Solid Waste Authority of Broward County, Florida

Task 4 White Paper: Future Needs Assessment

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1.0 INTRODUCTION

To inform the assessment of future solid waste system needs, an analysis was conducted of Broward County's projected population growth and associated waste generation rates. This analysis is based on population and solid waste material generation estimates at 5-, 10-, 20-, 30-, 40-, and 50-year intervals, using 2023 as the baseline to align with waste management data used by the Florida Department of Environmental Protection (FDEP). Recognizing the significant role of curbside recycling programs in achieving the waste diversion goals of the Solid Waste Authority of Broward County (Authority), the SCS Team performed a detailed evaluation of Single-Stream Recycling (SSR) versus Dual-Stream Recycling (DSR) systems. The findings, included in Appendix A, support a recommendation to maintain and expand Single-Stream (SS) collection systems.

Based on this foundational information, five (5) scenarios were developed to offer detailed options for meeting the future solid waste and recovered materials processing capacity necessary to achieve Florida and the Authority's 75% waste diversion goal by 2045. In addition, the SCS Team was guided by the Authority's guiding principle to "control their solid waste management destiny."

Each scenario incorporates a combination of advanced processing technologies, supporting infrastructure such as transfer stations to optimize waste transportation, as well as policy recommendations that have demonstrated effectiveness in other municipalities. These policy measures aim to influence community disposal behaviors and maximize materials recovery, aligning with the Authority's long-term waste diversion objectives. For each scenario, the analysis includes estimates of the type and number of required waste processing facilities, associated waste volumes, implementation timelines, detailed cost projections, and anticipated waste diversion rates. Appendix B details the associated collection costs for each scenario.

Additionally, the SCS Team assessed the planning scenarios through an environmental justice framework to evaluate potential community impacts associated with each solid waste management technology. The U.S. Environmental Protection Agency's Waste Reduction Model (WARM) was utilized to estimate Greenhouse Gas (GHG) emissions reductions achievable through various waste management practices. Cultural and political considerations were also examined to evaluate the feasibility and likelihood of successful implementation for each strategy.

The assessment of processing technologies, policies, and scenarios concludes that Scenario C is the most likely to achieve the Authority's waste diversion goals. However, this analysis is the initial step in facilitating further collaboration amongst the Authority, the SCS Team, decision-makers, and the public. A thorough evaluation of the trade-offs associated with each scenario is essential to refine the Solid Waste Master Plan, which will ultimately chart the recommended path toward achieving the Authority's 75% waste diversion goal by 2045.

2.0 WASTE GENERATION MODEL

The SCS Team developed a Solid Waste Mass Balance model (SWMB or Model) as part of Task 2 of the Regional Solid Waste and Recycling Master Plan project. This model estimates the tonnage of solid waste and recyclable materials generated within the County using publicly available data and information provided by Authority members and municipalities. The Model tracks the flow of waste through the Authority's solid waste system and out-of-County disposal facilities, encompassing four (4) key phases: **Generation, Collection, Transfer/Routing, and Diversion/Disposal.**

The Model projects waste flow by type and quantity from a 2020 baseline through 2070 (Planning Horizon), incorporating factors such as population growth and other variables influencing the Authority's waste management planning. For each phase, the model calculates the total tonnage and material-specific breakdown of the waste stream for both Interlocal Agreement (ILA member) and non-member municipalities. Using population growth and publicly available generation rates, the Model balances the total tonnage across the four (4) phases to ensure all waste is accounted for. After verifying the mass balance, the model advances year by year, incorporating growth rates and other factors allowing prediction of when receiving facilities will reach capacity and require expansion, or when rerouting of waste to alternative sites will be required.

The SWMB serves as the foundation for the modeling that was used to develop the Task 4 White Paper and is the most reliable available dataset. Key characteristics of the Model include:

- **Population Estimates:** Calculations are based on population data for each municipality starting in 2020, derived from U.S. Census Bureau data and the 2023 Broward County and Municipal Population Forecast and Allocation Model (PFAM).

- **Tonnage Calculations:** County data from the FDEP reports on Municipal Solid Waste (MSW) tonnage collected in 2023 calibrates generation rates for single-family, multi-family, and commercial waste. Construction and Demolition (C&D) debris and bulk waste (BW) tonnage are calculated as the residual after accounting for other waste streams.

- **Waste Generation and Waste Composition Studies:** Waste generation and composition was estimated utilizing County-wide data provided in the FDEP reports titled *2020 MSW Collected and Recycled by Generator Type By Descending Population* and *2020 Total Tons of MSW Materials Collected and Recycled In Florida*. This data included total population (as reported by the US Census Bureau) and the total tons of single-family, multi-family, and commercial MSW collected. Waste composition was based on the results in the Broward County 2023 Waste Characterization Study Final Report

- **Data Validation:** Published FDEP reports were cross-referenced to validate the data.

- **Waste Transfer and Routing:** Transfer and routing processes are based on ILA-member provided data as well as a review of ILA member collection contracts.

Using the SWMB, the SCS Team developed and modeled scenarios (Scenario Model), which are presented in Section 4.0, to enhance waste diversion and disposal, with the goal of achieving a 75% or higher recycling rate. The Scenario Model also forecasts future waste management facility needs. Based on these findings, scenario recommendations for optimizing the Authority's materials management system were developed and are presented in Section 4 of this White Paper.

3.0 COMPARISON OF SINGLE-STREAM VS. DUAL-STREAM RECYCLING SYSTEMS

As part of this Task 4, the SCS Team conducted an evaluation of SSR and DSR systems, the two most widely implemented methods for collecting household and commercial recyclables. SSR has emerged as the predominant method across Florida and the United States, utilized by over 96% of municipalities based on the quantity of materials recycled and the population served. Nevertheless, Dual-Stream (DS) recycling systems remain in operation, including in Palm Beach County, an adjacent and demographically comparable county to the north of Broward County.

SS systems are generally preferred due to their cost-efficiency, GHG emission savings, potential for higher diversion rates, and improved safety for collection personnel. Automated collection vehicles, typically used in SS systems, enhance driver safety compared to the manual collection vehicles often associated with DS systems. Moreover, SSR is highly favored by residents due to its convenience and lower costs. Notably, fewer than 0.5% of programs in North America revert to DS collection after transitioning to SS systems.

On the other hand, DS systems, such as the one implemented in Palm Beach County, are often commended by local solid waste managers for producing higher-quality recyclables. These systems achieve significantly lower contamination rates in incoming materials compared to SS systems. Palm Beach County's DS program, which is directly managed by the Solid Waste Authority of Palm Beach County (SWA), includes recyclable commodity marketing as part of its operations. This program is frequently cited as a model for effective recycling by advocates of DS systems, highlighting the benefits of its lower contamination rates and well-managed processes.

The SCS Team conducted a comprehensive analysis, detailed in Appendix A, which incorporates the latest research on both systems in U.S. municipalities. The analysis focuses on several critical factors, including:

- Functionality of recycling and materials processing facilities,
- Impact on collection system truck usage,
- Effect on operational efficiency and costs, and
- Influence on diversion rates due to changes in participation.

3.1 COMPARISON TO PALM BEACH COUNTY

For a direct and meaningful comparison, the SCS Team evaluated Broward County's extensive SS programs against Palm Beach County's DS system. Table 1 provides a detailed comparison of the two systems based on Broward-specific data. [1]

[1] Other Dual-Stream programs of sufficient scale including Montgomery County, MD, Marin County, CA, and those in and around New York City (including Long Island) were also studied but were sufficiently different from Florida's DS operations (e.g., Palm Beach County)

Table 1. Broward County Single-Stream Recycling System Compared to SWA Dual-Stream Recycling System

Point of Comparison		Broward County SS	Palm Beach County DS
Qualitative	**Quantitative**		
Collection Cost Efficiency	Collection cost per ton (per unit per year) • Labor • Transportation/ Equipment	\$162/ton (\$71/ unit)[2] 0.4 tons/ unit per year • Higher collection efficiency • Lower collection \$/ton	\$406/ton (\$130/ unit)[3] 0.3 tons/ unit per year • Lower collection efficiency, • Higher collection \$/ton
Processing (Sorting) Cost Efficiency	RMPF[4] sorting cost per ton • Initial investment • Cleaning and maintenance costs • Disposal costs	\$106/ton[5] • Lower sorting efficiency and quality • Higher sorting \$/Ton	\$71/ton[6] • Higher sorting efficiency and quality • Lower sorting \$/Ton
Participation rate/ Diversion rate	• Households in program / total households • Collected for recycling/ Waste disposed	SS may be perceived and has historically had higher participation rates compared to DS, but studies are largely inconclusive on the impact of factors like socio demographics, outreach and education, frequency of collection and container types, which all impact performance. Historical comparisons between counties specifically based in Florida are not conclusive in these areas either (Byars, 2012).	
Contamination rate	Waste disposed by sorting facility/ waste received by sorting facility	According to a study of RMPFs in Florida, DS RMPFs reported lower, on average, contamination rates in terms of inbound tonnage landfilled (18%) compared to SS RMPFs (27%). However, it is worth noting rates reported by individual SS RMPFs varied (ranging from 14% to 57%) (Townsend and Anshassi, 2020).[7]	
Est. Overall collection + processing cost based on research	**Cost per ton**	**\$268/ton**	**\$477/ton**

[2] Based on data provided by the Authority.
[3] Based on FY 2020 Curbside recycling Collection (385.57) + Transfer rate (29.89) (Solid Waste Authority of Palm Beach County, 2022).
[4] The term "Material Recovery Facility" (MRF) is often used interchangeably with "Recovered Materials Processing Facility" (RMPF). For permitting purposes, FDEP categorizes these facilities as a RMPF.
[5] Based on data provided by the Authority.
[6] Based on Figure 10: RMPF Throughput, Revenue and Expenses (not inclusive of recycling programs administration) (Solid Waste Authority of Palm Beach County, 2022).
[7] City of Seattle also reports that 2020 recycling composition hand sorts show contamination rates of ~11% (Cascadia Consulting Group, 2022).

The analysis highlights key trade-offs between SS and DS recycling systems. SSR offers lower collection costs but is associated with higher processing expenses and reduced material quality. Conversely, DSR entails higher collection costs but benefits from lower processing expenses and improved material quality.

Historical data since the inception of SSR demonstrates that total recovery of recyclables tends to increase due to higher participation rates and reduced effort for residents, such as simplified storage and the elimination of household sorting.

Despite these trade-offs, a cost analysis of combined collection and processing reveals that the current SSR program is more cost-effective based on the available data.

3.2 RECOMMENDATION ON CURBSIDE RECYCLING COLLECTION

The SCS Team recommends that the Authority retain its current SSR program due to the significant direct cost savings compared to a DSR system and other related net savings.

Contamination and material yield metrics for SSR can be significantly improved at a lower cost than transitioning to a DSR system by investing in the following initiatives:

1. **Uniformity Across Programs:** Establishing consistency in program design and operations.
2. **Targeted Educational Messaging:** Utilizing Community-Based Social Marketing (CBSM) techniques to effectively reach and influence diverse populations.
3. **Enhanced Enforcement:** Strengthening policies to reduce contamination and ensure compliance.

Some of the cost savings from maintaining a SSR system should be reinvested in critical areas, such as improved education programs and technological upgrades at RMPFs. These investments would enhance material quality, addressing the primary advantage typically associated with DSR systems.

The variability in contamination rates across SS RMPFs in Florida, and nationally, indicates that the Authority can maintain its SS recycling system while improving recovery quality and capture rates to levels comparable to DS systems. Case studies provide valuable insights:

- **DSR Systems:** Examples from Palm Beach County, FL, and Montgomery County, MD, demonstrate the ability of DS recycling systems to achieve higher material quality. However, these systems also incur additional education, administration, and enforcement costs.

- **Low-Contamination SSR Systems:** Outagamie County, WI, exemplifies a successful SSR program, consistently achieving contamination rates below 10% for over two (2) decades. This success is attributed to a robust and well-funded education program. Outagamie's RMPF, operational since 2009, further illustrates the capability of modern RMPF technologies to enhance material recovery.

WM's planned RMPF upgrades, scheduled for completion by 2025, provide a critical opportunity to implement technological and programmatic improvements. These advancements can help stabilize contamination rates and maximize the value of recovered materials. For instance, Seattle's residential SSR program demonstrated a low contamination rate of 11% in 2020 according to its

2020 recycling composition study, showcasing the effectiveness of combining modern infrastructure with targeted educational efforts (Cascadia Consulting Group 2022).

The recommendation to retain the SSR program also informs Section 4, which evaluates five scenarios for improving waste diversion. Cost savings associated with maintaining the SSR system and the transition costs of shifting to a DSR program are not detailed in this analysis. Transition costs would include sunk investments such as Broward's nearly two decades of SS education programs, haulers' investments in SS-compatible vehicles and carts, and costs avoided, such as purchasing additional vehicles or carts for a DSR system. Additionally, retaining the SSR program simplifies the logistics of potential new services proposed in some scenarios, such as curbside yard and food waste collection, by avoiding the complexity of managing multiple carts per household. The SCS team acknowledges however that technologies and markets may change. As such, it is recommended that the Authority revisits SSR vs DSR in the halfway point of the planning horizon (i.e., 10-15 years out).

4.0 FIVE SCENARIOS FOR PROCESSING CAPACITY AND NEEDS

To meet the Authority's solid waste management and processing capacity requirements over the next 20 years, the SCS Team developed five solid waste processing and management scenarios. These scenarios were informed by a comprehensive review of waste processing models implemented across North America and other developed nations, as detailed in Task 9.

4.1 MOST LIKELY OUTCOMES AND INSIGHTS FOR THE FIRST 20 YEARS

The scenarios were developed based on an analysis of comparable municipal solid waste systems, the Authority's geographic constraints, limited land availability, permitting processes at the local and state levels, and the anticipated regulatory framework for stricter segregation of waste streams at the source across residential, commercial, and industrial sectors.

These factors significantly limit the potential for solid waste diversion during the first 20 years of the planning horizon. Additionally, the integration of open market collection systems within the Authority presents challenges to full participation. The facilities required to process this waste are constrained, necessitating a practical and phased approach to planning. This involves focusing on immediate, achievable solutions for the initial 20-year period while projecting growth-related facility needs for subsequent decades.

4.2 KEY INSIGHTS FROM TASK 9

The analysis in Task 9 (Identify Innovative and Future Technologies) provided four (4) key insights into advanced waste processing technologies that have been incorporated into each scenario:

1. Challenges of Advanced Waste Refining Technologies

   Task 9 evaluated high-cost, high-risk, and largely unproven methods for refining mixed waste into outputs such as sugars, alcohols, and carbon products (e.g., pyrolysis, gasification, and Fischer-Tropsch hydrolysis). These technologies have faced issues including low recovery rates, operational inefficiencies, capital cost overruns, product inconsistencies, and frequent failures in North America. Similarly, efforts to develop residual fuels from organic solids, wood chips, or plastics have struggled to achieve sustainable operation in WTE systems. While advancements have been made, these methods remain less competitive compared to established approaches for solid waste diversion.

2. Optimizing the Organic Fraction of Waste Streams

   Proven methods such as composting, in-vessel aerobic systems, and Anaerobic Digestion (AD) offer the greatest potential for increasing diversion rates. These technologies are cost-effective, low-risk, and foundational to high-performance waste management strategies tailored to the Authority.

3. Advances in Sorting Technology

   Emerging sorting technologies significantly enhance the recovery of recyclables in Mixed Waste Processing (MWP) facilities. These include advanced automation systems, self-regulating motor controls, and material preparation techniques such as shredding and resizing. New features like recyclable material recirculation, air/density separation, and advanced optical sorting (e.g., near-infrared, artificial intelligence (AI)-assisted, x-ray) improve recovery rates, particularly when paired with organic extraction processes.

4. **Planning Framework for Waste Management**

   Each scenario incorporates a planning framework that evaluates facilities needed to manage projected waste volumes and compositions. This framework is based on:

   a. Proven advanced technologies for high diversion rates.

   b. Best practices for waste reduction and reuse.

   c. Practical strategies tailored to the Authority's unique geographic and demographic profile, including its coastal location and interconnectivity with neighboring counties.

   d. Sustainable processing methods prioritizing operational efficiency and environmental stewardship.

4.3 ENVIRONMENTAL IMPACT, PUBLIC HEALTH IMPACT, AND ENVIRONMENTAL JUSTICE

When planning for future recycling and waste related processing and disposal facilities, there are potential environmental impacts to consider. Different types of facilities and technologies pose various levels of risk to public health and the environment, including potential impacts to air, surface water, groundwater, and soil quality. It is important to acknowledge that although waste processing facilities may have some environmental impacts where they are sited (e.g. increased truck traffic and associated emissions, etc.), these facilities can provide net positive overall environmental benefits to a community when looking across an entire waste management system. It is also important to note that most environmental impacts are thoroughly reviewed during the permitting process with each facility being required to adhere to all pertinent local, state, and federal regulations to obtain operating permits. The permitting process evaluates various environmental impacts while providing for a review framework that is data driven based on what is deemed to be an acceptable level of risk as established by local, state, and federal regulations.

Although a detailed analysis of all public health and environmental impacts for each waste diversion scenario is beyond the scope of this Task 4 White Paper - given that such impacts are often site-specific and facility-dependent - the SCS Team did evaluate the potential environmental justice implications of each scenario. This analysis emphasized equitable outcomes for all communities, particularly those historically affected by environmental challenges, in alignment with the Authority's equity and inclusivity goals. The SCS Team also utilized available industry tools to quantify GHG emissions as part of the environmental impact review.

To estimate environmental impacts, the EPA's WARM model was used to assess GHG emissions across various scenarios. The management of SSR, food waste and yard waste across the different scenarios were entered into the WARM. The impact of special recycling, reuse and diversion programs was not modeled as it does not vary across the different planning scenarios, although these programs are expected to deliver an additional benefit of between 20-30% GHG emissions reductions. The input assumptions to the WARM were adjusted to reflect the conditions of the Authority. Details of the assumptions, inputs and output summary of the WARM model are provided in **Appendix D.**

4.4 INTEGRATION OF WASTE REDUCTION AND DIVERSION STRATEGIES

Each scenario incorporates actionable strategies to promote waste reduction, reuse, and recycling. Recommendations include:

- Policy initiatives to encourage waste diversion.
- Educational programs and outreach efforts to enhance public participation.
- Operational improvements to support increased diversion rates.

Detailed recommendations for implementing these strategies are presented in Section 7 of this White Paper.

The five scenarios that follow provide a comprehensive framework for shaping the Authority's sustainable waste management strategy over the next 40 years. This plan balances practicality, innovation, and inclusivity, to prepare the Authority to meet its long-term solid waste management challenges.

4.4.1 Scenario Overview and Key Assumptions

Following a comprehensive analysis of Broward County's current waste composition, generation patterns, and existing infrastructure, the SCS Team developed five scenarios to evaluate strategies for improving waste diversion across residential and commercial sectors. Each scenario presents a unique approach to collection methods and identifies the types of facilities required to achieve its goals, however all five scenarios also share a few key assumptions listed below.

- The SSR system will be continued and expanded to those households not currently receiving curbside collection.
- The existing WTE capacity at the South Broward Resource Recovery Facility (RRF) will continue to be utilized.
- A new Authority owned landfill is included in each scenario to ensure adequate disposal capacity for residue, ash, and other system byproducts.
- All scenarios include the development of eight (8) recycling drop-off centers to increase recycling access to those that do not receive curbside recycling collection and to host Household Hazardous Waste (HHW) and electronic waste collections.
- All scenarios envision a robust and sustained education and outreach campaign to promote waste reduction, recycling correctly, and proper management of other waste streams (i.e. yard waste, HHW, electronic waste, etc.).
- All scenarios incorporate new policy initiatives, new technologies, and operational improvements to capture and recover materials as identified in Section 7 of this report.

- All scenarios include the building of three (3) transfer stations, in addition to the existing private transfer stations in the market, to be strategically located in the north, central, and southern portions of the County to support efficient material flow in the system.

All scenarios are anchored by the recommendation to retain a SSR system, as detailed in Section 3 and **Appendix A**, rather than transitioning to a DS model. The associated costs for collection and facility development under each scenario are outlined in Sections 4 and 5, respectively.

Critical “soft costs,” including enhanced regulations, public communication, education, and stakeholder collaboration, are assumed as foundational elements in every scenario. These components, identified throughout the Plan as vital for the effective operation of the Authority, are integral to ensuring the success of the selected scenario(s). **Table 2** summarizes the proposed programs, facility requirements, and targeted diversion increases for each scenario.

The scenarios balance practicality with optimism, reflecting the feasible development of facilities within the County while maintaining optimal capacity at the lowest cost. Each scenario also considers the potential tonnage of waste that could realistically be processed, accounting for land use requirements and the availability of suitable sites for MSW processing.

Additionally, the scenarios are designed to elevate the Authority’s non-WTE diversion capabilities to state-of-the-art levels without becoming cost-prohibitive in the long term. Transitioning to once-a-week MSW collection can offer significant cost savings and reduced environmental impacts associated with collection vehicle emissions and other quality of life impacts and is assumed in all scenarios except for Scenario D. Although there may be some cultural resistance to transitioning to once-a-week MSW collection, it can be phased in over time. As residents begin to become more familiar with waste reduction practices, local reuse opportunities, and increase their participation in recycling programs and proper disposal of HHW and electronic waste at drop-off centers, the volume of MSW placed in garbage carts is expected to decrease over time.

As the Authority’s capacity grows and its waste management needs evolve, incremental adjustments to the number and size of facilities are anticipated to be feasible, ensuring flexibility and scalability in the implementation of the waste management strategy.

Table 2. Proposed Program Components by Scenario for Countywide with Likely Successful Outcomes Next 20 Years

Scenario	Programs	Additional Facility Needs and Capacity of Each Facility- Tons Per Year (TPY)	Target Diversion Rate Increase
A	• Reduce MSW 1x/week • Restore Recycling Services to 20% of Broward County • Add Curbside Yard Waste (YW) Collection • Add Food Waste (FW) Drop-Off Events • Add Permanent Household Hazardous Waste (HHW)/Electronics/Recycling Drop-Off Sites • Add reduction, reuse, and diversion programs and policies as outlined in Section 7 of this White Paper.	• Two (2) Single- Stream Material Recovery Facilities (250,000 TPY each) • Two (2) New Organics Processing Sites with: Two (2) Mulch/ Colorizing Operations (175,000 TPY each) and One (1) New Biochar Pyrolysis operation (30,000k TPY) • Two (2) C&D Recovery Facilities (450,000 TPY each) • Eight (8) Permanent Drop-Off Centers (2,400 TPY each) • Three (3) Transfer Stations (North, South, Central Broward County) • One (1) Landfill	+25 percentage points to 62%
B	• Reduce MSW 1x/week • Restore Recycling Services to 20% of Broward County • Add Curbside Yard Waste (YW) Collection • Add Opt-In Curbside Food Waste (FW) Composting Collection • Add Permanent HHW/Electronics/Recycling Drop-Off Sites • Add reduction, reuse, and diversion programs and policies as outlined in Section 7 of this White Paper. • Add new WTE capacity	• Two (2) Single Stream Material Recovery Facilities (250,000 TPY each) • Two (2) New Organics Processing Sites with: Two (2) (Mulch/ Colorizing) operations – (175,000 TPY), one (1) Covered Aerated Static Pile (CASP) composting operation (36,000 TPY FW + 37,000 TPY YW) And One (1) New Biochar Pyrolysis operation (30,000 TPY) • Two (2) C&D Recovery Facilities (450,000 TPY each) • Eight (8) Permanent Drop-Off Centers (2,000 TPY each) • Three (3) Transfer Stations (North, South, Central Broward County) • One (1) New WTE Facility (1M TPY) with Advanced Metals Recovery (AMR) • One (1) Landfill	+42 percentage points to 79%

Scenario	Programs	Additional Facility Needs and Capacity of Each Facility- Tons Per Year (TPY)	Target Diversion Rate Increase
C	• Reduce MSW 1x/week • Restore Recycling Services to 20% of Broward County • Add Curbside Co-Collection of Yard Waste (YW) and Food Waste (FW) for Composting • Add Permanent HHW/Electronics/Recycling Drop-Off Sites • Add reduction, reuse, and diversion programs and policies as outlined in Section 7 of this White Paper. • Add new WTE capacity	• Two (2) Single Stream Material Recovery Facilities (250,000 TPY each) • Two (2) New Organics Processing Sites with: Ten (10) CASP composting operations (36,000 TPY FW + 37,000 TPY YW) each and One (1) Biochar Pyrolysis operation (30,000 TPY) • Two (2) C&D Recovery Facilities (450,000 TPY each) • Eight (8) Permanent Drop-Off Centers (12,000 TPY each) • Three (3) Transfer Stations (North, South, Central Broward County) • One (1) New WTE Facility (1M TPY) with AMR • One (1) Landfill	+46 percentage points to 83%
D	• Convert MSW (2x/week) to Wet MSW (2x/week) • Convert Recycling to Dry MSW (1x/week) • Add Curbside Yard Waste (YW) Collection • Add Permanent HHW/Electronics/Recycling Drop-Off Sites • Add reduction, reuse, and relevant diversion programs and policies as outlined in Section 7 of this White Paper.	• Six (6) Dry Material Recovery Facilities (160,000 TPY each) • Three (3) New AD Organics Facilities for Wet Waste (160,000 TPY each) • Two (2) New Organics Processing Sites with: Two (2) (Mulch/ /Colorizing) operations (175,000 TPY each) and One (1) Biochar Pyrolysis operation (30,000 TPY) • Two (2) C&D Recovery Facilities (450,000 TPY each) • Three (3) Transfer Stations (North, South, Central Broward County) • Eight (8) Permanent Drop-Off Centers (2,000 TPY each) • One (1) Landfill	+14 percentage points to 51%

Scenario	Programs	Additional Facility Needs and Capacity of Each Facility- Tons Per Year (TPY)	Target Diversion Rate Increase
E	• Reduce MSW to 1x/week • Restore Recycling Services to 20% of Broward County • Add Curbside Co-Collection of Yard Waste (YW) and Food Waste (FW) for Composting • Add Permanent HHW/Electronics/Recycling Drop-Off Sites • Add reduction, reuse, and diversion programs and policies as outlined in Section 7 of this White Paper.	• Two (2) Single Stream Material Recovery Facilities (250,000 TPY each. • Two (2) New Organics Processing Sites with: Ten (10) CASP operations (36,000 TPY FW + 37,000 TPY YW) and One (1) Biochar Pyrolysis Facility (30,000 TPY) • Three (3) MWP Facilities (330,000 TPY each) • Single Stream Extraction • Fiber Extraction • AD • Two (2) C&D Recovery Facilities (450,000 TPY each) • Eight (8) Permanent Drop-Off Centers (2,000 TPY each) • Three (3) Transfer Stations (North, South, Central Broward County) • One (1) Landfill	+36 percentage points to 73%

4.4.2 Scenario Screening Summary

Scenario screening criteria were developed to guide the relative trade-offs for the Authority, which are presented in **Table 3**. In addition to the facility risk matrix analysis for each facility type discussed in Section 9 of this White Paper, the scenarios were assessed using the following factors:

- **Cost:** Financial feasibility, including initial investments, ongoing maintenance expenses, and funding sources.
- **Diversion:** Amount of MSW diverted from landfills and WTE.
- **Cultural Barriers:** Societal acceptance and adaptability to changes introduced by the strategy.
- **Political Barriers:** Legislative and regulatory challenges, stakeholder support, and policy alignment.
- **Geographic Constraints:** Physical and environmental limitations that may impact implementation and sustainability.
- **Environmental Justice:** Ensuring equitable distribution of benefits and burdens across all communities, particularly marginalized or disadvantaged groups, while avoiding disproportionate negative impacts. Low means minimal negative impact on disadvantaged groups.

