 ft from a residential zoned area were removed from the search. Secondary screening yielded a listing of 25 total parcels for further review, or 17 parcel sets, as some parcels identified were located adjacent to one another, as shown in Figure 5-5.

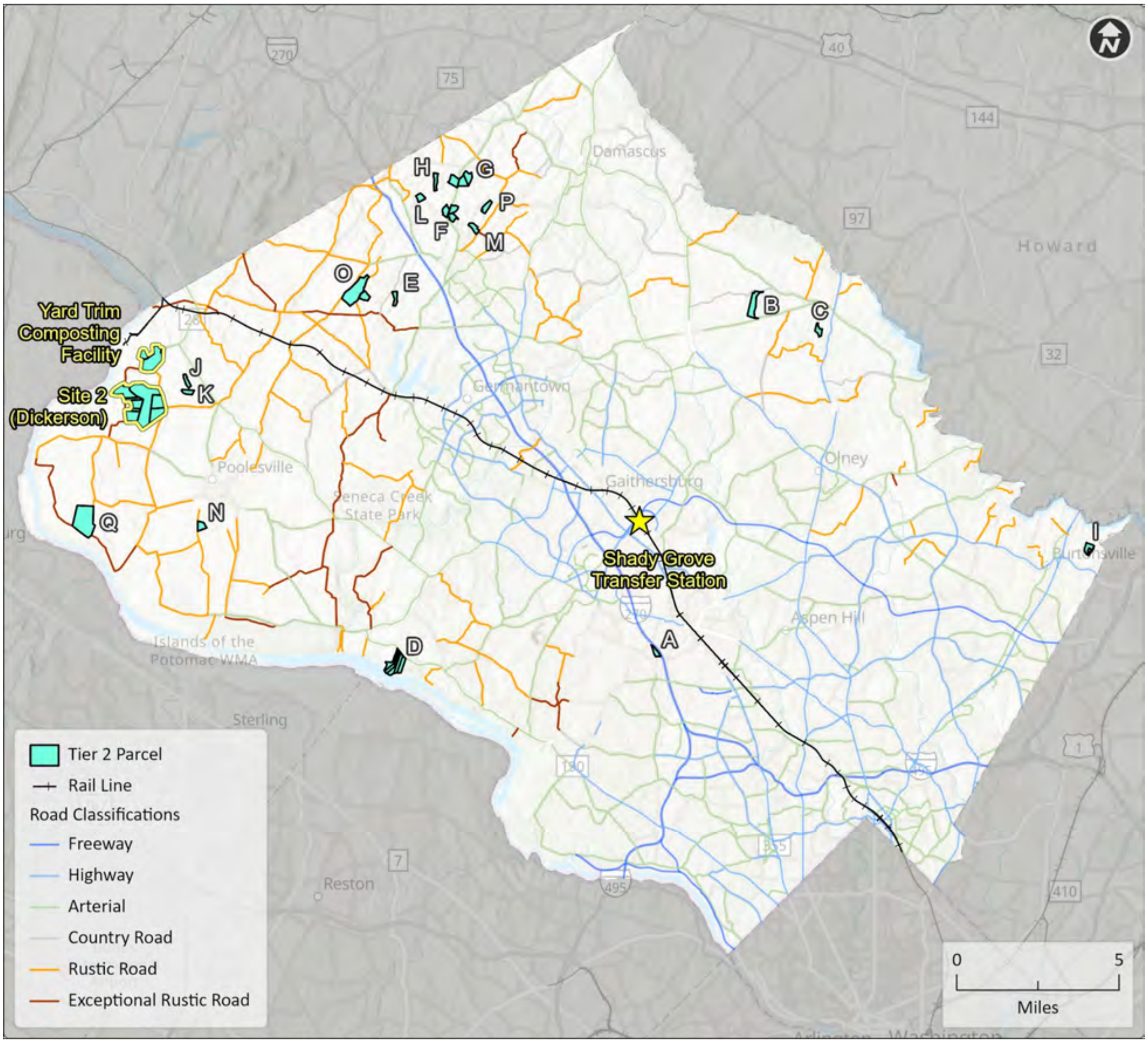

Figure 5-5. GIS Desktop Findings from Secondary (Tier 2) Screening

As a tertiary screening, the parcels were provided to Montgomery County's Department of General Services to verify parcel availability for future site development. Based on the Department of General Services review, it was found that of the 25 parcels previously identified:

- 22 parcels are located in recreational, regional and conservation parks deeded to M-NCPPC, including one parcel which is located in an Equity Emphasis Area (Montgomery County DEP 2023b), and three parcel sets that were identified as being accessible only from rustic or exceptionally rustic roads

- 2 parcels are located on County parcels, currently developed as the Montgomery County Detention Center and the Police Firearms Range

- 1 parcel is located in the Poolesville Golf Course owned by the Revenue Authority

5.4.1 Non-County Owned Parcels

As findings from review of County-owned parcels did not identify sites meriting further review, a GIS review of non-County-owned parcels was conducted. While this included a cursory screening for parcels over 25 acres, additional consideration for zoning and land use will be required, in addition to the County's considerations regarding property value and appropriate costs. Additional GIS review is required; however, Figure 5-6 identifies 59 parcels of adequate size in an industrial and use category that may be appropriate for further consideration.

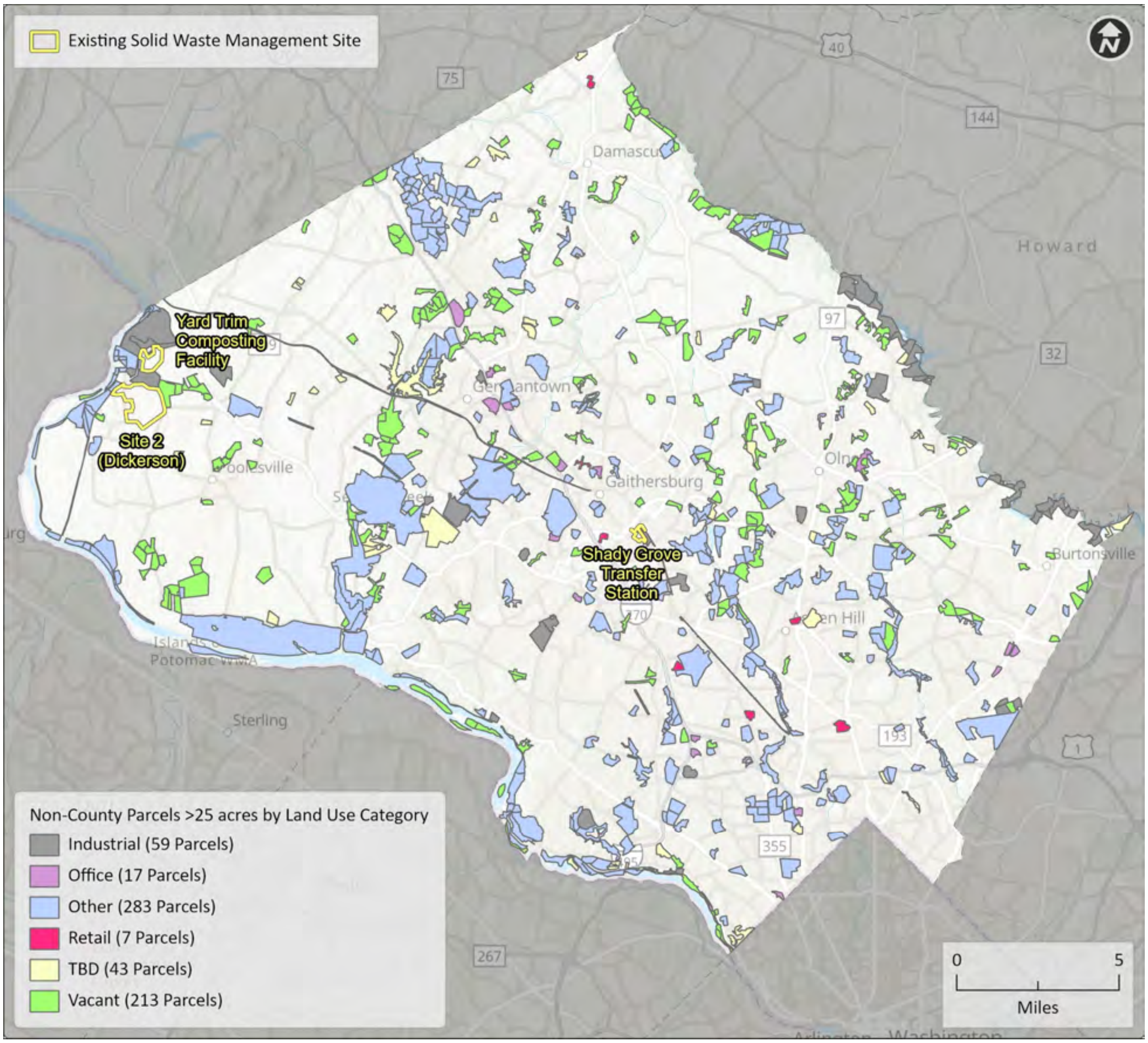

Figure 5-6. GIS Desktop Findings of Non-County-Owned Parcels

5.4.2 Transportation Analysis

Given the current reliance on truck and rail haul of waste within the County, a transportation analysis was conducted for 25 parcels previously identified. Transportation criteria considered include the distance from the Shady Grove TS, as the current County collection point for solid waste; and the amount of travel distance required on freeways, highways, arterials, and rustic roads. There were no sites identified in the desktop study that could be accessed only via exceptionally rustic roads. Seven sites identified in the desktop study required up to 3.8 miles of travel on a rustic roadway.

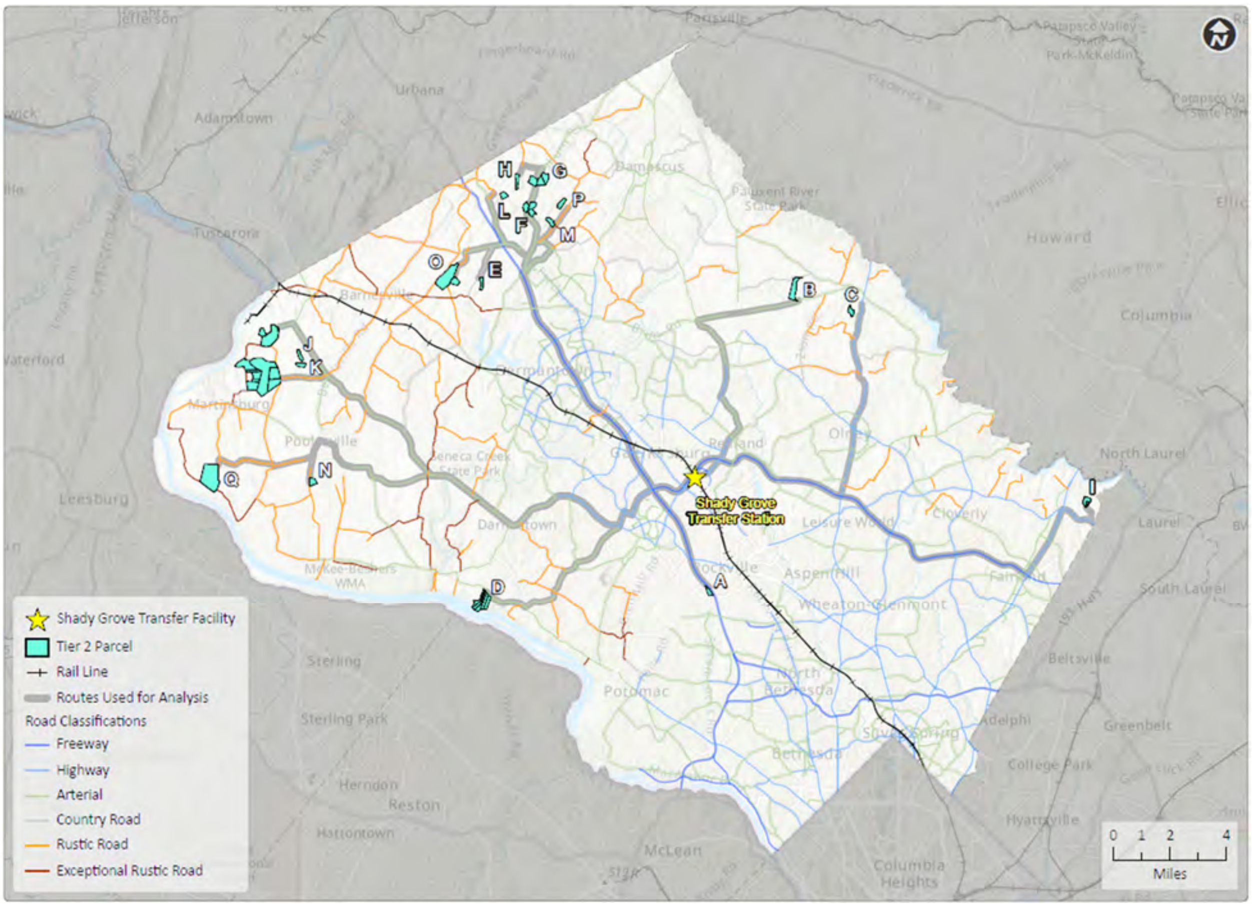

Figure 5-7. Transportation Analysis of Remaining Sites

5.5 SITE DEVELOPMENT REQUIREMENTS

Organics processing facilities in the state of Maryland are regulated by MDE. The regulations include requirements for composting facility operations, contact water and stormwater collection and discharge, air emissions, compost product quality, recordkeeping and reporting, and site setbacks. For AD, no permit program currently exists; however, MDE has provided guidance to outline the permitting pathway. In addition, County requirements for site development must be met.

5.5.1 Federal Requirements – Composting Facilities

MCYTCF and Site 2 are in an area identified by EPA as a Sole Source Aquifer system, the Poolesville Area Aquifer Extension of the Maryland Piedmont Aquifer. This designation is given to aquifers that supply at least 50% of the drinking water for its service area, with no reasonably available alternative drinking water sources should the aquifer become contaminated (EPA 2023). The program enables EPA to review proposed projects that will be located within the review area, to ensure there is no contamination possible to the aquifer from the project's design, construction, and operation that could create a significant hazard to public health.

5.5.2 State Requirements – Composting Facilities

COMAR 26.04.11, Composting Facilities, in effect since 1 January 2017, includes requirements for the design and operation of composting facilities, classified based on feedstock type (Type 1 – yard trim only, and Type 2 – food scraps and animal manure) and facility size (Small – producing less than 10,000 CY per year, or Large – producing more than 10,000 CY per year). Based on proposed feedstocks including food waste and projected capture volumes for processing greater than 10,000 CY annually, a Tier 2 Large facility permit is likely to be required. A pathogen reduction process, consisting of a minimum processing time and temperature combination, is required for Tier 1 and Tier 2 facilities. The process, known as the Process to Further Reduce Pathogens, is widely used in the composting industry and is derived from EPA regulations on sewage sludge. The federal Process to Further Reduce Pathogens for composting is incorporated by reference in the MDE regulations. For ASPs, the temperature of compost is required to be maintained at 55 degrees Celsius or higher for 3 days. If food scraps are comprised of meat, dairy, grease, fats, oils, and other non-vegetative organics, which can contain foodborne pathogens, pathogen reduction processes are required.

A general composting facility permit is sufficient for a facility that complies with all regulations without variance, while an individual permit is needed if site-specific variances are necessary. To initiate application of a composting facility permit, a Notice of Intent form and Composting Facility Operations Plan are required for submission to MDE, per COMAR 26.04.11.09. The Composting Facility Operations Plan must be kept on-site and reviewed annually and must include plans for preventing and responding to complaints of nuisances such as odors. Per COMAR 26.04.11.12, annual reporting to MDE will be required, including provision of detail regarding quantities and types of feedstocks, county of origin of feedstocks, and quantities and types of compost and residues produced at and removed from the site. A proposed composting facility can likely be covered under a General Permit if no exceptions are anticipated.

A Permit to Construct is required for compost facilities with sources of air emissions. This applies to internal combustion engines with at least 500-brake horsepower and may be relevant for aeration systems, sorting systems, grinders, shredders, drying and bagging equipment, and other machinery. A Permit to Operate may be required for specific air emissions sources, per COMAR 26.11.02.13. Facilities that create a nuisance or air pollution are prohibited by COMAR 26.11.06.08.

Per COMAR 15.18.04, Compost Registration is required for each brand or classification of compost before it can be sold or distributed in Maryland. This certification must be renewed annually, and includes compost testing, labeling, recordkeeping requirements, and a semiannual report submitted with a $0.25 fee for each ton of compost distributed in the state.

5.5.2.1 Facility Siting

Per COMAR 26.04.11, feedstock receipt, feedstock storage, active composting, curing, and compost storage areas of a composting facility may not be located closer than 50 ft to the property boundary; 300 ft to a dwelling; 100 ft to a domestic well; and 100 ft to a stream, lake, or other body of water except an impoundment for use in the composting process. The composting facility may not be in a floodplain, or in conflict with the Chesapeake Bay Critical Area or nontidal and tidal wetlands.

5.5.2.2 Facility Design and Construction

Compost facility design and construction must be in accordance with the requirements of COMAR 26.04.11.08. For a Tier 2 – Large facility, this includes requirements for the following:

- A 2- to 4-ft distance from the water table, depending on location within the Coastal Plain province and other factors, must be maintained.
- Curing and compost storage areas must be on an all-weather pad with slopes no greater than 6%.
- Feedstock receiving/storage and active composting areas must maintain compost on a low-permeability pad (e.g., concrete, cement, and compacted clay), with permeability of less than or equal to 10^{-5} centimeters per second.
- Containment structures must be designed for 25-year, 24-hour storm events for stormwater and contact water. Covered Tier 2 facilities need only size containment structures for contact water generated.
- Site stormwater discharges shall adhere to the General Permit for Stormwater Discharges Associated with Industrial Activity.
- A National Pollutant Discharge Elimination System permit for stormwater discharges associated with construction activity is required.

5.5.3 Local Requirements – Composting Facilities

Montgomery County requirements are derived from County Code, including Chapter 48 of the Code of Montgomery County Regulations regulating solid waste, including siting of solid waste facilities; and Chapter 59 of the County Code, containing the County's zoning ordinances.

As noted previously, the County is not required to adhere to zoning requirements with its owned land; however, discussion for select zoning ordinances is included here to demonstrate that zoning regulations do not provide specific guidance for where private or County composting facilities may be sited. The Montgomery County Zoning Ordinance specifies that landfills, incinerators, and transfer stations may only be sited in heavy industrial (IH) zones. Recycling collection and processing facilities are permitted in IH zones and have limited use in light industrial (IL) and moderate industrial (IM) zones. This does not directly apply to composting facilities, but composting facilities may be considered processing facilities, which could require industrial zoning. For agricultural reserve (AR), this zoning category is intended “to promote agriculture as the primary land use in areas of the County designated for agricultural preservation in the general plan by providing large areas of generally contiguous properties suitable for agricultural and related uses and permitting the transfer of development rights from properties in this zone to properties in designated receiving areas.

While composting through decentralized means is an important component of a County organic waste diversion approach, it is not specifically encouraged by Montgomery County Code. Portions of Montgomery County Code Chapter 48 restrict the backyard composting of food scraps. Chapter 48 allows for the use of compost piles to dispose of food scraps if each compost pile is completely rodent-proofed. Zoning code for community gardens does not address composting as a recognized activity of the garden. The zoning ordinance does include composting as an accessory use for on-farm composting, allowing for the production and manufacturing of compost on farms where up to 50% of the materials can come from off-site sources. This limits the amount of feedstock generated off-site that can be composted at any one farm. Current Montgomery County zoning codes and other applicable County codes, regulations, and policies do not specifically encourage the on-site composting of food scraps on farms, especially if the composting activities are not a direct result of on-farm operations. In addition, existing County zoning requirements limit the amount of on-farm composting activities within the Agricultural Reserve and indicate that composting is permitted only as an accessory use in these areas. The zoning ordinance states on-site composting must be permitted on-site at the business/commercial property/institution.

5.5.4 State Requirements – Anaerobic Digestion Facilities

The State of Maryland has no formal permitting path for anaerobic digestion facilities. However, there are suggested permits depending on the location, purpose, and type of facility (MDE 2022). These permits fall under MDE for solid waste and recycling, water, and air; MDA for soil conditioner or fertilizer; and the Maryland Public Service Commission for renewable energy generation. A summary table of potential permitting requirements for anaerobic digestion operations is included in Table 5-8.

Table 5-8. Anaerobic Digestion Permitting Summary Table

Subject/Activity	Department Permits and Approvals	COMAR
MDE – Solid Waste and Recycling		
Solid Waste Acceptance Facility	Refuse Disposal Permit	26.04.07
Sewage Sludge Management	Sewage Sludge Utilization Permit	26.04.06
MDE – Water		
Storm Water Discharge from Industrial Activities	General Permit For Discharges From Storm Water Associated with Industrial Activities	26.08.04
Groundwater Discharges	State Groundwater Discharge Permit	26.08.04
Surface Water Discharges	State/National Pollutant Discharge Elimination System Surface Water Discharge Permit	26.08.04
Discharges to Publicly Owned Wastewater Treatment Systems	Pretreatment Permit	26.08.08
Water and Sewerage Treatment Infrastructure Construction	Water and Sewerage Construction Permit	26.03.12
MDE – Air		
Sources of Air Pollution	Air Quality State Permit to Construct	26.11.02
	Air Quality State Permit to Operate	26.11.02
MDA – State Chemist		
Digestate Quality	Soil Conditioner or Fertilizer Registration	15.18.04
Maryland Public Service Commission – Renewable Energy Generation		
Construct Electric Generating System	Certificate of Public Convenience and Necessity Exemption	20.79.01
Interconnection to an Electric Utility Distribution System	Standard Small Generator Interconnection Agreement	20.50.09
Generate Renewable Energy Credits	Certification of a Renewable Energy Generating Facility	20.61.02
Trade Renewable Energy Credits	Renewable Energy Credit Account	20.61.02

5.6 ANALYSIS

Processing facility site locations are assessed and ranked in this section using the weighted criteria decision matrix approach evaluating alternatives based on specific evaluation criteria, weighted by the importance of each criterion. This decision-making tool treats each criterion independently, which helps avoid bias or emphasis on a specific criterion.

5.6.1 Siting Evaluation Criteria

To evaluate the sites most suitable for the development of a County facility, the EA Team and the County developed criteria against which to evaluate each site. As discussed previously, Montgomery County DEP personnel in management, planning, and operational roles assigned weighting factors on a scale of 1 to 5 to indicate the relative importance of each criterion. Average weighting factors are presented in Table 5-9 and are applied in the weighted matrix discussed later in this chapter.

Table 5-9. Facility Siting – Evaluation Criteria

Criteria	Definitions	Weighting Factor (Scale of 1-5)
Site Characteristics that May Affect Site Development		
1 – Site Size	A larger site area available for facility development will score higher.	4.8
2 – Site Topography	A more dissected site will score lower.	3.5
3 – Site Soils	A site with existing site soil requiring removal or amendment to support facility development (e.g., rock, karst, etc.) will score lower.	3.5
4 – Depth to Groundwater	A site with greater depth to groundwater will score higher.	3.8
5 – Electric Service	A site with existing three-phase (460-volt) electric service on-site or within proximity (considered 2,500 ft) to the site will score higher.	4.0
6 – Water and Sewer Service	A site with existing water and/or sewer service on-site or within proximity (considered 2,500 ft) to the site will score higher.	4.0
7 – Existing Infrastructure	A site with existing on-site infrastructure with the potential for re-use (e.g., internal access roads, paved working surfaces, buildings, etc.) will score higher.	4.0
8 – Permitting	A site with an existing solid waste permit issued by MDE will score higher. A site with no existing permits and/or requiring additional permitting effort will score lower.	3.8
Conditions Local to Site		
9 – Population Density	A site with higher population density surrounding the site will score lower.	5.0
10 – Site Access	A site with proximity (considered 5 miles) to existing transportation routes and networks appropriate for truck haul (e.g., four-lane arterial or interstate highway) will score higher. A site requiring extensive (more than 5 miles) travel on roadways not ideal for truck haul (e.g., rustic or exceptionally rustic roadways) will score lower.	5.0
11 – Quality of Existing Vehicular Traffic	Traffic quality along material receiving and product distribution routes, and intersections within 1,000 ft of site access, will be considered. Traffic quality with an AASHTO Level of Service of A (free flow traffic), B (reasonably free flow traffic, or C (stable flow traffic) will score higher. A Level of Service D (approaching unstable flow) or below will score lower.	3.8
12 – Feedstock Sources	A site with greater proximity to major sources of organic waste will score higher. Organic waste sources may be considered relative to the centralized locations of waste collection (e.g., Shady Grove TS), as appropriate. Proximity to Subdistrict A, B, or municipalities may also be considered for decentralized management approaches. Assume that material receiving can be collocated with material processing and storage.	4.5
13 – Natural gas transmission lines	A site with greater proximity (considered 1 mile) to natural gas transmission lines will score higher.	3.3
Community Considerations		
14 – Proximity to Sensitive Receptors	A site located in proximity (considered 1,500 ft) to hospitals, schools, daycare facilities, elderly housing and convalescent facilities, churches, parks, and shopping centers, will score lower.	4.5
15 – Equity Emphasis Areas	A site located in an Equity Emphasis Area will score lower.	3.5
16 – Environmental Justice	A site located in an Environmental Justice Area will score lower.	3.3

Criteria	Definitions	Weighting Factor (Scale of 1-5)
Site Characteristics that May Affect Site Development		
17 – Environmental History	A site with a history of environmental issues, or within 0.25 mile of a site with a history of environmental issues, will score lower.	4.0

Note:
AASHTO = American Association of State Highway and Transportation Officials

5.6.2 Site Scoring

To provide an independent assessment of each siting option, the EA Team scored each technology against the evaluation criteria, independent of technology or other detailed County considerations. Based on the EA Team's organics industry experience and familiarity with site development needs for organics processing facilities, a score was assigned to each site reflecting the merits and challenges of each site. Annotations for each score are provided in Table 5-10 to provide additional information underlining each assigned score.

Table 5-10. Siting Scoring

Criteria	County Sites		
	Shady Grove TS	**MCYTCF**	**Site 2**
Site Characteristics that May Affect Site Development			
1 – Site Size	1 – Limited Site Area	4 – Large Site Area (~70 acres)	5 – Large site area
2 – Site Topography	4 – Existing developed areas have limited slope	4 – Existing developed areas have limited slope	2 – Slope varies across parcel, including stream channel
3 – Site Soils	5 – No soil removal nor amendment required	5 – No soil removal nor amendment required	2- Groundwater concerns will require impervious areas over imported structural fill.
4 – Depth to Groundwater	3 – Over 10 ft to groundwater	5 – Over 30 ft to groundwater	5 – Over 30 ft to groundwater
5 – Electric Service	5 – Three-phase power available at site	5 – Three-phase power available at site	2 – No three-phase power available, would have to be brought in from MCYTCF or RRF
6 – Water and Sewer Service	5 – Public service approved with service to main (Category S-1)	2 – On-site water and sanitation only available	1 – Private on-site service only, likely uses well/septic (S-6)
7 – Existing Infrastructure	4 – High potential for re-use of existing developed site areas, although some modification may be required	4 – High potential for re-use of existing developed site areas, although some modification may be required	1 – Limited/no existing development on site
8 – Permitting	5 – Existing MDE Solid waste facility permit	5 – Existing MDE yard trim facility permit	5 – Existing MDE Solid waste facility permit
Conditions Local to Site			
9 – Population Density	1 – High population density surrounding site	5 – Limited population density surrounding site	5 – Limited population density surrounding site
10 – Site Access	5 – Freeway and highway easily accessible from site	3 – Site accessible from arterial road	2 – Site access requires traversing rustic road
11 – Quality of Existing Vehicular Traffic	2 – Level of service D/E	4 – Reasonably free traffic flow	4 – Reasonably free traffic flow
12 – Feedstock Sources	4 – Closer proximity to organic sources	2 – Limited proximity to organic sources	2 – Limited proximity to organic sources
13 – Natural gas transmission lines	4 – Natural gas line within 3,000 ft	2 – Natural gas line within 8,000 ft	4 – Natural gas line within 3,000 ft
Community Considerations			
14 – Proximity to Sensitive Receptors	2 – Some proximity to sensitive receptors	4 – Limited proximity to sensitive receptors	4 – Limited proximity to sensitive receptors
15 – Equity Emphasis Areas	3 – Site within proximity of Equity Emphasis Areas	5 – No site proximity to Equity Emphasis Areas	5 – No site proximity to Equity Emphasis Areas
16 – Environmental Justice	3 – Final Environmental Justice score 51.74	4 – Final Environmental Justice score 46.89	4 – Final Environmental Justice score 46.89
17 – Environmental History	4 – Few known site environmental issues	4 – No adverse environmental impact from 40+ years of composting operations on-site	2 – Site history of groundwater concerns

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5.6.3 Site Ranking

Organics processing sites ranked using a weighted criteria decision matrix technique are summarized in Table 5-11 and detailed in Table 5-12. To develop the weighted score, the score of each site was multiplied by the evaluation criteria weighting factor. The weighted score was totaled across all evaluation criteria for each site. The scores for each site were then compared to create a ranking among alternatives.

Table 5-11. Site Ranking Summary Table

Site	Weighted Score
MCYTCF	267.0
Shady Grove TS	236.0
Site 2	219.8

Based on the sites presented and ranked applying the County's evaluation factors with the EA Team's site scoring, the weighted matrix approach identifies the ranking of potential organics facility sites. The EA Team will proceed with consideration of ranked sites in consideration of final processing facility alternatives presented in Chapter 6.

"Organics" refers to the combination of food waste and food-soiled paper. Food waste includes meat as well as vegetable waste from processing, distribution, and/or kitchen operations that can potentially be separated from other wastes at the point of generation, whether pre- or post-consumer. This does not include yard trimmings, which are part of the current County recycling program.

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Table 5-12. Site Ranking Summary Table

Criteria	Weighting Factor	County Sites					
		Shady Grove TS		MCYTCF		Site 2	
		Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Site Characteristics that May Affect Site Development							
1 – Site Size	4.75	1	**4.8**	4	**19.0**	5	**23.8**
2 – Site Topography	3.5	4	**14.0**	4	**14.0**	2	**7.0**
3 – Site Soils	3.5	5	**17.5**	5	**17.5**	2	**7.0**
4 – Depth to Groundwater	3.75	3	**11.3**	5	**18.8**	5	**18.8**
5 – Electric Service	4	5	**20.0**	5	**20.0**	2	**8.0**
6 – Water and Sewer Service	4	5	**20.0**	2	**8.0**	1	**4.0**
7 – Existing Infrastructure	4	4	**16.0**	4	**16.0**	1	**4.0**
8 – Permitting	3.75	5	**18.8**	5	**18.8**	5	**18.8**
Conditions Local to Site							
9 – Population Density	5	1	**5.0**	5	**25.0**	5	**25.0**
10 – Site Access	5	5	**25.0**	3	**15.0**	2	**10.0**
11 – Quality of Existing Vehicular Traffic	3.75	2	**7.5**	4	**15.0**	4	**15.0**
12 – Feedstock Sources	4.5	4	**18.0**	2	**9.0**	2	**9.0**
13 – Natural Gas Transmission Lines	3.25	4	**13.0**	2	**6.5**	4	**13.0**
Community Considerations							
14 – Proximity to Sensitive Receptors	4.5	2	**9.0**	4	**18.0**	4	**18.0**
15 – Equity Emphasis Areas	3.5	3	**10.5**	5	**17.5**	5	**17.5**
16 – Environmental Justice	3.25	3	**9.8**	4	**13.0**	4	**13.0**
17 – Environmental History	4	4	**16.0**	4	**16.0**	2	**8.0**
TOTAL WEIGHTED SCORE			**236.0**		**267.0**		**219.8**

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6. DEVELOPMENT AND EVALUATION OF ALTERNATIVES (TASK 5)

As summarized in Section 2.5.4, the recipe for processing up to 97,400 tons (273,500 CY) of organic feedstocks including yard trim and food scrap is utilized as the basis for Phase I facility development detailed in this chapter. To meet the processing capacity needs identified in the mandatory program and some high capture scenarios (Table 2-20), costs are detailed for development of future facility expansion, identified as Phase II throughout this chapter. However, alternatives to centralized material receiving and processing at the Shady Grove TS will be required to meet processing capacity for these scenarios, in addition to the facility development proposed in the alternatives discussed herein.

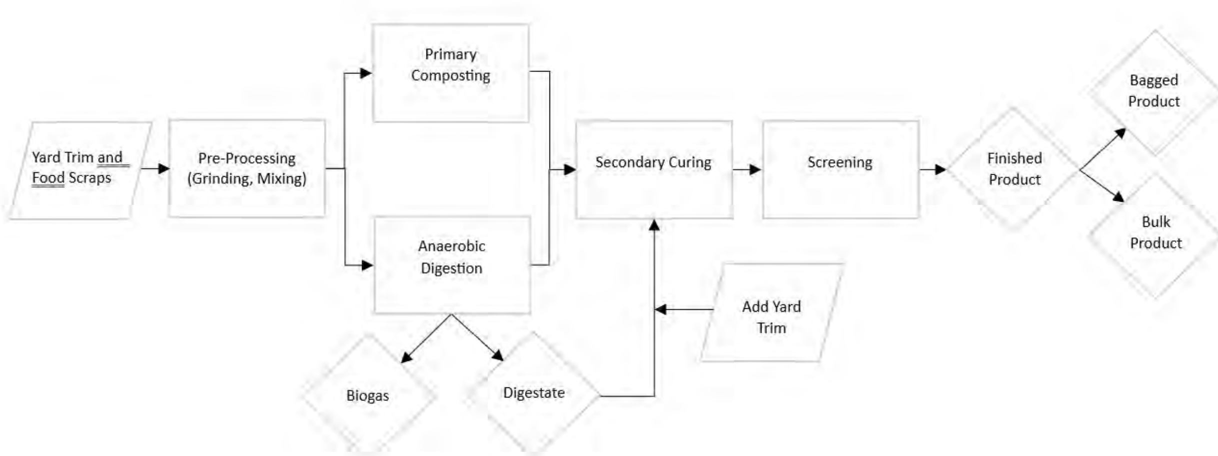

Figure 6-1. Organics Processing Flow Diagram

Based on the technology review presented in Table 3-8, the highest-ranked technologies include ASP composting, in-vessel tunnel reactor composting, agitated bed composting, and dry fermentation AD. Based on the siting review presented in Table 5-11, the existing sites in ranked order for siting a future organics processing facility are the MCYTCF, the Shady Grove TS, and Site 2; no additional parcels from the GIS study were identified for further review. The facility development alternatives outlined in this chapter pair the ranked technologies and sites; consider material hauling and transportation costs as necessary between material receipt and product distribution; and present capital and operations costs associated with development of each. Discussion of each alternative addresses infrastructure available or needed, phased implementation to meet processing needs, and preparation and distribution of end products. A weighted-criteria matrix is included later in this section for the alternatives presented.

As noted in the feedstock projections analysis in Chapter 2, this study has assumed that a new SSO diversion program in the County will be based on co-collection of food waste with yard trim. While voluntary sign-up programs usually have minimal contamination, mandatory programs do typically see higher contamination rates. While this equipment has not been assumed to be included in this analysis, depackagers or other material pre-processing equipment or steps may be necessary to address feedstock contamination. As a County food scrap diversion program is developed, consideration given to outreach and education aimed at minimizing contamination during organics capture will be critical to ensuring a high-quality product can be produced in the alternatives as outlined. Key themes and best practices for minimizing plastic and other contaminants in food scrap diversion programs are included in Appendix E for the County's consideration.

6.1 ALTERNATIVES

6.1.1 Option 1 – ASP Composting at Montgomery County Yard Trim Composting Facility (MCYTCF)

Given the site rankings developed for processing technologies and sites, ASP composting, the highest ranked technology, at the MCYTCF, the highest ranked site, is presented as Option 1. Site development and annual operation and maintenance (O&M) costs for Phase I and Phase II facility development for this alternative are presented in Appendix F and vendor product information is included in Appendix G.

Receipt of co-collected yard trim and food scrap could be centralized at the Shady Grove TS as it is now. Material pre-processing would consist of material receipt and grinding in an enclosed building, equipped with aeration and process odor controls, in preparation for ASP composting. After grinding, this "pre-processed" compostable mix would be transported to MCYTCF, by rail in covered hopper rail cars that could minimize the potential for in-transit odors, or by truck. While the material receipt and grinding operation could be relocated to the MCYTCF, this would require the transport of unprocessed food waste and yard trim from Shady Grove TS to MCYTCF and was not considered to be a feasible approach due to the cost of transporting high volume, low bulk density material.

The ASP system implemented at the MCYTCF would be used for primary composting to create a biologically stable (i.e., all decomposition complete) compost prior to the finishing steps of curing, screening, and bagging. The ASP system at MCYTCF could be individually bunkered ASPs, similar to the ASP system at the Howard County Alpha Ridge Landfill, an extended aerated static pile configuration like the composting approach used at the MCYTCF when it was the Dickerson Interim Sewage Sludge Composting Facility (1981–1982), or a fabric-covered ASP system, similar to the ASP system at the Prince George's County Organics Compost Facility. ASP systems provide scalable approaches that allow efficient expansion of processing capacity given the additional site development and related capital costs. After primary composting is complete, the curing, screening, and bagging processes would be the same as what is currently done to make LeafGro®, with finished product distribution from the MCYTCF site.

The MCYTCF is an ideal site for ASP composting of co-collected food waste and yard trim, given the sites existing infrastructure for windrow composting of yard trim, and trained personnel familiar with composting process requirements. The existing 48-acre bituminous pavement pad would be adequate to meet permit requirements for an all-weather pad in the curing and compost storage areas. Limited repairs and upgrades to the existing pad for these process areas have been included in the site development costs. Upgrading the facility to Type 2 feedstocks (e.g., accepting food scraps) does require that feedstock receiving (at Shady Grove

TS) and primary composting (at MCYTCF) areas must maintain processing on a low-permeability pad; the cost of surface upgrades to concrete for these process areas has been included in the site development costs.

Increased process water demand could be required based on the ASP system used, as bunker-style, extended aerated static pile, and bio- and fabric-covered aerated static pile systems all differ in their process water requirements during primary composting. If additional water service is required to accommodate an expanded composting facility, a public water main extension from the local water service provider, likely the Town of Poolesville for the MCYTCF site, may require up to 4.5 miles of public water main extension along Maryland Route 107 (Whites Ferry Road) and Wasche Road. Given an estimated cost of water main construction of $3–4 million per mile, an ASP system with minimal process water addition is recommended; instead, contact water, or runoff from the composting process, can be captured and re-applied for material wetting. Based on the approach of contact waste collection and re-use, the costs of contact water storage tanks have been included in site development costs, while additional costs for public sewer infrastructure are not included.

As an alternative to siting Option 1 at the MCYTCF, ASP composting developed at the Shady Grove TS could be considered but would require acquisition of additional land (the Eugene Casey Foundation parcels), with additional costs estimated at $12–15 million. ASP composting could also be developed on Site 2; however, the lack of existing infrastructure would elevate capital costs considerably, with additional costs estimated at $10–25 million.

6.1.1.1 Option 1.1 – Pilot Scale ASP at Montgomery County Yard Trim Composting Facility

While ASP composting is well-proven in the U.S., and with the bunker-style and fabric-covered aerated static pile installations in neighboring Howard and Prince George’s counties used for composting SSO, a pilot test of ASP composting of co-collected yard trim and food scrap at the MCYTCF is recommended. A multi-season food waste organics program could be designed to prove the process viability for food waste and yard trim, with an effective “recipe” tailored to the County’s feedstocks available for processing, and consideration of seasonal changes in weather and feedstock variability. A pilot program would also provide the County with the opportunity to test facility operations appropriate for meeting processing needs and regulatory requirements, and to reveal any operational challenges which could be addressed prior to embarking on a larger-scale implementation.

6.1.2 Option 2 – In-Vessel Tunnel Reactor Composting at Shady Grove TS and Product Finishing at MCYTCF

In-vessel tunnel reactors, the second highest ranked organics processing technology, sited at the Shady Grove TS, the second highest ranked site, is presented as Option 2. Given the area constraints of the Shady Grove TS site, this alternative assumes material receipt, pre-processing, and primary composting processes at Shady Grove, followed by material hauling by truck and/or rail to the MCYTCF for curing, screening, and bagging. Site development and annual O&M

costs for Phase I and Phase II facility development for this alternative are presented in Appendix F and vendor product information is included in Appendix G.

Material receipt and pre-processing at the Shady Grove TS would include receiving and grinding co-collected yard trim and food scrap in an enclosed building, equipped with aeration and process odor controls, in preparation for in-vessel tunnel reactor composting. Pre-processed feedstocks would be loaded into the tunnel reactor system for primary composting.

The in-vessel tunnel reactor approach for primary composting is effective in developed areas, where a higher degree of process and environmental controls are required. In-vessel tunnel reactor composting systems are currently installed in a dense environment for the City of Long Beach, California, and in a more rural setting for the Ottawa Valley Waste Recovery Centre in Canada. Concrete and stainless-steel construction on in-vessel tunnel reactors ensures a long installation service life. Tunnel reactor sizes can be configured to best meet the Shady Grove TS site layout, with construction assumed to occur in phases, as noted. The site constraints of the Shady Grove TS pose a significant challenge to siting a primary composting process at this location. While the tunnel reactors could be built out to up to 1 acre in Phase I and up to 3 acres in total in Phase II, existing site operations at the Shady Grove TS would require significant relocation to accommodate this. Given that no off-site areas have been identified to relocate existing operations, land acquisition and site development costs for the adjacent Eugene Casey Foundation parcels have been included in site development costs for this alternative.

After primary composting, the biologically stable, but immature compost would then be loaded into covered hopper rail cars for the product finishing steps at the MCYTCF. As the MCYTCF is already well-equipped for curing, screening, and bagging processes, this site is practical for product finishing. As material would be biologically stable after primary composting, curing could be conducted in windrows at MCYTCF, requiring only minimal site upgrades to accommodate. Moving the finished compost to market would be the same method as is used now from the MCYTCF.

It would be possible to develop primary composting via in-vessel tunnel reactors entirely at MCYTCF or at Site 2 after material pre-processing; however, given the remote location of both sites, the additional capital cost for an enclosed facility with a high degree of process control may not be justifiable. In-vessel tunnel reactor composting developed at the MCYTCF would require additional upgrades of existing site surfaces, with additional costs estimated at $12–15 million. In-vessel tunnel reactor composting could also be developed on Site 2; however, the lack of existing infrastructure would elevate capital costs considerably, with additional costs estimated at $10–25 million.

6.1.3 Option 3 – Agitated Bed Composting at Site 2

Agitated bed composting, the third highest ranked organics processing technology, sited at Site 2, the third highest ranked site, is presented as Option 3. This alternative assumes that only material receipt and pre-processing are conducted at the Shady Grove TS before material transport to Site 2 for primary composting and product finishing. Site development and annual

O&M costs for Phase I and Phase II facility development for this alternative are presented in Appendix F and vendor product information is included in Appendix G.

Material receipt and pre-processing at the Shady Grove TS would include receiving and grinding co-collected yard trim and food scrap in an enclosed building, equipped with aeration and process odor controls, in preparation for agitated bed composting. After grinding, this "pre-processed" compostable mix would be transported by rail to the RRF rail yard adjacent to the MCYTCF in covered hopper rail cars that could minimize the potential for in-transit odors, then trucked to Site 2. Alternatively, material could be hauled entirely by truck to Site 2. Given that roadways in the vicinity of Site 2 are rustic roads not developed to support the gross vehicle weight of haul trucks, Site 2 access would require development and use of an internal roadway developed through the GenOn site. Costs of Site 2 access roads have been included in site development costs.

