STATE OF PRACTICE REVIEW TO ASSESS THE COST AND MARKET POTENTIAL FOR YARD WASTE MANAGEMENT PRACTICES IN MIAMI-DADE COUNTY

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Miami-Dade County

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EXECUTIVE SUMMARY

The University of Florida (UF)'s Department of Environmental Engineering Sciences and the Hinkley Center for Solid and Hazardous Waste Management conducted research on the feasibility of instituting a yard waste composting or mulching facility in Miami-Dade County (the County). The research included first assessing the current mass of yard waste disposed of in the County boundaries, then a market analysis of potential recycled yard waste products, and finally a technical engineering analysis. Yard waste is defined as the organic debris resulting from pruning, trimming, or removing trees, shrubs, flowers, or groundcover. The work performed by the researchers included multiple site visits, the creation of yard waste mass estimation methodologies, and conversations with key stakeholders within the County geographic boundaries, both in the public and private sector. The project was divided into four tasks. In this report, the abbreviation "the County" by itself refers to the county government entity. When talking about the physical county, the phrases "County boundary" or "County geographic boundary" are used.

Task 1 consisted of estimating the amount of yard waste entering Miami-Dade County Trash and Recycling Centers (TRCs) from October 1, 2019, to September 30, 2020. The estimation yielded a value of 26,808 tons for loads with only yard waste (referred to as clean yard waste) and 10,918 tons of yard waste for loads mixed with both yard waste and other waste (referred to as yard waste in mixed trash), for a total of 37,726 tons of yard waste.

Task 2 included estimating quantities of yard waste collected elsewhere in Miami-Dade County, including disposal facilities, curbside waste, and that which is managed by the private sector. The processors and disposal facilities that manage yard waste were also mapped in this task. The total estimated generated yard waste was 443,135 tons. The resulting estimates are as follows: 9,692 tons were disposed of at the County's two landfills and Resource Recovery Facility (RRF), 165,610 tons were disposed of in curbside garbage, 175,933 tons were collected in curbside trash, and 53,696 tons were managed by the private sector.

Table ES-1. Estimation summary of yard waste in County boundaries for October 2019 through September 2020.

Yard Waste Handling Location	*Yard Waste (Tons)*
Clean yard waste entering TRCs	26,808
Yard waste in mixed trash entering TRCs	10,918
Clean yard waste entering landfills and RRF	9,692
Yard waste in curbside garbage (unincorporated and incorporated)	165,610
Yard waste in curbside trash (unincorporated and incorporated)	175,933
Yard waste in private sector	53,696
Total Yard waste	**443,135**

Task 3 consisted of conducting a market analysis of the viability of recycled products made from yard waste. First, information was gathered about yard waste recycling practices in all 67 Florida counties. Interviews were conducted with representatives from Hillsborough, Lee, and Sarasota counties to learn from the successes and setbacks of their respective yard waste diversion programs. Next, diverse stakeholders such as hardware stores, nurseries, and farms were contacted to measure the level of interest in a compost or mulch product made from recycled yard waste. The

market size for mulch and soil products in Miami-Dade County was estimated. UF calculated that Miami-Dade County residents purchased approximately 108,470 tons of mulch and 48,812 tons of soil products in 2019. A list of current price points for mulch and compost was assembled.

Task 4 comprised of a technical memorandum where UF summarized the types of technology, size, and costs associated with the County constructing facilities for both mulching and composting yard waste. Sizing calculations were based on the Task 2 results for the mass flow of yard waste (Table ES-1) that is currently disposed of at the Miami-Dade County owned facilities and that is potentially available to be processed. Additionally, UF estimated the capital and operating costs for each type of facility on a per ton of incoming yard waste basis for potential newly constructed mulch and composting facilities (see Table ES-2). Assuming 25% of the clean yard waste (91,301 tons/year) is recovered (22,549 tons/year) for yard waste windrow composting resulted in a total annual cost ranging from $389,000 to $1.02 million per year (depending upon the quality of the compost and its market value). While, if the same mass (22,459 tons/year) is mulched instead, the total annual cost ranged from $8,529 to $240,557 per year (depending upon if the mulch is processed to be sold or if it is provided at no cost to residents). The area requirement (for the 22,459 tons/year mass) for a mulching and a windrow composting facility (assuming on an already permitted site) would be 2 acres with 4 employees and 7 acres with 13 employees, respectively.

Lastly, UF provided a recommendation to Miami-Dade County on the cost effectiveness of mulching or composting yard waste. Based on Task 2 there is a total of 90,196 tons (for 10/2019 to 09/2020) of clean, easily segregated yard waste, where 36,500 tons entered a Miami-Dade County waste management facility (i.e., TRC, landfill, WTE). If those 36,500 tons were to be mulched or windrow composted instead of landfilled or combusted it is estimated that the County could save $14-$53 per ton of yard waste diverted (see Table ES-2), even when assuming no revenue from mulch or compost sale. Worth noting, if the County pays the tipping fee to another entity (like a privately owned landfill or WTE facility, or a facility that another government owns), then the $14-$53 is considered a true savings since the County avoids paying the tipping fee. The savings will be much smaller, however if the County owns the disposal facilities (as is the case for North and South Dade Landfills). That is because a lot of the costs associated with the disposal facilities are fixed (things like labor and facility/equipment amortization) and the County will pay the cost regardless of how much waste comes in. If there is available space on an existing permitted site, then the area requirement to mulch or compost (a conservative 22,459 tons/year) would be 2 to 3 acres, respectively.

Table ES-2. Comparison of the cost of different yard waste management in Miami-Dade.

Management Type	**Cost ($/ Ton)**
Composting	50*
Mulching	11**
Landfill daily cover	10-12
WTE tip fee	64
Landfill tip fee	64

*when including a high- and low-quality compost market revenue price ranges from $18-46/ton.

**when including a high-quality mulch market revenue and providing mulch for free for residents/ use as landfill cover price ranges from $1-11/ton.

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ABBREVIATIONS AND ACRONYMS

C&D	Construction and demolition
EPA	U.S. Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
MRF	Materials Recovery Facility
MSW	Municipal solid waste
SMM	Sustainable materials management
TRC	Trash and recycling center
WTE	Waste-to-energy

1 PROJECT OVERVIEW

1.1 Background and Research Motivation

The University of Florida (UF) and the Hinkley Center for Solid and Hazardous Waste Management conducted a feasibility study for a yard waste mulching or composting facility for Miami-Dade County. In this report, Miami-Dade County generally refers to the county government entity. When discussing the geographic area of Miami-Dade County, the phrase “Miami-Dade County boundaries” is generally used. The county consists of unincorporated regions and 34 municipalities. The 2019 population was 2,716,940 people (United States Census Bureau, 2019a), making Miami-Dade County the most populated county in Florida (Cubit, 2021).

Miami-Dade County wanted to examine the possibility of extending the life of yard waste materials, instead of disposing of them through landfilling or combustion. Motivation for this work was based on the US Environmental Protection Agency (EPA)’s growing trend towards the Sustainable Materials Management (SMM) model. The SMM model differs from the current solid waste management practice by expanding beyond solid waste management and including other systems, such as virgin materials extraction, processing, manufacturing, transportation, and usage. Each system is generally equivalent to a stage in a material’s life and may be referred to as a life stage. When each stage is aggregated together, UF can refer to it as a lifecycle. The SMM model takes into consideration the environmental, social, and economic impacts associated with a lifecycle. Typically, lifecycles are specific to materials, like newspaper. Solid waste decision-makers adopting the SMM model will make decisions on how to best manage a material throughout its lifecycle based on quantifiable impacts to the environment, society, and economy. By recycling yard waste into a new product, such as mulch or compost, less trees and other organic matter would need to be harvested to commercially produce the same products.

1.2 Project Objectives and Tasks

To conduct the feasibility study for implementation of a yard waste processing facility in Miami-Dade County, UF divided the research into five tasks:

Task 1: Yard Waste Estimation Study for Trash and Recycling Centers

UF identified the mass of potentially recoverable yard waste (e.g., branches, leaves) disposed of at Miami-Dade County’s Trash and Recycling Centers (TRCS). Preliminary site visits and meetings with Miami-Dade County were used to develop the estimation methodology. At multiple TRCs, roll-off boxes were designated to collect only yard waste. These roll-off boxes were then weighed upon entry and exit to the final disposal facility, and the weight of the loads were recorded. These data were used to estimate the quantity of clean yard waste. The team also visually inspected vehicles entering TRCs to quantify the yard waste in mixed loads.

Task 2: Map and Estimate the Flows of Yard Waste

Using data from Miami-Dade County, the yard waste collection study at the TRCS, and the private sector, the amount of yard waste generated, collected, recycled, and disposed of within Miami-Dade County boundaries was estimated.

Task 3: Conduct a Market Analysis

UF completed a market analysis for mulch and compost products. First, UF gathered data from other local governments in Florida that process yard waste through mulching or composting. Next, UF contacted local agriculture industries, landscapers, and construction stores to evaluate the viability of marketing recycled yard waste products. An estimation of the market size and market price of these products was provided. Lastly, state and local regulations related to mulching or composting yard waste were discussed and summarized.

Task 4: Complete a Technical Engineering Analysis

Using the data collected from Tasks 1-3, UF completed a technical memorandum summarizing the types of technology, size, and costs associated with newly constructing facilities for both mulching and composting yard waste. Sizing calculations were based on the Task 2 results for the mass flow of yard waste that is currently disposed of at the Miami-Dade County owned facilities and that is potentially available to be processed. Additionally, UF estimated the capital and operating costs for each type of facility. Lastly, UF provided a recommendation to Miami-Dade County on the cost effectiveness of mulching or composting yard waste.

Task 5: Conducting a Waste Composition Study

Task 5 included the execution of a two-season municipal solid waste (MSW) composition study at the South Dade Landfill to produce a material composition estimate of single-family residential waste. Each season's sort lasted five days with a sample size of 40 garbage loads and a minimum of 40 trash loads. The methodology and results are presented in a standalone report "2021 Miami-Dade County Waste Composition Study". However, results for yard waste were integrated into any relevant project tasks.

1.3 Report Organization

This report is separated into eight chapters. This current chapter provides the background, project tasks, and report organization. Chapter 2 describes Miami-Dade County's yard waste universe. Chapter 3 provides the calculation methodology and estimation results for yard waste mass entering Miami-Dade County TRCs. Chapter 4 provides estimations for yard waste handled by Miami-Dade County, municipalities, and the private sector as well as maps the mass flow. Chapter 5 is a market analysis which includes a summary of other Florida counties' management of yard waste, and descriptions of potential markets for mulch and compost products. Chapter 6 provides a technical engineering analysis for mulching and composting facilities. Chapter 7 concludes the report with recommendations for a yard trash processing facility.

2 YARD WASTE UNIVERSE

2.1 Yard Waste Definition

Per Florida Administrative Code (FAC) Chapter 62-709 (Florida Department of State, 2010), yard waste is defined as “vegetative matter resulting from landscaping maintenance or land clearing operations and includes materials such as tree and scrub trimmings, grass clippings, palm fronds, trees and tree stumps, and associated rocks and soils.” Clean wood is also included in the FAC definition (Florida Department of State, 2010). Yard waste is generated in both the residential and commercial sectors. Trash describes bulky items, such as furniture, white goods, construction and demolition (C&D) debris, and yard waste. Garbage is classified as household waste, and usually consists of kitchen and bathroom waste.

2.2 The Yard Waste Universe

Within the geographic boundaries of Miami-Dade County, yard waste can be separated into two spheres of management: Miami-Dade County government managed, and non-Miami-Dade County government managed. The two spheres have different mass flows. Yard waste that is Miami-Dade County managed is any mass that Miami-Dade County collects and or directly enters a Miami-Dade County-owned facility. The yard waste enters county management through multiple methods, such as curbside household garbage collection and curbside trash collection. Miami-Dade County collects this type of waste in the unincorporated regions and select municipalities. Miami-Dade County also manages yard waste that is brought to Miami-Dade County-owned sites, such as the Trash and Recycling Centers (TRCs), transfer stations, landfills, or Resource Recovery Facility (RRF) (which is a waste-to-energy facility (WTE)).

For nine municipalities, Miami-Dade County vehicles collect garbage and trash. The municipalities are as follows: Aventura, Cutler Bay, Doral, Miami Gardens, Miami Lakes, Opa-Locka, Palmetto Bay, Pinecrest, and Sunny Isles Beach. The residents within these nine municipalities are also allowed to use the TRCs. Other municipalities have either their own fleet of collection trucks or contract with private haulers to collect the municipalities’ waste. Some municipalities are contracted with Miami-Dade County to dispose of waste at Miami-Dade County facilities or not contracted but still bring their waste to the facilities. Miami-Dade County managed yard waste either stays at Miami-Dade County owned facilities or is sent to a private disposal facility, Medley Landfill, if a county owned disposal site cannot accept the load. Medley Landfill is owned and operated by Waste Management.

Non-Miami-Dade County managed yard waste is the material collected within Miami-Dade County geographic boundaries but not disposed of at Miami-Dade County facilities. One example is the yard waste collected by landscapers, across unincorporated and incorporated zones, and brought to a privately owned processing site or landfill. This material is considered non-Miami-Dade County managed even though it is collected in unincorporated regions because the yard waste does not enter a Miami-Dade County-run facility. Additionally, some municipalities dispose of their curbside collected waste at private landfills.

2.3 Further Detail of Miami Dade County Handling of Yard Waste

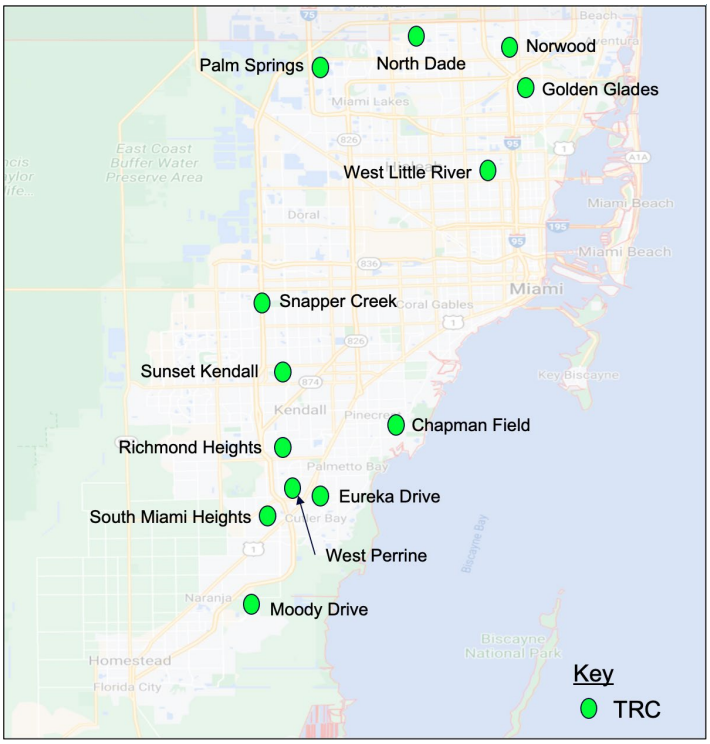
Miami-Dade County offers curbside collection of waste and operates 13 TRCs, three transfer stations, two landfills, and a WTE facility, all of which accept yard waste. A description of each is provided below.

2.3.1 Curbside Collection

Yard waste can enter Miami-Dade County management via curbside collection. In the unincorporated regions, residents can place yard waste in household garbage roll carts. Residents are also allotted 50 cubic yards (yd^3) of trash collection per year, which can be collected in one 50 yd^3 trash pick-up or split into two collections of 25 yd^3. The 50 yd^3 can consist of any material considered trash, as listed in Table 2-1. Municipalities which Miami-Dade County services as well as the municipalities which bring their waste to Miami-Dade County facilities might have variations of their curbside collection protocol.

2.3.2 TRCs

There are 13 TRCs in Miami-Dade County, as can be seen in Figure 2-1. These TRCs are available to residents of unincorporated Miami-Dade County, the nine municipalities which Miami-Dade County services, and landscapers. The materials and products eligible for disposal at the TRCs are yard waste, C&D debris, wooden fencing, furniture, household trash, tires, white goods, mattresses, motor oil, used electronics, and chain link fencing. See Table 2-1 for a list of the TRCs and the materials accepted at each site. Food waste and other household garbage is not allowed. Visitors' vehicles are limited to a load that is 10 feet long, 6 feet wide, and 6 feet high. C&D material is limited to 3 cubic feet per day.



Residents pay for access to the TRCs through property assessments. When they enter a site, a TRC attendant scans the visitor's license. If their address is in the database, the resident does not have to pay on site. Landscapers must purchase coupons ahead of time. One coupon cost $25.60. The only record of materials entering the TRC is found in the TRC attendant station logs. The attendant will either note a mixed load or mark the individual material categories.

The TRC sites consist of 4-5 roll off bins. Each roll off bin is accessed by two bays where visitors can back into, park, and unload their vehicles. All TRCs use 40 yd^3 roll off bins except Sunset Kendall, which uses 100 yd^3 open top tractor trailer containers. Specialty products, such as tires, motor oil, white goods, and electronics have separate drop off locations at each TRC and are not placed in the roll off bins. TRCs will either have a separate roll off bin for mattresses or a separate location on site for residents to stack the item.

Residents can bring in yard waste in two forms. If a resident brings a load that is solely yard waste, it is deemed a clean load of yard waste. If a resident brings a load that contains yard waste plus other materials, the load is considered mixed. Landscapers usually bring clean loads to the TRCs. Two TRCs, Snapper Creek and Sunset Kendall, designate one roll off bin to clean yard waste on the weekdays. If a vehicle comes in with a clean yard waste load, the resident will empty their load in the specified roll off bin. On the weekends, due to the high volume of vehicles using the TRCs, those entering with only yard waste are to dump in any of the roll off bins, with all other accepted materials. The remaining 11 TRCs do not collect yard waste separately, and all materials are dumped together, excluding specialty items like white goods, tires, and motor oil. Figure 2-2 displays a vehicle carrying a clean load on the left, and vehicle with a mixed load on the right.

Table 2-1. List of TRCs and accepted materials. An 'X' indicates that the material is accepted at the corresponding TRC.

TRCS	Household Trash	Tree and Yard Cuttings (Yard Waste) and Wooden Fencing	Construction and Demolition (C&D) Debris	Standard Automobile Tires	White Goods	Mattresses	Motor Oil	Used Electronics	Chain Linked Fence
Chapman Field	X	X	X	-	-	-	-	-	-
Eureka Drive	X	X	X	X	X	X	-	X	-
Golden Glades	X	X	X	X	X	X	X	X	X
Moody Drive	X	X	X	X	X	X	X	X	-
North Dade	X	X	X	X	X	X	-	X	X
Norwood	X	X	X	X	X	X	-	-	-
Palm Springs North	X	X	X	X	X	X	-	X	-
Richmond Heights	X	X	X	X	-	-	-	-	-
Snapper Creek	X	X	X	X	-	X	X	-	-
South Miami Heights	X	X	X	X	X	X	-	-	-
Sunset Kendall	X	X	X	X	X	X	-	X	-
West Little River	X	X	X	X	X	X	-	X	X
West Perrine	X	X	X	X	X	X	-	X	-

2.3.3 Transfer Stations, Landfills, and WTE

Miami-Dade County owns three transfer stations, two landfills, and a WTE facility. The three transfer stations are Central Transfer Station, Northeast Transfer Station, and West Transfer Station. The two landfills are North Dade Landfill and South Dade Landfill. North Dade Landfill is a Class III landfill meaning only trash is accepted. South Dade Landfill is a Class I landfill and accepts MSW. The RRF is owned by Miami-Dade County, operated by Covanta, and burns both garbage and trash. See Figure 2-3 for a map of these Miami-Dade County-owned facilities.

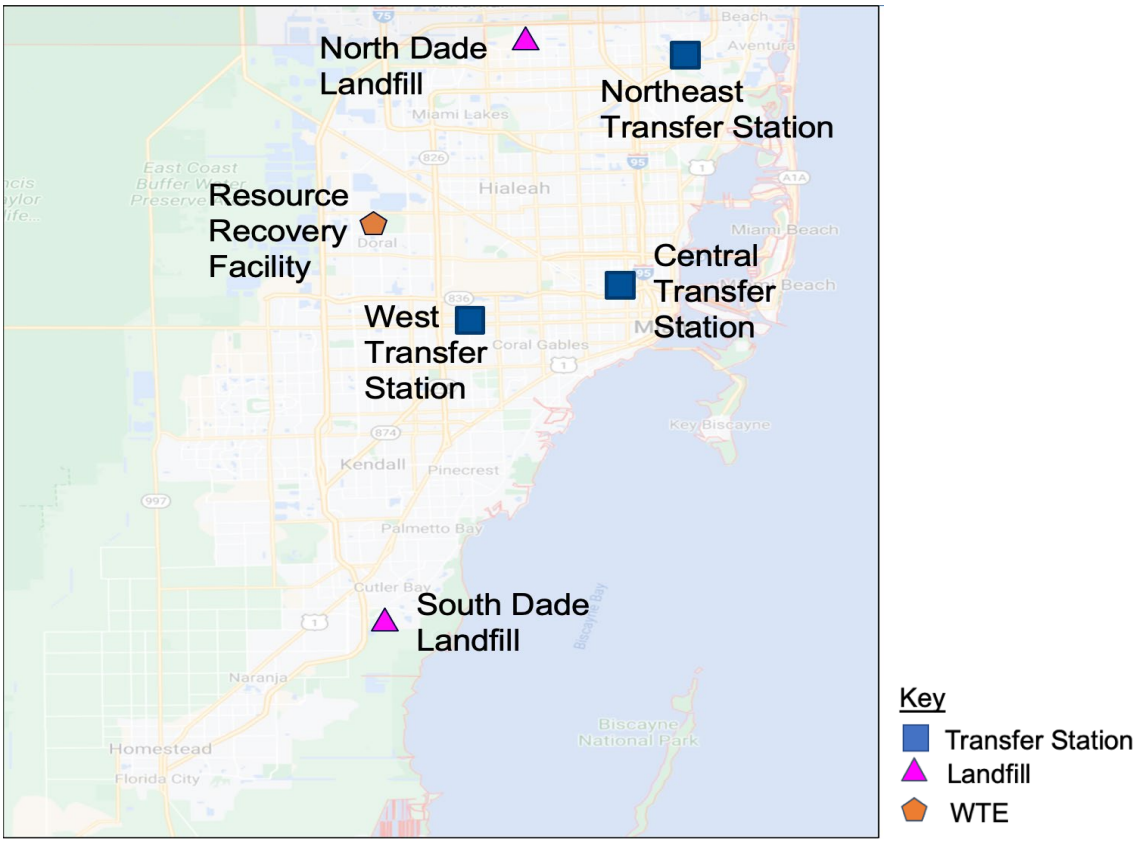


Figure 2-3. Miami-Dade County-owned transfer stations, landfills, and WTE facility.

Residents and landscapers can go to the transfer stations to drop off waste, but they must pay a tipping fee. There is not a specific tipping fee for yard waste at the transfer stations, so the visitors are charged standard non-contract hauler tipping fees. Similarly, the transfer station scale houses do not keep separate records for clean yard waste loads. Residents do not commonly dispose of yard waste at the transfer stations because they have access to the TRCs or curbside collection. Landscapers also do not commonly frequent the transfer stations because the tipping fee is higher compared to the TRCs or Miami-Dade County landfills.

Conversely, the two Miami-Dade County landfills and RRF do have a separate tipping fee for yard waste only loads and do keep separate tonnage records of clean loads. If a landscaper is dropping off a clean yard waste load at RRF or the landfills, the tipping fee is \$7.70 per yd^3. If a resident brings a clean yard waste load or a mixed load, they must pay the standard non-contract disposal rate of \$91.11 per ton.

3 YARD WASTE ESTIMATION STUDY FOR TRASH AND RECYCLING CENTERS

3.1 Methods for Yard waste Estimation at TRCs

The purpose of Task 1 was to estimate the tonnage of yard waste entering the trash and recycling centers (TRCs), both in clean and mixed loads. Yard waste not mixed in with other trash is considered “clean yard waste”. Yard waste mixed in with other trash material is considered “yard waste in a mixed load”. UF performed several site visits and created methodologies to estimate the quantity of clean yard waste and yard waste in mixed loads.

The quantity of clean yard waste is of interest for Miami-Dade County because this mass is easily divertible. If Miami-Dade County were to pursue a yard waste processing facility, the clean yard waste is already source-segregated and would require less processing. There are still contamination concerns associated with the clean yard waste stream. Visitors will sometimes bring in loads that appear to be solely yard waste but have other materials hidden underneath the vegetation. Even if the attendant pokes around and digs through the load, other trash materials are sometimes not visible. One impact this has on the TRCs is that the attendant records are not fully accurate. The attendant might mark down “clean yard waste” and the hidden materials are not recorded. Yard waste in mixed loads would require more processing on behalf of Miami-Dade County because the yard waste is not source-separated.