- **Likelihood of Success:** Assessing the probability of achieving desired outcomes based on resource availability, stakeholder cooperation, and potential risks or obstacles.

Table 3. Scenario Screening Criterion with Ratings

SCENARIO	COST	DIVERSION	CULTURAL	POLITICAL OR GEOGRAPHIC BARRIERS	ENVIRONMENTAL JUSTICE	LIKELIHOOD OF SUCCESS
A	Low	Medium	Low	Low	Medium	High
B	High	High	Medium	High	High	Medium
C	High	High	Medium	High	High	Medium
D	Medium	Medium	High	Medium	High	Low
E	High	High	Medium	High	High	Low

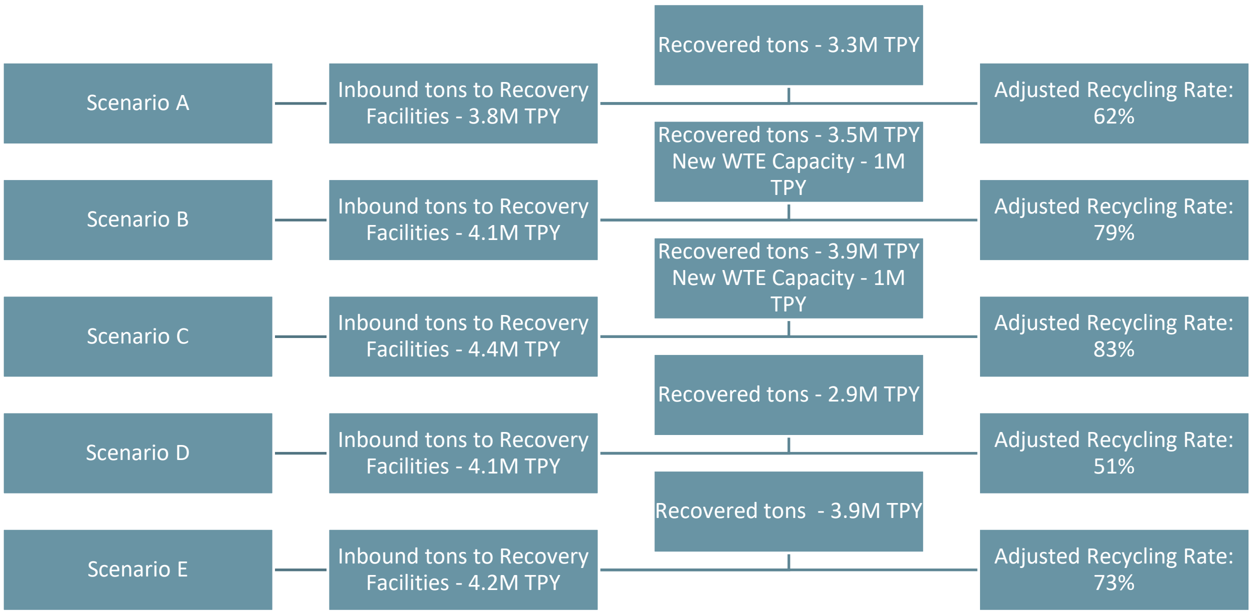
To inform the assessment of future solid waste system needs, an analysis was conducted of Broward County's projected population growth and associated waste generation rates. This analysis is based on population and solid waste material generation estimates, with **Table 4** presenting an overview of the next 20-year period.

Table 4. Broward County Population and Waste Generation Over 20 Years

Year	2025	2030	2035	2040	2045
Broward County Population Projection	2,020,000	2,090,000	2,140,000	2,190,000	2,230,000
Waste Tonnage Projection	5,320,000	5,690,000	6,000,000	6,260,000	6,500,000

For illustrative purposes, **Figure 1** provides a schematic of the best-case material flow in 2045 per scenario.

Figure 1. Estimated Material Flow Per Scenario



4.4.2.1 Scenario A – Maximizing Efficiency with Three Services/Week, Restoring Single-Stream Recycling and Adding Curbside Yard Waste Composting and Food Waste Drop-Off Centers

Scenario A is an option for the Authority to maximize efficiency of the current system and improve the overall diversion. In this scenario, residents will receive once a week curbside MSW pick-up and recycling collection, as well as once-a-week dedicated collection of yard waste.

Scenario A - Collections:

1. **MSW (1x/week):** Residential MSW collection would be reduced to once-a-week containerized collections to offset costs for the addition of a new yard waste collection service. Transitioning to once-a-week MSW collection can be phased in over time. As residents begin to become more familiar with waste reduction practices, local reuse opportunities, and increase their participation in recycling programs and proper disposal of HHW and electronic waste at drop-off centers, the volume of MSW placed in garbage carts will decrease over time.

2. **Recycling (1x/week):** Presently, 20% of residents do not have access to residential recycling, where five (5) municipalities (Coconut Creek, Deerfield Beach, Margate, Davie, and Pembroke Pines) have suspended or terminated their recycling programs, and recyclables are currently collected with their MSW and sent to the WTE (Coconut Creek Florida - Public Works, n.d.; Deerfield Beach Florida, n.d.; Margate Florida, n.d.; Pembroke Pines Florida, n.d.; Town of Davie, Florida, n.d.). In this first scenario, curbside residential recycling is restored for the 20% of the community that currently do not have service (representing approximately 70,000 single-family households). Some ILA member communities are recycling their SS recyclable materials and hauling directly to WM's

Reuter Recycling of Florida Facility (Reuter Facility) or long hauled from transfer stations before heading to this RMPF. Collection costs for the scenarios are detailed in Section 5 of this White Paper, however prices will vary between Automated-Side-Loader (ASL) collections and Rear End Loader (REL) collections.

3. **Yard Waste (1x/week):** Currently, Broward County does not directly or conventionally recycle residential yard or food waste within its jurisdiction. However, some yard waste delivered to transfer stations is diverted for use at third-party landfills as daily cover. According to the 2023 FDEP report, approximately 33% of the ~500,000 TPY of yard waste generated in the County is utilized as landfill cover (Florida DEP, 2024a). Broward County receives a 1:1 state recycling credit for the use of Alternative Daily Cover (ADC) under State Administrative Code 62-716.480 (Florida Department of State, 2012).

   Under **Scenario A**, the Authority introduces curbside yard waste collection services, with materials directed to two dedicated Organics Processing Facilities for mulch, biochar, and colorized product processing. These facilities are envisioned as scalable operations that can later incorporate food waste processing capabilities.

   To maximize the value of recovered organics in the form of compost, a comprehensive plan for marketing these materials as soil amendments is essential. As a next step, the Authority should engage qualified experts to conduct a market study and options analysis, focusing on the marketing and sale of compost-derived soil products. This strategic approach will ensure that recovered organics are effectively utilized, contributing to both economic and environmental sustainability.

4. **Food Waste (opt-in):** In the first scenario option, the Authority may add a cost-effective option for introducing food waste composting more widely to the community.

Scenario A - Option A: Establish Food Waste Drop-Off Special Events

To enhance food waste diversion, some communities across the country are establishing food waste drop-off events or centers where residents bring food waste on a weekly basis. In the case of the City of Alexandria, VA, the locality contracts with a third party to operate food waste collection at each of the farmers markets in the City (City of Alexandria Virginia, 2024). The contractor is responsible for the setup and breakdown of events each weekend and is staffed with up to two (2) attendants per site based on market size and traffic to educate residents about composting. Acceptable food waste is deposited weekly at no cost and compost caddies are given away to boost participation at program launch events or Earth Month events. **Figure 2** presents an image of a food waste drop-off center in Alexandria, VA.

Figure 2. City of Alexandria, VA Food Waste Drop-Off Centers

(Photo Courtesy: City of Alexandria)

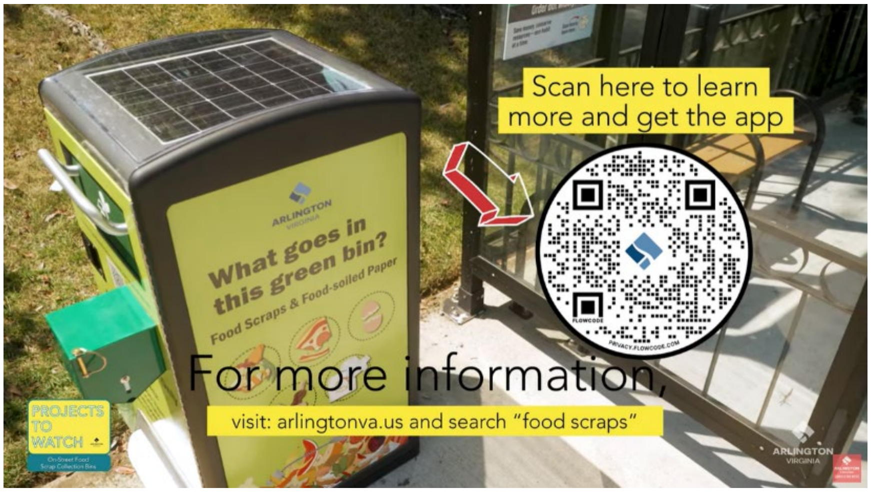
In a similar manner, the Authority may partner with existing farmers markets, recreation centers, libraries, or other areas of high traffic to establish food waste drop-off sites for composting. The small amount of food waste collected can be processed in community composting programs or can be co-composted at the mulch/biochar/colorization facilities.

Scenario A - Option B: Permanent Food Waste Drop-Off Sites

Establishing 24/7 permanent food waste drop-off sites is another potential option. However, since these sites are typically unstaffed, they offer limited opportunities for engagement and quality control, potentially resulting in higher contamination rates within the waste stream.

Falls Church, VA, provides a useful case study, having implemented both food waste drop-off events and permanent sites. Their findings indicate that the convenience of permanent drop-off locations increased participation by up to 40% compared to weekly drop-offs at farmers' markets (Johnston, 2017). This demonstrates the potential for permanent sites to significantly enhance community engagement and food waste diversion efforts. Figure 3 presents an informational resource for the food scraps collection program in Arlington County, VA.

Figure 3. Arlington County, VA "Food Scraps Collection"



Scenario A - Option C: On-Street Food Scraps Collection

A more contemporary approach involves local governments implementing on-street food scrap collection bins. For example, Arlington County, VA, launched a pilot program to collect food scraps and food-soiled paper using bins located outside multi-family properties. Participants are required to download an app that provides information on bin locations, availability, and accepted items. When the user's smartphone is within range of an available bin, the app unlocks the container, allowing for the disposal of food scraps.

Detailed program information, including an instructional video, is available on the County's website (Arlington County Virginia, n.d.).

For a summary of the collection cost analysis associated with each scenario, refer to **Appendix B**.

Scenario A - Processing:

1. **Municipal Solid Waste**

   Currently, MSW is hauled either directly to the only WTE facility currently operated in Broward County, the South Broward Resource Recovery Facility (RRF) or to transfer stations throughout the County, including Waste Management (WM) Davie, WM Deerfield and Waste Connections Pembroke Park. MSW is then sent to landfills including Broward County Landfill, J.E.D Landfill, Medley Landfill, Okeechobee Landfill, Desoto Recycling & Disposal, and the Monarch Hill Landfill. It should be noted that the South Broward RRF is owned and operated by WIN Waste, a private entity. Ash from the South Broward RRF is then disposed at the South Broward Ash Monofill.

   Scenario A recommends the construction of three transfer stations, to supplement the existing private transfer stations in the market, in order to support the efficient flow of material to disposal facilities. Scenario A assumes that the existing permitted disposal capacity at the South Broward RRF will continue to be used. It should be noted that WIN Waste Solutions, Inc. (WIN Waste) is currently contemplating the sale of the South

Broward RRF, and as such, future contract terms and conditions with a new owner/operator may be required for continued use of this disposal capacity. In addition, Scenario A contemplates the development of a new landfill while recognizing that existing landfill capacity may continue to be utilized in the future. However, consistent with the Authority's direction to "control their solid waste management destiny", the SCS Team has assumed that a new landfill, controlled by the Authority will be required.

2. **Single-Stream Recycling**

   Currently, the Authority processes its SSR at WM's Reuter Facility, with processing fees ranging from $90 to $200 per ton depending on community contracts. WM is constructing a new, state-of-the-art 127,000-square-foot RMPF adjacent to the Reuter Facility. This $80+ million RMPF will have a processing capacity of 66 Tons Per Hour (TPH), equivalent to 260,000 TPY, and is referred to as the WM Recycling South Florida (WM South Florida Facility). While the region's current SS processing capacity is theoretically sufficient for 2023 tons, Scenario A recommends the development of two additional SS RMPF's for managing additional inbound tons in 2045. This recommendation is based on the assumption that the Authority implements policies, educational programs, enforcement, and new technologies that are discussed in Section 7 of this White Paper in order to maximize the capture of recyclables for recovery. Please see 6.1.1 for a greater discussion on the SS RMPF, options, costs, and timeline.

3. **Organics Processing**

   Scenario A includes two Organics Processing Facilities with the ability to scale operations to meet additional processing capacity needs. Under this scenario, the facilities will process yard waste via two Mulch/Colorization operations and one Biochar Pyrolysis operation.

   The mulching process will involve grinding yard waste, removing contaminants, and stockpiling materials in windrows for further decomposition and processing. To address challenges in the regional market for mulch and soil amendments, incorporating a colorization process is recommended to enhance product marketability and increase revenue potential.

   Additionally, the pyrolysis of yard waste—particularly fibrous materials such as palm fronds and trimmings, which are slower to decompose—can provide operational flexibility for organics processing. This approach also creates market opportunities for biochar, a valuable end product with various applications in agriculture, landscaping, and environmental remediation.

4. **Construction & Demolition RMPF**

   Current C&D processing facilities appear to have sufficient capacity to handle the existing tonnage under existing market conditions. However, it should be noted that the WM Monarch Hill landfill is used to dispose of C&D components that are not segregated for recycling and sale to the secondary market. Further, as tonnage increases and new policies or market developments enhance materials recovery and marketability, additional facilities will be required to meet the growing demand.

To address these future needs, assuming that adequate secondary markets exist, it is recommended to establish up to two strategically located C&D RMPF facilities to expand the region's C&D processing capacity. Each facility should be designed to process up to 450,000 TPY (equivalent to 100 TPH) to accommodate the estimated 850,000 TPY of C&D materials requiring processing. These facilities may be publicly or privately owned and operated, depending on regional needs and stakeholder preferences.

5. **Drop-Off Center for Hard-to-Recycle Materials**

   – **Permanent Drop-Off Centers.** To strengthen recovery efforts, all five scenarios include the development of eight recycling drop-off centers. These permanent facilities will consist of two distinct areas:

     1. One gated and staffed area, operating up to two days per week, dedicated to the collection of HHW and electronics.
     2. A second, publicly accessible area, open 24/7, for the drop-off of SS recyclables and textiles.

     Further details on the design and operation of the drop-off centers can be found in Section 6.1.5, Drop-Off Centers.

6. **Waste -to Energy**

   Scenario A assumes that the existing permitted disposal capacity at the South Broward RRF will continue to be used. Note that WIN Waste is currently contemplating the sale of the South Broward RRF, and as such, future contract terms and conditions with a new owner/operator may be required for continued use of this disposal capacity.

Scenario A - Outcomes

Scenario A aims to strengthen the Authority's status quo by updating the recycling and organics recovery program through establishing additional infrastructure (organics) and negotiating access to existing capacity at the SSR Reuter Facility. **Table 4** summarizes expected recovery rates and **Table 5** presents the diversion facilities and capacity required, capital cost, operating cost, and summary of processing fees under Scenario A.

Table 4. Scenario A Recovery Tonnages Summary – Estimated Outcome in 2045

Scenario A	Estimated Outcome in 2045
Incoming Tons to New Recovery Facilities	3,800,000
Recovered Tons	3,300,000
Residue Tons	500,000
Traditional Recycling %	54%
Adjusted Recycling % with WTE and Landfill Credits	62%
GHG Benefit (MTCO2e)	1,500,000

Table 5. Scenario A New Diversion Facilities and Capacity Required, Capital Cost, Operating Cost, and Summary of Processing Fees (est. 2025 dollars)

Description	Qty	Capacity (TPY/Facility)	CapEx[8]/ Facility	Annual OpEx[9]/ Facility	Processing Fee ($/Ton)	Aggregated ($/Ton /Facility)
SS RMPF	2	250,000	$72M	$14M	$89	$35
Yard Waste Mulch Facility	2	175,000	$5M	$1.8M	$14	($32)
Pyrolysis	1	30,000	$10M	$700k	$57	$13
C&D RMPFs	2	450,000	$41M	$19M	$50	$60
Public Drop-Off Centers	8	12,000	$140k	$1M	$86	$86
Transfer Stations	3	890,000	$47M	$31M	$87	$27
Landfill	1	3M	$880M	$229M	$91	$41

4.4.2.2 Scenario B – Adding Curbside Food Waste Composting Collections and a New Waste-to-Energy Facility

Scenario B expands upon the food waste collection options presented in Scenario A. To enhance convenience and accessibility, curbside food waste collection services will be implemented weekly.

Given that 12% of Broward County's MSW stream is composed of food waste, a strategic adjustment to waste collection schedules is necessary. To optimize costs associated with adding a fourth collection stream, MSW collection frequency for all Authority residents will be reduced to once-a-week curbside pickup. Additionally, recycling services will be restored to the 20% of residents who currently lack access and separate once-a-week curbside collections will be established for food waste and yard waste.

Scenario B also includes the development of a new 1,000,000 TPY WTE facility. Assuming the new WTE facility will be equipped with AMR, approximately 46,200 TPY of metals will be recovered and it will produce approximately 675,000 megawatt hours (MWh) of energy annually. Note that the new WTE facility will supplement the existing 750,000 TPY South Broward RRF. In addition, Scenario B contemplates the development of a new landfill recognizing that existing landfill capacity may continue to be utilized in the future. However, consistent with the Authority's direction to "control their solid waste management destiny," the SCS Team has assumed that a new landfill, controlled by the Authority, will be required.

[8] Capital Expenditures (Cap/Ex)
[9] Operational Expenditures (Op/Ex)

Scenario B - Collections:

1. **MSW (1x/week):** As discussed in Scenario A, Scenario B also includes reduction of residential MSW collection to once-a-week containerized collections to offset costs.

2. **Recycling (1x/week):** As discussed in Scenario A, Scenario B also includes restoring curbside recycling access once a week to the 20% of residents currently lacking access.

3. **Yard Waste (1x/week):** Similar to Scenario A, Scenario B also adds yard waste curbside collection once-a-week to all residents. It is estimated that while the program is currently accessible to all residents, approximately 80% are anticipated to participate in the program.

4. **Food Waste Only (1x/week):** Scenario B adds a once-a-week dedicated curbside food waste collection. Diverting food waste from landfill to composting provides significant GHG emissions reductions and converts a waste product into a beneficial soil product.

    a. **Curbside Composting Implementation Paths** - Municipalities have several options for initiating curbside food waste collection programs, depending on their budget, population size, and local regulations. Three common implementation paths include:

        i. **Pilot Programs:** Many municipalities start with small-scale pilot programs in selected neighborhoods to test the effectiveness of food waste collection and public messaging designed to encourage participation. This phased approach helps identify potential challenges, including public participation, contamination levels, and collection logistics. Insights gained from pilot projects can inform larger-scale rollouts.

        ii. **Full-Scale Rollouts:** Some programs opt for immediate systemwide implementation. While this can provide faster results, it requires significant upfront investment in infrastructure, public education, and operational adjustments.

        iii. **Optional vs. Mandatory Participation:** In some cases, food waste collection is an optional service, while in others, participation is mandated. Optional programs allow residents to opt-in, while mandatory programs require all households to participate, which can lead to higher diversion rates but may require more aggressive marketing, education, and enforcement.

    b. **Collection Container Variety** - The choice of collection containers is crucial in curbside composting, as it affects both the efficiency of the program and public participation.

        i. **Kitchen Caddies:** In numerous municipalities, small countertop containers are distributed to residents ahead of the rollout of curbside food scrap collection programs. These containers help residents conveniently collect food scraps indoors before transferring them to larger outdoor bins. Typically, these caddies are equipped with biodegradable liners to minimize odors and prevent spillage, enhancing ease of use and encouraging greater participation in the program.

ii. **Curbside Bins:** Outdoor collection containers are available in different sizes, from 5-gallon buckets to 65-gallon bins, depending on pickup frequency and household size. Some municipalities use containers like those used for recycling or garbage, while larger municipalities may implement specialized, sealed bins to reduce odors and deter pests. Alexandria, Virginia's curbside food waste composting program uses green, 7-gallon containers with snap-on lids, along with compostable bags. These containers are manually collected at the curb. Some localities that have adopted smaller container programs, such as the 7-gallon bins in Alexandria, as opposed to standardized larger containers (35 or 65-gallon), have observed reduced contamination and improved quality of the organics stream.

iii. **Compostable Bags:** In some municipal curbside composting programs, residents are encouraged or required to use compostable bags inside their curbside bins. These bags make it easier for collectors to transfer waste and reduce the chances of spillage and contamination of non-compostable materials. This may be a suitable option for the Authority, particularly to manage odors, pests, and spillage.

c. **Vehicle Differences -** The choice of collection vehicles impacts the efficiency and cost-effectiveness of food waste collection. The following vehicle types are commonly used:

i. **Dedicated Organic Waste Trucks:** These trucks are specifically designed for organic waste collection and often include features like airtight compartments to prevent leaks and odors. Some options include a stainless-steel hopper due to the corrosive nature of food waste and its associated liquids. These trucks are ideal for municipalities with large-scale composting programs but represent a higher initial investment.

ii. **Retrofitted Garbage Trucks:** Retrofitting existing garbage trucks to accommodate food waste can be a cost-effective solution. These trucks may not have specialized features like dedicated organic collection vehicles, but they can serve as a temporary or permanent solution for smaller programs.

iii. **Vehicle types:** There are three primary options for collecting food waste at the curb: standard pickup trucks with a hopper, Rear-End Loader (REL) trucks, and Automated Side Loader (ASL) trucks. The first two options require manual collection of bags or carts, which are then loaded into the truck's hopper. In contrast, the ASL option uses a mechanical arm to collect the material and deposit it into the hopper, though it also necessitates the use of roll carts as the collection container.

iv. One advantage of using a standard pickup truck is that the driver is not required to hold a Commercial Driver's License (CDL), whereas both REL and ASL trucks do have this requirement. REL trucks typically require one CDL-certified driver and up to two helpers to manually collect carts and/or operate cart lifters to load materials into the truck. The selection of collection vehicles will depend on factors such as program participation levels and the frequency of collection.

d. **Financing and Payment Structures** - Curbside food waste collection programs present distinct operational challenges compared to traditional garbage or recycling programs. The design of a food waste collection system, including encompassing cart size, vehicle type, and processing capacity, will be influenced by numerous factors, including policy, budget, and community interest.

Participation rates can vary based on factors such as residential engagement, community awareness, community-based social marketing efforts, program costs, and convenience. Voluntary, opt-in, and partially subsidized programs see participation rates of up to 20%. In contrast, mandatory programs, incorporated into overall service fees, have achieved participation rates of 85-90% or higher on the West Coast, following years of education and strict enforcement efforts.

i. **Fully Subsidized Service Model:** In this model, the municipality fully funds the food waste composting service through its General Fund, Special Purpose/Enterprise funds, or residential refuse fees. All eligible residents are automatically enrolled in the program, receiving containers and weekly collection services.

ii. **Pay-As-You-Throw (PAYT) Model:** The PAYT model incentivizes waste reduction by charging residents based on the amount of material generated. This approach can effectively divert organics and reduce overall waste volumes.

iii. **Partially Subsidized Model:** This model shares the cost of the service between the municipality and residents. The municipality may cover initial setup costs (e.g., containers, delivery, educational materials, and compostable bags) and/or a portion of the weekly collection fees. In some cases, a trial period (e.g., six (6) months) is offered, after which residents can choose to continue the service at their own expense.

iv. **Open Market Model:** In this model, residents are responsible for selecting and contracting with private composting haulers to provide weekly collection services. Municipalities may facilitate this process by issuing a solicitation to attract haulers and offer bulk pricing to residents, reducing barriers to entry for haulers and increasing service options for residents.

5. **Scenario B - Additional Processing:**

a. **Municipal Solid Waste.** Scenario B recommends the construction of three new transfer stations, supplementing the existing private transfer stations in the market, to enhance the efficiency of material flow to disposal facilities. Additionally, Scenario B assumes the development of a new 1,000,000 TPY WTE facility, while continuing to utilize capacity at South Broward RRF. Development of a new landfill is required, recognizing that existing landfill capacity may continue to be utilized in the future.

b. **Single Stream Recycling.** Scenario B also recommends the addition of two SSR processing facilities to manage the increased volume of inbound material by 2045. This recommendation assumes the adoption of policies, educational programs, enforcement strategies, and new technologies, as discussed in Section 7 of this White Paper, to maximize the recovery of recyclables. For a more detailed discussion on the SS RMPF facility, including options, costs, and timeline, please refer to Section 6.1.1.

c. **Organics Processing Facilities.** Two new facilities with the ability to scale operations to increase processing capacity and meet the Authority's future capacity needs are recommended. As the mass of food waste increases (exceeding 15% by volume), one CASP composting operation will be added to provide efficient composting of the food waste along with a portion of the yard waste. CASP reduces odors and enables better control over operating parameters, making it an efficient composting technique. The remaining yard waste will be processed at the two Mulch/Colorization operations, One Biochar Pyrolysis operation will provide operational flexibility for yard waste processing. In addition, under this scenario, biochar can be used as an amendment to accelerate the composting process and/or added to the compost end-product to increase market value and thus revenue.

6. **Construction & Demolition Recycling RMPF**

   Up to two strategically located facilities are recommended to add processing capacity to the region. The facilities should each have a throughput capacity of 450,000 TPY or 100 TPH to manage the 850,000 TPY needing processing. Facilities may be either publicly- or privately- owned and operated, dependent on the Authority's goals and objectives.

7. **Drop-Off Centers for Hard-to-Recycle Materials**

   – **Permanent Drop-Off Centers:** To strengthen recovery efforts, all five scenarios include the development of eight recycling drop-off centers. These permanent facilities will consist of two distinct areas:

     i. One gated and staffed area, operating up to two days per week, dedicated to the collection of HHW and electronics.

     ii. A second, publicly accessible area open 24/7 for SS recyclables and textiles drop-off.

     Further details on the design and operation of the drop-off centers can be found in Section 6.1.11, Drop-Off Centers.

8. **Outcomes**

   Scenario B strengthens the Authority's status quo by conducting the infrastructure improvement discussed in Scenario A as well as the implementation of special collections and the development of a new WTE facility. **Table 6** summarizes expected recovery rates and **Table 7** presents the diversion facilities and capacity required, capital cost, operating cost, and summary of processing fees under Scenario B.