As with tunnel reactors, the agitated bed systems are used where the proximity of development or need to minimize nuisances calls for greater process and/or environmental control. Agitated bed composting systems are in operation for a biosolids composting operation in Burlington, New Jersey, and in various installations in Canada. The automated agitation and aeration systems minimize materials handling, requiring material loading and removal from process bays only. Housing of all primary composting within an enclosed facility equipped with biofilters ensures odor and process control to limit disturbance to receptors near Site 2. For the site development costs, it is assumed that the agitated bed compost building will be construction entirely in Phase I, with bays constructed in five-bay groups constructed with dedicated blowers for zone aeration, culminating in a total of 30 bays to meet the required capacity of Phase II by 2045. After primary composting, material would be cured, screened, and bagged as is currently done. As material would be biologically stable after primary composting, curing could be conducted on asphalt pads constructed at Site 2. Moving the finished compost to market would be the similar to the product distribution currently conducted from the nearby MCYTCF.

It would be possible to develop primary composting via an agitated bed system entirely at the MCYTCF after material pre-processing. This approach would require additional upgrades of existing site surfaces; however, it would not require the extensive site development of greenfield Site 2. Siting an agitated bed composting system at MCYTCF would save an estimated $12–15 million over facility construction at Site 2.

6.1.4 Option 4 – Dry Fermentation Anaerobic Digestion at Shady Grove TS with Product Finishing at MCYTCF via Tunnel Reactor Composting

Dry fermentation AD, the fourth highest ranked technology, sited at the Shady Grove TS, is presented as Option 4. Despite the area constraints of the Shady Grove TS site, this pairing of technology and sites was selected based on the proximity of the Shady Grove TS to potential end uses for biogas generated from AD. As with previous alternatives at the Shady Grove TS, the site area allows only material receipt, pre-processing, and anaerobic digestion on-site; hauling of digestate by truck and/or rail to the MCYTCF will allow primary composting, assumed tunnel reactor composting for this alternative, prior to curing, screening, and bagging. Site development and annual O&M costs for Phase I and Phase II facility development for this alternative are presented in Appendix F and vendor product information is included in Appendix G.

Material receipt and pre-processing at the Shady Grove TS would include receiving and grinding co-collected yard trim and food scrap in an enclosed building, equipped with aeration and process odor controls, in preparation for anaerobic digestion. Pre-processed feedstocks would be loaded into the digestors for processing and the resulting residual, or digestate, would look like the pre-processed SSO that went into the AD reactors, only wetter and with a higher odor profile than stable material after other primary composting processes. The digestate would be removed from the AD reactors, mixed with yard trim to increase the volatile solids content, and then loaded into covered hopper rail cars for primary composting and product finishing steps at the MCYTCF. The additional AD product of methane-rich biogas can be captured, cleaned, and stored, with additional purification for the conversion of the biogas to hydrogen fuel.

Dry fermentation AD systems, similar in process infrastructure to tunnel reactor composting, are currently installed at five California locations, including the City of Napa and for the Monterey Regional Waste Management District in Monterey. The site constraints of the Shady Grove TS pose a significant challenge to siting an AD process at this location. While the digesters could be built out to up to 1 acre in Phase I and up to 3 acres in total in Phase II, existing site operations at the Shady Grove TS would require significant relocation to accommodate this. Given that no off-site areas have been identified to relocate existing operations, land acquisition and site development costs for the adjacent Eugene Casey Foundation parcels have been included in site development costs for this alternative.

As the County is interested in evaluating options for producing hydrogen bus fleet fuel from biogas derived from SSO processing, an evaluation of energy consumption from methane to hydrogen conversion in summarized in Appendix D. Although commercial scale installations of conversion to hydrogen are limited, the capital cost of installation of a facility that can convert biogas to pipeline-quality methane to hydrogen may make economic sense if use of the hydrogen is paired with equipment that utilizes hydrogen as a fuel source. Siting of the dry fermentation AD system at Shady Grove TS provides the nearest proximity to the bus fleet headquarters in Silver Spring, Maryland, as compared to the other sites. Hydrogen produced for use by the bus fleet would need to be compressed and transported to the bus fleet headquarters in high-pressure tube trailers. Additional future considerations would be needed to address the carbon dioxide byproduct from hydrogen production.

As AD is solely extracting the energy value from SSO before it is further processed, coupling with a composting system is necessary for processing the digestate. The MCYTCF would require upgrades for development of in-vessel tunnel reactor for primary composting of the digestate and yard trim mix, but is already well-equipped for curing, screening, and bagging processes. Moving the finished compost to market would be the same method as is used now from the MCYTCF.

It would be possible to develop dry fermentation AD and primary composting via in-vessel tunnel reactors entirely at MCYTCF or at Site 2 after material pre-processing; however, given the remote location of both sites, the additional capital cost for an enclosed facility with a high degree of process control may not be justifiable. In addition, longer compressed hydrogen gas transport times and routes would be needed. Developing this processing technology implementation at the MCYTCF would incur additional costs estimated at $15–20 million. Dry fermentation AD and primary composting via in-vessel tunnel reactor composting could also be developed entirely at Site 2; however, the lack of existing infrastructure would elevate capital costs and transportation costs of end product considerably, with additional costs estimated at $15–35 million.

6.1.5 Option 5 – Dry Fermentation Anaerobic Digestion at Shady Grove Transfer Station with Product Finishing at MCYTCF via Windrow Composting

Option 5 combines hydrogen fuel-producing AD at the Shady Grove TS with windrow composting of the digestate in the existing windrow composting operation at the MCYTCF. Despite the area constraints of the Shady Grove TS site, this pairing of technology and sites was selected based on the proximity of the Shady Grove TS to potential end uses for biogas generated from AD. As with previous alternatives at the Shady Grove TS, the site area allows only material receipt, pre-processing, and anaerobic digestion on-site; hauling of digestate by truck and/or rail to the MCYTCF for windrow composting prior to curing, screening, and bagging. Site development and annual O&M costs for Phase I and Phase II facility development for this alternative are presented in Appendix F.

Similar to Option 4, material receipt and pre-processing at the Shady Grove TS would include receiving and grinding co-collected yard trim and food scrap in an enclosed building, equipped with aeration and process odor controls, in preparation for anaerobic digestion. Pre-processed feedstocks would be loaded into the digestors for processing and the resulting residual, or digestate, would look like the pre-processed SSO that went into the AD reactors, only wetter and with a higher odor profile than stable material after other primary composting processes. The digestate would be removed from the AD reactors, mixed with yard trim to increase the volatile solids content, and then loaded into covered hopper rail cars for primary composting and product finishing steps at the MCYTCF. The additional AD product of methane-rich biogas can be captured, cleaned, and stored, with additional purification for the conversion of the biogas to hydrogen fuel.

The site constraints of the Shady Grove TS pose a significant challenge to siting an AD process at this location; however, as with Option 4, siting of the dry fermentation AD system at Shady Grove TS provides the nearest proximity to the bus fleet headquarters in Silver Spring, Maryland. While the digesters could be built out to up to 1 acre in Phase I and up to 3 acres in total in Phase II, existing site operations at the Shady Grove TS would require significant relocation to accommodate this. Given that no off-site areas have been identified to relocate existing operations, land acquisition and site development costs for the adjacent Eugene Casey Foundation parcels have been included in site development costs for this alternative. Hydrogen produced for use by the bus fleet would need to be compressed and transported to the bus fleet headquarters in high-pressure tube trailers. Additional future considerations would be needed to address the carbon dioxide byproduct from hydrogen production.

As AD is solely extracting the energy value from SSO before it is further processed, coupling with a composting system is necessary for processing the digestate. The MCYTCF would require only limited upgrades to conduct primary composting via windrows, and is well-equipped for curing, screening, and bagging processes. Moving the finished compost to market would be the same method as is used now from the MCYTCF.

It would be possible to develop dry fermentation AD and windrow composting entirely at MCYTCF or at Site 2 after material pre-processing; however, given the remote location of both sites, the additional capital cost for an enclosed facility with a high degree of process control may not be justifiable. In addition, longer compressed hydrogen gas transport times and routes would be needed. Developing this processing technology implementation at the MCYTCF would incur additional costs estimated at \$5–10 million. Dry fermentation AD and windrow composting could also be developed entirely at Site 2; however, the lack of existing infrastructure would elevate capital costs and transportation costs of end product considerably, with additional costs estimated at \$15–35 million.

6.2 ADDITIONAL PROGRAM DEVELOPMENT MODEL

Consideration of a distributed approach to organics collection and processing, while it may require changes to organic waste collection and material receipt beyond the scope of this report, provides an alternative model for processing organics captured through the planning period.

Advantages of processing at multiple smaller-scale sites allows for maintaining organic waste collection and processing more local to the points of waste generation, and potentially a more local pathway for product distribution, decreasing the carbon footprint overall for organic waste processing. Relieving the Shady Grove TS site as the centralized waste receiving and pre-processing location for organic waste, as included in assumptions in previous alternatives, may ease the processing capacity demand currently at the Shady Grove TS site. In addition, implementation of an ASP could provide effective control over odors and vectors while also providing a scalable approach where additional processing capacity can be integrated at a given site without significant additional capital costs.

Disadvantages of processing at multiple smaller-scale sites has the challenge of identifying multiple sites across the County for organics processing. While smaller parcels may be easier to locate within proximity to the dense population areas, and thus more concentrated organic waste generation areas of the County, there may be increased opposition from residents to multiple sites as well as additional cumbersome site permitting processes. In addition, processing at multiple sites requires additional machinery (e.g., loaders), processing equipment (e.g., grinders, screening, bagging) and personnel to manage the composting process at multiple sites.

Shown in Figure 6-2 are 359 County-owned parcels that may be considered further for smaller 12-acre-footprint distributed ASP composting sites. While these sites were screened only by size and County-ownership, a more detailed GIS review will be necessary to determine site suitability considering zoning, required setbacks, and other exclusionary criteria. In addition, a future GIS review of transportation routes can be conducted to optimize the locations of smaller processing facilities.

Although no County-owned parcels are currently identified for development of a decentralized model, conceptual site development and annual O&M costs have been developed for future consideration.

Costs assume ASP composting systems are developed at distributed installations of up to four 12-acre sites across the County, considering phased development, and are presented in Appendix F as Option 6. Note that as available parcels which could potentially require land acquisition have not been identified, this option is not included in analysis later in this chapter.

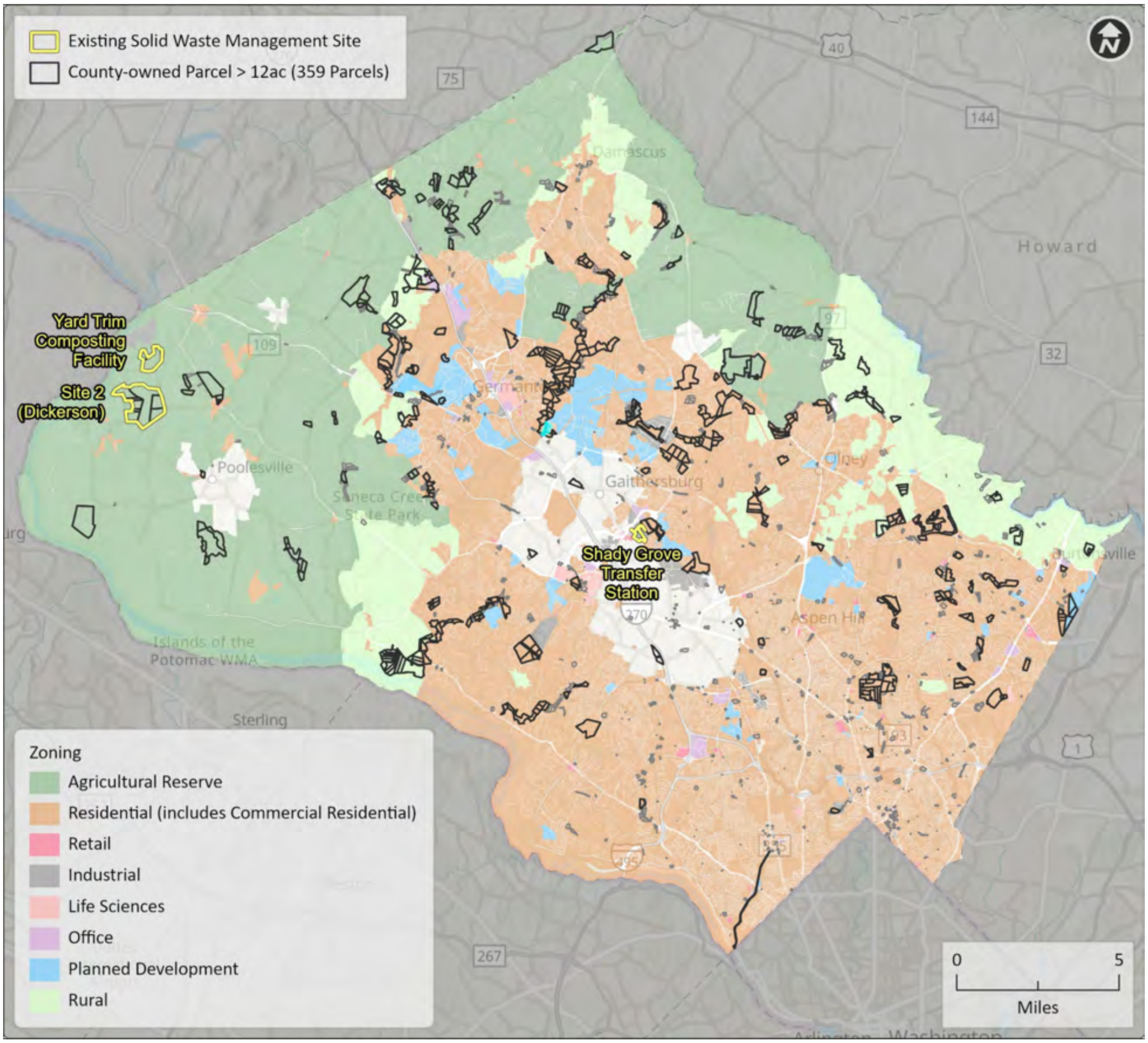

Figure 6-2. GIS Screening of County-Owned Sites for Distributed Composting

6.3 LIFE-CYCLE COST ANALYSIS

The EA Team has developed a Cost Analysis that compares the relative costs for the five alternatives noted, including assessment of capital costs and O&M costs of alternatives over the project planning period. This analysis will be utilized to provide insights into the project's economic feasibility given the previously evaluated alternatives in projected waste generation, processing approaches, end-product usage, and facility location. Costs provided were developed to compare and support selection of the option.

6.3.1 Conceptual Cost Estimates

Conceptual-level relative cost estimates have been prepared for each alternative, considering site development costs to implement organics processing technologies over a phased construction at each site, and annual O&M costs. Costs have been developed for the purposes of comparing alternatives only, and additional cost estimation will be necessary in the future during facility design. Costs have been developed based on vendor quotes, contractor bid pricing, RS Means national average data for construction costs, and the MDOT SHA Price Index for costs by Maryland county. Costs are presented with a 30% contingency appropriate for the concept-level nature of the evaluation without design layout or detailed planning. A summary of facility capital costs is included in Table 6-1.

Table 6-1. Conceptual Facility Capital Costs

Option	Option Description	Capital Cost		
		Phase I	Phase II	Total
1	ASP Composting at MCYTCF	$16,318,000	$14,917,000	$31,235,000
2	In-Vessel Tunnel Reactor Composting at Shady Grove TS and Product Finishing At MCYTCF	$42,315,000	$20,496,000	$62,811,000
3	Agitated Bed Composting at Site 2	$71,315,000	$18,317,000	$89,632,000
4	Dry Fermentation Anaerobic Digestion at Shady Grove TS with Product Finishing at MCYTCF via Tunnel Reactor Composting	$75,166,000	$67,122,000	$142,288,000
5	Dry Fermentation Anaerobic Digestion at Shady Grove TS with Product Finishing at MCYTCF	$58,425,000	$49,441,000	$107,866,000

A summary of annual O&M costs is included in Table 6-2. Note that O&M costs include costs for all labor and equipment necessary for site operations, and do not consider where existing labor or equipment on-site may be reused.

Table 6-2. Conceptual Facility Annual O&M Costs

Option	Option Description	Capital Cost	
		Phase I	Phase II
1	ASP Composting at (MCYTCF	$3,470,000	$7,580,000
2	In-Vessel Tunnel Reactor Composting at Shady Grove TS and Product Finishing At MCYTCF	$4,640,000	$9,130,000
3	Agitated Bed Composting at Site 2	$3,830,000	$8,430,000
4	Dry Fermentation Anaerobic Digestion at Shady Grove TS with Product Finishing at MCYTCF via Tunnel Reactor Composting	$6,310,000	$11,640,000
5	Dry Fermentation Anaerobic Digestion at Shady Grove TS with Product Finishing at MCYTCF	$5,270,000	$10,180,000

6.4 ANALYSIS

Project alternatives are assessed and ranked in this section using the weighted criteria decision matrix approach evaluating alternatives based on specific evaluation criteria, weighted by the importance of each criterion. This decision-making tool treats each criterion independently, which helps avoid bias or emphasis on a specific criterion.

6.4.1 Alternatives Evaluation Criteria

To evaluate the alternative most suitable for development for a County facility, the EA Team and the County developed criteria against which to evaluate each alternative. As discussed previously, County DEP personnel in management, planning, and operational roles assigned weighting factors on a scale of 1 to 5 to indicate the relative importance of each criterion. Average weighting factors are presented in Table 6-3 and are applied in the weighted matrix discussed later in this section. Among respondents, considerations regarding the ability of one site to accommodate all processing was the most heavily weighted evaluation criteria.

Table 6-3. Alternatives – Evaluation Criteria

Criteria	Definitions	Weighting Factor (Scale of 1-5)
1 – Facility Capital Costs	An alternative with a higher facility capital cost will score lower.	3.5
2 – Facility O&M Costs	An alternative with a higher annual O&M cost will score lower.	4.0
3 – All Processing Conducted on One Site	A site that can accommodate all processing (e.g., material receipt to bagging operations) on-site will score higher.	5.0
4 – Ease of Implementation	A site with greater local support for development will score higher.	4.0
5 – Ease of Construction	A site with more complex site development requirements and/or installation of more complex processing equipment will score lower.	3.8
6 – Proven System Implementation	A site with proven installations will score higher, considering both the processing technology and facility parameters.	4.3
7 – Transportation Resilience	A site that has multiple transportation options (e.g., rail, truck, etc.) for material receiving and/or distribution will score higher.	3.8
8 – Viability of renewable energy production and usage	A site with a viable pathway for renewable energy production and end use will score higher.	3.8

6.4.2 Alternatives Scoring

To provide an independent assessment of each alternative, the EA Team scored each alternative against the evaluation criteria, considering holistically the organics processing technology, site, and ability to meet County processing needs. Based on the EA Team's organics industry experience and familiarity with organics processing facilities, a score was assigned to each alternative reflecting the merits and challenges of each.

Table 6-4. Alternatives Scoring

Criteria	Option 1 – ASP Composting at MCYTCF	Option 2 – In-Vessel Tunnel Reactor Composting at Shady Grove TS and Product Finishing at MCYTCF	Option 3 – Agitated Bed Composting at Site 2	Option 4 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF via Tunnel Reactor Composting	Option 5 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF
1 – Facility Capital Costs	5	4	3	1	2
2 – Facility O&M Costs	5	4	3	1	2
3 – All Processing Conducted on One Site	3	2	3	2	2
4 – Ease of Implementation	1	2	4	2	2
5 – Ease of Construction	4	2	4	2	2
6 – Proven System Implementation	5	2	2	2	2
7 – Transportation Resilience	3	2	3	2	2
8 – Viability of renewable energy production and usage	1	1	1	4	4

6.4.3 Alternatives Ranking

Organics processing technologies ranked using a weighted criteria decision matrix technique are summarized in Table 6-5 and detailed in Table 6-6. To develop the weighted score, the score of each alternative was multiplied by the evaluation criteria weighting factor. The weighted score was totaled across all evaluation criteria for each technology. The scores for each technology were then compared to create a ranking among alternatives.

Based on the alternatives presented and ranked applying the County's evaluation factors with the EA Team's alternative scoring, the weighted matrix approach identifies the ranking of alternatives based on consistency with the County's stated goals.

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Table 6-5. Alternatives Ranking Summary Table

Alternative	Weighted Score
Option 1 – ASP Composting at MCYTCF	103.8
Option 3 – Agitated Bed Composting at Site 2	92.0
Option 2 – In-Vessel Tunnel Reactor Composting at Shady Grove TS and Product Finishing at MCYTCF	75.3
Option 5 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF	71.5
Option 4 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF via Tunnel Reactor Composting	64.0

Table 6-6. Alternatives Weighted Matrix

Criteria	Weighting Factor	Option 1 – ASP Composting at MCYTCF		Option 2 – In-Vessel Tunnel Reactor Composting at Shady Grove TS and Product Finishing at MCYTCF		Option 3 – Agitated Bed Composting at Site 2		Option 4 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF via Tunnel Reactor Composting		Option 5 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF	
		Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
1 – Facility Capital Costs	3.5	5	**17.5**	4	**14.0**	3	**10.5**	1	**3.5**	2	**7.0**
2 – Facility O&M Costs	4	4	**16.0**	4	**16.0**	3	**12.0**	1	**4.0**	2	**8.0**
3 – All Processing Conducted on One Site	5	3	**15.0**	2	**10.0**	3	**15.0**	2	**10.0**	2	**10.0**
4 – Ease of Implementation	4	1	**4.0**	2	**8.0**	4	**16.0**	2	**8.0**	2	**8.0**
5 – Ease of Construction	3.75	4	**15.0**	2	**7.5**	4	**15.0**	2	**7.5**	2	**7.5**
6 – Proven System Implementation	4.25	5	**21.3**	2	**8.5**	2	**8.5**	2	**8.5**	2	**8.5**
7 – Transportation Resilience	3.75	3	**11.3**	2	**7.5**	3	**11.3**	2	**7.5**	2	**7.5**
8 – Viability of renewable energy production and usage	3.75	1	**3.8**	1	**3.8**	1	**3.8**	4	**15.0**	4	**15.0**
TOTAL WEIGHTED SCORE			**103.8**		**75.3**		**92.0**		**64.0**		**71.5**

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7. SUMMARY AND CONCLUSIONS

The EA Team was contracted by MES for Montgomery County to prepare this organics siting study plan to evaluate the siting, technology, and capacity planning for a County-owned organics processing facility in Montgomery County to meet the food scrap, non-recyclable paper, and yard trim diversion needs of the County for the next 20 years. The EA Team completed the evaluation as outlined below.

7.1 SUMMARY

7.1.1 Source Separated Organics Processing Options Materials Feedstock Projections

The County has a long-standing yard trim diversion program, capturing around 90% of the yard trim generated, and processing up to the processing limit of 77,000 tons of yard trim per year at the MCYTCF. In contrast, food waste and non-recyclable paper present organic waste streams with significant opportunity to improve upon historically low capture rates.

Projections for capture of food waste and non-recyclable paper were developed based on eight scenarios considering the potential of low, medium, high, and mandatory participation by single-family, multi-family, and non-residential sectors in the County. Survey response data were used to inform the projections for single-family households, by creating an understanding for the potential for future public engagement. In four of the scenarios, decentralized processing strategies, including backyard, community, and on-farm composting were considered to understand the extent to which these pathways may process food scraps and offset the processing capacity required by the County. Projected food scrap capture quantities varied from 8,800 to 65,800 tons per year in low to mandatory scenarios, and up to 58,300 tons per year captured where diversionary measures through decentralized processing were in place. The food scrap capture projections were presented in Chapter 2 (Table 2-20), as noted in Table 7-1 below.

Table 7-1. Projected Food Scraps Capture (Tons) by Year

Scenario	2025	2030	2035	2040	2045
1	4,600	5,700	6,700	7,700	8,800
2	6,400	10,700	15,100	19,600	24,100
3	7,300	18,500	30,000	41,900	54,000
4	7,300	35,500	45,300	55,400	65,800
5	4,600	5,700	6,700	7,700	8,800
6	4,800	7,600	11,900	16,500	21,100
7	5,700	15,400	26,900	38,800	51,000
8	3,500	28,100	37,700	47,900	58,300

7.1.2 Source Separated Organics Processing Options

Organics processing technologies were reviewed, focusing on the current state-of-practice technologies and their potential to support municipal-scale processing of food scrap and yard trim. Several aerobic processing technologies were evaluated in this study, including ASP, enclosed in-vessel tunnel reactors, rotating drums, and agitated bed composting systems. In addition, anaerobic processing technologies were evaluated, including wet (low-solids) continuous-stirred tank reactor anaerobic digestion, high-solids dry fermentation AD, and high-solids plug flow AD. Technology review included discussion of pre- and post-treatment processing; pollutants of concern, including PFAS, MP, and PH; and GHG emissions assessment. To discern the most suitable organics processing technology, the EA Team used a weighted matrix approach to rank each technology with County input on 20 evaluation criteria considering systems factors, operations, end products, and environmental concerns. The technologies were ranked in Chapter 3 (Table 3-8), as noted in Table 7-2 below.

Table 7-2. Technology Ranking Summary Table

Technology	Weighted Score
ASP	269.8
Tunnel Reactor	253.5
Agitated Bed	227.5
Dry Fermentation	225.9
Rotating Drum	212.9
High Solids Plug Flow	201.5
Wet (low-solids) CSTR	185.3

7.1.3 Recycled Organics Product Usage Options

As all organics processing end products must have viable end markets to be successful, a review of the potential end products and capacities of end markets in the County to absorb recycled organics products from aerobic and anaerobic organics processing technologies was conducted. End products reviewed included compost, biogas, and digestate. Market capacity by sector was considered for landscaping, agriculture, and stormwater management for new construction/ redevelopment, with an estimated market capacity of 276,600 CY per year, or 69,800 CY per year for the County's market share. Although not quantified, additional emerging discussion included erosion and sediment control applications, development of soil organic matter content, and climate sequestration and climate action plans. Markets were discussed, but not quantified.

7.1.4 Siting Evaluation

To support an organics processing facility, a site must meet the needs to receive, process, and distribute organic feedstocks and finished products. The siting evaluation examined the feasibility of using County-owned property for the development of an organics management facility, including review of the Shady Grove TS, the MCYTCF at Dickerson, and the tract of land known as Site 2 in Dickerson. In addition, the EA Team performed a desktop analysis based on publicly available GIS data to determine whether any additional County-owned parcels merit further review as potential locations for facility siting. Site development and permitting requirements are reviewed later in the chapter. To discern the most suitable site, the EA Team used a weighted matrix to rank each technology with County input, using 17 evaluation criteria for evaluating each site, including site characteristics that may affect site development, conditions local to each site, and community considerations. The technologies were ranked in Chapter 5 (Table 5-11), as noted in Table 7-3 below.

Table 7-3. Site Ranking Summary Table

Technology	Weighted Score
MCYTCF	267.0
Shady Grove TS	236.0
Site 2	219.8

7.1.5 Evaluation of Alternatives

The projections, the technology evaluation, and the siting study were combined into five alternatives for consideration, based on rankings previously developed in this report. The alternatives presented considered a phased processing facility development, with adequate capacity to process up to 97,400 tons (273,500 CY) of yard trim and food scrap in Phase I, and to meet the future processing capacity needs identified in the mandatory program and some high capture scenarios in Phase II. Conceptual capital and O&M costs were developed for the purposes of comparing alternatives. To discern the preferred alternative, the EA Team used a weighted matrix to rank each alternative, with County input, using eight evaluation criteria important for facility development. The alternatives were ranked in Chapter 6 (Table 6-3), as noted in Table 7-4 below.

Table 7-4. Alternatives Ranking Summary Table

Alternative	Weighted Score
Option 1 – ASP Composting at MCYTCF	103.8
Option 3 – Agitated Bed Composting at Site 2	92.0
Option 2 – In-Vessel Tunnel Reactor Composting at Shady Grove TS and Product Finishing at MCYTCF	75.3
Option 5 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF	71.5
Option 4 – Dry Fermentation AD at Shady Grove TS with Product Finishing at MCYTCF via Tunnel Reactor Composting	64.0

7.1.6 Next Steps

While the alternatives presented require significant capital and operational investment, proceeding with a pilot program to test various composting technologies may be advantageous, to determine how best to tailor an organics processing facility to the County's needs. Where it is not possible to pilot test a particular technology, such as agitated bed, in-vessel tunnel reactor, or dry fermentation AD, it may benefit the County to conduct site visits to locally operating installations in order to evaluate their technologies and adapt them to suit specific requirements.

Additional steps the County may consider prior to developing an alternative considered in this report:

- Gathering additional community input and/or conducting engagement with local community organizations that may be invested in developing a given site
- Conducting an additional siting study of non-County-owned parcels

- Considering land acquisition of privately owned parcels considered in this report, or conducting additional study to identify other privately owned properties for County purchase

- Conducting additional program planning to determine a suitable re-location of processing activities currently located at the Shady Grove TS

- Conducting a study of material receiving and processing through multiple smaller sites

Upon determining a path forward for development of an organics processing technology at a particular site, an approximate timeline of site development steps is outlined below. Development of a County-owned organics processing facility may require approximately 2.5 to 4 years prior to completion of an operable facility.

- Issue Request for Quotation/Request for Proposal for site design and permitting – 3–6months

- Develop Site Investigation and Site Design – 12–18 months

- State and Local Permitting – 12–18 months

- Project Bidding – 3 months

- Facility Construction – 12–18 months

As outlined in this report, defining programmatic considerations, such as considering material collection methods, encouraging public participation, and conducting outreach and education prior to expanding organics programs are critical to ensure programmatic success.

7.1.7 Conclusions

The County has a demonstrated need for organics processing capacity to meet the yard trim and food scrap generation and capture projected over the planning period. Final alternatives provide the outline of facility site development alternatives that utilize proven organics processing technologies at County-owned sites. Achieving food scrap diversion at low, medium, or high capture levels will continue to require rigorous program development and public engagement.

While all alternatives presented rely on a centralized processing approach concentrating processing capacity at a single site, it is noted that a distributed processing approach merits further evaluation by the County, including identification of suitable land area for development. While pursuing a distributed processing approach would require further study, it may provide the County with an avenue to address its already burdened solid waste management facilities. Moreover, implementation of decentralized processing approaches may be effective for geographic regions of the County, while a centralized processing option located at an existing

County facility may also be an effective systems approach. Further, where diversionary measures, such as expanded backyard, community, and on-farm composting are utilized, the viable capacity life of proposed organics processing alternatives developed in this study may be extended beyond the planning period.

Developing a successful long-term organics diversion program requires a balance between collection strategies, processing methods, and end-product marketing and sales. This study has considered how a program may be successful, by developing organics generation and capture projections, reviewing organics processing technologies, assessing end-product markets, and evaluating County sites for facility siting, over the planning period 2025 to 2045. The County is encouraged to investigate multiple programmatic implementation considerations prior to expanding the food scrap diversion program beyond its current pilot phase:

- Evaluate the feasibility of and continue to develop programmatic support for decentralized organics processing, such as through backyard, community, and on-farm composting; to continue to develop food scrap diversion "know how" throughout the County.

- Benchmark actual food scrap generation and capture against projections as developed, to re-baseline for planning purposes, as needed.

- Evaluate the feasibility of converting yard trim collection to a cart-based system to facilitate the co-collection of yard trim and food scraps.

- Evaluate alternative food-scraps-only collection methods, including curbside collection, drop-off stations, and durable compost-bag programs.

- Coordinate with municipalities in the County to capture those organics for processing at a County-owned facility.

- As the County evaluates alternatives to processing MSW at the RRF, consider how non-diverted organics could be co-processed with diverted SSO.

- Explore how to develop a fundamentally structural demand for compost usage in the County through mechanisms such as minimum soil organic matter content for new development and soil profile rebuilding requirements for redevelopment.

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Appendix A:

Organic Waste Projections

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APPENDIX A1 - Organic Waste Generation, by Material Type

	Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Projection Basis	**SFA Housecount (1)**	92,418	93,478	92,615	92,901	**93,186**	93,651	94,115	94,544	95,008	**95,472**	95,937	96,437	96,901	97,401	**97,865**	98,348	98,830	99,312	99,794	**100,276**	100,759	101,241	101,723	102,205	**102,687**
	SFB Housecount (1)	126,315	127,674	129,028	129,426	**129,824**	130,471	131,118	131,715	132,362	**133,009**	133,656	134,352	134,999	135,696	**136,343**	137,014	137,686	138,358	139,030	**139,702**	140,373	141,045	141,717	142,389	**143,060**
	SFM Housecount (1)	38,845	39,361	39,674	39,796	**39,919**	40,118	40,317	40,500	40,699	**40,898**	41,097	41,311	41,510	41,724	**41,923**	42,130	42,336	42,543	42,749	**42,956**	43,162	43,369	43,576	43,782	**43,989**
	SF Total Housecount (1)	257,578	260,513	261,317	262,123	**262,929**	264,240	265,550	266,759	268,069	**269,379**	270,689	272,100	273,410	274,821	**276,131**	277,492	278,852	280,213	281,573	**282,934**	284,294	285,655	287,015	288,376	**289,736**
	MF Housecount (1)	140,272	140,882	143,104	145,241	**147,379**	149,516	151,654	153,689	155,827	**157,964**	159,796	161,628	163,460	165,292	**167,124**	168,956	170,788	172,620	174,453	**176,285**	178,117	179,949	181,781	183,613	**185,445**
	Montgomery County Total Housecount (1)	397,850	401,395	404,421	407,365	**410,308**	413,756	417,203	420,448	423,896	**427,343**	430,485	433,728	436,871	440,113	**443,256**	446,448	449,641	452,833	456,026	**459,218**	462,411	465,604	468,796	471,989	**475,181**
	Employment (1)	549,300	555,100	560,900	566,700	**572,500**	578,900	585,300	591,700	598,100	**604,500**	609,100	613,600	618,200	622,800	**627,400**	631,950	636,500	641,050	645,600	**650,150**	654,700	659,250	663,800	668,350	**672,900**
	Total County-Managed MSW (Tons) (2)(3)	**910,928**	**988,658**	**991,528**	**994,398**	**997,268**	**1,000,138**	**1,003,008**	**1,005,878**	**1,008,748**	**1,011,618**	**1,014,488**	**1,017,358**	**1,020,228**	**1,023,098**	**1,025,968**	**1,028,838**	**1,031,708**	**1,034,578**	**1,037,448**	**1,040,318**	**1,043,188**	**1,046,058**	**1,048,928**	**1,051,798**	**1,054,668**
Single-Family Subdistrict A	Yard Trim	28,129	30,532	30,245	30,332	**30,420**	30,507	30,595	30,682	30,770	**30,857**	30,945	31,032	31,120	31,208	**31,295**	31,383	31,470	31,558	31,645	**31,733**	31,820	31,908	31,995	32,083	**32,170**
	Food Scrap	17,568	19,069	18,889	18,944	**18,999**	19,053	19,108	19,163	19,217	**19,272**	19,327	19,381	19,436	19,491	**19,545**	19,600	19,655	19,709	19,764	**19,819**	19,873	19,928	19,983	20,038	**20,092**
	Non-Recyclable Paper	6,777	7,355	7,286	7,307	**7,328**	7,349	7,371	7,392	7,413	**7,434**	7,455	7,476	7,497	7,518	**7,539**	7,560	7,581	7,603	7,624	**7,645**	7,666	7,687	7,708	7,729	**7,750**
	Manure	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	Animal Protein	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	SFA Subtotal (Tons)	**52,474**	**56,956**	**56,420**	**56,583**	**56,747**	**56,910**	**57,073**	**57,237**	**57,400**	**57,563**	**57,727**	**57,890**	**58,053**	**58,216**	**58,380**	**58,543**	**58,706**	**58,870**	**59,033**	**59,196**	**59,360**	**59,523**	**59,686**	**59,850**	**60,013**
Single-Family Subdistrict B	Yard Trim	38,447	41,701	42,136	42,258	**42,380**	42,502	42,623	42,745	42,867	**42,989**	43,111	43,233	43,355	43,477	**43,599**	43,721	43,843	43,965	44,087	**44,209**	44,331	44,453	44,575	44,697	**44,819**
	Food Scrap	24,012	26,045	26,316	26,392	**26,468**	26,544	26,621	26,697	26,773	**26,849**	26,925	27,002	27,078	27,154	**27,230**	27,306	27,382	27,459	27,535	**27,611**	27,687	27,763	27,839	27,916	**27,992**
	Non-Recyclable Paper	9,262	10,046	10,151	10,180	**10,210**	10,239	10,268	10,298	10,327	**10,357**	10,386	10,415	10,445	10,474	**10,503**	10,533	10,562	10,592	10,621	**10,650**	10,680	10,709	10,738	10,768	**10,797**
	Manure	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	Animal Protein	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	SFB Subtotal (Tons)	**71,721**	**77,792**	**78,602**	**78,830**	**79,057**	**79,285**	**79,513**	**79,740**	**79,968**	**80,195**	**80,423**	**80,650**	**80,878**	**81,105**	**81,333**	**81,560**	**81,788**	**82,015**	**82,243**	**82,470**	**82,698**	**82,925**	**83,153**	**83,380**	**83,608**
Single-Family Municipalities	Yard Trim	11,823	12,856	12,956	12,994	**13,031**	13,069	13,106	13,144	13,181	**13,219**	13,256	13,294	13,331	13,369	**13,406**	13,444	13,481	13,519	13,556	**13,594**	13,631	13,669	13,706	13,744	**13,781**
	Food Scrap	7,384	8,029	8,092	8,115	**8,139**	8,162	8,185	8,209	8,232	**8,256**	8,279	8,303	8,326	8,349	**8,373**	8,396	8,420	8,443	8,466	**8,490**	8,513	8,537	8,560	8,584	**8,607**
	Non-Recyclable Paper	2,848	3,097	3,121	3,130	**3,139**	3,148	3,157	3,166	3,175	**3,184**	3,193	3,203	3,212	3,221	**3,230**	3,239	3,248	3,257	3,266	**3,275**	3,284	3,293	3,302	3,311	**3,320**
	Manure	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	Animal Protein	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	SFM Subtotal (Tons)	**22,056**	**23,983**	**24,169**	**24,239**	**24,309**	**24,379**	**24,449**	**24,519**	**24,589**	**24,659**	**24,729**	**24,799**	**24,869**	**24,939**	**25,008**	**25,078**	**25,148**	**25,218**	**25,288**	**25,358**	**25,428**	**25,498**	**25,568**	**25,638**	**25,708**
Single-Family (Subtotal)	Yard Trim	78,399	85,089	85,336	85,583	**85,830**	86,077	86,324	86,571	86,818	**87,065**	87,312	87,559	87,806	88,053	**88,300**	88,547	88,794	89,041	89,288	**89,535**	89,782	90,029	90,276	90,523	**90,770**
	Food Scrap	48,965	53,143	53,297	53,451	**53,606**	53,760	53,914	54,068	54,223	**54,377**	54,531	54,685	54,840	54,994	**55,148**	55,303	55,457	55,611	55,765	**55,920**	56,074	56,228	56,382	56,537	**56,691**
	Non-Recyclable Paper	18,887	20,499	20,558	20,618	**20,677**	20,737	20,796	20,856	20,915	**20,975**	21,034	21,094	21,153	21,213	**21,272**	21,332	21,391	21,451	21,510	**21,570**	21,629	21,689	21,748	21,808	**21,867**
	Manure	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	Animal Protein	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	SF Subtotal (Tons)	**146,251**	**158,731**	**159,191**	**159,652**	**160,113**	**160,574**	**161,035**	**161,495**	**161,956**	**162,417**	**162,878**	**163,339**	**163,799**	**164,260**	**164,721**	**165,182**	**165,642**	**166,103**	**166,564**	**167,025**	**167,486**	**167,946**	**168,407**	**168,868**	**169,329**
Multi-Family	Yard Trim	4,280	4,646	4,659	4,673	**4,686**	4,700	4,713	4,727	4,740	**4,754**	4,767	4,780	4,794	4,807	**4,821**	4,834	4,848	4,861	4,875	**4,888**	4,902	4,915	4,929	4,942	**4,956**
	Food Scrap	16,516	17,925	17,977	18,029	**18,081**	18,133	18,185	18,237	18,289	**18,341**	18,393	18,446	18,498	18,550	**18,602**	18,654	18,706	18,758	18,810	**18,862**	18,914	18,966	19,018	19,070	**19,122**
	Non-Recyclable Paper	7,747	8,408	8,432	8,457	**8,481**	8,506	8,530	8,554	8,579	**8,603**	8,628	8,652	8,677	8,701	**8,725**	8,750	8,774	8,799	8,823	**8,847**	8,872	8,896	8,921	8,945	**8,969**
	Manure	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	Animal Protein	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**	-	-	-	-	**-**
	MF Subtotal (Tons)	**28,543**	**30,979**	**31,069**	**31,159**	**31,249**	**31,339**	**31,428**	**31,518**	**31,608**	**31,698**	**31,788**	**31,878**	**31,968**	**32,058**	**32,148**	**32,238**	**32,328**	**32,418**	**32,508**	**32,598**	**32,687**	**32,777**	**32,867**	**32,957**	**33,047**
Non-Residential	Yard Trim	121,613	131,991	132,374	132,757	**133,140**	133,523	133,906	134,290	134,673	**135,056**	135,439	135,822	136,205	136,589	**136,972**	137,355	137,738	138,121	138,504	**138,888**	139,271	139,654	140,037	140,420	**140,803**
	Food Scrap	27,937	30,321	30,409	30,497	**30,585**	30,673	30,761	30,849	30,937	**31,025**	31,113	31,201	31,289	31,377	**31,465**	31,553	31,641	31,729	31,817	**31,905**	31,993	32,081	32,169	32,257	**32,345**
	Non-Recyclable Paper	10,368	11,252	11,285	11,318	**11,350**	11,383	11,416	11,448	11,481	**11,514**	11,546	11,579	11,612	11,644	**11,677**	11,710	11,742	11,775	11,808	**11,840**	11,873	11,906	11,938	11,971	**12,004**
	Manure	4,386	4,760	4,774	4,787	**4,801**	4,815	4,829	4,843	4,857	**4,870**	4,884	4,898	4,912	4,926	**4,939**	4,953	4,967	4,981	4,995	**5,009**	5,022	5,036	5,050	5,064	**5,078**
	Animal Protein	697	756	758	761	**763**	765	767	769	772	**774**	776	778	780	783	**785**	787	789	791	794	**796**	798	800	802	805	**807**
	NR Subtotal (Tons)	**165,000**	**179,080**	**179,600**	**180,120**	**180,640**	**181,159**	**181,679**	**182,199**	**182,719**	**183,239**	**183,759**	**184,279**	**184,798**	**185,318**	**185,838**	**186,358**	**186,878**	**187,398**	**187,918**	**188,437**	**188,957**	**189,477**	**189,997**	**190,517**	**191,037**
TOTAL	Total Yard Trim	204,293	221,725	222,369	223,013	**223,656**	224,300	224,944	225,587	226,231	**226,875**	227,518	228,162	228,806	229,449	**230,093**	230,737	231,380	232,024	232,668	**233,311**	233,955	234,599	235,242	235,886	**236,529**
	Total Food Scrap	93,418	101,389	101,683	101,978	**102,272**	102,566	102,860	103,155	103,449	**103,743**	104,038	104,332	104,626	104,921	**105,215**	105,509	105,804	106,098	106,392	**106,687**	106,981	107,275	107,570	107,864	**108,158**
	Total Non-Recyclable Paper	37,002	40,159	40,276	40,392	**40,509**	40,625	40,742	40,859	40,975	**41,092**	41,208	41,325	41,441	41,558	**41,675**	41,791	41,908	42,024	42,141	**42,257**	42,374	42,491	42,607	42,724	**42,840**
	Total Manure	4,386	4,760	4,774	4,787	**4,801**	4,815	4,829	4,843	4,857	**4,870**	4,884	4,898	4,912	4,926	**4,939**	4,953	4,967	4,981	4,995	**5,009**	5,022	5,036	5,050	5,064	**5,078**
	Total Animal Protein	697	756	758	761	**763**	765	767	769	772	**774**	776	778	780	783	**785**	787	789	791	794	**796**	798	800	802	805	**807**
	Total Organics Managed (Tons)	**339,795**	**368,789**	**369,860**	**370,931**	**372,001**	**373,072**	**374,142**	**375,213**	**376,283**	**377,354**	**378,425**	**379,495**	**380,566**	**381,636**	**382,707**	**383,777**	**384,848**	**385,919**	**386,989**	**388,060**	**389,130**	**390,201**	**391,271**	**392,342**	**393,413**

Sources:
(1) "Housecount Data CY for ML." Montgomery County. 04/21/2023. Housecount and employment data extrapolated from County projections for 2041-2045.
(2) "CY2021CaptureModel." Montgomery County. 5/16/2022. Waste categories and CY21 tons.
(3) "CY22 MRA Workbook" MMS. 08/17/2023. CY22 Total County-Managed MSW Only.