3.1.1 Site Visits

UF traveled to Miami-Dade County in October 2020 as an introductory visit. The purpose of this visit was to meet Miami-Dade County personnel as well as see general operations of two TRCs, Snapper Creek and Sunset Kendall. UF then traveled to Miami-Dade County from December 16 to 19, 2020 to practice data collection methodologies for estimating the average percentage of yard waste by volume in mixed loads. UF spent December 16 at the Moody Drive TRC, December 17 at the Golden Glades TRC, and December 18 and 19 at the Snapper Creek TRC.

UF then traveled to the County from January 31 through February 7, 2021, to set up a clean yard waste collection study. Because all roll off bins are weighed and marked as the same material when entering the transfer stations or landfills, there is currently no mass record of the clean yard waste that enters and leaves the TRCs. The clean yard waste collection study was established to collect clean yard waste separately, weigh the mass, and establish an average percent by mass of clean yard waste entering each TRC. This average yard waste percentage was then applied to each TRC’s total accepted tonnage to estimate an overall mass of clean yard waste entering the 13 TRCs.

3.1.2 Calculation Methodology

3.1.2.1 Clean Yard Waste TRC Method

This section will first discuss the clean yard waste estimation methodology and then the yard waste in mixed loads estimation methodology.

For the clean yard waste collection study, seven TRCs were selected. At each of these TRCs, one of the roll-off bins was designated for collecting only yard waste. If a vehicle came in with either no yard waste or mixed yard waste and other materials, the vehicle was directed to dump at the other roll off bins. Since designating a roll off bin only for clean yard waste can slow down operations at the TRC, not all 13 TRCs were included in this program. The seven TRCs chosen are geographically spread around the county and handle a wide range of total trash tonnages. The number of visitors bringing only yard waste varies between these TRCs, information that was sourced from TRC attendant station logs. Snapper Creek and Sunset Kendall already collect clean yard waste separately during the week, but their clean yard waste masses are not distinguished from the other TRC waste. See Table 3-1 for the selected TRCs, their total tonnage received, their location within the county, as well as the number of clean yard waste visitors from October 2019 through September 2020. As a reminder, Miami-Dade County's fiscal year is October 1 through September 30. The clean yard waste collection study occurred February 1 through February 7, 2021, from 7 AM to 5:30 PM. Some TRCs participated in the clean yard waste study for two weeks. Others participated for the first week, mainly the TRCs on the south end of Miami-Dade County boundaries. Some TRCs began participation a day or two after the start of the program and some commenced a few days early.

Table 3-1. Selected TRCs for clean yard waste collection program. Data are from October 1, 2019, through September 30, 2020.

TRC Locations	Total Incoming Tons	Location in County	% of Visitors with Clean Yard Waste Loads
Chapman Field	6,091	South	51%
Snapper Creek	28,834	Middle	42%
Golden Glades	6,692	North	36%
Moody Drive	15,264	South	34%
Palm Springs	12,319	North	32%
South Miami Heights	8,881	South	25%
Sunset Kendall	28,795	Middle	24%

TRC attendants and roll off truck drivers were notified of the study. The roll off truck drivers were alerted which roll off bin was designated for clean yard waste and once they received a scale house ticket, they were to write "clean yard waste" on the ticket. At the end of the day, they brought these marked tickets to their supervisor and all masses marked as "clean yard waste" were summed. The supervisor also summed the total trash, including the clean yard waste quantity and other trash, which entered the TRC each day.

The first step in the calculation methodology was to estimate a clean yard waste percentage per each TRC and per day. As outlined in Equation 3-1, per each TRC and per each day, UF divided the total mass of clean yard waste by the total mass of trash which entered the TRC. The resulting value was then multiplied by 100 to create a percentage of clean yard waste. As seen in Equation 3-2, an average percent of clean yard waste per TRC was calculated over the two-week time span. If a TRC was not participating in the clean yard waste study on a certain day, their average did not include that day. Table 3-2 lists the two-week percent clean yard waste values for each TRC.

Thirdly, an average of the seven TRC's two-week clean yard waste percentages was calculated, as seen in in Equation 3-3. The average percentage of clean yard waste by mass entering a TRC per day was 16%. To estimate the mass of clean yard waste that entered each TRC over the year, the 16% was applied to each of the 13 TRC's total trash tonnage from October 2019 to September 2020.

$$\%\ clean\ yard\ waste, per\ TRC-day\ \left(\frac{\%}{TRC-day}\right) = \frac{clean\ yard\ waste\ \left(\frac{tons}{TRC-day}\right)}{total\ tonnage\ collected\ \left(\frac{tons}{TRC-day}\right)} * 100$$

Eq. 3-1

$$\%\ clean\ yard\ waste, per\ \text{TRC}\ over\ two-week\ period\left(\frac{\%}{TRC-two-week\ period}\right) = \frac{\Sigma\left(\frac{\%}{TRC-day}\right)}{Number\ of\ days\ TRC\ has\ data}$$

Eq. 3-2

$$Average\ \%\ clean\ yard\ waste\ for\ any\ TRC-day\left(\frac{\%}{TRC-day}\right) = \frac{\Sigma(13\ \text{TRC}'\text{s}\%\ clean\ yard\ waste, per\ \text{TRC}\ over\ two-week\ period)}{7}$$

Eq. 3-3

Table 3-2. Two-week percent clean yard waste for each TRC.

TRC	% Clean Yard Waste
Palm Springs North	10%
Golden Glades	17%
Chapman Field	29%
Sunset Kendall	7%
Moody Drive	15%
South Miami Heights	28%
Snapper Creek	3%
Average	***16%***

3.1.2.2 Mixed Load Yard Waste TRC Method

The mass of yard waste within mixed loads was estimated using the clean yard waste quantity as well as visually estimating vehicles. Mixed trash loads can either consist of yard waste plus other trash items or no yard waste and entirely other trash items. These two types of loads are emptied into the same roll off bin at TRCs. During UF's December site visit, both students recorded and measured multiple elements of incoming vehicles, such as vehicle brand and model and the size of the truck bed, car trunk, or trailer. Sometimes UF used a yard stick to measure the truck bed dimensions. To estimate the quantity of yard waste within each vehicle, UF wrote down a percent yard waste by volume of the vehicle's load. Observations on the type and quality of yard waste was also frequently noted, such as if the materials were logs, branches, shrubs, and if the material was dried or freshly cut. Pictures were sometimes taken of loads with yard waste.

UF would often observe the same vehicles. Sometimes, one student would note observations about a load and then follow the vehicle to the bay while the other student stayed at the attendant station to look at incoming vehicles. At the bay, UF observed the disposed materials. UF also asked the visitor questions, such as how often the visitor frequents a TRC and what size land they own. Observing vehicles at the bays helped the accuracy of UF's estimations. The occurrence of a vehicle looking full of just yard waste and then having other materials underneath was infrequent.

Figure 3-1 provides an example of how the quantity of yard waste in mixed loads was determined. The load in Figure 3-1 looked to be about 20%, by volume, yard waste. Over the course of four days, over 620 vehicles were assessed between the two students. Of these, roughly 460 trucks carried either a mix of yard waste and other items, or no yard waste. UF each took an average of the yard waste in mixed load percentages and then an average of the two final values. UF had different initial averages of yard waste in mixed loads because UF evaluated most of the same vehicles but also inspected different vehicles. UF estimated that, on average, mixed vehicles' loads were 7.7%-yard waste by volume.

UF used this percentage of yard waste in mixed trash to calculate the annual mass of yard waste in mixed trash. For each of the 13 TRCS, the tonnage of clean yard waste tonnage was subtracted from the total trash tonnage collected from October 2019 through September 2020 to result in an available tonnage of mixed trash. Per each TRC, the 7.7% value was applied to the respective mixed trash tonnage. This resulting value was the yard waste found in mixed trash at each TRC for the year.

Figure 3-1. Example of yard waste in mix load estimation.

3.2 Results for Yard Waste Estimation at TRC

The tonnages of total trash and clean yard waste received per each TRC are shown in Table 3-3. The tonnages of mixed trash and yard waste in mixed trash are shown in Table 3-4.

Table 3-3. Clean yard waste tonnages entering each TRC (for 10/2019 to 09/2020).

TRC	Total Tons Entering TRC (tons)	Clean Yard Waste Entering TRC (tons)
North Dade TRC	12,456	1,980
Norwood	8,519	1,355
Palm Springs	12,319	1,959
Golden Glades	6,692	1,064
Snapper Creek	28,834	4,585
Sunset/Kendall	28,795	4,578
Chapman Field	6,091	968
Richmond Heights	7,984	1,269
West Perrine	10,113	1,608
Eureka Drive	10,605	1,686
South Miami Heights	8,881	1,412
Moody Drive	15,264	2,427
West Little River	12,053	1,916
TOTALS	***168,605***	***26,808***

Table 3-4. Yard waste in mixed loads for each TRC (for 10/2019 to 09/2020).

TRC	Mixed Trash (tons)	Yard Waste in Mixed Trash (tons)
North Dade TRC	10,475	807
Norwood	7,165	552
Palm Springs	10,361	798
Golden Glades	5,628	433
Snapper Creek	24,249	1,868
Sunset/Kendall	24,216	1,865
Chapman Field	5,122	394
Richmond Heights	6,715	517
West Perrine	8,505	655
Eureka Drive	8,919	687
South Miami Heights	7,469	575
Moody Drive	12,837	988
West Little River	10,137	781
TOTALS	***141,797***	***10,918***

In summary, 26,808 tons of clean yard waste and 10,918 tons of yard waste within the mixed trash are estimated to have entered the 13 TRCs between October 2019 and September 2020. These two tonnages are compared to the overall tonnage handled at the TRCs of 168,605 tons in Figure 3-2. The clean yard waste quantity is important for Miami-Dade County as this mass is easily accessible since it is already source separated.

If Miami-Dade County were to pursue a yard waste processing facility, this mass would require minimal effort to separate out contamination. The yard waste would then be ready for size reduction and other processing. Collection of the yard waste tonnage in mixed loads would require more effort on behalf of Miami-Dade County. Miami-Dade County would either need to implement protocols in which residents can only bring yard waste in clean loads, or the yard waste would need to be separated from other trash items at a processing facility.

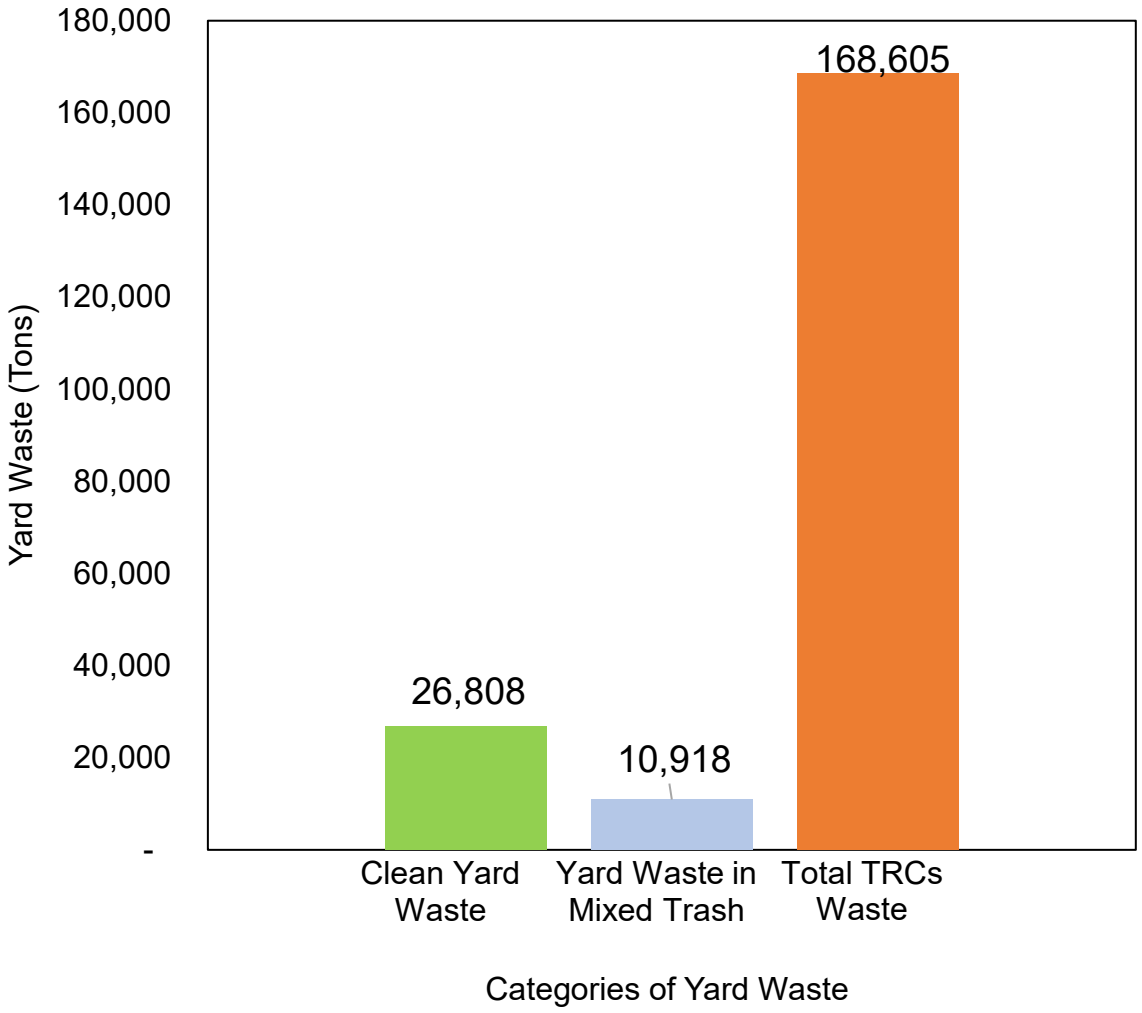


Figure 3-2. Clean yard waste, yard trash in mixed trash, and the total tonnage handled at the 13 TRCs (for 10/2019 to 09/2020).

4 MAP AND ESTIMATION OF YARD WASTE FLOWS IN MIAMI-DADE COUNTY

4.1 Task Overview

The purpose of Task 2 was to quantify and map the yard waste tonnages handled in the geographic boundaries of Miami-Dade County. As described in Chapter 1, Miami-Dade County-managed yard waste is any yard waste that enters Miami-Dade County-owned facilities. Non-Miami-Dade County managed yard waste is handled by municipalities and private companies, such as private landfills and yard waste recyclers. Although the values provided by Miami-Dade County and the private sector encompass different years, such as the 2019 calendar year, the 2019-2020 fiscal year, and the 2020 calendar year, UF assumed that quantities of yard waste generated and processed are generally consistent from year to year and are comparable. To estimate the yard waste flow within Miami-Dade County boundaries, three sectors were established. Sector A includes yard waste directly entering Miami-Dade County facilities, consisting of the TRCs, landfills, and WTE facility. Sector B is the yard waste found in curbside collected garbage and trash. This is yard waste that is collected and handled by both Miami-Dade County and municipalities. Two estimation methodologies of Sector B are presented. Sector C is the yard waste handled in the private sector.

4.2 Yard Waste Mass Flow Mapping

4.2.1 Sector A: Miami-Dade County Managed Yard Waste at TRCs, Landfills, and WTE Facility

4.2.1.1 TRCs

TRCs receive yard waste as clean yard waste loads and in mixed loads, as described in Chapter 3. The resulting tonnage of clean yard waste for all 13 TRCs from October 2019 to September 2020 was 26,808 tons. The resulting tonnage of yard waste in mixed trash was 10,918 tons for the same period. In total, the TRCs collected an estimated 37,726 tons of yard waste during the 2019-2020 fiscal year. The TRC waste, including yard waste, is sent to four separate locations. The waste from Palm Springs, North Dade, Norwood, and Golden Glades is sent to North Dade Landfill. West Little River waste is sent to Central Transfer Station, and Snapper Creek waste is sent to West Transfer Station. From these transfer stations, the waste is sent to RRF. The waste from Sunset Kendall, Richmond Heights, South Miami Heights, Moody Drive, Eureka Drive, Chapman Field, and West Perrine is sent to South Dade Landfill. If any of the disposal facilities are unable to accept waste, Miami-Dade County waste is sent to Medley Landfill. The flow of waste is seen in Figure 4-1. The clean yard waste tonnages, as calculated in Table 3-3, and the yard waste within the mixed trash, as calculated in Table 3-4, are shown for each TRC.

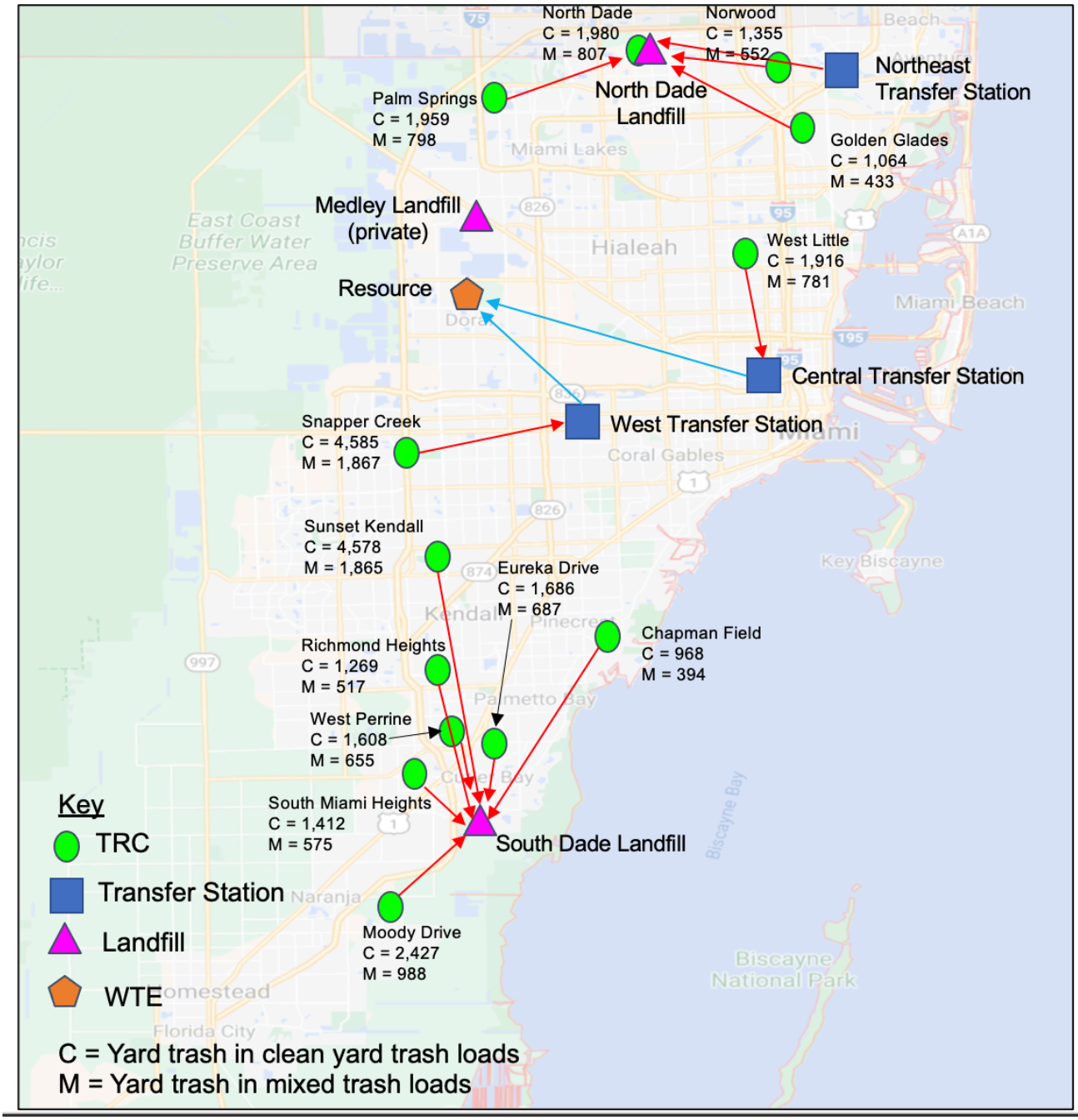


Figure 4-1. The flow of yard waste masses from the TRCs mapped (for 10/2019 to 09/2020). The red arrows show yard waste flow from TRC to handling facility. The blue arrows show yard waste flow from transfer stations to disposal sites.

4.2.1.2 Transfer Stations and Landfills

An estimate for yard waste directly entering Miami-Dade County-owned transfer stations was not calculated for multiple reasons. First, clean loads are not frequently brought to the transfer stations by either residents or landscapers due to the higher tipping fees at the transfer stations than at other Miami-Dade County-owned facilities. Though there is some quantity of yard waste that enters the transfer stations through contracted

haulers carrying curbside waste, yard waste masses are not recorded separately from other incoming trash at the scale house. Additionally, the waste in hauler vehicles is not source-separated. The yard waste included in contracted haulers' loads is discussed in Section 4.2.2.

Miami-Dade County's two landfills, North Dade and South Dade, and the WTE facility, RRF, accept yard waste. Residents entering with clean yard waste loads are charged the standard non-contacted hauler tipping fee of $91.11 per ton. Landscapers entering these facilities provide the dimensions of their load and are charged $7.70 per yd^3. Each facility's scale house maintains separate records for clean yard waste from other waste. As seen in Table 4-1, the total quantity of clean yard waste which directly entered RRF, South Dade Landfill, and North Dade Landfill from October 2019 to September 2020 was 9,692 tons. If Miami-Dade County were to pursue a yard waste operation, this quantity would be easily divertible as the material is already source-separated.

Table 4-1. Clean yard waste tonnages handled at RRF, South Dade, and North Dade landfills (for 10/2019 to 09/2020).

Disposal Facility	Quantity of Clean Yard Waste Entering from Residents (tons)	Quantity of Clean Yard Waste Entering from Landscapers (tons)	Total Clean Yard Waste Entering Facility (tons)
RRF	720	1,380	2,100
S Dade Landfill	2,218	3,342	5,459
N Dade Landfill	401	1,732	2,133
TOTAL	**3,339**	**6,453**	**9,692**

4.2.2 Sector B: Yard Waste in Unincorporated and Municipality Curbside Collected Garbage and Trash

4.2.2.1 Initial Estimation Methodology of Yard Waste in Curbside Waste

Curbside-collected waste can refer to waste generated by single-family, multi-family, or commercial sources, both in unincorporated and municipal zones. Waste is collected regularly on specific days by hauler vehicles. Yard waste can be found in either the curbside-collected garbage, trash, or both, depending on local protocols. As a reminder, garbage is household or commercial waste, generally from the kitchen, bathroom, or office. Trash is bulky waste, such as furniture, yard waste, and C&D. Estimating yard waste generation by any source not serviced by Miami-Dade County is difficult as there are fewer public records. As a starting point in estimating curbside yard waste, UF created a preliminary methodology to calculate a curbside yard waste tonnage per person using the population serviced by Miami-Dade County. UF then applied that ratio to the population not serviced by Miami-Dade County. This method is presented in Table A-2.

As a reminder, the population serviced by Miami-Dade County lives in single-family homes within the unincorporated area and 9 specific municipalities. Note in this methodology, UF paired populations that include both single-family and multi-family with waste tonnages generated by single-family homes. UF made this assumption as UF do

not have a reliable value for populations living in single-family homes, both serviced and not serviced by Miami-Dade County. Using this methodology, 274,681 tons of yard waste are estimated to be generated by the population serviced by Miami-Dade County and 169,963 tons of yard waste are estimated to be generated by the population not serviced by Miami-Dade County, for a total of 444,644 tons of yard waste (in garbage and trash collectively).

4.2.2.2 Detailed Estimation Methodology of Yard Waste in Curbside Waste

UF created a second estimation methodology for quantifying yard waste in curbside collected waste. The methodology involved splitting unincorporated regions and municipalities into three categories, depending on the governing entity managing curbside collection and where the waste was disposed. The three categories are shown in Table 4-2. The following discussion will detail the estimation methodologies for both the garbage and trash streams produced within these three categories. Table A-1 in the Appendix provides further detail on how values within Categories 1, 2 and 3 were calculated.

Table 4-2. Categories for estimating yard waste in curbside waste.

Category	Type of Waste
Category 1	Waste collected by Miami-Dade County (in both unincorporated zones and select municipalities) that is sent to Miami-Dade County facilities
Category 2	Waste not collected by Miami-Dade County that is sent to Miami-Dade County facilities
Category 3	Waste not collected by Miami-Dade County that is sent to non- Miami-Dade County facilities

To calculate estimates for each category, a yard waste composition value was necessary. Miami-Dade County commissioned a waste composition study in May 2021, and the resulting composition percentage for yard waste in the single-family curbside collected garbage stream was 13.5% by mass (Townsend et al, 2021). This value does not consider the bulky trash material composition. This value is separate from the estimate of yard waste in waste disposed at the TRCs. An estimate for the yard waste in the curbside collected trash (bulky waste) that is collected by Miami-Dade County was established by conducting a visual estimation study of trash trucks in May 2021. The resulting percentage of yard waste per trash truck was 36.2% by volume (Townsend et al, 2021). UF then applied this volume percentage to masses of trash to estimate the mass of yard waste collected. This is a similar approach to the estimation methodology used to estimate yard waste at the TRCs in Chapter 3. The methodology and more results of (Task 5) the May 2021 waste composition study and trash estimation study can be found in the document “2021 Miami-Dade Waste Composition Study Report”.