For summary results of the collection cost analysis for each scenario, see **Appendix B.**

Table 6. Scenario B Recovery Tonnages Summary – Estimated Outcome in 2045

Scenario B	Estimated Outcome in 2045
Incoming Tons to New Recovery Facilities	3,800,000
Recovered Tons	3,300,000
Residue Tons	500,000
Traditional Recycling %	54%
Adjusted Recycling % with WTE and Landfill Credits	78%
GHG Benefit (MTCO2e)	1,600,000

Table 7. Scenario B New Diversion Facilities and Capacity Required, Capital Cost, Operating Cost, and Summary of Processing Fees (est. 2025 dollars)

Description	Qty	Capacity (Tons Per Year/Facility)	CapEx/ Facility	Annual OpEx/ Facility	Processing Fee ($/Ton)	Aggregated ($/Ton /Facility)
SS RMPF	2	250,000	$72M	$14M	$89	$35
Yard Waste Mulch Facility	2	175,000	$5M	$1.8M	$14	($32)
CASP Compost Zones Incorporated in Organics Facility	1	73,000	$12M	$1.7M	$35	($80)
Pyrolysis	1	30,000	$10M	$700k	$57	$13
C&D RMPFs	2	450,000	$41M	$19M	$50	$60
Public Drop Off Centers	8	12,000	$140k	$1M	$86	$86
Transfer Stations	3	546,000	$28M	$19M	$86	$26
WTE	1	1,000,000	$990M	$14M	$14	$147
Landfill	1	2.2M	$1,086M	$182M	$99	$41

4.4.2.3 Scenario C – Co-Collecting Food Waste and Yard Waste and a New Waste-to-Energy Facility

In Scenario C, food waste and yard waste are co-collected in a single container using the same collection vehicle on a weekly basis. This co-collection approach represents an efficient method for collecting organic materials, as both waste streams are consolidated within a single route. By streamlining the collection process, co-collection reduces GHG emissions, hauling costs, and road wear compared to the alternative of collecting food waste and yard waste on separate routes.

Transitioning to a once-a-week service is recommended and has been incorporated into the cost model for this option to help mitigate the expenses associated with implementing organics collection. Additionally, as outlined in Scenarios A and B, recycling services would be expanded to provide access to the 20% of residents who currently lack recycling collection.

Scenario C also includes the development of a new 1,000,000 TPY WTE facility. Assuming the new WTE facility will be equipped with AMR, approximately 46,200 TPY of metals will be recovered and it will produce approximately 675,000 MWh of energy annually. Note that the new WTE facility will supplement the 750,000 TPY South Broward RRF. In addition, Scenario C contemplates the development of a new landfill recognizing that existing landfill capacity may continue to be utilized in the future. However, consistent with the Authority's direction to "control their solid waste management destiny," the SCS Team has assumed that a new landfill, controlled by the Authority, will be required.

Scenario C - Collection Services:

1. **Municipal Solid Waste – (1x/week):** Similarly to Scenarios A and B, Scenario C also includes reduction of residential MSW collection to once-a-week containerized collections to offset costs.

2. **Recycling – (1x/week):** Scenario C ensures that weekly curbside recycling service is restored to the 20% of residents without current access.

3. **Co-Collection of Food and Yard Waste – (1x/week):** Scenario C assumes once-a-week containerized residential food and yard waste co-collection.

   Rationale for Co-Collection. Many municipalities with progressive waste diversion policies (e.g., zero-waste initiatives) require organics diversion to achieve high diversion goals. Co-collecting food and yard waste in the same cart, vehicle, and route is among the most efficient and cost-effective methods to integrate organics into waste diversion programs. It should be noted that when co-collecting food and yard waste together, the entire volume of the combined waste is defined as solid waste and must be treated as such, based on Florida Statutes.

   a. **Implementation Considerations:** The implementation pathways for composting, and financing structures outlined in Scenario B, are also applicable to Scenario C. Curbside collection would require the use of REL trucks and the use of roll cart containers to effectively manage yard waste volumes.

   b. **Processing Capacity and Methods:** Collected food and yard waste will be processed at an organics facility utilizing either windrow composting or CASP.

c. **Participation Rate Impact:** Collection volumes and cost-per-ton are influenced by the program's participation rate. Participation refers to the proportion of eligible households that choose to include food waste in their co-collection carts alongside yard waste. Participation rates are highly variable and depend on program design, promotional efforts, education, outreach, supporting policies that encourage organics diversion, as well as enforcement, as applicable.

Co-collecting food and yard waste provides a cost-effective, environmentally sustainable path to addressing the Authority's waste management needs and aligns with the Authority's goals for waste diversion and resource recovery.

For summary results of the collection cost analysis for each scenario, see **Appendix B.**

Scenario C - Additional Processing:

1. **Municipal Solid Waste.** Scenario C recommends the construction of three new transfer stations, supplementing the existing private transfer stations in the market, to enhance the efficiency of material flow to the disposal facilities. Additionally, Scenario B assumes the development of a new WTE facility with a capacity of 1,000,000 TPY, while continuing to utilize capacity at South Broward RRF. Development of a new landfill is required, recognizing that existing landfill capacity may continue to be utilized in the future.

2. **Single Stream Recycling.** Scenario C also recommends development of two additional SS RMPFs for managing additional inbound tons of SS recyclables in 2045. This assumes that policy, educational programs, enforcement, and new technologies discussed in Section 7 of this White Paper are adopted to maximize the capture of recyclables for recovery. Please see 6.1.1 for a greater discussion on the SS RMPF facility, options, costs, and timeline.

3. **Organics Facilities:** Two facilities are recommended with scalable operations to accommodate varying needs. Additional recovered food waste can be managed alongside yard waste and composted using CASP technology. In total, 10CASP composting operations will handle both food and yard waste. Any remaining yard waste will be converted into biochar through a single biochar pyrolysis operation. Consistent with the other scenarios, biochar can be utilized to process yard waste that is difficult to decompose. It may also be incorporated into the composting process to accelerate decomposition and/or added to the final compost product to enhance its value.

4. **C&D Recycling RMPF:** Up to two (2) strategically located facilities are recommended to add processing capacity to the region. The facilities should each have a throughput capacity of 450,000 TPY or 100 TPH to manage the 850,000 TYP processing needs. Facilities may be either publicly- or privately- owned and operated.

5. **Drop-Off Center for Hard-to-Recycle Materials**

   – **Permanent Drop-Off Centers:** To enhance recovery efforts, all five scenarios propose the development of eight permanent recycling drop-off centers. These facilities will feature two distinct areas:

      i. A gated, staffed section operating up to two days per week for the collection of HHW and electronics.

ii. A publicly accessible section, open 24/7, for SS recyclables and textiles drop-off.

Further details on the design and operation of the drop-off centers can be found in Section 6.1.11, Drop-Off Centers.

6. **Outcomes:** Scenario C enhances the Authority's existing waste management framework by implementing the infrastructure improvements outlined in Scenario A while also including a new WTE facility. Additionally, it introduces targeted special collections to achieve modest gains in material recovery. A cornerstone of Scenario C is the implementation of an ambitious residential food and yard waste co-collection program, which drives a substantial increase in organics recovery and aligns with the Authority's broader sustainability objectives. **Table 8** summarizes expected recovery rates and **Table 9** presents the diversion facilities and capacity required, capital cost, operating cost, and summary of processing fees under Scenario C.

Table 8. Scenario C Recovery Tonnages Summary – Estimated Outcome in 2045

Scenario C	Estimated Outcome in 2045
Incoming Tons to New Recovery Facilities	4,200,000
Recovered Tons	3,600,000
Residue Tons	500,000
Traditional Recycling %	59%
Adjusted Recycling % with WTE and Landfill Credits	83%
GHG Benefit (MTCO2e)	1,820,000

Table 9. Scenario C New Diversion Facilities and Capacity Required, Capital Cost, Operating Cost, and Summary of Processing Fees (est. 2025 dollars)

Description	Qty	Capacity (Tons Per Year/Facility)	CapEx/ Facility	Annual OpEx/ Facility	Processing Fee ($/Ton)	Aggregated ($/Ton /Facility)
Single Stream RMPF	2	250,000	$72M	$14M	$89	$35
Yard Waste Mulch Facility	2	175,000	$5M	$1.8M	$14	($32)
CASP Compost Zones Incorporated in 2 Organics Facilities	10	73,000	$12M	$1.7M	$35	($80)
Pyrolysis	1	30,000	$10M	$700k	$57	$13
C&D RMPFs	2	450,000	$41M	$19M	$50	$60

Description	Qty	Capacity (Tons Per Year/Facility)	CapEx/ Facility	Annual OpEx/ Facility	Processing Fee ($/Ton)	Aggregated ($/Ton /Facility)
Public Drop-Off Centers	8	12,000	$140k	$1M	$86	$86
Transfer Stations	3	443,000	$24.5M	$17M	$94	$34
WTE	1	1,000,000	$990M	$14.4M	$14	$147
Landfill	1	2.1M	$1,131M	$177M	$100	$42

4.4.2.4 Scenario D – Wet/Dry MSW Collection and Yard Waste

Scenario D introduces a new approach to waste collection for the Authority by dividing MSW into two distinct streams: wet and dry waste.

This system aims to address gaps in recycling participation by capturing recyclable materials in the "dry waste" stream from the following sources:

- Multi-family units lacking access to recycling programs.
- Single-family households that do not actively participate in recycling programs.
- Public and commercial recycling access points where traditional recyclables are collected but may be of lower quality.

Scenario D - System Design

- Wet MSW Containers: Designed to collect organics, disposable hygienic paper, and other moisture-laden materials.
- Dry MSW Containers: Used for recyclables, separated packaging, household containers (e.g., films, storage containers, pottery), consumed or worn-out products, and other dry, non-hazardous waste materials.

Scenario D - Discussion

Wet-Dry solid waste systems first gained traction during the perceived landfill crisis of the late 20th century. At that time, dry waste was processed using screening technology to recover paper and metals, although plastics were excluded due to low market demand. While high paper prices between 1995 and 1997 initially supported the viability of these systems, subsequent declines in paper and cardboard prices, along with low landfill tipping fees (averaging $30 per ton nationally), made the facilities economically unsustainable. Most systems were closed or repurposed by the early 2000s.

Today, advancements in automated waste processing technology and the incorporation of organics processing, which were absent in earlier implementations, have revitalized Wet-Dry systems as a viable solution for achieving high-diversion goals. With current national landfill tipping fees averaging $58 per ton and Class I landfill (landfill that is permitted to receive MSW) fees in Broward County reaching $110 per ton, the economic rationale for these systems has strengthened.

Compared to MWP facilities (see Scenario E), modern Wet-Dry systems can achieve comparable diversion rates at potentially lower costs but require proper wet/dry waste sorting by solid waste customers. By leveraging advanced sorting technologies and robust organics processing, these systems maximize recovery across the waste supply chain, aligning with contemporary solid waste management goals.

Scenario D - Key Features of the Modern Wet-Dry System:

- Separation of Waste Streams: Distinct wet and dry collection for improved sorting efficiency and reduced costs.
- Advanced Automation: Utilization of modern technology to recover materials like plastics, metals, and high-quality fibers.
- Organics Processing: Inclusion of AD for wet MSW materials.
- Scalable Infrastructure: Designed to accommodate varying household types and participation levels.

This approach aligns with the Authority's goal of offering a flexible, efficient solution for managing solid waste.

Scenario D - Collection:

1. **Wet and Dry MSW Collection**
    a. **Wet MSW (2x/week) and Dry MSW (1x/week):**
        - **Residential Collection for Wet and Dry MSW.** Under this scenario, all residential units, including multi-family dwellings, would participate in Wet and Dry MSW collection. There would be no exclusions based on the number of units per complex. Multi-family properties exceeding a designated threshold would continue to be served by the open commercial market, which would also adopt wet-dry waste separation.
        - **Residential Requirements.** Residents would separate their waste into two distinct containers, each color-coded to differentiate wet waste from dry waste. This change would necessitate CapEx to provide new containers for all residential participants.
        - **Multi-Family Requirements.** Multi-family properties would require additional infrastructure to facilitate wet-dry waste separation. This could include separate containers, compactors, or split-body compactors. Properties served under municipal collection programs would remain under municipal contracts, while those outside this scope would be serviced by the open commercial market. Like single-family homes, these properties would also incur CapEx for new containers.
        - **Recyclables Recovery for Multi-Family Units.** Scenario D would enable high-density multi-family residences that currently lack recycling programs to recover

packaging materials, such as bottles, containers, paper, and cardboard, through processing at a proposed Commercial Dry MSW Recycling and a RMPF.

- **Infrastructure Investments.** Infrastructure investments would include CapEx for new waste containers across all residential units, ensuring the successful implementation of the Wet-Dry MSW system.

- **Mandatory Wet-Dry Separation for All Multi-Family Units:** This system ensures comprehensive coverage for multi-family dwellings, eliminating current restrictions based on unit thresholds. As part of the Authority's long-term zero-waste objectives mandatory commercial recycling collection for non-exclusive, open-market solid waste collectors may need to be introduced. Such regulatory changes could include targeted waste requirements based on industry-specific waste characteristics or minimum collection volumes per service interval.

2. **Single-Stream Recycling (Integrated with Dry MSW, 1x/week):** SSR would be integrated into the weekly Dry MSW collection to optimize the number of hauling streams required under this scenario. In addition to the recyclables currently collected curbside, rigid containers previously missing in the MSW stream would also be captured for processing.

3. **Yard Waste Collection (1x/week):** As with all scenarios, weekly yard waste collection remains a critical component of the Authority's strategy to achieve high diversion rates and align with sustainability goals.

This integrated approach supports efficient resource recovery, optimizes collection logistics, and advances the Authority's zero-waste objectives over the planning horizon.

For summary results of the collection cost analysis for each scenario, see **Appendix B.**

Scenario D - Additional Processing:

- **Municipal Solid Waste.** Scenario D recommends the building of three transfer stations, in addition to the existing private transfer stations in the market, to support the efficiency of material flow to disposal facilities. Scenario D assumes that the existing permitted disposal capacity for the WTE facility at South Broward RRF will continue to be used. It should be noted that WIN Waste is currently contemplating the sale of the South Broward RRF, and as such, future contract terms and conditions with a new owner/operator may be required for continued use of this disposal capacity. In addition, Scenario D contemplates the development of a new landfill recognizing that existing landfill capacity may continue to be utilized in the future. However, consistent with the Authority's direction to "control their solid waste management destiny," the SCS Team has assumed that a new landfill, controlled by the Authority, will be required.

- **Six Dry MRF (Recycling and Materials Processing Facilities)**

  – **Facility Overviews.** Each 160,000 TPY Dry MRF would target a diversion rate of 25%, leveraging advanced processing technologies to recover high-quality materials from the dry waste stream.

- **Dry MRF Diversion Benefits:**

  1. The absence of organics contamination ensures higher-quality recovered materials.
  2. Processing of dry residential materials would prioritize metals and plastics, with the potential to include paper containers (OCC) and other clean paper products.
  3. Expanded diversion efforts would include wood, clean film, bulky plastics, inert materials (e.g., brick and rock), and other recoverable items.

- **Key Dry MRF Recovery Targets:**

  1. 90% recovery of rigid containers not captured through existing recycling programs would be captured in this scenario.
  2. 25% recovery of clean film would be captured in this scenario.
  3. This scenario is projecting a minimum total dry waste diversion of 20–25%.

- **MRF Material Streams Processed:** The facilities would accept and process the following material streams currently underserved:

  1. Residential Dry Waste: The inclusion of these facilities would allow for increased material recovery from multifamily dwellings.
  2. Commercial SS Waste: The inclusion of these facilities would allow for increased recovery of non-organic, non-hazardous commercial waste streams.
  3. Processing Capacity: Two processing lines for Dry MSW, each handling 75–125 TPH.

- **Key Components Needed in MRFs:**

  1. A Pre-shred bag opener should be included to optimize material preparation.
  2. A Pre-sorting station should be included to remove bulky items, incompatible materials, large film pieces, and bag-in-bag waste.
  3. A Trommel screen, a machine that separates materials by size using a rotating drum with holes or mesh, should be included to segment materials into three size fractions for targeted separation.

- **Automated Sorting Technologies:**

  1. Optical and ballistic separators should be included to recover paper, rigid containers, films, and other recyclable materials.
  2. Magnets and eddy current separators should be included for recovering ferrous and non-ferrous metals, including aluminum.

- **Advanced Sorting Assistance:**

  1. Systems such as air density separation, paper drum magnets, optical identification (AI + NIR), air jets, or robotic sortation for precise material recovery should be included.

- **Residual Management:**

  1. The inclusion of a final optical sorter to capture remaining rigid containers and other targeted 3D materials, which are then recirculated through the system, should be included.

  2. Any remaining undersized materials in the residual are then directed to disposal.

- **AD Facilities.** Three AD facilities (160,000 TPY each) are recommended to capture wet waste for digestion and recovery of Renewable Natural Gas (RNG). In addition, dewatering to recover solid digestate and direct waste liquid to local wastewater treatment facilities is recommended. These recommendations result in a minimum total wet waste diversion of between 20-25%.

- **Organics Processing Facilities.** Two Mulch/Colorization operations and one Biochar Pyrolysis operation will process collected yard waste. The pyrolysis unit is capable of converting hard-to-decompose materials into biochar, which can generate revenue. Alternatively, biochar may be utilized in the AD process to enhance methane yield or potentially mitigate Per- and Polyfluoroalkyl Substances (PFAS), also known as forever chemicals that have been identified as a growing environmental threat, in the digester effluent. For additional details, refer to the Task 9: Innovative and Future Technologies White Paper.

- **C&D Recycling RMPF.** Up to two strategically located facilities are recommended to add processing capacity to the region. The facilities should each have a throughput capacity of 450,000 TPY or 100 TPH to manage the 850,000 TPY processing needs. Facilities may be either publicly or privately owned and operated.

- **Drop-Off Centers for Hard-to-Recycle Materials:**

  - **Permanent Drop-Off Centers -** To enhance recovery efforts, all five scenarios propose the development of eight permanent recycling drop-off centers. These facilities will feature two distinct areas:

    1. A gated, staffed section operating up to two days per week for the collection of HHW and electronics.

    2. A publicly accessible section, open 24/7, for SS recyclables and textiles drop-off.

    Further details on the design and operation of the drop-off centers can be found in Section 6.1.11, Drop-Off Centers.

Scenario D - Outcomes

Scenario D employs a distinct approach compared to the other Scenarios by splitting collections into two waste streams: Dry Waste (recyclables and non-organic materials) and Wet Waste (organics). Key outcomes include:

- Enhanced Material Recovery: Dedicated Dry MRFs enable the recovery of a broader range of recyclables and materials currently lost in traditional systems.
- Increased Organics Diversion: The Wet Waste stream incorporates a robust residential food waste collection program, significantly improving organics recovery rates.
- Integrated Waste Management: The program complements existing mulch initiatives, creating a comprehensive solution for achieving the Authority's diversion and sustainability goals.

This strategy leverages advanced infrastructure and technology to deliver high recovery rates, reduce contamination, and optimize waste stream management. **Table 10** summarizes expected recovery rates and **Table 11** presents the diversion facilities and capacity required, capital cost, operating cost, and summary of processing fees under Scenario D.

Table 10. Scenario D Recovery Tonnages Summary – Estimated Outcome in 2045

Scenario D	Estimated Outcome in 2045
Incoming Tons to New Recovery Facilities	4,000,000
Recovered Tons	2,700,000
Residue Tons	1,400,000
Traditional Recycling %	45%
Adjusted Recycling % with WTE and Landfill Credits	51%
GHG Benefit/(Increase) (MTCO2e)	(260,000)

Table 11. Scenario D New Diversion Facilities and Capacity Required, Capital Cost, Operating Cost, and Summary of Processing Fees (est. 2025 Dollars)

Description	Qty	Capacity (Tons Per Year/Facility)	CapEx/ Facility	Annual OpEx/ Facility	Processing Fee ($/ton)	Aggregated ($/ton /facility)
Dry MRF	6	160,000	$49M	$18M	$108	$61
AD (Wet Waste)	3	160,000	$64M	$10M	$100	$48
Yard Waste Mulch Facility	2	175,000	$5M	$1.8M	$14	($32)

Description	Qty	Capacity (Tons Per Year/Facility)	CapEx/ Facility	Annual OpEx/ Facility	Processing Fee ($/ton)	Aggregated ($/ton /facility)
Pyrolysis	1	30,000	$10M	$700k	$57	$13
C&D RMPFs	2	450,000	$41M	$19M	$50	$60
Public Drop Off Centers	8	12,000	$140k	$1M	$86	$86
Transfer Stations	3	1.0M	$52M	$35M	$84	$24
Landfill	1	3.4M	$814M	$261M	$89	$41

4.4.2.5 Scenario E – Mixed Waste Technologies, Fiber Capture, and Anaerobic Digestion

Scenario E is unique in that it diverts MSW to a MWP Facility for advanced processing. SSR is reintroduced for residents currently without service. Food and yard waste are co-collected and transported to an organics processing facility for composting, while the remaining MSW is directed to a MWP Facility equipped with fiber extraction technology to recover pulp, and an AD to process extracted wet waste. Additionally, SS recyclables are further recovered at the SSR Facilities.

Scenario E – Collections.

1. **MSW (1x/week):** Similarly to the other scenarios, Scenario E includes a reduction of residential MSW collection to once-a-week containerized collections to offset costs.

2. **Recycling (1x/week):** As discussed in the previous scenarios, Scenario E also includes restoring curbside recycling access once a week to the 20% of residents currently lacking access.

3. **Yard Waste (1x/week):** Scenario E adds once-a-week yard waste curbside collection to all Authority residents. It is estimated that while the program would be accessible to all residents, approximately 80% of Authority residents will participate in the program.

4. **Food Waste Co-Collected with Yard Waste (1x/week):** Scenario E assumes once-a-week containerized residential food and yard waste co-collection.

For summary results of the collection cost analysis for each scenario, see **Appendix B.**

5. **Additional Processing**

   – **Municipal Solid Waste.** Scenario E recommends the building of three transfer stations, in addition to the existing private transfer stations in the market. These additions would support the efficiency of material flow to disposal facilities. Scenario E assumes that the existing permitted disposal capacity at the South Broward RRF will continue to be used. Note that WIN Waste is currently contemplating the sale of the South Broward RRF, and as such, future contract terms and conditions with a new owner/operator may be required for continued use of this disposal capacity. In addition, Scenario E contemplates the development of a new landfill recognizing that existing landfill capacity may continue to be utilized in the future. However, consistent with the Authority's direction to "control their solid waste management destiny," the SCS Team has assumed that a new landfill, controlled by the Authority, will be required.

- **Single Stream Recycling.** Scenario E also recommends two additional SS RMPF's for managing additional inbound tons of SSR in 2045. This assumes that policy, educational programs, enforcement, and new technologies discussed in Section 7 of this White Paper are adopted to maximize the capture of recyclables for recovery. Please see 6.1.1 for a greater discussion on the SS RMPF facility, options, costs, and timeline.

Organics Processing Facilities. Two facilities are recommended with scalable operations to accommodate varying needs. Additional recovered food waste can be managed alongside yard waste and composted using CASP technology. In total, ten CASP composting operations will handle both food and yard waste. Any remaining yard waste will be converted into biochar through a single biochar pyrolysis operation. Biochar can be utilized to process yard waste that is difficult to decompose. It may also be incorporated into the composting process to accelerate decomposition and/or added to the final compost product to enhance its value. Alternatively, biochar may be utilized in the AD process to enhance methane yield or potentially mitigate PFAS in the digester effluent. For additional details, refer to Task 9: Innovative and Future Technologies White Paper.

- **Mixed Waste Processing Facility.** Scenario E enhances the Authority's waste management infrastructure by implementing the improvements outlined in Scenario A and introducing a robust residential food waste collection program. This initiative significantly boosts organics recovery rates. The remaining MSW of approximately 1,000,000 TPY is directed to a MWP Facility for advanced processing. Recyclables are sorted, and cellulose fiber is extracted for use in papermaking. A total of three MWP Facilities (330,000 TPY each) with single stream extraction, Fiber Extraction, and high solids AD. This facility is further described in Section 6.1.9.

- **Construction & Demolition Recycling RMPF.** Up to two strategically located facilities are recommended to add processing capacity to the region. The facilities should each have a throughput capacity of 450,000 TPY or 100 TPH to manage the 850,000 tons needing processing. Facilities may be either publicly- or privately- owned and operated.

- **Drop-Off Center for Hard-to-Recycle Materials:**

  - **Permanent Drop-Off Centers.** To strengthen recovery efforts, all five scenarios include the development of eight recycling drop-off centers. These permanent facilities will consist of two distinct areas:

    1. One gated and staffed area, operating up to two days per week, dedicated to the collection of HHW and electronics.

    2. A second, publicly accessible area open 24/7 for the drop-off of SS recyclables and textiles.

Further details on the design and operation of the drop-off centers can be found in Section 6.1.11, Drop-Off Centers.

Outcomes

Scenario E enhances the Authority's waste management system by implementing advanced MWP, introducing specialized collection programs to optimize recovery rates and enhance customer service, and launching an aggressive residential food waste collection program to significantly boost organics recovery. **Table 12** summarizes expected recovery rates and **Table 13** presents the diversion facilities and capacity required, capital cost, operating cost, and summary of processing fees under Scenario E.

Table 12. Scenario E Recovery Tonnages Summary – Estimated Outcome in 2045

Scenario E	Estimated Outcome in 2045
Incoming Tons to New Recovery Facilities	4,200,000
Recovered Tons	3,900,000
Residue Tons	2,100,000
Traditional Recycling %	64%
Adjusted Recycling % with WTE and Landfill Credits	73%
GHG Benefit (MTCO2e)	1,820,000

Table 13. Scenario E New Diversion Facilities and Capacity Required, Capital Cost, Operating Cost, and Summary of Processing Fees (est. 2025 dollars)

Description	Qty	Capacity (Tons Per Year/Facility)	CapEx/ Facility	Annual OpEx/ Facility	Processing Fee ($/Ton)	Aggregated ($/Ton /Facility)
SS RMPF	2	250,000	$72M	$14M	$89	$35
CASP Compost Zones Incorporated in 2 Organics Facilities	10	73,000	$12M	$1.7M	$35	($80)
Pyrolysis	1	30,000	$10M	$700k	$57	$13
MWP Facility with Fiber Extraction	3	330,000	$363M	$30M	$194	$124
C&D RMPFs	2	450,000	$41M	$19M	$50	$60
Public Drop Off Centers	8	12,000	$140k	$1M	$86	$86
Transfer Stations	3	703,000	$33M	$25M	$82	$22
Landfill	1	2.5M	$979M	$203M	$95	$41

5.0 CURBSIDE COLLECTIONS CONSIDERATIONS

5.1 COLLECTION TRUCKS OVERVIEW

This Section provides an overview of key curbside collection considerations, focusing on the differences between the two most common types of collection vehicles and the growing adoption of alternative fuel vehicles. The primary curbside collection trucks in use across the United States today include Automated Side Loader (ASL) and Rear-End Loader (REL) vehicles.

Cost examples for both ASL and REL scenarios, along with the associated assumptions, are detailed in **Appendix B.** It is important to note that these cost models apply exclusively to curbside single-family households and do not account for collection costs in multi-family or commercial sectors.

In addition, many local governments are exploring the use of alternative fuel collection vehicles to advance sustainability goals, given their potential for significantly reducing greenhouse gas (GHG) emissions.

REL collections: REL solid waste trucks are designed for manual collections and are typically equipped with lifting mechanisms, such as cart lifters. In a standard collection program, these trucks are staffed with three personnel: one CDL driver and two collectors. The collectors manually handle the carts, using cart tippers to lift containers or unloading waste directly into the hopper, which serves as the initial receiving point. REL trucks are equipped with hydraulic systems that compact the waste, enabling increased capacity and faster route completion times.

REL collections are particularly well-suited for urban and densely populated areas due to their smaller operational footprint, which provides a significant advantage over fully automated side-loader trucks. Automated trucks require more space to maneuver, making them less effective in narrow alleys or streets with heavy on-street parking (RRS, 2024).

ASL: Fully automated collection vehicles provide a significantly safer working environment for employees, as they eliminate the need for workers to exit the vehicle during operation. Refuse and recyclable material collection ranks as the seventh deadliest job across all industries, according to the U.S. Department of Labor's Bureau of Labor Statistics (Quinn, 2023). The solid waste and recycling industry has consistently ranked among the top 10 industries with the most dangerous occupations, with a national average injury rate of 4.7 cases per 100 full-time equivalent workers in 2022 (Quinn, 2023).