Notes:
(1) Housecount data utilized for residential sector projections. Employment data utilized for non-residential (commercial) projections.
(2) Employment represents the total number of jobs.
(3) Organic waste generation projections presented in this table represent organic waste generated in-County as identified by the County capture model.
(4) Organic waste generation projections developed only for capture model waste categories appropriate for organic processing through composting or anaerobic digestion.

Actual Data

APPENDIX A2 - Organic Waste Capture, Food Scrap Only

	Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Projection Basis	SFA Housecount (1)	92,418	93,478	92,615	92,901	93,186	93,651	94,115	94,544	95,008	95,472	95,937	96,437	96,901	97,401	97,865	98,348	98,830	99,312	99,794	100,276	100,759	101,241	101,723	102,205	102,687
	SFB Housecount (1)	126,315	127,674	129,028	129,426	129,824	130,471	131,118	131,715	132,362	133,009	133,656	134,352	134,999	135,696	136,343	137,014	137,686	138,358	139,030	139,702	140,373	141,045	141,717	142,389	143,060
	SFM Housecount (1)	38,845	39,361	39,674	39,796	39,919	40,118	40,317	40,500	40,699	40,898	41,097	41,311	41,510	41,724	41,923	42,130	42,336	42,543	42,749	42,956	43,162	43,369	43,576	43,782	43,989
	SF Total Housecount (1)	257,578	260,513	261,317	262,123	262,929	264,240	265,550	266,759	268,069	269,379	270,689	272,100	273,410	274,821	276,131	277,492	278,852	280,213	281,573	282,934	284,294	285,655	287,015	288,376	289,736
	MF Housecount (1)	140,272	140,882	143,104	145,241	147,379	149,516	151,654	153,689	155,827	157,964	159,796	161,628	163,460	165,292	167,124	168,956	170,788	172,620	174,453	176,285	178,117	179,949	181,781	183,613	185,445
	Montgomery County Total Housecount (1)	397,850	401,395	404,421	407,365	410,308	413,756	417,203	420,448	423,896	427,343	430,485	433,728	436,871	440,113	443,256	446,448	449,641	452,833	456,026	459,218	462,411	465,604	468,796	471,989	475,181
	Employment (1)	549,300	555,100	560,900	566,700	572,500	578,900	585,300	591,700	598,100	604,500	609,100	613,600	618,200	622,800	627,400	631,950	636,500	641,050	645,600	650,150	654,700	659,250	663,800	668,350	672,900
	Total County-Managed MSW (Tons) (2)(6)	910,928	988,658	991,528	994,398	997,268	1,000,138	1,003,008	1,005,878	1,008,748	1,011,618	1,014,488	1,017,358	1,020,228	1,023,098	1,025,968	1,028,838	1,031,708	1,034,578	1,037,448	1,040,318	1,043,188	1,046,058	1,048,928	1,051,798	1,054,668
Single-Family Subdistrict A	Capture Model Generation (Tons)	17,627	19,131	18,889	18,944	18,999	19,053	19,108	19,163	19,217	19,272	19,327	19,381	19,436	19,491	19,545	19,600	19,655	19,709	19,764	19,819	19,873	19,928	19,983	20,038	20,092
	Capture Model Capture (Tons)	501	521	581	640	700	759	819	878	938	997	1,057	1,116	1,176	1,235	1,295	1,354	1,414	1,473	1,533	1,592	1,652	1,711	1,771	1,830	1,890
	Percent Capture (%)	2.84%	2.72%	3.07%	3.38%	3.68%	3.98%	4.28%	4.58%	4.88%	5.17%	5.47%	5.76%	6.05%	6.34%	6.62%	6.91%	7.19%	7.48%	7.76%	8.03%	8.31%	8.59%	8.86%	9.14%	9.41%
	Low Scenario: Current Trends (%)			3.07%	3.38%	3.68%	3.98%	4.28%	4.58%	4.88%	5.17%	5.47%	5.76%	6.05%	6.34%	6.62%	6.91%	7.19%	7.48%	7.76%	8.03%	8.31%	8.59%	8.86%	9.14%	9.41%
	Medium Scenario: Current Trends + New Programs (%)			3.77%	4.37%	4.97%	5.57%	6.16%	6.75%	7.33%	7.91%	8.49%	9.06%	9.64%	10.20%	10.77%	11.33%	11.89%	12.45%	13.00%	13.55%	14.09%	14.64%	15.18%	15.72%	16.25%
	High Scenario : Current Trends + New Programs + Projected Participation (%)																									
Single-Family Subdistrict B	Capture Model Generation (Tons)	24,012	26,045	26,316	26,392	26,468	26,544	26,621	26,697	26,773	26,849	26,925	27,002	27,078	27,154	27,230	27,306	27,382	27,459	27,535	27,611	27,687	27,763	27,839	27,916	27,992
	Capture Model Capture (Tons)	682	709	790	871	952	1,033	1,114	1,195	1,276	1,357	1,438	1,519	1,600	1,681	1,762	1,843	1,924	2,005	2,086	2,167	2,248	2,329	2,410	2,491	2,572
	Percent Capture (%)	2.84%	2.72%	3.00%	3.30%	3.60%	3.89%	4.19%	4.48%	4.77%	5.06%	5.34%	5.63%	5.91%	6.19%	6.47%	6.75%	7.03%	7.30%	7.58%	7.85%	8.12%	8.39%	8.66%	8.93%	9.19%
	Low Scenario: Current Trends (%)			3.00%	3.30%	3.60%	3.89%	4.19%	4.48%	4.77%	5.06%	5.34%	5.63%	5.91%	6.19%	6.47%	6.75%	7.03%	7.30%	7.58%	7.85%	8.12%	8.39%	8.66%	8.93%	9.19%
	Medium Scenario: Current Trends + New Programs (%)			3.25%	3.61%	3.97%	4.32%	4.68%	5.03%	5.38%	5.72%	6.07%	6.41%	6.75%	7.09%	7.43%	7.77%	8.10%	8.43%	8.76%	9.09%	9.42%	9.74%	10.06%	10.38%	10.70%
	High Scenario : Current Trends + New Programs + Projected Participation (%)																									
Single-Family Municipalities	Capture Model Generation (Tons)	17,568	19,069	18,889	18,944	18,999	19,053	19,108	19,163	19,217	19,272	19,327	19,381	19,436	19,491	19,545	19,600	19,655	19,709	19,764	19,819	19,873	19,928	19,983	20,038	20,092
	Capture Model Capture (Tons)	209	217	242	267	291	316	341	366	391	415	440	465	490	515	539	564	589	614	639	663	688	713	738	763	787
	Percent Capture (%)	1.19%	1.14%	1.28%	1.41%	1.53%	1.66%	1.79%	1.91%	2.03%	2.16%	2.28%	2.40%	2.52%	2.64%	2.76%	2.88%	3.00%	3.11%	3.23%	3.35%	3.46%	3.58%	3.69%	3.81%	3.92%
	Low Scenario: Current Trends (%)			1.28%	1.41%	1.53%	1.66%	1.79%	1.91%	2.03%	2.16%	2.28%	2.40%	2.52%	2.64%	2.76%	2.88%	3.00%	3.11%	3.23%	3.35%	3.46%	3.58%	3.69%	3.81%	3.92%
	Medium Scenario: Current Trends + New Programs (%)			1.28%	1.41%	1.53%	1.66%	1.79%	1.91%	2.03%	2.16%	2.28%	2.40%	2.52%	2.64%	2.76%	2.88%	3.00%	3.11%	3.23%	3.35%	3.46%	3.58%	3.69%	3.81%	3.92%
	High Scenario : Current Trends + New Programs + Projected Participation (%)																									
Single-Family (Subtotal)	Capture Model Generation (Tons)	48,965	53,143	53,297	53,451	53,606	53,760	53,914	54,068	54,223	54,377	54,531	54,685	54,840	54,994	55,148	55,303	55,457	55,611	55,765	55,920	56,074	56,228	56,382	56,537	56,691
	Capture Model Capture (Tons)	1,393	1,447	1,613	1,778	1,943	2,109	2,274	2,439	2,605	2,770	2,935	3,101	3,266	3,431	3,597	3,762	3,927	4,093	4,258	4,423	4,589	4,754	4,919	5,085	5,250
	Percent Capture (%)	2.84%	2.72%	3.03%	3.33%	3.63%	3.92%	4.22%	4.51%	4.80%	5.09%	5.38%	5.67%	5.96%	6.24%	6.52%	6.80%	7.08%	7.36%	7.64%	7.91%	8.18%	8.45%	8.72%	8.99%	9.26%
	Low Scenario: Current Trends (%)			3.03%	3.33%	3.63%	3.92%	4.22%	4.51%	4.80%	5.09%	5.38%	5.67%	5.96%	6.24%	6.52%	6.80%	7.08%	7.36%	7.64%	7.91%	8.18%	8.45%	8.72%	8.99%	9.26%
	Medium Scenario: Current Trends + New Program Participation			3.22%	4.60%	5.98%	7.36%	8.74%	10.11%	11.49%	12.86%	14.23%	15.60%	16.97%	18.33%	19.70%	21.06%	22.42%	23.78%	25.14%	26.50%	27.85%	29.21%	30.56%	31.91%	33.26%
	High Scenario : Survey Data (%)			3.22%	5.34%	7.47%	9.60%	11.72%	13.85%	15.98%	18.10%	20.23%	22.35%	24.48%	26.61%	28.73%	30.86%	32.99%	35.11%	37.24%	39.37%	41.49%	43.62%	45.75%	47.87%	50.00%
	Mandatory Diversion Requirement					7.47%	10.10%	12.72%	28.93%	30.76%	32.59%	34.41%	36.24%	38.07%	39.90%	41.72%	43.55%	45.38%	47.21%	49.03%	50.86%	52.69%	54.52%	56.34%	58.17%	60.00%
Multi-Family	Capture Model Generation (Tons)	16,516	17,925	17,977	18,029	18,081	18,133	18,185	18,237	18,289	18,341	18,393	18,446	18,498	18,550	18,602	18,654	18,706	18,758	18,810	18,862	18,914	18,966	19,018	19,070	19,122
	Capture Model Capture (Tons)	32	134	141	147	154	160	166	173	179	185	192	198	204	211	217	224	230	236	243	249	255	262	268	274	281
	Percent Capture (%)	0.19%	0.75%	0.78%	0.82%	0.85%	0.88%	0.91%	0.95%	0.98%	1.01%	1.04%	1.07%	1.11%	1.14%	1.17%	1.20%	1.23%	1.26%	1.29%	1.32%	1.35%	1.38%	1.41%	1.44%	1.47%
	Low Scenario: Current Trends			0.78%	0.82%	0.85%	0.88%	0.91%	0.95%	0.98%	1.01%	1.04%	1.07%	1.11%	1.14%	1.17%	1.20%	1.23%	1.26%	1.29%	1.32%	1.35%	1.38%	1.41%	1.44%	1.47%
	Medium Scenario: Current Trends + New Programs + Projected Participation (%)			1.27%	1.35%	1.43%	1.52%	1.61%	1.69%	1.78%	1.87%	1.95%	2.03%	2.12%	2.20%	2.28%	2.37%	2.45%	2.53%	2.61%	2.69%	2.77%	2.85%	2.93%	3.01%	3.08%
	High Scenario : Survey Data (%)			1.27%	1.98%	2.70%	3.42%	4.14%	4.86%	5.58%	6.30%	7.02%	7.74%	8.46%	9.17%	9.89%	10.61%	11.33%	12.05%	12.77%	13.49%	14.21%	14.93%	15.65%	16.36%	17.08%
	Mandatory Diversion Requirement					1.43%	4.20%	5.87%	9.72%	11.21%	12.69%	14.18%	15.67%	17.16%	18.64%	20.13%	21.62%	23.10%	24.59%	26.08%	27.56%	29.05%	30.54%	32.03%	33.51%	35.00%
Non-Residential	Capture Model Generation (Tons)	27,937	30,321	30,409	30,497	30,585	30,673	30,761	30,849	30,937	31,025	31,113	31,201	31,289	31,377	31,465	31,553	31,641	31,729	31,817	31,905	31,993	32,081	32,169	32,257	32,345
	Capture Model Capture (Tons)	2,670	2,427	2,460	2,494	2,528	2,562	2,596	2,630	2,664	2,699	2,734	2,768	2,803	2,839	2,874	2,909	2,945	2,981	3,017	3,053	3,089	3,125	3,162	3,198	3,235
	Percent Capture (%)	9.56%	8.00%	8.09%	8.18%	8.26%	8.35%	8.44%	8.53%	8.61%	8.70%	8.79%	8.87%	8.96%	9.05%	9.13%	9.22%	9.31%	9.39%	9.48%	9.57%	9.65%	9.74%	9.83%	9.92%	10.00%
	Low Scenario: Current Trends (%)			8.09%	8.18%	8.26%	8.35%	8.44%	8.53%	8.61%	8.70%	8.79%	8.87%	8.96%	9.05%	9.13%	9.22%	9.31%	9.39%	9.48%	9.57%	9.65%	9.74%	9.83%	9.92%	10.00%
	Medium Scenario: Current Trends + New Programs (%)			9.20%	9.49%	9.79%	10.09%	10.38%	10.67%	10.97%	11.26%	11.55%	11.84%	12.12%	12.41%	12.70%	12.98%	13.26%	13.55%	13.83%	14.11%	14.39%	14.66%	14.94%	15.22%	15.49%
	High Scenario : Current Trends + New Programs + Projected Participation (%)					9.79%	13.18%	16.57%	19.96%	23.35%	26.74%	30.13%	33.52%	36.92%	40.31%	43.70%	47.09%	50.48%	53.87%	57.26%	60.65%	64.04%	67.43%	70.82%	74.21%	77.60%
	Mandatory Diversion Requirement					9.79%	21.86%	33.92%	45.99%	47.85%	49.71%	51.57%	53.42%	55.28%	57.14%	59.00%	60.86%	62.72%	64.58%	66.44%	68.30%	70.16%	72.02%	73.88%	75.74%	77.60%
TOTAL	Total Low Capture (Tons)			4,214	4,419	4,625	4,830	5,036	5,242	5,448	5,654	5,861	6,067	6,274	6,481	6,688	6,895	7,102	7,310	7,517	7,725	7,933	8,141	8,349	8,558	8,766
	Total Medium Capture (Tons)			4,738	5,596	6,459	7,326	8,196	9,070	9,947	10,828	11,712	12,600	13,491	14,385	15,283	16,185	17,090	17,998	18,910	19,826	20,745	21,667	22,593	23,523	24,456
	Total High Capture (Tons)			1,941	3,098	7,258	9,478	11,710	13,955	16,213	18,483	20,765	23,060	25,368	27,688	30,020	32,366	34,723	37,093	39,476	41,871	44,279	46,699	49,132	51,578	54,036
	Total Mandatory Capture (Tons)					7,258	12,892	18,362	31,601	33,529	35,468	37,418	39,378	41,348	43,329	45,320	47,322	49,334	51,356	53,390	55,433	57,487	59,552	61,627	63,712	65,808
	Total Low Capture (%)			4.14%	4.33%	4.52%	4.71%	4.90%	5.08%	5.27%	5.45%	5.63%	5.82%	6.00%	6.18%	6.36%	6.53%	6.71%	6.89%	7.07%	7.24%	7.42%	7.59%	7.76%	7.93%	8.10%
	Total Medium Capture (%)			4.66%	5.49%	6.32%	7.14%	7.97%	8.79%	9.62%	10.44%	11.26%	12.08%	12.89%	13.71%	14.53%	15.34%	16.15%	16.96%	17.77%	18.58%	19.39%	20.20%	21.00%	21.81%	22.61%
	Total High Capture (%)			1.91%	3.04%	7.10%	9.24%	11.38%	13.53%	15.67%	17.82%	19.96%	22.10%	24.25%	26.39%	28.53%	30.68%	32.82%	34.96%	37.10%	39.25%	41.39%	43.53%	45.67%	47.82%	49.96%
	Total Mandatory Capture (%)					7.10%	12.57%	17.85%	30.63%	32.41%	34.19%	35.97%	37.74%	39.52%	41.30%	43.07%	44.85%	46.63%	48.40%	50.18%	51.96%	53.74%	55.51%	57.29%	59.07%	60.84%

Sources
(1) "Housecount Data CY for ML." Montgomery County. 04/21/2023. Housecount and employment data extrapolated from County projections for 2041-2045.
(2) "CY2021CaptureModel." Montgomery County. 5/16/2022. Waste categories and CY18-CY21 tons.
(3) "Multi-Family_Food_Scraps_Recycling_Collection_Data." RRMD. 2023-06-05.
(4)"CY20-CY23_MOCO_COMMERCIAL_FOOD_SCRAP_COLLECTION_DATA." RRMD. 2023-06-05.
(5)"RRMD Responses to Questions from EA Engineering." RRMD. 04/19/2023.
(6) "CY22 MRA Workbook" MMS. 08/17/2023.

Notes
(1) Low capture scenario continues the trend observed in capture from CY18-CY21 Capture Models provided by the County.
(2) Medium capture scenario applies the CY18-CY21 capture model trend as noted in low scenario, with the addition of capture within new County programs for Food Scrap diversion.
(3) High capture scenario applies CY18-CY21 capture model trend, participation in new County programs, and public participation interest, as assessed from data provided by DEP RRMD surveys of County residents.
(4) Mandatory requirement assumes capture based on a county diversion requirement applicable to residential and commercial sections with program implementations assumed to begin in 2025.

Actual Data

APPENDIX A3 - Organic Waste Capture, Other Material Types

	Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Projection Basis	**SFA Housecount (1)**	92,418	93,478	92,615	92,901	93,186	93,651	94,115	94,544	95,008	95,472	95,937	96,437	96,901	97,401	97,865	98,348	98,830	99,312	99,794	100,276	100,759	101,241	101,723	102,205	102,205
	SFB Housecount (1)	126,315	127,674	129,028	129,426	129,824	130,471	131,118	131,715	132,362	133,009	133,656	134,352	134,999	135,696	136,343	137,014	137,686	138,358	139,030	139,702	140,373	141,045	141,717	142,389	142,389
	SFM Housecount (1)	38,845	39,361	39,674	39,796	39,919	40,118	40,317	40,500	40,699	40,898	41,097	41,311	41,510	41,724	41,923	42,130	42,336	42,543	42,749	42,956	43,162	43,369	43,576	43,782	43,782
	SF Total Housecount (1)**	257,578	260,513	261,317	262,123	262,929	264,240	265,550	266,759	268,069	269,379	270,689	272,100	273,410	274,821	276,131	277,492	278,852	280,213	281,573	282,934	284,294	285,655	287,015	288,376	288,376
	MF Housecount (1)	140,272	140,882	143,104	145,241	147,379	149,516	151,654	153,689	155,827	157,964	159,796	161,628	163,460	165,292	167,124	168,956	170,788	172,620	174,453	176,285	178,117	179,949	181,781	183,613	183,613
	Montgomery County Total Housecount (1)	397,850	401,395	404,421	407,365	410,308	413,756	417,203	420,448	423,896	427,343	430,485	433,728	436,871	440,113	443,256	446,448	449,641	452,833	456,026	459,218	462,411	465,604	468,796	471,989	471,989
	Employment (NR proxy) (1)	549,300	555,100	560,900	566,700	572,500	578,900	585,300	591,700	598,100	604,500	609,100	613,600	618,200	622,800	627,400	631,950	636,500	641,050	645,600	650,150	654,700	659,250	663,800	668,350	668,350
	Total County Managed Waste CY2021 (Tons) (2)(3)	910,928	988,658	991,528	994,398	997,268	1,000,138	1,003,008	1,005,878	1,008,748	1,011,618	1,014,488	1,017,358	1,020,228	1,023,098	1,025,968	1,028,838	1,031,708	1,034,578	1,037,448	1,040,318	1,043,188	1,046,058	1,048,928	1,051,798	1,054,668
Non Recyclable Paper	Generation (tons/yr)	37,002	40,159	40,276	40,392	40,509	40,625	40,742	40,859	40,975	41,092	41,208	41,325	41,441	41,558	41,675	41,791	41,908	42,024	42,141	42,257	42,374	42,491	42,607	42,724	42,840
	Low Scenario (tons/yr)			1,669	1,750	1,832	1,913	1,995	2,076	2,158	2,240	2,321	2,403	2,485	2,567	2,649	2,731	2,813	2,895	2,977	3,060	3,142	3,225	3,307	3,390	3,472
	Medium Scenario (tons/yr)			1,877	2,217	2,559	2,902	3,246	3,593	3,940	4,289	4,639	4,991	5,343	5,698	6,054	6,411	6,769	7,129	7,490	7,853	8,217	8,582	8,949	9,317	9,687
	High Scenario (tons/yr)			769	1,227	2,875	3,754	4,638	5,527	6,422	7,321	8,225	9,134	10,048	10,967	11,891	12,820	13,753	14,692	15,636	16,585	17,538	18,497	19,461	20,429	21,403
	Percent Capture - Low Scenario (%)			4.14%	4.33%	4.52%	4.71%	4.90%	5.08%	5.27%	5.45%	5.63%	5.82%	6.00%	6.18%	6.36%	6.53%	6.71%	6.89%	7.07%	7.24%	7.42%	7.59%	7.76%	7.93%	8.10%
	Percent Capture - Medium Scenario (%)			4.66%	5.49%	6.32%	7.14%	7.97%	8.79%	9.62%	10.44%	11.26%	12.08%	12.89%	13.71%	14.53%	15.34%	16.15%	16.96%	17.77%	18.58%	19.39%	20.20%	21.00%	21.81%	22.61%
	Percent Capture - High Scenario (%)			1.91%	3.04%	7.10%	9.24%	11.38%	13.53%	15.67%	17.82%	19.96%	22.10%	24.25%	26.39%	28.53%	30.68%	32.82%	34.96%	37.10%	39.25%	41.39%	43.53%	45.67%	47.82%	49.96%
Manure	Generation (tons/yr)	4,386	4,760	4,774	4,787	4,801	4,815	4,829	4,843	4,857	4,870	4,884	4,898	4,912	4,926	4,939	4,953	4,967	4,981	4,995	5,009	5,022	5,036	5,050	5,064	5,078
	Capture (tons/yr): Assume 100% Maintained	4,386	4,760	4,774	4,787	4,801	4,815	4,829	4,843	4,857	4,870	4,884	4,898	4,912	4,926	4,939	4,953	4,967	4,981	4,995	5,009	5,022	5,036	5,050	5,064	5,078
	Percent Capture (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Yard Trim	Generation (tons/yr)	204,293	221,725	222,369	223,013	223,656	224,300	224,944	225,587	226,231	226,875	227,518	228,162	228,806	229,449	230,093	230,737	231,380	232,024	232,668	233,311	233,955	234,599	235,242	235,886	236,529
	Capture (tons/yr): Assume 90% maintained	181,588	199,553	200,132	200,711	201,291	201,870	202,449	203,029	203,608	204,187	204,766	205,346	205,925	206,504	207,084	207,663	208,242	208,822	209,401	209,980	210,559	211,139	211,718	212,297	212,877
	Percent Capture (%)	89%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Animal Protein	Generation (tons/yr)	697	756	758	761	763	765	767	769	772	774	776	778	780	783	785	787	789	791	794	796	798	800	802	805	807
	Capture (tons/yr): Assumed 100% maintained	697	756	758	761	763	765	767	769	772	774	776	778	780	783	785	787	789	791	794	796	798	800	802	805	807
	Percent Capture (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Sources:

(1) "Housecount Data CY for ML." Montgomery County. 04/21/2023. Housecount and employment data extrapolated from County projections for 2041-2045.

(2) "CY2021CaptureModel." Montgomery County. 5/16/2022. Waste categories and CY21 tons.

(3) "CY22 MRA Workbook" MMS. 08/17/2023. CY22 Total County-Managed MSW Only.

APPENDIX A4 - Organic Waste Capture, Decentralized and Non-County Managed Food Scrap

	Year	2021	2022	2023	2024	**2025**	2026	2027	2028	2029	**2030**	2031	2032	2033	2034	**2035**	2036	2037	2038	2039	**2040**	2041	2042	2043	2044	**2045**
Projection Basis	**SFA Housecount (1)**	92,418	93,478	92,615	92,901	**93,186**	93,651	94,115	94,544	95,008	**95,472**	95,937	96,437	96,901	97,401	**97,865**	98,348	98,830	99,312	99,794	**100,276**	100,759	101,241	101,723	102,205	**102,205**
	SFB Housecount (1)	126,315	127,674	129,028	129,426	**129,824**	130,471	131,118	131,715	132,362	**133,009**	133,656	134,352	134,999	135,696	**136,343**	137,014	137,686	138,358	139,030	**139,702**	140,373	141,045	141,717	142,389	**142,389**
	SFM Housecount (1)	38,845	39,361	39,674	39,796	**39,919**	40,118	40,317	40,500	40,699	**40,898**	41,097	41,311	41,510	41,724	**41,923**	42,130	42,336	42,543	42,749	**42,956**	43,162	43,369	43,576	43,782	**43,782**
	SF Total Housecount (1)**	257,578	260,513	261,317	262,123	**262,929**	264,240	265,550	266,759	268,069	**269,379**	270,689	272,100	273,410	274,821	**276,131**	277,492	278,852	280,213	281,573	**282,934**	284,294	285,655	287,015	288,376	**288,376**
	MF Housecount (1)	140,272	140,882	143,104	145,241	**147,379**	149,516	151,654	153,689	155,827	**157,964**	159,796	161,628	163,460	165,292	**167,124**	168,956	170,788	172,620	174,453	**176,285**	178,117	179,949	181,781	183,613	**183,613**
	Montgomery County Total Housecount (1)	397,850	401,395	404,421	407,365	**410,308**	413,756	417,203	420,448	423,896	**427,343**	430,485	433,728	436,871	440,113	**443,256**	446,448	449,641	452,833	456,026	**459,218**	462,411	465,604	468,796	471,989	**471,989**
	Employment (NR proxy) (1)	549,300	555,100	560,900	566,700	**572,500**	578,900	585,300	591,700	598,100	**604,500**	609,100	613,600	618,200	622,800	**627,400**	631,950	636,500	641,050	645,600	**650,150**	654,700	659,250	663,800	668,350	**668,350**
	Total County Managed Waste CY2021 (Tons) (2)	**910,928**	**988,658**	**991,528**	**994,398**	**997,268**	**1,000,138**	**1,003,008**	**1,005,878**	**1,008,748**	**1,011,618**	**1,014,488**	**1,017,358**	**1,020,228**	**1,023,098**	**1,025,968**	**1,028,838**	**1,031,708**	**1,034,578**	**1,037,448**	**1,040,318**	**1,043,188**	**1,046,058**	**1,048,928**	**1,051,798**	**1,054,668**
Backyard	Low Scenario (tons/yr): Assume 5.0 lbs captured for household per week			1,699	1,704	**1,709**	1,718	1,726	1,734	1,742	**1,751**	1,759	1,769	1,777	1,786	**1,795**	1,804	1,813	1,821	1,830	**1,839**	1,848	1,857	1,866	1,874	**1,874**
	Medium Scenario (tons/yr): Assume 6.75 lbs captured for household per week			2,293	2,760	**3,230**	3,710	4,194	4,682	4,705	**4,728**	4,751	4,775	4,798	4,823	**4,846**	4,870	4,894	4,918	4,942	**4,965**	4,989	5,013	5,037	5,061	**5,061**
	High Scenario (tons/yr): Assume 8.5 lbs captured for household per week			2,888	4,055	**5,230**	6,424	7,629	8,843	8,886	**8,930**	8,973	9,020	9,064	9,110	**9,154**	9,199	9,244	9,289	9,334	**9,379**	9,424	9,469	9,515	9,560	**9,560**
Community	Low Scenario (tons/yr): Assume 5 composting sites			40	40	**41**	41	41	41	42	**42**	42	43	43	43	**44**	44	44	44	44	**45**	45	45	45	45	**46**
	Medium Scenario (tons/yr): Assume 15 composting sites			120	121	**122**	123	123	124	125	**126**	127	128	129	130	**131**	131	132	133	133	**134**	134	134	134	134	**137**
	High Scenario (tons/yr): Assume 30 composting sites			240	242	**243**	245	247	249	251	**252**	254	256	258	259	**261**	262	264	265	266	**268**	268	268	268	268	**274**
On Farm	Low Scenario (tons/yr): Assume on-farm production is 0.01 tons per acre per month					**425**	425	425	425	425	**425**	425	425	425	425	**425**	425	425	425	425	**425**	425	425	425	425	**425**
	Medium Scenario (tons/yr): Assume on-farm production is 0.05 tons per acre per month					**2,124**	2,124	2,124	2,124	2,124	**2,124**	2,124	2,124	2,124	2,124	**2,124**	2,124	2,124	2,124	2,124	**2,124**	2,124	2,124	2,124	2,124	**2,124**
	High Scenario (tons/yr): Assume on-farm production is 0.07 tons per acre per month					**2,974**	2,974	2,974	2,974	2,974	**2,974**	2,974	2,974	2,974	2,974	**2,974**	2,974	2,974	2,974	2,974	**2,974**	2,974	2,974	2,974	2,974	**2,974**
Private	Low Scenario (tons/yr): Assume annual growth of 4%		2,500	2,569	2,672	**2,779**	2,890	3,006	3,126	3,251	**3,381**	3,516	3,657	3,803	3,955	**4,114**	4,278	4,449	4,627	4,812	**5,005**	5,205	5,413	5,630	5,855	**6,089**
	Medium Scenario (tons/yr): Assume annual growth of 6%		2,500	2,619	2,776	**2,943**	3,119	3,306	3,505	3,715	**3,938**	4,174	4,424	4,690	4,971	**5,270**	5,586	5,921	6,276	6,653	**7,052**	7,475	7,924	8,399	8,903	**9,437**
	High Scenario (tons/yr): Assume annual growth of 8%		2,500	2,668	2,882	**3,112**	3,361	3,630	3,921	4,234	**4,573**	4,939	5,334	5,761	6,221	**6,719**	7,257	7,837	8,464	9,141	**9,873**	10,662	11,515	12,437	13,431	**14,506**

Sources:

(1) "Housecount Data CY for ML" provided by the county 04/21/2023. Housecount and employment data extrapolated from County projections for 2041-2045.

(2) Waste categories and CY21 tons from CY2021CaptureModel, Montgomery County, 5/16/2022.

Notes:

(1) Backyard composting scenarios assume participation only by Single-family households.

Appendix B:

Current County Food Scrap Diversion Efforts

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DEPARTMENT OF
ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND

Food Scraps Programs and Initiatives

April 2023

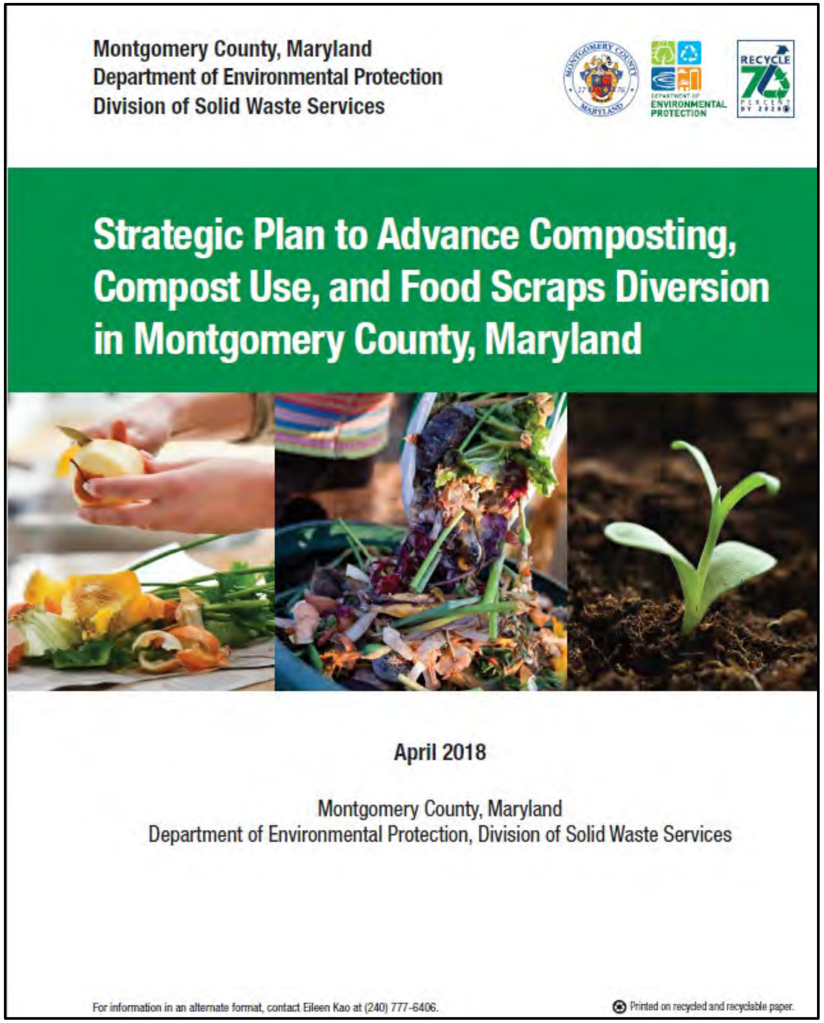
Food Scraps
The Next Opportunity

DEPARTMENT OF ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND

- **Recycling food scraps provides our next greatest opportunity to reduce waste and recycle more**
- **Important part of the County's waste diversion and recycling efforts, aiming towards zero waste**
- **Important element in fighting climate change**

Implementation of The Strategic Plan

DEPARTMENT OF ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND


Montgomery County, Maryland
Department of Environmental Protection
Division of Solid Waste Services

Strategic Plan to Advance Composting, Compost Use, and Food Scraps Diversion in Montgomery County, Maryland

April 2018

Montgomery County, Maryland
Department of Environmental Protection, Division of Solid Waste Services

For information in an alternate format, contact Eileen Kao at (240) 777-6406.

Printed on recycled and recyclable paper.

- Reducing Wasted Food/Channeling Food to Others
- In-Home, Backyard, and Community-Scale Composting
- On-Site Institutional and On-Site Business Composting
- On-Farm Composting
- Composting Capacity to Serve Montgomery County
- Strategies to Maximize Food Scraps Collection at the Curb

Reducing Wasted Food & Channeling Food to Others

DEPARTMENT OF ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND

Reducing Wasted Food

DEPARTMENT OF ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND

- Developed additional outreach and educational materials to reduce wasted food
  - Brochure
  - Magnet

- Expanded education and training opportunities to include:
  - More mindful purchasing;
  - Meal preparation tips;
  - Food storage recommendations; etc.

- Translated information into Spanish, Mandarin and French

Reducing Wasted Food & Channeling Food to Others

DEPARTMENT OF ENVIRONMENTAL PROTECTION
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Developed/Updated Educational Materials

Food is Too Good to Waste Education Campaign

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Food is Too Good to Waste Education Campaign

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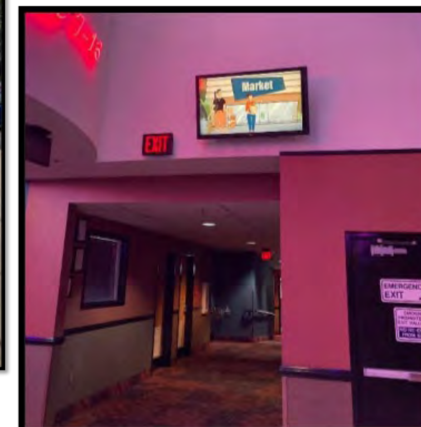
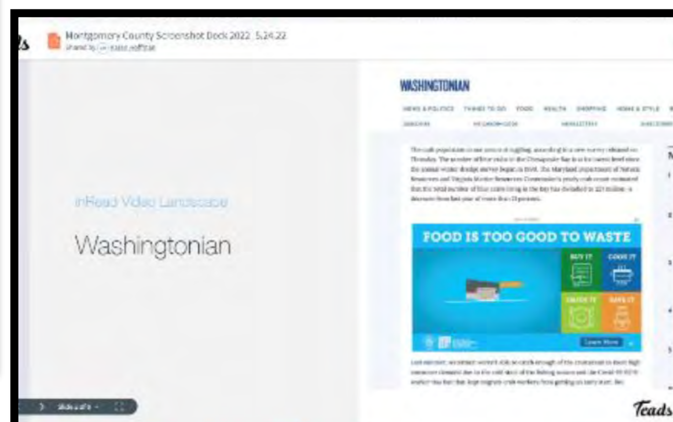
- Cable television
- Streaming radio
- Bus advertising
- Bike kiosks
- Mobile
- Social media
- Web streaming
- Chamber of Commerce websites
- Cinema
- Insert in weekly Food Section of *The Washington Post*





Food Waste Prevention Week

DEPARTMENT OF ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND

- Increase community awareness regarding the amount of food waste generated and how to take action to reduce wasted food at home, work and school
- Dedicated national Food Waste Prevention Week from April 10-16, 2023
- DEP/RRMD is a registered Food Waste Prevention Week Partner
- Broad-based multi-media educational campaign with heightened level of focus during Food Waste Prevention Week
- Daily social media posts during week
- Focused multi-lingual outreach at three shopping centers providing information in English, Spanish and Mandarin

Reducing Wasted Food & Channeling Food to Others

DEPARTMENT OF ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND

- Increase Awareness of Reducing Wasted Food and Food Donations
  - Educational Materials
    - Tips to Reduce Wasted Food by Business Type
    - Update information in existing educational materials
  - Broad-Based Awareness Campaign
    - Tips to reduce wasted food
    - Tips to donate and channel food to those in need
  - Seminars and Webinars
    - Presentations
    - Guest speakers/Case Studies
- Review current efforts undertaken by businesses and organizations and multi-family properties to identify and encourage best practices

Edible Food Recovery

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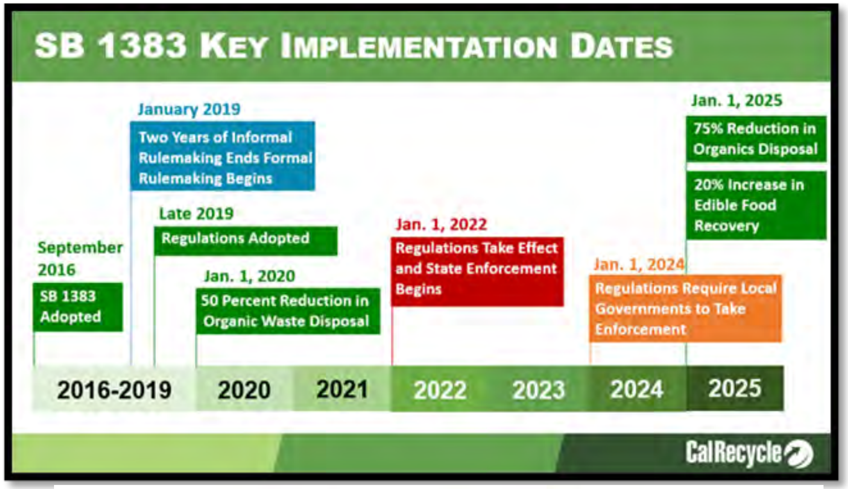
- Channel edible food in excess of generators' needs to others with unmet needs

- Increase donation of edible food to organizations that distribute/provide food to community members experiencing food insecurity

- Created/convened Working Group of County agencies and community partners to develop recommendations

Edible Food Recovery



- Reviewed edible food recovery aspects of California SB 1383
- Benchmarked edible food recovery requirements in other states
- Work to define what makes sense for Montgomery County
- Developing policy recommendations to present to County Executive

Backyard Composting of Food Scraps

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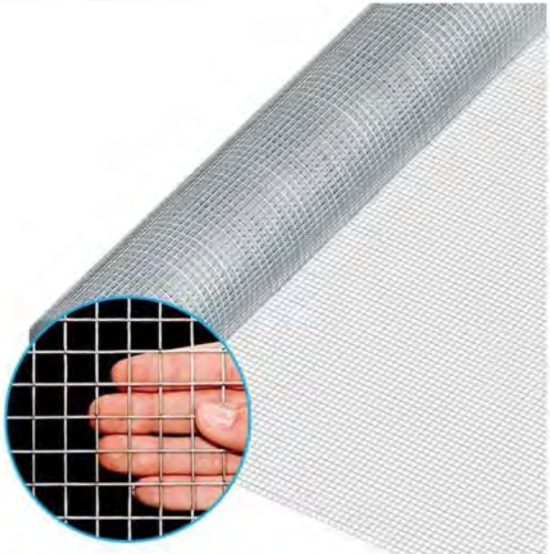

Backyard Composting of Food Scraps

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Test a variety of backyard compost bins designed to include certain types of food scraps for composting:

- ~ 1,000 resident volunteers
- Developed educational materials, including best management practices
- Conduct virtual training workshops
- Provide backyard compost bins and educational materials/resources to resident volunteers
- Monitor and provide troubleshooting techniques
- Use data and feedback to build program
- Additional survey tool to obtain feedback from residents

Commercial Food Scraps Recycling Partnership Program

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Commercial Food Scraps Recycling Partnership Program

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Program Objectives:

Facilitate & increase food scraps recycling by generators, collectors, and processors; and document and demonstrate these efforts through measurement, feedback, and data.