Category 1 includes the curbside waste which Miami-Dade County’s fleet collects. Miami-Dade County services single-family homes in unincorporated zones and nine municipalities, which are Aventura, Cutler Bay, Doral, Miami Gardens, Miami Lakes, Opa-Locka, Palmetto Bay, Pinecrest, and Sunny Isles Beach. Table 4-3 provides both the total garbage and trash tonnages collected by the County for the service locations, labeled “Curbside Collected Garbage (tons)” and “Curbside Collected Trash (tons)”, respectively. Of the total garbage and trash collected by the County’s fleet, garbage comprises 64% by mass and trash comprises 36% by mass. For the garbage tonnage, the 13.5%-yard waste composition value was applied, which is labeled “Yard Waste in Curbside Garbage

(Tons)". For the trash tonnage, the 36.2%-yard waste composition value was applied, which is labeled "Yard Waste in Curbside Trash (Tons)". As a result, 77,880 tons of yard waste are estimated to be in Category 1's curbside garbage and 115,529 tons in the curbside trash, from single-family homes. The yard waste in curbside waste from multi-family homes or businesses was not estimated here.

Table 4-3. Estimate of yard waste in curbside waste for Category 1.

Included Regions	Data Source and Collection Period	Curbside Collected Garbage (tons)	Yard Waste in Curbside Garbage (tons)	Curbside Collected Trash (tons)	Yard Waste in Curbside Trash (tons)
Unincorporated Miami-Dade County + Aventura, Cutler Bay, Doral, Miami Gardens, Miami Lakes, Opa-Locka, Palmetto Bay, Pinecrest, Sunny Isles Beach	Miami-Dade County, 2019-2020 fiscal year	576,893	77,880	319,140	115,529

Category 2 includes curbside garbage and trash that municipalities collect, either with their own fleet or with private haulers, and dispose of at Miami-Dade County facilities. Category 2 also focuses on single-family homes only. In Miami-Dade County's 2019-2020 fiscal year, 15 municipalities contracted with Miami-Dade County to bring curbside waste to Miami-Dade County facilities. Nine of these municipalities have their own fleet, including Coral Gables, Homestead, City of Miami, Miami Shores, Miami Springs, North Bay Village, South Miami, Surfside, and West Miami. Six municipalities contact haulers to collect waste and bring the material to Miami-Dade County facilities and include Bal Harbour, Bay Harbor Islands, Miami Beach, North Miami, North Miami Beach, and Sweetwater. Three additional municipalities, Village of Biscayne Park, El Portal, and Golden Beach, do not have contracts with Miami-Dade County but still bring their waste to Miami-Dade County facilities, per municipality representatives.

For waste coming from the municipalities that use private haulers, County scale house records do not specify geographic origin. These municipalities pay hauling companies which then pay Miami-Dade County to dump the waste. When a hauler truck enters the scale house, the hauling company's account is charged, and thus a specific municipality is not identified. Additionally, a hauler truck can sometimes service multiple municipalities on a route, and so Miami-Dade County is not able to identify the waste as originating from one specific municipality. For all municipalities who are contracted with Miami-Dade County, Miami-Dade County provided a collective garbage and trash value. For the municipalities which Miami-Dade County does not track tonnages for, Miami-Dade County estimates a collective garbage and trash tonnage based on populations. These tonnages estimated by Miami-Dade County are used in this estimate methodology unless the municipality provided data.

When a combined garbage and trash tonnage was provided (either by Miami-Dade County or the municipality), UF multiplied the total tonnage by 64% to result in the mass of garbage and 36% to result in the mass of trash. These percentages are sourced from

the garbage-to-trash ratio in Miami-Dade County collected waste. Next, for each garbage and trash value, the yard waste mass estimate of 13.5% and 36.2% were applied, respectively. Some municipalities do not allow for yard waste in the garbage stream, as indicated by dashes in Table 4-4, and thus only a yard waste estimate within the trash stream was calculated.

Through discussion with municipality representatives, curbside waste or yard waste tonnages were sometimes provided. These tonnages, alongside the values provided by Miami-Dade County, were used in Table 4-4. A Miami Shores representative said 200 trucks a month are used to collect yard waste. Each truck is 30 cubic yards (yd^3). Using a density for uncompacted mixed yard waste of 250 pounds per yd^3 (EPA, 2016), an annual yard waste generation of 9,000 tons for Miami Shores was calculated. A representative of North Bay Village said 2-4 tons of trash are collected three times a week and for each collection, the trash is 50%-yard waste. Using the lower collection quantity of 8 tons of trash per week, 312 tons of trash are collected per year and of that, 156 tons is yard waste. A city of North Miami representative reported that 10,941 tons of garbage and trash were collected in 2019. The Village of Biscayne Park reported that 2,412 tons were collected in 2019. Lastly, a City of Coral Gables representative provided that roughly 35,000 tons of bulky trash are collected annually, 70-75% of which is yard waste. The City of Coral Gables brings some yard waste to the City of Miami's composting operation, per Miami-Dade County records, and bulky waste to Waste Management Delta Recycling facility in the City of Hialeah, per a city solid waste representative. Through conversation with a City of Miami representative, yard waste is diverted to a Waste Management facility, when possible, but a yard waste tonnage was not provided by the representative. UF estimated the City of Miami's yard waste the same way as other contracted municipalities. These tonnages, alongside the values provided by Miami-Dade County, were used in Table 4-4. Table 4-4 has similar structure to Table 4-3.

Table 4-4. Estimates of yard waste in curbside waste for Category 2.

Included municipalities	Tonnage Data Source and Collection Period	Combined Garbage and Trash (tons)	Curbside Collected Garbage (tons)	Yard Waste in Curbside Garbage (tons)	Curbside Collected Trash (tons)	Yard Waste in Curbside Trash (tons)
Village of Bal Harbour[a,c]	MDC, 2019-2020	5,502	3,542	-	1,960	709
Bay Harbor Islands[a,c]	MDC, 2019-2020	741	477	100	264	96
City of Coral Gables[a]	City of Coral Gables, Unspecified year	44,180	9,180	-	35,000	12,670
City of Homestead[a]	MDC, 2019-2020	58,639	37,754	-	20,885	7,561
City of Miami[a,d]	MDC, 2019-2020	154,006	99,154	13,386	54,852	19,857
City of Miami Beach[a]	MDC, 2019-2020	13,192	8,493	1,147	4,699	1,701
Miami Shores Village[a]	City of Miami Shores, Unspecified year	Unknown	Unknown	-	Unknown	9,000
City of Miami Springs[a]	MDC, 2019-2027	4,140	2,665	360	1,475	534
North Bay Village[a]	MDC, 2019-2020	4,757	3,063	413	1,694	613
City of North Miami[a]	City of North Miami, 2019	10,941	7,044	951	3,897	1,411
City of North Miami Beach[a,c]	MDC, 2019-2020	16,997	10,943	-	6,054	2,191
City of South Miami[a]	MDC, 2019-2020	10,626	6,841	924	3,785	1,370
Town of Surfside[a]	MDC, 2019-2020	5,272	3,394	458	1,878	680
City of Sweetwater[a,c]	MDC, 2019-2020	5,842	3,761	508	2,081	753
City of West Miami[a]	MDC, 2019-2020	2,994	1,928	260	1,066	386
Village of Biscayne Park[b,e]	Village of Biscayne Park, 2019	Unknown	Unknown	-	2,412	873
El Portal[b,e]	-	Unknown	Unknown	Unknown	Unknown	Unknown
Golden Beach[b,e]	-	Unknown	Unknown	-	Unknown	Unknown
TOTAL	-	337,829	198,240	18,506	142,001	60,404

Dashes (-) indicate yard waste is not allowed in garbage and thus no estimate of yard waste was calculated
a= Municipality is contracted to bring garbage and trash to Miami-Dade County facilities
b= Municipality is not contracted to bring garbage and trash to Miami-Dade County facilities, but municipality representative relayed that waste is sent to Miami-Dade County facilities
c= Combined garbage and trash value is an estimate by Miami-Dade County based on population
d= Some yard waste is diverted to Waste Management facility for recycling, but the mass is unknown
e= Municipality does not have a disposal contract with the Miami-Dade County but still brings waste to Miami-Dade County facilities. Municipality representative did not provide certain tonnage information

Category 3 includes municipalities that use their own fleet or private haulers and dispose of their material at private disposal sites. The curbside waste, including yard waste, does not enter Miami-Dade County System. Of the 34 municipalities within the County geographic boundaries, the waste of 27 municipalities is disposed of at Miami-Dade County facilities. Seven municipalities either dispose of waste at Miami-Dade County facilities but did not provide that information or their waste is dumped at private landfills, such as Medley Landfill, Monarch Hill Landfill, Okeechobee Landfill (also known as Berman Road Landfill), or J.E.D Landfill (also known as Oak Hammock Disposal). Since not all municipalities provided their disposal locations and yard waste tonnages, the Florida Department of Environmental Protection (FDEP) 2019 Landfill Report was used to estimate their quantities.

Every year, FDEP produces a Landfill Report, which organizes all landfilled tonnages by the origin county and the type of waste, either Class I waste (MSW), Class III waste (also known as trash), and Other Wastes (such as ash). The Other Wastes category within the FDEP Landfill Report was not included in this estimation. Table 4-5 lists the tonnage of garbage disposed at each landfill. As this waste is likely from single-family, multi-family, and commercial sources, the 2010 waste composition study yard waste composition percentage of 6.3% (HDR, 2010) by mass was applied to the garbage tonnages. This is the most recent yard waste composition value available that encompasses multiple sources. The yard waste in trash for this category was not calculated because UF do not have a composition value that encompasses all generator sources.

Table 4-5. Estimate of yard waste in curbside waste for Category 3. *Note the Okeechobee Landfill primarily has non-yard waste garbage and was therefore not included.

Included Disposal Sites	Tonnage Data Source and Collection Period	Curbside Collected Garbage (tons)	Yard Waste in Curbside Garbage (tons)
Medley Landfill	FDEP Landfill Report, 2019	803,163	50,599
Monarch Hill Landfill		32,396	2,041
J.E.D Landfill (Oak Hammock Disposal)		270,805	17,061
Lena Road County Landfill		2	0
Okeechobee Landfill, Inc (Berman Road LF)		213,392*	NA
TOTAL		1,319,758	69,701

In summary, 165,610 tons of yard waste are estimated to be within curbside collected garbage within unincorporated and incorporated Miami-Dade County. Additionally, 175,933 tons of yard waste are estimated to be within curbside collected trash within unincorporated and incorporated Miami-Dade County boundaries. Table 4-6 provides a summary of yard waste management within municipalities from which Miami-Dade County does not collect. UF gathered information from municipality websites and conversations with municipality representatives. Note, the municipalities were marked with a “no” for allowing yard waste in garbage if they explicitly prohibit the material in the roll carts. Municipalities that do accept yard waste might not prefer yard waste in the roll

carts but allow small pieces to be included or do not explicitly inform residents to not include the material. Additionally, some municipalities prefer yard waste to be separated from other bulky trash when set out on the curb, or the municipality has a designated collection day just for yard waste.

Table 4-6. Yard waste management in municipalities.

Municipality	Contracted to Bring Waste to Miami-Dade County?	Is Yard Waste Allowed in Curbside Garbage?	Is Yard Waste Collected with Other Bulky Trash?
Village of Bal Harbour	Yes	No	Yes
Bay Harbor Islands	Yes	Yes	Yes
Village of Biscayne Park	No	Yes	Yes
City of Coral Gables	Yes	No	No, collected separately
Village of El Portal	No	Yes	Yes
Florida City	No	No	Yes
Town of Golden Beach	No	No	No, collected separately
City of Hialeah	No	Yes	Yes
City of Hialeah Gardens	No	Yes	No, collected separately
City of Homestead	Yes	No	Yes
Village of Indian Creek	No	Yes	Yes
Town of Medley	No	No	Yes
City of Miami Beach	Yes	-	-
Miami Shores Village	Yes	No	Yes
City of Miami Springs	Yes	Yes	Yes
City of North Miami	Yes	Yes	Yes
City of Miami	Yes	Yes	Yes
Village of North Bay	Yes	No	Yes
City of North Miami Beach	Yes	No	Yes
City of South Miami	Yes	-	Yes
Town of Surfside	Yes	No	Yes
City of Sweetwater	Yes	-	-
Village of Virginia Gardens	No	No	Yes
City of West Miami	Yes	No	Yes

A summary of yard waste within curbside garbage within Categories 1, 2, and 3 is shown in Figure 4-2. A summary of yard waste within curbside trash within Categories 1 and 2 is shown in Figure 4-3. The yard waste within curbside waste would be difficult for Miami-Dade County to capture. Within curbside waste, yard waste is mixed with other waste. To capture yard waste in these waste streams, yard waste only collection routes would have to be established, if not already available. Additionally, ordinances would have to be set in place where yard waste cannot be placed in garbage bins because mixing garbage and yard waste makes separation difficult.

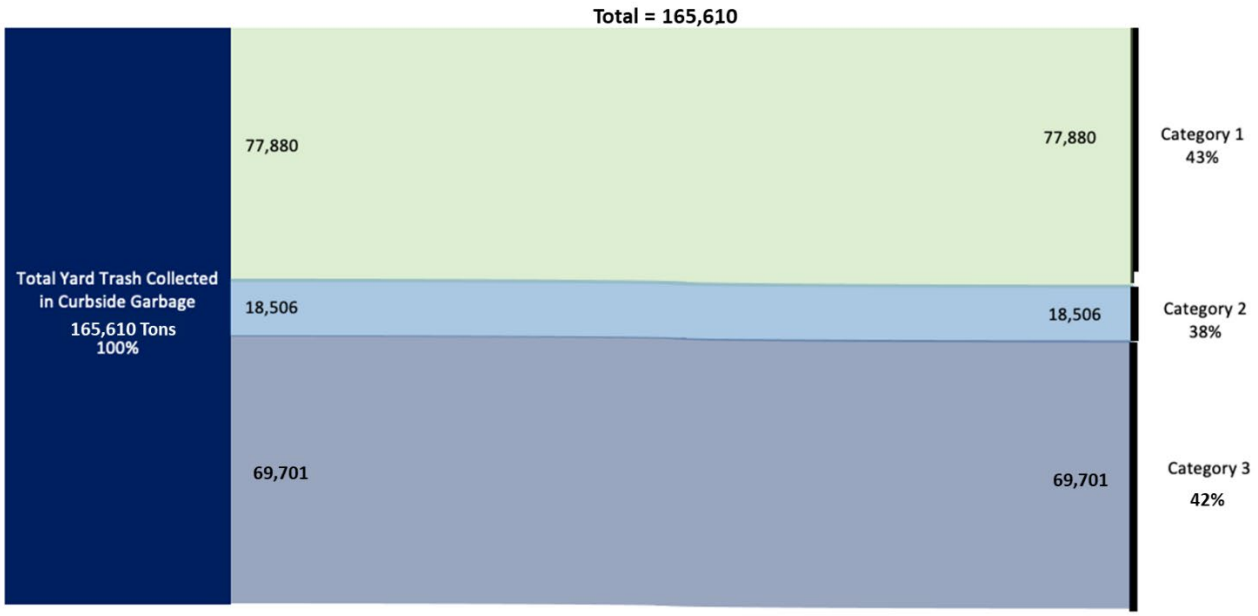


Figure 4-2. Summary of yard waste masses within curbside garbage within Categories 1, 2, and 3.

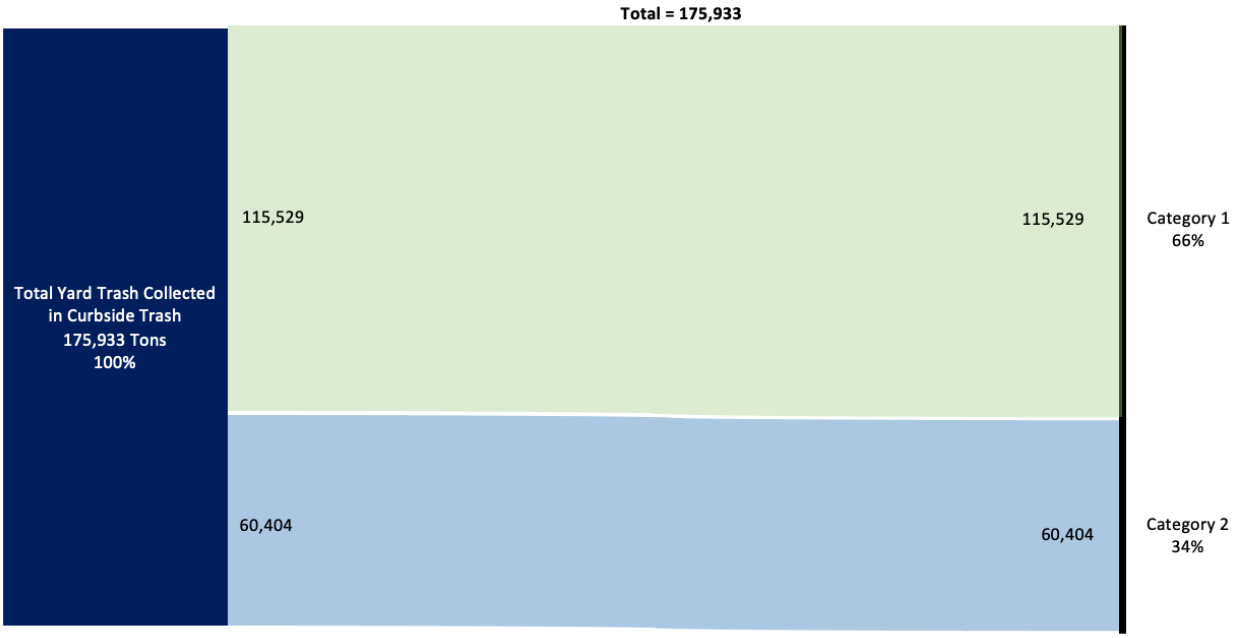


Figure 4-3. Summary of yard waste masses within curbside trash within Categories 1 and 2.

4.2.3 Sector C: Yard Waste Handled by the Private Stakeholders

Local, private entities that manage yard waste are mapped in Figure 4-4. Known yard waste quantities managed by the businesses are displayed on the map.

Figure 4-4. Private businesses who handle yard waste.

The private businesses can be split into two different categories, A and B. Category A consists of businesses that accept and either recycle yard waste themselves or send it off for processing. Five businesses fit this category: Florida Wood Recycling, Atlas Grinding and Recycling Group (Atlas), EPS Organics/Enviroco, Waste Management Recycling Hialeah Transfer Station, and Sherlock Tree Company. Category B consists of businesses that either accept and then landfill yard waste or do not accept yard waste at all.

Florida Wood Recycling accepts yard waste and processes the material into a mulch product. The FDEP 2019 recycling workbook reported that Florida Wood Recycling recycled 18,706 tons of yard waste. An FDEP recycling workbook is a report summarizing recycled materials and tonnages for each Florida county. For some materials such as yard waste, businesses are not required to report tonnages. Further discussion of recycling workbooks is found in Chapter 5.

Atlas accepts yard waste and processes the material into mulch and compost products. The company sold 550 yd^3 of mulch in January 2021 and 300 yd^3 of compost in January 2021. As seen in Equation 4-1, an average density factor of 0.4 tons per yd^3 for mulch (USDA NCRS, 2012) was used to convert the volume sold in one month to tons sold in the 2020 calendar year. As seen in Equation 4-2, an average density factor of 0.45 tons per yd^3 for compost (Khater, 2015) was used to convert the volume sold in one month to tons sold in the 2020 calendar year. As seen in Equation 4-3, an estimate for the yard waste handled by Atlas is as follows: 2,640 tons of mulch and 1,620 tons of compost for a total of 4,260 tons of yard waste product per year. UF assumed 1 ton of yard waste equals 1 ton of mulch or compost.

$$Known\ value\text{: } Quantity\ of\ Atlas\ mulch\ sold = \frac{550\ yd^3}{January\ 2021}$$

$$Tons\ of\ Mulch\ Sold\ by\ Atlas\ in\ 2020 = \frac{550\ yd^3}{1\ month} * 0.4\frac{tons}{yd^3} * \frac{12\ months}{year} = \frac{2640\ tons\ mulch}{year}$$

Eq. 4-1

$$Known\ value\text{: } Quantity\ of\ Atlas\ compost\ sold = \frac{300\ yd^3}{January\ 2021}$$

$$Tons\ of\ Compost\ Sold\ by\ Atlas\ in\ 2020 = \frac{300\ yd^3}{January} * 0.45\frac{tons}{yd^3} * \frac{12\ months}{year} = \frac{1620\ tons\ compost}{year}$$

Eq. 4-2

$$Total\ YT\ handled\ by\ Atlas = Quantity\ of\ Mulch\ sold + Quantity\ of\ Compost\ Sold = \frac{2640\ tons\ mulch}{year} + \frac{1620\ tons\ compost}{year} = \frac{4260\ tons\ yard\ trash}{year}$$

Eq. 4-3

The company EPS Organics/Enviroco is a yard waste processor, and UF have accounted for 30,730 tons of yard waste handled by the company. The 2019 Miami-Dade County recycling workbook included an entry for 30,730 tons of yard waste under the name Enviroco. The company does not currently hold an operating permit with Miami-Dade County and when called, the staff member said the company went out of business mid-2020. The Enviroco address listed in the recycling workbook matches the address for EPS Organics. EPS Organics is currently in business as UF spoke with a nursery who purchases from them. The same owner and phone number are found on multiple online sources under the names Enviroco, Environmental Processing Systems, Inc., and EPS Organics; thus, UF have deduced they are all the same company.

UF located another 1,105 tons of yard waste for EPS Organics/Enviroco by visiting nurseries. UF visited multiple plant nurseries during the February trip, but only one business provided a quantity for yard waste products purchased. A representative of Native Tree Nursery said they purchase 50 yd^3 of a mulch and compost mixture from EPS Organics per week. Based on an average of the mulch and compost densities used in Equations 4-1 and 4-2, UF used a density of 0.425 tons per yd^3 of yard waste product because UF assumed the mixture Native Tree Nursery purchases is equal parts mulch and compost. This conversion also assumes that 1 ton of yard waste equals 1 ton of mulch or compost product. UF estimate that 1,105 tons of yard waste was used by the nursery in the 2020 calendar year, as seen in Equation 4-4. There is uncertainty surrounding the EPS operations and products as the company would not answer any questions. EPS might source some of their organic material from outside of Miami-Dade County boundaries. UF did not add this value of 1,105 to the already accounted for 30,730 tons handled by EPS Organics. This is because UF assumed the 30,730 tons already includes the 1,105 tons. In Figure 4-2, the company is labeled as EPS Organics/Enviroco.

$$Known\ value\text{: }Quantity\ of\ Compost\ \&\ Mulch\ purchased\ from\ EPS\ Organics = \frac{50\ yd^3}{week}$$

$$Yard\ Trash\ handled\ by\ Native\ Tree = \frac{50\ yd^3}{week} * 0.425 \frac{tons\ \frac{compost}{mulch}}{\mathrm{yd}^3} * \frac{52\ weeks}{year}$$
$$= \frac{1{,}105\ tons\ yard\ trash}{year}$$

Eq. 4-4

Waste Management Recycling Hialeah Transfer Station is a transfer station owned by Waste Management that accepts yard waste. No residential waste is allowed, only commercial. As no manual unloading of waste is allowed, only dump trucks can enter. Yard waste is stored separately on site and sent to Waste Management's Reuters Recycling Composting and Transfer Station in Pembroke Pines, which is located in Broward County, Florida. The annual quantity of yard waste handled at the Hialeah Transfer Station was not provided.

The last company within Category A is Sherlock Tree Company, which is headquartered outside of Miami-Dade County but provides landscaping services within Miami-Dade County boundaries. They do mulch their yard waste products and sell their material, but UF are unsure how much is generated as well as sold within Miami-Dade County boundaries. Landscapers play a large role in the yard waste private industry. Some landscapers landfill yard waste whereas others process their own material. Due to difficulty in gathering this information, masses are not available for individual businesses or the landscaping sector beyond what is brought to Miami-Dade County facilities.

Category B businesses are not mapped in Figure 4-4. The companies who accept but landfill yard waste are Recycle Capital, SS National Waste, P.H. Waste Collection Services, Inc., Great Waste and Recycling Services, and the Waste Connections Materials Recovery Facility (MRF) and Transfer Station. These are generally companies

which do not see large quantities of yard waste and do not allow yard waste to be dropped off directly at their facilities. For all companies listed besides the Waste Connections MRF and Transfer Station, if a customer rents out a roll off bin and yard waste is included in the collected material, the yard waste is landfilled because these businesses are not permitted to process the waste. From speaking with these businesses, yard waste comprises a very small quantity of their overall handled waste stream. The Waste Connections MRF and Transfer Station only accepts Waste Connections vehicles which are carrying City of Hialeah's waste. An operator at the facility said that limited quantities of yard waste are seen, and the facility's waste is sent to J.E.D Landfill in St. Cloud, which is in Osceola County, Florida.