This ongoing safety concern highlights the importance of prioritizing measures to protect collection workers.

By reducing the number of workers needed per route, ASL vehicles significantly lower the risk of injuries and fatalities. These vehicles allow a single operator to complete the route without leaving the driver's seat, if carts are correctly placed for the collection arm to access them. All servicing is conducted remotely, eliminating exposure to many hazards. Fully automated systems are compatible only with cart-based collection programs, as loose bags or other containers cannot be handled by the collection arm.

In addition to safety, fully automated systems address ergonomic concerns, such as back injuries and workplace illnesses caused by repetitive lifting or exposure to hazardous materials (e.g., needle sticks or viral pathogens). Advocacy groups like the National Council for Occupational Safety and Health (COSH) emphasize the need to eliminate workplace hazards rather than relying solely on safety measures dependent on worker actions, such as wearing high-visibility clothing. COSH warns that such measures may provide a false sense of security and fail to address the root cause of injuries.

While fully automated collection systems require higher initial capital investments for vehicles and carts, the long-term financial benefits can offset these costs. Savings from reduced workplace injury claims, lower insurance premiums due to minimized risks, and improved employee retention should be carefully considered. In contrast, semi-automated rear-load trucks, which require up to three staff members per vehicle, involve lower initial costs but higher labor requirements. Fully automated vehicles, which require only one (1) operator per truck, allow for labor reductions or the reallocation of personnel to other specialized collection programs, such as electronics, textiles, HHW, bulky waste, and C&D.

The primary advantage of fully automated vehicles is their significant improvement in worker safety. Collection workers face risks such as falls from trucks, being pinned, or truck rollovers (SWANA, 2023). Fully automated systems mitigate these hazards by eliminating the need for workers to ride on the back of vehicles or repeatedly enter and exit the truck. Additionally, they reduce repetitive lifting motions that often lead to long-term injuries. Operators remain safely inside the vehicle, using the automated arm to collect materials from the curb. Many municipalities that transition to fully automated collection report reduced workers' compensation claims and lower insurance costs.

Fully automated vehicles also offer operational efficiencies, with faster collection times. They can typically handle 1,000 to 1,200 collections per day per vehicle, compared to 800 to 1,000 collections for semi-automated trucks (Roberts, 2014). These efficiencies, combined with safety and cost benefits, make fully automated systems an attractive option for advancing solid waste collection programs.

Alternative Fuel and Electric Collection Vehicles

Beyond transitioning to automated collection vehicles, the use of alternative fuel and electric collection vehicles is a consideration for future fleet purchases that would result in additional environmental benefits. A Solid Waste Association of North America (SWANA) Applied Research Foundation study (the report), Evaluation of Electricity and Other Alternative Fuels for Solid Waste and Recycling Collection Vehicles, evaluates alternative fuels for waste collection vehicles, focusing on electricity, CNG, and hydrogen fuel cells (SWANA Applied Research Foundation, 2019). The report compares these alternatives to diesel, analyzing energy usage, greenhouse gas emissions, and costs. Electric trucks show the lowest cost per mile and emissions but are still in the demonstration phase, hindering widespread adoption. Hydrogen fuel cell trucks also offer benefits but lack United States demonstration projects.

The report compares alternative fuels for refuse and recycling collection, as shown below.

Fuel Costs: Electricity is the least expensive fuel at $0.66 per mile. CNG is slightly more expensive at $1.14 per mile. Diesel costs $1.29 per mile. Hydrogen fuel cell truck is the most expensive option in regard to fuel costs at $2.05 per mile.

GHG Emissions: Electric refuse trucks emit the lowest amount of GHG at 2,115 grams of CO2e per mile. CNG trucks emit 4,079 grams of CO2e per mile. Diesel trucks emit 4,406 grams of CO2e per mile. Hydrogen fuel cell trucks emit the highest level of GHG gases at 11,003 grams of CO2e per mile.

- **Commercial Viability:** Diesel and CNG refuse trucks are fully commercialized. Electric refuse trucks are in the demonstration stage of commercialization. There are currently 50–100 demonstration projects in North America. Hydrogen fuel cell refuse trucks are in the early demonstration stage of commercialization. Demonstration projects are occurring in Europe, but not in the U.S.

- **Other Considerations:** Electric refuse trucks are quieter than diesel trucks and produce no tailpipe emissions. As such, there are environmental justice benefits with improved air quality and reduced human health impacts such as asthma for communities with significant truck traffic. Electric vehicles also use less energy than other alternative-fueled trucks. However, they have high upfront capital costs, require new charging infrastructure, and limited experience in real-world service environments. Hydrogen fuel cell refuse trucks also offer zero tailpipe emissions, regenerative braking capabilities, and low noise levels. They have driving ranges comparable to diesel trucks.

The report advises fleet managers to continue using diesel and CNG trucks while preparing to transition to renewable alternatives as they become cost competitive. It also recommends exploring opportunities to generate electricity and renewable CNG from solid waste (RNG). Implementation of AD for treatment of organic waste could provide an opportunity for onsite vehicle fuel use. For fleets considering electric trucks, the report suggests waiting until test project data has been analyzed before making the switch. In October 2024, Republic Services introduced an all-electric recycling and waste collection truck fleet in Louisville, Colorado, making it the first U.S. city to adopt a fully electric collection fleet.

5.2 SCENARIOS COLLECTIONS COSTS OVERVIEW

5.2.1 Scenario A – Restoring Single-Stream Recycling and adding Curbside Yard Waste Composting

MSW (1x/week) - In scenario A, the trash collection schedule would be reduced to once a week to accommodate the addition of yard waste collections. Using 2045 population numbers, the estimated annual cost for MSW collection and disposal, utilizing ASL collections once-a-week, is approximately $23 million, equating to $4.98 per household per month. Alternatively, conducting all collections with rear-end loaders would cost approximately $48 million annually, or $10.07 per household per month. These costs are already accounted for and do not represent additional expenses under this scenario. Reducing the trash collection to once a week would result in savings of approximately

$5.34 per household per month, which would support the added costs of adding in yard waste composting collections,

Single-Stream Recycling (1x/week) – Restoring SSR services to the 20% of residents currently without access is estimated to cost approximately $3.7 million annually, or $3.88 per household per month, utilizing ASL collection vehicles. This cost would be allocated solely to the households receiving the restored service. If rear-end loaders are utilized, the cost would be approximately $7 million annually, or $7.46 per household per month.

Yard Waste Composting (1x/week) – Implementing yard waste collection services is estimated to cost $19 million annually, or $4.00 per household per month. The proposed service would be containerized, with each household receiving a 95-gallon cart for yard waste. Additional cart size options may be offered, and households may also have the option to use paper bags for collection. For estimation purposes, REL vehicles, rather than ASLs, are assumed for this service to accommodate the manual collection of paper-bagged and/or containerized/bundled yard waste.

The costs for yard waste collection will be distributed across all Authority households, with participation rates anticipated to be approximately 80%. Due to the seasonal nature of yard waste generation and the variability in yard sizes, the volume of yard waste collected along with the number of households serviced per route are typically greater than those for MSW or SSR.

Food Waste Composting (Special Collections) – Scenario A assumes the collection of food waste through the establishment of drop-off events or centers where residents can bring food waste on a weekly basis. The contractor is responsible for setting up and dismantling the events each weekend and provides up to two attendants per site, depending on market size and traffic, to educate residents about composting. Residents can deposit acceptable food waste at no cost, and compost caddies are distributed during program launch events or Earth Month activities to encourage participation.

Education – The recommended education costs for materials management programs are incorporated into the scenario based on The Recycling Partnership's (TRP) guidance of $10 per household annually (Bandhauer et al., 2021).

Table 14 presents estimated collection costs under Scenario A.

Table 14. Estimated Collection Costs under Scenario A

Collection Description	# of Residents	Annual Total	$/HH YR	$/HH/Month
Reduce MSW (1x/week)	390,000	($25,300,000)	($64.87)	($5.41)
Restore SSR (1x/week)	80,000	$3,700,000	$46.25	$3.85
Add Yard Waste Composting (1x/week)	390,000	$18,900,000	$48.46	$4.04
Add Food Waste Drop-Off (x1/week)	390,000	$1,700,000	$4.36	$0.36
Education	390,000	$3,900,000	$10.00	$0.83
	Total	**$2,900,000**	**$44.20**	**$3.68**

5.2.2 Scenario B – Adding Curbside Food Waste Composting Collections

MSW (1x/week) - In Scenario B, reducing MSW collection to once a week would result in cost savings that could be used to support the implementation of new programs and services. This reduction is estimated to save approximately $20 million annually, which translates to an average savings of about $5.34 per month per household.

Single-Stream Recycling (1x/week) – Restoring SSR services to the 20% of residents currently without access is estimated to cost approximately $3.7 million annually, or $3.88 per household per month, utilizing ASL collection vehicles. If REL are utilized, the cost would be approximately $7 million annually, or $7.46 per household per month. This cost would be allocated solely to the households receiving the restored service.

Yard Waste Composting (1x/week) – As discussed in Scenario A, implementing yard waste collection services is estimated to cost $19 million annually, or $4.00 per household per month.

Food Waste Composting (1x/week) – Scenario B includes an opt-in food waste curbside composting collection once a week. The customer would bear the costs, estimated at $7.46 per month. In this scenario, it was assumed a participation rate of 20%.

Education – The recommended education costs for materials management programs are incorporated into the scenario based on TRP guidance of $10 per household annually (Bandhauer et al., 2021).

Table 15 presents estimated collection costs under Scenario B.

Table 15. Estimated Collection Costs Under Scenario B

Collection Description	# of Residents	Annual Total	$/HH YR	$/HH/Month
Reduce MSW (1x/week)	390,000	($25,300,000.00)	($64.87)	($5.41)
Restore SSR (1x/week)	80,000	$3,700,000.00	$46.25	$3.85
Add Yard Waste Composting (1x/week)	390,000	$18,900,000.00	$48.46	$4.04
Opt-In Food Waste (1x/week)	80,000	Costs to customer		
Education	390,000	$3,900,000.00	$10.00	$0.83
	Total	**$1,200,000**	**$39.84**	**$3.32**

5.2.3 Scenario C – Co-Collecting Food Waste and Yard Waste

MSW (1xweek) - In Scenario C, MSW collection is also reduced to once-a-week, resulting in cost savings that could be used to support the implementation of new programs and services. This reduction is estimated to save approximately $20 million annually, which translates to an average savings of about $5.34 per month per household.

Single-Stream Recycling (1x/week) – Restoring SSR services to the 20% of residents currently without access is estimated to cost approximately $3 million annually, or $3.88 per household per month, utilizing ASL collection vehicles. If REL are utilized, the cost would be approximately $7 million annually, or $7.46 per household per month. This cost would be allocated solely to the households receiving the restored service.

Food & Yard Waste Composting (1x/week) – Co-collecting food and yard waste with strong engagement and education efforts, policies such as mandatory organics recycling, and enforcement, can yield capture rates as high as 70-85% (Portland, OR, Seattle WA, and San Francisco, California) with 90% plus participation. The model assumes an 85% participation rate for single-family households, 40% for multifamily households, and 50% for commercial businesses.

Education – The recommended education costs for materials management programs are incorporated into the scenario based on TRP guidance of $10 per household annually (Bandhauer et al., 2021).

Table 16 presents estimated collection costs under Scenario C.

Table 16. Estimated Collection Costs Under Scenario C

Collection Description	# of Residents	Annual Total	$/HH YR	$/HH/Month
MSW (1x/week)	390,000	($25,300,000.00)	($64.87)	($5.41)
SSR (1x/week)	80,000	$3,700,000.00	$46.25	$3.85
Food + Yard (1x/week)	390,000	$20,100,000.00	$51.54	$4.29
Education	390,000	$3,900,000.00	$10.00	$0.83
	Total	**$2,400,000.00**	**$42.92**	**$3.58**

5.2.4 Scenario D – Wet/Dry MSW Collection, Single-Stream, and Co-Collection of Food + Yard Waste

Wet MSW (2x/week) – Scenario D modifies the current twice-a-week MSW collection schedule by converting into two separate collections: Wet (twice-a-week) and Dry (once-a-week). This approach would not require additional vehicles, nor would it increase maintenance, repair, or fuel costs. However, the added expense comes from the need for an additional cart, along with the costs associated with cart distribution and maintenance to support the separation of MSW. These costs are outlined below under the Wet MSW line item.

Dry MSW (1x/week) – As described in 5.1.4 Scenario D, the SSR would no longer be collected separately, but would instead be integrated into the Dry MSW once-a-week to optimize the number of hauling streams required under this scenario. This assumes that the current recycling cart is utilized for the dry MSW collections. To ensure all residents of the Authority have access to this service, the 20% of residents currently without SS will need to be added. This addition is estimated to cost approximately $3 million annually, or $3.88 per household per month, utilizing ASL collection vehicles. This cost would be allocated solely to the households currently not receiving recycling services.

Yard Waste Composting (x1/week) – As discussed in Scenario A, implementing yard waste collection services is estimated to cost $19 million annually, or $4.00 per household per month.

Education – The recommended education costs for materials management programs are incorporated into the scenario based on TRP guidance of $10 per household annually (Bandhauer et al., 2021).

Table 17 presents estimated collection costs under Scenario D.

Table 17. Estimated Collection Costs Under Scenario D

Collection Description	# of Residents	Annual Total	$/HH YR	$/HH/Month
Wet MSW (2x/week)	390,000	$-	$-	$-
Dry MSW (1x/week)	80,000	$3,700,000.00	$46.25	$3.85
Yard (1x/week)	320,000	$18,900,000.00	$59.06	$4.92
Education	390,000	$3,900,000.00	$10.00	$0.83
	Total	**$ 26,500,000.00**	**$115.31**	**$9.61**

5.2.5 Scenario E – Mixed Waste Technologies and Fiber Capture

Scenario E maintains the same levels of service and collection efforts as Scenario C, with the key difference being that MSW would be transported to a MWP Facility prior to disposal. Existing transfer stations could be utilized for this purpose; however, the logistics of hauling waste from these transfer stations to the new MWP Facility will need to be considered.

MSW (1x/week) - In Scenario E, MSW is hauled to the MWP Facility and includes fiber extraction.

Single-Stream Recycling (1x/week) – Restoring SSR services to the 20% of residents currently without access is estimated to cost approximately $3 million annually, or $3.88 per household per month, utilizing ASL collection vehicles. This cost would be allocated solely to the households receiving the restored service.

Food & Yard Waste Composting (1x/week) – Co-collecting food and yard waste with strong engagement and education efforts, policies such as mandatory organics recycling, and enforcement can yield capture rates to as high as 70-85% (Portland, OR, Seattle WA, and San Francisco, California) with 90% plus in participation. The model assumes an 85% participation rate for single-family households, 40% for multifamily households, and 50% for commercial.

Education – The recommended education costs for materials management programs are incorporated into the scenario based on TRP guidance of $10 per household annually (Bandhauer et al., 2021).

Table 18 presents estimated collection costs under Scenario E.

Table 18. Collection Costs Under Scenario E

Collection Description	# of Residents	Annual Total	$/HH YR	$/HH/Month
MSW (2x/week)	390,000	($25,300,000.00)	($64.87)	($5.41)
SSR (1x/week)	80,000	$3,700,000.00	$46.25	$3.85
Food & Yard (1x/week)	390,000	$20,100,000.00	$51.54	$4.29
Education	390,000	$3,900,000.00	$10.00	$0.83
	Total	**$2,400,000**	**$43.40**	**$3.62**

6.0 FACILITIES OVERVIEW

Section 6 of this White Paper summarizes the estimated costs tied to the solid waste and processing facilities needed by the Authority to execute the scenarios presented in Section 4. The analysis includes key cost factors such as facility capacity, size, capital equipment, operational needs, and related expenses. It also breaks down financial metrics like the cost per ton of waste processed and the cost per household. Given that the number of facilities required for each scenario is different, the conceptual facility costs are summarized below for **each** facility. Revenue estimates include tip fees generated from respective facilities and sales of commodities (e.g., finished compost, sorted recyclable, RNG sales, etc.).

Table 19 presents the estimated new processing facility capital summary. Please note, the **cost of land is excluded** in the summary below as there are multiple ways of funding and financing new facilities. No decisions have been made with respect to which facilities will be constructed and whether they will be owned by the Authority or managed through a Public-Private Partnership (P3). These estimates are planning level estimates intended to be used in comparing the scenarios and assisting in the decision-making process.

Table 19. New Processing Facility Capital Summary

Facility (Each)	Space (Acres)	TPY	CapEx[e]	OpEx	Revenue	Processing $ /Ton (OpEx + CapEx)	Net$/Ton/ Facility
SS RMPF	20	250,000	$72M	$14M	($13.5M)	$89	$35.14
Mulch Facility	3	175,000	$5M	$1.8M	($8.2M)	$14	($32.17)
Compost Facility (CASP)[a]	8	73,000[a]	$12M	$1.7M	($10.4M)	$35	($80.43)
Biochar (YW)	1	30,000	$10M	$700k	($1.7M)	$70	$13.48
AD	5	160,000	$64M	$10M	($8.4M)	$100	$47.66
C&D RMPF	12	450,000	$41M	$19M[b]	($2.3M)	$50[b]	$60[c]
Dry MRF	15	160,000	$49M	$18M	($13.3M)	$116	$61
MWP Facility (Fiber Extraction Dry MRF + AD + MRF)	30	330,000	$363M	$30M	($23M)	$194	$124
Public Drop-Off Centers	0.5	12,000	$140k	$1M	Negligible	$86	$86
Transfer Stations [d]	15	3,120,000	$140M	$156.5M	$187M	$84	$24
WTE	30	1M	$900M	$14.4M	$32.6	$14	$147
Landfill	640	3,4M	$814M	$261M	$435M	$89	$41

[a] Total mix throughput is 90,000 tons per year consisting of 36,000 tons per year of food waste, 37,000 tons per year of yard waste, and 17,000 tons per year wood chips (obtained separately from the recovered organic waste stream).
[b] Includes cost of disposal (transfer and disposal to landfill) and fines management.
[c] Assumes 80% Capacity of C&D Facility.
[d] Assumes the largest capacity needed under all scenarios and three (3) facilities and excludes vehicles.
[e] CapEx cost excludes land acquisition as well as any site-specific considerations.

Table 20 presents the projected number of new facilities for each scenario.

Table 20. Number of New Facilities per Scenario

Technology	Number of Facilities per Scenario				
	A	B	C	D	E
SS RMPF	2	2	2		2
Organics Processing Facility	2	2		2	
AD Food Waste (FW)				3	
Yard Waste (YW) Mulch Windrow	2	2		2	
FW/YW Compost (CASP)		1	10*		10*
Biochar YW (optional)	1	1	1	1	1
MWP Facility					3
Dry MRFF				6	
C&D RMPF	2	2	2	2	2
Public Drop-Off Recycling Facility	8	8	8	8	8
Transfer Stations	3	3	3	3	3
WTE		1	1		
Landfill	1	1	1	1	1

*The 10 Food waste/Yard Waste CASP zones will be part of two (2) organics processing facilities.

6.1 FACILITIES IMPLEMENTATION TIMELINES

Please note that the timelines below are for illustrative purposes only. Each type of facility may differ based on the time and complexity of the project. For most of the required infrastructure, there will be combinations of facilities (transfer stations and processing facilities) which are combined on one site to eliminate costs in permitting, site development, logistics, and operations. **Table 21** presents the facility implementation description, action, and timelines.

Table 21. Facility Implementation Description, Action, and Timelines

Action	Description	Timeline
Permitting	Solid waste permitting, licensure, and special (e.g., wetlands, antiquities, EJ concerns)	6 to 36 months
Funding	Bond issues, Grants and/or Fund availability	6 to 18 months
Procurement	Request for Qualifications (RFQ)/Request for Proposals (RFP) process, vendor selection, contracting	6 to 24 months

Action	Description	Timeline
Preliminary Design	Site, building and equipment layout and selection by Authority/Owner's engineer	6 to 18 months
Equipment Manufacture	Facility equipment, specialty facility components	24 to 36 months
Site/Building Design and Manufacture	Assume pre-engineered	9 to 12 months
Site Construction	Initial site grading and preparation	6 months
Building Construction	Engineer and erect building including concrete foundation and walls	6 to 12 months
Equipment Installation	Dependent upon complexity of facility and equipment	Up to 18 months
Acceptance Testing	Dependent upon the complexity of the facility	Up to 30 days or longer

The Authority must account for potential delays due to power outages, flooding, and hurricane cleanup as part of its contingency planning. During the COVID-19 pandemic, equipment delivery times reached up to 26 months following contract approval. While current delivery times have improved, they still range from approximately 12–18 months for complete systems and 10–14 months for individual sorting components.

The project timeline will vary significantly depending on the entity responsible for final design and the stages at which various approvals are required. A critical factor is determining the extent of government involvement in siting, ownership, and operation. This decision influences the timing of subsequent government actions at each stage, with each decision potentially adding months to the overall timeline.

6.1.1 Single-Stream RMPF

As previously outlined, the Authority currently processes its SSR at the Reuter Facility. Processing fees for this facility range from $90 to $200 per ton, depending on community contracts. WM is in the process of constructing a new, state-of-the-art, 127,000 square foot RMPF adjacent to the existing site. This $80+ million RMPF will have a processing capacity of 66 TPH, equivalent to 260,000 TPY, and is referred to as the WM South Florida Facility.

To prepare for increased SS recyclable volumes anticipated by 2045, the following processing options are outlined for consideration:

1. **Leverage Existing Private Infrastructure**
2. **Issue a New Solicitation for Private RMPF Development**
3. **Pursue a P3 for a Public RMPF in Collaboration with a Neighboring Jurisdiction**

It is important to note that additional capacity exists in nearby counties. For example, WM and Lee County are expanding SS processing capacities to 60 TPH (equivalent to 260,000 TPY), which could be accessed through transfer agreements.

6.1.1.1 Strategic Options for Long-Term Single-Stream Recycling Needs

To address future requirements and ensure cost efficiency, the Authority should employ competitive procurement processes to explore the following options:

Option A: Maintain the Status Quo - Continue utilizing the WM Reuter Facility and the adjacent new WM South Florida Facility that will replace it after construction is completed. While straightforward, this approach may lead to higher processing fees unless alternative strategies are pursued to foster market competitiveness.

Option B: Issue a Competitive RFP for Private RMPF Development - Release an RFP inviting private entities to establish a new RMPF within the boundaries of Broward County. This option aims to promote cost efficiency through competition and market expansion.

Option C: Develop a Regional Public RMPF or P3 - Collaborate with other units of government outside of Broward County to procure a regional public RMPF. A P3 approach would optimize resources, increase processing capacity, and capitalize on cost-sharing opportunities and economies of scale.

6.1.1.2 Considerations for Implementation

Each option offers distinct advantages and challenges in terms of cost, operational efficiency, and long-term sustainability. It is likely that a combination of these strategies will be required to meet the Authority's evolving waste management goals while providing cost-effective and environmentally responsible service to its residents.

Additionally, constructing a new SS RMPF can be approached through various models. The table below provides an overview of the estimated capital and operational costs for a new facility with a capacity of 250,000 TPY (60 TPH). **Table 22** presents the estimated capital and operating costs of a new 250,000 TPY RMPF.

Table 22. Estimated Capital and Operating Costs of a New 250,000 Ton Per Year Facility

Single Stream RMPF	Estimated Cost	Description
Total Throughput (per site)	250,000 TPY	Inbound SS recyclable tons including residue
Capital Cost (per site)	$72,000,000	Includes the cost of construction, RMPF equipment, and rolling stock. Excludes the cost of land.
Annual Facility Cost	$22,300,000	OpEx plus annualized CapEx
Estimated Revenues	($13,500,000)	Estimated generated revenues ($54.52/ton using a 10-yr AVG of South East ACR)*
Average Cost Per Ton	$35	Includes operating cost and annualized capital costs spread over incoming tons

*Assumption: Cost of disposal of residue at $82.50 per ton (average between Class I landfill and WTE fees).

6.1.2 Organics Processing Facilities

Siting facilities for organics processing presents several challenges, primarily due to the high cost and limited availability of suitable land.[10] Additionally, transporting organic materials over long distances is less cost-effective due to their high moisture content. Facility locations must also consider potential community concerns regarding odor and traffic impacts. Based on these considerations, two potential sites have been identified for organics processing facilities: Reuter Facility site in Pembroke Pines and the Broward County Landfill site.

Each facility will utilize a tailored mix of technologies to efficiently process the quantity and composition of recovered organic materials while responding to market demands. Mulching is recommended for processing yard waste independently, as it is the simplest and most cost-effective method. Composting is necessary for food waste to ensure stabilization, pathogen control, and odor reduction, while also producing a valuable product to recycle nutrients and improve soil health. Yard waste, when combined in appropriate proportions with food waste, can serve as a bulking agent and a carbon source, enhancing the composting process.

The market for mulch and soil amendments in Broward County is limited. Estimates using the Mulch & Soil Council methodology suggest a total market size of approximately 74,000 TPY for mulch and 33,000 TPY for soil amendments such as compost and topsoil.[11] However, recycled organic waste-based mulch and compost face competition from traditional wood mulch and premium organic compost products. Additionally, the high concentration of palm material in regional yard waste poses challenges to degradation during processing.

To address these challenges and improve the viability of organics processing by the Authority, several additional strategies are recommended:

- **Pyrolysis Unit:** Incorporating a pyrolysis unit to process hard-to-decompose organic material, such as palm waste, into biochar. Biochar offers additional market opportunities and supports soil health initiatives.

- **Colorizing Process:** Adding a colorizing step to enhance the aesthetic appeal of recycled mulch products, increasing market competitiveness.

- **Trained Salesforce:** Employing a highly trained salesforce to promote end products effectively, ensuring market penetration and customer education.

By implementing these measures, the Authority can develop a more robust and sustainable organics processing system that addresses existing challenges and maximizes resource recovery.

It's important to note that, in Florida, a solid waste management facility that produces compost or mulch is required to be permitted pursuant to Section 403.707, F.A.C, 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

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[10] A search conducted on 12/11/2024 showed no agricultural land available.

[11] The report produced for Miami-Dade County by Townsend et al., 2021, assumes 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 24-30 ft^3. For every yd^3 of bagged mulch sold per year, approximately two (2) yd^3 of bulk mulch is sold. Finally, soil products are about 40% of mulch volume in unit sales. According to 2019 Census information, the number of single-family households in Broward County is 349,006.

standards, operational features, operations plan, water quality, compost facility data, and certification by an engineer or public officer.

Table 23 presents the operations or zones needed across the organics processing facilities for each scenario.

Table 23. The Operations or Zones Needed Across the Organics Processing Facilities to Meet Recovered Organics under Each Scenario

Technology	Number of Facilities per Scenario				
	A	B	C	D	E
AD FW	0	0	0	3	0
YW Mulch Windrow	2	2	0	2	0
FW/YW Compost (CASP)	0	1	10	0	10
Biochar YW (Optional)	1	1	1	1	1

6.1.3 Windrow Mulch

Broward County, like many Florida counties, generates a significant amount of yard waste. An analysis conducted by the University of Florida in 2021 analyzed treatment of yard waste for Miami-Dade County (Townsend et al., 2021). The study concluded that mulching yard waste was more economical than composting yard waste given market conditions in the region.

Mulching is the simplest, least expensive treatment for yard waste. It is practiced by several Florida counties (e.g., Hillsborough, Sarasota, Lee), as a means for diverting yard waste from landfill.