Program Status:

- **34 partners have participated or currently are in the Program**
- **1 drop out (for specific reason)**
- **6 on deck for future start dates**
- **All graduates continue recycling their food scraps**

Commercial Food Scraps Recycling Partnership Program

DEPARTMENT OF ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND

Program Highlights

- Technical assistance
- Educational materials
- Staff training
- Food scraps recycling containers and compostable bags
- Food scraps recycling collection service
- Food scraps recycling processing
- Tracking amounts of food scraps recycled

Commercial Food Scraps Recycling Partnership Program

DEPARTMENT OF ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND

Updated and Developed Educational Materials

- Educational Materials
  - Brochures
  - Posters
  - Labels
  - Manuals
  - Videos

Commercial Food Scraps Recycling Partnership Program

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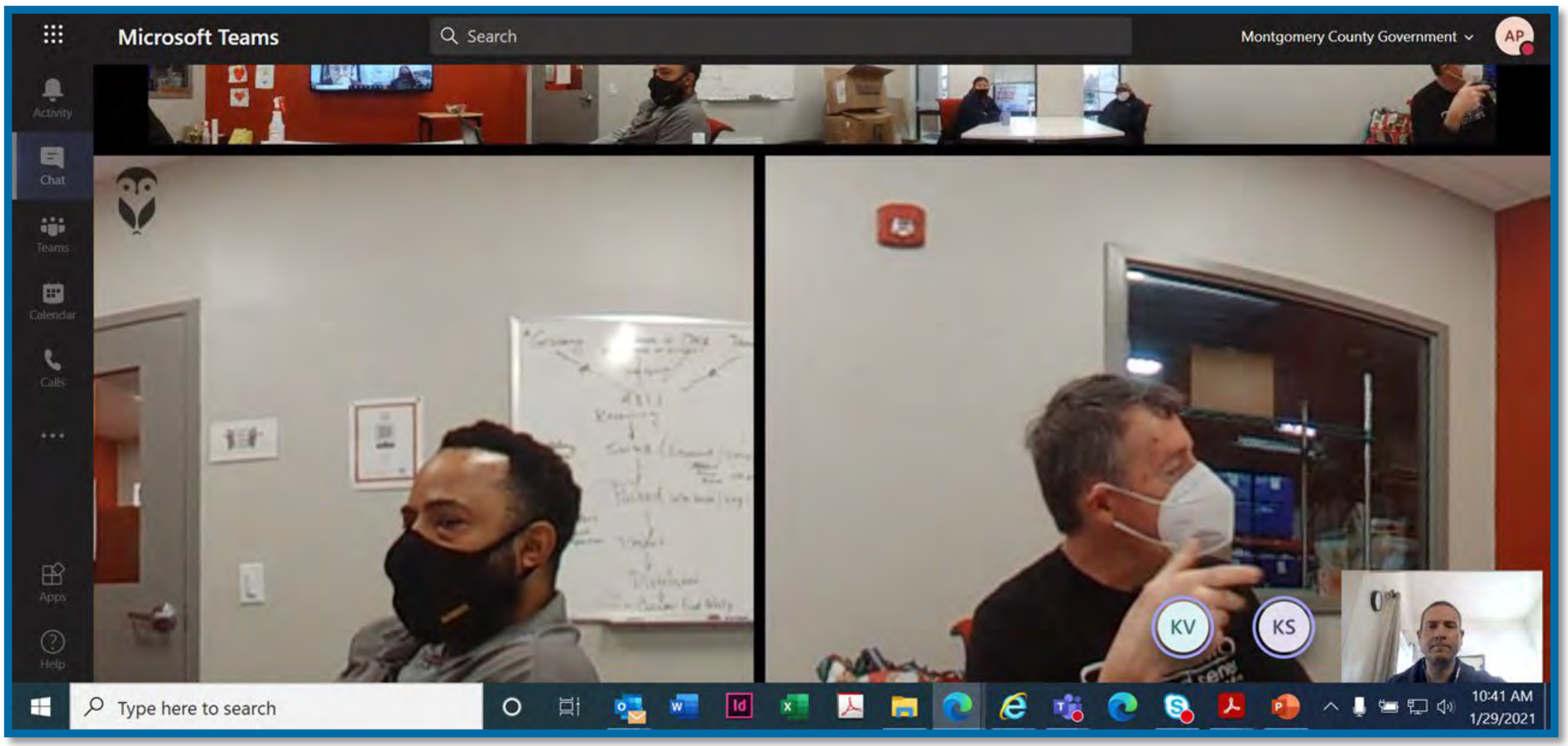
Tools and Resources for Partners

- Training
  - On-site or virtual training opportunities
  - Bi-lingual as needed



Single-Family Curbside Collection of Food Scraps

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Single-Family Curbside Collection of Food Scraps

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Phase I: Single-Family Curbside Food Scraps Recycling Pilot

- Maximum 1,700 total volunteer households in 2 pilot areas
  - 701 homes in area of Silver Spring in Subdistrict A
  - 348 homes in area of Potomac in Subdistrict B
- Weekly pickup
- Each household testing:
  - 35-gallon wheeled cart with locking lid
  - 2-gallon in-kitchen container
  - Compostable liners for in-kitchen container
  - Instructional & education materials

Single-Family Curbside Collection of Food Scraps

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Monitoring and Evaluations

- Participation/set out rates
- Pounds of food scraps set-out by each household each collection
- Scale house tickets
- Total tonnages by area
- Contamination issues

Feedback and Assessment

- Participant surveys (3-month, 6-month, 1-year)
- Focus Group research (1-year)

Pilot experience, data and feedback will inform planning for future countywide program

Single-Family Curbside Collection of Food Scraps

DEPARTMENT OF ENVIRONMENTAL PROTECTION
MONTGOMERY COUNTY • MARYLAND

Phase II: Single-Family Curbside Food Scraps Recycling Pilot

- Maximum 1,700 total volunteer households in 2 additional pilot areas
  - Area of Bethesda in Subdistrict A
  - Area of Montgomery Village/Gaithersburg in Subdistrict B
- Currently have 324 households registered in Bethesda
- Collection began March 27
- Currently have 139 households registered in Montgomery Village/Gaithersburg

Single-Family Curbside Collection of Food Scraps

DEPARTMENT OF ENVIRONMENTAL PROTECTION
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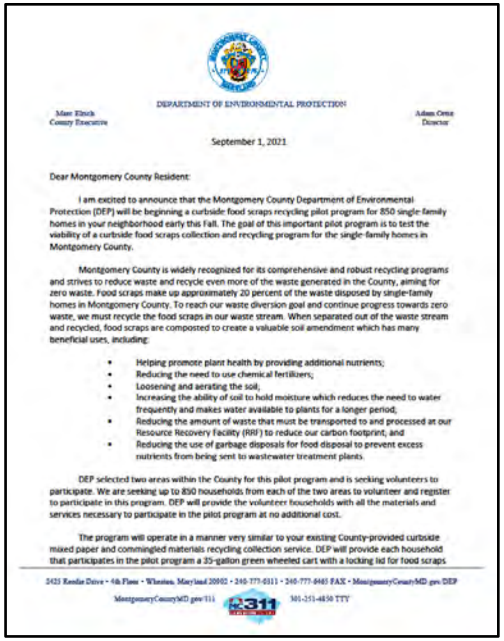
Phase II: Single-Family Curbside Food Scraps Recycling Pilot

- Recruiting volunteer households that have never separated food scraps for recycling collection before in each of 2 areas
- Conducting targeted outreach to raise awareness and solicit participation
    - Letter from RRMD
    - Doorhangers
    - Outreach via any HOA's or Civic Associations within areas
    - Outreach by staff in the communities



DEPARTMENT OF ENVIRONMENTAL PROTECTION

Marc Elrich
County Executive

Adam Ortiz
Director

September 1, 2021

Dear Montgomery County Resident:

I am excited to announce that the Montgomery County Department of Environmental Protection (DEP) will be beginning a curbside food scraps recycling pilot program for 850 single-family homes in your neighborhood early this Fall. The goal of this important pilot program is to test the viability of a curbside food scraps collection and recycling program for the single-family homes in Montgomery County.

Montgomery County is widely recognized for its comprehensive and robust recycling programs and strives to reduce waste and recycle even more of the waste generated in the County, aiming for zero waste. Food scraps make up approximately 20 percent of the waste disposed by single-family homes in Montgomery County. To reach our waste diversion goal and continue progress towards zero waste, we must recycle the food scraps in our waste stream. When separated out of the waste stream and recycled, food scraps are composted to create a valuable soil amendment which has many beneficial uses, including:

- Helping promote plant health by providing additional nutrients;
- Reducing the need to use chemical fertilizers;
- Loosening and aerating the soil;
- Increasing the ability of soil to hold moisture which reduces the need to water frequently and makes water available to plants for a longer period;
- Reducing the amount of waste that must be transported to and processed at our Resource Recovery Facility (RRF) to reduce our carbon footprint; and
- Reducing the use of garbage disposals for food disposal to prevent excess nutrients from being sent to wastewater treatment plants.

DEP selected two areas within the County for this pilot program and is seeking volunteers to participate. We are seeking up to 850 households from each of the two areas to volunteer and register to participate in this program. DEP will provide the volunteer households with all the materials and services necessary to participate in the pilot program at no additional cost.

The program will operate in a manner very similar to your existing County-provided curbside mixed paper and commingled materials recycling collection service. DEP will provide each household that participates in the pilot program a 35-gallon green wheeled cart with a locking lid for food scraps

2425 Reedie Drive • 4th Floor • Wheaton, Maryland 20902 • 240-777-0311 • 240-777-0403 FAX • MontgomeryCountyMD.gov/DEP

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Questions?

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Appendix C:

Single-Family Survey

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Public Participation Assessment

Background:

As part of the feasibility study, the EA Team conducted a brief, online survey to:

- Help inform high capture tonnage projections for forecasting the adoption of food scraps and food waste diversion practices among single-family households. The aim was to develop a more realistic understanding of the rate at which households might embrace diversion approaches. This involved assessing the current and potential engagement of residents in various food scraps and food waste diversion approaches.

The survey targeted residents living in single-family houses, townhouses, or small apartment buildings with six or fewer units (collectively referred to as SFH population).[1] The survey gathered insights and perceptions about food waste diversion approaches such as curbside food scraps collection, food scraps drop-off stations, backyard composting, and edible food donation to food banks and shelters. Qualitative input from this survey complemented the EA Team's quantitative data that is the foundation for forecasting tonnage projections. Asking residents about their current habits to reduce and divert food waste and their likelihood to adopt new behaviors provided the EA Team information on emerging trends not present in historical data. Survey findings were incorporated into the EA Team's food waste management scenario projections.

Methodology:

<u>Survey Development Process</u>

The EA Team met with MES and Montgomery County staff to review and confirm project goals and obtain relevant materials and resources to review prior to developing the survey. In this meeting, MES and Montgomery County staff shared information about the extensive work the Recycling Resource Management Division (RRMD) has conducted on initiatives to reduce food waste and support food scraps recycling in residential and business settings. The EA Team reviewed several RRMD products (e.g., food scraps recycling presentation, webinar, County-wide waste survey, reports) and met with the RRMD team to learn more about past, current, and upcoming food scraps and food waste recycling initiatives. After reviewing this input and the team's experience developing similar surveys in other municipalities, the EA Team created a brief survey that explored residents' current habits regarding food scraps and food waste, and their level of interest in a variety of different approaches to reduce and divert food waste from trash (see Appendix C-1). The EA Team, MES and Montgomery County staff agreed that to maximize response for a voluntary survey, it was important to keep the survey short. Once the survey was finalized by the County and EA Team, the County translated the survey into

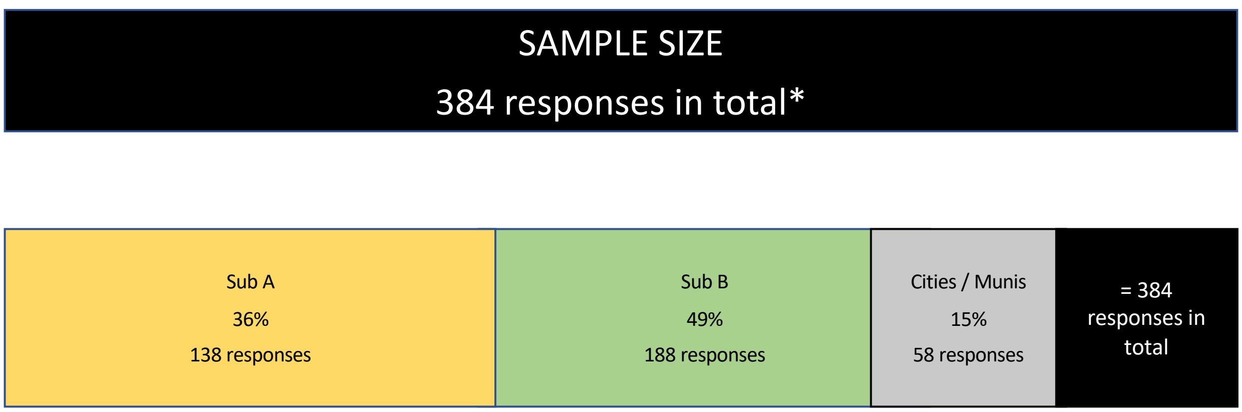
[1] Montgomery County chose not to deploy surveys to multi-family owners/operators and business and institution managers.

Spanish. Shareable links to both the English and Spanish survey were included in County communications to residents, giving them the option to respond to either one.

Sample Sizes for Target Populations

The EA Team calculated smaller target sample sizes which enabled us to gather data efficiently while meeting the budget and time requirements of the project. The Team determined the appropriate sample sizes (i.e., completed survey responses) for four target populations of interest for the County: 1) total survey responses, 2) responses from municipalities, 3) responses from Subdistrict A, and 4) responses from Subdistrict B. Chart 1-1 shows the sample sizes, which were determined based on a 95% confidence level and a 5% margin of error.

Chart 1-1. Desired Sample Sizes for Study's Populations of Interest



* Sample size is based on total SFH with less than or equal to six units in Subdistrict A, Subdistrict B, Cities/Municipalities from CY 2022

Because County-provided background reports (see bulleted list below) for each target population were zip code based, the EA Team matched survey respondents with their respective target populations using the zip codes they provided in response to a survey question. This match was done using the following County-provided sources:

- GIS map of County zip codes
- Zip code information from a table listed in the 'Comprehensive Solid Waste Management Plan 2020-2029' (Table 3.4 Materials Management in Incorporated Cities and Municipalities)
- Detailed County map illustrating distinct regions for each municipality, Subdistrict A, and Subdistrict B; and House Count Data from 2022

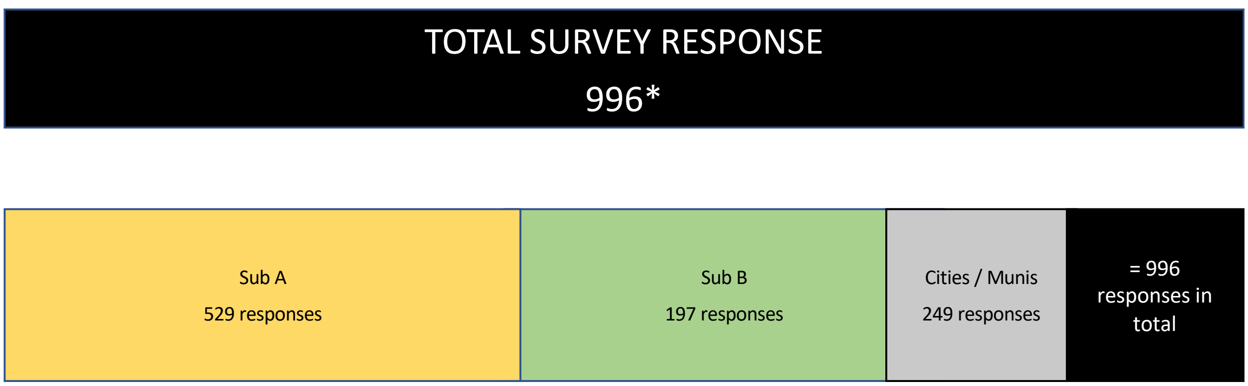
By tracking the zip codes of incoming survey respondents, the EA Team was able to monitor at what point the survey had reached the target sample size for each population.

Survey Distribution

The surveys were distributed by the County via multiple channels through messages that included a shareable link sending respondents to the SurveyMonkey platform. The EA Team developed content to support promoting the survey in email, newsletters, social media, and other distribution channels. DEP's Partnership and Engagement Program Manager distributed the survey link and QR code to multiple email lists and networks over the course of four weeks, June 8 through July 6, 2023. For a more comprehensive list of the promotion channels, see Appendix C-2.

To increase responses in particular regions when numbers were lower than in other areas, the County's Partnership and Engagement Program Manager targeted outreach to those areas. In this way, additional outreach assisted in achieving the desired sample size for all areas. Once the sample sizes were reached, the EA Team closed the survey (see Chart 1-2).

Chart 1-2. Sample Sizes Reached for Each Target Population



* Sample size is based on total SFH with less than or equal to six units in Subdistrict A, Subdistrict B, Cities/Municipalities from CY 2022

Data Limitations

It is important to note that while small sample sizes have limitations, they can still be appropriate and informative in certain contexts, such as for this forecasting tonnage projections study. As discussed with MES and the County, with a small sample size and a shareable link survey, however, it becomes difficult to perform statistically significant, meaningful analysis on subgroups within the sample (i.e., by race, income, language, etc.). Subgroup analyses with a small sample and a shareable link survey size lack statistical power and result in unreliable conclusions. Therefore, the EA Team cautions against generalizing survey subgroup findings to the broader County population.

Results and Analysis

Listed below are highlights of survey results:

- In total, 996 residents responded to the survey (992 took the English survey and four residents took the Spanish survey).
- Over 90% respondents agreed that getting edible food waste and food scraps out of the waste stream is the right thing to do for the environment.
- There was strong support for the idea of participating in a County-sponsored curbside collection program. Fewer than 10% of residents said they would *not* participate, except for Subdistrict B respondents, where that number was higher (18% of residents).
- Responses to questions were frequently similar across all target populations.

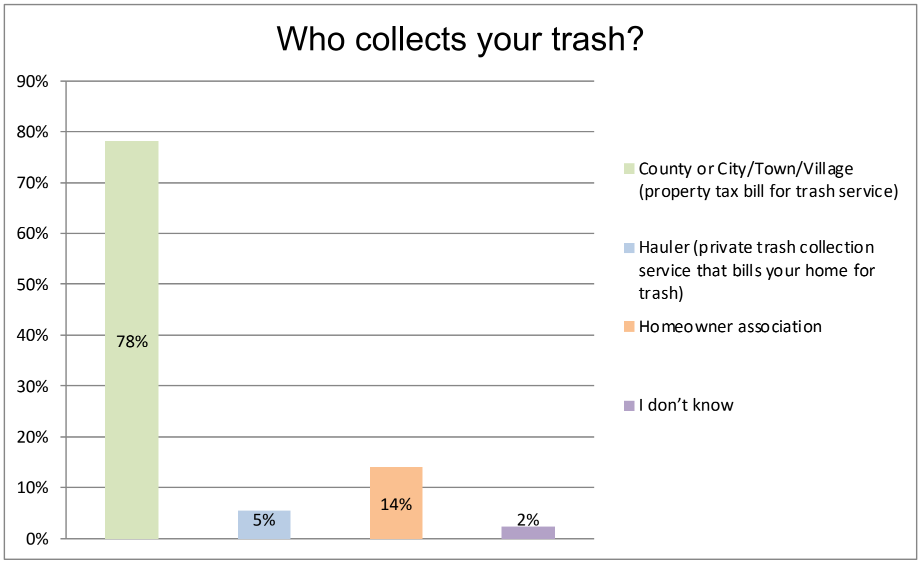
The intent of the resident survey was to gather information about residents' attitudes and behaviors regarding food waste and food scraps management to help inform tonnage projections. It assessed current practices and gauged interest in potential programs like curbside food scraps collection or backyard food scraps composting. The survey aimed to understand residents' concerns and level of agreement with making food scraps separation and collection mandatory. Additionally, the survey determined the frequency of food donations to shelters or food banks and the likelihood of residents using nearby drop-off locations for such donations if available.

Responses to all survey questions and respondents' demographic data are provided in Appendix C-3. Survey comments are provided in Appendix C-4. Below are responses and a brief analysis of the questions that most pertain to the tonnage projections.

<u>Residential Trash Collection</u>

78% of survey participants' trash is collected by the County or a City, Town or Village (see Chart 1-3).

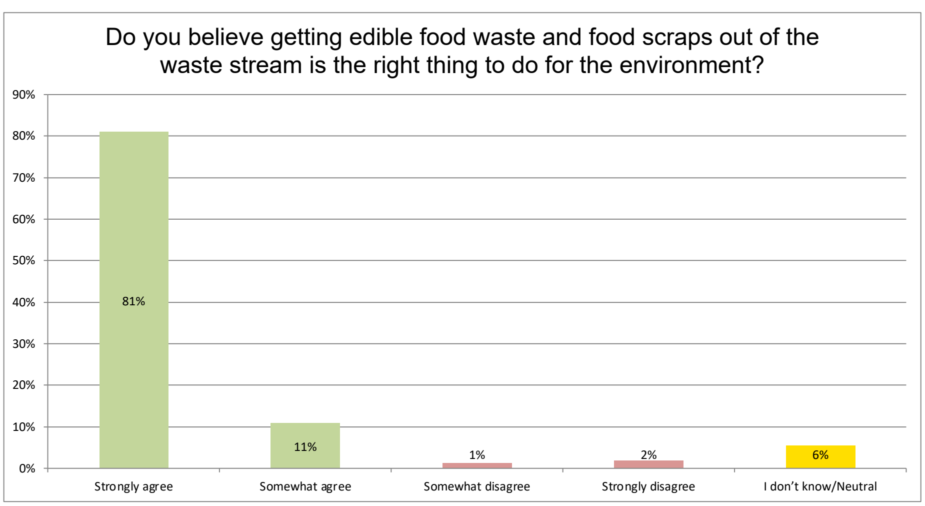
Chart 1-3. Majority of Respondents Indicate Their Trash is Collected by the County, or a City, Town or Village.



Diverting Food Scraps and Food Waste from Waste Stream

Over 90% of respondents agreed that getting edible food waste and food scraps out of the waste stream is the right thing to do for the environment (Chart 1-4). This aligns with other waste management studies conducted by the County, including the Montgomery County 'Aiming for Zero Waste Plan Baseline Survey Summary'. Many County residents have said in surveys they place value on "doing the right thing" for the natural environment.

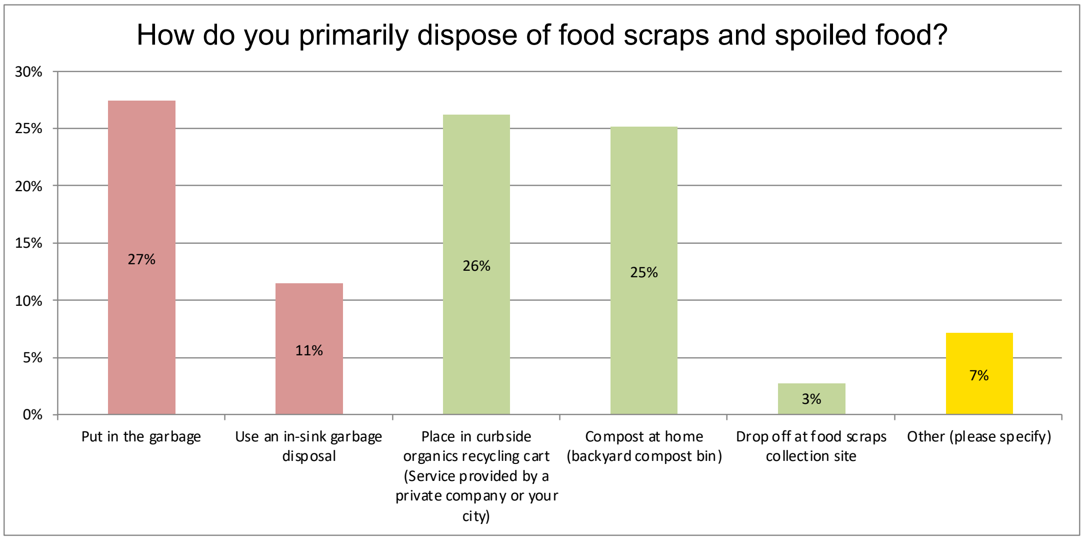
Chart 1-4. High Level of Support for Diverting Food Scraps and Food Waste from Waste Stream



Current Habits for Food Waste Disposal

More than 50% of survey respondents reported they backyard compost, use a private collection service (e.g., Compost Crew), or drop off food scraps at a collection site (see Chart 1-5).

Chart 1-5. Survey Respondents Included Current Composters and Non-Composters



Many of the respondents who selected the option ‘other’ used the comments field to describe their approach to food scraps and spoiled food disposal. The majority of commenters already do some type of composting. Some respondents said they only compost fruits and vegetables; others said they use grocery store drop-off sites such as at Mom’s Organics or Whole Foods; and, others drop off food scraps at a farmer’s market during the summer. Other comments described the use of food planning strategies to minimize waste. Comments also revealed topics that could be addressed in awareness and education materials. Some respondents noted they use the garbage disposal for food scraps to “keep it out of the landfill,” which can be an issue for public utility pipes. Another stated that they have no food waste because “they eat everything.”

Responses to this question reveal an opportunity for the County to deploy outreach/education to help all residents understand the definition of food scraps and edible food waste. Educating on the compost process, as well as on what constitutes edible food waste (leftovers) versus food scraps (e.g., banana peels, orange rinds, coffee grounds, etc.) would likely broaden participation in currently available composting programs and prepare residents for a future County-wide program.

Curbside Food Scraps Collection

In general, there was strong support for the idea of participating in a County-sponsored curbside food scraps collection program. This is evident in that fewer than 10% of residents said they would not participate, except for Subdistrict B respondents, where the number who indicated they would not participate was higher (18%). Nonetheless, more than half of Subdistrict B respondents indicated they would participate in a County-wide program.

Of the total responses for Subdistrict B, 29% answered 'no' or 'I don't know' in response to the prompt asking if they would participate in a voluntary curbside collection program (Table 1-1). Subdistrict B residents' interest could be explored further to better understand their perceived barriers. This could be done through focus groups or in-person surveying at highly frequented venues such as libraries, local coffee shops, kids' sporting events, and community events.

Table 1-1. Willingness to Participate in a Curbside Food Scraps Collection Program If Offered[2]

Q8		Subdistrict A	Subdistrict B	Municipalities	All Respondents
If the County offered curbside food scraps collection, would you participate? You would separate food scraps from your garbage and place them in a curbside bin for pick up.	Yes	83%	58%	74%	82%
	No	5%	18%	9%	10%
	I don't know	7%	11%	8%	9%

For residents who stated they would not or were unsure if they would participate in a curbside food scraps collection program, the survey included a follow up question exploring their concerns. 25% of respondents were concerned about food scraps attracting insects and vermin. In the 'Other' option regarding respondents' apprehension, respondents wrote specific concerns about attracting rats, raccoons, and "having a street filled with 100% food scraps on pick-up day, that will most certainly attract wildlife." Concern about odor was also frequently listed. Additional reasons to not participate that were captured in the comments included:

[2] Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

I don't have the storage space for curbside container

Restaurants should be the ones to do this

Compostable plastic bags are really bad.

Consideration needs to be given to the pollution of trucks for pick up

Still confused about what goes into the current recycling bins. Now you want to add another layer.

As a senior it would not be an easy thing for us to do

It should also be noted, however, that in response to the follow-up question "What are your concerns about participating in a curbside food scraps program?", 55% of the 66 respondents who commented in the 'other' option stated they currently compost and/or like the ability to create and use their own compost in their garden/yard.

80% of participants agreed with a potential proposed mandatory County food scraps separation and curbside collection program (Table 1-2). Like the voluntary curbside food scraps collection question (Table 1-1), fewer Subdistrict B respondents favored this idea. However, this does not mean that Subdistrict B is opposed to a mandatory program. It would be worth investigating this further by asking Subdistrict B residents in focus groups about a mandatory food scraps collection program. Insights from these conversations could help with the development of outreach and education materials if the County were to make curbside food scraps collection mandatory.

Table 1-2. Level of Agreement with a County Mandated Food Scraps Separation and Curbside Collection Program[3]

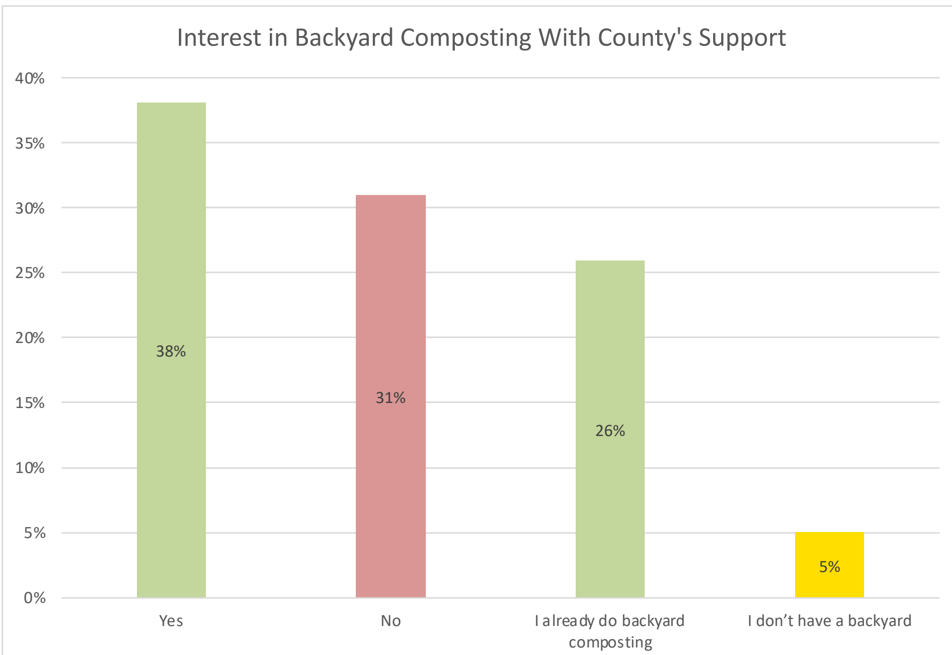
Q10		Subdistrict A	Subdistrict B	Municipalities	All Respondents
The County is considering making food scraps separation and curbside collection mandatory for households. What is your level of agreement with this potential approach?	Strongly agree	59%	34%	55%	57%
	Somewhat agree	21%	23%	19%	23%
	Somewhat disagree	6%	10%	6%	7%
	Strongly disagree	6%	18%	5%	9%
	Don't know/Neutral	3%	3%	6%	4%

[3] Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Backyard Composting

Montgomery County currently has a backyard composting program in place. This survey probed interest in backyard composting for food scraps and yard waste. Close to 40% of 902 respondents expressed interest in participating in backyard composting if the County provided them support (see Chart 1-6). However, 30% of respondents were not interested in backyard composting. While the County currently has a backyard composting program for yard waste, there may be an opportunity to promote it more and provide materials and support on backyard food scraps and yard waste composting.

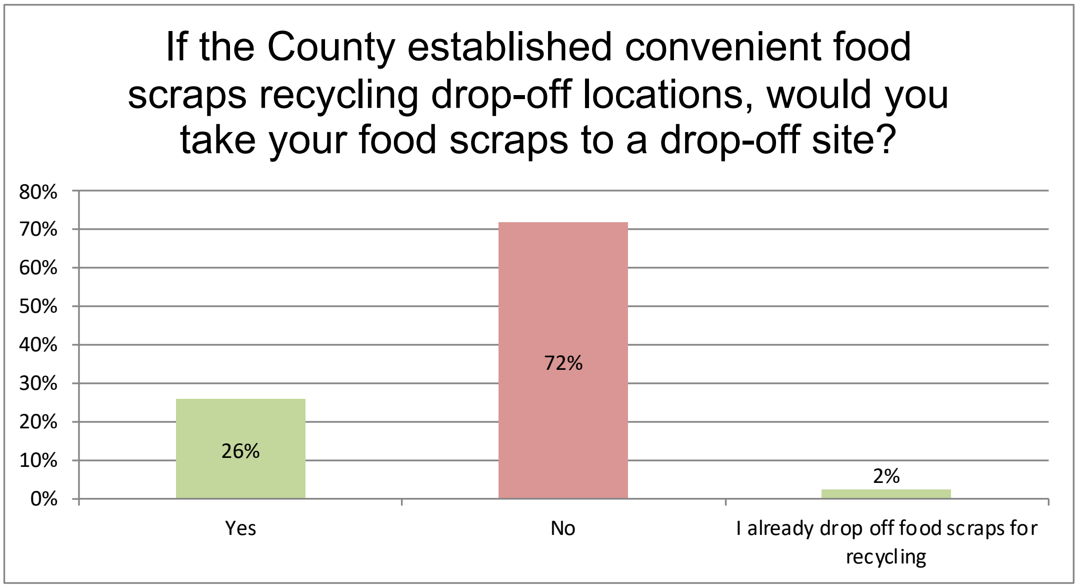
Chart 1-6. Moderate Interest Backyard Composting of Food Scraps and Yard Waste



Drop-off Locations and Donation Centers

Generally, respondents across all sub-groups expressed low interest in dropping off food scraps, even at conveniently located sites (Chart 1-7). This is not surprising as the extra step of transporting food scraps to a drop-off location is a challenge people reference in most communities. However, it should be noted that residents of Takoma Park who use the local food scrap drop off site expressed strong support for this option.

Chart 1-7. Majority of Respondents Are Not Interested in Drop-off Locations



<u>Edible Food Recovery</u>

Currently, 3% of survey respondents donate excess edible food (e.g., to a shelter or local food bank) once a month. 78% either rarely or never donate their excess edible food (see Appendix C-3). It should be noted that when presented with the idea of donating excess edible foods at a nearby drop-off location, 19% of respondents indicated greater interest and that they would donate edible food frequently (once a month).

Recommendations:

Below is a list of recommendations the County may want to consider if it opts to develop a curbside food scraps collection program:

1) **Continue to collect input about a curbside food scraps collection program, particularly among residents in equity emphasis areas and more rural parts of the County.** This does not have to be a costly effort. Asking residents about curbside composting during community events and identifying topics of concern offers an opportunity to informally gauge interest and field questions residents have about a potential program.
2) **Determine if a County curbside food scraps collection program will produce compost available for the community's use.** Residents who currently compost in their backyard or with a private companies said they liked having access to the finished product.
3) **Provide clarity on how this program will co-exist with privately run food scraps collection programs.** Be prepared to respond to questions about how a County food scraps collection program will work with private service offerings such as Compost Crew, Takoma Park food scraps drop off sites, etc. Because people can feel loyal towards their private compost service or comfortable with an established routine, communication will need to address that.

4) **Develop more than one message for building community support.** While much of the County's residents will agree that composting is the right thing to do for the environment, additional messages – such as ones that mention the economic benefits to the County or that local parks and gardens will see improved soil – will appeal to other residents.
5) **Learn more about Takoma Park's drop-off site.** If the County is interested in drop-off sites, the Takoma Park location is one to investigate. Variables such as how much volume is received, percentage of contamination, hours of operation, and frequency of drop-offs can help the County plan additional drop-off sites.

Conclusion

As stated previously, the EA team used survey response data to help inform high capture tonnage projections for the widespread adoption of food scraps and food waste diversion practices among single-family households.

The survey findings demonstrate there is interest in food scraps collection in the County. While a concerted effort was made to reach a variety of audiences using a shareable link survey distributed through County e-newsletters, emails, and social media, many of the respondents either already compost food scraps or are supportive of composting. This might be due to the explosive growth in awareness of composting and in availability of private haulers servicing the County in recent years; or, that those who believe in the value of composting felt compelled to respond to the survey to ensure their voices are heard. As previously stated, due to the small sample size and the shareable link survey method, the County should continue to explore the community's interest in composting while simultaneously raising awareness of the benefits of developing a food scraps program.

As the County explores the optimal approach for food waste diversion through a curbside collection program, it is advisable to maintain an ongoing dialogue with residents to further explore the level of interest in such a program. RRMD could capitalize on current outreach activities (e.g., backyard composting, single-family household food scraps and recycling collection pilot, and promotion of reducing wasted food and edible food recovery) underway by the Waste Recycling and Resource Management Division. RRMD could also engage residents at local events, conduct community conversations, or organize focus groups to expand engagement. This proactive outreach and continued community input will raise awareness about curbside food scraps collection and other diversion approaches. It will also serve to identify potential partners and influential groups throughout the County to support curbside collection program promotion in the future. Sustained community engagement will be invaluable should the County decide to advance a County-wide food scraps collection program, as resident feedback can serve as the foundation for a well-defined strategy that effectively addresses the questions and concerns of many residents.

Appendix C-1.

Montgomery County Survey

We want to hear from our residents!

Montgomery County is a national leader in reducing waste and improving recycling. Together we can go further! Reducing food waste and separating food scraps from the trash is the next greatest opportunity for the County to address its sustainable waste management goals.

We want to hear from residents to help inform policies and programs. The survey should take approximately 10 minutes to complete. Survey responses are anonymous.

Thank you for taking the survey and supporting our County!

Montgomery County Survey

1. Do you live in Montgomery County?

- ◯ Yes
- ◯ No

2. What is your home zip code in Montgomery County? [fill in blank]

3. Do you live in a single-family house, townhouse, or a small apartment building (6 units or less)?

- Yes
- No

4. Who collects your trash?

- ◯ County or City/Town/Village (property tax bill for trash service)
- ◯ Hauler (private trash collection service that bills your home for trash)
- ◯ Homeowner association
- ◯ I don’t know

5. Do you believe getting edible food waste and food scraps out of the waste stream is the right thing to do for the environment?

- Strongly agree
- Somewhat agree
- Somewhat disagree
- Strongly disagree
- I don’t know/Neutral

6. Do you practice any of the following habits to reduce your household’s food waste? Select all that apply.

- ☐ Buy smaller quantities of fruits and vegetables
- ☐ Buy smaller quantities of prepared foods
- ☐ Freeze food, including leftovers
- ☐ Donate uneaten, edible food to local food banks and shelters
- ☐ All of the above
- ☐ None
- ☐ Other (please specify)

7. How do you primarily dispose of food scraps and spoiled food?

- ◯ Put in the garbage
- ◯ Use an in-sink garbage disposal
- ◯ Place in curbside organics recycling cart (Service provided by a private company or your city)
- ◯ Compost at home (backyard compost bin)
- ◯ Drop off at food scraps collection site
- ◯ Other (please specify)

Montgomery County Survey

Montgomery County is considering new approaches for residents to reduce food waste. We would like your opinion on possible approaches.

8. If the County offered curbside food scraps collection, would you participate? You would separate food scraps from your garbage and place them in a curbside bin for pick up.

- ◯ Yes
- ◯ No
- ◯ I don’t know

9. What are your concerns about participating in a curbside food scraps program? Select your top concern.

- ◯ Too much trouble
- ◯ Need more information before making a decision
- ◯ Not enough space in my house to separate food scraps
- ◯ Potential odors
- ◯ Collecting food scraps attracts insects and vermin
- ◯ Concerned about the added cost associated with this
- ◯ Other (please specify)

10. The County is considering making food scraps separation and curbside collection mandatory for households. What is your level of agreement with this potential approach?

- ◯ Strongly agree
- ◯ Somewhat agree
- ◯ Somewhat disagree
- ◯ Strongly disagree
- ◯ Don’t know/Neutral

11. If the County provided support to interested households for starting backyard composting, would you participate? You would separate food scraps and place them in a backyard rodent-proof compost bin.

- Yes
- No
- I already do backyard composting
- I don’t have a backyard

12. If the County established convenient food scraps recycling drop-off locations, would you take your food scraps to a drop-off site?

- ◯ Yes
- ◯ No
- ◯ I already drop off food scraps for recycling

13. How often do you donate excess edible food (e.g., to a shelter or local food bank)?

- ◯ Frequently (once a month)
- ◯ Occasionally (several times a year)
- ◯ Rarely (once a year)
- ◯ Never

14. How often would you donate excess edible foods to a nearby drop-off location if it were available?

- ◯ Frequently (once a month)
- ◯ Occasionally (several times a year)
- ◯ Rarely (once a year)
- ◯ Never

Almost done! Final three questions.

15. In what language do you prefer to receive written information?

- English
- Spanish
- Chinese
- French
- I prefer not to answer
- Other (please specify)

16. What is your race or ethnicity? (Select all that apply)

- ☐ American Indian, Alaska Native, Native American, or Indigenous
- ☐ Asian
- ☐ Black or African American
- ☐ Middle Eastern or North African
- ☐ Native Hawaiian or Pacific Islander
- ☐ White
- ☐ Hispanic or Latino/Latina/Latine/Latinx
- ☐ I prefer not to answer
- ☐ I prefer to self-describe

17. How much do you anticipate is your household’s total income before taxes for the current year? (Please include in your total income money from all sources for all persons living in your household.)

- Less than $25,000
- $25,000 to $49,999
- $50,000 to $74,999
- $75,000 to $99,999
- $100,000 to $149,999
- $150,000 or more
- I prefer not to answer

Montgomery County Survey

Thank you for your interest!

Thank you for your interest in participating in our survey. This survey only targets residents who live in Montgomery County. We appreciate your time and apologize for any inconvenience.

Montgomery County Survey

Thank you for your interest!

Thank you for your interest in participating in our survey. This survey only targets residents who live in a single-family house, townhouse, or small apartment building with six units or less. Future surveys will target additional County residents. We appreciate your time and apologize for any inconvenience.

Thank you for your time!

Encuesta del Condado de Montgomery

¡Queremos conocer la opinión de nuestros residentes!

El Condado de Montgomery es líder nacional en la reducción de residuos y en promover el reciclaje. ¡Juntos podemos cuidar nuestra comunidad al máximo! Reducir el desperdicio de alimentos y separar los restos de comida de la basura es una gran oportunidad para la gestión sostenible de la basura.

Queremos escuchar a los residentes para formar el futuro de las políticas y los programas. La encuesta toma aproximadamente 10 minutos. Las respuestas de la encuesta son anónimas.

¡Gracias por participar en la encuesta y por apoyar a nuestro Condado!

Encuesta del Condado de Montgomery

1. ¿Vive usted en el Condado de Montgomery?

- ◯ Sí
- ◯ No

2. ¿Cuál es el código postal de su casa en el Condado de Montgomery? [entre el numero en el espacio en blanco]

3. ¿Vive usted en una casa unifamiliar, en un townhouse o un edificio pequeño de apartamentos (6 unidades o menos)?

- ◯ Sí
- ◯ No

4. ¿Quién le recoge la basura de su casa?

- ◯ El Condado o Ciudad (servicio de basura incluido en la factura de impuestos de la propiedad)
- ◯ Una compañíá privada de servicios de recolección de basura que factura a su hogar
- ◯ Asociación de propietarios (una HOA)
- ◯ No lo sé

5. ¿Cree usted que separar de la basura los residuos de comida comestibles y no comestibles ayuda a proteger el medio ambiente?

- Totalmente de acuerdo
- Algo de acuerdo
- Algo en desacuerdo
- Totalmente en desacuerdo
- No lo sé/Neutral

6. ¿Practica alguno de los siguientes hábitos para reducir el desperdicio de alimentos de su hogar? Seleccione todas las opciones que correspondan.

- [ ] Compro cantidades más pequeñas de frutas y verduras
- [ ] Compro cantidades más pequeñas de alimentos preparados
- [ ] Congelo los alimentos, incluyendo las sobras
- [ ] Hago donaciones de alimentos comestibles (que no se han tocado) a los bancos de alimentos y refugios locales
- [ ] Todo lo anterior
- [ ] Ninguno
- [ ] Otros:

7. ¿Cómo se deshace principalmente de los restos de comida y los alimentos en mal estado?

- ○ Los pongo en la basura
- ○ Uso un triturador de basura en el fregadero/lavaplatos
- ○ Los separo en un carrito de reciclaje para productos orgánicos en la acera (servicio proporcionado por una empresa privada o del Condado)
- ○ Los pongo en un contenedor en el patio trasero para hacer compost en casa
- ○ Los llevo a un sitio de recolección de restos de comida
- ○ Otros:

Encuesta del Condado de Montgomery

Condado de Montgomery está considerando nuevas formas para que los residentes reduzcan el desperdicio de alimentos. Nos gustaría conocer su opinión.

8. Si el Condado ofreciera recolección de restos de comida en la acera de donde usted vive, ¿Usted participaría? ¿Separaría los restos de comida de su basura y los colocaría en un contenedor junto a la acera para que el Condado lo recoja?

- ◯ Sí
- ◯ No
- ◯ No lo sé

9. ¿Cuáles son sus preocupaciones acerca de participar en un programa de restos de comida en la acera? Seleccione su principales preocupaciones.