The Waste Management C&D Facility, Waste Connections 1st Place C&D Facility, and Waste Management MRF do not accept yard waste. These facilities are included in the discussion only to provide an in-depth assessment of disposal facilities present in Miami-Dade County boundaries. Note, the Waste Management C&D facility does not accept yard waste but does accept land clearing debris. Land clearing debris can contain similar materials to yard waste but is only accepted at the facility if the commercial generator states that material came from land clearing activity. Any wood material, which mostly consists of wood pallets from C&D sources, are sent to Florida Wood Recycling.

In summary, 53,696 tons of yard waste can be accounted for in the private sector. This value includes the tonnages collected from Florida Wood Recycling, Atlas, and EPS Organics/Enviroco. Although the values provided by each business describe different years, UF assumed that yard waste tonnages produced, processed, or used are generally consistent from year to year.

4.2.4 Total Mapped Yard Waste for All Sectors

All previously described stakeholders of yard waste within the three sectors are mapped in Figure 4-5. The flow of estimated yard waste tons sourced from the TRCs are also mapped.

A mass balance is described below to summarize the estimated masses of yard waste discussed throughout this chapter. There are seven components, A-F, to this mass balance. Component A represents the clean yard waste that entered the 13 TRCs. The value for A, as calculated in Section 3.1.2.1, is 26,808 tons. Component B represents the yard waste in mixed loads that entered the 13 TRCs. The value for B, as calculated in Section 3.1.2.2, is 10,918 tons. Component C represents the clean yard waste that entered RRF, South Dade Landfill, and North Dade Landfill. The value for C, as calculated in Section 4.2.1.2, is 9,692 tons. Component D represents the estimated yard waste found in the curbside garbage. The value for D, as calculated in Section 4.2.2.2, is 165,610 tons. Component E represents the estimated yard waste found in the curbside trash. The value for E, as calculated in Section 4.2.2.2, is 175,933 tons. Component F represents the yard waste handled in the private sector. The value for F, as calculated in Section 4.2.3, is 53,696 tons. See Equation 4-5 for these masses displayed in the mass balance. Figure 4-6 displays this mass balance in a Sankey diagram.

Figure 4-5. Miami-Dade County and non- Miami-Dade County owned handlers of yard waste.

$$Total\ yard\ waste\ handled\ in\ the\ County = 443{,}135\ tons = A\ + B + C + D + E + F$$

Eq. 4-5

Where:

$A = Clean\ yard\ waste\ at\ the\ 13\ TRCs\ = 26{,}808\ tons$

$B = Yard\ waste\ in\ mixed\ trash\ at\ the\ 13\ TRCs = 10{,}918\ tons$

$C = Clean\ yard\ waste\ at\ Resource, North\ Dade\ Landfill, and\ South\ Dade\ Landfill$
$= 2{,}100\ tons_{Resource} + 5{,}459\ tons_{South\ Dade\ Landfill}$
$+ 2{,}133\ tons_{North\ Dade\ Landfill} = 9{,}692\ tons$

$D = Yard\ waste\ in\ curbside\ garbage$
$= 77{,}880\ tons_{Collected\ by\ Miami-Dade\ County\ in\ unincorp.+9\ municipalities}$
$+ 18{,}506\ tons_{Municipalities\ from\ which\ Miami-Dade\ County\ does\ not\ collect\ but\ go\ to\ County\ facilities}$
$+ 83{,}145\ tons_{Municipalities\ from\ where\ yard\ trash\ not\ taken\ to\ Miami-Dade\ County\ failities}$
$= 165{,}610\ tons$

$E = Yard\ waste\ in\ curbside\ trash =$
$115{,}529\ tons_{Collected\ by\ County\ in\ unincorp.+9\ municipalities} +$
$60{,}200\ tons_{Municipalities\ from\ which\ Miami-Dade\ County\ does\ not\ collect\ but\ go\ to\ County\ facilities} =$
$175{,}729\ tons$

$F = Yard\ waste\ handled\ by\ the\ private\ sector$
$= 18{,}706\ tons_{Florida\ Wood\ Recycling} + 4{,}260\ tons_{Atlas}$
$+ 30{,}730\ tons_{EPS\ Organics/Enviroco} = 53{,}696\ tons$

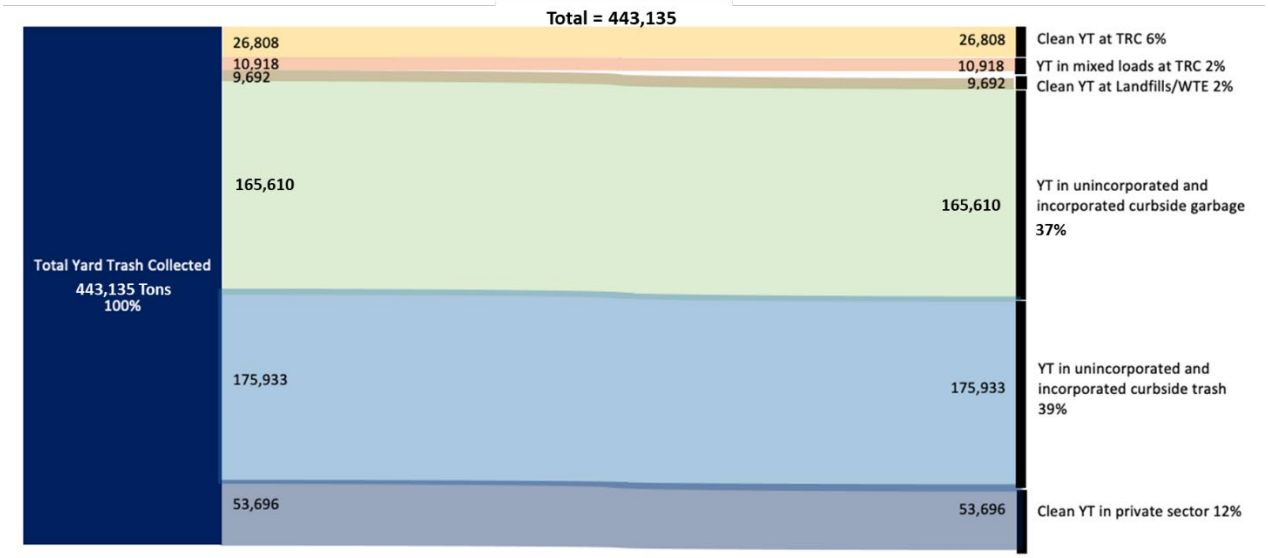


Figure 4-6. Estimated masses of yard waste handled within the County boundaries.

A lower bound estimate for the overall yard waste generated and collected within the boundaries of Miami-Dade County was sourced from the FDEP's Waste Composition Calculation Model (WasteCalc). WasteCalc allows for a county to input solid waste values, such as landfilled, combusted, and recycled tonnages. The program outputs a

tonnage estimate for each of FDEP's 18 monitored material categories, one of which is yard waste. WasteCalc used yard waste composition data from the 2010 Miami-Dade Waste Composition Study Report (reported as 5.2%) and United States Environmental Protection Agency (EPA) national material generation information. WasteCalc's 2019 calendar year estimate for Miami-Dade County was 272,883 tons of yard waste generated.

An upper bound estimate was estimated from manually calculating the hypothetical maximum, using provided disposed values in WasteCalc (the 5.2%). UF added up the masses generated within Miami-Dade County boundaries that include yard waste: total MSW landfilled and total MSW combusted. UF then subtracted out the landfilled combustor ash. The total available MSW mass was then 3,388,240 tons. UF then applied the 13.5%-yard waste composition value (as opposed to the 5.2% value) to the total available MSW mass to result in 457,412 tons of yard waste. Next, UF added the amount of known yard waste recycled by the private industry, 53,696 tons of yard waste, to result in 511,108 tons of potential yard waste generated within the geographic boundaries of Miami-Dade County. This methodology creates an upper bound estimate because it uses the 13.5%-yard waste composition value, which is expected to be an overestimate for the yard waste produced by multi-family and businesses. That was assumed because in the 2010 Miami-Dade Waste Composition Study Report, yard waste composition values for multi-family and business loads were each less than the single-family composition value. Applying a single-family value to waste generated by all three sources may result in an overestimation. Figure 4-7 compares the estimates for lower bound, upper bound, and UF's estimate derived from site visits and estimation studies.

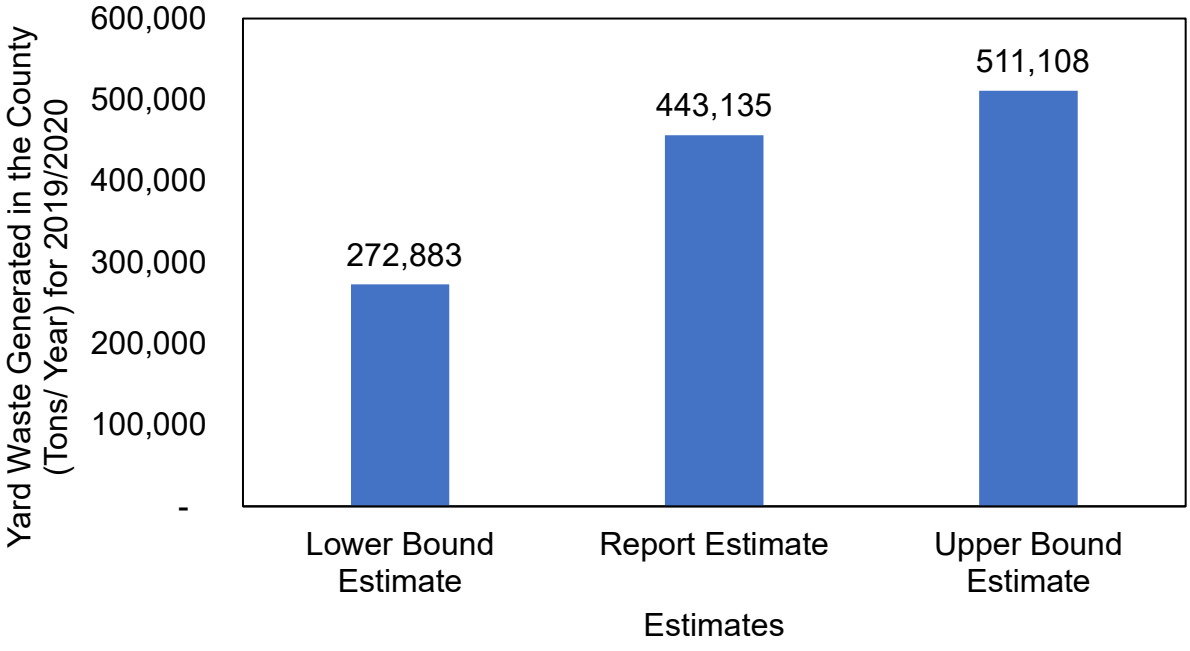


Figure 4-7. Lower bound estimate (based on Miami-Dade Annual 2019 FDEP Reporting), report estimate, and upper bound (both based on Task 2 results for 2019/2020 data) estimate of yard waste generated in the geographic boundaries of Miami-Dade County.

5 MARKET ANALYSIS OF PROCESSED YARD WASTE

5.1 Task Overview

To evaluate the feasibility of a mulching or composting facility, it is essential to understand the market conditions behind the products that can be made from the raw materials of yard waste. To gain this understanding, the task was broken down into five key actions:

1. Gather data from other local governments in Florida that process yard waste through mulching or composting and ascertain to which markets their products are sold.
2. Contact local agricultural industries, landscapers, construction stores, and other key stakeholders to evaluate the viability of marketing finished yard waste which has either been mulched or composted.
3. Compile data on the size of the market available locally in the county and in Florida.
4. Estimate the projected market price of mulched or composted yard waste from various viable industries or business.
5. Report on any state or local regulations relating to mulching or composting yard waste.

5.2 Action 1: Local Governments Data Collection

5.2.1 FDEP 2019 Recycling Workbooks Examination

In order to understand how other local governments in Florida currently process their yard waste, UF first requested the 2019 Florida Department of Environmental Protection (FDEP) recycling workbooks for each county. The FDEP recycling workbook is a document containing various spreadsheets, each one related to a different aspect of recycling, that is to be completed by the recycling coordinator of each county to track recycling initiatives and tonnages within the state. Particularly pertinent to this project, the workbooks include a spreadsheet enumerating reported tonnages of different commodities (including yard waste), which company or government entity processes the commodities, and their final use.

As an example, Figure 5-1 below shows a screenshot of a section from the first tab (Non-Certified Tons) of Miami-Dade County's 2019 workbook. Outlined in red are the three entries for yard waste: 30,730 tons from Enviroco, 18,706 tons from Florida Wood, and 1,108.79 tons from Walmart. These three recycling sources total to 50,544.79 tons of yard waste recycled in Miami-Dade County for 2019. Note that these entries are not the only instances of yard waste recycling in Miami-Dade County but rather are the only ones reported to the recycling coordinator. Therefore, the recycling workbooks are not a complete depiction of all recycling efforts in a county but do give some sense as to the names of entities recycling yard waste and the final use.

	A	B	C	D	E
1	County: Miami Dade				
2	Shipped Tons	Commodity	Company	Use (specifically yard waste, compost and concrete) ie. Landfill cover, fill, mulch, etc.	Address
3	2448.43	Misc. Tab Total	*Total from misc. worksheet tab*		
4		Processed Fuel	*Total From Re-TRAC*		
5	50559	White Goods	*50559*		
6					
7	30730	yard waste	Enviroco	mulch	14530 NW 112 Ave
8	18706	yard waste	Fla Wood	mulch	9651 NW 89 Ave
9	1.58	Aluminum Cans	Wallmart		Miami Dade County
10	3.7	Platic Bottles	Wallmart		Miami Dade County
11	13883.05	OCC	Wallmart		Miami Dade County
12	12.15	Office Paper	Wallmart		Miami Dade County
13	1108.79	yard waste	Wallmart		Miami Dade County
14	373.38	other plastic	Wallmart		Miami Dade County
15	34.82	ferrous	Wallmart		Miami Dade County
16	20.6	other paper	Wallmart		Miami Dade County

Non-Certified Tons | Sheet2 | Miscellaneous Tons | Landfill Tons | Other MSW used Landfill Cover | Recycling Credits | Generator Type

Figure 5-1. Screenshot of the non-certified recycling tonnages tab of the 2019 Miami-Dade County recycling workbook.

UF examined the workbooks, noting the yard waste entries for all 67 counties in a spreadsheet. UF included important information for each entry, such as tonnages recorded and the final use for the yard waste as described in the workbooks. The categories for final use of the yard waste were divided into the following: mulch, compost, landfill cover, mulch/compost, and other/unknown. Some entries specified that the yard waste was processed into “compost/mulch” or “mulch and compost”. It was unclear whether the “compost/mulch” designations meant that the material was turned into either compost or mulch or both compost and mulch in unspecified quantities. The other/unknown category included diverse entries such as “recycled”, “Atlas peat”, “firewood”, and “diversion”. UF used this spreadsheet to calculate the tonnages reported for each final use category in order to have a better understanding of how yard waste typically is recycled in Florida.

Of Florida’s 67 counties, 23 either had no mention of yard waste in their workbooks or recorded a collected tonnage of yard waste but reported a yard waste recycling rate of 0%. The remaining 44 counties had varying amounts of reported recycling rates, from Lafayette County’s 10% up to Lake County’s reported 100%. Note that yard waste is not required to be reported to the county recycling coordinator and therefore, the actual rates of yard waste recycling per county may vary.

The total reported tonnage for yard waste recycling from the FDEP recycling workbooks was 3,399,847 tons annually for Florida in 2019. Of this, yard waste recycled into only mulch comprised 32% (1,085,023 tons). Landfill cover comprised 21% (724,482 tons). The compost/mulch category comprised 12% (424,442 tons). Yard waste recycled into only compost comprised 1% (30,613 tons). The remaining 33% (1,135,288 tons) was processed as other/unknown. Figure 5-2 below shows a pie chart of this breakdown. Note that due to rounding, the percentages do not add up to 100%. Though there is a lot of

unknown information, it is clear that two common ways of recycling yard waste by local governments in Florida are through mulching or use as landfill cover.

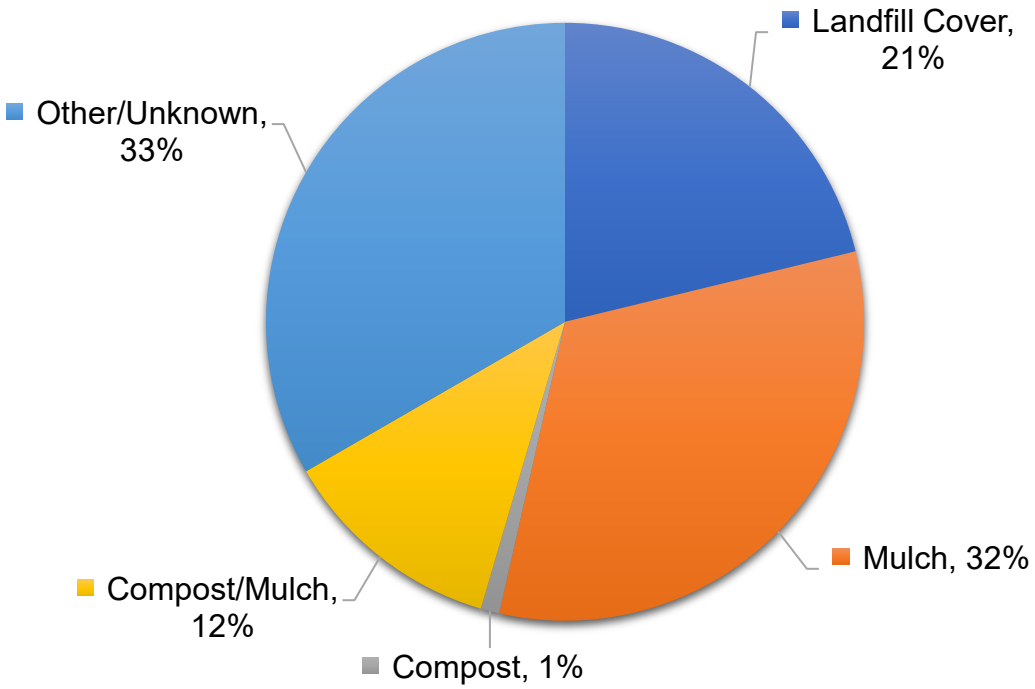


Figure 5-2. Florida yard waste recycling breakdown by end use.

To give a more complete understanding of yard waste tonnages managed and recycled by each county in Florida, UF summarized relevant yard waste recycling information from the 2019 FDEP County Annual Solid Waste Management Reports as show in Table 5-1.

Table 5-1. Summary of yard waste recycling in Florida in descending order by percentage of yard waste recycled.

County	Population	Yard Waste Collected (tons)	Yard Waste Recycled (tons)	Recycled (%)	Yard Waste Recycled as Landfill Cover (tons)	Yard Waste Recycled as Landfill Cover (%)
Lake	357,247	23,248	23,166	100%	0	0%
Pinellas	978,045	280,000	273,737	98%	0	0%
Charlotte	180,843	231,239	225,282	97%	0	0%
Manatee	387,414	137,140	130,109	95%	0	0%
Osceola	370,552	19,020	17,232	91%	0	0%
Clay	215,246	27,978	24,570	88%	21,577	88%
Martin	158,598	118,963	104,261	88%	0	0%
Collier	376,706	448,706	369,944	82%	45,363	12%

Table 5-1. Continued.

County	Population	Yard Waste Collected (tons)	Yard Waste Recycled (tons)	Recycled (%)	Yard Waste Recycled as Landfill Cover (tons)	Yard Waste Recycled as Landfill Cover (%)
Seminole	471,735	33,068	26,398	80%	26,398	100%
Walton	70,071	10,345	8,240	80%	0	0%
Palm Beach	1,447,857	293,512	230,690	79%	0	0%
Indian River	154,939	131,075	102,060	78%	12,827	13%
Monroe	76,212	33,842	25,930	77%	0	0%
Broward	1,919,644	246,804	187,980	76%	162,000	86%
Hernando	187,830	25,883	18,248	71%	0	0%
Hillsborough	1,444,870	310,184	221,184	71%	3,806	2%
Sarasota	426,275	120,011	84,652	71%	35,936	42%
St. Lucie	309,359	72,382	51,040	71%	51,040	100%
Brevard	594,259	431,434	303,596	70%	173,627	57%
Bradford	28,682	2,447	1,686	69%	1,670	99%
Pasco	527,122	104,193	70,653	68%	3,562	5%
Lee	735,148	398,432	260,147	65%	0	0%
Orange	1,386,080	117,181	70,099	60%	31,061	44%
Polk	690,606	198,394	115,957	58%	19,202	17%
St. Johns	254,261	37,665	20,174	54%	20,174	100%
Hardee	27,385	2,247	1,186	53%	1,654	139%
Volusia	538,763	187,145	97,661	52%	112,266	115%
Escambia	321,134	65,087	31,812	49%	30,839	97%
Okaloosa	201,514	30,026	13,550	45%	13,052	96%
Santa Rosa	179,054	25,893	11,704	45%	11,704	100%
Putnam	72,790	9,300	3,826	41%	3,541	93%
Citrus	147,744	24,348	9,023	37%	7,752	86%
Duval	970,672	274,590	99,211	36%	82,418	83%
Union	15,505	1,037	341	33%	341	100%
Alachua	267,306	153,995	47,826	31%	0	0%
Marion	360,421	260,615	74,681	29%	0	0%
Nassau	85,070	2,948	614	21%	0	0%
Miami-Dade	2,812,130	272,883	50,545	19%	0	0%
Wakulla	32,976	314	52	17%	0	0%
Baker	28,249	1,144	146	13%	125	86%
Bay	166,989	60,284	7,119	12%	7,119	100%
Lafayette	8,482	159	17	11%	0	0%
Taylor	22,458	351	36	10%	0	0%
Leon	296,499	34,866	2,600	7%	0	0%
Levy	41,330	553	17	3%	0	0%
Calhoun	14,067	94	0	0%	0	0%
Columbia	70,492	3,134	0	0%	0	0%
Desoto	36,065	1,778	0	0%	0	0%
Dixie	16,610	173	0	0%	0	0%
Flagler	110,635	2,487	0	0%	0	0%
Franklin	12,273	9,276	0	0%	0	0%
Gadsden	46,277	4,271	0	0%	0	0%
Gilchrist	17,766	223	0	0%	0	0%
Glades	13,121	302	0	0%	0	0%

Table 5-1. Continued.

County	Population	Yard Waste Collected (tons)	Yard Waste Recycled (tons)	Recycled (%)	Yard Waste Recycled as Landfill Cover (tons)	Yard Waste Recycled as Landfill Cover (%)
Gulf	12,833	399	0	0%	0	0%
Hamilton	14,600	189	0	0%	0	0%
Hendry	40,120	1,514	0	0%	0	0%
Highlands	103,434	3,330	0	0%	6,221	0%
Holmes	20,049	62	0	0%	0	0%
Jackson	46,969	1,110	0	0%	0	0%
Jefferson	13,680	520	0	0%	0	0%
Liberty	8,772	41	0	0%	0	0%
Madison	19,570	694	0	0%	0	0%
Okeechobee	39,394	2,997	0	0%	0	0%
Sumter	128,633	3,135	0	0%	0	0%
Suwannee	43,422	903	0	0%	0	0%
Washington	25,387	301	0	0%	0	0%
TOTAL	**21,200,241**	**5,297,864**	**3,419,002**	**N/A**	**885,275**	**N/A**
AVERAGE	**N/A**	**N/A**	**N/A**	**65%**	**N/A**	**26%**

5.2.2 Case Study Interviews

UF contacted several local governments in Florida that currently have robust yard waste recycling projects to hear more about these programs and learn from their successes and challenges. UF interviewed representatives from Hillsborough, Sarasota, and Lee counties.

5.2.2.1 Hillsborough County

Hillsborough County has placed a focus on yard waste recycling. Hillsborough County's FDEP workbook states that 310,184 tons of yard waste were collected in the county in 2019 and of that, 71% was recycled (221,184 tons). There were various entries related to yard waste found in the workbook, including 117,723 tons which were mulched for Hillsborough County by Raynor Shine, a private processing company. UF spoke with a representative from Hillsborough County about their past and current yard waste recycling programs and experiences.

Hillsborough County provides residents weekly yard waste curbside collection services. The weekly curbside limit is two yd^3. The county also has yard waste processing facilities: Falkenburg Yard Waste Processing Facility, Northwest Yard Waste Processing Facility, and South County Yard Waste Processing Facility. If residents have more yard waste than their weekly allotment, they can bring up to two tons per year to these three facilities for free. Companies can also drop off their yard waste at these facilities for a fee. The tipping fee for yard waste for both companies and residents exceeding their two-ton allotment is $37.06 per ton.

Hillsborough County used to send a portion of their yard waste to the Wheelabrator Ridge Mass Burn Facility, which recently closed, and some to a gasification plant in Brooksville, FL. The county wanted a more sustainable solution than combustion, so they made a switch to Raynor Shine in 2015, a yard waste processing company based out of

Apopka, FL. Raynor Shine ground, screened, and mulched the county's yard waste, reselling the material to another processor that would dry the material further and then dye it. The final product was sold to places like Home Depot.