To accommodate the maximum yard waste, two mulching operations should be sited, one at each Organics Processing Facility, each with a capacity of 175,000 TPY.

Table 24 presents the characteristics of a windrow mulch operation.

Table 24. Characteristics of a Windrow Mulch Operation

Windrow Mulch Operation Characteristics	Target Facility
Mass Throughput TPY	175,000
Volume Throughput Yd^3/Year[a]	360,600
Volume Throughput Per Day Yd^3/Day[b]	1,387
Mass Output Tons/Year[c]	140,000
Volume Output Yd^3/Year[b]	280,000
Volume Output Per Day Yd^3/Day[c]	1,077

[a] Density of mixed yard waste 1,000lbs/yd^3
[b] Shrink factor during mulching 20% (includes 1% residuals)
[c] Assumes 260 operating days/yr

Table 25 presents the facility design parameters for a yard waste mulching operation.

Table 25. Facility Design for Yard Waste Mulching

Equipment Units Needed[a]	Count
Tub Grinder Total Units	3
Front End Loader Total Units	3
Post Trommel Total Units	2
Personnel Needed	TBD
Operators Needed Total Employees	23
Managers Needed Total Employees	9
Trained Salespeople	2
Total Facility Footprint (Assuming New Site)	
Graded Area Total Acres	18
Mulching Operation Footprint	
Pile Length ft	536
Total Receiving Area Acres	0.37
Storage Area Sizing	
Pile Length ft	430
Total Receiving Area Acres	0.30
Total Volume and Area Sizing	
Total Area (Based on Daily Flow) Acres	3

[a]Extrapolated from Table 6-11 (Townsend et al., 2021)

Factors and Parameters:

Buffer Area 500ft
Support Area Ratio 2
Cross Sectional Ratio 0.5 to 0.66
Pile Dimensions 4'H X 30'W

The mulching process begins with grinding the yard waste using a tub grinder to a coarse size, which is then screened to remove contaminants and formed into long narrow piles (windrows). Mulching is more efficient in terms of time, land, and resources compared to windrow composting which involves more turning and a curing period. However, the quality of the mulch and demand for mulch may limit marketability. Advanced screening processes using multiple screen sizes can be used to remove contaminants like plastic and metals. Curing time in the pile can allow the mulch to reach an optimal temperature to destroy weeds or invasive seeds.

Conceptual capital cost parameters for a yard waste windrow mulching facility are presented in **Table 26.**

Table 26. Capital Cost Parameters Used to Estimate Cost of Constructing Yard Waste Windrow Mulching Facility

Equipment	\$/Unit[a]	Equipment life
Tub Grinder[a]	$430,000	10
Front End Loader[a]	$260,000	10
Post Trommel[a]	$170,000	10
Colorizing Equipment[b]	$200,000	10
Facility [a,c]	**Units**	
Grading Cost Per Acre $/acre	$14,700	
Grading Requirement acre/TPD	0.022	
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%	

[a] Based upon Table 6-12 adjusted to 2025 US$ (Townsend et al., 2021).

[b] For information on mulch colorizing equipment, refer to the Soil and Mulch Producers News article found in https://www.soilandmulchproducernews.com/mulch-coloring-equipment-an-investment-that-will-increase-your-mulch-sales/ (Heller, 2020).

[c] Land acquisition costs are not included.

Due to the market challenges discussed, it is not uncommon in Florida for yard waste mulch to be given away free to residents. In fact, yard waste mulch may be provided to residents for free at additional Drop-Off Centers discussed in Section 6.1.11. The UF study modeled the revenue from mulch to range from $0-$10.29 per ton (Townsend et al., 2021). Colorization processing can be used to increase the marketability of the yard waste-derived mulch, and a well-qualified sales staff (two of whom are included in the operating expenses) can drive sales and other utilization opportunities. Therefore, a value of $5 per ton of mulch was assumed. The facility is assumed to receive $42 per ton in tipping fees for the yard waste which is also considered revenue.

Table 27 presents a per ton cost summary for each windrow mulching operation.

Table 27. Summary Costs Per Ton Input for Each Windrow Mulching Operation

Capital Costs	($/ Ton)
Equipment	$1.27
Grading and Engineering cost[a]	$1.28
Total Capital Costs	**$2.62**
Operating Costs	($/ Ton)
Equipment maintenance	$0.68
Facility energy use	$2.97
Personnel	$6.59
Total Operating Costs	**$10.25**
Capital & Operating Costs	$14.47
Revenue	**($/Ton)**
Value of mulch product (high quality) – bulk[b]	$4.64
Tipping Fees	$42.00
Total Revenue	($46.64)
Capital + Operating Costs – Rev	($32.17)

[a] May not be required for existing, permitted site
[b] Adjusted to per ton of input YW.

6.1.4 Biochar Pyrolysis Unit

Pyrolysis to produce biochar is gaining popularity as a technology to manage high carbon content solid waste including yard waste. For example, pyrolysis is well suited to convert palm fronds which can be difficult to decay via composting into biochar. Biochar is a carbon-rich material produced by heating organic matter in the absence of oxygen. The structure and properties of biochar make it a desirable soil amendment as well as suitable for certain industrial applications. Biochar has numerous applications, including as a soil amendment, due to its ability to improve water retention and promote microbial activity. Biochar is commonly added at 5% to 10% by weight to compost to increase its value. Studies have also shown that biochar can promote microbial activity to improve aerobic and anaerobic processes, potentially reducing compost times and increasing biogas production respectively. Biochar also possesses properties that make it suitable for filtration, construction, and various industrial applications, including potentially treating PFAS. Pyrolysis also has shown promise as a method to destroy PFAS, particularly in low moisture feedstock (Keller et al., 2024). (See Task 9 Innovative and Future Technologies White Paper.)

A biochar operation with a capacity of 30,000 TPY of yard waste is included in the organics' facility scenarios. Capital expenses are estimated to be $10 million including a pyrolysis unit and a rotary dryer. Operating expenses are estimated to be $700,000 per year. This includes equipment maintenance costs at 2.5% of capital expense, 8- to 12-hours per day of labor for operation and maintenance, and utility costs. Pyrolysis units are recommended to be run continuously for a minimum of 8,000 hours per year.[12]

The process is expected to produce approximately 2,250 tons of biochar annually. Biochar has a wide range of applications and can be marketed to several end-use sectors. Potential uses include integration into the existing organics processing operation, such as incorporation into the CASP or AD processes or blending with finished compost to enhance its value and marketability.

To determine the optimal use of biochar, an analysis of current market conditions and operational requirements is essential, recognizing that these factors may evolve over the project's lifespan. For conceptual cost estimates, it is assumed that the biochar will be sold for industrial or commercial applications.

Biochar pricing varies widely based on factors such as region, quality, and shipment size. Lower prices are typical for bulk purchases, with a general range of $200–$1,000 per metric ton (Elias et al, 2022). For this analysis, a conservative value of $200 per ton is applied for biochar. The carbon contained in biochar is highly stable and resistant to degradation, allowing it to remain in soil for over a thousand years. As a result, biochar production is considered carbon-negative because it sequesters carbon that would otherwise be released into the atmosphere during biomass decomposition.

Although biochar may qualify for Biochar Carbon Removal (BCR) credits, and the BCR credit market is currently performing well, no revenue from these credits is assumed in this analysis to maintain a conservative estimate. Conceptual capital and operating costs and cost per ton parameters for a biochar processing facility are presented in **Table 28.**

Table 28. Capital and Operating Costs and Costs Per Ton for Organics Facilities

Capital Costs		($/ Ton)
Modular Pyrolysis Unit	$5,640,00	$6.27
Rotary Kiln Dryer	$5,680,000	$13.33
Total Capital Costs	$11,320,000	**$19.60**
Operating Costs		($/ Ton)
Total Operating Costs	$660,000	**$22.01**
Capital & Operating Costs	$2,100,000	$70.48
Revenue		**($/ Ton)**
Biochar	$450,000	$15.00
Tipping Fees	$1,260,000	$42.00
Total Revenue	$1,710,000	57.00
Capital & Operating Costs – Revenue		**$13.48**

[12] Pyrolysis units are optimally run continuously or greater than 8,000hr/yr. If a correctly sized unit is not available, then the capital and operating costs may vary.

6.1.5 Covered Aerated Static Pile Composting

CASP composting is one of the most cost-efficient and straightforward methods for processing large volumes of food-based organic waste. This method is particularly suited for materials with high moisture content, a greater propensity for odor generation, and "messy" organic waste streams.

6.1.5.1 Key Features of Covered Aerated Static Pile Composting

- **Aeration System:** CASP composting utilizes an aeration system to circulate air through the composting mass. Depending on factors such as incoming material composition, site geography, and operator preference, either positive or negative aeration systems can be implemented:
  - **Negative Aeration:** Draws air into the pile, effectively managing odors. This method requires biofilters to treat emissions and volatile organic compounds (VOCs).
  - **Positive Aeration:** Pushes air through the pile and is commonly used. The pile is typically covered with a synthetic fabric or a biofilter layer (e.g., finished compost or wood chips) to retain heat, maintain moisture, and reduce odors and emissions.
- **Enhanced Degradation:** By introducing airflow, CASP systems maintain aerobic conditions, optimal moisture levels, and temperatures conducive to microbial activity, maximizing degradation efficiency while minimizing pathogens.
- **Operational Simplicity:** Unlike windrow composting, CASP systems do not require pile turning, as airflow provides necessary oxygenation. However, piles must be moved between phases, reducing overall operational costs.
- **Odor and Emission Control:** Controlled airflow and covers help mitigate odors and emissions, minimizing the facility's impact on neighboring areas.
- **Stormwater Management and Visual Appeal:** CASP systems improve stormwater runoff quality by preventing rainwater from contacting decomposing waste. Covered systems also enhance the visual appeal of composting facilities.

6.1.5.2 Composting Process and Phases

CASP composting typically takes three to six months to produce finished compost, proceeding through the following phases:

1. **High-Rate Active Composting:** 21–28 days
2. **Maturation/Curing:** 14–28 days
3. **Finishing (Optional, Uncovered):** 14–28 days

6.1.5.3 Infrastructure and Operational Requirements

CASP systems require a range of infrastructure and equipment, including:

- Aeration components: blowers, relay panels, electrical service, power panels, and switchboards.
- A concrete pad for active composting.

- Optional concrete bin blocks for containment and waterproof covers for controlling air and moisture levels.
- Front-end loaders for moving material between phases.

6.1.5.4 Preliminary Cost and Capacity Estimates

A CASP facility capable of processing 73,000 TPY of organics (36,000 TPY food waste and 37,000 TPY yard waste) requires an additional 17,000 TPY of wood chips for bulking, achieving optimal carbon-to-nitrogen ratios and moisture content. This brings the total processing capacity to 90,000 TPY. It is assumed wood chips will be sourced at no cost from commercial and industrial drop-offs or storm debris.

Each 90,000 TPY CASP operation will require approximately 8–12 acres, including:

- Feedstock receiving and storage areas
- Active composting and curing pads
- Finished compost storage and distribution areas
- Stormwater management systems
- Space for pile movement, screening, and grinding

Site development costs such as land acquisition, surveys, engineering, roads, utilities, water management systems, and buffering are not included in this preliminary estimate, as they will depend on the selected site.

6.1.5.5 Example Facility Design

An active composting pad with 46–52 zones (26 feet wide x 80 feet long x 10 feet high) can accommodate 35,000 cubic yards at a time. With a 45-day cycle and an average material density of 670 pounds per cubic yard, this design supports 90,000 TPY throughput.

The table below summarizes the site size and staffing requirements for a facility with a 90,000 TPY capacity.

Table 29 presents site sizing and staffing requirements for a CASP composting facility.

Table 29. Site Size and Staffing Requirements for CASP Facilities

CASP Facility Characteristics	Units
Total Throughput - CY Per Year	262,000
Total Throughput - Tons Per Year	90,000
Total Site Area – Acres	8-12
Total Composting Pad Area – Acres	3-4

CASP Facility Characteristics	Units
Active Composting Time – Days	45
Equipment – Pieces	9
Staff – FTE (including two equipment operators, scale operator, mechanic and supervisor)	5
Total Marketed Material – CY	105,000
Total Marketed Material – Tons	37,300

Table 30 presents the equipment requirements and estimated capital costs for a CASP composting facility.

Table 30. Equipment Requirements and Estimated Capital Costs for CASP Facilities

Equipment	Estimated Capital Cost	Notes
Rolling Stock/Portable Equipment		
Loader – Large Bucket Capacity	$325,000	Volvo L120H, or Similar
Loader – Medium	$165,000	Volvo L20 or Caterpillar 928 HZ
Grinder	$515,000	Doppstadt AK315 Grinder, or Similar
Screener	$325,000	Doppstadt SM617.2, or Similar
Dump Truck	$50,000	
Service Truck	$50,000	
Pickup Truck	$35,000	Silverado 2500 Work Truck, or Similar
5,000 Watering Tank and Trailer	$15,000	Assumed Used from Construction Sales
Air Compressor	$250,000	
Small Tools/Initial Parts	$5,000	
Permanent Equipment		
Scale	$100,000	Included in Site Development Costs
Cover (i.e. Gore)	$2,300,000	Included in Site Development Costs

Table 31 presents the estimated capital and operating costs and associated revenues for the CASP composting facility. Even at an overall estimated capital costs of $12.1M, with the tip fees and compost sales, the net revenue of the facility is $80.43 per ton of incoming material. The costs assume:

- Expected revenue for the sale of 80% of the finished compost each year at $30 per calendar year for bulk loaded and $5.33 per 30-pound bag (assuming 50% is sold bulk and 50% is sold bagged).
- Up to 17,000 tons of wood chips are provided at no cost, or from the mulching/grinding operation. The wood chips are added as bulking agent to the food waste and yard waste mix.
- A tipping fee of $42 per ton for any feedstock (this is less than the $50 per ton landfill tip fee in the area).
- The cost of land purchase is NOT included.
- The CASP pad of 3-4 acres is constructed of engineered concrete.
- The rest of the site is constructed of engineered gravel.

Table 31. CASP Facility Costs

CASP Facility Costs	Units
COSTS	
Equipment Capital ($)	$1,800,000
Site Development and Building Capital ($)	$10,4004,000
Total Facility Capital Cost	$12,0100,000
Total Annualized Cost of Capital ($)	$1,500,000
Total Annual Operating Cost - Labor, Maintenance, Equipment, Disposal ($)	$1,700,000
REVENUES	
Tip Fees	($3,100,00)
Compost Sales	($7,300,0000)
Total Annual Revenues	($10,400,000)
Capital Operating Costs –Rev ($/Processed Ton)	($80.43)

* The projected compostable material tip fee is less than landfill yard trash tip fee of $50 per ton resulting in community savings.

6.1.6 Anaerobic Digestion Facility

The initial development of AD in North America has primarily focused on co-digestion applications at farms and wastewater treatment facilities, targeting industrial and commercial food waste with low solids content. A regional example is the North Regional Wastewater Treatment Plant (NRWWTP) in Pompano Beach, Florida. However, the use of AD for MSW is gaining traction as a key technology for achieving organic waste diversion targets. One prominent example is Ontario, Canada's food waste management system, which integrates the DRUMBO food processing facility with the London biodigester to process over 150,000 tons of MSW and industrial source-separated food waste annually.[13]

6.1.6.1 Pre-Processing Operations

- To prepare collected wet waste for AD, a comprehensive pre-processing phase is essential. This phase may include the following steps:
- **Shredding:** Initial size reduction of waste materials.
- **Contaminant Inspection:** Manual inspection to identify and remove physical contaminants.
- **Recyclables and Residual Removal:** Manual or mechanical separation of non-organic materials.
- **Particle Size Reduction:** Further refinement to meet feedstock specifications.
- **Amendments:** Addition of water or low-solids organic wastewater to achieve a slurry with 12–14% solids content.
- **De-Packaging:** Removal of packaging materials for Industrial, Commercial, or Institutional (ICI) food waste, as needed.
- **Degritting:** Final removal of residual contaminants missed during earlier stages.

These processes ensure the feedstock meets the technical specifications required for efficient digestion and optimal system performance.

- **Capital Costs:** $5.5 million per 160,000 TPY facility.
- **Operating Costs:** $0.5 million annually per facility.
- **Land Requirements:** A minimum of three-acres per facility.

6.1.6.2 Anaerobic Digestion and Biogas Production

The refined slurry is fed into ADs, where it is processed to produce biogas and digestate (the residual byproduct). To meet the Authority's needs, three bioreactor facilities are recommended, each with an annual capacity of 160,000 tons of food waste. These facilities can feature a single large digester

[13] Generate Upcycle Canada

(approximately 5.5 million gallons) or multiple smaller digesters, with scalability to accommodate future growth.

- **Tipping Fees:** Estimated at $42 per ton, making food waste diversion more cost-effective than WTE or landfill disposal.
- **Capital Costs:** $43.8 million per 160,000 TPY facility.[14]
- **Operating Costs:** $4.1 million annually per facility.[15]
- **Revenue:** $6.7 million annually from tipping fees, with additional revenue potential from accepting industrial and commercial low-solids food waste for dilution or parameter stabilization.
- **Land Requirements:** A minimum of five-acres per facility; up to ten-acres may be needed if pre-processing infrastructure is included.

Each facility is expected to produce approximately 1,000[16] standard cubic feet per minute (scfm) of biogas, which can be upgraded to about 475,400 MMBtu/year of RNG for injection into natural gas pipelines.[17]

6.1.7 Biogas Upgrading and Pipeline Injection

Recent trends favor upgrading biogas to RNG, which can either fuel vehicles onsite or be injected into natural gas pipelines. This approach has the potential to generate approximately $1.7 million annually in RNG sales, assuming a market value of $3.50 per MMBtu.

6.1.7.1 Additional Revenue Opportunities

- **Environmental Attributes:** RNG generated from AD of MSW qualifies for D5 Renewable Identification Numbers (RINs) under the Renewable Fuel Standard, potentially generating an additional $9.6 million annually.[18]
- **Low Carbon Fuel Standards (LCFS):** RNG sold in markets like California or Oregon could yield additional revenue (California Air Resources Board, 2022).
- **Government Incentives:** Federal Investment Tax Credits (ITC) and other incentives may offset capital costs. [19]

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[14] Based on data provided by NREL adjusted for TPY (Milbrandt, 2021).
[15] Based on data provided by NREL adjusted for TPY (Milbrandt, 2021).
[16] Assuming 3,300 scf/ton food waste based upon U.S. Environmental Protection Agency, Region 9 (East Bay Municipal Utility District, 2008).
[17] Assuming 1020 btu/scf, 97% upgrade efficiency and 91% facility uptime.
[18] Based upon D3 RIN price of $2.30/RIN, Assuming 114,000 BTU/GGE (Capozzola, 2024).
[19] For example, while the price of RINS can vary, current D3 RINS are valued at $2.85 (D3 Cellulosic RINs (OPIS) Futures Quotes - CME Group) Calculating $/RIN*RIN/0.077mmBTU=$37/RIN which would deliver an addition $23M/yr or $147/ton input.

6.1.7.2 Costs and Requirements

- **Upgrading and Injection Costs:** Estimated at $20.2 million for upgrading equipment and injection infrastructure (e.g., piping and compression) (California Air Resources Board, 2022).
- **Operating Costs:** Estimated at $1.9 million annually (California Air Resources Board, 2022).
- **Regulatory Requirements:** EPA approvals and commercial pipeline agreements are mandatory for RNG injection.

This comprehensive approach positions AD and biogas production as cornerstone technology for sustainable waste management and renewable energy generation.

Table 32 presents the capital expenses for AD and biogas facilities.

Table 32. Capital Expenses for AD & Biogas Facilities

	Capex	$/Ton
Capital Expenses		
Pre-Processing	$5,500,000	$3.24
Digester	$43,800,000	$25.86
RNG[a]	$20,200,000	$11.91
Capital Expense total	$ 64,000,000	$37.80
Operating Expenses		
Preprocessing and Digester	$ 7,000,000	$43.68
RNG	$ 3,500,000	$21.70
Operating Expense Total[c]	$ 7,400,000	$62.26
Capital and Operating Total	$ 71,400,000	$100.06
Revenue[b]		
Tipping Fees	$ 6,700,000	($42.00)
RNG Sales[b]	$ 1,700,000	($10.40)
Total Revenue	$8,400,000	($52.40)
Capital & Operating Costs – Rev[b]	$ 63,000,000	$47.66

[a] Includes clean up and injection. Injection costs represent approximately 25%. Clean-up costs may be reduced if utilized onsite as vehicle fuel.
[b] Additional revenue from the sale of attributes, LCFS or other offsets not included24.
[c] Costs for digestate management are included in the operational expense.

6.1.8 Digestate Management

Managing digestate, the byproduct of AD, is a critical consideration in facility design and operation.

- **Solid Digestate:** Separated solids can be composted, requiring additional site space, or converted into biochar through innovative treatment technologies.
- **Liquid Digestate:** Options include:
  - **Land Application:** Used as organic fertilizer within a 25-mile radius. Farmers often absorb the cost of transportation in exchange for the material.
  - **Wastewater Treatment:** Trucking the liquid digestate to nearby wastewater treatment facilities for further processing and discharge. This option incurs additional transportation costs depending on the distance to the WWTF.

By carefully integrating these considerations into facility planning and design, AD projects can achieve operational efficiency, financial viability, and compliance with environmental regulations.

6.1.9 Mixed Waste Processing Facility with Fiber Extraction

Mixed waste processing facilities separate valuable materials such as metals, paper, and plastics from organic or non-recyclable waste. Over time, these facilities have evolved significantly, driven by the need to enhance resource recovery, minimize landfill use, and comply with increasing regulatory requirements for waste diversion.

6.1.9.1 Historical Development

The concept of mixed waste processing facilities originated in the 1970s as a response to the growing need for resource recovery from increasing waste streams. Early facilities were limited by inefficient, labor-intensive separation methods. As recycling gained popularity, simple mechanical technologies were introduced, enabling modest recovery of materials like metals, but inefficiencies and high residual waste levels persisted.

Technological advancements over subsequent decades—such as disc screens, optical sorting, eddy current separators, and air classifiers transformed the industry. Automation enhanced both efficiency and safety. More recently, cutting-edge technologies like robotics, artificial intelligence (AI), and data analytics have further maximized resource recovery. Many facilities now incorporate AD or composting to recover organics, reflecting the industry’s shift toward integrated waste management.

6.1.9.2 Modern MWP Processing Technologies

Today’s advanced MWP facilities leverage a combination of mechanical, digital, and analytical technologies to enhance resource recovery:

- **Optical Sorting and AI-Powered Robotics:** Optical sorters, using visual and near-infrared (NIR) spectrum technologies, efficiently separate materials based on chemical composition. Integrating AI and machine learning enables rapid identification and sorting, significantly improving accuracy and throughput.

- **Advanced Mechanical Separation:** Facilities deploy trommel screens, air classifiers, ballistic separators, and eddy current separators to segregate materials by size, density, and magnetic properties.

- **Data Analytics and Smart Facility Management:** Sensors and Internet of Things (IoT) devices monitor equipment performance and waste flow in real time. Operators use this data to optimize processes, reduce maintenance, and address inefficiencies, enhancing productivity and reducing downtime.

- **Circular Economy Integration:** Many facilities now contribute to circular economy initiatives by producing secondary raw materials and collaborating with manufacturers to "close the loop" on material use. These efforts direct recovered materials into sustainable supply chains, reducing reliance on virgin resources.

6.1.10 Dry Mixed Waste Processing Facility

A wet-dry waste management system is a dual-stream collection system that separates waste at the source into wet waste (organic waste, food scraps) and dry waste (recyclables and non-organics). Dry MWPs are specialized plants that handle the dry fraction of the waste stream in a set-dry waste management system, accomplishing sorting, recovery, and diversion of recyclable materials before landfilling or energy recovery.

6.1.10.1 Historical Development

During the 1900's and early 2000's several Canadian cities implemented wet-dry systems in Ontario and Quebec. The communities of Guelph and Markham Ontario were early pioneers of the wet-dry approach utilizing concepts developed the firm R. Cave and Associates. The system concept aimed to divert organic waste from landfills while simplifying recycling and recycling participation. By the mid-2000's most wet-dry systems had moved away from the concept toward one with a Green Bin for source separated organics and a traditional Blue Bin for single stream recyclables.

The move was motivated by high contamination rates in the dry stream, insufficient sorting technology, and lack of marketplace acceptance for recovered materials. The experience did prove fruitful in that both communities have continued to evolve toward diversion rates that approach or exceed 80% and have built community behavior patterns that support continued high recovery rates.

Now, new advances in sorting technologies during the last few decades such as disc screens, optical sorting, eddy current separators, and air classifiers enable the industry to once again consider this more efficient collection approach. Automation has been able to enhance both efficiency and safety. More recently, cutting-edge technologies like robotics, advanced air sortation, AI, and data analytics have further maximized resource recovery. Finally, instead of composting, management of the wet stream can now more efficiently employ AD for the purpose of extracting clean renewable energy from the organic fraction.

6.1.11 Fiber Recovery as a Chemical Recycling Solution

Fiber recovery is an advanced chemical recycling method focused on extracting high-value fibers from materials that are traditionally difficult to recycle, such as food-contaminated paper and plastic-coated packaging. This process provides a sustainable alternative for managing materials that would otherwise be sent to landfills or incinerators due to contamination.

A key aspect of the fiber recovery facility approach is its integration with an upstream MSW processing system. This system uses mechanical sorting technologies to remove non-fiber-based materials (e.g., plastics, metals, glass) and contaminants. Additionally, the process incorporates a downstream AD component for further material diversion and energy recovery.

6.1.11.1 Fiber Recovery Process Overview

After mechanical sorting, the residual waste is directed to the fiber recovery stage, where materials are pulped using water and mechanical action to separate the fibers. Key steps in the process include:

- **Specialized Pulping:** Designed to handle food-soiled and plastic-coated materials, enabling efficient fiber recovery.
- **Separation and Refinement:** Processes such as autoclaving for sanitation and contaminant separation, additional contaminant removal, and fiber refinement ensure the purity and quality of the recovered fibers.
- **Fiber Collection:** The refined fibers are dewatered, dried, and prepared as raw material for producing new paper and packaging products, closing the recycling loop and reducing the need for virgin fibers.
- **Residual Waste Utilization:** Remaining waste is processed through AD, providing energy recovery to offset the energy demands of the recycling process.

6.1.11.2 Facility Design and Requirements

To manage the post-recycling MSW flow of approximately 1,000,000 TPY as considered in Scenario E, the Authority will require a facility with the following specifications:

- **Facility Quantity and Capacity:** Three MWP Facilities with Fiber Extraction with 330,000 TPY each.
- **Facility Size:** A 240,000-square-foot building on a 20- to 40 acre site.
- **Operational Features:** The facility will include areas for waste delivery, tipping floors for waste management, and three core operational functions:
  1. **Sorting:** To separate non-fiber-based commodities and contaminants.
  2. **Fiber Extraction:** To recover and refine fibers from contaminated materials.
  3. **Anaerobic Digestion:** To process residual waste for energy recovery.
- **Product Logistics:** Dedicated infrastructure for shipping recovered fibers and energy products, ensuring the facility achieves its recovery and diversion goals.

6.1.11.3 Cost Analysis Assumptions

The following assumptions were made in preparing the cost analysis:

- The facility must handle the full MSW flow after initial recycling.
- Integration of advanced sorting, fiber recovery, and AD technologies is required.
- The site and infrastructure must accommodate efficient operations, product handling, and compliance with environmental and regulatory standards.

By implementing this integrated approach, the fiber recovery facility can significantly enhance recycling rates, reduce landfill dependency, and contribute to the circular economy through the production of sustainable raw materials.