- ◯ Mucho trabajo
- ◯ No tengo suficiente información
- ◯ No hay suficiente espacio en mi casa para separar los restos de comida
- ◯ Posibles malos olores
- ◯ La recolección de restos de comida puede atraer insectos y alimañas
- ◯ Me preocupa el costo adicional asociado con esto
- ◯ Otros:

10. El Condado está considerando hacer que la separación de restos de comida y la recolección en la acera sean obligatorias para los hogares. ¿Qué tan de acuerdo esta con este enfoque?

- ◯ Totalmente de acuerdo
- ◯ Algo de acuerdo
- ◯ Algo en desacuerdo
- ◯ Totalmente en desacuerdo
- ◯ No lo sé/Neutral

11. ¿Si el Condado le apoya a usted en comenzar el compostaje en su patio trasero, usted separaría los restos de comida y los colocaría en un contenedor de compost a prueba de roedores?

- ◯ Sí
- ◯ No
- ◯ Ya hago compostaje en el patio trasero
- ◯ No tengo patio o jardín dónde hacer compostaje

12. ¿Si el Condado estableciera lugares convenientes para llevar los restos de comida para ser reciclados, usted los llevaría?

- ◯ Sí
- ◯ No
- ◯ Ya los estoy llevando

13. ¿Con qué frecuencia dona usted el exceso de alimentos comestibles (por ejemplo, a un refugio o banco de alimentos local)?

- ◯ Con frecuencia (una vez al mes)
- ◯ Ocasionalmente (varias veces al año)
- ◯ Raramente (una vez al año)
- ◯ Nunca

14. ¿Con qué frecuencia donaría el exceso de alimentos comestibles a un lugar de entrega cercano si estuviera disponible?

- Con frecuencia (una vez al mes)
- Ocasionalmente (varias veces al año)
- Raramente (una vez al año)
- Nunca

Encuesta del Condado de Montgomery

¡Casi listo! Las ultimas tres preguntas.

15. ¿En qué idioma prefiere recibir información escrita?

- ◯ Inglés
- ◯ Español
- ◯ Chino
- ◯ Frances
- ◯ Prefiero no responder
- ◯ Otros:

16. ¿Cuál es su raza o etnicidad? Seleccione todas las opciones que correspondan.

- ☐ Indio americano, nativo de Alaska, nativo americano o indígena
- ☐ Asiático
- ☐ Negro o afroamericano
- ☐ Oriente Medio o África del Norte
- ☐ Nativo de Hawái o de las islas del Pacífico
- ☐ Blanco
- ☐ Hispano o Latino/Latina/Latine/Latinx
- ☐ Prefiero no responder
- ☐ Prefiero autodescribir: ____________

17. ¿Cuánto anticipa que sea el ingreso total de su hogar antes de impuestos para el año en curso? (Por favor, incluya en su ingreso total dinero de todas las fuentes para todas las personas que viven en su hogar.)

- Menos de $25,000
- $25,000 a $49,999
- $50,000 a $74,999
- $75,000 a $99,999
- $100,000 a $149,999
- $150,000 o más
- Prefiero no decir

Encuesta del Condado de Montgomery

¡Gracias!

Mensaje emergente: Gracias por su interés en participar en nuestra encuesta. Esta encuesta solo se dirige a las personas que viven en el Condado de Montgomery. Agradecemos su tiempo y nos disculpamos por cualquier inconveniente.

Encuesta del Condado de Montgomery

¡Gracias!

Cerrar encuesta. Mensaje emergente: Gracias por su interés en participar en nuestra encuesta. Esta encuesta solo se dirige a los residentes que viven en una casa unifamiliar, casa adosada o edificio de apartamentos pequeños con seis unidades o menos. Las encuestas futuras se dirigirán a residentes adicionales del Condado. Agradecemos su tiempo y nos disculpamos por cualquier inconveniente.

¡Gracias por su tiempo!

Appendix C-2.

DEP's Partnership and Engagement Program Manager Outreach Efforts

Date	Action	Format	Channel
6/8	Survey Distribution	By email (AA)	Shared to County's email list (50 people; includes representatives from 38 different organizations/community groups)
6/8	Survey Distribution	By email (AA)	MCPS Director of Sustainability and Compliance (not confirmed whether POC distributed more widely within MCPS)
6/8	Survey Distribution	Electronic Newsletter	Silver Spring, Bethesda Chevy Chase, and Mid county regional centers
6/12	Survey Distribution	Electronic Newsletter	Up County and East County Regional Centers
6/15	Survey Distribution	By email (AA)	Public Libraries POC (was not distributed more widely within Public Libraries)
6/16	Survey Distribution	Radio Show and Social Media (Facebook)	County Council en Español segment
6/16	Survey Distribution	Social Media (ME)	NextDoor post by Marilu
6/16	Survey Distribution	Electronic Newsletter	Upcounty Citizens Advisory Board Newsletter
6/16	Survey Distribution	Electronic Newsletter	East County Newsletter
6/23	Survey Distribution	Electronic Newsletter	Montgomery Village Foundation (encompassing 40,000 homes – distributed electronically to at least one of their newsletters)
6/23	Survey Distribution	Electronic Newsletter	Upcounty Citizens Advisory Board Newsletter
6/24	Survey Distribution	Flyer In-Person (AA)	Caribbean American Heritage Celebration and Resource Fair (Wheaton)
6/24	Survey Distribution	Electronic Newsletter	East County Newsletter
6/29	Survey Distribution	Electronic Newsletter	Bethesda Chevy Chase Regional Services Center Newsletter
7/4	Survey Distribution	Flyer In-Person (D. Frank)	Montgomery Village 4th of July Celebration
7/5	Survey Distribution	Social Media (DEP)	DEP Social Media - Facebook
7/6	Survey Distribution	Social Media (DEP)	DEP Social Media - Twitter

Appendix C-3.

Montgomery County Community Assessment

Single-Family Home Residents

Survey Results

August 15, 2023

Notes:

- Intent of study:
    - Help inform tonnage projections for organics generation and capture in Montgomery County by gathering information about residents' attitudes and behaviors regarding food waste and food scraps management.

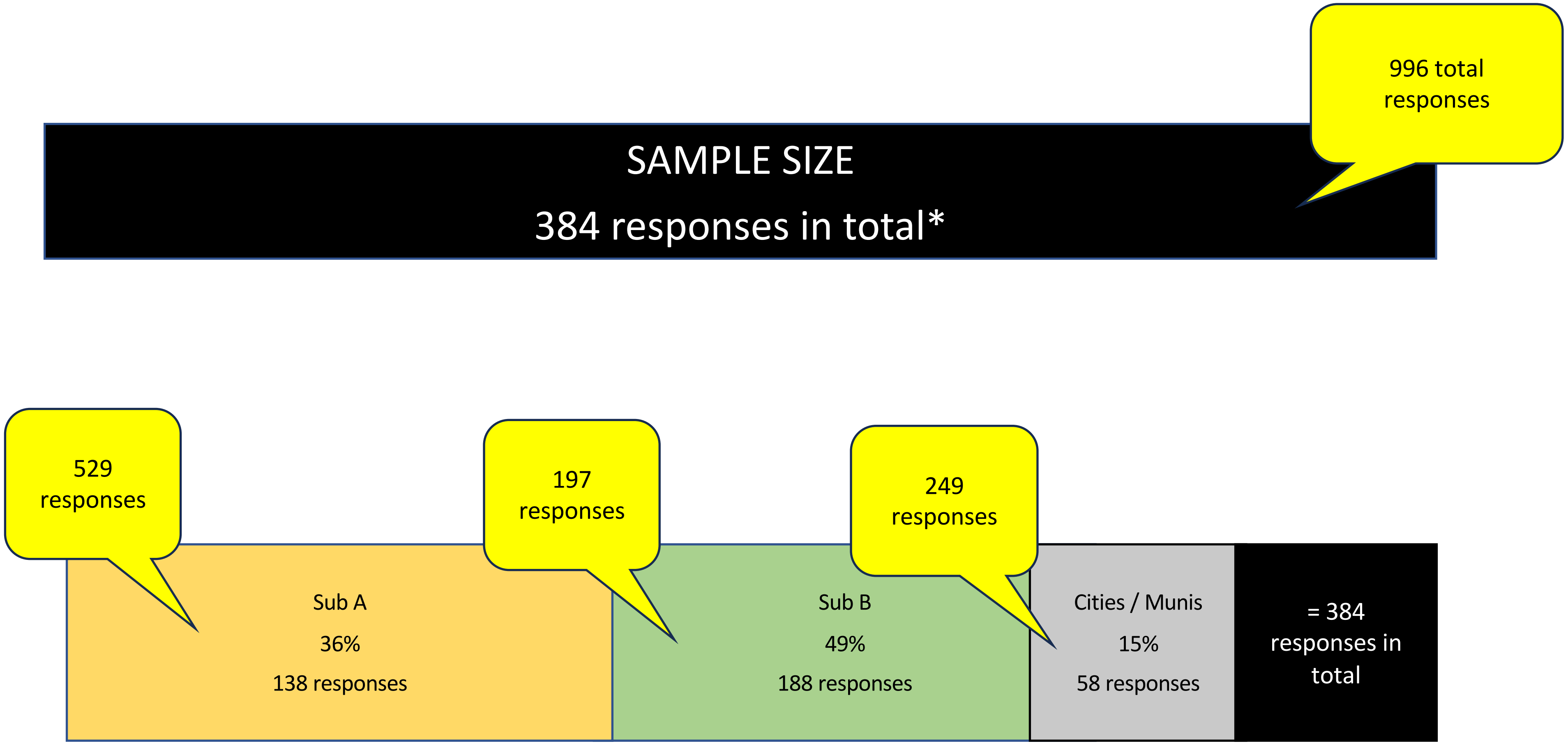
- 996 responses in total
- Target sample size was reached for each subgroup
- Number of respondents per subgroup varied (see slide 4)
- Response rate per question varied since all questions were voluntary
- It is important to exercise caution when comparing across subgroups because of these variations

Data Limitations

- It is important to note that while small sample sizes have limitations, they can still be appropriate and informative in certain contexts, such as for this forecasting tonnage projections study. As discussed with MES and the County, with a small sample size and a shareable link survey, however, it becomes difficult to perform statistically significant, meaningful analysis on subgroups within the sample (i.e., by race, income, language, etc.). Subgroup analyses with a small sample and a shareable link survey size lack statistical power and result in unreliable conclusions. Therefore, the EA Team cautions against generalizing survey subgroup findings to the broader County population.

- As a result of these data limitations, the EA Team cautions against generalizing survey subgroup findings to the broader County population.

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.



* Sample size is based on total SFH with less than or equal to six units in Subdistrict A, Subdistrict B, Cities/Municipalities from CY 2022

Q4		Subdistrict A	Subdistrict B	Municipalities	All Respondents
Who collects your trash?	County or City/Town/Village (property tax bill for trash service)	95%	12%	78%	78%
	Hauler (private trash collection service that bills your home for trash)	1%	12%	9%	5%
	Homeowner association	1%	60%	4%	14%
	I don't know	1%	8%	2%	2%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q5		Subdistrict A	Subdistrict B	Municipalities	All Respondents
Do you believe getting edible food waste and food scraps out of the waste stream is the right thing to do for the environment?	Strongly agree	83%	55%	77%	81%
	Somewhat agree	7%	17%	11%	11%
	Somewhat disagree	1%	3%	0%	1%
	Strongly disagree	1%	7%	0%	2%
	I don't know/Neutral	5%	10%	4%	6%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q6		Subdistrict A	Subdistrict B	Municipalities	All Respondents
Do you practice any of the following habits to reduce your household's food waste?	Buy smaller quantities of fruits and vegetables	58%	51%	54%	60%
	Buy smaller quantities of prepared foods	47%	49%	45%	50%
	Freeze food, including leftovers	69%	60%	65%	71%
	Donate uneaten, edible food to local food banks and shelters	8%	9%	7%	9%
	All of the above	10%	11%	11%	11%
	None	4%	8%	3%	4%
	Other	29%	20%	29%	28%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q7		Subdistrict A	Subdistrict B	Municipalities	All Respondents
How do you primarily dispose of food scraps and spoiled food?	Put in the garbage	23%	41%	19%	27%
	Use an in-sink garbage disposal	9%	19%	10%	12%
	Place in curbside organics recycling cart (Service provided by a private company or your city)	33%	2%	25%	26%
	Compost at home (backyard compost bin)	23%	20%	27%	25%
	Drop off at food scraps collection site	2%	4%	4%	3%
	Other	7%	5%	7%	7%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q8		Subdistrict A	Subdistrict B	Municipalities	All Respondents
If the County offered curbside food scraps collection, would you participate? You would separate food scraps from your garbage and place them in a curbside bin for pick up.	Yes	83%	58%	74%	82%
	No	5%	18%	9%	10%
	I don’t know	7%	11%	8%	9%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q9		Subdistrict A	Subdistrict B	Municipalities	All Respondents
What are your concerns about participating in a curbside food scraps program?	Too much trouble	1%	1%	1%	5%
	Need more information before making a decision	3%	1%	2%	12%
	Not enough space in my house to separate food scraps	0%	2%	0%	4%
	Potential odors	0%	3%	1%	6%
	Collecting food scraps attracts insects and vermin	2%	10%	4%	25%
	Concerned about the added cost associated with this	2%	2%	1%	9%
	Other	5%	11%	7%	40%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q10		Subdistrict A	Subdistrict B	Municipalities	All Respondents
The County is considering making food scraps separation and curbside collection mandatory for households. What is your level of agreement with this potential approach?	Strongly agree	59%	34%	55%	57%
	Somewhat agree	21%	23%	19%	23%
	Somewhat disagree	6%	10%	6%	7%
	Strongly disagree	6%	18%	5%	9%
	Don’t know/Neutral	3%	3%	6%	4%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q11		Subdistrict A	Subdistrict B	Municipalities	All Respondents
If the County provided support to interested households for starting backyard composting, would you participate? You would separate food scraps and place them in a backyard rodent-proof compost bin.	Yes	35%	32%	36%	38%
	No	31%	22%	29%	31%
	I already do backyard composting	27%	20%	20%	26%
	I don't have a backyard	2%	11%	5%	5%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q12		Subdistrict A	Subdistrict B	Municipalities	All Respondents
If the County established convenient food scraps recycling drop-off locations, would you take your food scraps to a drop-off site?	Yes	24%	30%	18%	26%
	No	70%	53%	67%	72%
	I already drop off food scraps for recycling	0%	3%	5%	2%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q13		Subdistrict A	Subdistrict B	Municipalities	All Respondents
How often do you donate excess edible food (e.g., to a shelter or local food bank)?	Frequently (once a month)	3%	3%	3%	3%
	Occasionally (several times a year)	17%	19%	17%	19%
	Rarely (once a year)	35%	31%	33%	37%
	Never	39%	34%	37%	41%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q14		Subdistrict A	Subdistrict B	Municipalities	All Respondents
How often would you donate excess edible foods to a nearby drop-off location if it were available?	Frequently (once a month)	18%	18%	16%	19%
	Occasionally (several times a year)	36%	32%	36%	38%
	Rarely (once a year)	26%	18%	26%	27%
	Never	16%	19%	12%	17%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q15		Subdistrict A	Subdistrict B	Municipalities	All Respondents
In what language do you prefer to receive written information?	English	93%	86%	87%	99%
	Spanish	0%	0%	0%	0.2%
	Chinese	0%	0%	0%	0.1%
	French	0%	0%	0%	0.2%
	I prefer not to answer	0%	1	1%	1%
	Other	0%	0%	0%	0.1%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q16		Subdistrict A	Subdistrict B	Municipalities	All Respondents
What is your race or ethnicity? (Select all that apply)	American Indian, Alaska Native, Native American, or Indigenous	1%	1%	0%	0.8%
	Asian	3%	7%	7%	6%
	Black or African American	2%	5%	1%	2%
	Middle Eastern or North African	0%	2%	0%	0.7%
	Native Hawaiian or Pacific Islander	0%	0%	1%	0.3%
	White	78%	62%	69%	80%
	Hispanic or Latino/Latina/Latine/Latinx	3%	7%	3%	5%
	I prefer not to answer	8%	10%	10%	10%
	I prefer to self-describe	2%	2%	1%	2%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Q16		Subdistrict A	Subdistrict B	Municipalities	All Respondents
How much do you anticipate is your household's total income before taxes for the current year? (Please include in your total income money from all sources for all persons living in your household.)	Less than $25,000	1%	3%	0%	0.9%
	$25,000 to $49,999	3%	4%	1%	2%
	$50,000 to $74,999	2%	6%	3%	5%
	$75,000 to $99,999	0%	11%	8%	8%
	$100,000 to $149,999	0%	17%	16%	19%
	$150,000 or more	78%	25%	39%	45%
	I prefer not to answer	3%	22%	21%	21%

Note: Subgroup percentages were calculated based on the number of people in that subgroup who took the survey. Some questions had fewer respondents. For this reason, the percentages in each subgroup column do not sum to 100.

Appendix C-4.

Q6. Do you practice any of the following habits to reduce your household's food waste?

OTHER:

compost
Compost
We have a small electric composter
Compost vegetable scraps
compost
Make meal plans. Use leftovers.
Compost
Compost some food scraps
Backyard compost
Composting
compost at home
plan meals and only buy what we will use
compost all food scraps
Compost
never eat out, or buy prepared or processed foods, buy for meal plan, freeze proteins until needed, head to hoof
I collect food waste and take it to a compostable waste bon in Gaithersburg.
Only buy what we expect to consume in the next week
Compost
use the garbage disposal to keep wastes out of landfill
Compost
we compost
Home compost
We use a private composte service
freeze food scraps for drop in Mom's food recycling bins
Compost food waste
We pay for a third-party composting service
Compost
Throw into our woods for wildlife
Give away food purchases that aren't what we thought they were on Buy Nothing
buy only what i know the household will eat.
Compost
Pay for private collection of food waste for composting.
Compost fruit and vegetables
Use Buy Nothing group to distribute unwanted, unexpired food.
compost food waste
Composting at home
participate in private compost service
Compost
Compost

Compost
Compost
I compost with a private service
compost
Buy only as much as our family can reasonably consume before the next grocery store run
Compost
Compost at home. Save veg scraps for broth. Try to use all parts (e.g. tops of beets)
we eat everything we make, waste nothing.
Try to buy smaller but not always successful
Compost waste
Compost
Compost in back yard
Compost, grow our own
compost food waste
compost
Compost at home.
we cook according to the number residents, only what we will consume to avoid waste.
Compost
Garden
Compost
Compost
Compost
Compost
Recycle at farmers market in summer
Compost
Compost
Eat leftovers
Private composting service
was composting on my own. My composter is full and I need to purchase a new one.
Periodically have a refrigerator meal from foods on hand
composting
Eat leftovers for lunch the next day.
Compost food waste
keep leftovers to be eaten in a few days
Drop off compostables at MV Farmers' Market or MOMS grocery store
Eat all my leftovers and compost what I can.
i rarely waste food
we compost fruit and vegetable scraps
Donate food to neighbors in our Buy Nothing group.
compost
Grow much of our own food and compost as much as we can
I prepare all meals from scratch. Typically waste is generated from cutting vegetables
Compost
Compost

compost
take food waste to Whole Foods to vompost
Compost
Compost coffee grinds, corn cobs, etc.
Pay a private contractor who specializes in compost
Compost non-meat in backyard
Pay for a composting service
Compost
Private compost pile, reduce food waste with proper storage
We compost in our backyard.
Compost
Compost
I eat grasshoppers
Compost
compost
take waste to Mom's market for recycling
We size our purchases so that very little food is thrown out.
Compost
Compost
Composting
Compost what is inedible or goes bad
Compost
compost!
Compost vegetable waste
Compost
Compost
compost food scraps
subscribe to Compost Crew
Compost food scraps
Many scraps go to the dogs!
composting
Grow my own vegetables. I only pick what I need that day. Compost food scraps in a two-chamber tumbling composter.
compost in back yard
compost raw vegetable trimmings
compost
Use a private composting service
Curbside composting
buy from Hungry Harvest
I eat almost all of the fruits and vegetables that I buy!

Compost at home
Compost
compost
Pay for composting
Pay for compost crew service
Give leftovers to friends & neighbors
compost
Compost
be aware of what's in the fridge
use a compost service
Compost with Compost Crew
We home compost vegetable waste
Recycle compostable waste
compost crew service
My city does curbside compost
Household compost
Compost
Compost
Compost
Pay Compost Crew weekly pickup of all food waste
Compost
Use commercial compost service
Compost!
pay for weekly compost pick-up, share food with neighbors
compost
Compost waste
I pay for composting, but strongly believe this should be a county-provided service that all residents get for free but most adhere to. We save on so much garbage that way!!
We are pretty good about eating all leftovers. We try not to buy more than we need.
Compost
Use composting service
I ate leftovers unless they are absolutely rotten
Eat up all leftovers all the time
Donate at DC markets to DC food scrap collection program
Eat leftover food
We compost in the backyard, but have had trouble with rats.
Compost
we use a weekly commercial compost service that we pay for
backyard composting
only buy what I will eat
compost

Compost
Compost
Eat our leftovers right away
Subscribe to compost service and to Hungry Harvest
Compost
We don't buy small quantities. But we never throw food out. We always consume what we buy or donate it in a very few instances if there's extra.
compost
Compost fruit and veggie scraps
I save vegetable scraps for stock, and we compost the rest here at home.
compost
Compost
Compost
participate in Takoma Park composting program, and compost in my own yard also
Mulch food scraps at home
We buy appropriate amounts of fruits and veggies and pay for a compost service.
We also currently participate in the pilot food scrap composting program run by county.
compost pick up
I recycle all food scraps, except meat, fish, egg shells, cheese and mushrooms in my garden.
Compost some raw fruits and vegetables
re-purpose food scraps, i.e. make my own stock and dog food.
Pay for composting service (Veteran Compost)
Buy at Farmer's Markets
Compost scraps; eat what we buy
Compost through a private company
Take fruit and veggies to be composted
Consume all edibles
Pay for composting
Cook so that fresh ingredients are used up.
Compost food scraps
Compost
compost
I make smoothies or soup with veggie parts. Add fruit, etc. Good fiber and less waste.
Compost veggie and fruit waste
Compost
Compost coffee grounds, fruits, vegetables and breads
compost
Compost our left over food waste
We participate in the residential food scraps collection pilot program.
Compost and feed leftovers to hens
Composting
Compost

Compost in a rotating composter
refrigerate leftovers and eat the next day or two
pay monthly for Compost Crew
compost food scraps in back yard
compost at home
Compost
Compost
We compost vegetables and fruuit
Compost leftover and spoiled food
Use compost crew for my compost
Compost food scraps through county program
worm compost
Buy a weekly compost pickup
Compost food scraps
Compost
compost
Buy smaller quantities of all fresh food
Composting for reuse on plant beds
Contract with Compost Crew to pick up my food scraps every week.
Households are greatly restricted on donation
Grow some vegetables and herbs for my own comsumption
Compost
Compost
Grow some of our food so we can harvest when we will eat it
backyard compost pile
Composting food scraps
Make sure we use what we buy and freeze when necessary.
we plan meals to use up leftovers; food scraps we can't eat go in the compost
compost
Compost; grow our own fruits and vegetables
use compost bin
Compost in rat-proof tumbler
home composting, but can't compost everything, alas
I am single and buy only what I think I can consume. So I'm not buying "smaller" quantities of anything. I don't have uneaten or edible food and do freeze food. I contribute $100/month to Manna.
Compost Crew
Buy frozen vegies
Compost food scraps in my yard
Pay for composting service--Compost Crew
Home Composting Bin
Compost fruits and vegetables
Home Compost
Compost it (doesn't reduce waste but reduces food trash)

Home compost
Compost in our backyard
Compost crew composting
Compost and participate in Takoma Park's food waste collection program.
Give food prep waste to Compost Crew
Use leftovers in other dishes
Compost food waste
cook more at home than buying out to be efficient with food
Share with neighbors
Pay separately for a private composting service to pick up food waste
I compost all possible food scraps so there *is* no food waste beyond chicken bones
COMPOST!
compost waste food items in our own bins

Q7. How do you primarily dispose of food scraps and spoiled food?

OTHER:

We have a small electric composter that composts within hours
eat next day, rarely frozen
Put in compost pail, which city picks up weekly.
Also compost
Loki scrap conposter
Compost bin that is picked up weekly
Pay for compost pickup service
Compost the compostable but also use disposal and put some things in the garbage too
Compost Crew
Indoor composter
I rarely have either food scraps or spoiled food
Food scraps: compost. Spoiled food: trash.
I have done both composting at home and food scrap collection site for many, many years.
signed up for compost collection
combination of garbage, garbage disposal, and backyard compost bin
drop at Whole Foods
Compost bin that gets picked up by a private service on a weekly basis
Feed to dog or wildlife.
Commercial compost service
Pay private compost company -compost crew
feed to the rats
Compost pilot program
County food scraps
County pilot curbside compost program
Compost produce in worm bin
We have a compost collection service
pay for private compost service
We participate in the county pilot project on composting.
pay for compost service with the Compost Crew
Curbside compost Takoma park
Worm bin
Takoma Park has a municipal food waste collection. I wish the whole county had this service.
we pay for a service to pick up our compost
Used a compost company before, but now use garbage (waiting for county to start program)
Pay for Compost Crew services
Equal parts garbage, disposal and compost
both backyard and through MOCO compost pilot program
We take in bucket to Koiner Farms in Silver Spring for composting.
County compost pilot

Drop off at my mother's house - she is part of the moco food scraps composting program. I can't wait for it to come to our part of the neighborhood!
I blend all good scraps n the blender and dig into my composting holes.
Put in county provided compost bin
Freeze until trash collection day
Food scraps pilot program
Veterans compost
County pilot
County collection pilot program
Pay for weekly Compost Crew collection
Compost through town
Compost vegetable scraps, trash for the redt
Participate in county food scraps program
Kitchen compost bin for weekly curbside collection
Food scraps are collected by th county o a weekly basus as compost
Compost some, feed some to animals, throw some away.
Combination of compost, disposal and trash.
Compost waste what I eat at work in our compost bin.. Attempted compost at home but did not keep up with it. Paid for compost pickup at one point but found it expensive. So at home a mix of throwing it away and compost. We do not use a garbage disposal.
Pay compost collection company for weekly pickup
multiple answers: compost bin (rat-proof), garbage disposal, or double-bagged in trash.
I put it with mixed with yardtrim
collected by City of Takoma Park
separate coffee grounds and tea from bags and add to soil in garden.
aaa
Compost Crew
depends; fruits and vegs are home composted; meat is discarded
Both put in trash and use compost (depending on the food)

Q9. What are your concerns about participating in a curbside food scraps program? Select your top concern.

OTHER:

prefer to compost it by myself
I don’t have much good scrapes
already compost at home
My city, Takoma Park, already provides this service.
most of the above
There will be some that store scraps outside. This will attract RATS! No, just No.
All of the above
Both odors, wildlife, and potentially not separating the scraps appropriately
As a senior it would not be an easy thing for us to do.
No concerns
keeping animals out of a whole street filled with 100% food scrap bins
Don't need such a program because I compost.
I'm all for doing curbside pick up and would love my taxes to go for that. But for me personally, I'd miss out on the compost I now make at home. Also, consideration of pollution of trucks to pick up
any food scraps/waste go in our compost pile
We already compost all of our food scraps, and use the finished compost as a resource on our property.
Already composting in backyard
Already compost most of our food waste
Storage space for curbside container.
Still confused about what goes into the current recycling bins. Now you want to add another layer.
Already compost all food scraps except meat
No scraps leftover
Restaurant should be the ones to do this
Many of the above as well as "compastable" plastic bag are really bad.
my pets
toom much trouble, do not want another bin to collect garbage/recycling that might attract pests and I think food in garbage dumps only helps in decompostion of trash.
i do some composting. meat scraps cannot be composted, but have little of that. proposed container size is much too big to be useful to me. question all the above potential problems.
I live in a townhouse community and am constantly picking up trash after recycling day. Haveing another truck come through our neighborood would only cause more confusion as trash is left behind after recycling. I can only imagine what it would be like if we had food scrap collection.
A central location for dropping off food scraps such as the City of Gaithersburg would make more sense to me than individual bins. If residents were more consciotious, it might work. But centralizing it is the only way I can see it working. Until recently I composted in my back yard and took food scraps to the City of Gaithersburg food scrap pickup.

Waste discarded on walkway or in street. Residents having to clean it up. Odors, critters, & vermin.
you are waisting your resources, it is not a problem to be concerned
Don't need it. We compost everything we can.
I already compost. Any edible scraps are fed to my dogs or chickens.
I compost food scraps on my own property
Only that we usually have very little spoiled and wasted food that it might not make sense for us.
I'm already doing backyard composting which I use on my garden. For those not already composting, curbside collection would be great.
We already compost food scraps in our backyard.
I LIKE composting and would miss it! :-)
I already compost in my back yard. But I think it is great that the County is considering adding that service.
Would lead to fights with my husband who would not remember to separate out food scraps and would resent reminders
Two members of household don't want to
already compost our food scraps
Have a composting area
Takoma Park already provides this service
I already use all my food scraps in my gardening composting.
I plan to start composting
we will continue backyard composting. But many won't do it on their own, so please offer curbside foodscraps pickup!
racoons
Probably don't have enough compostable scraps to participate in curbside because I already compost
On3 acres. Already compost
I like Compost Crew.
We already compost if the county where to pick up a little bit of meat and fish bones then I would put them out but as far as vegetables and fruits, etc. that is all come posted in our own yard
I have a very restricted diet, eat little regular food (mostly liquids)
Leaving scraps curbside rather than in a private protected bin could lead to real messes from animals and people
Attracts rodents. Every time I compost I get mice in my shed and kitchen.   I tried moving recycling bin far away from my house then I get mice in my shed
We compost our own
We use ours in our compost.
MDUs @ Avenel have a hard time with recycling, horrible problem with dumpster collection for all others (HOC tenants do not follow rules)
We like generating compost for yard. Also more efficient than hauling to Dickerson.
We do our own composting for our vegetable gardens.
1 person household, few food scraps

I compost in my yard. The City of Takoma Pk has program.
Spend our tax money elsewhere .i.e where it is NEEDED
I compost in my yard. Would probably continue with that
No concerns - I already participate in Takoma Park's food waste collection program.
I already said: I compost my own
Composting myself for my garden

Appendix D:

Biogas and Hydrogen Yield Analysis from Food Waste

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Commentary

for

Biogas to Hydrogen Conversion

for EA Engineering
March 18, 2024

OBJECTIVE

Montgomery County, Maryland, is interested in evaluating the feasibility of conversion of biogas produced in anaerobic digesters into hydrogen gas. This hydrogen could be readily stored and used to fuel vehicles and other hydrogen-burning equipment for the county.

This analysis presents a high-level analysis and commentary about the biogas-to-hydrogen conversion with respect to gas mass balance and energy balance. Vendors have been contacted to develop an estimate of CAPEX and OPEX of a conversion system. Currently an estimate of CAPEX for the methane-to-hydrogen equipment only and exclusive of installation and operating costs has been received and will be presented.

Methane to Hydrogen Energy Evaluation

The process of steam reforming methane (SRM) is a mature technology in the oil and gas industry.[1,2] In this method, methane that is captured from subsurface hydrocarbon repositories is reacted at high temperatures (700 °C – 1000 °C) and with water. This reaction produces hydrogen gas and carbon monoxide. A further reaction is then performed on the gas which transforms carbon monoxide into carbon dioxide and nets one more molecule of hydrogen. In these reactions, 1 mole of methane is transformed into four moles of hydrogen gas while some energy is consumed. The stoichiometric reactions and the overall reaction are presented in equations 1-3 below.

(1) $CH_4 + H_2O \Rightarrow 3H_2 + CO$ Energy: 206 kj/mol

(2) $CO + H_2O \Rightarrow H_2 + CO_2$ Energy: -41 kj/mol

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(3) $CH_4 + 2H_2O \Rightarrow 4H_2 + CO_2$ Energy: 165 kj/mol

[1] Song H. et al. 2022. Energy, environment, and economic analyses on a novel hydrogen production method by electrified steam methane reforming with renewable energy accommodation. Energy Conversion Management, 258
[2] Challiwala M.S. et al. 2017. A combined thermos-kinetic analysis of various methane reforming technologies: Comparison with dry reforming. Journal of CO2 Utilization, 17, 99-111.

As the equations show, the process requires an input of energy. The net energy required for both reactions is 165 kj/mol of CH_4 converted into hydrogen.

There are other methods such as dry reforming methane (DRM) that produce a similar gas mixture with the goal of producing hydrogen gas from organic precursors.[3]

For this analysis, we considered only SRM for hydrogen formation as it is the most mature and commercially available method. The other methods may be worth investigation if vendor with suitably mature technology could be identified.

Data about system operation was taken from the websites of Linde Engineering and HyGear. The energy requirements reported by HyGear are significantly lower than what is expected from the stoichiometry. It is possible that the HyGear process is able to incorporate efficiencies in their design that lower the net energy cost for conversion using SRM. EA is still working with HyGear to understand the energy balance in their process and those results are not presented here. Several things are apparent from an evaluation of the stoichiometry:

1) There is a net gain in energy contained in the hydrogen gas after conversion from methane. The net gain in 1000 SCF of methane gas is approximately 46 KWh.
2) There is a net negative balance of energy over the whole reaction. Approximately 8 KWh of energy are required for the conversion of 1,000 SCF of methane to 4,000 SCF of hydrogen.
3) The net energy contained in 1000 SCF of methane gas drops from 270 KWh to 79 KWh (316/4).

Table 1. Energy balance for conversion of methane to hydrogen.

Item	Unit	per m3 of gas	per 1000 SCF Methane**
Methane Energy	KWh	10	270
Hydrogen Energy	KWh	11.2	316
Energy Consumed (Stoichiometry)	KWh	1.9	55
Net Energy Stiochiometry	KWh	-0.3	-8

*SCF = Standard cubic foot = 1 ft3 of gas at 1 atm and 15 C

For conversion of methane gas to hydrogen, high purity is required of the initial gas. This will require removal of hydrogen sulfide primarily. Ammonia and other trace impurities such as siloxanes also likely will need to be addressed in systems burning either methane or with conversion to hydrogen. Therefore, there is no difference in cost for the pretreatment of biogas for use as methane or for use after conversion to hydrogen.

There will be a capital expense for the methane conversion equipment. Base equipment cost for the methane-to-hydrogen conversion equipment will be $3,175,000 for a system capable of converting 177 SCFM of methane to hydrogen. With engineering and installation, the total cost will likely be ~$9,525,000. Additional costs associated with pressurization equipment, gas storage equipment, gas purification equipment, and finished gas transportation equipment will

[3] Song et al.

need to be added for a final cost of the system. There will also be operating expenses for conversion equipment. Operating expenses are not known at this time.

With respect to carbon emissions, one carbon dioxide molecule is produced from burning a single molecule of methane. One carbon dioxide molecule is also produced during the conversion of methane to hydrogen. Therefore, there is no reduction in carbon dioxide or carbon emissions when converting methane to hydrogen.

There are some advantages to conversion of methane to hydrogen:

1) Convenient storage and unlimited shelf life of hydrogen gas.
2) Use of hydrogen in equipment that is designed to burn hydrogen gas.
3) No carbon emissions at the point of use of the hydrogen gas.

Methane to Production Evaluation

Methane production depends on the organic content of the feedstocks to the anaerobic digester as well as the availability of the feedstocks for conversion to methane. Organic molecules contain differing amounts of energy depending on their type. For example, carbohydrates have much less energy than fats. Therefore, much more methane is produced per gram of material by the digester when the feedstock has larger proportions of fats than carbohydrates. The county would like to have a general estimate of expected gas production based on the feedstocks that will be digested in the reactor. This section provides very general estimates for methane production values and is based on value available in the literature. Actual values should be determined by performing a biochemical methane potential (BMP) test for each feedstock. A BMP test prior to accepting a feedstock is standard practice for facilities that wish to implement anaerobic digestion processes.

Because BMP testing was not performed, a number of assumptions were made for this analysis. These are:

1) There will be 70,000 tons, wet weight, of yard trim per year.
2) There will be 27,400 tons, wet weight, of food scraps per year.
3) Biogas production from food scraps is 110 m^3/2,200 lbs @35 ºC.
4) Biogas production from yard trim is 33 m^3/2,200 lbs @35 ºC.
5) Electricity cost is $0.10/kWh.
6) Hydrogen value is $1.36/lb.

Table 2 presents the results of the analysis based on the above assumptions. It is anticipated that digestion of the yard trim/food scraps waste will produce 3,369,027 pounds of hydrogen per year. This process will consume 8,773,515 kWh of electricity to convert the methane produced to hydrogen.

Table 2. Analysis of hydrogen production and energy consumption of a digester converting a mix of yard trim and food scraps.

Waste Type	Yearly Disposal, Ton	Yearly Disposal, lbs	Yearly Biogas, m3	H2 gas production, lbs/year	Energy Consumption, kWh/year
Food Scraps	27,400	54,800,000	2,740,000	1,907,259	4,966,825
Yard Trim	70,000	140,000,000	2,100,000	1,461,768	3,806,691
Total	97,400	194,800,000	4,840,000	3,369,027	8,773,515

Based on the above productions and assumed prices for hydrogen and energy, the net value of hydrogen produced each year will be $3,716,776 (Table 3).

Table 3. Net value of conversion of methane to hydrogen with respect to energy cost only.

Value of Hydrogen Produced, $/year	4,594,128
Energy Cost to Produce, $/year	877,352
Net Value, $	3,716,776

CONCLUSIONS

1. There is a consumption of energy from conversion of methane to hydrogen due to energy consumed in the reaction. Energy consumption will be >8 KWh/1000 SCF of methane.
2. There is no advantage to conversion of methane to hydrogen with respect to carbon emissions.
3. Both gas products (e.g. methane or hydrogen) will require similar pretreatment of the raw biogas prior to use.
4. There are costs associated with the purchase and upkeep of methane-to-hydrogen conversion equipment.
5. Treating 97,400 tons of mixed waste could produce 3,369,027 lbs of hydrogen per year.
6. The process would consume 8,773,515 kWh of energy per year.
7. The net value of hydrogen produced considering energy costs only will be $3,716,776.

Methane-to-hydrogen conversion is a common and cost-effective way of generating hydrogen gas from fossil fuel. There is a relatively small consumption of energy for conversion of methane to hydrogen. Capital cost of installation of a facility that can convert 177 SCFM of methane to hydrogen may make economic sense if use of the hydrogen is paired with equipment that uses hydrogen, not methane, as a fuel source.

March 18, 2024

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Appendix E:

Outreach and Education – Minimizing Contamination

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Montgomery County Feasibility Study
Outreach and Education: Minimizing Contamination

Overview

Contamination is a pervasive issue for municipalities implementing composting initiatives. Many communities address this challenge by initially establishing voluntary composting programs, which attract the most dedicated composters, those most inclined to follow composting guidelines. By fostering awareness and promoting education, communities can progressively broaden these programs to boost participation and ensure correct composting practices.

The focus of this memo is to provide a recommended approach to outreach and education to reduce contamination in compost. It particularly emphasizes the operational consequences of contamination, including its impact on facility equipment, operations staff, and related aspects.

Outreach and Education Components

To ensure an impactful public education and awareness program roll-out:

- **Deploy visually striking educational materials** featuring clear lists of compostable and non-compostable items, incorporating vivid photo images for quick comprehension.

- **Utilize visual aids** that vividly depict the detrimental consequences of contamination, such as compost windrows marred by plastics.

- **Employ straightforward, simple symbols** (i.e., checks and x's) to ensure the material is easily understood by anyone in the community.

- **Consistently and repetitively deliver messaging** to enhance memorability.

Composting Do's and Don'ts list (Hutchinson, MN)

- **Emphasize the importance of sustained public education** and motivation, as one-time-only approaches will fail.

- **Equip elected officials, senior staff, and others with well-crafted communication materials**, including talking points and social media posts, to bolster the anti-contamination cause.

- **Maintain an ongoing process of monitoring and evaluation**, focusing on problematic areas through cart inspections, waste auditing, and community assessments, adapting outreach and education strategies as necessary.

Four Themes for Outreach and Education on Contamination

It is crucial to give people a clear understanding of why contamination is a problem in food scraps collection/compost programs, so they can grasp its significant impact. This section presents four themes for all messages associated with contamination. Effective communication campaigns are based on a concise set of messages. This ensure the messaging is focused, memorable, and consistent.

Theme One: Plastic bags and other non-organic contaminants wreak havoc on compost facility machinery.

Theme Two: Because plastic disintegrates into tiny fragments, complete removal during processing is impossible, thus creating non-usable compost.

Theme Three: Screening to remove contaminants involves manual and machine removal. This is resource-intensive and costly for the County.

Theme Four: Prevention is up to you. The ideal way to manage contamination is to prevent it from entering the compost stream in the first place.

Outreach and Education Messages for Each Theme

The goal of outreach messaging is to motivate the community to compost correctly. The key to good messaging is to present compelling information that is easy to understand coupled with a clear call to action. To help ensure that selected messages resonate for the County's target audience, it's important to test a few messages with sample audiences. Refine and then use the messages that appeal to the broadest number of people.

Theme One: Plastic bags and glass wreak havoc on compost facility machinery.

- Compost facilities deal with costly machinery and contamination. Let's make our County investments last by not jamming up the machinery with plastic or glass.
- Plastic bags and glass jam and break the moving parts of our County's compost facility equipment, leading to costly and frequent breakdowns and damage. Do your part, don't put plastic or glass in your organics cart!
- Removing plastic bag remnants from compost machinery is a time-consuming and costly process. Plastic bags cause frequent maintenance and repair issues, driving up operational

expenses for compost facilities. Have a heart, keep the plastic and glass out of your organics cart!

- Plastic bags love to jam, making compost facility staff say, "Oh, damn!" So, be the change, it's not a big ask – leave out the plastic, it's an easy task!

Theme Two: Plastic disintegrates into tiny fragments making complete removal from compost impossible.

- Help keep Montgomery County's compost stream contamination-free! Recycle your plastics or toss them in your garbage can. Keep all plastic out of your organics carts.
- Plastic breaks down into stubborn bits, a composting facility nightmare. Protect our County's compost's value - no plastic in your cart!
- Out with the plastics! Wrap, elastics, ties, straws, and stir sticks spell chaos for the County's compost facility. Keep our organics pristine!
- Compost facilities grapple with trying to screen out disintegrating plastic. Do your part, remove even those tiny plastics from your food scraps!
- Contaminated compost affects our County's haulers, gardeners, farmers, and more. Be part of the solution, don't put plastics into your organics cart!

Theme Three: Screening to remove contaminants is costly for the County.

- While the County employs both manual and mechanical methods to remove plastic and other contaminants from organics carts, the best method is what you can do at home. Make sure only organics material goes into your food scraps and yard waste cart. When in doubt, leave it out. Be a contamination-fighting hero - keep your organics pure!
- Did you know? Plastic bags wreak havoc on compost facility machinery. They clog up the equipment, causing it to shut down. This can damage the equipment and lead to higher costs. Do your part, keep plastic bags out of your organics cart!
- Our County grapples with the financial burden of purchasing and maintaining expensive compost facilty machinery and dedicating staff to contamination removal. Help keep costs in check by keeping plastics and other contaminants out of your organics cart. Be a cost-conscious champion - keep your organics clean!
- Compost is an amazing material that benefits soil by providing nutrients, microbes, and improved soil structure. The County can generate revenue from the sale of our finished compost as long as we keep plastic and other contaminants out of it. Keep plastic out, and let's turn compost into cash!
- Glass is a safety concern for our compost haulers and facility staff. Be a safety ally, keep glass out of your organics cart!