Currently the county is using Raynor Shine as an interim contractor to mulch the yard waste. Some of this mulch (about 30,000 tons) is being used for a Modified Static Aerobic Pile composting operation where it is combined with biosolids from the county's wastewater treatment plants. A picture of the facility can be seen in Figure 5-3. The processed final product is sold as a soil amendment to local farmers. Though constructed recently in 2019, this project is showing signs of success and has been nominated as a Public Works Project of the Year by the American Public Works Association. The rest of the mulch processed by the county is being stockpiled at the Southeast Hillsborough County Landfill to be used at a later date for further composting operations. The representative said that the mulch could potentially be used for landfill cover, but the county currently uses waste-to-energy ash for this purpose.

Figure 5-3. Hillsborough County's biosolids and yard waste composting operation.

The county used to provide two yd^3 of mulch for residents to pick up free of cost. This program was not widely advertised because since product was not highly processed, the county could not guarantee the product to be without invasive plants and weed seeds. The representative said that there are several difficulties with mulch giveaways. There is often a lower demand than supply. Liability issues can also arise, including injuries that could occur during the loading and unloading of mulch as well as the potential for spreading invasive plants and weed. The accidental inclusion of treated wood in the mulch can also potentially add unwanted chemicals such as arsenic.

5.2.2.2 Sarasota County

Sarasota County also emphasizes yard waste recycling. Their 2019 FDEP workbook states that 120,011 tons of yard waste were collected in 2019 and of that tonnage, 71 % was recycled (84,652 tons). Of the tonnage recycled, 50,330 tons were processed by Sarasota County Central County Landfill for "daily cover, compost, mulch".

UF spoke with a representative from Sarasota County to learn more about their yard waste program and experiences.

Per the representative, Sarasota County has a contract with Waste Management (WM), which operates the Class I landfill and the yard waste processing facility. Sarasota County does provide weekly yard waste curbside collection services. This yard waste and material from some commercial entities such as landscapers goes to the yard waste processing facility. Residential and commercial sources are processed separately within the facility because commercial yard waste tends to be fairly clean whereas the residential yard waste may have contamination such as plastic bags, which have to be removed before further processing.

WM subcontracts out the first part of the yard waste processing to Cooper Timber, who use grinders to mulch the yard waste. They then place the mulched material into windrows and allow it to age. Another company, Scotts, then uses screeners to screen the material into overs and fines. Scotts then takes the fines to a facility to be made into compost. The leftover mulch and overs become cover material for the landfill.

The county also holds some of the fines for free giveaway to residents. The overs and raw mulch are not given to residents because there could be exotic plants or seeds left in the material. The giveaway program has changed slightly in light of the COVID-19 pandemic; the material is placed out front instead of inside the landfill as was done before to limit contact. The program is popular with residents. The county does not currently check resident ID right now, but there is enough material that the county would rather see it go to good use even if it is not to residents. There is no specific advertising campaign for the giveaway.

The representative said that the yard waste operation tends to use more area than is preferred. The county receives a lot of yard waste, over 50,000 tons per year. Sarasota County's contract with WM does not specify how WM should manage the yard waste, but it does specify that if they operate the landfill, they must also run the yard waste facility. Although the county prefers that the yard waste material be processed for beneficial reuse instead of landfilled, the county has no control over how the yard waste is handled once it is processed. Therefore, the county does not know exactly how much revenue yard waste generates or conversely, how much processing the yard waste costs.

The representative thinks that marketing recycled mulch or compost products locally makes more sense than state-wide. Because hauling costs are so high, recycled mulch or compost may only be profitable if there is a nearby market. The representative mentioned the company Synagro, which has had some success with recycled yard waste because they have a built-in market since they are a large, well-known company. Sarasota County is now a primarily tourist driven county, and less agricultural, so the market may not be as robust in Sarasota County as elsewhere. The representative then named several other programs that have had some success, including a facility in Lee County (because it is in a primarily agricultural area), Hillsborough County, Manatee County, and Charlotte County.

5.2.2.3 Lee County

Lee County also has a special program for yard waste recycling. Their 2019 FDEP workbook states that in 2019, 408,678 tons of yard waste were collected in the county of which 64% were recycled (260,147 tons). Of this recycled tonnage, around 23,000 tons were diverted for Lee County's biosolids and yard waste composting operation. The remainder was managed by private companies.

Like Hillsborough and Sarasota, Lee County also provides weekly yard waste curbside collection for residents. Up to 50 pounds of material can be left curbside each week. Residents are encouraged to place their yard waste in containers or bundles rather than in bags to minimize contamination. Residents and businesses can also drop off yard waste at the Buckingham Solid Waste Resource Recovery Facility for a fee.

All of Lee County's residential and some commercial yard waste is accepted at the Buckingham Solid Waste Resource Recovery Facility, where it is first processed to remove contamination such as plastic bags. For the initial processing and grinding of the mulch, the county decided to contract with a third-party vendor because of the high costs associated with the machinery necessary for these steps, namely the tub grinders. The vendor uses these tub grinders to grind the yard waste into mulch which is windrowed and undergoes pathogen reduction. Most of the mulch is then sent to the compost production facility at the Lee/Hendry Regional Solid Waste Disposal Landfill. The remainder is either given away to residents for free or mixed with soil and used as landfill cover or erosion control. Because the mulch is given away for free and there is education over its quality, the county does not receive many complaints over weed seeds or exotic species from residents.

For the mulch that is sent to the compost production facility, upon arrival it is mixed with the biosolids in roughly a 1:2 ratio by volume. The representative from Lee County said that the operation is limited by the amount of biosolids produced by the county, meaning that they have more yard waste than they can use at the facility. The compost facility consists of nine separate buildings and uses aerated piles as their composting method. The composting process takes about 90-100 days, in which the material is consistently turned and dried.

Once the mulch and biosolids are fully composted, the final product is marketed and sold as OrganicLee® Compost. This product has two different certifications: a fertilizer license and a certificate from the U.S. Composting Council. The county sells the compost both bagged and in bulk and offers a delivery service. Some of the clients are residents seeking to use the product on their yards, but most are from the agricultural sector, especially citrus growers. In 2019, the county sold 21,453 tons of compost.

5.2.2.4 Case Study Summary

Table 5-2 below summarizes the results of UF's interviews with other local government entities about their yard waste recycling operations.

Table 5-2. Summary of yard waste recycling management from local government entities in Florida.

County	Yard Waste Total Generated (tons)	Yard Waste Total Recycled (tons)	Recycled Yard Waste Managed by County (tons)	Yard Waste County Operations
Miami-Dade	272,883	50,545	2,100	Yard waste is sent to RRF to be combusted.
Hillsborough	310,184	221,184	117,723	County grinds yard waste then third-party vendors process it to create mulch for retail. The county also uses some of the mulch for a biosolids and yard waste composting operation.
Sarasota	120,011	84,652	50,330	County contracts with WM to grind yard waste which creates overs and fines; overs used for landfill cover and fines are provided to residents for free and to another company which uses them for composting.
Lee	408,678	260,147	23,000	Third party vendor grinds yard waste for mulch, some of which is used at the county-run yard waste and biosolids composting operation to produce compost for sale. The rest is given to residents for free.

5.3 Action 2: Local Industries, Landscapes, and Construction Stores Data Collection

In order to understand whether a recycled yard waste product such as mulch or compost is viable in the local market, UF contacted several experts from local businesses, including yard waste processers, landscapers, hardware stores, and agricultural businesses such as nurseries and farms. UF also spoke with representatives from several government entities to ascertain whether government departments might be inclined to procure a recycled mulch or compost for their needs.

In this chapter, UF will sometimes use the terms “conventional” and “recycled” to refer to types of mulch. Conventional mulch in this report refers to mulch that is not made from diverted yard waste and instead is composed of either trees that were harvested specifically for the purpose of creating mulch (such as eucalyptus or cypress) or the byproducts of trees harvested for other purposes (such as pine bark). Recycled mulch in this report will refer to mulch made specifically from diverted yard waste or land clearing debris. Similarly, recycled compost in this report will refer to compost made out of diverted yard waste or land clearing debris. In Miami-Dade County geographic boundaries,

customers can purchase either conventional or recycled mulch and compost from a variety of businesses, including hardware stores, nurseries, or directly from the processors themselves.

5.3.1 Processors

UF spoke with representatives from two local processing companies. The first company accepts yard waste for a tipping fee and repurposes this yard waste into recycled mulch. A representative from the company said that recycled mulch is often not a high-quality product. One issue with the mulch made from yard waste is that it smells stronger than conventional mulch (perhaps because of the decomposition from the leaves) and that its composition tends to be more unpredictable. The latter quality limits its usefulness for agricultural purposes because crops fare better with compost and mulch that have a particular pH and composition of nutrients. Due to these issues, most of the company's recycled material comes from trees sourced from land clearing for construction projects, which tends to be cleaner and of a higher quality than yard waste brought in by residents and landscapers.

The representative said that sales of the mulch made from recycled yard waste represent a very small proportion of his total sales. For example, in one month, he sold 22,000 yd^3 of mulch, 155 yd^3 of which were recycled yard waste mulch, or only 0.7%. He stated that he makes this mulch as a courtesy for his clients. For his other products, he has a diversified customer base including residents, landscapers, grocery stores, shopping centers, and homeowners' associations, among others.

This representative recommended alternative options for yard waste, including using it as landfill cover or using an air curtain incinerator to make biochar out of it. He mentioned that he has seen many yard waste processing businesses start, receive material until the facility is at capacity, and then close when they are unable to offload the material.

The second company receives yard waste from some residents but mostly landscapers, who pay a fee ($7.85 per yd^3 up to $13.00 per yd^3 depending on the type of yard debris) to dispose of their yard waste at the facility. The company then grinds the material and processes it for pathogen reduction. Yard debris that is composed of mostly hardwoods is used to make mulch, and the softer woods and other yard debris is generally used for compost.

Most of the second company's customers are nurseries and farms, but some residents purchase the compost and mulch as well. The representative said that they have few problems with weeds or diseases because they are constantly checking the material for these issues. In January 2021, the facility sold around 300 yd^3 of recycled compost and 550 yd^3 of recycled mulch. However, the representative also mentioned that in December through February, the facility does not sell as much material due to the agricultural cycles.

5.3.2 Landscapers

Landscapers represent both a promising potential market because of their demand for mulch as well as a challenging market because they are looking for mulch with certain specification. One landscaper that UF spoke with mentioned that the business is much

more likely to purchase recycled mulch than compost because of general client needs. In addition, clients oftentimes prefer a specific mulch (color, size, wood type) to achieve a certain aesthetic for their yard. For this reason, some clients prefer conventional mulch and may not want recycled mulch for reasons mentioned by processors. Some landscapers in Miami-Dade County geographic boundaries have their own grinders and are therefore able to process their own yard waste. This mulch is generally used in the yards of their clients or is sometimes given away or sold cheaply to farms and other businesses. These landscapers will be less likely to purchase mulch produced by Miami-Dade County. Landscapers not only contract with residents but also with municipalities and Miami-Dade County to maintain right-of-ways or medians. These right-of-way or median contracts represent both a challenge as well as an opportunity. Contracts often last for multiple years, and the landscapers may not be willing to switch to a new recycled yard waste product before the contracts ends. However, once the contract is up for renewal, the client (Miami-Dade County or the municipalities) could specify that they prefer the mulch or compost to be procured from the county.

5.3.3 Hardware Stores

Hardware stores represent an important source of mulch and compost for residents and occasionally landscapers. There are three large hardware companies that operate in Miami-Dade County: Ace Hardware (17 locations in the county), Lowe's (four locations), and Home Depot (17 locations). In addition, there are several small, locally operated hardware businesses. UF visited several Lowe's and Home Depots in the area and found that both companies sell predominantly conventional mulch as opposed to recycled mulch. Representatives from both companies also indicated that the businesses prefer large, national companies like Scott's or Oldcastle due to consistency and price. The impression the employees had was that it would be difficult for a local mulch or compost product to make it to the shelves of these establishments. The Ace Hardware store that UF visited, on the other hand, only sold a locally made, recycled wood mulch, the classic red mulch from Florida Wood Recycling. UF therefore believe that targeting small, locally owned hardware stores might yield the best results when marketing the mulch or compost product.

5.3.4 Agricultural Services

UF contacted nurseries around the county to ascertain whether they might be inclined to purchase a recycled mulch or compost product. Of the 61 UF contacted, 10 sold mulch and eight sold compost. Most of the mulch that is sold is conventional mulch procured from large, national companies, but a few of the nurseries did sell recycled mulch from local companies such as Florida Wood Recycling. Some of the nurseries that did sell mulch were willing to offer recycled mulch or compost but emphasized that the price and quality of the product would have to be carefully considered. The nurseries generally did not buy mulch for their own plant cultivation needs but sometimes purchased compost.

Within Miami-Dade County boundaries, there are over 64,000 acres of farmland divided into more than 2,500 farms (United States Department of Agriculture, 2017). These farms represent a large potential market for mulch or compost. As mentioned earlier, most of the OrganicLee® Compost made by Lee County is sold to citrus farms

around the area. UF spoke with a few farms in Miami-Dade to understand if they would be willing to purchase a recycled mulch or compost product. UF interviewed a representative from a large farm of around 1,500 acres who told us that because the farm is so large, it would be economically unfeasible to purchase mulch and soil for that many acres of land. Therefore, they tend to disc spent crops back into the soil for nutrient addition. However, UF did speak with a farmer who does purchase mulch for his smaller farm. Another representative from a small farm told us that they make their own compost at the farm. Due to these conversations, UF think that it may be possible for Miami-Dade County to market their recycled mulch or compost product to smaller farms. Fortunately, most farms in Miami-Dade are small, from one to nine acres. Only 6% of the farms in the county are more than 50 acres in size (United States Department of Agriculture, 2017).

5.3.5 Governmental Agencies

UF next interviewed representatives from the Parks Department and Maintenance Department in the county. UF found that the Parks Department would be willing to purchase recycled mulch and has done so in the past, but they emphasized that the mulch must originate from a trusted and certified source. This is because they have to be cautious about the introduction and spread of exotic and invasive species within the mulch. They informed us that the department does not purchase compost.

The representative from the Maintenance Department informed us that the mulching activities performed on the rights-of-way are done by official contracted landscapers, who make the mulch purchasing decisions. The Maintenance Department could potentially specify in future contracts that they prefer the mulch to be procured from the prospective Miami-Dade County-run facility.

5.4 Action 3: Market Size Evaluation

The method suggested by the Mulch & Soil Council to calculate market potential of mulch or soil products (both compost and topsoil) is the following: 74% of U.S. households have a yard or garden and 24% of these households purchase mulch. The average household that purchases mulch will purchase 12-15 bags per year. Each standard bag of mulch is two cubic feet (ft^3), so that would equal about 24-30 ft^3. An yd^3 is equal to 27 ft^3, so UF can estimate that each household that does purchase mulch will purchase about one yd^3 per year.

The Mulch & Soil Council also relayed those two thirds of the mulch market is bulk mulch sales. Bulk mulch is mulch that is sold in large quantities so that instead of being purchased in a bag, it is purchased without a container and loaded into a truck for hauling. For every yd^3 of bagged mulch sold per year, approximately two yd^3 of bulk mulch is sold. Finally, they gave the estimation that soil products are about 40% of mulch volume in unit sales.

According to 2019 Census information, the number of single-family households in Miami-Dade County is 508,962 (United States Census Bureau, 2019b). If approximately a highly conservative 74% of these single-family households have a yard or garden, that would equal about 376,632 households. If 24% of these single-family households with a yard or garden purchase mulch, this would equal about 90,392 households. If these

90,392 households purchase one $yd^3$of bagged mulch, that would equal 90,392 yd^3 of bagged mulch.

Because for every yd^3 bag sold, two yd^3 of bulk mulch are sold, this would equal 180,784 yd^3 of bulk mulch. UF's estimation for the market of both bulk and bagged potentially sold in Miami-Dade County would therefore be 271,176 yd^3. Using a density factor of 0.4 tons/yd^3.(USDA NCRS, 2012), Miami-Dade County residents purchased an estimated 108,470 tons of mulch in 2019. Because soil products represent about 40% of mulch volume sales, UF can deduce that the market for soil products in Miami-Dade County is about 108,470 yd^3. Using a density factor of 0.45 tons/yd^3. (Khater, 2015), Miami-Dade County residents purchased an estimated 48,812 tons of soil products in 2019.

UF also used a second approach to estimate the quantity of mulch or compost purchased by homeowners, landscapers, nurseries, construction stores, and agricultural entities within Miami-Dade County boundaries. According to polling data, the average homeowner in the United States spends about $122 annually on mulch and soil (Statistica, 2019). As previously mentioned, there are about 508,693 single-family households in Miami-Dade County boundaries. This calculation yields approximately $62,060,546 spent on both mulch and soil products by residents alone per year.

5.5 Action 4: Market Price Estimates

To estimate the current market price of mulch or compost products made from recycled yard waste, UF contacted several businesses in Miami-Dade County boundaries to inquire about the price point of their various products. UF also identified price information on some businesses' websites, which UF included in the analysis as well. The following section will outline the current price points of mulch and compost products sold in Miami-Dade County boundaries. Both mulch and compost products can be sold either in bulk or bagged. Some places choose to sell both ways for their customers' convenience.

5.5.1 Mulch Product

Throughout the research, UF found that most mulch being sold is conventional mulch. Though any final product created by a future Miami-Dade County yard waste processing facility will be a recycled product, it was important to assess the prices of both recycled and conventional products to make a competitively priced product. Based on conversation with the first local yard waste processing company, UF know that mulch made with recycled yard waste tends to be a lesser quality product which means that it would generally have a lower selling price. The research corroborates this hypothesis. UF will split the following section into the various mulch providers.

5.5.1.1 Processors

Florida Wood, a local processor, makes a variety of mulch products. Nutra Mulch™, which is Florida Wood's mulch blend that includes recycled yard waste, costs $175.63 for a pallet of 70 bags (with varying sizes), which equals $2.51 per bag (Buy Mulch Direct, 2019). This is also Florida Wood's least expensive mulch product. In comparison, many of their other mulch varieties are priced at either $205.59 for 70 bags ($2.94 per bag) or up to $308.69 for 60 bags ($5.14 per bag) for recycled yard waste

mulch. Florida Wood does not sell their mulch products in bulk, only bagged. Atlas Grinding & Recycling, another local yard waste processor, has a few different recycled mulch products. They do sell in bulk, with the hardwood mulch being sold for \$15 per yd^3. Another type of mulch that is lesser in quality sells for \$10 per yd^3 or \$2.49 per bag.

5.5.1.2 Hardware Stores

As previously mentioned, both Lowe's and Home Depot do not carry recycled wood mulch. They do carry a variety of conventional mulch products from large, national companies. UF created a spreadsheet of the prices for mulch products from varying hardware stores in Miami-Dade County boundaries. Prices for the standard two cubic foot (ft^3) bag range from \$2.27 (for a bag of undyed cypress blend mulch from Home Depot) to \$8.99 (for a bag of dyed pine bark mulch from the Ace Hardware in the City of Bricknell). UF averaged the price of the 57 different price points which yielded the value of \$4.72 per standard-size bag of conventional mulch. Note that this includes a variety of different mulches, including value-added mulches such as those that have been dyed or have added herbicide. Table 5-3 below lists the various price points.

Table 5-3. Prices of bagged mulch sold at hardware stores in Miami-Dade County.

City	Hardware Store	Company	Price ($)	Product	Specific Tree Type	Dyed?
Hialeah	Lowe's	Oldcastle	2.88	NoFloat Cypress blend	Cypress blend	No
Hialeah	Lowe's	Oldcastle	3.58	Premium 100% Cypress Mulch	100% Cypress	No
Hialeah	Lowe's	Preen	4.98	Extended Control Weed Preventor	Pine	Midnight black
Hialeah	Lowe's	Preen	4.98	Mulch Plus Weed Barrier Russet Red	No	Red
Hialeah	Lowe's	Preen	4.98	Mulch Plus	Pine	Red
Hialeah	Lowe's	Scotts	3.98	NatureScapes	Hardwood	Brown
Hialeah	Lowe's	Scotts	3.98	NatureScapes	Eucalyptus	Red
Hialeah	Lowe's	Scotts	3.98	NatureScapes	Eucalyptus	No
Hialeah	Lowe's	Scotts	3.98	NatureScapes	Hardwood	Black
Hialeah	Lowe's	Scotts	3.98	Florida Select	Citrus & Eucalyptus	No
Hialeah	Lowe's	Texas Native	3.33	Premium Red Mulch	No	Red
Hialeah	Lowe's	Texas Native	3.33	Premium Brown Mulch	Hardwood	Brown
Hialeah	Lowe's	Texas Native	3.33	Premium Black Mulch	No	Black
Hialeah	Lowe's	Timberline	2.98	Gold Mulch	Hardwood	Gold
Hialeah	Lowe's	Timberline	2.58	Red Mulch	Hardwood	Red
Calle Ocho	Home Depot	Scotts	3	EarthGro	No	Black
Calle Ocho	Home Depot	Scotts	3	EarthGro	No	Brown
Calle Ocho	Home Depot	Scotts	3	EarthGro	No	Red
Calle Ocho	Home Depot	Home Depot	2.27	Cypress Blend	Cypress blend	No
Calle Ocho	Home Depot	Home Depot	3.67	Pine Bark Nuggets	Pine	No
Calle Ocho	Home Depot	Vigoro	3	Premium Brown Mulch	No	Brown
Calle Ocho	Home Depot	Vigoro	3	Premium Red Mulch	No	Red
Bricknell	Ace Hardware	Ace Brown	5.99	Cypress Blend	Cypress blend	No
Bricknell	Ace Hardware	Ace Brown	6.59	Brown Cedar Mulch	Cedar	Brown
Bricknell	Ace Hardware	Ace Brown	8.99	Pine bark	Pine	Brown

Table 5-3. Continued.

City	Hardware Store	Company	Price ($)	Product	Specific Tree Type	Dyed?
Bricknell	Ace Hardware	Oldcastle	3.99	NoFloat Cypress blend	Cypress blend	No
Bricknell	Ace Hardware	Scotts	6.99	NatureScapes	No	Sierra Red
Bricknell	Ace Hardware	Scotts	6.99	NatureScapes	No	Brown
Bricknell	Ace Hardware	Scotts	6.99	NatureScapes	No	Black
Bricknell	Ace Hardware	Scotts	6.99	NatureScapes Triple Shred	No	Sierra Red
Bricknell	Ace Hardware	Scotts	6.99	NatureScapes Triple Shred	No	Brown
Bricknell	Ace Hardware	Scotts	6.99	NatureScapes Triple Shred	No	Black
Bricknell	Ace Hardware	Timberline	4.99	Black Mulch	No	Black
Bricknell	Ace Hardware	Timberline	4.99	Red Mulch	No	Red
Bricknell	Ace Hardware	Timberline	4.99	Brown Mulch	No	Brown
Bricknell	Ace Hardware	Timberline	5.99	Brown Cedar Mulch	Cedar	Brown
Miami	Shell Lumber and Hardware	Blue Flamingo	4.85	Premium Cedar Mulch Blend	Cedar Blend	No
Miami	Shell Lumber and Hardware	Great North	6.03	Cedar Mulch	Cedar	No
Miami	Shell Lumber and Hardware	Mid America	4.74	Black Mulch	No	Black
Miami	Shell Lumber and Hardware	Mid America	4.74	Brown Mulch	No	Brown
Miami	Shell Lumber and Hardware	Mid America	5.26	Hardwood Mulch	Hardwood	No
Miami	Shell Lumber and Hardware	Mid America	5.61	Pine Bark Mulch	Pine	No
Miami	Shell Lumber and Hardware	Mid America	4.74	Red Mulch	No	Red
Miami	Shell Lumber and Hardware	Northwoods Organics	4.53	Red Mulch	No	Red
Miami	Shell Lumber and Hardware	Oldcastle	2.79	Brown Cypress Blend	Cypress	No
Miami	Shell Lumber and Hardware	Oldcastle	3.99	Mini Pine Bark Nuggets	Pine	No
Miami	Shell Lumber and Hardware	Oldcastle (Jolly Gardener)	3.49	Natural Eucalyptus	Eucalyptus	No
Miami	Shell Lumber and Hardware	Oldcastle	3.99	Natural Pine Bark Nuggets	Pine	No
Miami	Shell Lumber and Hardware	Oldcastle (Jolly Gardener)	2.59	Red Mulch	No	Red
Miami	Shell Lumber and Hardware	Preen	5.67	Extended Control	No	Red
Miami	Shell Lumber and Hardware	Preen	5.67	Mulch Plus Rlack Mulch	No	Midnight Black
Miami	Shell Lumber and Hardware	Preen	5.67	Mulch Plus Brown Mulch	No	Chestnut Brown

Table 5-3. Continued.