The timeline required from permitting, site development, procurement, education, to operation is expected to take approximately two years. Siting, preliminary design, and Authority approval will likely take an additional two to three years, depending on the Authority's budgeting, permitting, and approval process.

6.1.11.4 Challenges and Opportunities

While advancements in MWP processing are significant, challenges remain:

- **Material Contamination:** Contaminants in mixed waste streams degrade the quality of recovered materials, complicating recycling efforts. Further development of advanced sorting and decontamination techniques is essential.
- **Policy and Regulation:** Stringent regulatory requirements for recycling and emissions reductions are increasing both capital and operational costs, requiring facilities to innovate and adapt.
- **Technological Innovation:** Continued progress in robotics, AI, and other advanced technologies will drive further improvements in sorting efficiency, accuracy, and adaptability, making facilities more resilient to evolving waste streams.

Table 33 presents the estimated cost for one MWP Facility with fiber extraction and an AD Facility.

Table 33. MWP with Fiber Extraction and AD Facility Estimated Cost

MWP Facility [20]	Estimated Cost	Description
Total Throughput	330,000 TPY	MSW Tons Excluding SSR Material
Capital Cost (Per Site) * Excludes: Cost of Land	$363,000,000	Estimated Cost
Annual Facility Cost ** Excludes: Cost of Land	$64,000,000	OpEx Plus Annualized CapEx
Estimated Revenues	$(23,000,000)	Estimated Generated Revenues
Average Cost Per Ton	$124	Includes Net Operating Cost and Annualized Capital Costs Spread Over Incoming Tons

6.1.12 Drop-Off Centers

It is recommended that at least one Drop-Off Center be established per ILA Member City, for a total of up-to 30-sites. However, given the limited space available and cost of land, at a minimum, one Drop-Off Center should be established per 150,000 Authority residents, with a minimum of 13-sites. Given the existing five drop-off center facilities currently located in Broward County, the Authority would need eight additional drop-off centers. Each Center should be sited in an area that is most convenient to potential users, whether that means it is centrally located, along a commonly traveled highway, or near popular areas of interest (e.g., parks, shopping malls, and recreation areas).

Table 34 presents the materials that would be collected at the Drop-Off Centers and the anticipated end market.

Table 34. Drop-Off Center Anticipated Materials

Material	End Market/Contractor
HHW	Contracted Vendor
Electronic waste, Batteries	Contracted Vendor
Textiles	Local Non-Profit/Charity
Glass bottles and containers	Glass Beneficiation Site
SSR	SS RMPF
Yard Waste	Contracted Vendor
Tires	Contracted Vendor, Tires Recycler
Scrap Metal	Contracted Vendor, Scrap Metal Recycler

[20] RRS, 2024, various equipment and building vendor quotations.

Each site should allocate approximately 0.25 to 0.5 acres of operational space for material handling and storage. Materials will be collected using various container types, including roll-off containers, Gaylord boxes (large, corrugated cardboard boxes designed for bulky or irregularly shaped items), and metal donation bins. To support efficient operations, each site will be equipped with two shipping containers designated for the storage of HHW, paint, and electronic waste. Additional site requirements include one electric pallet jack, Closed Circuit Television (CCTV) cameras for monitoring and deterring illegal dumping, and four roll-off containers. Anticipated costs for these facilities include land development and site preparation expenses.

6.1.12.1 Operational Staffing and Contracts

The management of HHW, electronic waste, and batteries will be overseen by a qualified chemist and trained technicians, while laborers will handle other material streams. It is assumed that chemists and technicians will be contracted through a third-party vendor. An RFP for a 10-year HHW and Electronics Recycling Contract should incorporate costs for necessary equipment and facilities, including sheds, drums, and shipping containers. Laborers may either be contracted or hired as Authority staff.

To ensure effective oversight and operational efficiency, it is recommended that the Authority hire up to two internal managers to handle administrative responsibilities, data management, and maintenance tasks.

6.1.12.2 Tire Recycling Performance and Recommendations

Florida counties have demonstrated varying levels of success in recycling tires. While many have achieved high recycling rates, the FDEP reported that Broward County recycled only 3% of the 24,483 tires generated in the County. In comparison, neighboring Palm Beach County achieved a 65% recycling rate, Miami-Dade County achieved 53%, and Collier and Hendry Counties reported rates of 66% and 55%, respectively (Florida DEP, 2024b).

Drop-Off Centers are practical solutions for collecting small quantities of tires from residents. Typically, contractors provide a roll-off container or trailer at each center, which on-site staff fill with tires over time. Proper training in tire stacking, or “lacing,” is critical to maximize the trailer’s capacity and ensure operational efficiency.

6.1.12.3 Yard Waste, Glass, and Other Materials

Materials such as yard waste and glass bottles and containers will be collected in roll-off containers. These materials will then be transported to appropriate end markets or interim processing facilities for further handling or recycling. **Table 35** presents the estimated cost for each Drop-Off Center.

Table 35. Drop-Off Centers Estimated Costs

Drop-Off Centers	Estimated Cost	Description
Capital Cost (Per Site)*	$140,000	Includes: roll-off containers, eight-yard dumpsters, site development (site leveling, grading, paving, fencing, cantilever gates, lighting fixture, striping, CCTV cameras for illegal dumping, etc.)
Operating Cost (Per Site)	$1.03M	Includes: 3x/week, eight-yard dumpster service for SS; roll-off service for yard waste, glass, tires, and scrap metal; labor, contracted processing costs for HHW and e-waste, processing/tip fees and HHW facility/equipment costs spread over 10-yr period through contract; porta potty rentals for center staff
Total Cost (Per Site)	**$1.17M**	

* Capital cost excludes the cost of land.

The projected timeline for completing permitting, site development, procurement, public education, and initiating operations is approximately 18 months. However, the siting process, preliminary design, and securing Authority approval may extend this timeframe by an additional one to two years, contingent on the Authority's budgeting, permitting, and approval procedures.

The design of the Drop-Off Centers should prioritize adaptability to accommodate shifting market demands and the emergence of new material streams. This flexibility can be achieved, in part, by selecting sites with more space than is initially required. Furthermore, strategies for mitigating illegal dumping should be incorporated into the planning and operational framework.

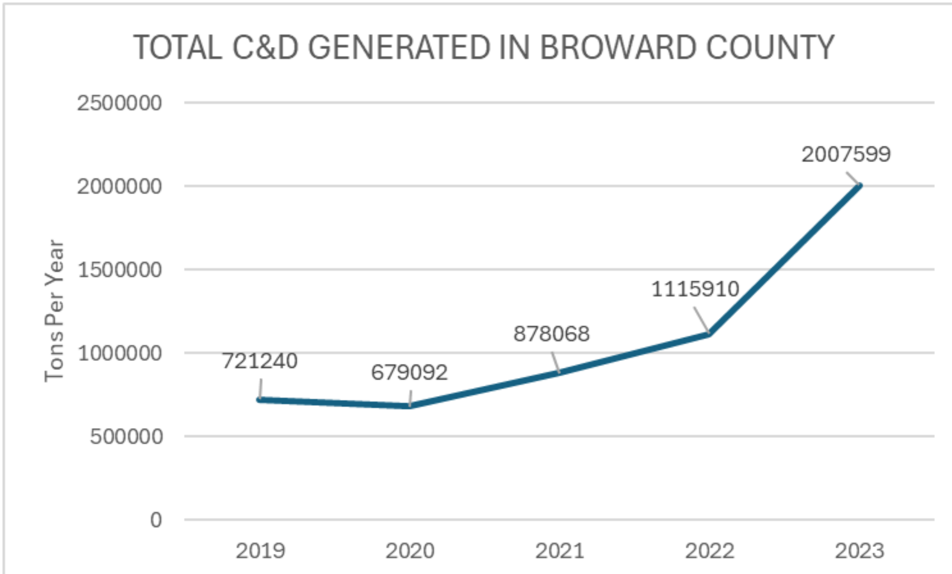
6.1.13 C&D Recycling Facility

According to the FDEP, Florida has a MSW recycling goal that includes C&D, which accounts for nearly 25% of the state's total MSW stream. FDEP reported that over 19 million tons of C&D debris were generated statewide in 2023, with Broward County contributing more than 10% of this total, approximately 2 million tons. While about 800,000 tons of C&D debris were recycled within the County, an estimated 1.5 million tons remained in the waste stream and were sent to landfills (Florida DEP, 2024).

As reflected in **Table 36**, between 2019 and 2023, Broward County experienced a significant 178% increase in C&D debris generation. This growth is attributed to several factors, including net in-migration driving increased construction, demolition, and remodeling activities, as well as the escalating impact of natural disasters, which has become the most significant contributing factor. The generation of C&D and its consequent waste characterization is complex.[21]

[21] Florida is fortunate to have resident scholars on C&D's nature and composition, and much more information can be deciphered through some of their outstanding work, i.e., Townsend, PhD., T, University of Florida, Anshassi, M, PhD., FL Polytechnical University, "Waste Management Principles and Practices:", Construction and Demolition Debris", Springer Nature Press, Switzerland, 2023.

Table 36. Total C&D Generated in Broward County



For planning purposes, C&D can generally be classified into a few general categories, as described below.

6.1.13.1 Heavy Demolition Debris

Separated, heavy demolition debris includes clean concrete, asphalt, and uncontaminated rubble (e.g., dirt, rock, sand). This material typically has well-established, localized direct recovery channels for each type of material and is generated from roads, bridges, concrete building exteriors, sidewalks, and other structures. Concrete, aggregate, and asphalt processors crush, size, and return these materials to construction projects for use in concrete production, asphalt mixes, inert materials such as sized rocks, stones, and concrete for road bases, foundations, riprap, drainage, reclamation, and other applications. Due to its relatively homogenous and inert nature, heavy demolition debris is cost-efficient to recycle and requires minimal processing. Removal transportation is provided by tilt-body (side or rear tilt), heavy duty trailers. Recovery may increase through regulation, so more is captured, especially by permit enforcement of construction site sorting requirements before material is mixed.

Heavy demolition debris, which is less likely to be processable, originates from two primary sources:

- **Heavy Mixed Debris.** This material is generated during the removal, replacement, or improvement of buildings, often involving large-scale demolition using heavy equipment. While some limited recovery and recycling of materials such as metals (e.g., electrical cables, fasteners, and structural steel), clean unreinforced concrete, road asphalt, and wood takes place on-site, most of the debris consists of highly heterogeneous materials. These include a large proportion of heavy, crushed building materials, along with a smaller fraction of lighter materials such as wood, plastic, asbestos, roofing panels, insulation, drywall, paneling, flooring, and lighting. The materials are sized, crushed, and mixed, resulting in a high volume of fines (particles under 4 inches). Additionally, universal waste is often mixed into the debris. The mixing and cross-contamination, along with the significant quantity of fines, make this segment particularly challenging to recycle. Much like separated debris, a large portion of this material requires specialized transport, such as tilt-trailers.

Heavy demolition debris also accumulates during storm flows caused by tropical weather events, where mixed debris must be quickly removed from damaged or destroyed structures. These materials often contain high moisture content, which accelerates spoilage, further mixing constituents, and increasing odor. As a result, much of this debris is ultimately directed to landfills because it becomes too damaged for processing. A common example is wet drywall and plaster materials.

- **Light C&D.** After excluding the heavy debris, the remaining mixed C&D are generated during new construction, remodeling, and the replacement of building components (such as roofs and patios). According to the most recent data from the USEPA, the national C&D waste stream generates approximately 600 million tons annually, more than twice the amount of MSW. Heavy debris constitutes the majority of C&D generation, while construction-related debris represents less than 10% of the total (USEPA, 2018).

6.1.13.2 Mixed C&D Processing Opportunity

Mixed C&D materials are typically collected through conventional disposal methods, such as roll-off containers, open dump trucks, and self-haul vehicles (e.g., stake body trucks).

Processing mixed C&D debris presents a significant opportunity to reduce disposal costs associated with light mixed C&D materials by separating traditional recyclables and bulk divertible materials for non-landfill applications. The key benefits of sorting mixed C&D debris include:

1. **Preserving Landfill Space** – Diverting materials from disposal helps preserve valuable landfill space.

2. **Reducing Disposal Costs** – Recovering divertible materials and recyclables can offset processing fees, reducing overall disposal costs.

3. **Beneficial Reuse** – Recovered materials can be used at landfill operations for purposes such as ADC, road construction, or slope stabilization.

4. **Green Building Certification Compliance** – Recovery efforts can help achieve compliance with green building certification requirements.

At mixed C&D MRFs, recovery rates vary based on the composition of incoming materials. Typically, facilities target the following recovery rates:

- **20–40% recovery of traditional recyclables and other divertible materials,** with actual recovery rates averaging between 15–30%. These materials include metals, plastics, and paper that are clean enough for resale. Bulk divertible materials, such as clean wood, inert materials (e.g., rock, brick, dirt, ceramics), and clean concrete, generally have lower market value, but their diversion significantly reduces disposal costs.

- **30–50% recovery of fines (Recovered Screened Materials, or RSM),** which are mixed fines smaller than three inches in size. RSM can boost recovery rates (sometimes exceeding 60%) when used as ADC in landfills. This application also offers GHG benefits by reducing the need to import soil for landfill cover. However, if RSM cannot be used as ADC, it is typically landfilled.

- **25–45% landfill disposal** of remaining materials.

While shingles and gypsum/drywall materials can be easily separated, they are often not recovered at C&D recycling facilities in the Southeast U.S. due to the additional processing required, including odor and asbestos management, as well as the ephemeral nature of the markets for these materials. These challenges make recovery economically unfeasible outside of regions with high landfill tipping fees. To improve recovery rates in South Florida, active market development and regulatory solutions, such as procurement preferences, will be essential. Further study is needed, or these materials will continue to be landfilled.

6.1.13.3 C&D Processing Facility Characteristics

Mixed C&D Processing Facilities are designed with inherent flexibility, enabling adjustments to sorting processes based on material composition, transportation costs, and local market conditions. For instance, the ability to recover RSM because they will need to be disposed, or more fines for landfill cover, replacing the need to import dirt and other materials, is a matter of how material is sized and crushed after arrival on the site, and adjustable residence time exposed to screening.

Existing C&D processing facilities may have adequate capacity to manage the current tonnage of C&D under current market conditions. However, with increasing tonnage and the potential for new policies and the evolution of markets that improve the recovery and marketability of materials, additional facilities will likely be needed.

To manage these new inbound tons, the Authority should consider the future development (whether publicly or through a P3) of up to two strategically located facilities that add processing capacity to the region. The facilities should each have a throughput capacity of 450,000 TPY or 100 TPH to manage the 850,000 tons needing processing.

The largest capital component is the building and site improvements to accommodate the efficient movement and storage of materials at all phases of processing. Siting a C&D processing facility at or very close to a landfill presents the ideal scenario to allow for the expeditious disposal of non-marketable fractions as well as the mutual use of facility scales and some rolling stock.

The scenario presented herein, including the estimated facility costs reflected in Table 37, assumes co-location of a mixed C&D processing facility at a landfill or transfer station site.

Table 37. C&D Processing Facility Costs

Estimated C&D Processing Facility Costs					
Fixed Depreciation Costs	**CapEx**	**Annual St. Line Depr. (Years)**	**Annual Cost**	**$/Ton 100% Capacity**	**$/Ton 80% Capacity**
Building and Site	$31,000,000	25	$1,240,000	$2.76	$3.44
Equipment	$8,000,000	10	$800,000	$1.78	$2.22
Heavy Equipment	$2,000,000	5	$400,000	$0.89	$1.11
TOTAL FIXED				**$5.42**	**$6.78**
OpEx			**$6,400,000**	**$14.22**	**$17.78**
	TONS	**T&D to LF** (Okeechobee)			
Disposal (50% of Inbound Material)	225,000	$48	$10,800,000	**$24.00**	**$30.00**
Fines Management- (Assumes $0 Disposal for Alternative Daily Cover)	**TONS- 30 % Fines**	**Trans- $300/22.5 T load**			
Transportation to Market	135,000	$ 13.33	$ 1,800,000	**$ 4.00**	**$5.00**
TOTAL COST PER TON				**$47.64**	**$59.56**

Curbside collection of construction debris is generally not provided, as it is not needed on a regular basis. Additionally, roll-off containers and specialized trucks do not handle curbside pickups, meaning there is no per-household fee associated with this service.

Different sites and locations will require varying levels of preparation, permitting, and other project development phases, all of which will influence the timeline. The development process outlined here represents a typical sequence of project milestones, without knowledge of the specific status of the selected site's siting process, procurement and budget approval requirements, or necessary permitting. It is also important to acknowledge that both the Authority and any vendors involved will be subject to time constraints, influenced by decision-making timelines, budget cycles, and the need for specialized equipment.

Co-locating a C&D processing facility with a landfill and a yard waste/organics complex could streamline the development process. Additionally, integrating the facility with a yard waste processing site would result in multiple efficiencies, including shared scales, management capabilities, processing of clean wood, and savings in transportation and disposal logistics.

Table 38 presents a conceptual development timeline for a C&D facility.

Table 38. C&D Processing Facility General Development Timeline

QUARTER	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Siting	•	•														
Preliminary Design	•	•	•													
Authority Approval			•	•												
Operating Partner Procurement Process				•	•	•										
Final Building & Site Design						•	•	•								
Permitting								•	•							
Site Development (Utilities, Water, Parking, Fencing, Roads, Pads, etc.)									•	•	•	•	•			
Building Construction										•	•	•	•			
Building Inspections Sign-off												•	•	•		
Process Equipment Selection & Procurement								•	•	•	•	•	•	•	•	
Sequential Hiring Training Staff													•	•	•	•
Equipment Installation														•	•	
Equipment Startup & Training[22]															•	
Throughput & Efficiency Testing																•
Operation																•

6.1.14 Transfer Stations

Transfer stations are solid waste facilities that allow for an efficient and economical means to transfer waste from a centralized collection point (transfer station) to the final disposal facility. At a transfer station, MSW from local collection vehicles is unloaded, then reloaded into larger tractor trailers for delivery to appropriate disposal facilities. Transfer stations can reduce the collection cost of hauling waste, by allowing for shorter trips and consolidation of waste before delivery to the final disposal facility, and they have the added benefit of reducing overall collection truck traffic on public roadways.

As noted in the Task 2 White Paper, Waste Management owns and operates the Davie Transfer Station, which is located at 2380 College Avenue, Davie, FL 33317. This transfer station receives approximately 1,000 TPD of Class I MSW. Considering the amount of MSW that will need to be

[22] Florida DEP, 2024.

managed by the Authority, the SCS Team is considering multiple transfer stations that are strategically located throughout Broward County (i.e., north, central, south).

6.1.14.1 Transfer Station Facility Design and Requirements

The following elements are critical when evaluating the design of a transfer station:

- Design Capacity
- Operating Days/Hours
- Storage Requirements/Constraints
- Land Area
- Tunnel/Loading Configuration
- Peak Loading Conditions
- Number of Unloading Positions
- Building Size
- Tipping Floor Storage Size
- Queuing Distances
- Scale/Scalehouse
- Stormwater Management
- Utilities
- Site Layout
- Tipping Floor
- Leachate Management
- Environmental Controls (e.g., Odor, Dust, Noise)

In addition, consideration should be given to the ultimate location of a transfer station. In the case of the Authority, it would be ideal for the transfer station to be sited within 10-miles of I-75 and within 20-miles of the population centers. It is highly desirable to achieve harmony with surrounding area by seeking an area that has appropriate zoning and is compatible with its surrounding area.

Based on the design assumptions, approximately 15-acres would be secured for each transfer station that would range in capacity between approximately 1,700 TPD and 4,000 TPD. Ample area is specified for each transfer station site to account for truck scales, queuing, on-site circulation and other facility features, including a biofilter, trailer storage area, security features, and associated site improvements. To maximize throughput, it is assumed that each transfer station would use a full-depth tunnel configuration. It is further assumed that each building would be an uninsulated structure with a steel frame with steel roof and wall panels, with translucent panels installed in the walls and roof to provide some natural lighting. On the upper level, the eave height would be a minimum of 35-feet. Within the transfer station, the floor-to-floor difference in elevation would be approximately 15-feet from the tipping floor elevation to the transfer tunnel floor elevation.

In terms of ancillary spaces, it is assumed that transfer trailer storage space would be required. An odor control system would be contained within a biofilter building, or a portable, modular system could be used. The transfer station could also use a misting, vapor, or other air filtration system to control odors. These systems would not require a separate building and could be included in the station building. Three key objectives are summarized below:

- **Operational safety** results from applying a set of planning parameters employed in developing the site and the transfer station. Safety would be achieved through security fencing around the perimeter of the site; separation of collection vehicles from transfer trailers; commonly used roadway design principles; and signage.

- **User-friendly features** provide for ease of use of the facilities. They would include directional signage; wide roadways to allow for easy collection vehicle circulation throughout the site; enclosed vehicle maneuvering areas; unobstructed enclosed unloading areas (tipping floor); and associated facilities.

- **Cost-effective design** approaches should lead to economical facility construction through efficient and functional use of the site areas to minimize the extent of the area required to be developed; use of standard construction materials for the site work and transfer station structure; and incorporating into the design the use of conventional building systems (e.g., a pre-engineered metal building for the transfer station, a modular structure for the scale house). Any transfer station would be required to adhere to Broward County building standards.

While the actual locations for the proposed transfer stations will be further explored in future white papers, the design for each transfer station would address the following elements at a minimum:

6.1.14.2 Transfer Station Facility Siting

Siting considerations would include a review of local and state site restrictions, applying exclusionary (e.g., wetlands and floodplains, endangered and protected flora and fauna habitats, protected sites of historical, archeological, or cultural significance) and technical siting criteria (e.g., proximity, access to major transportation routes, site area, circulation, buffers, topography, access to utilities, ability to expand, additional site uses, zoning concurrency), and environmental justice.

6.1.14.3 Transfer Station Cost Considerations

When developing transfer station cost estimates, regardless of the procurement approach, there are certain costs elements that must be considered. These items include:

- Site acquisition
- Construction
- Vehicle and Equipment
- Staffing
- Operations and Maintenance (e.g., Professional Services, Repairs, Fuel, Utilities, Supplies, Minor Capital Outlays, Insurance, Fees)

Table 39 presents the cost estimate by scenario, excluding vehicles and equipment.

Table 39. Transfer Station Cost Estimates by Scenario

	Scenario				
	A	B	C	D	E
Facilities	3	3	3	3	3
Total Area/Facility (Acres)	13	10	10	15	12
Annual Tons/Facility	890,000	546,000	443,000	1,040,000	703,000
CapEx/Facility	$46.6M	$28M	$24.5M	$52M	$32.7M
Annual OpEx/Facility	$31M	$19M	$17M	$35M	$25M
Annual Revenue/Facility[a]	$160.1M	$98.3	$79.8	$187.1	$126.6
Cost (Per Ton)	$87	$86	$94	$84	$82
Net Dollars (Per Ton)	$27	$26	$34	$24	$22

[a] Assumes a tipping fee of $60/ton.

It should be noted that the financial analysis is budgetary at this stage, as a detailed scope and site-specific parameters have not yet been identified but will be as the master planning process progresses.

6.1.15 Waste-to-Energy

The first solid waste incinerators, which were the predecessors to modern WTE facilities, were initially developed in New York in 1885 to process the high volume of waste being generated at that time. According to the Energy Information Administration, the first WTE facility in the U.S. (a facility that produced electricity from the combustion of solid waste) went online in New York in 1898. However, WTE technology was not widely used until the 1970's. Instead, the use of rudimentary incineration facilities grew during the early decades of the 20th century until the 1930s, when there were more than 700 units in operation. In the early 1960s, the US Public Health Service (USPHS) solid waste program began to study problems with incineration as a means of disposal. At that time, many major US cities depended on those antiquated, poorly designed, and operated incineration facilities to manage a major portion of their waste disposal tonnage.

With the assistance of USPHS, the industry began to develop new concepts in design, materials, and operation. New designs included the installation of scales to help monitor and control the waste feed throughput of the facility, and larger tipping floors and pits designed to handle the volume of the facilities. Hoppers were designed to allow gravity flow of MSW into furnaces and to provide a seal at the charging end of the unit. Bridge cranes became the main means for charging furnace hoppers. Terminology became more standard with design terms. Several advancements in air pollution control technology and improved combustion practices continued.

In 1970, the Resource Recovery Act (RRA) amended the federal solid waste legislation and developed a broader solid waste role for the federal government. RRA defined resource recovery as the recovery of both materials and energy recovery from MSW. This led to the widespread use of WTE technology and the development and improvement of the modern WTE facility concept. Many old incinerators were shut down due to pressures of the Clean Air Act as well as the emergence of sanitary landfills. The RRA gave federal solid waste program opportunities to address WTE with financial and staffing resources and to expand the efforts that began during the 1960's to enhance and increase the efficiencies of WTE facilities. Throughout the 1970's and 1980's federal solid waste programs studied many new MSW combustion concepts, specifically, ones that would allow for the recovery of both materials and energy.[23] Since that time, many 'modern' WTE facilities were constructed in the United States and WTE is considered a commercially proven and effective thermal conversion technology, with more than 60 facilities currently in operation today.

In July 2015, the Solid Waste Authority of Palm Beach County achieved commercial operations of the 3,000 TPD Palm Beach Renewable Energy Facility No. 2, which was the most recent new WTE facility constructed in the United States and several new or expansion projects are currently in the planning and implementation stages throughout North America as existing infrastructure reaches the end of its useful life and capacity needs grow.

6.1.15.1 Existing Waste-to-Energy Infrastructure in Broward County

The South Broward WTE Facility, also known as the South Broward RRF, is located at 4400 South State Road 7, Fort Lauderdale, FL 33314. The facility is currently privately owned and operated by WIN Waste. The facility is a mass burn WTE facility that was constructed in 1991 and consists of three Municipal Waste Combustor (MWC) units with auxiliary burners, lime storage and processing facilities, ash storage and processing facilities, a cooling tower and ancillary support equipment. The facility operates 24-hours a day, every day of the year and only accepts processible residential, commercial, and nonhazardous waste. The facility's MWC's each have a nominal design capacity of 750 TPD, and a total throughput capacity is limited to a maximum of 2,589 TPD. The nominal (i.e., generator nameplate) electric generating capacity of the facility is 66.1 megawatts (MW), which the net electricity after in-house electrical usage is sold to the local utility company. The South Broward RRF receives and processes a large portion of the Authority's waste stream. The resulting ash residue from the facility is disposed in an onsite Class I ash monofill owned by Broward County. Note that WIN Waste is currently contemplating the sale of the South Broward RRF.

6.1.15.2 WTE Process Description

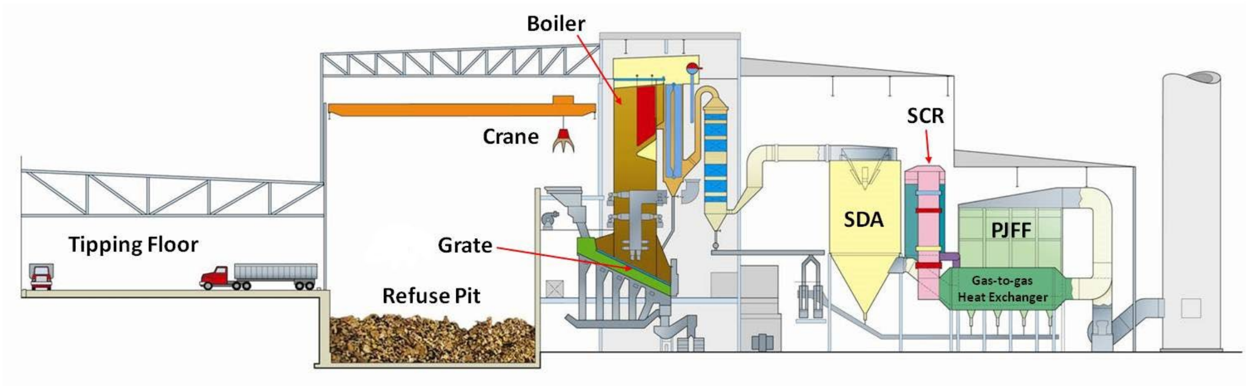
Mass-burn/waterwall combustion is one of the most common commercially viable technologies for conversion of MSW to energy. The South Broward RRF currently uses the mass burn/waterwall WTE technology and as such mass-burn/waterwall combustion would also be the technology recommended should the Authority move forward with development of a new WTE facility.