Theme Four: **It's up to you: preventing contaminants from entering organic waste bins is an individual responsibility.**

- While the County employs both manual and mechanical methods to remove contaminants, this is expensive and imperfect! Contamination removal is best done at home. As you collect your household's food scraps, remember that proper sorting is key to clean compost. Ensure only organic waste goes into your compost bin. Take action today to be a clean compost champion!
- While the County employs both manual and mechanical methods to remove contaminants, this is expensive! The ideal way to manage contamination is to prevent it from entering the compost stream in the first place. Make sure only organics material goes into your food scraps and yard waste cart. When in doubt, leave it out!
- To create quality compost at the end of our County's food waste recycling process, it needs to be free of non-compostable material. The compost quality journey starts with you. As you collect your food scraps, remember - no plastics or non-organics allowed. Be the change at home and keep your compost stream clean!

Evaluation of Outreach and Education

Periodically evaluate whether your messaging is reaching and impacting your target community. This could be done through measuring outputs (reach and engagement indicators) through activities such as social media (likes, shares), and tracking materials messaging (number of recipients). Additionally, measure outcomes such the amount of food waste diverted from landfills, the percentage of contamination over time, the number of individuals who signed up for service or started putting food scraps in their composting bins, and shifts in awareness and attitudes towards to compost participation. This can be done through surveys that track awareness, attitudes and behaviors, and waste audits for a comprehensive understanding. The ultimate goal is to ensure that your messaging fosters improved public comprehension of key points and drives positive change in composting practices.

Appendix F:

Capital and O&M Cost Estimates

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Montgomery County Siting Study

Engineer's Estimate of Probable Capital Costs

Option 1 - ASP Composting at Montgomery County Yard Trim Composting Facility (MCYTCF)

October 2023

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		FACILITY CAPITAL COSTS						
1	Construction Mobilization	Site mobilization, including equipment, office trailer establishment, submittals, bonding, and construction administration. Assume 5% of facility capital costs.	$628,000	LS	1	$628,000	0.9	$574,100
2	Site Preparation at Shady Grove TS	Site preparation for material receiving on-site, including relocation of existing site activities and minor site demolition in Upper Lot or other area for siting of material receiving and pre-processing.	$500,000	LS	1.0	$500,000	1.0	$500,000
3	Site Preparation at MCYTCF	Site preparation including topographic survey and minor site demolition.	$5,000	AC	10.5	$52,700	7.7	$38,700
4	Erosion and Sediment Controls at MCYTCF	Site controls, including silt fence, diversion fence, stabilized construction entrances, rip rap, stabilization, etc.	$150,000	LS	1.0	$150,000	0.7	$110,200
5	Stormwater Management at MCYTCF	Stormwater management facility repair, including retrofit to existing SWM ponds.	$300,000	LS	0.75	$225,000	0.25	$75,000
6	Site Access Road Improvements at MCYTCF	Improvements to 30 ft two-lane asphalt access road.	$200,000	LS	0.75	$150,000	0.25	$50,000
7	Concrete Pad at Shady Grove TS	12" thick reinforced concrete pad with 12" no. 57 stone, in area of feedstock receiving.	$101.00	SY	6,800	$686,800	16,200	$1,636,200
8	Receiving Building at Shady Grove TS	Pre-engineered steel building, 120' width clear, span rigid frame, for feedstock receiving. Includes aeration and biofilter. Includes SWM facility construction and E&SC.	$30.00	SF	61,000	$1,830,000	-	$0
9	Concrete Pad at MCYTCF	12" thick reinforced concrete pad with 12" no. 57 stone, in area of active composting.	$101.00	SY	5,570	$562,570	12,280	$1,240,300
10	ASP Composting Equipment	Assume covered aerated static pile compost system featuring high flow aeration and automated controls, covers, monitoring equipment, installation guide, and operations training.	$13,824,700	LS	0.5	$6,912,400	0.5	$6,912,400
11	Asphalt Pad Improvements at MCYTCF	Improvements to 25% of existing bituminous pavement pad in compost curing, screening, storage and distribution areas. Assume 7" HMA and 4" GAB section.	$60.00	SY	10,080	$604,800	4,050	$243,000
12	Contact Water Storage Tanks	2-15k gallon storage tanks for contact water holding and reuse as process water.	$30,900	EA	2.00	$61,800	1.00	$30,900
13	Electrical and Communications	Electrical site service and communication connections upgrades, including telecom and system commissioning; excluding primary cables and BGE charges.	$250,000	LS	0.75	$187,500	0.25	$62,500
			SUBTOTAL			**$12,552,000**		**$11,474,000**
			CONTINGENCY (30%)			**$3,766,000**		**$3,443,000**
			TOTAL CAPITAL COSTS			**$16,318,000**		**$14,917,000**

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		ANNUAL OPERATIONS AND MAINTENANCE COSTS						
1	Labor and Utilities Cost							
		Full-time Facility Supervisor at Shady Grove TS.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at Shady Grove TS.	$70,200.00	EA	2	$140,400	5	$351,000
		Part-time Facility Technician at Shady Grove TS.	$84,240.00	EA	1	$84,300	1	$84,300
		Full-time Facility Supervisor at MCYTCF.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at MCYTCF.	$70,200.00	EA	2	$140,400	5	$351,000
		Full-time Bagging Operators at MCYTCF.	$70,200.00	EA	1	$70,200	3	$210,600
		Electrical.	$0.15	$/kWh	23,200	$3,500	63,900	$9,600
		Water addition during material pre-processing.	$0.02	$/gallons	5,051,500	$100,100	13,966,500	$276,600
2	Equipment							
	Grinder	Annual cost, assuming 5 yr service life.	$220,000.00	$/Year	2	$440,000	4	$880,000
	Loader	Annual cost, assuming 8 yr service life.	$37,500.00	$/Year	4	$150,000	10	$375,000
	Screener	Annual cost, assuming 5 yr service life.	$30,000.00	$/Year	1	$30,000	2	$60,000
	Replacement Covers	Annual cost, assuming 7 yr service life.	$291,428.57	$/Year	1	$291,429	2	$582,857
	Cover Winder Machine	Annual cost, assuming 15 yr service life.	$23,333.33	$/Year	1	$23,333	1	$23,333
	Misc Maintenance Costs	Replacement cables, sensors, probes, etc.	$60,000.00	$/Year	1	$60,000	1	$60,000
	Equipment Repairs		$175,000.00	$/Year	1	$175,000	1	$175,000
	Fuel	Fuel for Grinder, Loaders, Screener and Cover Winder.	$4.00	GAL	26,700	$106,800	56,700	$226,800
3	Service							
		Annual Software Subscription Service, and Annual Support Contract with On-Site Service Check & Report.	$74,800.00	$/Yr	1	$74,800	1	$74,800
4	Material Transportation							
		Assume 25% increase over average truck haul cost ($12.72/ton, $17.61 from Silver Spring) and rail haul cost ($15.03/ton)	$18.90	$/Ton	67,600	$1,277,700	186,900	$3,532,500
		Covered hopper rail cars for yard trim and food scrap transport to MCYTCF.	$10,000.00	$/Year	10	$100,000	10	$100,000
		TOTAL ANNUAL O&M COSTS				**$3,470,000**		**$7,580,000**

Montgomery County Siting Study
Engineer's Estimate of Probable Capital Costs
Option 2 - In-Vessel Tunnel Reactor Composting at Shady Grove TS and Product Finishing at MCYTCF
October 2023

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		FACILITY CAPITAL COSTS						
1	Construction Mobilization	Site mobilization, including equipment, office trailer establishment, submittals, bonding, and construction administration. Assume 5% of facility capital costs.	$1,628,000	LS	1	$1,628,000	0.5	$788,600
2	Land Acquisition of Casey Parcels	Acquisition of 13.2 ac adjacent parcels. Market value assumed at double 2023 property valuation of $6M.	$12,000,000	LS	1	$12,000,000	0.0	$0
3	Site Preparation at Casey Parcels	Site preparation including wetland and stream delineation, forest conservation and additional site permitting and development.	$1,500,000	LS	1.0	$1,500,000	0.5	$750,000
4	Site Preparation at Shady Grove TS	Site preparation including relocation of existing site activities and minor site demolition in area of material receipt and active composting.	$500,000	LS	1.0	$500,000	1.0	$500,000
5	Site Preparation at MCYTCF	Site preparation including topographic survey and minor site demolition.	$5,000	AC	9.6	$48,200	5.6	$28,300
6	Erosion and Sediment Controls at Shady Grove TS	Site controls, including silt fence, diversion fence, stabilized construction entrances, rip rap, stabilization, etc. Includes Casey parcels.	$400,000	LS	0.75	$300,000	0.25	$100,000
7	Erosion and Sediment Controls at MCYTCF	Site controls, including silt fence, diversion fence, stabilized construction entrances, rip rap, stabilization, etc.	$150,000	LS	1.0	$150,000	0.6	$88,000
8	Stormwater Management at Shady Grove TS	Existing Stormwater management facility upgrades. New stormwater management facilities for Casey parcels.	$450,000	LS	0.75	$337,500	0.25	$112,500
9	Stormwater Management at MCYTCF	Stormwater management facility repair, including retrofit to existing SWM ponds.	$300,000	LS	0.75	$225,000	0.25	$75,000
10	Site Access Road Improvements at MCYTCF	Improvements to 30 ft two-lane asphalt access road.	$300,000	LS	0.75	$225,000	0.25	$75,000
11	Concrete Pad at Shady Grove TS	12" thick reinforced concrete pad with 12" no. 57 stone, in area of feedstock receiving and active composting. Includes incidental earthwork.	$101.00	SY	10,620	$1,072,620	9,200	$929,200
12	Receiving Building at Shady Grove TS	Pre-engineered steel building, 120' width clear, span rigid frame, for feedstock receiving. Includes aeration and biofilter. Includes SWM facility construction and E&SC.	$30.00	SF	61,000	$1,830,000	-	$0
13	In-Vessel Composting Equipment at Shady Grove TS	Includes concrete and stainless steel tunnel-type composting components, aeration system, control and monitoring system, motorized doors, and biofilter system. Includes equipment and construction.	$23,692,800	LS	0.5	$11,846,400	0.5	$11,846,400
14	Asphalt Pad Improvements at MCYTCF	Improvements to 25% of existing bituminous pavement pad in compost curing, screening, storage and distribution areas. Assume 7" HMA and 4" GAB section.	$60.00	SY	11,650	$699,000	6,830	$409,800
15	Electrical and Communications	Electrical site service and communication connections upgrades at Shady Grove TS, including telecom and system commissioning; excluding primary cables and BGE charges.	$250,000	LS	0.75	$187,500	0.25	$62,500
			SUBTOTAL			**$32,550,000**		**$15,766,000**
			CONTINGENCY (30%)			**$9,765,000**		**$4,730,000**
			TOTAL CAPITAL COSTS			**$42,315,000**		**$20,496,000**

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		ANNUAL OPERATIONS AND MAINTENANCE COSTS						
1	Labor and Utilities Cost							
		Full-time Facility Supervisor at Shady Grove TS.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at Shady Grove TS.	$70,200.00	EA	5	$351,000	7	$491,400
		Full-time Facility Technician at Shady Grove TS.	$168,480.00	EA	1	$168,500	2	$337,000
		Full-time Facility Supervisor at MCYTCF.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at MCYTCF.	$70,200.00	EA	3	$210,600	7	$491,400
		Full-time Bagging Operators at MCYTCF.	$70,200.00	EA	1	$70,200	3	$210,600
		Electrical at Shady Grove TS.	$0.15	$/kWh	2,104,400	$315,700	4,208,800	$631,400
		Water addition during active composting.	$0.02	$/gallons	10,989,800	$217,600	12,569,900	$248,900
2	Equipment							
	Grinder	Annual cost, assuming 5 yr service life.	$220,000.00	$/Year	2	$440,000	3	$660,000
	Loader	Annual cost, assuming 8 yr service life.	$37,500.00	$/Year	8	$300,000	14	$525,000
	Screener	Annual cost, assuming 5 yr service life.	$30,000.00	$/Year	1	$30,000	2	$60,000
	Misc Maintenance Costs	Replacement cables, sensors, probes, etc.	$250,000.00	$/Year	1	$250,000	1	$250,000
	Equipment Repairs		$250,000.00	$/Year	1	$250,000	2	$500,000
	Fuel	Fuel for Grinder, Loaders, and Screener.	$4.00	GAL	36,700	$146,800	63,400	$253,600
3	Service							
		Annual Support.	$125,000.00	LS	1	$125,000	1	$125,000
4	Material Transportation							
		Assume 25% increase over average truck haul cost ($12.72/ton, $17.61 from Silver Spring) and rail haul cost ($15.03/ton).	$18.90	$/Ton	77,300	$1,461,000	213,700	$4,039,000
		Covered hopper rail cars for yard trim and food scrap transport to MCYTCF.	$10,000.00	$/Year	10	$100,000	10	$100,000
		TOTAL ANNUAL O&M COSTS				**$4,640,000**		**$9,130,000**

Montgomery County Siting Study
Engineer's Estimate of Probable Capital Costs
Option 3 - Agitated Bed Composting at Site 2
October 2023

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		FACILITY CAPITAL COSTS						
1	Construction Mobilization	Site mobilization, including equipment, office trailer establishment, submittals, bonding, and construction administration. Assume 5% of facility capital costs.	$2,743,000	LS	1	$2,743,000	0.3	$704,600
2	Site Preparation at Shady Grove TS	Site preparation for material receiving on-site, including relocation of existing site activities and minor site demolition in Upper Lot or other area for siting of material receiving and pre-processing.	$500,000	LS	1.0	$500,000	1.0	$500,000
3	Site Preparation at Site 2	Site preparation including topographic survey, wetland and stream delineation, tree removal, site permitting and site development.	$50,000	AC	9.6	$481,300	5.6	$282,200
4	Erosion and Sediment Controls at Site 2	Site controls, including silt fence, diversion fence, stabilized construction entrances, rip rap, stabilization, etc.	$300,000	LS	1.0	$300,000	0.6	$175,900
5	Stormwater Management at Site 2	Stormwater management facility construction. Includes storm drain piping, manholes, fittings and appurtenances.	$550,000	LS	0.75	$412,500	0.25	$137,500
6	Site Access Road Development at Site 2	Development of internal roadway from RRF railyard to Site 2 through GeoOn site.	$1,000,000	MILE	1.55	$1,550,000	0.45	$450,000
7	Concrete Pad at Shady Grove TS	12" thick reinforced concrete pad with 12" no. 57 stone, in area of feedstock receiving and active composting.	$101.00	SY	6,800	$686,800	-	$0
8	Receiving Building at Shady Grove TS	Pre-engineered steel building, 120' width clear, span rigid frame, for feedstock receiving. Includes aeration and biofilter. Includes SWM facility construction and E&SC.	$30.00	SF	61,000	$1,830,000	-	$0
9	Concrete Pad at Site 2	12" thick reinforced concrete pad with 12" no. 57 stone, in area of feedstock receiving and active composting.	$101.00	SY	32,500	$3,282,500	-	$0
10	Agitated Bed Compost Building at Site 2	120,000 SF Insulated coated steel structure, ventilated to house full build out (Phase I and II) of agitated bed equipment, including material receiving and active composting areas.	$150	SF	118,500	$17,775,000	-	$0
11	Agitated Bed Composting Equipment at Site 2	30 compost bays, 5-100 HP agitators, aeration equipment for four aeration zones per bay; biofilter, including concrete, ductwork, fans and media.	$20,100,000	LS	0.5	$10,050,000	0.5	$10,050,000
12	Asphalt Pad Construction at Site 2	Installation of bituminous pavement pad in compost curing, screening, storage and distribution areas. Assume 7" HMA and 4" GAB section.	$60.00	SY	46,590	$2,795,400	27,320.00	$1,639,200
13	Electrical and Communications	Electrical site service and communication establishment at Site 2, including telecom and system commissioning; excluding primary cables and BGE charges.	$600,000	LS	0.75	$450,000	0.25	$150,000
14	Water	Public water main extension approximately 4.0 miles in length along MD 107 (Whites Ferry Road) and Wasche Road.	$3,000,000	MILE	4.00	$12,000,000	-	$0
			SUBTOTAL			**$54,857,000**		**$14,090,000**
			CONTINGENCY (30%)			**$16,458,000**		**$4,227,000**
			TOTAL CAPITAL COSTS			**$71,315,000**		**$18,317,000**

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		ANNUAL OPERATIONS AND MAINTENANCE COSTS						
1	Labor and Utilities Cost							
		Full-time Facility Supervisor at Shady Grove TS.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at Shady Grove TS.	$70,200.00	EA	2	$140,400	5	$351,000
		Part-time Facility Technician at Shady Grove TS.	$84,240.00	EA	1	$84,300	1	$84,300
		Full-time Facility Supervisor at Site 2.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at Site 2.	$70,200.00	EA	4	$280,800	9	$631,800
		Full-time Bagging Operators at Site 2.	$70,200.00	EA	1	$70,200	3	$210,600
		Electrical at Site 2.	$0.15	$/kWh	2,104,400	$315,700	4,208,800	$631,400
		Water addition during active composting.	$0.02	$/gallons	4,546,400	$90,100	12,569,900	$248,900
2	Equipment							
	Grinder	Annual cost, assuming 5 yr service life.	$220,000.00	$/Year	2	$440,000	4	$880,000
	Loader	Annual cost, assuming 8 yr service life.	$37,500.00	$/Year	6	$225,000	14	$525,000
	Screener	Annual cost, assuming 5 yr service life.	$30,000.00	$/Year	1	$30,000	2	$60,000
	Misc Maintenance Costs	Replacement cables, sensors, probes, etc.	$150,000.00	$/Year	1	$150,000	1	$150,000
	Equipment Repairs		$250,000.00	$/Year	1	$250,000	2	$500,000
	Fuel	Fuel for Grinder, Loaders, and Screener.	$4.00	GAL	30,000	$120,000	66,700	$266,800
3	Service							
		Annual Support.	$50,000.00	LS	1	$50,000	1	$50,000
4	Material Transportation							
		Assume 25% increase over average truck haul cost ($12.72/ton, $17.61 from Silver Spring) and rail haul cost ($15.03/ton)	$18.90	$/Ton	67,600	$1,277,700	186,900	$3,532,500
		Covered hopper rail cars for yard trim and food scrap transport to Site 2.	$10,000.00	$/Year	10	$100,000	10	$100,000
		TOTAL ANNUAL O&M COSTS				**$3,830,000**		**$8,430,000**

Montgomery County Siting Study

Engineer's Estimate of Probable Capital Costs

Option 4 - Dry Fermentation Anaerobic Digestion at Shady Grove TS with Product Finishing at MCYTCF via Tunnel Reactor Composting

October 2023, Revised March 2024

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		FACILITY CAPITAL COSTS						
1	Construction Mobilization	Site mobilization, including equipment, office trailer establishment, submittals, bonding, and construction administration. Assume 5% of facility capital costs.	$2,891,000	LS	1	$2,891,000	0.9	$2,625,300
2	Land Acquisition of Casey Parcels	Acquisition of 13.2 ac adjacent parcels. Market value assumed at double 2023 property valuation of $6M.	$12,000,000	LS	1	$12,000,000	0.0	$0
3	Site Preparation at Casey Parcels	Site preparation including wetland and stream delineation, forest conservation and additional site permitting and development.	$1,500,000	LS	1.0	$1,500,000	0.5	$750,000
4	Site Preparation at Shady Grove TS	Site preparation including relocation of existing site activities and minor site demolition in area of material receipt and AD.	$500,000	LS	1.0	$500,000	1.0	$500,000
5	Site Preparation at MCYTCF	Site preparation including topographic survey and minor site demolition.	$5,000	AC	9.6	$48,200	5.6	$28,300
6	Erosion and Sediment Controls at Shady Grove TS	Site controls, including silt fence, diversion fence, stabilized construction entrances, rip rap, stabilization, etc. Includes Casey parcels.	$400,000	LS	0.75	$300,000	0.25	$100,000
7	Erosion and Sediment Controls at MCYTCF	Site controls, including silt fence, diversion fence, stabilized construction entrances, rip rap, stabilization, etc.	$150,000	LS	1.0	$150,000	0.6	$88,000
8	Stormwater Management at Shady Grove TS	Existing Stormwater management facility upgrades. New stormwater management facilities for Casey parcels.	$450,000	LS	0.75	$337,500	0.25	$112,500
9	Stormwater Management at MCYTCF	Stormwater management facility repair, including retrofit to existing SWM ponds.	$300,000	LS	0.75	$225,000	0.25	$75,000
10	Site Access Road Improvements at MCYTCF	Improvements to 30 ft two-lane asphalt access road.	$300,000	LS	0.75	$225,000	0.25	$75,000
11	Concrete Pad at Shady Grove TS	12" thick reinforced concrete pad with 12" no. 57 stone, in area of feedstock receiving and AD.	$101.00	SY	14,460	$1,460,460	21,220	$2,143,300
12	Receiving Building at Shady Grove TS	Pre-engineered steel building, 120' width clear, span rigid frame, for feedstock receiving. Includes aeration and biofilter. Includes SWM facility construction and E&SC.	$30.00	SF	61,000	$1,830,000	-	$0
13	Dry Fermentation Anaerobic Digestion at Shady Grove TS	Dry fermentation AD reactors, controls, and equipment.	$45,000,000	LS	0.35	$15,750,000	0.65	$29,250,000
14	Hydrogen Conversion Equipment	Methane to hydrogen conversion equipment. Assume 180 SCFM capacity.	$9,525,000.00	LS	0.75	$7,143,800	0.25	$2,381,250
15	Concrete Pad at MCYTCF	12" thick reinforced concrete pad with 12" no. 57 stone, in area of feedstock receiving and active composting.	$101.00	SY	3,840	$387,840	10,610	$1,071,700
16	In-Vessel Composting Equipment at MCYTCF	Includes concrete and stainless steel tunnel-type composting components, aeration system, control and monitoring system, motorized doors, and biofilter system. Includes equipment and construction.	$23,692,800	LS	0.5	$11,846,400	0.5	$11,846,400
17	Asphalt Pad Improvements at MCYTCF	Improvements to 25% of existing bituminous pavement pad in compost curing, screening, storage and distribution areas. Assume 7" HMA and 4" GAB section.	$60.00	SY	11,650	$699,000	6,830	$409,800
18	Electrical and Communications at Shady Grove TS	Electrical site service and communication connections upgrades at Shady Grove TS, including telecom and system commissioning; excluding primary cables and BGE charges.	$400,000	LS	0.75	$300,000	0.25	$100,000
19	Electrical and Communications at MCYTCF	Electrical site service and communication connections upgrades at MCYTCF, including telecom and system commissioning; excluding primary cables and BGE charges.	$300,000	LS	0.75	$225,000	0.25	$75,000
			SUBTOTAL			**$57,820,000**		**$51,632,000**
			CONTINGENCY (30%)			**$17,346,000**		**$15,490,000**
			TOTAL CAPITAL COSTS			**$75,166,000**		**$67,122,000**

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		ANNUAL OPERATIONS AND MAINTENANCE COSTS						
1	Labor and Utilities Cost							
		Full-time Facility Supervisor at Shady Grove TS.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at Shady Grove TS.	$70,200.00	EA	6	$421,200	8	$561,600
		Full-time Facility Technician at Shady Grove TS.	$168,480.00	EA	1	$168,500	2	$337,000
		Full-time Facility Supervisor at MCYTCF.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at MCYTCF.	$70,200.00	EA	5	$351,000	7	$491,400
		Full-time Bagging Operators at MCYTCF.	$70,200.00	EA	1	$70,200	3	$210,600
		Full-time Facility Technician at MCYTCF.	$168,480.00	EA	1	$168,500	2	$337,000
		Electrical at Shady Grove TS.	$0.15	$/kWh	2,104,400	$315,700	4,208,800	$631,400
		Electrical at MCYTCF.	$0.15	$/kWh	2,104,400	$315,700	4,208,800	$631,400
		Water addition during active composting.	$0.02	$/gallons	10,989,800	$217,600	12,569,900	$248,900
2	Equipment							
	Grinder	Annual cost, assuming 5 yr service life.	$220,000.00	$/Year	2	$440,000	3	$660,000
	Loader	Annual cost, assuming 8 yr service life.	$37,500.00	$/Year	11	$412,500	15	$562,500
	Screener	Annual cost, assuming 5 yr service life.	$30,000.00	$/Year	1	$30,000	2	$60,000
	Misc Maintenance Costs	Replacement cables, sensors, probes, etc.	$350,000.00	$/Year	1	$350,000	1	$350,000
	Equipment Repairs		$250,000.00	$/Year	1	$250,000	2	$500,000
	Fuel	Fuel for Grinder, Loaders, and Screener.	$4.00	GAL	46,700	$186,800	66,700	$266,800
3	Service							
		Annual Support.	$250,000.00	LS	1	$250,000	1	$250,000
4	Material Transportation							
		Assume 25% increase over average truck haul cost ($12.72/ton, $17.61 from Silver Spring) and rail haul cost ($15.03/ton)	$18.90	$/Ton	77,300	$1,461,000	213,700	$4,039,000
		Covered hopper rail cars for yard trim and food scrap transport to MCYTCF.	$10,000.00	$/Year	10	$100,000	10	$100,000
		High pressure tube trailer for Hydrogen gas transport.	$600,000.00	EA	1	$600,000	2	$1,200,000
			TOTAL ANNUAL O&M COSTS			**$6,310,000**		**$11,640,000**

Montgomery County Siting Study

Engineer's Estimate of Probable Capital Costs

Option 5 - Dry Fermentation Anaerobic Digestion at Shady Grove TS with Product Finishing at MCYTCF

October 2023, Revised March 2024

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		FACILITY CAPITAL COSTS						
1	Construction Mobilization	Site mobilization, including equipment, office trailer establishment, submittals, bonding, and construction administration. Assume 5% of facility capital costs.	$2,248,000	LS	1	$2,248,000	0.9	$1,942,700
2	Land Acquisition of Casey Parcels	Acquisition of 13.2 ac adjacent parcels. Market value assumed at double 2023 property valuation of $6M.	$12,000,000	LS	1	$12,000,000	0.0	$0
3	Site Preparation at Casey Parcels	Site preparation including wetland and stream delineation, forest conservation and additional site permitting and development.	$1,500,000	LS	1.0	$1,500,000	0.5	$750,000
4	Site Preparation at Shady Grove TS	Site preparation including relocation of existing site activities and minor site demolition in area of material receipt and AD.	$500,000	LS	1.0	$500,000	1.0	$500,000
5	Site Preparation at MCYTCF	Site preparation including topographic survey and minor site demolition.	$5,000	AC	9.6	$48,200	5.6	$28,300
6	Erosion and Sediment Controls at Shady Grove TS	Site controls, including silt fence, diversion fence, stabilized construction entrances, rip rap, stabilization, etc. Includes Casey parcels.	$400,000	LS	0.75	$300,000	0.25	$100,000
7	Erosion and Sediment Controls at MCYTCF	Site controls, including silt fence, diversion fence, stabilized construction entrances, rip rap, stabilization, etc.	$150,000	LS	1.0	$150,000	0.6	$88,000
8	Stormwater Management at Shady Grove TS	Existing Stormwater management facility upgrades. New stormwater management facilities for Casey parcels.	$450,000	LS	0.75	$337,500	0.25	$112,500
9	Stormwater Management at MCYTCF	Stormwater management facility repair, including retrofit to existing SWM ponds.	$300,000	LS	0.75	$225,000	0.25	$75,000
10	Site Access Road Improvements at MCYTCF	Improvements to 30 ft two-lane asphalt access road.	$300,000	LS	0.75	$225,000	0.25	$75,000
11	Concrete Pad at Shady Grove TS	12" thick reinforced concrete pad with 12" no. 57 stone, in area of feedstock receiving and AD.	$101.00	SY	14,460	$1,460,460	21,220	$2,143,300
12	Receiving Building at Shady Grove TS	Pre-engineered steel building, 120' width clear, span rigid frame, for feedstock receiving. Includes aeration and biofilter. Includes SWM facility construction and E&SC.	$30.00	SF	61,000	$1,830,000	-	$0
13	Dry Fermentation Anaerobic Digestion at Shady Grove TS	Dry fermentation AD reactors, controls, and equipment.	$45,000,000	LS	0.35	$15,750,000	0.65	$29,250,000
14	Hydrogen Conversion Equipment at Shady Grove TS	Methane to hydrogen conversion equipment. Assume 180 SCFM capacity.	$9,525,000.00	LS	0.75	$7,143,800	0.25	$2,381,250
15	Asphalt Pad Improvements at MCYTCF	Improvements to 25% of existing bituminous pavement pad in compost curing, screening, storage and distribution areas. Assume 7" HMA and 4" GAB section.	$60.00	SY	11,650	$699,000	6,830	$409,800
16	Electrical and Communications at Shady Grove TS	Electrical site service and communication connections upgrades at Shady Grove TS, including telecom and system commissioning; excluding primary cables and BGE charges.	$400,000	LS	0.75	$300,000	0.25	$100,000
17	Electrical and Communications at MCYTCF	Electrical site service and communication connections upgrades at MCYTCF, including telecom and system commissioning; excluding primary cables and BGE charges.	$300,000	LS	0.75	$225,000	0.25	$75,000
			SUBTOTAL			**$44,942,000**		**$38,031,000**
			CONTINGENCY (30%)			**$13,483,000**		**$11,410,000**
			TOTAL CAPITAL COSTS			**$58,425,000**		**$49,441,000**

Item	Cost Categories and Items	Description	Unit Cost	Units	Ph I Qty	Ph I Cost	Ph II Qty	Ph II Cost
		ANNUAL OPERATIONS AND MAINTENANCE COSTS						
1	Labor and Utilities Cost							
		Full-time Facility Supervisor at Shady Grove TS.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at Shady Grove TS.	$70,200.00	EA	6	$421,200	8	$561,600
		Full-time Facility Technician at Shady Grove TS.	$168,480.00	EA	1	$168,500	2	$337,000
		Full-time Facility Supervisor at MCYTCF.	$105,300.00	EA	1	$105,300	1	$105,300
		Full-time Facility Operators at MCYTCF.	$70,200.00	EA	2	$140,400	5	$351,000
		Full-time Bagging Operators at MCYTCF.	$70,200.00	EA	1	$70,200	3	$210,600
		Electrical at Shady Grove TS.	$0.15	$/kWh	2,104,400	$315,700	4,208,800	$631,400
		Water addition during active composting.	$0.02	$/gallons	12,569,900	$248,900	10,989,800	$217,600
2	Equipment							
	Grinder	Annual cost, assuming 5 yr service life.	$220,000.00	$/Year	2	$440,000	3	$660,000
	Loader	Annual cost, assuming 8 yr service life.	$37,500.00	$/Year	8	$300,000	13	$487,500
	Screener	Annual cost, assuming 5 yr service life.	$30,000.00	$/Year	1	$30,000	2	$60,000
	Misc Maintenance Costs	Replacement cables, sensors, probes, etc.	$250,000.00	$/Year	1	$250,000	1	$250,000
	Equipment Repairs		$250,000.00	$/Year	1	$250,000	2	$500,000
	Fuel	Fuel for Grinder, Loaders, and Screener.	$4.00	GAL	36,700	$146,800	60,000	$240,000
3	Service							
		Annual Support.	$125,000.00	LS	1	$125,000	1	$125,000
4	Material Transportation							
		Assume 25% increase over average truck haul cost ($12.72/ton, $17.61 from Silver Spring) and rail haul cost ($15.03/ton)	$18.90	$/Ton	77,300	$1,461,000	213,700	$4,039,000
		Covered hopper rail cars for yard trim and food scrap transport to MCYTCF.	$10,000.00	$/Year	10	$100,000	10	$100,000
		High pressure tube trailer for Hydrogen gas transport.	$600,000.00	EA	1	$600,000	2	$1,200,000
		TOTAL ANNUAL O&M COSTS				**$5,270,000**		**$10,180,000**

Appendix G:

Vendor Product Information

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Technical Memo

Attention: Regina Cagle P.E. **Date:** September 18, 2023

From: Brian Fuchs
Brett Hoyt

Purpose: Maryland Project SSO 260k tons/ year
SG Bunker® System with GORE® Cover Support Information

Project Description: Sustainable Generation and GORE® Cover is providing system sizing, preliminary layout and budgetary information for processing of Source Separated organics (SSO) organic waste. For discussion purposes only.

Enclosed we will provide concepts for developing a compost facility based on experience from similar design concepts, similar feed stocks and similar climate conditions.

We are using our standard 2 Phase 6-week (42 days) process to achieve regulatory compliant stabilized high-quality compost. While achieving a high level of environmental controls for protection of air (odors and VOC emissions) and water (separation of leachate from storm water) quality.

Note: Our scope of supply is centered on the composting portion of the project for supply of equipment and services for the SG Bunker® System using GORE® Cover technology. All other critical components, scale, office buildings, receiving area (open or covered), biofilter and adjacent processing equipment and materials handling outside the composting pad to be supplied by other. We are happy to share our experience from relevant reference facilities.

Key Assumptions:

- **~200,000-ton green organics (leaf & yard debris, landscaping and clean wood waste)**
- **~60,000-ton food organics (residential and/or commercial)**
- **SG Bunker® System with GORE® Cover**
- **Power supply (clean power, solar, generator….)**

Mass Balance Calculations and Assumptions

Assumptions	Project Information	
Feed Stocks (Organics)	SSO, Bulking Materials and Screened Over's	
Total Throughput Volume / Year	Tons	Cubic Yards @ 925lbs/y^3
Design Capacity Required	260,000	562,162
Design Capacity Proposed	261,398	565,185
Total Compost Pad Footprint	~ 8.0 acres including driving area	
Treatment Time	2 Phase Process – 42 Days*	
Phase 1 Active Composting	21 Days (or 28 Days)	
Phase 2 Maturation Composting	21 Days (or 14 Days)	

*Mixed adjusted

SG Bunker® System Sizing & Design Capacity:

Process Time		6	weeks	Active	Curing	Finishing
				Phase 1	Phase 2	Phase 3
Days per Week Operation		6				
# of Bunkers		48		24	24	0
Heap Length		164	ft			
Heap Width	inside wall	25.67	ft			
Heap Height		12	ft			
Actual Mix*		**925**	**lbs/y3**		0.46	US ton/y3
Volume per bunker		1359	y3			
Volume on pad	(if pad full)	65214	y3			
Total Throughput Volume						
	per year	**565185**	**y3**			
	per week	**10869**	**y3**			
	per day	**1811**	**y3**			
Tons per bunker		628	US ton			
Tons per pad (if pad full)		30161	US ton			
Total Throughput Tons		**Actual mix***				
	per year	**261398**	**US ton**			
	per week	**4189**	**US ton**			
	per day	**838**	**US ton**			
Foot Print/ Space Required						
	Compost Pad Length	175	ft			
	Compost Pad Width	1647	ft			
	Compost Pad	**288254**	**sq ft**	**6.62**	**acre**	
	Driving Space	65887	sq ft			
Total Compost Pad		**354141**	**sq ft**	**8.13**	**acre**	
***Actual Mix is mixed input material entering Phase 1; inclusive of screened overs and added process water to adjust moisture**						

The **SG Bunker® System** solution **Budgetary Pricing**: Purchase

GORE® Cover System	Configuration	Pricing ($USD)
SG Bunker® System	**48 SG Bunker® with 48 GORE® Cover**	
	164ft Length x 27ft Width x 11.5ft Height	
	SG Bunker® System	**Included**
SG SmartStart™	**Installation Guide, Pre-Design Support / Construction Support/ Installation Supervision**	
Service Package	**Commissioning, Start Up Services & Operating Training Module, Ongoing Technical Support**	**Included**
CWM	**Cover Winding Machine**	**Included**
	Total	**$ 11,000,000.00**

*Engineering Design, Construction not part SG scope of supply – supplied by other.

- Prices include estimated Duty and Shipping delivered to project site.
- All other Taxes not included.
- Tariffs not included, if any
- State and Local Sales Tax payable by Buyer
- Subject to Terms and Conditions in the formal Quotation

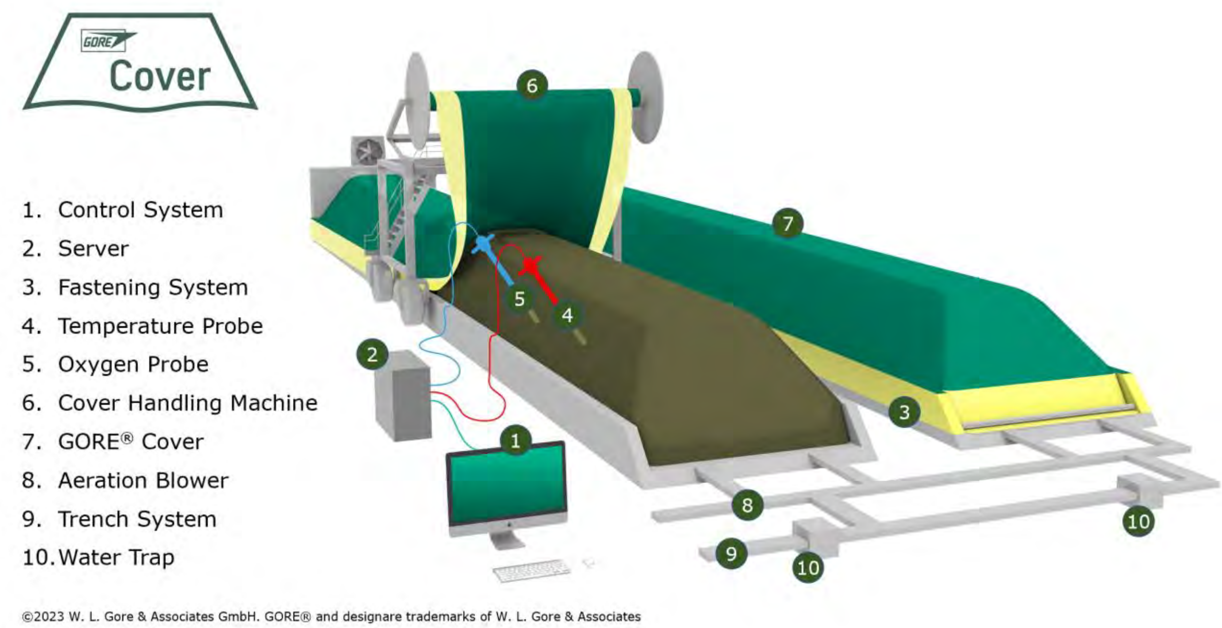
For budgetary purposes only, pricing and configuration are subject to change. Upon agreed equipment configuration and determined scope of work for services, a formal quote will be developed. Any and all information in this **budgetary quotation shall be kept confidential and shall not be shared with third parties without the express written approval of Sustainable Generation**.

Total Project Cost Summary Estimate: (See Capex Opex document September 18, 2023)

			All costs are in $USD	
Customer Worksheet:	**September 18, 2023**	**TOTAL CAPEX: SG BUNKER® System with Winder and SG Smartstart® Services (Civils & concrete works excluded)**	**$11,000,000**	
Regina Cagle		**TOTAL Annual Cost = OPEX**	**$1,359,920**	Years 1-4
EA Associates		**TOTAL Annual Cost = OPEX + Annual CAPEX Reserve**	**$1,737,063**	Starting Year 5
		Estimated Fully Constructed Cost for SG BUNKER® System only (includes SG CAPEX costs above)	***$24,000,000 - $30,000,000***	

The SG Bunker® System using GORE® COVER is an innovative solution that include:

Equipment and Service Supply Package



SG Bunker® System Equipment Supply Package

- **GORE® Cover**
- **SG Compost Control** system inclusive of software, programing and hardware
  - Server, PC, Laptop or Bunker Device
  - Modes of Operation
    - Interval Mode
    - O2 Mode
    - Manual Mode
    - Safety Mode
- **Temperature Probes**
- **Oxygen Probes**
- **Blower**
- **Aeration System** consisting of:
  - Polymer Concrete Trench for SG Bunker®
    - Water Trap
    - Leachate Collection Pipe
- **Side Wall Fastening System**
- **Winding Machine** type for deployment and retracting the GORE ® Cover.

SG Scope of Supply of Services

The SG Service (SG SmartStart™ Service Package) includes a high level of interaction between the owners, engineering consultants and the construction company. It is very important that the installation of the GORE® Cover technology and Operating Manual be followed to insure a successful installation and sustainable operation.

Installation Guide: According to Final Agreement

- Drawings, Component Specification, Detail and Installation Guidelines

Operations Manual: According to Final Agreement

- SG Bunker® System using GORE® Cover technology
- Cover Winder Machine

Permitting Support Services: According to Final Agreement

- Support permitting process with technical information

System Design Guidance / Support: As part of the Installation Guide Package

- Preliminary Layout and Drawings as defined in the bid document
- Layout Drawings to handed over to the Buyer's Engineer for design and construction

Construction Guidance / Support: According to Final Agreement

- Pre-Construction Meeting
- Installation Services/ Guidance
    - Aeration Trench Installation Support
    - Electronics Installation Support
- Portable Winding Machine Installation/Testing/Commissioning
- Compost Process Commissioning, Start Up and First Heap Construction
- Performance Test

Training for Site Management and Operators: According to Final Agreement

- Classroom and On-site training
    - Training 1 - at reference site or on-site (up to 3 days)
        - Site Reference Visits (optional)
    - Training 2 – during system check and start-up (up to 3 days)
    - Training 3 – 12 weeks after commissioning (up to 3 days)

<u>Typical Facility and Process Flow including all pertinent steps (see diagram)</u>

The overall design includes identifying the optimum layout for the facility and the best usage of available area. It is recommended that the layout of the compost pad be optimized taking into consideration:

- Practicality for the front-end loader to move between the heaps and to and from the pre-treatment to the compost pad and the screening/ storage area.
- Process water and storm water management.
- Likelihood of expanding the capacity of the facility.

Mix Recipe - Pre-treatment

Feedstock must be adequately prepared for composting in the GORE® Cover system. To be properly prepared, the feedstock must be mixed together in the right ratio to obtain:

- A beginning carbon to nitrogen ratio (C: N) of approximately 25-35:1.
- A beginning moisture content of approximately 55-65%
- Adequate structure material to optimize the mixed material porosity, sized to approximately 80mm or 3 inch minus shredded green/leaf/yard waste or wood chips.

Typical Compost Facility Layout and Process Flow Diagram

Step 1: Receiving Area / Tipping Building: (supplied by other)
The feedstock material will be received outdoors or inside a Tipping Building where it will be inspected for quality control. The feedstock materials will be mixed to create mix recipe.

Step 2: Mixing / Grinding Equipment: (supplied by other)

See Typical Compost Facility Layout and Process Flow Diagram (previous page)

Step 3: Phase 1: Active / High-Rate Composting – 21 to 28 Days*
The composting process begins with a front-end loader moving the material from the mixing area to a heap in the Phase I section to begin the active composting period. Once a heap is built, it is covered, the temperature and oxygen probes are installed and the software is turned on, which then controls the rate of aeration.

Step 4: Phase 2: Maturation / Curing – 14 to 21 Days*
After Phase I, the GORE® Cover is removed from the heap and the compost is moved by front- end loader to a heap in the Phase II area. Once a heap is built, it is covered, the temperature and oxygen probes are installed and the software is turned on, which then controls the rate of aeration.

Step 5: Phase 3: Finishing/ Curing – 14 Days (optional) NOT PART OF THIS PROPOSAL**
After Phase II, the compost is moved by front- end loader to a heap in the Phase III area. Once a heap is built, covered or uncovered, only the temperature probe is installed and the software is turned on, which then controls the rate of aeration.

Step 6: Screening Equipment (supplied by other)

Step 7: Storage: (supplied by other)
Finished compost material can then be screened upon leaving Phase III of the process. Typically, the screened material can be sold directly or placed into storage for additional curing/aging.