City	Hardware Store	Company	Price ($)	Product	Specific Tree Type	Dyed?
Miami	Shell Lumber and Hardware	Preen	6.79	Mulch Plus Red Mulch	No	Russet Red
Miami	Shell Lumber and Hardware	Scotts	5.33	Brown Mulch	No	Brown
Miami	Shell Lumber and Hardware	Scotts	5.33	NatureScapes Mulch, Black	No	Black
Miami	Shell Lumber and Hardware	Scotts	5.33	NatureScapes Mulch, Red	No	Red
Miami	Shell Lumber and Hardware	Scotts	5.72	NatureScapes Triple ShredMulch, Red	No	Red

A few hardware stores offer bulk purchases of mulch in addition to bagged mulch. These mulches also tend to be conventional. Table 5-4 shows a list of seven bulk prices UF obtained from a Home Depot. UF averaged the price for seven different bulk mulch price points which yielded the value of $313 for a five yd^3 load.

Table 5-4. Prices of bulk mulch (five yd^3) sold at hardware stores in Miami-Dade County.

Store	Location	Price ($)	Product	Specific Type	Dyed?
Home Depot	Calle Ocho	274	Kids Karpet Bulk Playground Mulch	Engineered wood fiber	No
Home Depot	Calle Ocho	359	Brown Landscape	No	Brown
Home Depot	Calle Ocho	359	Black Landscape	No	Black
Home Depot	Calle Ocho	269	Red Landscape	No	Red
Home Depot	Calle Ocho	330	Pine Mini Nuggets	Pine	No
Home Depot	Calle Ocho	340	Cypress Loose	Cypress	No
Home Depot	Calle Ocho	262	Hardwood	Hardwood	No

In addition to conventional bagged or bulk mulch, UF were able to find one price point for recycled mulch. The Ace Hardware in Doral carries a mulch that is locally made at Florida Wood partially out of recycled yard waste. The product is the classic red mulch, and its price was $3.29 for a standard-size bag.

5.5.1.3 Nurseries

Nurseries represent an occasional source of mulch for residents and landscapers. Some nurseries only grow and sell plants whereas other nurseries include a garden center store whereby mulch may be sold. Upon calling and visiting many nurseries in the county, UF learned that nurseries do not necessarily carry mulch; out of 61 nurseries contacted, only 10 said that they carry mulch. Most of this mulch is conventional mulch. From these 10, UF were able to ascertain a range of standard prices for mulch sold at nurseries. Table 5-5 shows the price points of bagged mulch from various nurseries. A standard size bag (two ft^3) of mulch of any kind is sold anywhere between $1.50 to $4.00, with the average price being $2.78.

Table 5-5. Prices of bagged mulch sold at nurseries in Miami-Dade County.

Nursery	City	Price	Kind(s)
Aaron Agriculture	Miami	$ 2.50	Red, brown, cypress, black
Alton Road Nursery	Miami Beach	$ 4.00	Recycled
Dixon Nursery	Miami	$ 3.00	Red mulch, Spanish gold
Exclusive Nursery & Landscape	Hialeah	$ 2.50	Black, brown, and red
Galloway Farm Nursery Inc.	Miami	$ 3.50	Cypress
Galloway Farm Nursery Inc.	Miami	$ 4.25	Pine nuggets
Galloway Farm Nursery Inc.	Miami	$ 3.50	Red mulch
Jenny Sod and Nursery	Miami and Homestead	$ 3.50	Eucalyptus
Jenny Sod and Nursery	Miami and Homestead	$ 2.25	Spanish Gold
Jenny Sod and Nursery	Miami and Homestead	$ 2.25	Red Mulch
Jenny Sod and Nursery	Miami and Homestead	$ 2.50	Jolly Gold 65
Jenny Sod and Nursery	Miami and Homestead	$ 2.25	Jolly Black 65
Jenny Sod and Nursery	Miami and Homestead	$ 3.25	Pine Bark 65
Jenny Sod and Nursery	Miami and Homestead	$ 2.50	Cypress 75
Jenny Sod and Nursery	Miami and Homestead	$ 3.25	Mini pine bark
Jenny Sod and Nursery	Miami and Homestead	$ 2.49	Premium Brown
Jenny Sod and Nursery	Miami and Homestead	$ 2.25	Jolly Brown
Jenny Sod and Nursery	Miami and Homestead	$ 2.15	Jolly Red 65
Kendall Nursery and Landscaping	Miami	$ 2.80	N/A
Kenia's Nursery and Sod	Opa-Locka	$ 1.50	Red, black
Killian Grower's Nursery	Miami	$ 2.75	Mulch from Florida Wood
Margarita's Gardens Inc.	Miami	$ 2.25	Recycled wood mulch (from Florida Wood), pink bark, a few others

5.5.2 Compost Product

In contrast to the standard two-ft^3 size bag in which mulch is often packaged, compost tends to be packaged in a wider variety of sizes and measurements, making it more difficult to compare prices. Complicating the issue further, there is some confusion about the term “compost”. People and product labels sometimes interchange the words “compost”, “fertilizer”, and “topsoil”. Many places sell topsoil, but not compost. Table 5-6 shows a list of compost price points found in various hardware stores in Miami-Dade County boundaries.

As seen in Table 5-6, much of the compost sold is not necessarily made with recycled yard waste. One place that does sell compost made from recycled yard waste is Atlas Grinding & Recycling. They sell several different types of compost in bulk. One is

called Compost 1 which sells for $15 per yd^3. The second is Compost Grueso which sells for $16.50 per yd^3. Their highest quality compost, Compost Premium, sells for $20 per yd^3.

Table 5-6. Prices of bagged compost sold at hardware stores in Miami-Dade County.

Store	City	Price ($)	Size of Bag	Company	Product	Characteristics
Ace Hardware	Bricknell	6.99	1 ft^3	EcoGro	Organic Compost 1	Feed stocks of ground tree and limb, leaves, grass, source separated food, brewery residuals
Ace Hardware	Bricknell	4.99	1 ft^3	Greensmix	Blend 5	Organic compost
Ace Hardware	Bricknell	6.99	1 ft^3	Greensmix	Mushroom compost	Mushroom compost
Ace Hardware	Bricknell	4.99	1.5 ft^3	Omni	Organic Compost	N/A
Ace Hardware	Bricknell	8.99	1 ft^3	Sungro	Black Gold	Compost, Bark, Peat Moss, Forest Products
Home Depot	Calle Ocho	22.97	16 quarts	Gardener's Gold	Premium Compost	No manure, sludge
Home Depot	Calle Ocho	55.98	20 lbs	Humalfa	Nature's Prescription Organic Fertilizer & Soil Amendment	Cow Manure and alfalfa
Home Depot	Calle Ocho	29.98	8 lbs	Super Compost	2/2/02	Cow Manure, Alfalfa Meal, Earthworm Castings
Home Depot	Calle Ocho	39.88	12 lbs	Super Compost	2/2/02	Cow Manure, Alfalfa Meal, Earthworm Castings
Lowe's	Hialeah	5.28	1 ft^3	Black Kow	Organic Compost & Cow Manure	100% Cow Manure
Lowe's	Hialeah	3.98	0.75 ft^3	Just Natural	Organic Compost	Mushroom compost
Lowe's	Hialeah	2.98	0.75 ft^3	Just Natural	Natural & Organic Composted Cow Manure	Cow Manure
Lowe's	Hialeah	1.98	1 ft^3	Timberline	Cow Manure and Compost	Compost and Manure

5.6 Action 5: Local Regulations Data Collection

5.6.1 State Regulations

Florida Statute 403.707 stipulates that solid waste management facilities must have a current and valid permit issued by the FDEP (Florida Statue 403.707, (Florida Senate 2019)). In Chapter 62-701 of the Florida Administrative Code (FAC), yard waste processing facilities are exempted from airport safety citing regulations (62-701.320(13)(d)3) (Florida Department of State, 2016). Chapter 62-701.710 reiterates the need for a valid permit issued by FDEP. Under 62-701.710(2), a permit application is

required to construct, operate, or modify a waste processing facility. The remainder of the chapter focuses on the design requirements, necessary application materials, certification process, closure requirements, financial assurances, and recordkeeping requirements. For further details, Chapter 62-701.710 should be consulted.

FAC Chapter 62-709 outlines the state regulations specifically regarding yard waste processing facilities (Florida Department of State, 2010). Chapter 62-709.201 contains the definitions relating to organics processing. Yard waste is defined as "vegetative matter resulting from landscaping maintenance or land clearing operations and includes materials such as tree and scrub trimmings, grass clippings, palm fronds, trees and tree stumps, and associated rocks and soils. For purposes of this chapter, it also includes clean wood." A yard waste processing facility is defined as "a yard waste transfer station or a facility at which yard waste is processed into a size-reduced, usable material or is composted, but does not include a facility used for the disposal of yard waste."

FAC chapter 62-709.300 outlines the general provisions for compost facilities, including the requirement of a permit, closure requirements, and certain prohibitions (Florida Department of State, 2010). This chapter lays out different options for disinfection of compost, but states that compost produced exclusively from yard waste or pre-consumer vegetative wastes is exempt. Chapter 62-709.300(9) stipulates the permit fees: the yard waste composting facility construction permit fee is $2,000, an operation permit fee is $1,000, and the yard waste processing facility registration is $35. Other fees may apply as well including registration for composting of yard waste ($35) and request for an alternative procedure ($500).

Under 62-709.320, yard waste processing facilities must register with the FDEP before beginning operation (Florida Department of State, 2010). The registrant must provide a variety of information as well as documentation that the registrant either owns the land upon which the facility will be cited or has permission from the landowner to use the land. Chapter 62-709.320 also stipulates monthly records of incoming and outgoing material which should be kept for at least three years. The facility must re-register and complete an annual report by July 1 of every year to the FDEP. These registrations are considered operation permits under Chapter 62-709.320(1)(d). Chapter 62-709.320(2) outlines the design and operating requirements. For more specific details, it is recommended to consult 62-709.320(2).

In addition to the provisions of 62-709.320, facilities that only accept yard waste and no other materials must abide by 62-709.330, which states that processed material may only remain at the facility for up to 18 months with exceptions for those facilities that are authorized under an additional Department's solid waste management facility permit (Florida Department of State, 2010). In this case, the Department may authorize storage of more than 18 months if demonstration of a particular use for the material such as erosion control or cover can be proven. The final stipulation under 62-709.330 is that only yard waste and the bags used to collect yard waste can be accepted at the facility.

62-709.500 outlines the design criteria for permitted facilities, which includes regulations pertaining to the design plans, stormwater system design standards, and

operational features (Florida Department of State, 2010). For more specific details, it is recommended to consult 62-709.500.

62-709.510 outlines the operation requirements for all permitted composting facilities, including stipulations that the facility must be designed and operated to control vectors and odors as much as possible (Florida Department of State, 2010). Other requirements include ensuring that an attendant is on hand during all hours when solid waste is received and having communication mechanisms in place in case of emergencies. Incoming waste must not be mixed with finished compost. More than half of the compost stored at the facility must be sold or used within each year starting the third year after facility startup. The amount of compost stored at the facility should not be more than the designed capacity and yard waste that is not to be processed should be removed at least once monthly. Finally, material other than yard waste that is received by the facility must be separated, stored, and removed within 72 hours.

62-709.530 contains the testing, recording, and reporting requirements for compost (Florida Department of State, 2010). For more specific details, it is recommended to consult 62-709.530.

Chapter 62-709.550 lays out the different classifications used for compost (Florida Department of State, 2010). Compost made from only yard waste whose product maturity is either mature or semi-nature (as opposed to fresh) would be considered Type Y. In this case, a foreign matter content of less than 2% and a metal concentration equivalent to code 1 are both assumed. Code 1 means that concentrations of cadmium, copper, lead, nickel, and zinc are under 15, 450, 500, 50, and 900 mg/kg dry weight, respectively. Under Chapter 62-709.600, Type Y compost has unrestricted distribution.

Other mentions of mulch or compost in the FAC include in 373.185 which defines the concept of “Florida-friendly landscaping”, or landscaping that is intended to conserve water and otherwise protect Florida’s natural resources instead of depleting them (University of Florida IFAS, 2006). Mulching and compost are both mentioned as potential components of Florida-friendly landscaping.

5.6.2 Local Regulations

In addition to state regulations, Miami-Dade County has several local ordinances regarding yard waste as outlined in the Code of Miami-Dade County, Florida (Miami-Dade County, 2020). Section 15-5.1 establishes the intent of the Miami-Dade County Board of Commissioners to create a “Yard waste Management Ordinance” Section to conserve Class I landfill space and improve the ability of the county to manage and dispose of yard waste. Section 15-5.2 prohibits the comingling of yard waste and other forms of waste in several different situations, including curbside and at the TRCs. Section 15-18 outlines the requirements for a resource recovery and management facility permit.

Under Section 18A, which is the Miami-Dade County Landscaping Ordinance, the use of cypress mulch is discouraged because of potential damage during harvest to cypress wetlands (Miami-Dade County, 2020). Additionally, red dyed mulch is not recommended because it may contain pressure-treated lumber chips. Section 18A-2(A), echoing state legislature, also encourages the use of Florida-friendly landscaping, including mulch. It is stipulated under 18A-6(G) that mulch should be applied and

maintained following the guidelines of “A Florida Friendly Landscaping”, written by the Institute of Food and Agricultural Sciences at the University of Florida (University of Florida IFAS, 2006). Among general guidelines about the application and use of mulch, “A Florida Friendly Landscaping” includes a section on recycled mulch. One recommendation is to heat compost any mulch to kill stray seeds. Section 18B, which is the Miami-Dade County Right-of-Way Landscape Ordinance, echoes Section 18A in encouraging the use of the guidance from “A Florida Friendly Landscaping” (18B-4(B)(13)) and discouraging the use of cypress mulch ((18B-4(B)(14)).

Section 24-5 defines a resource recovery and management facility as “any facility the purpose of which is disposal, recycling, incineration, processing, storage, transfer, or treatment of solid or liquid waste” (Miami-Dade County, 2020). Yard waste is defined as “solid waste comprised of vegetative matter resulting from landscaping maintenance or land clearing operations and shall include, but not be limited to, Melaleuca, Australian pine, Brazilian pepper and other tree and shrub trimmings, grass clippings, palm fronds, tree and tree stumps, and soils not containing any hazardous materials.” Section 24-15 states that any facility must have plan approval and Sections 24-15-1 through 24-15-4 outline the specific procedures, standards, and personnel qualifications necessary for the plan approval. Section 24-17 require a certificate of occupancy after the completion of the approved plan for the facility. Section 24-18 states the requirement of a permit for resource recovery and management facilities, which cannot be obtained without the written recommendation of approval from the Director of Solid Waste Management. There is a fee associated with the permit. Section 24-19 outlines the requirements for the operation of the facility, including hiring competent and knowledgeable personnel (Miami-Dade County, 2020).

6 TECHNICAL FEASBILITY STUDY FOR PROSPECTIVE MULCHING/COMPOSTING YARD WASTE FACILITY

6.1 General Approach for Feasibility of Yard Waste Processing Facilities

In this section UF provide the facility design and costs associated with a yard waste windrow composting and mulching facility. Task 4 comprised of a technical memorandum where UF summarized the types of technology, size, and costs associated with facilities for both mulching and composting yard waste. Sizing calculations were based on the Task 2 results for the mass flow of yard waste (Table 6-1) that is currently disposed of at the Miami-Dade County owned facilities and that is potentially available to be processed. UF assumed three types of recovery potential (low, mid, and high) and used these masses in UF's facility design and cost estimates.

UF first identified the process flows for a yard waste windrow composting and mulching facility. The composting and mulching facility design calculations are discussed in Sections 6.3.1 and 6.4.1, respectively. Then, UF estimated the capital and operating costs for each type of facility on a per ton of incoming yard waste basis. The cost analysis for a composting and mulching facility are detailed in Sections 6.3.2 and 6.4.2, respectively. The actual total cost estimate for Miami-Dade County to construct and operate a yard waste windrow composting and mulching facility are shown in Sections 6.3.3 and 6.4.3, respectively. Lastly, recommendations for the County regarding composting/mulching yard waste management are discussed in Section 6.5.

Table 6-1. Mass flows of yard trimming based on Task 2 estimates. The recovery potential was calculated for low (assuming 25% of the Task 2 estimate is recovered), mid (assuming 75% of the Task 2 estimate is recovered), and high (assuming 100% of the Task 2 estimate is recovered).

	Source: *Task 2 Estimates*	Recovery Potential		
Sector	Generation	Low	Mid	High
Clean Yard Waste	**90,196**	**22,549**	**67,647**	**90,196**
At TRCs	26,808	6,702	20,106	26,808
At Landfills/WTE	9,692	2,423	7,269	9,692
In private sector	53,696	13,424	40,272	53,696
Yard Waste in mixed loads	**366,383**	**91,596**	**274,787**	**366,383**
At TRCs	10,918	2,730	8,189	10,918
Curbside garbage	165,610	44,883	134,649	165,610
Curbside trash	175,933	43,983	131,950	175,933
Total Yard Waste	**443,135**	**114,145**	**342,434**	**443,135**
At TRCs	37,726	9,432	28,295	37,726
At Landfills/WTE	189,224	47,306	141,918	189,224
In private sector	229,629	57,407	172,222	229,629

6.2 Potential Yard Waste Processing Facility Site Locations

In Florida, a solid waste management facility that produces compost or mulch is required to be permitted pursuant to Section 403.707, Florida Statutes, and in accordance with Rule 62-709, Florida Administrative Code. The permitting application requires details on the facility design (e.g., dimensions of the site, plan for receiving/production/curing), facility performance and design standards, operational features, operations plan, water quality, compost facility data, and certification by engineer or public officer. For this report, the exact location for the siting of a yard waste processing facility will not be identified since it relies on various criteria (e.g., it can be on already permitted land for waste management processing, it can be on new unpermitted land that needs to be reviewed for its suitability).

6.3 Yard Waste Composting Facility

6.3.1 Composting Facility Design

In a windrow composting facility, the yard waste is ground, typically using a tub grinder, to a coarse size fraction which is then organized outdoors into long narrow piles (called windrows) using front-end loaders. The yard waste decomposes in the windrow pile via high heat and introduced oxygen which allows for microorganisms to breakdown the organic content. The key management processes in a windrow composting facility are ensuring the windrow's temperature and oxygen levels are optimum. These processes are usually managed using mechanical equipment (e.g., windrow turner and front-end loader). The windrow turner is normally around the same height of the pile and introduces oxygen to the pile while allowing for thorough mixing of the pile for temperature control. The yard waste will degrade in the windrows for approximately 2 months, then it is screened to remove any contaminants (e.g., plastic films, metal pieces). The post-screened degraded material will be transferred into another pile for curing for approximately 1 month. After curing, the compost is bagged or sold in bulk. A schematic of this process is shown in Figure 6-1.

Average windrow composting facility operation schedules (e.g., annual operating days, daily operating hours) are detailed in Table 6-2. The windrow facility engineering design (based on two mass estimates: lower bound (22,549 tons/year) and upper bound (443,135 tons/year) are shown in Table 6-3. The total area for a windrow facility (assuming on a newly permitted site) would be 7 acres with 13 employees and 131 acres with 248 employees, respectively for lower and upper bound masses. The area for the windrow process was 3 and 53 acres, respectively, this estimate was calculated by estimating the area for three processes in the facility: 1) receiving area, where the incoming yard waste is placed; 2) active pad area, where the windrow piles are organized; and 3) curing/storage area, where the final step of compost is conducted. The area needed for the active pad, curing/storage, and receiving for the lower and upper bound masses are included in Table 6-3. Other details included the volume of yard waste at each process, the dimensions of the piles/areas, and the number of windrows is also included in Table 6-3.

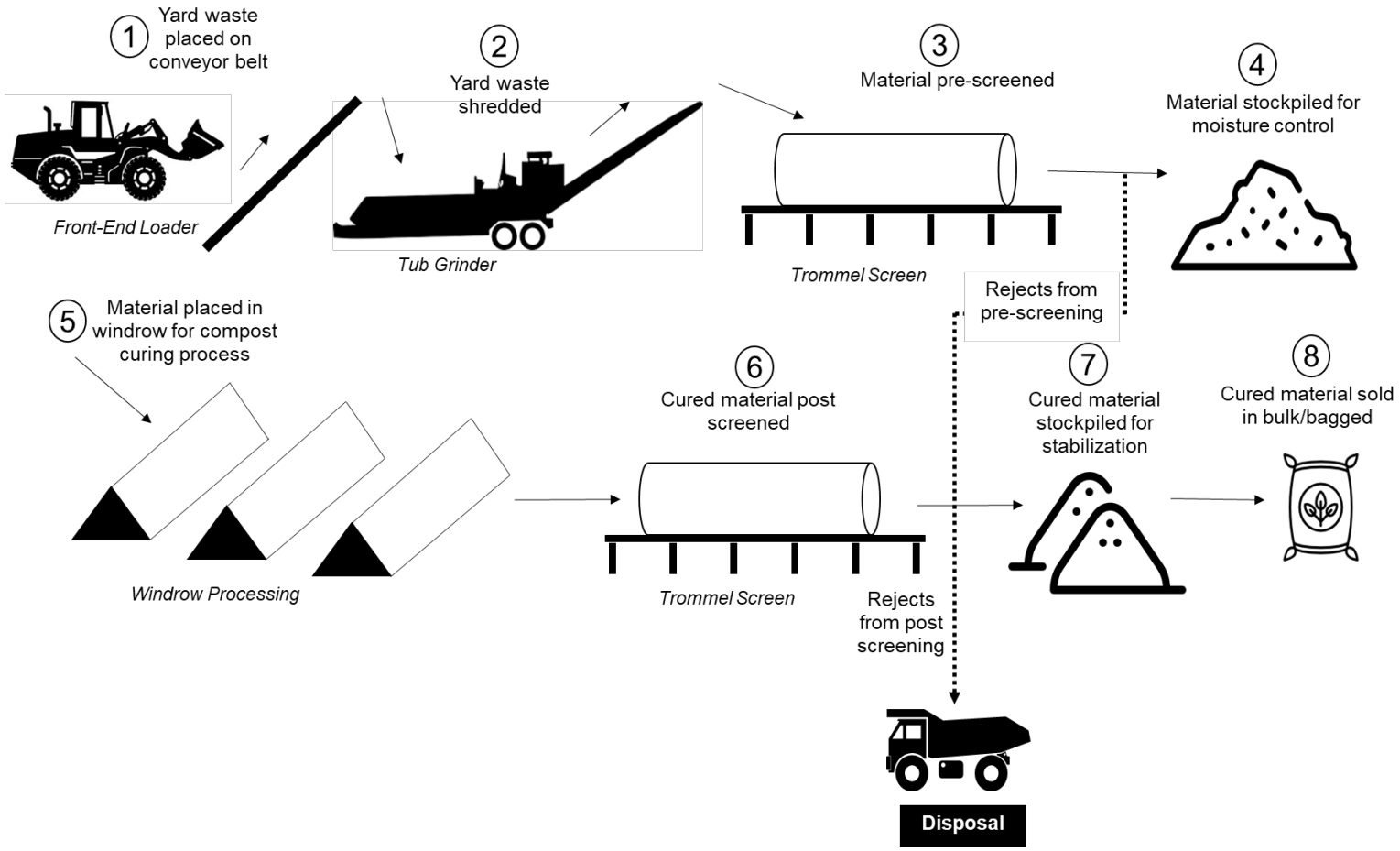


Figure 6-1. Schematic of prospective yard waste windrow composting facility. The flow of yard waste in the system begins at step 1 and ends at step 8.

Table 6-2. The facility operation schedule for yard waste windrow composting.

Facility Operation Time	Units	Value
Windrow operation		
Annual operating days	days/year	260
Daily operating hours	hours/day	8
Time spent at tipping floor	Mg/day	1
Weekly operating days	days/week	5
Active composting time	days	70
Curing time	days	30
Turning frequency	1/days	0.33
Frequency of turning during curing phase	1/day	0.14

Note: All values were retrieved from the Solid Waste Optimization Framework Life Cycle Assessment Model (which shares the same data as the US EPA Municipal Solid Waste Decision Support Tool) (Levis and Barlaz, 2013).

Table 6-3. Facility engineering design for yard waste windrow composting calculated for the lower and upper bound mass estimate from Table 6-1. The results for equipment units needed, personnel needed, and total facility footprint (assuming new site) were calculated using the data from Table 6-4 and 6-5. The results for composting operation footprint were calculated using equations provided by the Vermont Department of Environmental Conservation (Vermont DEC).