With the mass-burn/waterwall combustion technology, refuse does not require pre-processing before it can be combusted. However, waste screening still occurs, including separation of oversized materials and removal of hazardous or potentially explosive materials. Refuse is stored in a pit and moved via an overhead crane into a feedchute and then typically a hydraulic ram pushes the waste onto a reciprocating or roller grate. The grate moves the refuse through a combustion furnace on the grate until combustion is complete. Combustion air in excess of stoichiometric amounts is supplied both below and above the grate. Water-filled tubes in the furnace walls are used to recover heat to produce steam and/or electricity. Generally, mass burn units range from 50 to 1,250 TPD, and multiple units can be installed at a single facility. Residual ash, usually about 10% of the initial volume (25% of the weight) of the incoming MSW, remains after the combustibles in the waste are burned. In addition, this process produces flue gas, which includes pollutants that must be strictly

23 https://www.mswmanagement.com/collection/article/13001185/a-brief-history-of-solid-waste-management-during-the-last-50-years-part-9a

treated via air pollution control devices.[24] An example side profile of a mass-burn WTE facility is shown in **Figure 4** below.

Figure 4. Example Profile Configuration of a Mass-Burn WTE Facility in the U.S.



6.1.15.3 Schedule Considerations

The development of a WTE facility typically takes seven to ten years to complete. This time frame, which includes the preliminary planning stage, siting, permitting, financing, procurement, design, and construction, varies depending upon the complexity of the project and extent of the regulatory and public concerns. The site ultimately selected for any development of a WTE facility will have its own unique schedule impact considerations, which could extend or compress the schedule duration. A summary of schedule considerations associated with the implementation and development of a WTE facility is below.

6.1.15.4 Siting/Planning

Several activities are identified for the siting of a new WTE facility that are required to support the regulatory, permitting, design, and construction phases. Siting/Planning includes the following activities:

- Siting selection and land acquisition, if applicable
- Public outreach activities

6.1.15.5 Financing

Construction of a large capital project, such as a WTE facility, is most often financed, as most entities do not have the available funds to pay for the capital costs when constructed. A number of financing options exist for funding large capital projects, with the most common being municipal bond financing. It is anticipated that the Authority would most likely use a form of long-term revenue bond financing. Bond financing terms can vary and are determined during agreement development.

First, a financial plan for bond issuance would be developed to determine the bond issuance method and schedule. This would include bond issuance support and a cash flow analysis at the

24 https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf

commencement of the project and possibly a phased financing strategy, with interim and final financing. The interim financing could correspond with initial planning, permitting and procurement activities required prior to contractor notice to proceed. The final financing would likely correspond with the contractor notice to proceed and/or receipt of all regulatory approvals for construction.

Note that the financing tasks are not consecutive, and do not occur directly one after the other. The typical total duration for financing tasks, commencing with the bond issuance(s) and cash flow analysis and ending with the final financing, is estimated to be between four and six years. The financing tasks typically take place concurrently with the permitting and procurement tasks.

6.1.15.6 Regulatory/Permitting

The preliminary schedule reflects the permitting process including application preparation, submission, clarification, and issuance of permits and approvals required for the construction and start-up of a new WTE facility. The critical path typically includes preparation of required permits (i.e., dredge and fill permit, air permit, Public Service Commission (PSC), and Power Plant Siting Act (PPSA) permitting/approval processes). These and other permits can be developed concurrently in order to reduce the permitting duration; however, permitting would still be anticipated to range from approximately 3.5 to 4.5 years from preliminary application development through issuance of all required permits.

There are many variables associated with the permitting process that could affect the duration of the permitting effort. The ultimate permitting duration will depend on RFIs, potential public opposition or protest, or change in law.

6.1.15.7 Procurement

The procurement process associated with the development of a new WTE facility typically includes the following:

- Design criteria development
- Procurement strategy development
- RFI development, response, and response evaluation
- RFQ development, response, and response evaluation
- RFP development, response, and response evaluation
- Legal activities associated with development of the draft and final Construction and Operating Agreements

The design criteria development is required as part of the RFQ/RFP procurement process and is estimated to take approximately 6 months to one-year. The RFQ/RFP procurement process is estimated to take approximately two to three years and would occur concurrently with the permitting and financing activities.

6.1.15.8 Design and Construction

As any project moves forward, detailed construction schedules are developed as part of the planning and procurement process. Typical construction-related activities include the following and the associated schedule is presented in **Table 40**:

- Preliminary construction activities, such as initial site work and preparation
- Detailed design
- Preliminary site and utilities work
- Procurement of major equipment
- Procurement of long lead time items
- Construction
- Start-up and commissioning
- Acceptance testing
- Final inspection and contract close-out

Table 40. WTE Facility Implementation and Construction Timeline

Total Project Duration	7 –10 years
Estimated Commercial Operation	2033 - 2035
Siting/Planning	**1.5 years**
Siting Analysis and Land Acquisition	N/A
Financing	**1.5 years**
Permitting	**3.5 years**
Army Corps of Engineers Dredge and Fill Permit	1 year
Environmental Resource Permit	1 year
PSD Air Construction Permit	2 years
PPSA Process Activities	2.5 years
Procurement	**2 - 3 years**
Design Criteria Development	6 months – 1 year
RFQ / RFP Process	1.5 - 2 years
Design and Construction	**4 years**
Design	3 years
Procurement of Major Equipment	3 years
Preliminary Site and Utilities Work	9 months
Construction	2.5 years
Start-up and Commissioning	6 months
Acceptance Testing to Commercial Operations	2 months
Final Inspection and Contract Closeout	6 months

6.1.15.9 Estimated Costs for Development of a WTE Facility

Siting evaluation criteria and associated site conditions will impact the overall cost for the development and operation of a new WTE facility. The following summarizes impacts to the capital and operational costs.

Capital Costs

The following may affect the capital costs for development of a new WTE facility.

- Local market labor and equipment and material costs
- WTE facility design (i.e., water cooled vs. air-cooled condenser, carbon capture equipment, etc.).
- Off-site road development when an access road to the site is not yet available
- Off-site utilities construction for interconnection to the nearest pipeline typically include:
  - Ductile iron pipeline for potable water
  - Potable water booster pump station
  - PVC force main for wastewater
  - Natural gas pipeline for use as auxiliary fuel for start-up, shutdown, and emissions control
  - Electrical transmission mains
  - An industrial water supply well, where permittable, or rehabilitation of existing wells
  - Additional right of ways or easements required for off-site utilities or access
- Additional stormwater requirements for high groundwater levels or floodplain mitigation
- Additional stormwater requirements for temporary retainage during construction
- Geotechnical site preparation work including:
  - Lake fill costs (if necessary)
  - Removal of unsuitable soils
  - Replacement with select fill
  - Additional geotechnical requirements, such as vibrocompaction of fill or other structural requirements
- Floodplain mitigation by elevating structures.

- Wildlife mitigation for Protected, Threatened or Endangered species
- Permanent wetland mitigation
- Additional zoning and permitting cost possibly required for greenfield sites
- Additional permitting cost associated with difficulty due to site location or constraints

Cost Considerations Summary

Table 41 presents the preliminary capital cost and annual operations and maintenance cost estimates. Note that the capital cost excludes land acquisition as well as any site-specific considerations

Table 41. Estimated Capital and Operational Costs for 1M tpy (3,000 TPD) WTE Facility.

	Estimated Cost (2025 Dollars)	Estimated Cost (2045 Dollars)
WTE Facility		
Capital	$990,000,000	$1,800,000,000
Annual Net O&M	$14,200,000	$36,900,000
Estimated Operational Data		
Annual Ash Disposed (Tons)	283,000 (No AMR)	76,000 (With AMR)
Annual Ferrous Recovered (Tons)	23,000 (No AMR)	42,000 (With AMR)
Annual Non-Ferrous Recovered (Tons)	1,400 (No AMR)	4,200 (With AMR)
Gross Energy Generated (MWh)	675,000	

Costs assume an annual escalation rate of 3%. Net O&M costs do not include ash hauling.

6.1.16 Landfills

Landfills are a necessary component to managing MSW that is not beneficially used. While this White Paper presents scenarios to maximize the beneficial use of waste stream components, the fact remains that a landfill remains an essential component of an integrated solid waste management system. In addition, there are regulatory requirements that must be considered. Specifically, Fla. Stat. § 403.706 (2021) specifies that "The governing body of a county has the responsibility and power to provide for the operation of solid waste disposal facilities to meet the needs of all incorporated and unincorporated areas of the county." This is consistent with Goal 6.0 of the Broward County Comprehensive Plan - Solid Waste Element, which states, "Provide a cost-effective and equitable solid waste disposal system which emphasizes waste minimization and resource recovery and meets all federal, state, and local environmental quality standards," and Objective 6.3, which states, "Broward County shall ensure the availability of solid waste facilities with sufficient capacity to process and dispose of present and future volumes of solid waste, using adopted level of service standards." While the Authority may meet these requirements via contracted capacity, it requires consideration of the associated risks (e.g., financial, environmental, equity) and consideration of the Authority's stated guiding principle to "control its solid waste management destiny" by developing the services, programs, and facilities such that the Authority takes responsibility for managing the solid waste generated by its members and the outcomes of its decisions. For the purposes of this White Paper, the development of a new landfill within Broward County is assumed. If policy direction is to secure new disposal capacity outside of Broward County, further analysis will be required to assess the transportation mode (e.g., long-haul vehicles, rail).

As detailed in the Task 2 White Paper, MSW generated in Broward County is currently disposed at four landfills, two of which are located within Broward County. However, it is important to note that one pathway for the Authority to "control their solid waste destiny," which is reflected in the following sections, is the consideration of a new Class I landfill in Broward County. However, developing a new landfill is often controversial. To that end, it should be noted that there has not been a new publicly-owned landfill constructed in Florida in more than 25-years. The last publicly owned landfill to open was the Sarasota landfill in 1998. The challenge is due, in part, to a lengthy development process (e.g., siting, permitting, constructing, and commencing operations) requiring between 10 to potentially more than 20-years before the first ton of waste can be disposed once policy direction is provided. Depending on the size and phasing plan designed for the landfill, construction and operation will span multiple decades. Following closure, monitoring will continue for another 30-years. However, throughout the active life of the landfill, the Authority will be able to meet its disposal needs as part of a sustainable waste management approach that can also integrate enhanced waste reduction, recycling, and diversion initiatives to further extend the lifespan of the landfill past the initial designed capacity.

An outline of the timeline expected for siting and opening a landfill is shown in **Table 42**. The estimate for permitting a site is conservative and depends on the required approval from regulatory bodies.

Table 42. Conceptual New Landfill Development Timeline

Task	Estimated Time
Develop concept and budget for proposed landfill, including size and additional onsite facilities	6 months
Perform siting study by determine constraints and ranking potential options	6 months
Site Selection	3 months
Perform due diligence, such as hydrogeological and geotechnical studies, site assessment, and wetlands/ecological surveys	1 year
Property Purchase	1 year
Zoning Approval(s)	2 years
Permitting (FDEP, Broward County, ACOE, etc.)	3 years
Initial Cell Construction	2 years
Commence Operations	-

6.1.16.1 Technical Assessment

The development of a new Subtitle D landfill for Class I waste to support the solid waste management needs of the Authority would offer long term capabilities to accommodate the expected population growth for ILA Members.

6.1.16.2 Siting

A siting analysis would be required to determine viable locations for a new landfill. The task of determining the location, size, design, and operation of an additional landfill and associated solid waste management facility is challenging. The search for potential land for landfill development would begin by determining any available land parcels. Following this first filter, siting criteria, or exclusionary criteria, is developed to account for regulatory siting restrictions, community values and concerns, and current technology. The availability of current and representative data of waste composition and tools to evaluate waste management options also plays a significant role in the process. Additionally, the process by which the decisions are made must be open and transparent to the public.

The exclusionary criteria will be used to filter out any locations violating regulatory and zoning restrictions. Specifically, the following exclusionary criteria must be considered:

- Conservation Areas
- Distance to Airports - FAA Advisory Circular 150/5200-34 imposes restrictions on a location near public airports
- Natural Resource Protection Area (NRPA)
- Distance to Class 1 Surface Water as defined by FAC 17-302.600
- Land Use – Existing areas designated as Urban and Built Up (except Open Land), Transportation, Communication, and Utilities
- Distance to the community water system, as defined by FAC 62-550.200
- Areas of Critical State Concern
- Developments of Regional Impact
- Historical/Archaeological/Cultural areas

Following Authority direction, evaluative criteria would be developed and applied to further screen potential locations within the County. Evaluative criteria are different from exclusionary criteria because they are based on the issues and concerns of the community. A citizen's organization can assist in the process of developing, ranking, and weighting the evaluative criteria. Some examples of evaluative criteria may include protection of regional groundwater; impacts caused by blowing litter, dust, and odors; traffic impacts; effects on surrounding wells; topography; hauling costs, costs of land and roads; impacts on neighboring properties; and landscape preservation. The site identification process can take up to a year to complete, depending on the cooperation of community and regulatory stakeholders.

6.1.16.3 Design Considerations

Lining System and Leachate Management

All disposal cells will have a double composite lining system consisting of a primary and a secondary lining system. Each of the primary and secondary lining systems will include a geocomposite drainage layer, a geomembrane liner, and a geosynthetic clay liner as a composite component to the liner system. Leachate collected in the primary system will be conveyed to a primary leachate sump and liquids collected in the secondary system will be conveyed to a secondary sump. Leachate from each sump will be pumped in independent lines to a common leachate force main after passing through a flow meter to measure flow rate and cumulative flow volume. The leachate force main consists of a double-cased piping system to collect any leaks from the primary leachate force main if it ever occurs. Leachate will be conveyed through a leachate line for disposal at wastewater treatment facility or via a deep injection well.

Surface Water Management System

A surface water management system is required and often consists of a detention pond and discharge to a surface water body.

Gas Management System

The landfill will be equipped with vertical and horizontal gas collection wells. The collected gas will be conveyed through gas headers to a gas management compound where it can wither be flared, or preferably for beneficial use.

Permitting Approach

The following activities are required for permitting a new landfill:

1. Conduct groundwater modeling to confirm compliance with wellfield protection requirements that restrict solid waste disposal facilities in wellfield risk management zones.

2. Conduct a detailed environmental survey of the proposed site including wetlands, connections of water bodies to the United States navigable waters, environmentally sensitive areas, floodplain boundaries, wildlife habitat determination, wildlife corridor easements, endangered species nesting, seasonal use of the land by wildlife, etc.

3. Conduct a detailed technical evaluation of the proposed site. This evaluation should include a geotechnical evaluation, hydrogeologic evaluation, waste and liner stability analysis, leachate generation analysis, waste settlement evaluation, floodplain compensatory storage evaluation, surface water management system evaluation for the entire expansion system, stormwater discharge rate evaluation, etc.

4. Complete the FDEP permitting process:

   – Submit application for a permit in accordance with Chapter 62-701 of the Florida Administrative Code;

   – Publish notice of permit application in a newspaper of general circulation in the area where the facility is located;

- Mail notice of the application to the Chair of the Board of County Commissioners and each state senator and representative serving the jurisdiction in which the project is located;
- After the agency completes the permit review, the agency shall send a copy of the notice of intent to issue or deny the permit to these same elected officials;
- Publish notice of the intent to issue in a newspaper of general circulation in the area where the facility is located;
- In the event of no petition filed with FDEP, the final permit will be issued following the 15-day wait period after the public notice is issued;
- In the event of an acceptable petition is filed, the case will be transferred to the FDEP Administrative Hearing branch for processing the petition and permit; and
- A public hearing may be held by the FDEP if requested by elected officials or the public.

6.1.16.4 Financial Feasibility

The use of a landfill as an end-of-life waste management facility typically offers the lowest cost alternative, although there are many other objective and subjective factors that should be considered. In addition, the planning, development and operational costs depend on various factors, specifically the size and expected capacity of the potential landfill.

For planning purposes, a new landfill is assumed to have a total site area of 640-acres with a disposal footprint of 411-acres with 28 disposal cells. The corresponding landfill life is projected to be between 22 and 36 years of capacity based on the selected scenario, assuming 1,500 lbs/cubic yards of in-place waste density and between 2,100,000 and 3,400,000 tons per year requiring disposal in 2045. The cost for developing a new landfill is estimated between $813,900,000 and $1,131,1000,000, excluding land acquisition.

Table 43 presents the annual required capacity in 2045 under the identified scenarios and **Table 44** presents the estimated landfill cost by scenario.

Table 43. Disposal Capacity needed in 2045

Scenarios	Status Quo	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E
Landfilled Waste (tons)	4,200,000	2,668,057	1,637,986	1,329,797	3,117,322	2,110,080

Table 44. Landfill Cost Estimate by Scenario

	Scenario				
	A	B	C	D	E
Total Area (Acres)	640	640	640	640	640
Disposal Area (Acres)	410	410	410	410	410
Capital Life (Years)	25	34	36	22	30
Tons (Annual)	3,000,000	2,200,000	2,100,000	3,400,000	2,500,000
Capital Cost (Total)	$879,800,000	$1,085,700,000	$1,131,100,000	$813,900,000	$978,500,000
OpEx (Annual)	$228,800,000	$181,600,000	$176,600,000	$261,300,000	$203,400,000
Revenue (Annual)	$381,300,000	$302,700,000	$294,400,000	$435,400,000	$338,900,000
Cost (Per Ton)	$91	$99	$100	$89	$95
Net Dollars (Per Ton)	$41	$41	$42	$41	$41

It should be noted that the financial analysis is budgetary at this stage, as a detailed scope and site-specific parameters have not yet been identified but will be as the master planning process progresses.

7.0 INCREASING DIVERSION

7.1 POLICY APPROACHES & WASTE REDUCTION BEST PRACTICES

Waste-related policies are essential for municipalities to optimize recycling systems and improve waste diversion efforts. These policies can be customized to meet the specific needs and conditions of the Authority. Below is an overview of common local waste-related policies. To achieve a 75% diversion rate, nearly all of the policies listed will need to be implemented.

Scenario D, which employs a wet/dry MSW collection system, is the only scenario where the waste diversion policy significantly differs. In this scenario, policies that require the source separation of food waste from wet MSW and recyclables from dry MSW are not necessary. However, it remains important to implement related policies that ensure proper separation within the collection system.

7.1.1 Waste Diversion Goals

Municipalities often establish waste diversion goals through sustainability plans or resolutions. While some goals adopted may be aspirational and lack dedicated funding or enforcement mechanisms, they serve as a framework for shaping future waste-related policies and programs.

Official diversion goals are typically used by local government and environmental advisory boards to evaluate engagement initiatives and analyze hauler data. These goals provide a basis for long-term planning and improvement of waste management systems.

7.1.2 Florida's Statewide Diversion Goal

Florida's waste diversion goal, established by the Energy, Climate Change, and Economic Security Act of 2008, aimed to divert 75% of MSW from landfills by 2020. This target was designed to mitigate the environmental impacts of waste disposal while promoting recycling, composting, and other waste reduction strategies.

7.1.3 Broward County's Current Status

In 2023, Broward County reported a traditional recycling rate of 30%, with an adjusted total recycling rate of 39%, which includes recycling credits for renewable energy generated from WTE. While progress is ongoing, the Authority continues to work towards achieving the state's ambitious 75% recycling goal.

By implementing and refining waste-related policies, such as the policies that follow, municipalities can enhance recycling efforts, support sustainability initiatives, and align with state and local environmental objectives.

7.1.4 Pay-As-You-Throw (PAYT)

PAYT, also known as volume-based pricing, requires residential waste haulers to offer pricing structures based on the amount of waste generated. Residents are charged according to the size of their MSW cart, bags, or stickers, while recycling (and sometimes composting) carts are provided at no additional cost, the program is tailored to household needs.

PAYT is recognized as a best practice for incentivizing waste reduction and diversion. In Broward County, the City of Plantation operates one of the longest-running PAYT programs in the US, employing a system of four bag types differentiated by material type and quantity, each priced accordingly. Additionally, carts have been implemented for multifamily and selected communities.

7.1.5 Extended Producer Responsibility (EPR)

EPR, also known as product stewardship, shifts the responsibility for a product's entire lifecycle, including its end-of-life management, from municipalities to producers of packaging. Under EPR, producers or brand owners are accountable for recycling or properly disposing of their products and packaging, either physically or financially.

Through a concept known as eco-modulation, EPR incentivizes producers to design products and packaging that are less toxic, lighter, less bulky, made from recycled content, and more recyclable. This results in environmental, economic, and GHG reduction benefits. Collection under EPR must be free and convenient for all residents to ensure participation, with materials management costs and program planning responsibility and accountability shifted to the producers. Often, the producers work closely with the government entity overseeing the program to ensure that accountability and the costs to run the program are reimbursed to the government by the producers.

EPR is most commonly enacted at the state level, covering items such as:

- Batteries
- Carpet
- Electronics
- Printed paper and packaging (PPP)
- Mattresses
- Medical sharps and pharmaceuticals
- Paint
- Solar panels and wind turbines

7.1.6 Organized Collections

Municipalities can negotiate contracts with one or more waste haulers, incorporating diverse policy elements. Contracts often mandate transparent pricing and recycling services, with options to include PAYT systems, walk-out services, and other waste management enhancements. Homeowners Associations (HOAs) may also establish independent contracts with haulers.

7.1.7 Adequate and/or Equal Space Ordinance

Florida law (Chapter 403.706, F.S.) requires newly developed multifamily and commercial properties receiving certificates of occupancy after July 1, 2012, to provide adequate space for recycling. However, the Authority could adopt stricter ordinances, eliminating exemptions and extending requirements to organics programs once implemented.

An equal space requirement could replace "adequate space" language to aid enforcement and improve diversion. Additionally, a waiver program could be introduced for pre-2012 properties unable to meet physical space requirements, ensuring broader compliance.

7.1.8 No Burn/Bury Policies

Disposal bans restrict the disposal of specific material types in landfills or WTE facilities. While effective for educating the public on keeping certain materials out of waste streams, enforcement can be challenging without the ability to impose fines or reject tipping loads. These requirements can be included in contracts with landfills and facilities to ensure financial penalties when these items are attempted to be disposed of in these locations. Yard waste and recyclables are common examples of material banned from U.S. landfills.

7.1.9 Harmonized Recycling List

Currently, recycling programs throughout Broward County vary widely, creating confusion and hindering outreach efforts. While a residential recycling ordinance exists, it applies only to unincorporated areas and includes an outdated list of acceptable recyclables (e.g., specifying only narrow-necked plastic bottles without caps).

Establishing a universal recycling list for all jurisdictions within the Authority would simplify participation by ensuring consistency in accepted materials across homes, schools, businesses, and public spaces. A harmonized list would form the basis of effective education and outreach campaigns and lead to less recycling contamination.

Periodic reviews of the list are recommended to account for evolving packaging types and recycling technologies. Updates are needed to ensure continued growth in the volume of recyclables collected and reduced contamination. Any instance where a list is updated needs to signal a new round of education and outreach to ensure that the message is received. Any updates need to be seen seven to ten times by residents and communicated by community influencers.

To implement a harmonized recycling list, the following approaches may be considered:

- Establishing Authority-wide standardized recycling ordinance
- Standardizing hauler contracts
- Voluntary collaboration among municipalities to align accepted materials and outreach strategies

7.1.10 Mandatory Universal Recycling Statute

Universal Recycling Ordinances (UROs) mandate that residential households, commercial properties, including businesses and multi-family housing buildings, provide recycling (and sometimes composting) access to residents, staff, and tenants. Typically, UROs are implemented after successful residential recycling programs and strong community support. UROs ensure that residents and visitors have access to waste diversion services regardless of their location. Broward County currently has a mandatory residential recycling ordinance, but it only applies to single-family and multifamily dwellings in unincorporated areas and excludes commercial properties (§14-71-75).

7.1.11 Mandatory Food Waste Recycling Ordinance

Food waste recycling ordinances mirror universal recycling statutes for food waste and composting. To manage food waste, states and local governments have enacted mandatory food waste recycling laws for commercial sectors generating significant amounts of food waste, such as grocery stores, universities, hospitals, and large restaurants. These requirements typically necessitate source separation of food waste and its delivery to composting or AD facilities. They often include provisions to encourage food waste reduction, donation, and specific food waste utilization for animal feed.

Additionally, phased-in policies may be implemented to gradually expand participation among commercial entities.

The City of Gainesville, Florida, has enacted mandatory food waste source separation and composting for commercial businesses generating greater than one cubic yard of food waste per week. The City of Gainesville, Florida is currently in the process of implementing mandatory source separation, curbside collection, and composting of organic food waste for residents (Ordinance 200381).

7.1.12 Industrial Organics Diversion

While industrial organic waste was not part of the review for this White Paper, the SCS Team presents additional considerations including anaerobic co-digestion of industrial food waste and direct land application of raw shredded green waste (RGW). For more information, please see Appendix C.

7.1.13 Food Waste Donation

Some municipalities require businesses, particularly grocery stores and restaurants, to donate surplus food to food banks or charitable organizations to prevent food waste. For example, San Francisco's Mandatory Commercial Organics Recycling Ordinance requires large food-related businesses to donate surplus food to charities, reducing food waste and helping food-insecure communities. These policies can often lead to partnerships formed between municipalities and food pantries / non-profit organizations / churches to connect surplus food to those in need.

7.1.14 Reporting

Broward County already requires haulers to submit monthly reports specifying tonnages and the number of units served (§14-74). The Authority could implement a policy to enhance these reports by incorporating organics and MSW tonnages, as well as material destination. Beyond broad material categories, more detailed information on material types can aid in material management planning. For example, haulers could specify scrap metal, C&D, commingled recycling, or old corrugated cardboard as subcategories. Additionally, recycling facilities, composting, and AD facilities could be required to report tonnage received, tonnage sent to end markets, and tonnage disposed by material type.

7.1.15 Sustainable Purchasing Program

The Authority could adopt sustainable purchasing requirements to establish standards for select products and services purchased by the ILA Member governments. A portion of the budget could be allocated to purchasing products meeting sustainable product standards. Such policies can encourage the purchase of locally generated compost, reduce waste in foodservice contracts, and increase demand for products with recycled content.

7.1.16 Emergency Management Planning

Landfills often serve as the default disposal point for debris generated during hurricanes and other natural disasters. Strategic planning for both collection and disposal of such debris can reduce reliance on landfilling.

7.1.17 Construction & Demolition Debris

C&D recycling ordinances vary in complexity, ranging from simple reporting requirements to more stringent mandates, such as on-site sorting and recycling, and requirements for recycling solutions that must be met by bidders to be awarded construction or demolition contracts by participating municipalities. One widely adopted green building ordinance is deconstruction, a systematic disassembly process that maximizes material recovery and value. Soft-stripping, or materials extraction, involves removing valuable components for reuse. Cities such as Portland, Palo Alto, San Antonio, Boulder, Milwaukee, and Vancouver have implemented deconstruction ordinances. Additionally, various communities across the United States, including those in Colorado, Illinois, Florida, Wisconsin, Washington, Texas, Connecticut, Missouri, North Carolina, and California—have adopted C&D landfill diversion ordinances.