*** Phase 1 Active, Phase 2 Maturation / Curing treatment times are flexible depending on the quality of product being produced and the market that the finished compost is being applied.**

**** Phase 3 Finishing / Curing treatment is optional and generally used for temperature and moisture management prior to screening and storage. Phases can also be covered.**

SG Bunker® System using GORE® Cover

SG BUNKER® System with GORE® Covers
CAPEX OPEX Worksheet

Typical Model for SG BUNKER® System for Planning Purposes only. Customer specific model to be confirmed by customer's design engineer and project team.

Customer Worksheet: **September 18, 2023**
Regina Cagle
EA Associates

	All costs are in $USD	
TOTAL CAPEX: SG BUNKER® System with Winder and SG Smartstart® Services (Civils & concrete works excluded)	**$11,000,000**	
TOTAL Annual Cost = OPEX	**$1,359,920**	Years 1-4
TOTAL Annual Cost = OPEX + Annual CAPEX Reserve	**$1,942,777**	Starting Year 5

Estimated Fully Constructed Cost for SG BUNKER® System only (includes SG CAPEX costs above)	***$24,000,000 - $30,000,000***

ASSUMPTIONS Assumptions to be confirmed by Customer's Design Engineer and Project Team

SG BUNKER® System
- Standard Bunker Design
- Gore Covers for Phase 1 and 2
- Compost Control System
- In-Ground Trenching w/ Water Traps
- Cover Fastening System
- SG SmartStart® Service Pack

System Configuration- BATCH PROCESSING	TOTAL	Phase 1	Phase 2	Phase 3
# of Windrows	48	24	24	0
# of covers	48	24	24	0
Design	Bunker			
length (ft)	164			
width (ft)	27.0			
height (ft)	11.5			
Space beween bunker (ft)	7.0			
Driving Space (loader manuauveing in front of bunker for loading & unloading) (ft)	40			

System Throughput	US-Tons per Year*
	260,000

*includes bulking agent

Composting Pad Layout:	(ft)	(sq ft)
Length	175	
Width	1647	
Area		288254
Driving Space (loader manuauveing in front of bunker for loading & unloading)		65886
TOTAL COMPOST PAD w/ Driving Alleyway		354,140

CAPITAL COSTS

SG BUNKER® System	Price ($USD)
Complete System: Includes SG BUNKER® System Equipment, GORE® Covers, Installation Guide, Installation Supervision, Training.	Included
CWM Cover Winder Machine for Bunker Design	Included
Subtotal: SG BUNKER® System with Winder ($USD)	***$11,000,000***

Customer responsible for Design, Engineering, Permitting and Construction costs

CAPEX Reserve	($USD)	
Cover average life span in years	7	*Typical Cover lifespan is 6-8 years*
Replacement Cover Price($USD)	$85,000	
Total Cap Ex Replacement Reserve each 7 years($USD)	$4,080,000	
Annual CAPEX Reserve Fund($USD)	**$582,857**	

OPERATIONAL COSTS

TYPICAL OPEX (Composting Pad only- does not include scale, grinding/mixing/screening/storage/site housekeeping)

Material Movement	**Units**	Total Hours	
Hours per Heap- (hr)	5.0		
Cover/Rim Placement (hr)	1		
Phase 1 (heaps/wk.)	8.00	48.0	
Phase 2 (heaps/wk.)	8.00	48.0	
Phase 3 (heaps/wk.)	0.00	0.0	
Material moved to screening	8.00	40.0	
	Total Hours per week	**136.00**	
Cost Per Hour Loader+ Operator ($USD)	$160		*Estimated Fully Loaded Cost Rate*
Cost per week ($USD)	$21,760		
Sub-total - Annual Cost (Labor and Loader)($USD)	**$1,131,520**		

Control System Operator/Technician - Hours per week	5	**($USD)**	
Cost per Hour Control System Operator ($USD)	$60		*Estimated Fully Loaded Cost Rate*
Cost per week ($USD)	**$300**		
	Annual Cost (Control System Operator)	$15,600	*Estimated Fully Loaded Cost Rate*

Power Consumption	($USD)	
cost of power $/kWh	$0.1500	*Estimated Electrical Rate Cost*
kWh/ton Use Factor (8 week process)	2	
Sub-total - Annual Cost - (Power)($USD)	**$78,000**	

Maintenance Costs	**Repair Costs/incident($USD)**	**Number of Repairs/yr.**
Temperature Sensors	$400	12
Oxygen Sensor	$600	24
Probe Cables	$300	12
Misc. Equipment Repairs	$3,000	1
Cover Winder Machine Maintenance	$3,000	1
Annual Software Subscription Service	$96,000	1
Annual Support Contract with On-Site Service Check & Report	$10,000	1
Sub-Total - Annual Cost (Maintenance)($USD)	**$134,800**	

BUDGETARY QUOTATION

Client: EA Engineering
Facility: Maryland
By: Baraka Poulin
Date: 9/8/2023
Basis: Aerated static pile compost system featuring high air flow aeration and automated controls.
Option 1: in vessel composting followed by postiively aerated static pile (ASP) composting.
Option 2: biolayer covered ASP with reversing aeration followed by unaerated windrow.

		Option 1		Option 2:	
Sizing	(US units)	Primary	Secondary	Primary	Secondary
Throughput	TPY	90,000	76,214	90,000	76,214
Throughput (365 d/yr)	TPD	247	209	247	209
Density	lb/CY	827	827	827	827
Aeration Type		Positive	Positive	Reversing	None
Aeration Floor Type		B/G Sparger	B/G Sparger	Trench	None
Pile Arrangement		Vessel	Mass Bed	Bunker	Windrow
Retention Time	days	13	24	16	48
Independent Zones	#	10	10	10	40
Fan Groups	#	10	1	1	4
Zone Width	ft	35	33	35	16
Zone Length	ft	80	120	95	200
Pile Depth	ft	8.2	8.6	8.2	7.5
Cover Depth	ft	0.0	0.0	1.0	0.0
Time to Fill Zone	days	1.4	2.4	1.6	1.2
Total Volume Aerated	CY	8,100	12,200	9,600	25,200
Mechanical					
Aeration Rate - Peak	CFM/CY	4.5	2.5	4.5	0.0
Fan Power - Installed (total)	HP	175	40	125	0
Fan Energy (Annual)	kWh/yr	705,000	171,000	478,000	0
Pile Surface Irrigation		Automated		Automated	
Process Area					
Paved Area (Process, Mechanical + Apron)	ft^2	39,600	51,000	45,000	193,200
Cost Estimate					
Total ECS Scope of Work ($USD)		$ 2,660,000	$ 740,000	$ 2,270,000	$ -
Construction (ECS Guess)		$ 7,900,000	included	$ 3,200,000	n/a
Constructed Price (ECS Guess)		$ 11,300,000		$ 5,470,000	

ECS SCOPE OF WORK

Client: EA Engineering
Date: 9/8/2023
Basis: Aerated static pile compost system featuring high air flow aeration and automated controls.

Aeration System (Above Grade)	Description	By
Fans	Per ECS Spec	ECS
Aeration Ducting	Per ECS Spec	ECS
Duct Hangers and Supports	Per ECS Spec	ECS
Zone Damper Assemblies	Dampers per ECS Spec, Electric Actuators	ECS
Makeup Air Inlet Damper	Per ECS Spec, Electric Actuators	ECS
Balance Damper	per ECS Spec,	ECS
Irrigation - Control+Distribution	Control Valves, Integration to CompTrollers, Sprinklers	ECS
Irrigation - Water Supply	Pipe & Fittings to each zone.	OTHERS
Electrical	Wiring and Conduit	OTHERS
Duct & Fan Condensate Drains	Pipe & Fittings	OTHERS

Aeration Floor System	Description	By
HDPE Components	Fabricated HDPE Pipe & Fittings	ECS
HDPE Pipe	DR17 HDPE Pipe, Pulling Ends, Duct to Flex Fittings	ECS
HDPE Pipe	On-site fusing and drilling	OTHERS
Embedded Stainless Steel Components	Trench Boots, hardware, SS304	ECS
Surface Stainless Steel Components	Trench Covers, Cover Clamps, SS304	ECS
Drainage Line: Zones to Sump	Pipe & Fittings, Level Maintained Sump	OTHERS
Drainage Line: Sump to Re-use System	Pipe & Fittings	OTHERS

Control System	Description	By
CompTroller Hardware & Software	Web-based, distributed, ruggedized	ECS
Fan Drives	Variable frequency drives, filters	ECS
Process Sensors	Temperature, pressure	ECS
Temp Probe Holders	Mild Steel	ECS
Moisture Addition Control	1 per zone - control output and software	ECS
Electrical	Wiring and Conduit	OTHERS
Control Skid	Per ECS Spec	ECS
Electrical Service	Fan Panel, MCC, Breakers, DCs, Fuse, Filters	OTHERS
Control Shed	Approximately 10x12ft shed	OTHERS

Vessel Components	Description	By
Vessel Doors	Insulated panels, Stainless Steel, Manual	ECS
Vessel Irrigation System	Valves, Pipes, Nozzles	OTHERS
Vessel Exterior Insulation	Insulated Concrete Walls	OTHERS

Biofilter System	Description	By
Air Temperature & Pressure Sensors	Integrated with ECS Control System	ECS
Biofilter Media Temperature Probes	Integrated with ECS Control System	ECS
Building & Process Air Mixing Controls	Integrated with ECS Control System	ECS
Exhaust Duct Humidification System	Supply lines, filtration, pump, compressor, controls. Duct ring for nozzles.	ECS
Control of Air Humidification	Integrated with ECS Control System	ECS
Building Exhaust Fan VFDs	Network Drives	ECS
Building Makeup Air	MUA supply, Building Conditioning	OTHERS
Suspended Aeration Floor	Pre-stressed concrete panels, Rubber Pads	ECS
Exhaust Duct to Suspended Floor Inlets	SS304	ECS
HDPE Pipe	Pipe-on-Grade, Drilled with End Caps	ECS
Biofilter Plenum	SS304, per ECS Spec	ECS
Biofilter media Irrigation System	All mechanical components (installed by others)	ECS
Biofilter Media (i.e. wood chips)	Shredded wood per ECS spec	OTHERS
Suspended Aeration Floor Pillars	Concrete pillars formed in Sonotubes (~18"high x ~18" dia)	OTHERS
Suspended Aeration Floor Basin	Per ECS Design (~22" deep, area = BF footprint)	OTHERS
Electrical	MCC shed with thermostatically controlled cooling fans, inlet air filters, power distribution panels, conduit, power, disconnects. All power & control wiring to devices.	OTHERS
Biofilter Duct Supports	Painted Steel, duct saddles	OTHERS
Biofilter Basin, Floor Blocks & Apron	Concrete	OTHERS
Biofilter Drain	Drain to Sump	OTHERS
Media Containment Blocks & Curbs	as needed	OTHERS

Services	Description	By
Exhaust System/Biofilter M&E Design	System Description and Mechanical & Electrical Drawings (not stamped)	ECS
Construction Technical Support	On-site for key meetings, otherwise remote support	ECS
System Start-up and Training	Mostly on-site, follow up trainings via web and phone	ECS
Biofilter Performance Testing's	Odor measurements at start-up and after one year	ECS
Operational Support	Per special warrantee and performance agreement	ECS
Construction Services	All phases	ECS
Construction Engineering	All permits and PE stamped drawings	OTHERS

Other	Description	By
System Engineering	Technical Submittal, CASP system installation drawings, construction support	ECS
Startup	ECS on site commissioning, operator training and unlimited 1 year remote support. M&E construction must be complete before ECS visits the site.	ECS
Freight	Includes freight allowance FOB site	ECS
Warranty	1yr equipment warranty	ECS

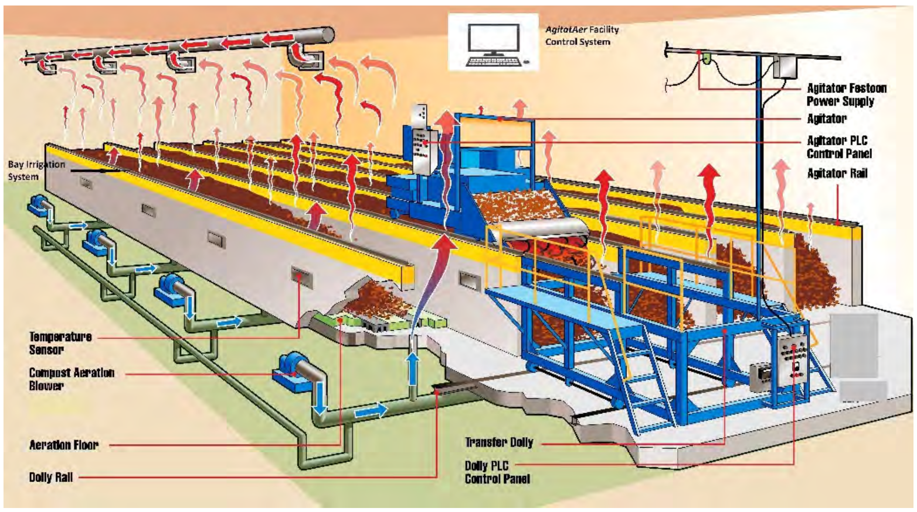
Professional Services	Permitting, Civil/Structural Design, Construction Management	OTHERS
Concrete work	Design, Reinforcement, Supply, Installation	OTHERS
Installation	All ECS supplied equipment	OTHERS
Surface Water Management	Leachate + Stormwater Storage and Distribution, Design and Supply	OTHERS
Rolling Stock	Pre/post processing equipment, On-site material handling	OTHERS

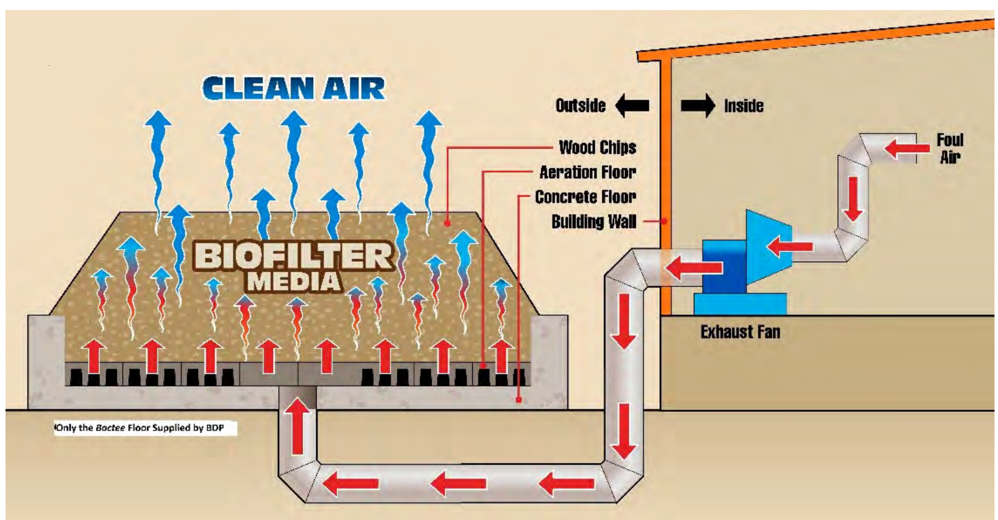
Budget Pricing	
Budget Cost: ECS Scope of Supply	$ 3,400,000

OTHERS=Design and Supply by other team members

Note: ECS deliverables exclude: a lead role in obtaining permits, any professional engineering services required for permits or constructing the facility, construction management, any phase of construction or equipment installation, any equipment not specifically called out above, any local taxes or fees.

Montgomery County, MD Budgetary Estimate
180,000 WTPY Food & Green Waste
Enclosed, Agitated and Aerated Compost System





Submitted 19 September 2023 to:

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Regina,

BDP Industries (BDP) offers this budgetary estimate for process design of, and select process equipment for an **automated, agitated bay with forced aeration type in-vessel compost system** (ICS) that provides the advantage of conserving energy, space, material handling, and manpower in the biological conversion of food and green waste to a compost product. The BDP ICS Technology is one of the few commercially available compost systems that includes all 3 mechanical methods of enhancing the compost process;

1) *Fully Enclosed*. To best prevent weather related negative impacts to the compost process as well as to contain liquid and gaseous emissions for treatment.

2) *Agitation. A*gitation of the compost material is proven to enhance the process by maintaining good porosity as well as for remixing of the materials to best allow microbes access to food, water, air and volatile solids for heat creation.

3) *Aeration.* Forced aeration ensures optimized aerobic and temperature conditons are maintained.

EAEST DESIGN REQUIREMENTS

For the Montgomery County, MD project BDP understands the design requirements are as follows:

CAPACITY:

- *80,000 WTPY of ground pre- and post- consumer food waste +*
- *100,000 WTPY of ground leaf, yard and tree waste (Green Waste)*
  The 2 streams will be co-ground prior to composting.

COMPOST PROCESS DISCHARGE REQUIREMENTS:

- Maturity Index: *Not stated. As this project proceeds, BDP would recommend that EAEST include some metric for compost maturity in the design basis to ensure equivalent compost solutions are proposed by all bidders. E.g. 20 days in an enclosed, agitated and aerated process will produce a more mature end product than 20 days in an aerated static pile type process.*
- Pathogen Destruction (PFRP) *Required*
- Vector Attraction Reduction (VAR) *Required*

SITE DETAILS:

- *(2) Potential Sites – one @ 15 acres and the other much larger.*
- *Both sites should be considered as high odor sensitivity locations such that only enclosed treatment processes are being considered.*

OPERATIONS: *6 days/week & 8 hrs/day*

BDP DESIGN APPROACH

BDP has selected a compost facility size of thirty (30) bays @ 10 Ft width x 8 ft Depth x 230 Ft length as shown on the drawings below. The bays are designed to retain the material for approximately 20 days to achieve Pathogen Destruction (3 days @ >= 55C) and Vector Attraction Reduction (14 days at >= 40C/45C Avg.) while also accommodating peak capacity days. **The ICS compost facility with biofilters, MCC and access areas fits within a 4 acre space which should leave sufficient remaining space on the 15 acre parcel for Waste Receipt/Processing and Compost Curing.**

BDP's scope includes the basic facility design for the Active Composting Bays area, MCC and Biofilters. Detailed design of these areas is by others as well as all other portions of the overall treatment facility, including:

- Raw Material Receipt, Storage and Preparation Areas
- Post Composting Curing, Screening/Refining Area
- Product Storage Area
- Office/Lab and Maintenance Spaces
- Ancillary requirements such as storm water retention ponds, pumping stations, truck scales, etc…

The BDP compost process, like all compost processes, is ultimately volume based. The compost bays are designed to receive and process a maximum quantity of 1,154 cubic yards per day of feedstock, 6 days per week as per the below Materials Balance. BDP requires that the maximum density of the feedstock material will be 0.6 tons/yds3 which should be well within actual conditions. All hard inorganic objects such as stones and metals shall be removed in the material preparation process. For protection of BDP's agitator equipment, as well as to maximize facility capacity, BDP requests that all Feedstock material be size reduced to 4" maximum in any direction with 2" being the preferable target.

Table 1: Material Balance – 180,000 WTPY Food and Green Waste.

MATERIALS BALANCE

ICS Composting Facility

E&AEST Montgomery County, MD Organics Study

80,000 WTPY Food Waste + 100,000 WTPY Green Waste

MATERIALS	WET TONS PER DAY	PERCENT DRY SOLIDS	DRY TONS PER DAY	VOLUME CY	BULK DENSITY TONS/CY
Food Waste	256	25%	64.1	366	0.70
Ground Green/Yard Waste	321	50%	160.3	916	0.35
Recycled Overs	0	60%	0.0	0	0.30
INPUT TO BAYS	**577**	**39%**	**224**	**1154**	**0.50**
OUTPUT to CURING	**296**	**55%**	**163**	**741**	**0.40**
Recycled Overs	**0**	**60%**	**0**	**0**	**0.30**
FINISHED COMPOST FOR DISTRIBUTION	**296**	**60%**	**163**	**741**	**0.40**

Agitated Bay Design Criteria and Assumptions

1.	80000	Wet Tons per Year (WTPY) of Food Waste Design Capacity.
2	100000	WTPY of Ground Green Waste Design Capacity
3	30	Bays at 230 ft long required
4	41	Cubic yard Charges per Agitation
5	28	Bays loaded and Agitated per day at 6 Days/week
6	20	Days in the Bays Retention
7	26	Estimated Carbon to Nitrogen ratio of infeed mix

It is understood that the Compost Facility feedstock will be made up of:

Ground Green Waste at an average solids content of 50% and at a presumed density of 0.35 tons/yd post grinding. Acceptable Green Waste feedstock are presumed to be:

- Trees, Branches and Stumps
- Flowers, plants and shrubs
- Grass clippings and leaves
- Lumber, sawdust, wood chips and wood waste (untreated/unpainted)

Food Scraps at an average solids content of 25% and at a presumed density of 0.7 tons yard (post grinding). Acceptable Food Waste are presumed to contain:

- spoiled or unused food.
- food soiled paper (paper towels, plates, tissues, "to-go" packaging, and pizza boxes), and
- *compostable plastics* (compostable plastic bags, cutlery, and "to-go" packaging). BDP has piloted processing compostable plastics with good results. The combination of high heat and aggressive agitations will degrade this material much quicker than static type composting processes.

NOTES:

1) It is presumed the (2) feedstock components will be co-ground prior to being delivered to the Compost Facility which should also provide a rough mixing such that no dedicated mixer device is needed prior to loading the bays.

2) The proposed compost facility is a once thru type. I.e. no amount of Recycled Screening Overs is included in the materials balance as supplemental bulking agent nor are they required for proper compost feedstock conditions on average. However, it is expected that there will be seasonal periods where green waste material is limited and therefore stored Overs may need to be used to achieve an appropriate compost feedstock.

3) It is understood that there will be some inorganic contaminants in the feedstock to the compost facility. For discussion purposes BDP presumes these contaminants would be <5% by volume. As long as they are properly sized reduced BDP is not concerned with contamination level from an equipment damage standpoint. However, from a composting process standpoint, the issue becomes one of putting material in the bays that will have an adverse impact on the process and capacity.

4) It is expected that moisture addition will be required at some point in the process to keep it at optimal conditions. Provisions are included in this estimate for an in bay moisture addition system supplied by BDP to maintain compost DS content <= @ 65% DS. The feedstock goal is to achieve a solids content of 38% minimum - 45% maximum (seasonally dependent) for proper composting. It is presumed some sort of moisture addition system will be available during, or post, grinding prior to loading the bays. The attached Materials Balance indicates, based on BDP's solids content assumptions, that

the feedstock will meet this moisture criteria on an average basis. The need for moisture addition in the bays will vary seasonally. For discussions purposes an estimate of 500 – 1000 GPD per bay should be considered. Moisture addition for the biofilter is also expected on a seasonal basis. It is understood that we will wish to utilize as much storm water and condensate as possible within the facility. We expect this can be done without significant issue other than perhaps screening for particulate removal.

5) For space optimization purposes, the @ 10,000 SF/side biofilter size shown is based on using synthetic media like that produced by Biorem Inc. If natural wood chip type media were to be used, the biofilter size would increase by approximately 50%. Biorem will also offer the Cty an odor guarantee.

Feedstock material is loaded into the front 20ft long portion of the bays in 40 cubic yard "charges" following an agitation. Charges can either be loaded via a front end loader or an overhead automated conveyance system. For this application BDP has presumed the bays will be loaded via front end loaders.

Figure 1: Estimated Site Plan Illustration

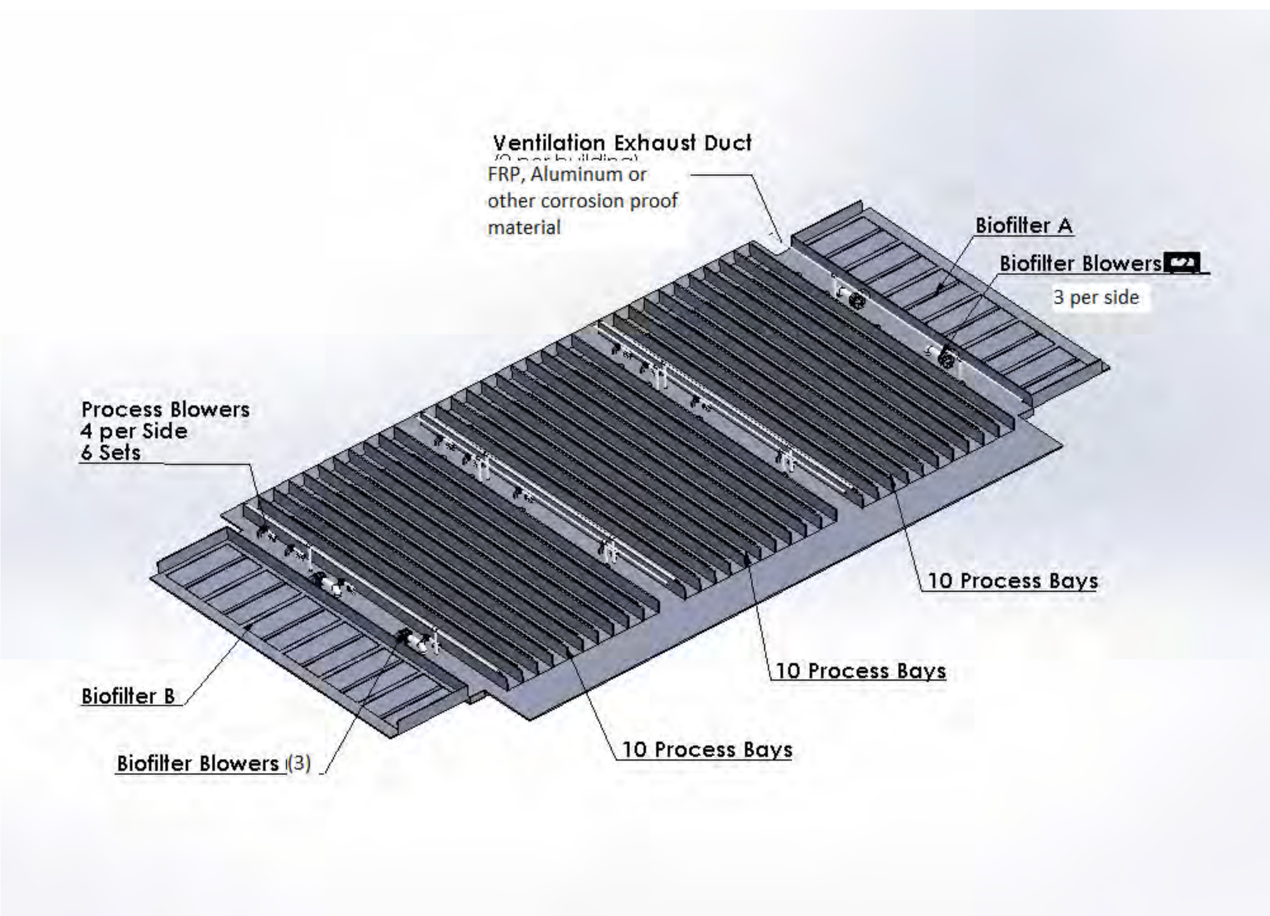
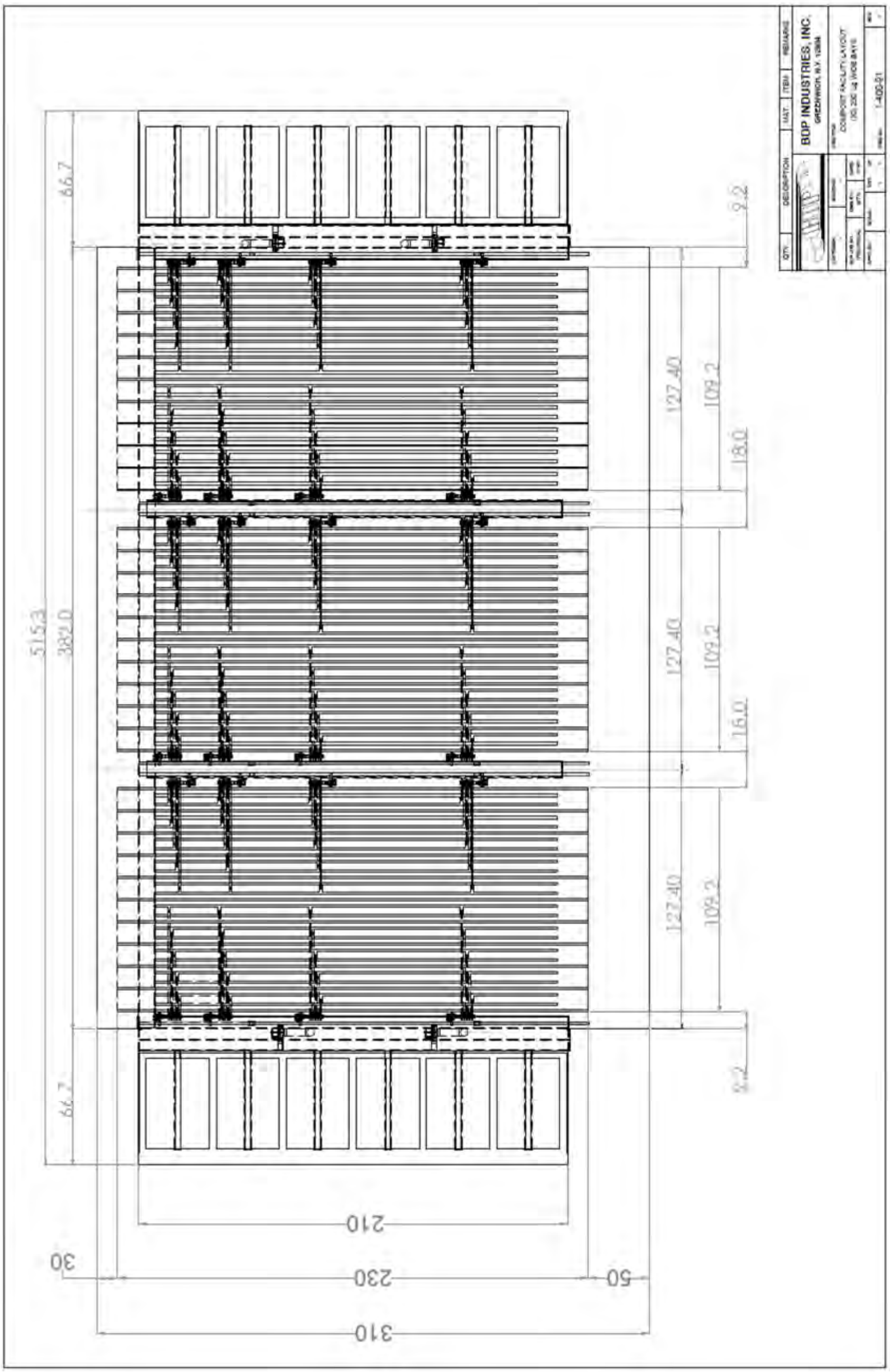


Figure 2: Estimated Facility Plan with Dimensions.



The @ 160,000 SF size compost facility would incorporate (30) 10ft wide (inside) x 8 ft high x 230 ft long bays as shown on the drawings above. There is a 50ft long x 315 ft wide open area in front of the bays for Feedstock Receipt. There is a 30ft long x 315 ft wide area at the back of the bays for locating the BDP supplied Transfer dollies and for loader access to unload the bays.

Five BDP 100 HPe Agitators are proposed to service the (30) bays. Each week, the facility will require that the bays be loaded and agitated 168 times to match incoming capacity. For a 6 day work week that would equate to 28 bays being loaded/agitated per day which can be done within an 8 hr work day with (5) agitators.

The bays are arranged in (3) 10 bay groups to accommodate interior aisles for roof supports and process equipment. Each 10 bay group is considered (2) 5 groups for process control purposes. Each bay would be divided into (4) independent Aeration Zones (A – D). Each (5) bay group would have (1) dedicated blower/zone to provide aeration needs across all 5 bays. Each zone would have a dedicated temperature probe located in the bay walls for blower control. So e.g. Bay/Zones 1A – 5A would be served by one blower (A1-5) and for a 5 bay group there would be 5 bays x 4 zones = 20 temp probes with probes 1A – 5A being averaged to control blower A1-5. Therefore each 5 bay group would have (4) blowers associated with them located in an aisle as shown on the drawings below.

Once a charge is loaded in the bay, it is translated down the bay length an average of 13 ft following an agitation. BDP includes a bay leveling device on the agitator conveyor assembly which modulates compost throw from 13 ft – 16 ft to offset pile height loss as the product composts thus maximizing bay capacity. Once an agitation is completed, the front 16 ft of the bay is open to accommodate the next charge of feedstock.

All compost movement within the bays is done by the agitator with the BDP supplied AgitatAer SCADA system tracking material movement and time at temperature for PFRP and VAR compliance. Following 20 days in the BDP bays, the compost material in the last 18 ft of the bay would be removed by front end loaders and moved to the Curing area. The bays could also be automatically discharged (by the agitators) onto a conveyor belt that runs below the bays if so desired by the Customer.

The facility could be housed in anything from a fabric roof to structure to an insulated/coated steel structure.

A detailed process description is included at the end of this document.

TABLE 2 - CAPITAL COST ESTIMATE

ICS COMPOSTING FACILITY

E&AEST Montgomery County, MD Organics Study

30 WIDE BAYS

ITEM		BUDGETARY COST
CONSTRUCTION		
Site Work (4 Acres)	$	400,000
Compost Building (@ 120,000 SF Equipped Except for BDP Equipment)		23,200,000
MCC Room (Equipped)		2,000,000
Drives - asphalt		500,000
Biofilter Odor Control incl, Concrete, Duct, Fans and Media[1]		6,000,000
BDP Equipment and Services[2]		10,100,000
Miscelaeous Equipment		2,000,000
Front End Loaders		2,000,000
SUBTOTAL:	**$**	**46,000,000**
ENGINEERING AND SERVICES; Pemitting thru Construction	$	5,000,000
ESTIMATED TOTAL PROJECT COST:	**$**	**51,000,000**

1 Biorem Media Estimate of $1000/YD. Biofilter floor included in BDP Scope/Price

2 BDP Equipment includes ICS Proprietary Equipment Package per Table 3 Technology Purchase Schedule. Services are provided during design, construction and operational start-up training. Also includes an estimate of shipping of ICS Equipment FOB. Miscellaneous Equipment (Outdoor Lights, Pumps, Tanks, etc…)

NOTE: The above is for equipment and structures shown on the attached BDP drawings only. Other areas, structures, equipment not included such as roads, scales, etc…

Table 3 - BDP SCOPE of SUPPLY	
ICS COMPOSTING FACILITY	
E&AEST Montgomery County, MD Organics Study	
30 WIDE BAYS	
ITEM	**QUANTITY**
EQUIPMENT	
Agitator & Dolly - 100HP with Level Bed Device	5 Each
Agitator Bay Wall Rails with Wall Embeds and all Hardware	7,590 Ft
Dolly Rails	760 Ft
Bay Wall Temp Sensors and Mounting Boxes	120 Zones
Bay Irrigation System	30 Ea
Bay Aeration Floors with Iris Valves	120 Zones
AgitatAer™ Process and Facility Control System	1 Each
Biofilter Aeration Floor (Included in CAPEX estimate under "Odor Control")	1 System
ENGINEERING AND SERVICES	
Internal Engineering Support	As Required
Design Engineering Support	40 Days/8 Trips
Construction Support	20 Days/4 Trips
Start Up Commissioing and Process Support	80 Days/12 Trips
Post Start Up Support	10 Days/3 Trips
ESTIMATED BDP PRICE INCLUDING FREIGHT: $	**10,100,000**

NOTE: The above BDP scope of supply is intended to include proprietary equipment only. For cost efficiency purposes "off the shelf" process related equipment such as fans, blowers, piping, ductwork, etc… are not included in BDP's scope but are included in the overall CAPEX budget in Table 2.

BDP will provide design specifications for all process related equipment to be procured by others.

Table 4 - ANNUAL O & M COST IMPACTS

ICS COMPOSTING FACILITY

E&AEST Montgomery County, MD Organics Study

30 WIDE BAYS

Item		Annual Qty
Labor		
Facility Manager	1 @	260 Days/Yr
Loader Operators	6 @	312 Days/Yr
Laborers	2 @	312 Days/Yr
Maintenance/Weekend Spvsr	1 @	260 Days/Yr
Energy & Utilities		
Electrical		See Table 5
Fuel (diesel for Loaders)		20,000 gal/yr
Water (Bay and Biofilter Irrigation)		TBD

Table 5: Electrical Consumption Estimate

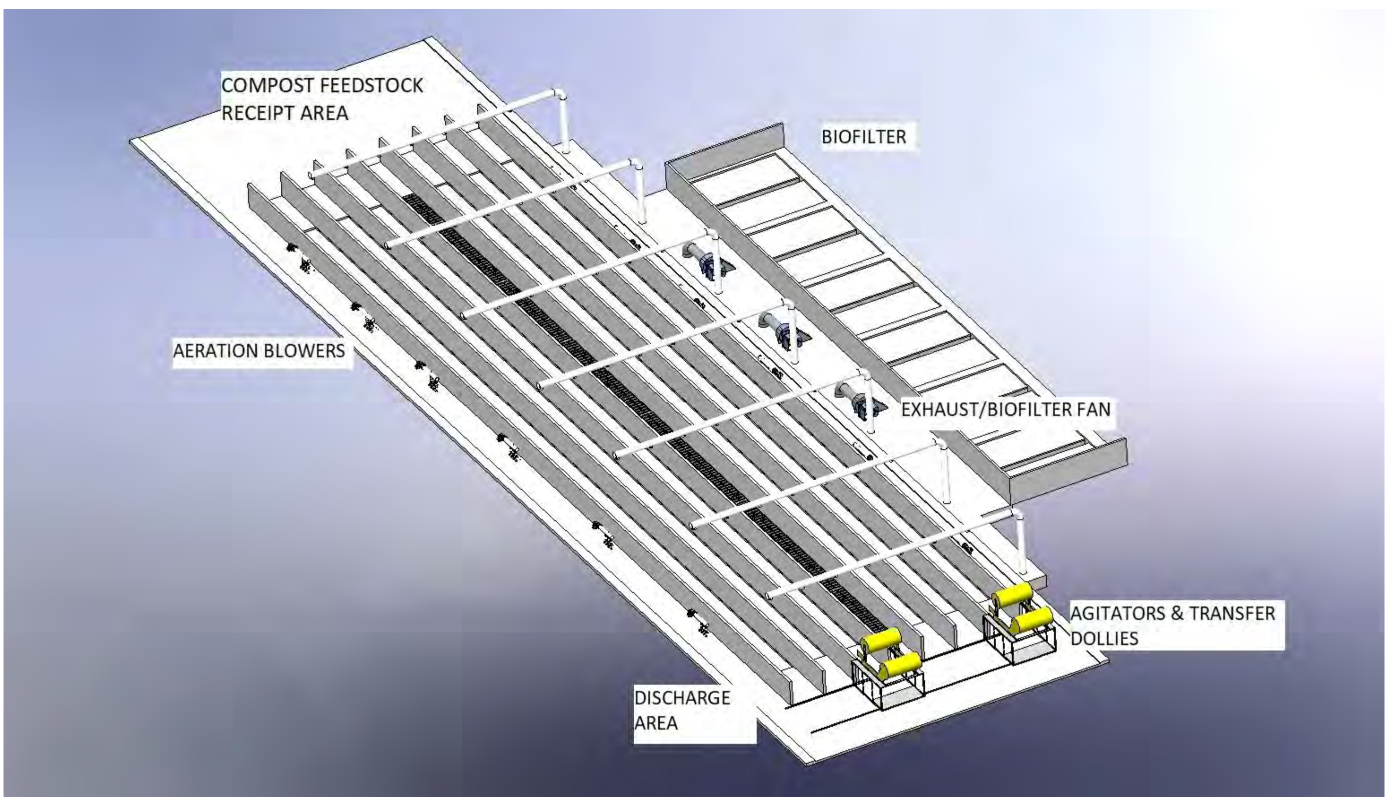
Equipment	Blower	Static Hd	Factor	Quantity	Motor			Connected
	Capacity	Head			Rating		Energy	Load
	cfm	in w.c.	%		kW	HP	kWh/yr	kW
Process Air Blowers - Zone A	5,000	10	59%	6	11.2	15	347,472	67.23
Proces Air Blowers - Zone B	5,000	10	59%	6	11.2	15	347,472	67.23
Process Air Blower - Zone C	4,400	10	59%	6	7.5	10	231,648	44.82
Process Air Blower - Zone D	3,500	10	62%	6	7.5	10	243,426	44.82
Biofilter Blowers	40,000	8	49%	6	75	100	1,931,580	450.00
Agitator			25%	5	75	100	702,000	375.00
Biofilter Pump			50%	2	1.5	2	13,140	3.00
Control System			95%	1	1.125	1.5	9,362	1.13
					Sub-total		3,826,099	1,053
Lights and Misc.			10%				382,610	
Annual Basis					Total		4,208,709	1053

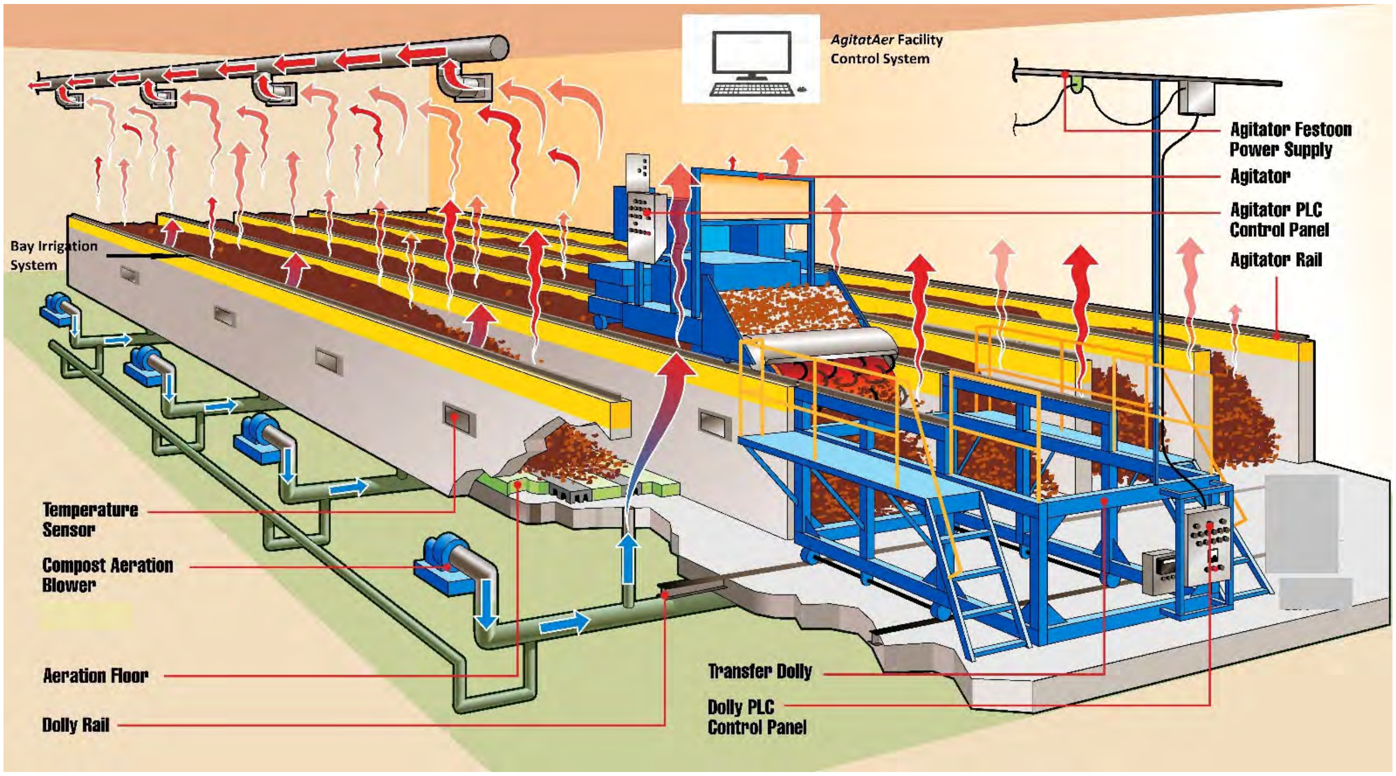
Montgomery County, MD Detailed Process Description

Prior to feedstock material being delivered to the Compost facility it will have gone thru a seperate Materials Receipt and Preparation Facility where it inorganics will be removed as needed and the balnce of organic waste will be co-ground at an approximate volume ratio of (1) food waste to (2.5) yard waste. By co-grinding the materials it eleiminates the need for a dedicated mixer prior to composting. The rough mixing accomplished in the grinder is sufficient to load the bays. Within 2 – 3 agitations the feedstock should be well homogenized.