Facility Design	Units	Results for lower bound mass	Results for upper bound mass
Mass flow			
Mass throughput	tons/year	22,549	443,135
Volume throughput	yd3/year	45,098	913,157
Mass output	tons/year	9,020	182,631
Volume output	yd3/year	18,039	365,263
Equipment units needed			
Windrow turner	total units	11	216
Tub grinder	total units	1	5
Pre-trommel	total units	1	4
Front End Loader	total units	1	4
Post trommel	total units	1	4
Personnel needed			
Operators needed	total employees	9	176
Managers needed	total employees	4	72
Total facility footprint (assuming new site)			
Graded area	total acres	7	131
Storage footprint area	total ft2	31,737	642,620
Office footprint area	total ft2	1,587	32,131
Fenced area	total ft	3,698	74,879
Composting operation footprint			
Schedule and reduction factors parameters			

Time on active composting pad	months	3	3
Time in curing and storage	months	1	1
Volume reduction[a]	%	60	60
Density of mixed yard waste[a]	lbs/yd3	1,000	1,000
Shrink factor during composting[a]	%	20	20
Shrink factor during curing[a]	%	60	60
Windrow sizing			
Height[b]	ft	6 to 9	6 to 9
Width[b]	ft	9 to 16	9 to 16
Length[c]	ft	1,000	1,000
Spacing[d]	ft	20	20
Cross sectional ratio[e]		0.5 to 0.66	0.5 to 0.66
Total area per windrow	acres	0.29	0.29
Total volume per windrow	ft3	54,375	54,375
Number of windrows on active pad	windrows	3	70
Active pad sizing			
Width of windrows	ft	43	873
Width of work alleys	ft	69	1,397
Total pad width	ft	112	2,269
Total pad length	ft	1,000	1,000
Total pad area	acres	2.6	52
Curing/Storage area sizing			
Time period of windrow in curing[a]	weeks/windrow	2	2
Number of windrows in curing area	windrows	2	2
Volume per windrow	yd3/ windrow	694	14,049
Total curing area	acres	0.61	0.61
Receiving area sizing			
Pile height[a]	ft	4	4
Pile width[a]	ft	30	30
Pile length[a]	ft	30	30
Workspace safety factor[a]		2	2
Total receiving area	acres	0.04	0.04
Total volume and area sizing			
Volume of throughput actively composted	yd3	8,673	175,607
Volume on active composting pad	yd3	6,938	140,486
Volume in curing/storage area	yd3	1,487	30,104
Total area (active pad + curing + receiving)	acres	3	53

Note: All values (unless indicated otherwise) were retrieved from the Solid Waste Optimization Framework Life Cycle Assessment Model (which shares the same data as the US EPA Municipal Solid Waste Decision Support Tool) (Levis and Barlaz, 2013).

a) Source for value is from (Vermont DEC, 2015).

b) Source for value is from (JACOBS Engineering, 2018; Rob van Haaren, 2009; SCS Engineers, 2020; Vermont DEC, 2015).

c) Source for value is from correspondence via phone calls with composting facilities in Miami-Dade County and Florida.

d) Source for value is from (SCS Engineers, 2020).

e) Source for value is from (Rob van Haaren, 2009; SCS Engineers, 2020; Vermont DEC, 2015)

6.3.2 Composting Cost Analysis

The costs associated with constructing and operating a yard waste windrow composting facility were estimated from existing sources and tools on typical US facilities. The data was primarily retrieved from the Solid Waste Optimization Framework Life Cycle Assessment Model (which shares the same data as the US EPA Municipal Solid Waste Decision Support Tool) (Levis and Barlaz, 2013). The economic costs were segregated into three main parameters: 1) capital cost parameters, which consists of the costs to purchase equipment and to construct a facility; 2) operating costs parameters, which include the energy, fuel, and personnel used to operate the facility/equipment and the revenue from the sale of compost product; and 3) financial parameters, which are current discount rates, electricity and diesel fuel costs. Details of each cost item (e.g., capital cost of a windrow turner) for the three parameters are shown in Tables 6-4 for capital costs parameters, 6-5 for operating costs parameters, and 6-6 for financial parameters.

The data in Tables 6-4 through 6-6 were used to estimate the capital and operating cost per one ton of yard waste incoming to a windrow composting facility as reported in Table 6-7. The total capital cost per ton of yard waste composted was calculated as $30.20 and the total operating cost per ton was $19.41. The total cost per ton for constructing and operating a windrow yard waste composting facility was $49.61 (Table 6-7). When including the results for selling bulk compost in Miami-Dade County made from recycled yard waste from the market analysis (based on existing retailers) in Task 3 the total cost per ton ranged from $17.25 to $45.43, depending on the quality of the compost and assuming sold in bulk.

Table 6-4. The capital costs parameters used to estimate the economic cost of constructing a windrow yard waste composting facility. These data are used with Table 6-5 and Table 6-6 to estimate a cost per ton associated with yard waste windrow composting in Table 6-7.

Capital Costs Parameters	Units	Value
Equipment		
Windrow turner	$/unit	26,701
Tub grinder	$/unit	370,844
Pre-trommel	$/unit	148,337
Front End Loader	$/unit	222,506
Post trommel	$/unit	148,337
Windrow Turner	units/tpd	0.157
Tub grinder	units/tpd	0.0034
Pre-Screen	units/tpd	0.0023
Front end loader	units/tpd	0.0027
Post Screen	units/tpd	0.0023
Windrow turner	Equipment Life (years)	10
Tub grinder	Equipment Life (years)	10
Pre-trommel	Equipment Life (years)	10
Front End Loader	Equipment Life (years)	10
Post trommel	Equipment Life (years)	10
Facility		
Facility useful life	years	20
Grading cost per hectare	$/ha	31,400
Paving cost	$/ha	123,000
Building cost (equip., stag.)[a]	$/ft2	150
Office cost[a]	$/ft2	300
Fencing cost	$/ft	9
Engineering, design, supervision	% Direct Project Costs	15
Management overheads	% Direct Project Costs	10
Commissioning	% Indirect Project Costs	5
Contingency	% Indirect Project Costs	10
Contractor's fees	% Indirect Project Costs	10
Grading requirement	ha/tpd	0.027
Warehouse requirement	ft2/tpd	332
Office requirement	ft2/tpd	17
Land requirement	ha/tpd	0.36
Fencing requirement	ft/tpd	39

Note: All values (unless indicated otherwise) were retrieved from the Solid Waste Optimization Framework Life Cycle Assessment Model (which shares the same data as the US EPA Municipal Solid Waste Decision Support Tool) (Levis and Barlaz, 2013). Also, tpd refers to tons per day.

a) Source for value is from (Gordian and RSMeans Data, 2021).

Table 6-5. The operating costs parameters used to estimate the economic cost of operating a windrow yard waste composting facility. These data are used with Table 6-4 and Table 6-6 to estimate a cost per ton associated with yard waste windrow composting in Table 6-7.

Operating Costs Parameters	Units	Value
Facility Operation		
Annual operating days	days/year	260
Daily operating hours	hours/day	8
Time spent at tipping floor	t/day	1
Weekly operating days	days/week	5
Active composting time	days	70
Curing time	days	30
Turning frequency	1/days	0.33
Frequency of turning during curing phase	1/day	0.14
Equipment Operation		
Waste shredding grinder power rating	kWh/t	10
Windrow turner power rating	kWh/t	0.22
Screening power rating	kWh/t	0.82
Front end loader energy required per flow of material	kWh/t	0.30
Waste shredding grinder fuel consumption	Gal/kWh	0.066
Windrow turner fuel consumption	Gal/kWh	0.034
Screening fuel consumption	Gal/kWh	0.069
Front end loader fuel consumption	Gal/kWh	0.069
Office area required per ton per day of material	ft2/tpd	17
Energy required to power an office	kWh/ft2-yr	27
Windrow turner	Repair (% Initial Cost)	60
Tub grinder	Repair (% Initial Cost)	60
Pre-trommel	Repair (% Initial Cost)	60
Front End Loader	Repair (% Initial Cost)	60
Post trommel	Repair (% Initial Cost)	60
Personnel		
Operator wage	$/hr-person	10
Manager wage	$/hr-person	25
Operators required	person/tpd	0.09
Managers required	person/tpd	0.04
Overhead percentage	%	0.1
Revenue		
Density of compost[a]	lb/ft3	27
Bulk high quality from recycled yard waste[b]	$/ft3 bulk	0.4
Bulk low quality from recycled yard waste[b]	$/ft3 bulk	0.06
Value of compost product (high quality) - bulk	$/t	32.4
Value of compost product (low quality) - bulk	$/t	4.19

Note: All values (unless indicated otherwise) were retrieved from the Solid Waste Optimization Framework Life Cycle Assessment Model (which shares the same data as the US EPA Municipal Solid Waste Decision Support Tool) (Levis and Barlaz, 2013). Also, tpd refers to tons per day.
a) Source for value is from (Woods End Laboratories, 2021)
b) Source for value is from results of Task 3.

Table 6-6. The financial parameters used to estimate the cost of electricity and diesel used in a composting and mulching facilities. These data are used with Tables 6-4 and 6-5 to estimate the cost of yard waste windrow composting in Table 6-7. These data are also used with Tables 6-12 and 6-13 to estimate the cost of yard waste mulching in Table 6-14.

Financial Parameters	**Unit**	**Value**
Discount rate[a]	%	0.025
Electricity cost (Florida industrial, April 2021)[b]	$/kWh	0.07
Diesel fuel cost (Lower Atlantic No 2 Diesel Retail Prices, 2020)[c]	$/Gal	2.49

Note:

a) Source for value is from correspondence with municipalities and engineers on the current 20-year municipal bond.

b) Source for value is from (US EIA, 2021).

c) Source for value is from (US EIA, 2020).

Table 6-7. The capital and operating cost of a yard waste windrow composting facility in units of $ per ton of incoming yard waste processed. These data were calculated using Tables 6-4 through 6-5.

Cost Parameters	**Value ($/ Ton)**
Capital Costs Parameters	
Equipment purchase	
Windrow turner	1.84
Tub grinder	0.56
Pre-trommel	0.15
Front End Loader	0.27
Post trommel	0.15
Facility construction	
Grading cost	3.29
Building cost (equip., stag.)	12.28
Office cost	1.23
Fencing cost	1.36
Engineering, design, supervision	2.72
Management overheads	1.82
Commissioning	0.91
Contingency	1.82
Contractor's fees	1.82
Total Capital Costs	**30.20**
Operating Costs Parameters	
Equipment maintenance	
Windrow turner	1.10
Tub grinder	0.34
Pre-trommel	0.09
Front End Loader	0.16
Post trommel	0.09
Facility energy use	

Tub grinder electricity	0.71
Windrow turner electricity	0.02
Pre-trommel electricity	0.06
Post trommel electricity	0.06
Front end loader electricity	0.02
Office area electricity	0.13
Tub grinder fuel	1.58
Windrow turner fuel	0.02
Front end loader fuel	0.05
Pre-trommel fuel	0.14
Post trommel fuel	0.14
Personnel	
Labor	7.26
Managers	7.44
Overhead	0.01
Total Operating Costs	**19.41**
Revenue Parameters	
Value of compost product (high quality) - bulk	32.37
Value of compost product (low quality) - bulk	4.19
Total Cost Factor	
Capital + Operating Costs Parameters	**49.61**
Capital + Operating Costs Parameters – Revenue Bulk High Quality	**17.25**
Capital + Operating Costs Parameters – Revenue Bulk Low Quality	**45.43**

6.3.3 Estimated Composting Costs

The estimated composting costs for a yard waste windrow composting facility is shown in Tables 6-8 and 6-9. The costs were calculated using the two cost values in Table 6-7 (high ($17.25) and low ($45.43) quality compost) and the mass estimates shown in Table 6-1. Referring to the lower and upper bound masses shown in Table 6-3 (22,549 and 443,135 tons/year) the corresponding costs were $388,915 and $7.9 million per year (assuming a high-quality compost revenue) (Table 6-8). When considering a low-quality compost revenue, the results are $1.02 million and $7.9 million per year for the lower and upper bound masses (Table 6-9). Based on Task 2 there is a total of 90,196 tons (for 10/2019 to 09/2020) of clean segregated yard waste, where 36,500 tons entered a Miami-Dade County waste management facility (i.e., TRC, landfill, WTE). Using 36,500 tons/year the costs would range from $388,915 to $1.2 million per year (high quality compost revenue) or $1.02 million to $3.07 million per year (low quality compost revenue).

Table 6-8. Composting total cost based on mass estimates in Table 6-1 and economic cost from Table 6-9 (assuming high quality compost revenue). All units are in $/year.

	Recovery Potential		
Sector	Low	Mid	High
Clean Yard Waste	**$388,915**	**$1,166,746**	**$1,555,661**
At TRCs	$115,593	$346,780	$462,373
At Landfills/WTE	$41,791	$125,373	$167,163
In private sector	$231,531	$694,594	$926,125
Yard Waste in mixed loads	**$1,579,802**	**$4,739,407**	**$6,319,210**
At TRCs	$47,077	$141,232	$188,309
Curbside garbage	$774,121	$2,322,364	$3,096,485
Curbside trash	$758,604	$2,275,812	$3,034,416
Total Yard Waste	**$1,968,718**	**$5,906,153**	**$7,874,871**
At TRCs	$162,670	$488,011	$650,682
At Landfills/WTE	$815,912	$2,447,736	$3,263,648
In private sector	$990,135	$2,970,406	$3,960,541

Table 6-9. Composting total cost based on mass estimates in Table 6-1 and economic cost from Table 6-9 (assuming low quality compost revenue). All units are in $/year.

	Recovery Potential		
Sector	Low	Mid	High
Clean Yard Waste	**$1,024,301**	**$3,072,904**	**$4,097,206**
At TRCs	$304,442	$913,327	$1,217,769
At Landfills/WTE	$110,066	$330,199	$440,265
In private sector	$609,793	$1,829,379	$2,439,172
Yard Waste in mixed loads	**$4,160,787**	**$12,482,360**	**$16,643,147**
At TRCs	$123,989	$371,967	$495,956
Curbside garbage	$2,038,833	$6,116,499	$8,155,332
Curbside trash	$1,997,965	$5,993,894	$7,991,859
Total Yard Waste	**$5,185,088**	**$15,555,265**	**$20,740,353**
At TRCs	$428,431	$1,285,294	$1,713,725
At Landfills/WTE	$2,148,899	$6,446,697	$8,595,597
In private sector	$2,607,758	$7,823,273	$10,431,031

6.4 Yard Waste Mulching Facility

6.4.1 Mulching Facility Design

In a yard waste mulching facility, the yard waste is ground, typically using a tub grinder, to a coarse size fraction which is then screened to remove any contaminants, stockpiled, and sold or given away at no cost to local residents. The mulching process requires less time, land, and resources than the windrow composting process. However, the quality of mulch largely depends on the screening process, where more advanced screening (e.g., different screen sizes used simultaneously) allows for increased removal of contaminants (e.g., plastic films, metal pieces). The curing time after screening in the stockpile is impactful to the quality mulch as well, where the pile reaches an optimum temperature to destroy any weeds or invasive plants/seeds. A schematic of this process is shown in Figure 6-2. In Florida, some counties rely on mulching as their main method of yard waste management, where the mulch is often provided at no cost for local residents, used as alternative daily cover, or a certain size fraction from screening is sold/provided to local composting facilities.

Average mulching facility operation schedules (e.g., annual operating days, daily operating hours) are detailed in Table 6-10. The mulching facility engineering design (based on two mass estimates: lower bound (22,549 tons/year) and upper bound (443,135 tons/year) are shown in Table 6-11. The total area for a mulching facility (assuming on a newly permitted site) would be 2 acres with 4 employees and 45 acres with 83 employees, respectively for lower and upper bound masses. The area for the mulching process was 2 and 5 acres, respectively, this estimate was calculated by estimating the area for two processes in the facility: 1) receiving area, where the incoming yard waste is placed and grinded; and 2) storage area, where the stockpiled mulched yard waste is organized. The total area includes an assumed buffer and support area to account for any noise disturbances to the local residents. The area needed for the receiving, storage, and buffer/support for the lower and upper bound masses are included in Table 6-11. Other details included the volume of yard waste at each process, the dimensions of the piles/areas, and the number of equipment is also included in Table 6-11.

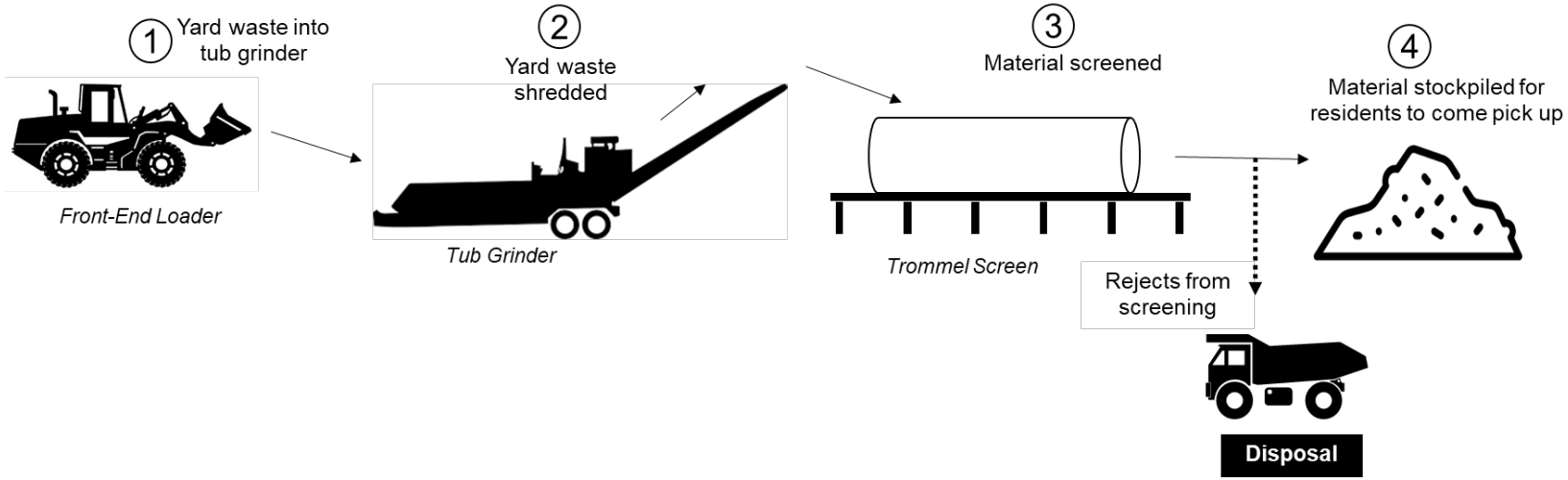


Figure 6-2. Schematic of prospective yard waste mulching facility. The flow of yard waste in the system begins at step 1 and ends at step 4.

Table 6-10. The facility operation schedule for yard waste windrow composting.

Facility Operation Time	Units	Value
Windrow operation		
Annual operating days	days/year	260
Daily operating hours	hours/day	8
Time spent at tipping floor	Mg/day	1
Weekly operating days	days/week	5

Note: All values were retrieved from the Solid Waste Optimization Framework Life Cycle Assessment Model (which shares the same data as the US EPA Municipal Solid Waste Decision Support Tool) (Levis and Barlaz, 2013).

Table 6-11. Facility engineering design for yard waste mulching calculated for the lower and upper bound mass estimate from Table 6-1. The results for equipment units needed, personnel needed, and total facility footprint (assuming new site) were calculated using the data from Table 6-12 and 6-13. The results for mulching operation footprint were calculated using data provided by other local mulch processors in Florida.

Facility Design	Units	Results for lower bound mass	Results for upper bound mass
Mass flow			
Mass throughput	tons/year	22,549	443,135
Volume throughput	yd3/year	45,098	913,157
Volume throughput per day	yd3/day	173	3,512
Mass output	tons/year	18,039	365,263
Volume output	yd3/year	36,078	730,526
Volume output per day	yd3/day	139	2,810
Equipment units needed			
Tub grinder	total units	1	7
Front End Loader	total units	1	6
Post trommel	total units	1	5
Personnel needed			
Operators needed	total employees	3	59
Managers needed	total employees	1	24
Total facility footprint (assuming new site)			
Graded area	total acres	2	45
Mulching operation footprint			
Schedule and reduction factors parameters			
Density of mixed yard waste[a]	lbs/yd3	1,000	1,000
Shrink factor during mulching[b]	%	20	20
Buffer area[b]	ft	500	500
Support area ratio[b]		2	2
Receiving area sizing			
Cross sectional ratio[c]		0.5 to 0.66	0.5 to 0.66
Pile height[a]	ft	4	4
Pile width[a]	ft	30	30
Pile length[d]	ft	67	1,362
Total receiving area	acres	0.05	0.94
Storage area sizing			
Cross sectional ratio[c]		0.5 to 0.66	0.5 to 0.66
Pile height[a]	ft	4	4
Pile width[a]	ft	30	30
Pile length[e]	ft	54	1,090
Total receiving area	acres	0.04	0.75
Total volume and area sizing			
Total area (based on daily flow) (receiving + storage + support + buffer)	acres	2*	5

**The linear model used to estimate the total volume and area sizing for a mulching facility was adjusted for smaller masses of yard waste managed, where if the linear model returned results less than 2 acres then the minimum value used was 2 acres instead of the model results. This was done to ensure appropriate area dimensions that correspond with realistic dimensions.*

Note: All values (unless indicated otherwise) were retrieved from the Solid Waste Optimization Framework Life Cycle Assessment Model (which shares the same data as the US EPA Municipal Solid Waste Decision Support Tool) (Levis and Barlaz, 2013).

a) Source for value is from (Vermont DEC, 2015).

b) Source for value is from correspondence via phone calls with mulching facilities in Miami-Dade County and Florida.

c) Source for value is from (Rob van Haaren, 2009; SCS Engineers, 2020; Vermont DEC, 2015)

d) Calculated based on the pile height, width, cross sectional ratio, and the volume throughput per day.

e) Calculated based on the pile height, width, cross sectional ratio, and the volume output per day.

6.4.2 Mulching Cost Analysis

The costs associated with constructing and operating a yard waste mulching facility were estimated using the same data sources and methods for the composting facility. Again, the economic costs were segregated into three main parameters: 1) capital cost parameters, 2) operating costs parameters, and 3) financial parameters. Details of each cost item (e.g., capital cost of a tub grinder) for the three parameters are shown in Tables 6-12 for capital costs parameters, 6-13 for operating costs parameters, and the same financial parameters in Table 6-6 were used.

The data in Tables 6-6, 6-12, and 6-13 were used to estimate the capital and operating cost per one ton of yard waste incoming to a mulching facility as reported in Table 6-14. The total capital cost per ton of yard waste mulched was calculated as $2.63 and the total operating cost per ton was $8.05. The total cost per ton for constructing and operating a yard waste mulching facility was $10.67 (Table 6-14). When including the results for selling bulk mulch in Miami-Dade County made from recycled yard waste from the market analysis (based on existing retailers) in Task 3 the total cost ranged from $0.38 to $10.67. UF assumed the low-quality mulch would not generate any revenue and would instead be used as alternative landfill daily cover or provided at no cost for residents (as similarly done by other Florida counties).

Table 6-12. The capital costs parameters used to estimate the economic cost of constructing a yard waste mulching facility. These data are used with Table 6-13 and Table 6-6 to estimate a cost per ton associated with yard waste mulching in Table 6-14.

Capital Costs Parameters	**Units**	**Value**
Equipment		
Tub grinder	$/unit	370,844
Front End Loader	$/unit	222,506
Post trommel	$/unit	148,337
Tub grinder	units/tpd	0.0034
Front end loader	units/tpd	0.0027
Post Screen	units/tpd	0.0023
Tub grinder	Equipment Life (years)	10
Front End Loader	Equipment Life (years)	10
Post trommel	Equipment Life (years)	10
Facility		
Grading cost per hectare	$/ha	31,400
Engineering, design, supervision	% Direct Project Costs	15
Management overheads	% Direct Project Costs	10
Commissioning	% Indirect Project Costs	5
Contingency	% Indirect Project Costs	10
Contractor's fees	% Indirect Project Costs	10
Grading requirement	ha/tpd	0.009

Note: All values (unless indicated otherwise) were retrieved from the Solid Waste Optimization Framework Life Cycle Assessment Model (which shares the same data as the US EPA Municipal Solid Waste Decision Support Tool) (Levis and Barlaz, 2013). Also, tpd refers to tons per day.

Table 6-13. The operating costs parameters used to estimate the economic cost of operating a yard waste mulching facility. These data are used with Table 6-12 and Table 6-6 to estimate a cost per ton associated with yard waste mulching in Table 6-14.

Operating Costs Parameters	Units	Value
Facility Operation		
Annual operating days	days/year	260
Daily operating hours	hours/day	8
Time spent at tipping floor	t/day	1
Weekly operating days	days/week	5
Equipment Operation		
Waste shredding grinder power rating	kWh/t	10
Screening power rating	kWh/t	1
Front end loader energy required per flow of material	kWh/t	0.30
Waste shredding grinder fuel consumption	Gal/kWh	0.066
Screening fuel consumption	Gal/kWh	0.069
Front end loader fuel consumption	Gal/kWh	0.069
Tub grinder	Repair (% Initial Cost)	60
Front End Loader	Repair (% Initial Cost)	60
Post trommel	Repair (% Initial Cost)	60
Personnel		
Operator wage	$/hr-person	10
Manager wage	$/hr-person	25
Operators required	person/tpd	0
Managers required	person/tpd	0
Overhead percentage	%	0
Revenue		
Density of mulch[a]	lb/ft3	63
Value of mulch product (high quality) – bulk[b]	$/t	10
Value of mulch product (low quality) – bulk[c]	$/t	0

Note: All values (unless indicated otherwise) were retrieved from the Solid Waste Optimization Framework Life Cycle Assessment Model (which shares the same data as the US EPA Municipal Solid Waste Decision Support Tool) (Levis and Barlaz, 2013). Also, tpd refers to tons per day.

a) Source for value is from (Specialized Environmental Technologies, Inc., 2021)

b) Source for value is from results of Task 3.

c) Source for value is from correspondence via phone calls with Florida counties that mulch their yard waste which reported that they provide it for free for their residents.