The individual process steps include (Refer to General Schematic below)

1. **Feedstock Receiving –** Each of the six working days per week, 1,154 cubic yards, will be delivered in some manner to the front 50 ft long x 315 ft wide „Receiving Area" of the Compost Facility.
2. **Charging** or loading @ 40 yds of feedstock into the process bays in the front 20ft of the bays
3. **Active Composting** by agitating and aerating the material along the 230 ft bay length over 20 days
4. **Discharging** or unloading the processed material from the bays in the final 315 ft wide x 30 ft long area at the end of the bays.
5. **Odor control** – @ 20,000 sf biofiltration – for air from Receiving and Active Composting.





AgitatAer Facility Control System
Agitator Festoon Power Supply
Agitator
Agitator PLC Control Panel
Agitator Rail
Bay Irrigation System
Temperature Sensor
Compost Aeration Blower
Aeration Floor
Dolly Rail
Transfer Dolly
Dolly PLC Control Panel

Photo 1 – Co-ground feedstock material belt conveyed to Compost Facility Feedstock Receipt Area

Step 1 Feedstock Receipt – Each of the six working days per week, 1,154 cubic yards, will be delivered in some manner to the front 50 ft long x 315 ft wide „Receiving Area" of the Compost Facility. Feedstock Material can be delivered via Loaders, Truck or conveyor belt as shown above. Feedstock shall be in the 38% - 45% DS range depending on season.

Step 2 – Bay Charging or Loading

The bays are designed to receive nominally 40 yds3 of feedstock (or "charge") following an agitation. The front 20 ft of each bay is a non-aerated concrete pad designated as the Loading Area of the bays. For this application BDP has presumed the bays will be loaded with a loader as shown in Photo 2 but could also be auto loaded as shown in Photo 3

Photo 2 - Front End Loader "Charging" Bays

Photo 3 – Automated Bay Loading technique.

Step 3 – Active Composting - For this application, the (30) bays are 10 ft wide x 8 ft high x 230 ft long for a retention time of 20 days. The (30) bays are seperated into (3) contiguous groups of 10 bays. Each (10) bay group are cosidered as (2) 5 bay groups from a process perspective. Equipment and personnel access aisles are on each side of the outer bays. With each pass of the agitator along the length of the bay, the process material will be mixed and translated towards the bay discharge end an average of @ 13 ft with the agitator *Capacity Optimization Gate* device automatically modulating the agitator conveyor discharge throw between 10 ft and 16 ft to offset pile height loss as the material composts.

Photo 4 – Agitator on Transfer Dolly

Photo 5 – Agitator working in bay next to empty bay.

Photo 6 - Capacity Optimization Gate (COG) in closed position near bay discharge

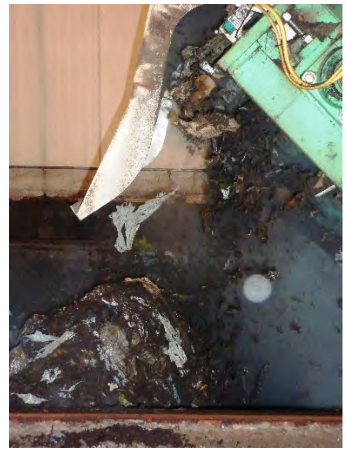


Photo 7 - COG in full open position near bay loading

i. ***Aeration System*** - Each of the (30) bays is divided into (4) separate aeration zones (A – D) for a total of 120 Aeration Zones (i.e. 4 aeration zones/bay x 30 bays) designed and equipped by BDP's partner BacTee Systems. The aeration system provides sufficient oxygen to the process between agitation cycles and removes condensate from the process bays. The BDP supplied *AgitatAeR™* process control system (system) allows continuous modulation of process air based on temperature feedback from the process material. The system also allows high/low cyclical aeration control as a default control strategy in the event temperature inputs are inadvertently disabled.

The aeration zones in each set of (5) bays are linked by a common below-grade manifold to a blower for that particular zone. Thus for the (120) total aeration zones, (24) aeration blowers are being supplied and located in the aisles.

The BacTee floor system consists of BacTee's polymeric baseplates as shown below that are encased in the floor but can be removed for periodic full-access cleaning. The baseplates are adjacently located to a Cross-Arm which provides a plenum cavity between the baseplates and a spigot that transports air upward from a below-grade manifold pipe.

Photo 8 - BacTee Polymeric HT Baseplate

Photo 9 - Baseplate embedded in the tunnel floor

Process material temperature is continuously monitored and supplied to the control system from RTD type temperature sensors mounted in the bay walls of each aeration zone in each bay. The temperature inputs from the same aeration zone in each of the (5) bay groups are averaged by the control system to drive the blower to aerate the respective zone. All blowers are operated through a variable frequency drive (VFD) to provide continuous modulation of the air flow to precisely maintain process material temperature about a floating set point within the control system.

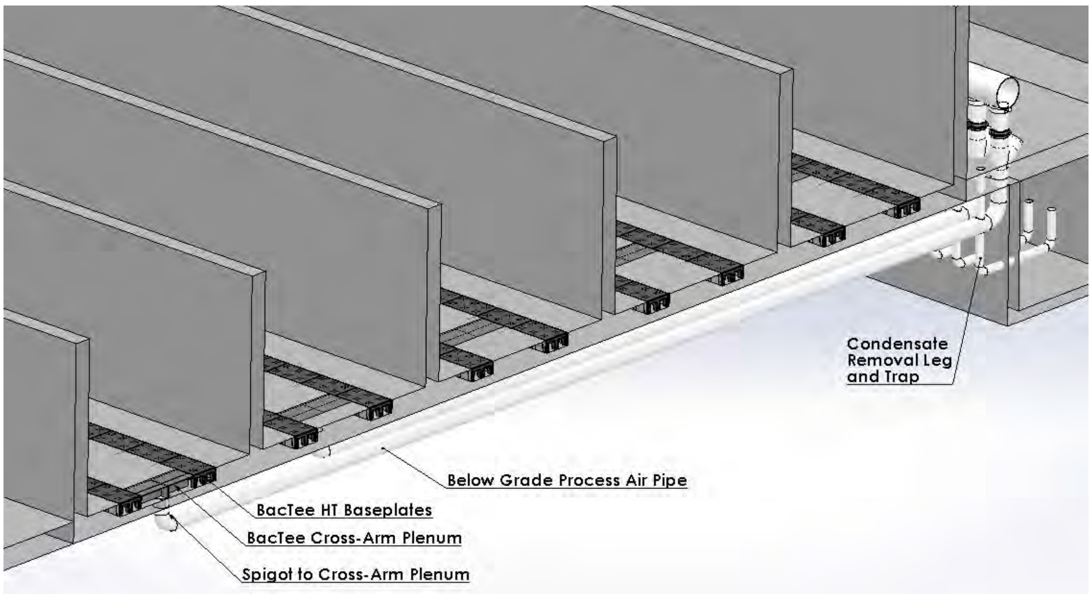


Photo 10: Compost Aeration Floor Components

Photo 11: Temperature probe in wall of empty Bay

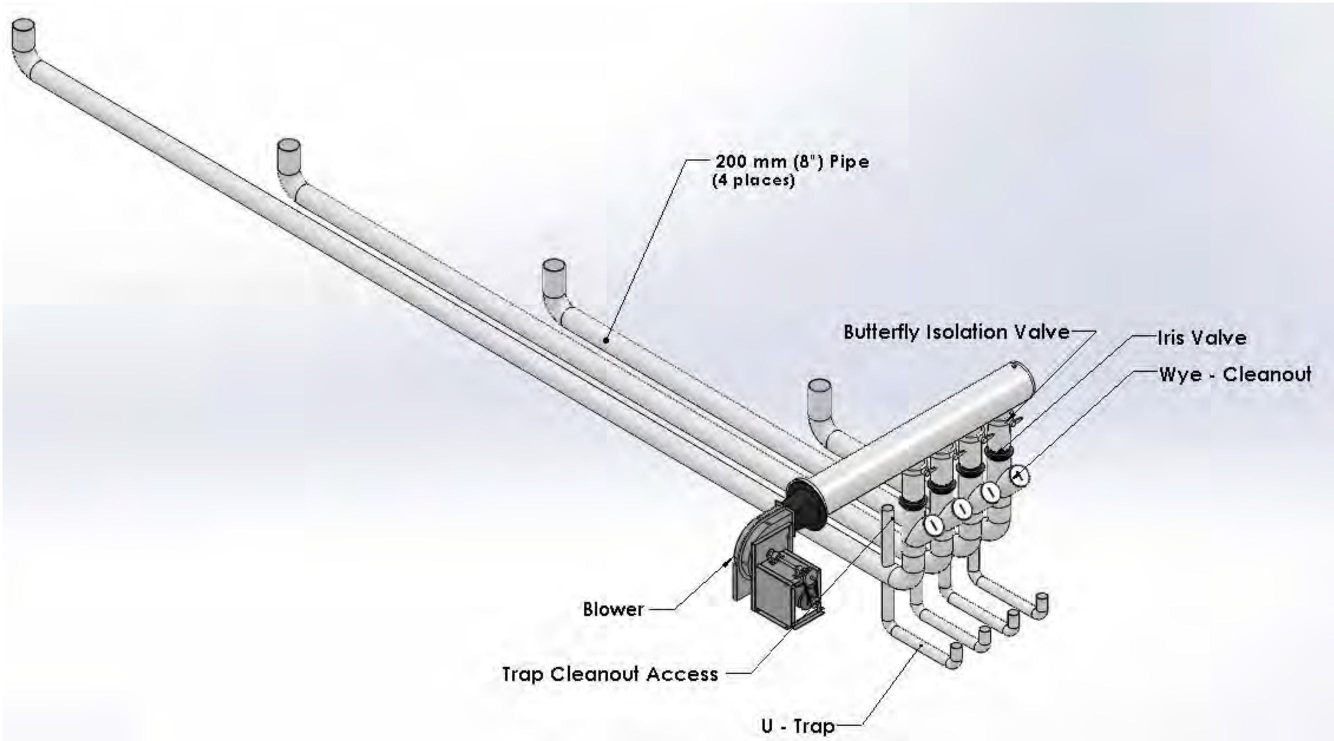


Photo 12: Typical Bay Aeration Piping Arrangement (as shown for 4 bays)

The aeration zones vary in length to provide adequate aeration throughout the composting process. Zones at the beginning of the bay are shorter and provide more airflow to support the higher level of biological activity that produces temperatures that are higher than in those zones nearer the discharge end of the bays. The aeration zones become progressively longer from the fill to the discharge end of the bays. In addition to the aeration zone length varying from the fill to discharge ends of the bays, the air flow rates are decreased. Consequently, blower air flow capacity decreases for the zones nearest the discharge end.

All aeration plenum and manifold units (i.e. pipe) are designed to transport condensate water away from the process bays. The low point of the below-grade aeration manifolds is equipped with a U-trap to prevent short-circuiting of air flow while allowing disposal of water to a below-grade drain manifold. In this case, the drain manifold is also the central process and ventilation exhaust plenum. A collection sump incorporated into the floor of the process area serves as a collection reservoir for the water. The water collected will be discharged to the sewer or recycled for other areas of the facility if permitted.

ii. ***Bay Moisture Addition –*** As the compost material progresses down the length of the bays over time it will lose moisture by design. The process air is entrapping the moisture. It becomes blended with the ventilation air and is subsequently transported through the biofilter. In some cases, depending on facility location and feedstock, the compost process begins to suffer due to moisture depletion in the bays. Essentially the compost microbes become starved for water. This tends to occur towards the end of the bays as the compost begins to exceed 60% solids. It is anticipated that the Montgomery County, MD facility could encounter this moisture deficiency during some periods of the year. Therefore, BDP is supplying a moisture addition system to add moisture back into the bays. It uses PVC pipe with spray nozzles nested in the rail that runs along the top of the bay walls as shown in Figure 13. This moisture addition system is controlled by the BDP *AgitatAer*™ SCADA system and usually runs for prescribed time period based on operator experience.

The water supply for the moisture addition should be designed to supply 500 - 1000 gallons/day/bay. The water source does not need to be potable but does need to be free of pathogens. Captured rain water should be appropriate.

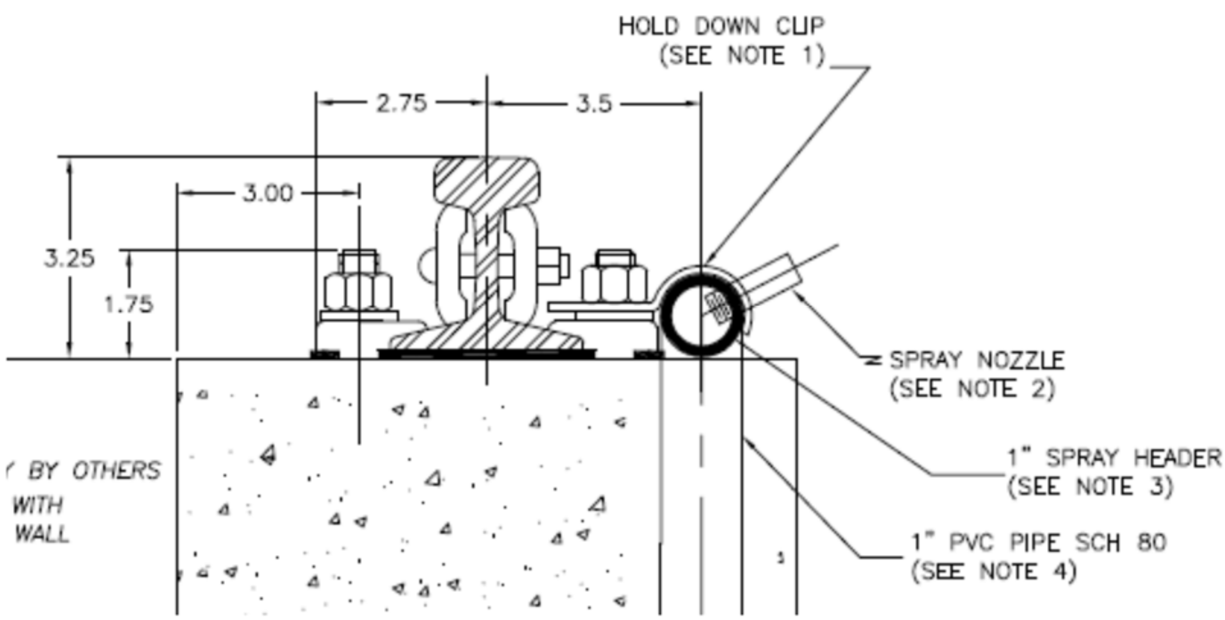


Photo 13: Bay Irrigation System

iv. ***AgitatAeR™ Computer Control*** – The BDP *AgitatAeR™* Process Control System (system) is designed to be the total compost facility control system interfacing with the various fans, blowers, agitators and other miscellaneous equipment.

i. The primary function of the system is to ensure that the compost material in the bays is subjected to the required USEPA Time/Temperature protocol = 3 continuous days at >= 55C for pathogen destruction (PFRP) and 14 days at >= 45C for Vector Attraction Reduction (VAR). This is done by the system monitoring the (120) bay wall mounted RTD type temperature probes (Photo 9) and correlating that data with the material movement through the bays. The compost temperature at the bay wall should be the coolest spot due to the heat sink effect of the concrete wall.

Each 40 yd3 "charge" of material that is loaded in the front of the bays is assigned a unique 4-digit Charge Number as shown in Photo 11 below. For the 230 ft length bay, there will be about 17 individual charges per bay. The system also monitors which bays are agitated on a given day. As indicated above, with each agitation the compost pile in a bay is translated about 13 feet towards the end of the bay. Charge movement down the length of the bay is estimated by the system via a site specific charge movement algorithm. With each bay agitation, the computer advances the charges towards the discharge end of that bay. The system correlates the appropriate wall temperature measurement to the charge as it moves.

Photo 14 – Sample Charge Status Screen

The charges are color coded such that the operator can visually tell the status of a charge as it moves thru bay. When the charge is initially loaded into the bay, the charge number is presented in black text. When the charge achieves the time/temp protocol, the charge number text color changes to green indicating the material has met this requirement. If the charge gets within the last 5 segments in the bay, and does not achieve time/temp protocol, the charge number text turns red indicating to the operator corrective action for that charge is required (typically taking hand probe temperature probe measurement). If the charge does not reach time/temp protocol when it is discharged, it will be recycled back to the front of the facility for re-processing.

The system can generate detailed time/temperature reports for compliance proof as shown below.

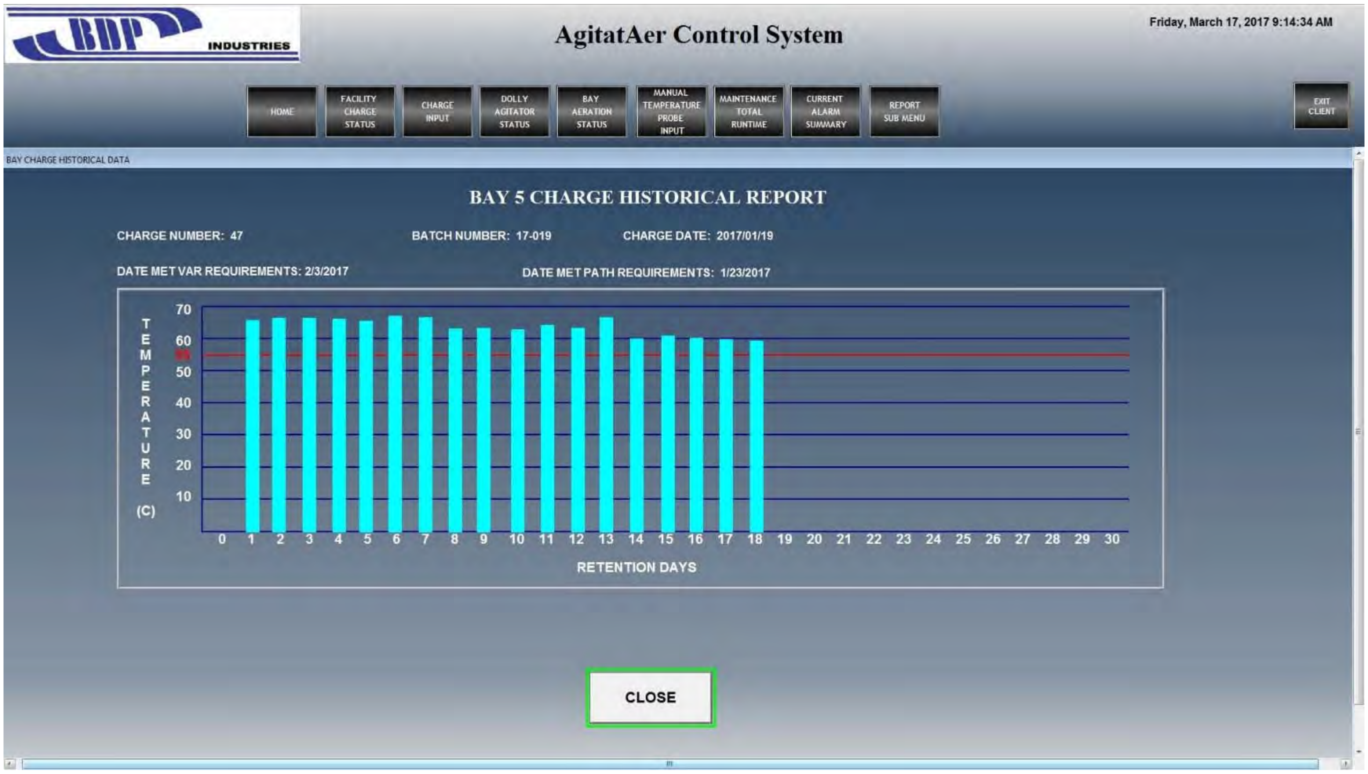


Photo 15 – Sample Charge Historical Report

ii. The system also is used to automatically control the aeration blowers to optimize compost conditions and to maintain aerobic conditions in the bays. The goal is to discharge a suitably mature compost product from the bays that can be moved outdoors for Curing without significant odor concerns. The system modulates the process blower speed, as needed, to allow the process temperatures to stay within a limited range. The desired range of process temperature is determined by input parameters that may be varied by simple menu-driven changes to the control system if feedstock properties and the objective final material properties change.

Both process control and data acquisition functions are provided within the system. The screen shot below indicates aeration blower control and monitoring for a 5 zone (A – E) bay.

Photo 16 – Sample Blower Control Screen

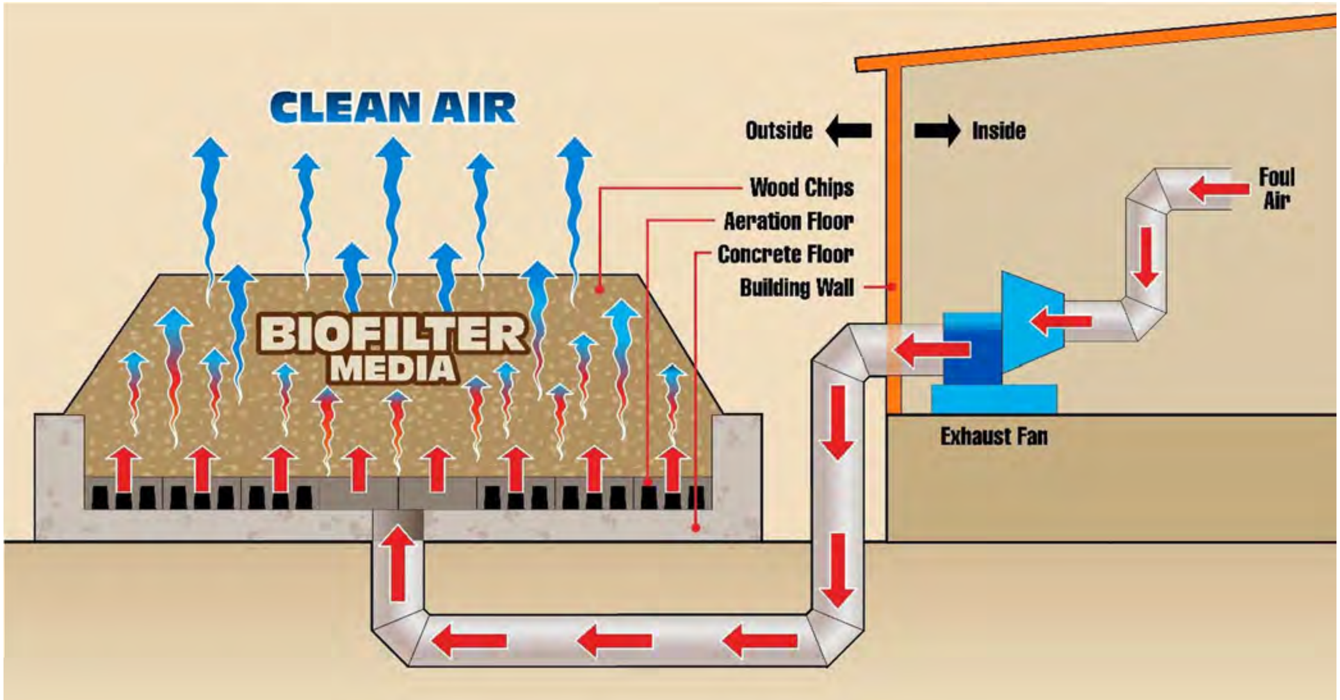
iii. The system is also used to control the building ventilation fans/blowers VFD drives to control the fans speed to maintain negative pressure conditions within the building for optimal odor containment.

v. ***Ventilation*** – The fully-enclosed Composting structure is maintained under a slight negative pressure by the (6) 100 HPe Exhaust Fans drawing process air from the building. Fresh air is drawn into the structure through louvered grilles in the sidewalls of the building. The negative pressure maintained within the duct draws air through a series of intakes located in the Feedstock Receiving and Composting areas.

Step 4 – Composting Material Discharge – After approximately 20 days in the bays the compost material is moved by the agitator into the final 16 ft discharge zone of the bays. Like the loading Zone at the front of the bays, the discharge zone is a solid concrete floor with no aeration. BDP presumes the compost is removed from the bay by loaders but can also be automated as shown below. At this point the compost is expected to have a solids content in the range of 60% and a density of about 0.4 tons/yd^3. Approximately 25 yd^3 of material are removed from each bay after each agitation and transferred to the outdoor Curing area.

Photo 17 – Optional Automated Bay Unloading

Step 6 – Odor Control – Biofiltration



A biofilter odor control system treats all process and ventilation air from the building. Building air is drawn under negative pressure, created by the suction side of the Exhaust Fans, into the main duct. Three 100 HP Exhaust Fans are located at the entrance to each the biofilters to maintain a constant, slightly-negative air pressure within this duct under the control of the AgitatAeR™ system. The Exhaust Fans transport the air through the biofilter bays and media.

The biofilters will be equipped with the BacTee biofilter aeration floor components. Due to space constraints, the proposed biofilter media is a synthetic media like that manufactured by Biorem Inc.

Condensate may form in all air manifolds before and within the air passageways of the biofilter. A condensate leg and trap conveys condensate formed in the aeration zone piping and can be removed via a condensate drain to appropriate storage or disposal. In addition, heavy rains may potentially permeate through the biofilter media. Consequently, condensate collection and drain piping is provided to remove water from the biofilter unit for re-use/disposal. Condensate is removed from both the biofilter and duct via ports at low points in the respective plenums.

Sample Biofilter related drawings:

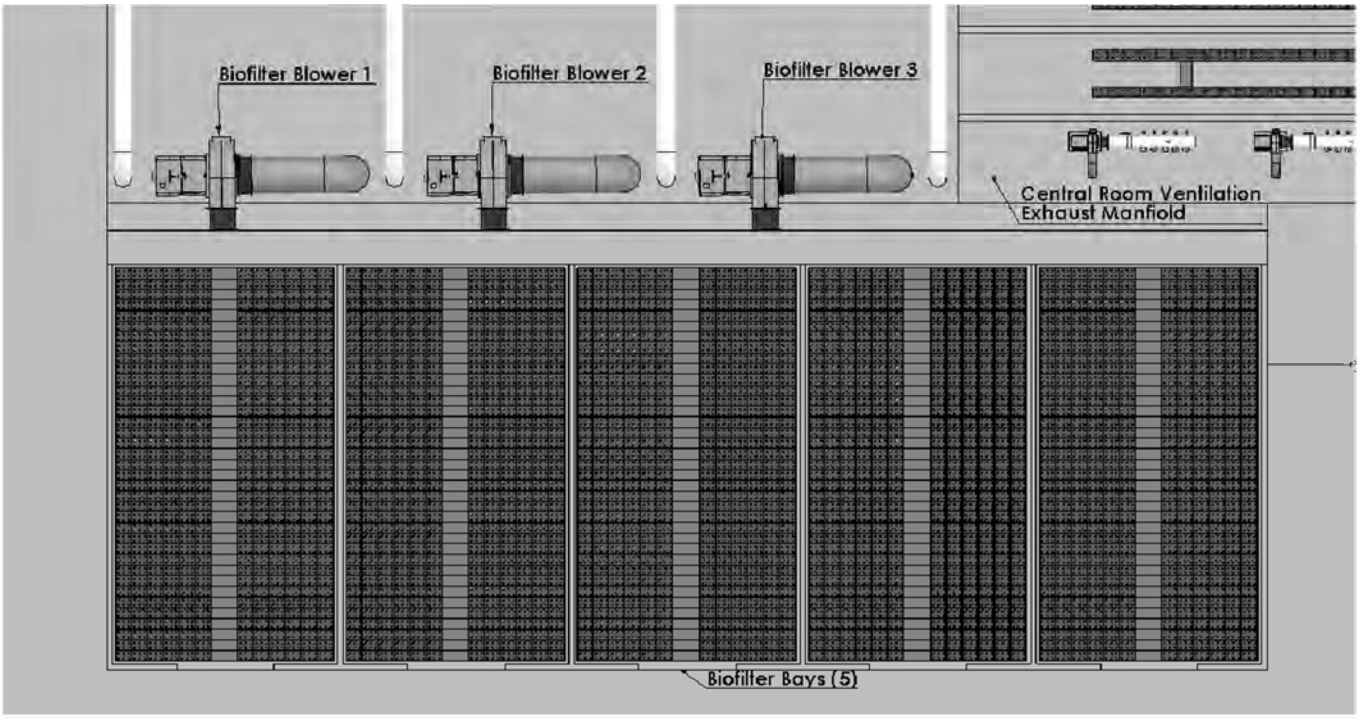


Figure 1: Conceptual Biofilter

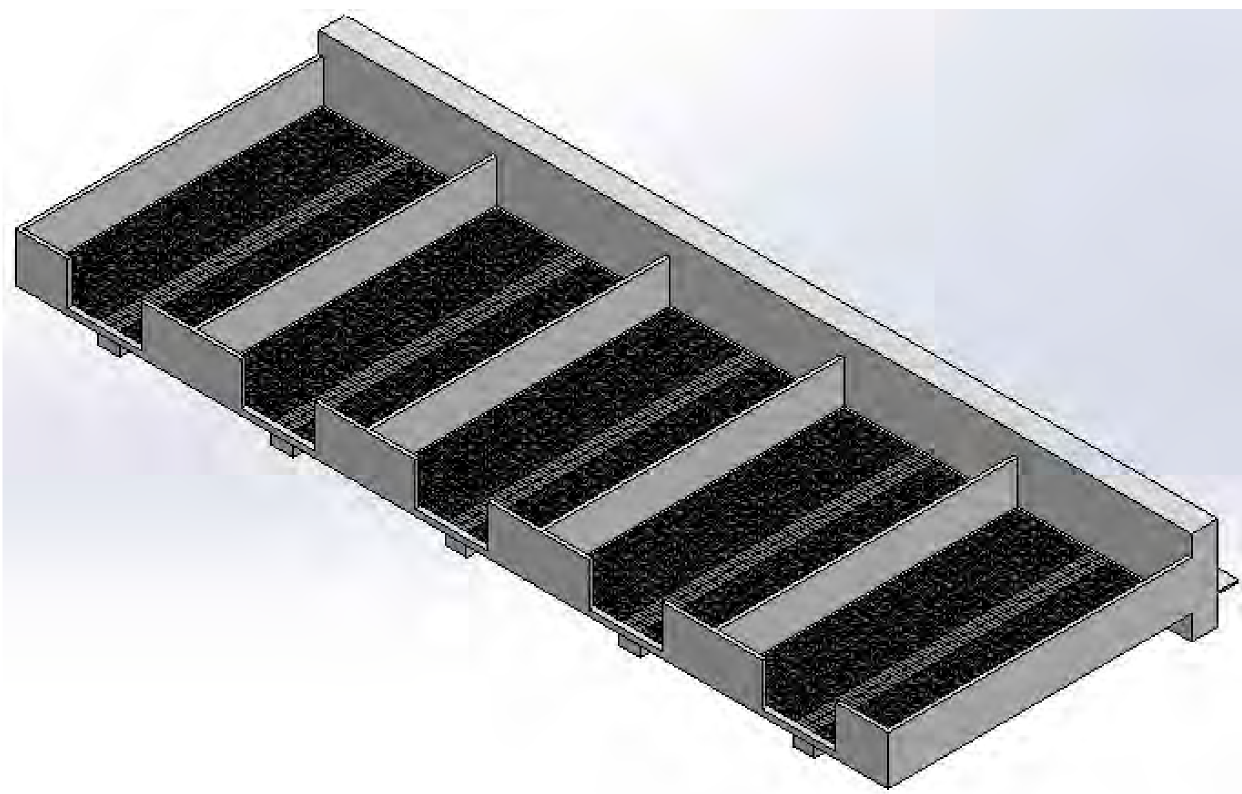


Fig 2: Conceptual Biofilter showing concrete details for media placement access

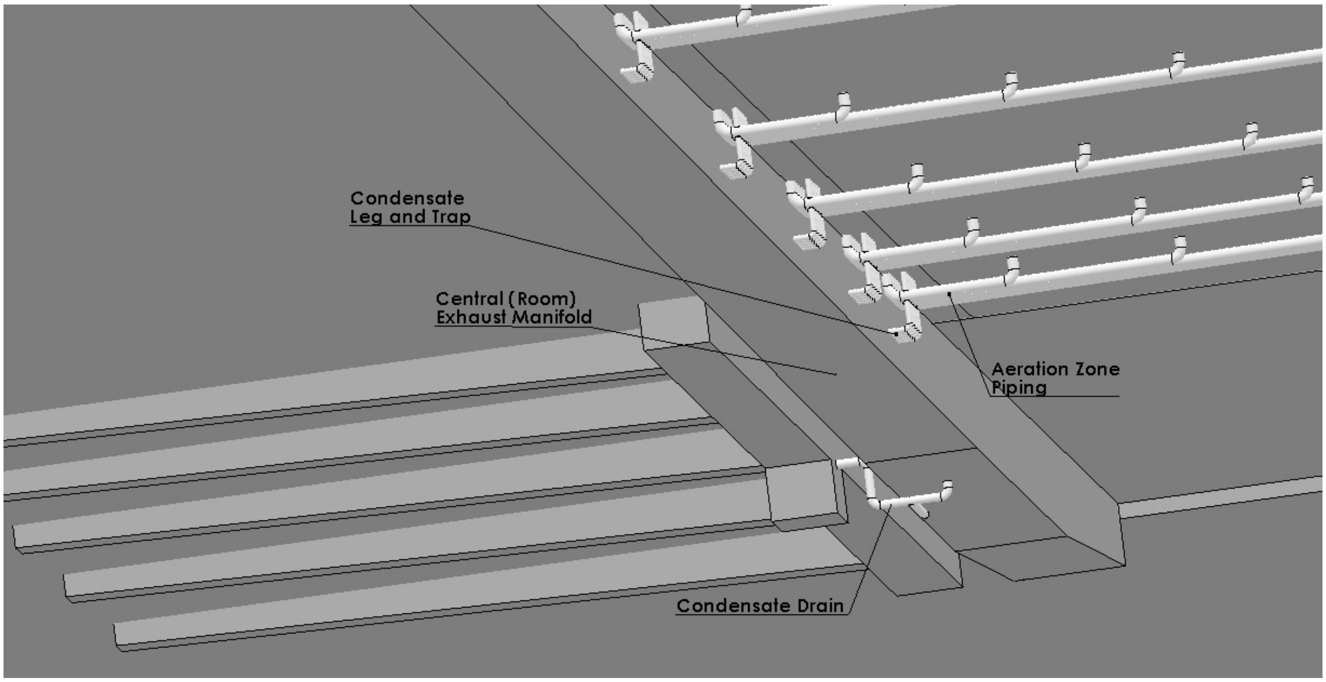
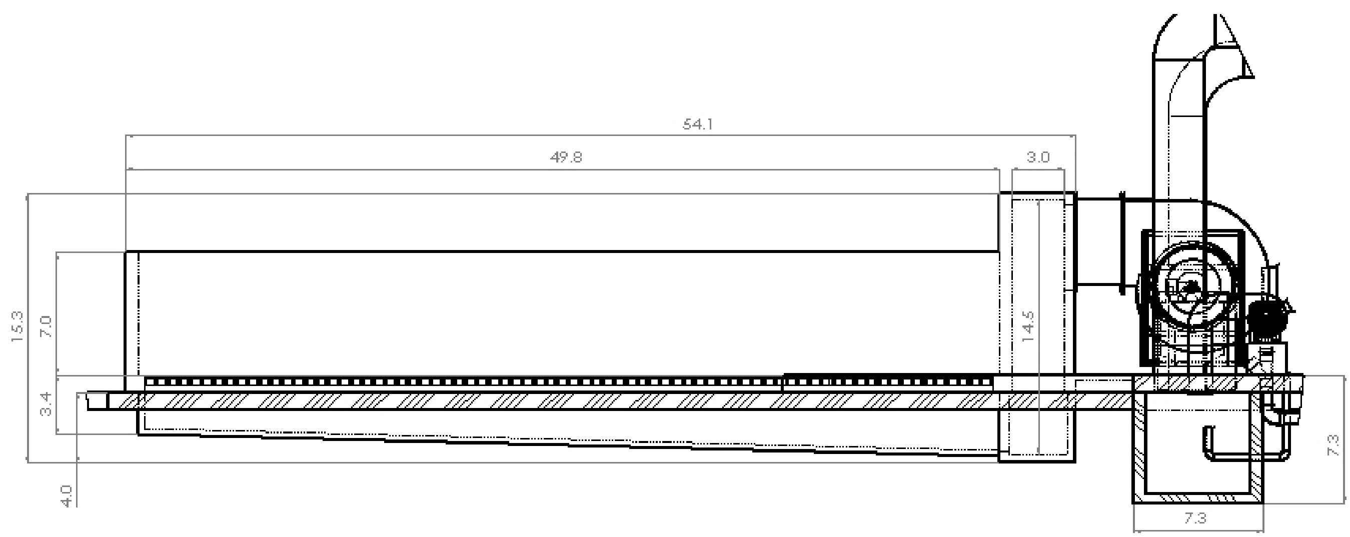


Fig. 3: Biofilter Drain Piping (typical)

Fig 4 – Biofilter Detail



Commentary

for

Biogas to Hydrogen Conversion

for EA Engineering
August 16, 2023

OBJECTIVE

Montgomery County, Maryland, is interested in evaluating the feasibility of conversion of biogas produced in anaerobic digesters into hydrogen gas. This hydrogen could be readily stored and used to fuel vehicles and other hydrogen-burning equipment for the county.

This analysis presents a high-level analysis and commentary about the biogas-to-hydrogen conversion with respect to gas mass balance and energy balance. Vendors have been contacted to develop an estimate of CAPEX and OPEX of a conversion system. Currently an estimate of CAPEX for the methane-to-hydrogen equipment only and exclusive of installation and operating costs has been received and will be presented.

RESULTS

The process of steam reforming methane (SRM) is a mature technology in the oil and gas industry.[1,2] In this method, methane that is captured from subsurface hydrocarbon repositories is reacted at high temperatures (700 °C – 1000 °C) and with water. This reaction produces hydrogen gas and carbon monoxide. A further reaction is then performed on the gas which transforms carbon monoxide into carbon dioxide and nets one more molecule of hydrogen. In these reactions, 1 mole of methane is transformed into four moles of hydrogen gas while some energy is consumed. The stoichiometric reactions and the overall reaction are presented in equations 1-3 below.

(1) $CH_4 + H_2O \Rightarrow 3H_2 + CO$ Energy: 206 kj/mol

(2) $CO + H_2O \Rightarrow H_2 + CO_2$ Energy: -41 kj/mol

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(3) $CH_4 + 2H_2O \Rightarrow 4H_2 + CO_2$ Energy: 165 kj/mol

[1] Song H. et al. 2022. Energy, environment, and economic analyses on a novel hydrogen production method by electrified steam methane reforming with renewable energy accommodation. Energy Conversion Management, 258
[2] Challiwala M.S. et al. 2017. A combined thermos-kinetic analysis of various methane reforming technologies: Comparison with dry reforming. Journal of CO2 Utilization, 17, 99-111.

As the equations show, the process requires an input of energy. The net energy required for both reactions is 165 kj/mol of CH_4 converted into methane.

There are other methods such as dry reforming methane (DRM) that produce a similar gas mixture with the goal of producing hydrogen gas from organic precursors.[3]

For this analysis, we considered only SRM for hydrogen formation as it is the most mature and commercially available method. The other methods may be worth investigation if vendor with suitably mature technology could be identified.

Data about system operation was taken from the websites of Linde Engineering and HyGear. The energy requirements reported by HyGear are significantly lower than what is expected from the stoichiometry. It is possible that the HyGear process is able to incorporate efficiencies in their design that lower the net energy cost for conversion using SRM. EA is still working with HyGear to understand the energy balance in their process and those results are not presented here. Several things are apparent from an evaluation of the stoichiometry:

1) There is a net gain in energy contained in the hydrogen gas after conversion from methane. The net gain in 1000 SCF of methane gas is approximately 46 KWh.
2) There is a net negative balance of energy over the whole reaction. Approximately 8 KWh of energy are required for the conversion of 1,000 SCF of methane to 4,000 SCF of hydrogen.
3) The net energy contained in 1000 SCF of methane gas drops from 270 KWh to 79 KWh (316/4).

Table 1. Energy balance for conversion of methane to hydrogen.

Item	**Unit**	**per m3 of gas**	**per 1000 SCF Methane****
Methane Energy	KWh	10	270
Hydrogen Energy	KWh	11.2	316
Energy Consumed (Stoichiometry)	KWh	1.9	55
Net Energy Stiochiometry	KWh	-0.3	-8

*SCF = Standard cubic foot = 1 ft3 of gas at 1 atm and 15 C

For conversion of methane gas to hydrogen, high purity is required of the initial gas. This will require removal of hydrogen sulfide primarily. Ammonia and other trace impurities such as siloxanes also likely will need to be addressed in systems burning either methane or with conversion to hydrogen. Therefore, there is no difference in cost for the pretreatment of biogas for use as methane or for use after conversion to hydrogen.

There will be a capital expense for the methane conversion equipment. Base equipment cost for the methane-to-hydrogen conversion equipment will be $2,500,000 for a system capable of converting 180 SCFM of methane to hydrogen. With engineering and installation, the total cost will likely be ~$7,500,000. Additional costs associated with pressurization equipment, gas storage equipment, gas purification equipment, and finished gas transportation equipment will

[3] Song et al.

need to be added for a final cost of the system. There will also be operating expenses for conversion equipment. Operating expenses are not known at this time.

With respect to carbon emissions, one carbon dioxide molecule is produced from burning a single molecule of methane. One carbon dioxide molecule is also produced during the conversion of methane to hydrogen. Therefore, there is no reduction in carbon dioxide or carbon emissions when converting methane to hydrogen.

There are some advantages to conversion of methane to hydrogen:

1) Convenient storage and unlimited shelf life of hydrogen gas.
2) Use of hydrogen in equipment that is designed to burn hydrogen gas.
3) No carbon emissions at the point of use of the hydrogen gas.

CONCLUSIONS

1. There is a net gain in energy from conversion of methane to hydrogen of 117%.
2. There is a consumption of energy from conversion of methane to hydrogen due to energy consumed in the reaction. Energy consumption will be >8 KWh/1000 SCF of methane.
3. There is no advantage to conversion of methane to hydrogen with respect to carbon emissions.
4. Both gasses will require similar pretreatment of the raw biogas prior to use.
5. There are costs associated with the purchase and upkeep of methane-to-hydrogen conversion equipment.

Methane-to-hydrogen conversion is a common and cost-effective way of generating hydrogen gas from fossil fuel. There is a relatively small consumption of energy for conversion of methane to hydrogen. Capital cost of installation of a facility that can convert 178 SCFM of methane to hydrogen may make economic sense if use of the hydrogen is paired with equipment that uses hydrogen, not methane, as a fuel source.

August 16, 2023

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