Table 6-14. The capital and operating cost of a yard waste mulching facility in units of $ per ton of incoming yard waste processed. These data were calculated using Tables 6-12 through 6-13.

Cost Parameters	Value ($/ Ton)
Capital Costs Parameters	
Equipment purchase	
Tub grinder	0.56
Front End Loader	0.27
Post trommel	0.15
Facility construction	
Grading cost	1.10
Engineering, design, supervision	0.16
Management overheads	0.11
Commissioning	0.05
Contingency	0.11
Contractor's fees	0.11
Total Capital Costs	**2.62**
Operating Costs Parameters	
Equipment maintenance	
Tub grinder	0.34
Front End Loader	0.16
Post trommel	0.09
Facility energy use	
Tub grinder electricity	0.71
Post trommel electricity	0.06
Front end loader electricity	0.02
Tub grinder fuel	1.58
Front end loader fuel	0.05
Post trommel fuel	0.14
Personnel	
Labor	2.42
Managers	2.48
Overhead	0.00
Total Operating Costs	**8.05**
Revenue Parameters	
Value of mulch product (high quality) - bulk	10.29
Value of mulch product (low quality) - bulk	0.00
Total Cost Factor	
Capital + Operating Costs Parameters	**10.67**
Capital + Operating Costs Parameters – Revenue Bulk High Quality	**0.38**
Capital + Operating Costs Parameters – Revenue Bulk Low Quality	**10.67**

6.4.3 Estimated Mulching Costs

The estimated composting costs for a yard waste windrow composting facility is shown in Tables 6-15 and 6-16. The costs were calculated using the two cost values in Table 6-14 (high ($0.38) and low ($10.67) quality compost) and the mass estimates shown in Table 6-1. Referring to the lower and upper bound masses shown in Table 6-3 (22,549 and 443,135 tons/year) the corresponding costs were $8,529 and $172,699 per year (assuming a high-quality mulch revenue) (Table 6-15). When considering a low-quality mulch revenue, the results are $240,557 and $4.9 million per year for the lower and upper bound masses (Table 6-16). Based on Task 2 there is a total of 90,196 tons (for 10/2019 to 09/2020) of clean easily segregated yard waste, where 36,500 tons entered a Miami-Dade County waste management facility (i.e., TRC, landfill, WTE). Using 36,500 tons/year the costs would range from $8,529 to $25,587 per year (high quality mulch revenue) or $240,557 to $721,672 per year (low quality mulch revenue).

Table 6-15. Mulching total cost based on mass estimates in Table 6-1 and economic cost from Table 6-14 (assuming high quality mulch revenue). All units are in $/year.

	Recovery Potential		
Sector	Low	Mid	High
Clean Yard Waste	**$8,529**	**$25,587**	**$34,116**
At TRCs	$2,535	$7,605	$10,140
At Landfills/WTE	$916	$2,749	$3,666
In private sector	$5,078	$15,233	$20,310
Yard Waste in mixed loads	**$34,646**	**$103,937**	**$138,583**
At TRCs	$1,032	$3,097	$4,130
Curbside garbage	$16,977	$50,930	$67,907
Curbside trash	$16,637	$49,910	$66,546
Total Yard Waste	**$43,175**	**$129,525**	**$172,699**
At TRCs	$3,567	$10,702	$14,270
At Landfills/WTE	$17,893	$53,680	$71,573
In private sector	$21,714	$65,142	$86,856

Table 6-16. Mulching total cost based on mass estimates in Table 6-1 and economic cost from Table 6-14 (assuming low quality mulch revenue). All units are in $/year.

	Recovery Potential		
Sector	Low	Mid	High
Clean Yard Waste	**$240,557**	**$721,672**	**$962,229**
At TRCs	$71,498	$214,495	$285,993
At Landfills/WTE	$25,849	$77,547	$103,396
In private sector	$143,210	$429,630	$572,840
Yard Waste in mixed loads	**$977,161**	**$2,931,483**	**$3,908,644**
At TRCs	$29,119	$87,357	$116,475
Curbside garbage	$478,820	$1,436,460	$1,915,280
Curbside trash	$469,222	$1,407,667	$1,876,889
Total Yard Waste	**$1,217,718**	**$3,653,155**	**$4,870,874**
At TRCs	$100,617	$301,851	$402,469
At Landfills/WTE	$504,669	$1,514,007	$2,018,677
In private sector	$612,432	$1,837,296	$2,449,728

6.5 Summary of Cost Impacts

Miami-Dade County residents from 10/2019 to 09/2020 generated 90,196 tons of clean segregated yard waste (based on Task 2 results, Figure 4-6) of which 36,500 tons entered a Miami-Dade County waste management facility (i.e., TRC, landfill, WTE). When compared to the mass of yard waste managed by Lee and Sarasota counties (not by their private sectors), the mass of clean segregated yard waste in the County (36,500 tons/year) falls within the range of those two counties (23,000 to 50,3330 tons/year, respectively, Table 5-2). The mass analysis result indicates that there is an adequate mass of yard waste that can be diverted from the landfill or WTE facility to a prospective yard waste processing facility.

Assuming a conservative mass of 22,549 tons per year (a little less than the amount of clean yard waste collected annually at all 13 TRCs (26,808 tons/year, Table 6-1)), the total facility footprint for windrow composting (assuming on a newly permitted site) would be 7 acres, while when assuming the facility would be constructed on already permitted site the footprint would be 3 acres for 3 windrows with dimensions of height (7.5 ft), width (12.5 ft), and length (1,000 ft) and 13 employees. For the same mass but assuming 173 yd^3 per day of incoming yard waste the results for a mulching facility were: 2 acres for newly permitted site, and 2 acres for on an already permitted site (see Table 6-11 note for details), a receiving pile size of height (4 ft), width (30 ft), and length (67 ft) and a stockpile size of height (4 ft), width (30 ft), and height (54 ft). Based on these results it is recommended that the potential mulching or compost facility be constructed and operated on already permitted sites in Miami-Dade County.

On a cost basis, the average total capital and operating cost for a composting and mulching facility were $50 and $11 per ton of incoming yard waste (Table 6-17). It is most likely that the compost produced from recycled yard waste will not have the same quality characteristics of compost produced from land clearing debris or other cleaner sources of yard waste (no plastics or metals contaminants). Therefore, UF accounted for two revenue options of $32 and $4 per ton for a high and low, respectively, quality compost product based on existing composting facilities in the County (Section 5.5). For the mulching revenue UF assumed only one revenue option (representing a high-quality mulch product) for $11 and assumed that the low quality would be provided at no cost for residents or used as alternative daily cover (this is based on correspondence with other Florida counties that mulch yard waste). The revenue estimates were derived from local Miami-Dade County processors that used recycled yard waste and land clearing debris (from findings from Task 3). The costs of composting in the County compared to those in engineering feasibility reports for US cities and counties; they range from $20-70/ton of windrowed compost (Haaren, 2009; Levis et al., 2013). Note these composting costs are primarily for food waste and yard waste co-composting. UF collected mulching data from Sarasota and Hillsborough counties to compare to the $11/ton estimate; these were $15-20/ton and $30/ton, respectively for Hillsborough (117,723 tons/year mulched) and Sarasota County (50,330 tons/year mulched). Both counties have a more advanced mulching post-screening process than in the system described in Figure 6-2, where the post-screened unders are sent to a composting site. Additionally, the higher costs (relative to the $11/ton) for these counties are partially attributed to the costs of

transporting and disposal of the residuals; these costs were not included in the $11/ton estimate.

When considering the cost effectiveness of mulching or composting yard waste it is important to understand the current cost of managing the yard waste and how those costs would be impacted. The summarized costs are shown in Table 6-17. For instance, if those 36,500 tons were to be mulched or windrow composted instead of landfilled or combusted the County could potentially save $14-53 per ton of yard waste diverted, even when assuming no revenue from mulch or compost sale. Therefore, there may be an opportunity for the County to reduce costs associated with managing yard waste through composting/ mulching, a more sustainable yard waste management practice. Worth noting, if the County pays the tipping fee to another entity (like a privately owned landfill or WTE facility, or a facility that another government owns) then the $14-$53 is considered a true savings since the County avoids paying the tipping fee. The savings will be much smaller, if the County owns the disposal facilities (as is the case for example for North and South Dade Landfills) because many of the costs associated with the disposal facilities are fixed (e.g., labor and facility/equipment amortization) and the County will pay the cost regardless of how much waste comes in.

Table 6-17. Comparison of the cost of composting and mulching yard waste with disposal of yard waste at a WTE or landfill facility (in Miami-Dade County).

Management Type	**Cost ($/ Ton)**
Composting	50*
Mulching	11**
Landfill daily cover	10-12
WTE tip fee	64
Landfill tip fee	64

*when including a high- and low-quality compost market revenue price ranges from $18-46/ton.

**when including a high-quality mulch market revenue and providing mulch for free for residents/ use as landfill cover price ranges from $1-11/ton.

7 RECOMMENDATIONS FOR YARD WASTE PROCESSING FACILITY

Like other Florida Counties, yard waste makes up a sizable amount of the total municipal solid waste stream in Miami Dade County. Our estimates, which includes yard waste currently being disposed of at both County-operated facilities (TRCs, landfills, and RRF) and privately operated facilities (e.g., Florida Wood Recycling, EPS Organics/Enviroco), project that yard waste is generated annually ranging from 274,000 to 511,000 tons. Currently all the yard waste managed by the County is disposed of in the landfills or the WTE facility (RRF). A major goal of the work reported here was to assess the feasibility of the County diverting some of this yard waste to a mulching or composting operation. This could free up capacity for other wastes to be processed in the WTE facility but would require changes to the current operation and success depends on the County's ability to secure a stable market for the end product.

We estimated a potential yard waste recovery range of anywhere from 23,000 tons to 457,000 tons per year. In some cases, this yard waste already arrives separate from other wastes at County facilities. The TRCs are estimated to receive 27,000 tons of separated clean yard waste annually, while another 10,000 tons of separated yard waste are disposed of at County disposal facilities. To reach the estimated 27,000 tons, new separate collection containers designated for only clean yard waste would need to be implemented in all the TRCs except for Sunset Kendall and Snapper Creek. To divert segregated TRC yard waste for composting or mulching, system changes would need to be initiated to transport targeted yard waste containers to the new processing operation instead of their current disposal destination. Yard waste loads delivered to the landfill would need to be diverted to the new facility, unloaded in an area designated at the landfill site for processing, or stockpiled for later transport to an off-site processing operation.

Additional yard waste volumes could be retrieved from the mixed waste stream. Some of this could be retrieved from the TRCs by requiring customers to separate all yard waste as a condition of acceptance (11,000 tons annually). But most of the remaining yard waste managed by the County exists in the mixed curbside garbage and trash streams (180,000 and 176,000 tons annually, respectively). Collection of this material would require a major change to the manner curbside wastes are collected in the County. Currently single-family home customers producing yard waste, in addition to utilizing the TRC disposal option, can place their yard waste in their curbside cart or request up two annual bulky waste pickups for up to 25 yd^3 of waste. Implementation of a collection system for yard waste only would require the addition of a third weekly/bi-weekly collection route: garbage, recyclables, and yard waste. To minimize the number of collection vehicles used and the number of vehicles driving through residential neighborhoods there will need to be a new collection operation plan. A more realistic collection operation would be to transform one of the weekly garbage collection routes to be specific to only yard waste collection. Another potential operation is to have residents place their yard waste for pickup every other week, potentially with either recycling or garbage. Either collection operation (even one beyond the two here) would require new education campaigns by the County for customer training.

Additional yard waste is currently managed as part of the private sector (54,000 tons annually). The source of this waste is from landscapers and residents that send their yard waste to recycling facilities that produce a mulch or compost product from the yard

waste (i.e., EPS Organics/Enviroco, Florida Wood Recycling, Atlas Grinding and Recycling Group). Retrieving this waste stream for processing in potential county yard waste processing facilities will be challenging since the source of incoming waste is from various untracked sources and doing so may disrupt private operations.

Based on the possible range of yard waste collection volumes in the County, UF developed a high-level cost estimate to construct and operate both composting and mulching operations. A composting facility would consist of a front-end loader to place incoming yard waste into a tub grinder, with the ground material screened and placed in windrows for compost stabilization over 6 to 8 weeks. Mulching facilities would be similar, but the storage time would be much smaller, thus the size and operational intensity of the facility would be smaller. The cost estimates are strongly influenced by whether the final product (mulch or compost) is sold, and if so, at what price. For each technology scenario we thus estimated total costs (capital + operation) using both typical market values for similar products on today's market in Miami-Dade County, and for the case when the materials are simply given away (only done for mulching). The average estimated total cost for a composting and mulching facility were $50 and $11 per ton of incoming yard waste, respectively. The estimated net costs for constructing and operating a composting and mulching facility ranged from $18-46 per ton and $1-11 per ton for, respectively. The costs of windrow composting compared to those reported in engineering feasibility reports for US cities and counties ($20-70 per ton) and mulching costs compare to Hillsborough and Sarasota Counties ($15-30 per ton).

It must be emphasized that the success of either a compost or mulching operation depends on the ability to secure an end market for the final product. Potential markets for compost and mulch include local residents, agriculture operations, nurseries, public works (e.g., rights-of-way, parks, playgrounds), hardware stores, and use as landfill alternative daily cover. Locally in Miami-Dade County, only a few local hardware stores sold compost and mulch made from recycled yard waste; a more likely market for these products would be with local agriculture and nurseries. Overall, we have identified multiple potential end users of products from a County-operated yard waste mulching or composting operation, the County will need to explore opportunities for stable and reliable outlets; this is especially true for those higher value commodities that the County desires to sell. Our evaluation found that local governments in Florida often rely on lower-value markets for mulch and compost outlets, including landfill daily cover and providing products free to residents.

Given the infrastructure and collection system changes that would accompany the County's implementation of a yard waste mulching or composting operation, as well as the importance of securing reliable end markets for the final product, starting off with a smaller project could prove a valuable next step. Based on the flow analysis presented in Chapter 3, sufficient segregated yard waste could be collected from the TRCs to begin a processing operation that could produce 10 to 20 thousand tons per year of product. In Chapter 6, cost estimates suggest that this operation could be conducted at approximately $11 per ton for simple mulching; if the county were to co-locate this operation at an existing solid waste management facility, costs should be lower. Many of the local governments evaluated in Chapter 5 conducted yard waste processing operations at their landfill sites, with final product being used for daily cover at the landfill

and provided to residents for free pickup. Results of a program such as this would provide valuable information (product quality, potential markets) to the County to assist in decision making on whether expansion of the program is warranted.

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APPENDIX

Table A-1. Supporting data and calculations for yard waste in curbside garbage and trash calculations.

Item	Item Title	Data	Units	Sources
A	Total population in Miami-Dade County boundaries	2,716,940	people	United States Census Bureau (2019)
B	Population serviced by Miami-Dade County (Unincorporated, Aventura, Cutler Bay, Doral, Miami Gardens, Miami Lakes, Opa-Locka, Palmetto Bay, Pinecrest, Sunny Isles Beach)	1,678,402	people	United States Census Bureau (2019)
C	Population not serviced by Miami-Dade County (people)	1,038,538	people	United States Census Bureau (2019)
D	Percentage of population in Miami-Dade County serviced areas	0.62	percent	B/A
E	Clean yard waste entering the 13 TRCs	26,808	tons	Research team estimation, explanation provided in Chapter __ of the report
F	Mixed yard waste entering the 13 TRCs	10,918	tons	Research team estimation, explanation provided in Chapter __ of the report
G	Clean yard waste entering Resource, North Dade Landfill, and South Dade Landfill	9,692	tons	Miami-Dade County scale house records, 2019-2020 fiscal year
H	Yard waste handled by the private sector	54,801	tons	FDEP 2019 recycling workbook and discussing with businesses
I	Curbside garbage generated by population in Miami-Dade County serviced areas	576,893	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
J	Yard waste composition of curbside garbage generated by the single-family population serviced by Miami-Dade County	0.135	percent	Miami-Dade Waste Composition Study Report, August 2021
K	Yard waste in curbside garbage generated by population in Miami-Dade County served areas	77,880	Tons	I*J
L	Curbside trash generated by population in Miami-Dade County served areas	319,140	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
M	Yard waste composition of curbside trash generated by the single-family population serviced by Miami-Dade County	0	tons	Miami-Dade Waste Composition Study Report, August 2021

Table A-1. Continued

Item	Item Title	Data	Units	Sources
N	Yard waste in curbside trash generated by population in Miami-Dade County served areas	115,529	tons	L*M
O	Garbage contribution in Miami-Dade County total curbside collected waste (i.e garbage + trash)	0.64	percent	Miami-Dade County curbside collection records, 2019-2020 fiscal year. Garbage was 576,893 tons and total trash was 896,033 tons
P	Trash contribution in Miami-Dade County total curbside collected waste (i.e garbage + trash)	0.36	percent	Miami-Dade County curbside collection records, 2019-2020 fiscal year. Trash was 319,140 tons and total trash was 896,033 tons.
Q	Combined Bal Harbour garbage + trash	5,502	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
R	Bal Harbour curbside garbage	3,542	tons	Q*O
S	Bal Harbour curbside trash	1,960	tons	Q*P
T	Yard waste in Bal Harbour curbside trash	709	tons	S*M
U	Combined Bay Harbour Island garbage + trash	741	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
V	Bay Harbour Island curbside garbage	477	tons	U*O
W	Yard waste in Bay Harbour curbside garbage	100	tons	V*J
X	Bay Harbour Island curbside trash	264	tons	U*P
Y	Yard waste in Bay Harbour Island curbside trash	96	tons	X*M
Z	Combined Coral Gables garbage + trash	44,180	tons	AA+AC
AA	Coral Gables curbside garbage	9,180	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year

Table A-1. Continued

Item	Item Title	Data	Units	Sources
AB	Coral Gables curbside trash	35,000	tons	City solid waste representative, unknown year of data
AC	Yard waste in Coral Gables curbside trash	12,670	tons	AB*M
AD	Combined Homestead garbage + trash	58,639	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
AE	Homestead curbside garbage	37,754	tons	AD*O
AF	Homestead curbside trash	20,885	tons	AD*P
AG	Yard waste in Homestead curbside trash	7,561	tons	AG*M
AH	Combined City of Miami garbage + trash	154,006	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
AI	City of Miami curbside garbage	99,154	tons	AH*O
AJ	Yard waste in City of Miami curbside garbage	13,386	tons	AI*J
AK	City of Miami curbside trash	54,852	tons	AH*P
AL	Yard waste in City of Miami curbside trash	19,857	tons	AK*M
AM	Combined Miami Beach garbage + trash	13,192	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
AN	Miami Beach curbside garbage	8,493	tons	AM*O
AO	Yard waste in Miami Beach curbside garbage	1,147	tons	AN*J
AP	Miami Beach curbside trash	4,699	tons	AM*P
AQ	Yard waste in Miami Beach curbside trash	1,701	tons	AP*M

Table A-1. Continued

Item	Item Title	Data	Units	Sources
AR	Yard waste in Miami Shores curbside trash	9,000	tons	City solid waste representative
AS	Combined Miami Springs garbage + trash	4,140	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
AT	Miami Springs curbside garbage	2,665	tons	AS*O
AU	Yard waste in Miami Springs curbside garbage	360	tons	AT*J
AV	Miami Springs curbside trash	1,475	tons	AS*P
AW	Yard waste in Miami Springs curbside trash	534	tons	AV*M
AX	Combined North Bay Village garbage + trash	4,757	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
AY	North Bay Village curbside garbage	3,063	tons	AX*O
AZ	Yard waste in North Bay Village curbside garbage	413	tons	AY*J
BA	North Bay Village curbside trash	1,694	tons	AX*P
BB	Yard waste in North Bay Village curbside trash	613	tons	BA*M
BC	Combined North Miami garbage + trash	10,941	tons	City solid waste representative
BD	North Miami curbside garbage	7,044	tons	BC*O
BE	Yard waste in North Miami curbside garbage	951	tons	BD*J
BF	North Miami curbside trash	3,897	tons	BC*P
BG	Yard waste in North Miami curbside trash	1,411	tons	BF*M

Table A-1. Continued

Item	Item Title	Data	Units	Sources
BH	Combined North Miami Beach garbage + trash	16,997	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
BI	North Miami Beach curbside garbage	10,943	tons	BH*O
BJ	North Miami Beach curbside trash	6,054	tons	BH*P
BK	Yard waste in North Miami Beach curbside trash	2,191	tons	BJ*M
BL	Combined South Miami garbage + trash	10,626	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
BM	South Miami curbside garbage	6,841	tons	BL*O
BN	Yard waste in South Miami curbside garbage	924	tons	BM*J
BO	South Miami curbside trash	3,785	tons	BL*P
BP	Yard waste in South Miami curbside trash	1,370	tons	BO*M
BQ	Combined Surfside garbage + trash	5,272	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
BR	Surfside curbside garbage	3,394	tons	BQ*O
BS	Yard waste in Surfside curbside garbage	458	tons	BR*J
BT	Surfside curbside trash	1,878	tons	BQ*P
BU	Yard waste in Surfside curbside trash	680	tons	BT*M
BV	Combined Sweetwater garbage + trash	5,842	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
BW	Sweetwater curbside garbage	3,761	tons	BV*O

Table A-1. Continued

Item	Item Title	Data	Units	Sources
BX	Yard waste in Sweetwater curbside garbage	508	tons	BW*J
BY	Sweetwater curbside trash	2,081	tons	BV*P
BZ	Yard waste in Sweetwater curbside trash	753	tons	BY*M
CA	Combined West Miami garbage + trash	2,994	tons	Miami-Dade County curbside collection records, 2019-2020 fiscal year
CB	West Miami curbside garbage	1,928	tons	CA*O
CC	Yard waste in West Miami curbside garbage	260	tons	CB*J
CD	West Miami curbside trash	1,066	tons	CA*P
CE	Yard waste in West Miami curbside trash	386	tons	CD*M
CF	Village of Biscayne Park curbside trash	2,412	tons	City solid waste representative
CG	Yard waste in Village of Biscayne Park curbside trash	873	tons	City solid waste representative
CH	Yard waste composition in 2010	0	-	2010 Miami-Dade County Waste Composition Study Report
CI	Garbage from unknown sources within the County boundaries, disposed at Medley Landfill	803,163	tons	2019 FDEP Landfill Report
CJ	Yard waste within garbage from unknown sources within the County boundaries, disposed at Medley Landfill	50,599	tons	CI*J
CK	Garbage from unknown sources within the County boundaries, disposed at Monarch Hill Landfill	32,396	tons	2019 FDEP Landfill Report

Table A-1. Continued

Item	Item Title	Data	Units	Sources
CL	Yard waste within garbage from unknown sources within the County boundaries, disposed at Monarch Hill Landfill	2,041	tons	CK*J
CM	Garbage from unknown sources within the County boundaries, disposed at J.E.D Landfill	270,805	tons	2019 FDEP Landfill Report
CN	Yard waste within garbage from unknown sources within the County boundaries, disposed at J.E.D Landfill	17,061	tons	CM*CO
CO	Garbage from unknown sources within the County boundaries, disposed at Lena Road County Landfill	2	tons	2019 FDEP Landfill Report
CP	Yard waste within garbage from unknown sources within the County boundaries, disposed at Lena Road County Landfill	0	tons	CO*J
CQ	Garbage from unknown sources within the County boundaries, disposed at Okeechobee Landfill	213,392	tons	2019 FDEP Landfill Report
CR	Yard waste within garbage from unknown sources within the County boundaries, disposed at Okeechobee Landfill	13,444	tons	CRQ

Table A-2. Initial methodology for estimating yard waste in curbside garbage and trash.

Calculation Step	Value	Numerical Value	Unit	Notes or Definition of Value
Step 1	Total population in the County boundaries	2,716,940	people	Item B in Table A-1
Step 2	Population serviced by the County	1,678,402	people	Item C in Table A-1
Step 3	Population not serviced by the County	1,038,538	people	Item D in Table A-1
Step 4	Yard waste disposed at TRCS/Resource/Landfills by produced by the populations serviced by the County	47,418	tons	Includes: clean and mixed yard waste which entered TRCs (Items E and F in Table A-1); clean yard waste which entered Resource/North Dade/South Dade Landfills (Item G in Table A-1)
Step 5	Yard waste in curbside garbage/trash from population serviced by the County	193,409	tons	Items J and M in Table A-1
Step 6	Yard waste generated by the population serviced by the County handled in the private sector	33,854	tons	The population serviced by the County is 62% of the population (Item D in Table A-1). The yard waste handled in the private sector (Item H in Table A-1) was multiplied by 62% to account for the yard waste coming from homes within that population but then ending up at a private business.
Step 7	Estimation of total yard waste generated by the population serviced by the County	274,681	tons	Summed Steps 4-6.
Step 8	Yard waste produced by population serviced by the County	0.16	tons/person	
Step 9	Yard waste generated by population not serviced by the County	169,963	tons	Step 3* Step 8
Step 10	Total yard waste in curbside waste	444,644	tons	Step 7+ Step 9