7.1.18 Data

While Florida tracks some recovery, a more detailed assessment of remaining materials in the disposal stream would inform diversion strategies and market development efforts. This analysis should be conducted regularly. A more detailed assessment (waste characterization), done at regular intervals (every five years), of the types of all materials remaining in the disposal stream would inform progress toward diversion of specific materials and the market development efforts that are needed to recover what remains in disposal.

7.1.19 Single-Use Item Bans and Fees

Many jurisdictions have implemented bans or fees on single-use items like plastic bags, fess on all types of carry out bags, straws, and Styrofoam to encourage reusable alternatives. These policies aim to reduce litter and water pollution, though their impact on recycling rates is minimal.

By adopting these policy models, the Authority can significantly improve waste diversion, recycling rates, and overall environmental outcomes.

7.1.20 Textiles Recovery

Many municipalities offer drop-off locations and pickup services for textiles and electronics, facilitating the reuse of these materials or ensuring they are recycled responsibly rather than disposed of in landfills. For instance, New York City's **ReFashion NYC** program provides donation bins for clothing and textiles in residential buildings, streamlining the process for residents to contribute to reuse and recycling efforts. Additionally, innovative services like **Retrievr** now offer convenient home pickup options for textiles, further encouraging participation in sustainable waste management practices (also picks up electronics and shoes). [25]

7.1.21 Spring / Fall Clean-Ups

Some municipalities organize seasonal clean-up events, typically in the spring or fall, or designate specific days for curbside bulk waste collection. These initiatives encourage residents and local donation organizations to repurpose furniture and other household items by "scavenging" reusable goods before waste haulers collect them.

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[25] Retrivr picks up electronics, textiles, shoes, and clothing: https://retrievr.com/?utm_source=google&utm_medium=reg&utm_campaign=eac&gad_source=1&gclid=Cj0KCQiAo5u6BhDJARIsAAVoDWsvmSIFx36ay1zC00ovxtqpwdiF2OvoAXmdgDaoRdF-I0XUV-jOQyUaAlfWEALw_wcB

An alternative approach involves coordinating curbside setouts for furniture and donation-eligible items, allowing nonprofit organizations to preemptively collect these materials for donation and reuse. This method can be implemented on a prescheduled basis, with communication to residents in advance, enabling nonprofits to drive designated routes ahead of refuse or bulk collection services. This strategy not only reduces waste sent to landfills but also promotes community engagement in sustainability efforts.

7.1.22 Grasscycling

Grasscycling is a practice where residents are encouraged to mow their lawn and leave their grass clippings without bagging for disposal. The grass clippings that are left on the lawn help restore nutrients back into the soil, conserves water and improves overall quality and health of the lawn. In Florida, St. Augustine grass and Bermuda grass are the most commonly used for lawn grass and are well suited for grasscycling and leaving the clippings on the lawn after mowing.[26] Lawn clippings left on the grass also saves time and effort for the resident from bagging, as well as reducing the amount of waste going for disposal.

7.1.23 Backyard Composting

Municipalities across the United States are increasingly promoting backyard composting as a key strategy to reduce household waste, decrease landfill reliance, and advance sustainability goals. It is recommended that the Authority develop a backyard composting program to accompany all five scenarios as a means of encouraging residents to be more informed about the impacts of food waste on the environment and to foster personal responsibility to manage waste more sustainably.

Some cities incorporate backyard composting into their broader zero-waste or waste-reduction strategies, using mandates or incentives to encourage residents to divert organic waste from landfills. For example, in San Francisco, the Zero Waste Program mandates that residents compost food scraps and yard waste. While curbside compost collection services are provided, the program also promotes backyard composting as an effective and sustainable alternative. These efforts often involve providing education, resources, and incentives to residents while collaborating with nonprofits and community organizations to implement and support composting initiatives.

Municipalities often offer free or discounted compost bins to residents to encourage them to start composting. Some may even provide additional tools such as aerators or compost covers. For example, San Francisco offers residents compost bins at a reduced cost and provides additional composting materials upon request. The District of Columbia offers a rebate of up to $75 to residents who purchase home composting systems from the Department of Public Works (Zero Waste DC, n.d.). In Austin, Texas, the Resource Recovery program provides $75 rebates on compost bins as part of its Home Composting Rebate Program. [27]

Many municipalities offer free or low-cost workshops to educate residents about backyard composting. These sessions typically cover topics such as constructing and maintaining a compost pile, selecting appropriate materials, and addressing common challenges. For instance, the City of Seattle regularly conducts composting workshops through its partnership with the Master Composter/Sustainability Steward (MC/SS) volunteer program. This initiative empowers residents to

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[26] University of Florida Grass-cycling. https://sfyl.ifas.ufl.edu/sarasota/natural-resources/waste-reduction/composting/what-is-composting/what-can-be-composted/grass-cycling/

[27] https://www.austintexas.gov/homecompostguide

build worm bins, recycle food and yard waste, and foster sustainable practices like reducing, reusing, and building healthy urban soils.

Similarly, municipalities often partner with nonprofit organizations to enhance outreach and engagement. For example, the City of Los Angeles collaborates with local environmental groups to host composting workshops and distribute educational materials to the community.

7.2 EDUCATION AND OUTREACH APPROACHES

All recycling guidelines evolve over time. These changes are essential to keeping up with market fluctuations, advancements in recycling technology, updates to waste hauling agreements, and in situations like Broward County, where a countywide or regional solid waste authority is formed. However, people generally don't expect these shifts and often lack the up-to-date information needed to recycle correctly. Many believe they know how to recycle, but when tested, they're frequently mistaken, confused, or relying on outdated information.

As packaging design, recycling innovations, and materials management programs continue to evolve at a faster pace, we need a robust "communications infrastructure" that matches our collections systems. This will help bridge the gap, encourage people to adapt to ongoing changes, and make learning about recycling more accessible, engaging, and rewarding.

Without consistent information, feedback on recycling habits, or a clear resource for answers, people often create their own recycling methods. Unfortunately, these are often based on misconceptions or outdated knowledge, leading to unintentional mistakes. This contributes to the contamination of as much as 25% of collected recyclables, which can no longer be processed, as reported by the USEPA.[28]

Each of the scenarios described in this White Paper assumes a significant investment in education and outreach to achieve the projected waste diversion rates. Task 8 of this project provided a detailed account of best practices when crafting an integrated education, outreach, and marketing.

The three main themes around behavior change include the following:

1) **Access** - Access typically refers to whether recycling bins are available at a place of residence or whether residents have to walk or drive to drop-off centers. This further reflects factors that influence a person's ability and opportunity to recycle. Do people have convenient access to the services and recycling bins necessary for successful participation? Is it as easy for them to recycle, compost, etc. as it is to throw it away?

2) **Knowledge** - This involves the information people need in order to make decisions about what, when, and how to recycle. Are there clear guidelines on what belongs in the recycling bin, such as on-container labels, mailed guides, or online resources? How frequently are they receiving updates and reminders? Do product and packaging labels support or hinder their understanding?

3) **Engagement** - This is more abstract and involves an individual's values, beliefs, attitudes, and identity, as well as the social dynamics and norms within their household and

[28] U.S. GAO: Recycling Facts and Figures. https://www.gao.gov/products/gao-21-87#:~:text=Based%20on%20GAO%20analysis%20of,products%20(see%20fig.).

community. Essentially, it addresses the question: once someone has access to recycling and the necessary information, will they actively participate, and will they do so correctly?

Access

Section 4 of this White Paper details the facility types, that residents will have access to for their recycling, reuse, or other disposal methods. Ensuring that each resident has the opportunity to recycle, compost, or reuse materials that are at their end-of-life in their households is as easy as throwing something away, is vital to the success of any materials management program. It is essential that all residents, regardless of their ethnicity, primary language, or socioeconomic status have the same access to these programs and that the instructions they receive to participate in the programs are in their language of choice.

Knowledge

A strong investment in education is necessary to ensure that people are well-informed and motivated to dispose of waste properly. This strong level of investment can boost a recycling rate beyond what could be achieved with infrastructure improvements alone. Based on research in various US communities[29] from TRP, a national nonprofit that is the gold standard on recycling education, it was found that combining access to recycling with comprehensive education not only improves and maintains high recycling rates, but it also results in cleaner materials for RMPFs and reprocessors.

Resident confusion is one of the key reasons why they do not recycle correctly.[30] Therefore, when trying to reach residents across municipal boundaries, it is best to harmonize the list of what can and can't be recycled, in order to reduce confusion. That way, if someone works in Lauderhill, but lives in Coral Springs and goes to the beach in Pompano Beach, they can be certain that they are recycling correctly no matter where they are. Harmonization, and consistency in messaging (look and say the same things across municipal boundaries) are crucial to reducing resident recycling confusion and thereby reducing contamination. Making it easier to understand how and what to dispose of where, will likely result in increased participation.

Making knowledge easy to access is also a key factor in reducing contamination and increasing participation. It is important that residents know what website, tool, or smart app, such as Recycle Check, to access to get their most up-to-date information. If a smart app is not obtainable due to cost, a tool can be integrated into the website, called a Waste Wizard, that can be used by residents to determine how best to dispose of a specific product or material. However, residents need to know that these tools are available and need to be able to understand the information provided.

A best practice approach is to send a mailer three times a year that residents can hang on their refrigerator with a list of what is and isn't to be disposed of on what day (including a schedule), and also a postcard that specifically mentions a top contaminant. There are several Smart Apps for recycling that can assist the Authority in implementing a harmonized program (see the Task 9 White Paper). Ensuring that the database that backs up the App, and the website itself is updated regularly, is imperative to a successful program.

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[29] Resource Recycling: *The Cost of Transformation*. https://resource-recycling.com/recycling/2021/08/15/the-cost-of-transformation/

[30] The Recycling Partnership: *Consumer Research on Recycling Behavior*. https://recyclingpartnership.org/consumer-research-on-recycling-behavior-and-attitudes-regarding-on-pack-labeling/

In order to measure these education approaches and then have them working complementary with operations, a "Feet on the Street" (FoTS) program is a best practice. Ideally, a postcard with what is and isn't recyclable (this can be used for food waste and other disposal options as well), goes out three to five weeks prior to FoTS. The week before the FoTS program is scheduled to start, send a notice via text or email to let the resident know about the program and its purpose. FoTS is when you hire local temporary labor, led by key experts, to walk around neighborhoods (a specific rout and time is designated), and have staff check what's in the disposal carts. A door hanger is left on the cart or the door of the residence with boxes checked by contaminants that were in the disposal cart or other things that need correction.

Keeping track of what residents on a particular route needed to be notified of, another mailer can be sent to that neighborhood or route and call out a top contaminant or a top behavior that needs to be changed. It can then be tracked again after the full FoTS is completed through a waste audit.

Another method of bringing complementary educational tools to a household is by implementing a school curriculum so that school-aged children are aware of how, what, and when to dispose of what items from their homes. There are several available curriculums to help the Authority implement a similar program. After the Solid Waste Authority picks what type of program they will implement, a curriculum should be specifically designed to reflect the program.

Engagement

A fully optimized recycling collection and processing system, however, cannot reach its full potential without effective education, outreach, and community engagement. It's not enough to just "tell" residents what it is they need to know. They must be met where they are by people they trust.

This means determining what residents already know through surveys and focus groups, what the obstacles are to them understand what and how to recycle such as access, language barriers, and more, and determining what method of outreach can best reach and teach them, whether it be schools, religious leaders, government leaders, or others.

Engaging community leaders from a wide range of special interest groups, homeowner's associations, religious and service organizations, educational teams, museum staff, as well as a diverse range of media personalities, satisfies a best practice requirement of finding someone your residents trust to deliver the most updated information.

Whether it's on a community message board, spoken about at regular meetings, briefed on during a sermon, educated on in schools, presented in a museum, or a 10-second blurb on the radio, the information meets people where they are and where they want to get their information from.

By harmonizing the disposal program across jurisdictions, you also have the opportunity to provide consistent messaging from the Authority and municipalities that are a part of the program. When a resident sees information seven to ten times a year, they are more often to implement that behavior, whether that is correcting the way they dispose of materials and thereby reducing contamination, or getting residents to start new behaviors, thereby increasing participation.

Jurisdictions can get this message out via their social media channels, included in utility bills, and sent out via email regularly, to name a few. These channels come at very little cost but go a long way toward awareness of the program and consistency of message.

If there are additional funds in the budget, it is also a best practice to advertise to the community through social media. Short video and audio messages can be created and then sent to residents via social media through targeting. Targeting can be done via zip code, street address, city name, and more. The more targeted the message, the more costly it can be, but also the higher the return on investment.

Traditional methods of outreach through billboards, newspaper advertisements, television, and radio advertisements can also be included in approaches if budget is there to accomplish these tactics.

All of the above best practices together complement each other and work best when all are implemented as part of an integrated communications, education, and engagement plan.

Costs of Engagement

As was discussed at the first Executive Committee of the Authority meeting about the Solid Waste Management Plan, there is a cost to an integrated communications, education, and engagement plan. TRP calculated the educational costs using insights from seven years of data and found that that addressing contamination at the curb costs approximately $3 to $5 per household annually and significantly reduces material contamination. In addition, ongoing education is essential for building recycling knowledge and public trust, which encourages greater participation.

The true costs of education in cities of different sizes were examined, operating under the principle that people need to be informed at least seven times a year to develop consistent recycling habits (based on best practices discussed in detail in Task 8). The additional expenses necessary to raise awareness of schedules, program details, and the importance of recycling were also included in the cost estimates.

Ultimately, TRP estimated that an investment of $10 per household per year is required to fully enhance recycling education.[31]

7.2.1 Operational Approaches

7.2.1.1 Special Collection Programs

A significant portion of the current municipal waste stream is hard to recycle materials. As part of the set of integrated strategies, regional Zero Waste Centers will need to be established to collect these hard to recycle materials. To maximize collection of special waste, curbside collection of special waste or specific materials streams curbside can be offered periodically (monthly, bimonthly, seasonally, or biannually) or on-demand curbside selection services can be utilized.

There are a number of technology options for supporting periodic or on-demand curbside collection. Smart apps can be utilized both to remind residents of scheduled services as well as to request and schedule on demand services (discussed in more detail in task 9). Convenience of curbside service also can be either charged to the resident when the service is scheduled or covered by the Authority.

[31] The Recycling Partnership: *Paying It Forward Report* https://recyclingpartnership.org/wp-content/uploads/dlm_uploads/2021/05/Paying-It-Forward-5.18.21-final.pdf

Table 45 presents examples of communities that utilize periodic or on-demand waste collection services for various types of waste streams. If desired, a third-party company can be contracted for both drop-off centers and periodic and/or on demand curbside collection.

Table 45. Community Examples of On-Demand Waste Collection Services

Item Collected	How Service is Offered	Jurisdiction
Batteries, electronics, HHW	Third Party, On-Demand, QR code/website for scheduling, Paid for by Household at Time of Scheduling	Arapahoe County, CO
Textiles	Third party, On-demand, registration form on website, free for residents and city government	Boston, MA
Brush, Scrap Metal/ Appliance	Scheduled through website, On-demand, free, service provided by county services	Arlington, VA

For multifamily buildings, options can be made available for property managers to schedule collection events onsite each season for clothing and textiles, scrap metal, and bulky waste, electronics and HHW.

7.2.2 Technologies to Assist with Measurement, Targeted Outreach, and Enforcement

There are a variety of hardware and software systems that can be utilized to assist with measuring and tracking program performance as well as in deploying targeted outreach or enforcement.

7.2.2.1 RFID Systems

The Authority can include requirements for haulers to equip vehicles with a county-approved Radio Frequency Identification (RFID) reader capable of reading carts with RFID tags. The RFID systems will allow the Authority to establish participation and capture rates, measurements which will help evaluate and track progress toward collection goals. The data can then be used to focus funding and outreach on specific additional education, engagement, evaluation, and enforcement efforts to boost further diversion.

Additionally, RFID readers may be used to keep haulers accountable for tracking missed collections and early starts for noise complaints. The Authority may also establish requirements that haulers must equip their collection vehicles with Automated Vehicle Location (AVL) Systems, a global positioning system (GPS) capable of identifying and logging the direction of travel, speed, major braking or accelerating events, and logging of the collection vehicles during the route day. This data can further support safety initiatives and route optimization efforts to reduce emissions and assist in ensuring that haulers are taking materials to the correct place (e.g., not taking recycling loads to a Municipal Solid Waste facility), and ensuring no early starts that can lead to noise complaints.

7.2.2.2 Camera Systems to Monitor and Track Curbside Cart Contamination

Trucks also may be outfitted with camera systems such that pictures of carts or inside of a cart can be taken when being tipped. A software system can then be used so that the driver can indicate the cart contains contamination and associate a picture with the note. This is helpful in automating communications to residents for enforcement related to violations or for targeted communications regarding recycling and trash management practices. AI-enabled camera systems, which can identify types of contamination, are also beginning to be deployed in trucks. WM reports that trucks deployed with this technology, combined with targeted outreach and education, can reduce contamination by up to 20%. [32]

7.2.2.3 Handheld Automation

In addition to automation systems for haulers to collect data during collection, another option is to utilize street teams periodically throughout the year for data capture and to capture data on a phone-based app or similar (known as Feet on the Street and described in further detail in Task 8). This program can be utilized to track cart set out rates, contamination in bins, overflowing trash and recycling bins, and whether outreach materials were left for the household on the cart.

7.2.2.4 Automated Cameras on Drop-Off Containers

Cameras can be added to dumpster and drop-off containers and more broadly at drop-off container sites. Cameras placed in dumpsters can measure fullness and take pictures to show contamination within the bins. This can be helpful to ensure efficient collection of drop-off bins. Outdoor cameras also can be used at drop-off sites to identify any illegal dumping, and vandalism type issues.

7.2.2.5 Reuse Directories

Reuse directories serve as either online or physical resources, listing local businesses, nonprofits, and centers where residents can donate or purchase second-hand items. These directories facilitate the reuse of goods such as clothing, furniture, electronics, and household items. For example, the City of Alexandria, Virginia, has developed an online Reuse Directory. This platform connects residents with organizations that accept a diverse range of items for donation or resale, thereby diverting waste from landfills and extending product lifespans.

The directory includes:

- **Donation and Resale Options:** Nonprofits and churches that accept household items, furniture, textiles, shoes, toys, and even food for redistribution.

- **Repair Services:** Information on local businesses offering repair services for items like bicycles, instruments, and electronics, helping residents restore rather than discard items.

- **Plastic Bag Recycling:** Drop-off locations at partnering retailers and grocery stores for plastic bag take-back programs.

- **Zero-Waste Shopping:** A list of businesses encouraging package-free and refill shopping, where residents can bring their own containers to minimize single-use packaging waste.

- **Safe Disposal Programs:** Permanent and event-based drop-off points for prescription medications, ensuring environmentally responsible disposal. This initiative exemplifies how a centralized resource can empower residents to make sustainable choices and reduce overall waste.

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[32] https://www.wastedive.com/news/ai-truck-mounted-cameras-contamination-identification-wm-the-recycling-partnership/711099/

7.2.2.6 Sharing and Exchange of Reusable Materials

Many cities have established online platforms to facilitate the exchange of reusable materials among residents and businesses. These platforms often feature items like building materials, furniture, appliances, and even surplus food, available for free or at reduced costs. By connecting individuals and organizations, these exchanges promote circular use of resources and further reduce waste. These strategies underscore the importance of local-level collaboration and innovation in advancing sustainable waste management practices.

Austin, Texas, operates a ReBlend Paint Reuse Program, where residents can drop off unused paint at recycling centers and then the City redistributes it to those in need.[33] In Cambridge, Massachusetts, their recycling drop-off center includes a share table where residents can bring and pick up items (e.g., 3-ring binders in excellent condition, books, etc.) to encourage reuse.[34]

Many municipalities offer free or low-cost workshops to educate residents about backyard composting. These sessions typically cover topics such as constructing and maintaining a compost pile, selecting appropriate materials, and addressing common challenges. For instance, the City of Seattle regularly conducts composting workshops through its partnership with the Master Composter/Sustainability Steward (MC/SS) volunteer program. This initiative empowers residents to build worm bins, recycle food and yard waste, and foster sustainable practices like reducing, reusing, and building healthy urban soils.

Similarly, municipalities often partner with nonprofit organizations to enhance outreach and engagement. For example, the City of Los Angeles collaborates with local environmental groups to host composting workshops and distribute educational materials to the community.

7.2.2.7 Online Resources

Municipal governments also provide comprehensive online tools, including guides, instructional videos, and downloadable resources, to support residents in adopting backyard composting. In Portland, Oregon, the city offers a detailed home composting guide on its municipal website, with translations available in languages such as Russian, Vietnamese, Chinese, and Spanish to ensure accessibility for diverse communities.

Through a combination of educational initiatives, partnerships, and accessible resources, municipalities are empowering residents to embrace composting as a practical and impactful way to contribute to waste reduction and environmental sustainability.[35]

Similarly, municipalities often partner with nonprofit organizations to enhance outreach and engagement. For example, the City of Los Angeles collaborates with local environmental groups to host composting workshops and distribute educational materials to the community.

[33] https://www.austintexas.gov/reblend
[34] https://www.cambridgema.gov/services/recyclingcenter
[35] https://www.portland.gov/bps/garbage-recycling/compost

8.0 FINANCIAL EVALUATION FOR FUTURE CAPACITY NEEDS

Establishing the Authority is a complex endeavor, particularly because it begins with no existing facilities or staff, and only the Executive Director at the helm.

The foundation of effective financial planning for the Authority lies in the comprehensive analysis of anticipated revenues and expenditures. This process is called revenue sufficiency analysis.

A revenue sufficiency analysis involves comparing projected revenues (e.g., from recycling processing fees or disposal charges) against expected expenditures. These expenditures include day-to-day operational costs (e.g., staffing, maintenance, fuel) and larger capital expenses (e.g., building facilities like transfer stations, RMPFs, and yard waste processing plants). The analysis identifies whether the Authority has sufficient income to cover both current and future financial needs, and if not, it helps pinpoint the gap that may need to be filled by additional funding sources such as loans, bonds, or fee increases.

8.1 ESTIMATING INITIAL REVENUE

The first step in the revenue sufficiency analysis involves estimating the potential revenue from the Authority's primary sources, such as waste disposal fees, special assessment revenues, tipping fee surcharges, or any other revenue mechanisms the Authority may have at its disposal. As the Authority is newly established, the revenue diversification opportunities may initially be limited to the revenue mechanisms that apply to its current operations and facilities.

For example, in the initial stages, the Authority will rely heavily on waste disposal fees from residents and businesses. This revenue stream can be projected based on the population size, waste generation rates, and proposed fee structures. Additionally, securing financial support from local government entities can provide a stable revenue base to cover initial operational costs.

As facilities are constructed, the Authority can bond for the construction of the facilities and utilize non-ad valorem special assessments to recover the costs of debt service from benefitting parcels in the County. These additional facilities can charge for services provided to cover the cost of operations. For example, the RMPF will charge recycling processing fees.

8.2 PLANNING FOR CAPITAL EXPENDITURES

As the Authority begins to develop its infrastructure, capital expenditures become a significant consideration. The analysis must account for the costs associated with acquiring land, constructing facilities, and purchasing essential equipment. The engineers will help the Authority determine the capital costs themselves. The revenue sufficiency analysis will determine whether the projected revenue is adequate to cash-fund these capital costs or if additional funding through loans, grants, or bonds will be necessary.

8.3 PLANNING FOR NEW PROGRAMS & SERVICES

As the Authority develops and expands, planning for new programs and essential services becomes an important part of the Authority's responsibilities. Such programs and services improve the efficiency of waste management and play a key role in community engagement.

For example, the Authority will need to allocate funds for education and outreach. This involves raising public awareness about waste reduction, recycling programs, and the importance of sustainable waste management practices. Effective outreach can reduce contamination in recycling streams, promote waste diversion, and encourage residents and businesses to properly sort their waste. The Authority will likely invest in creating educational materials such as brochures, website content, and social media campaigns. These efforts might include conducting workshops, school programs, museum exhibitions, and community events aimed at educating residents about the services offered and how to participate in waste diversion programs (see Task 8 white paper for more details).

The budget for these programs will need to cover costs for staffing, marketing materials, outreach events, public speaking engagements, smart apps, and more. The Authority may also need to develop partnerships with local schools, community organizations, or environmental groups to amplify the impact of these initiatives. As new facilities are built and more services are introduced, these education programs will likely need to be scaled up to reflect the expanded materials management offerings, ensuring that the community remains informed and engaged.

Outsourcing the collection of waste and recyclables is another key consideration for the Authority as it grows. The decision to outsource waste collection or recycling services can provide flexibility and allow the Authority to focus resources on other areas, like facility operations or expanding services. However, outsourcing will require careful planning, including evaluating and selecting service providers, negotiating contracts, and monitoring the performance of the contracted services.

The Authority will need to ensure that contracts with third-party providers are structured to incentivize performance, such as timely collection, proper recycling practices, technology inclusion, and adherence to environmental standards. The contracts may also include clauses for performance monitoring, service audits, and penalties for non-compliance to ensure that the contractor meets the expected service levels.

As these programs evolve, the Authority will also need to ensure that there is adequate communication with residents and businesses about the changes, whether it is outsourcing collection services or promoting new educational initiatives. The Authority should plan for clear messaging to minimize confusion and ensure the smooth implementation of new strategies.

8.4 PLANNING FOR OPERATIONAL NEEDS

8.4.1 Staffing Requirements

As the Authority expands its facilities and services, the need for additional staff will grow. The development of new facilities will necessitate hiring operational staff, administrative personnel, and specialized roles such as equipment operators and facility managers.

In addition to staffing, professional services are considered in estimating operating costs. The Authority will need to account for costs during the infrastructure development phase, which includes wages, professional services costs, and facility procurement and/or capital investment.

Once the infrastructure is developed, the Authority will need to estimate the ongoing labor costs for permanent staff, such as operators, maintenance workers, supervisors, and administrative personnel. These staffing costs will depend on the size and complexity of the facility and will scale with the size of the facility or as the facility begins to accept more volume/tonnage.

8.4.2 Other Operating Costs

After construction of the facilities and implementation of the services and programs, the Authority will need to consider the costs associated with program management and operating and maintaining the facilities on a day-to-day basis. This includes maintenance costs to ensure the facility and equipment remain functional, as well as utility costs for electricity, water, and fuel for operational equipment.

The Authority will also incur expenses for consumables, such as safety supplies, office materials, and other operational necessities. Additionally, there may be waste disposal or processing costs, depending on whether the Authority owns and operates certain facilities. These costs will vary depending on the volume and type of waste and recyclables accepted at the facility.

The Authority will need to allocate funds for ongoing compliance with environmental regulations, which may include costs for testing, reporting, and maintaining necessary permits. Insurance costs will also need to be factored in, including property insurance for the facility, liability insurance for operational risks, and workers' compensation insurance for staff.

Finally, the Authority must consider the depreciation of both the facility and the equipment over time. This includes planning for the eventual replacement of machinery and making sure that funds are set aside to maintain or replace worn-out equipment or infrastructure.

8.4.3 Adjusting the Revenue Base

To meet the growing needs of the Authority, it may be necessary to expand the revenue base. The revenue sufficiency analysis will guide decisions on how and when to adjust fees or seek additional funding sources to support the Authority's financial requirements.

8.5 DETERMINING FEES

Once the total costs have been estimated, the Authority has the revenue requirement for its fees. The fee structure is typically based on the programs and services offered and volume or type of waste processed at the facility. For example, the Authority may charge a fee per ton for waste disposal, a fee per ton for recycling processing services, and may have different rates or fees for specialized or one-time services, such as large items, yard waste processing, or hazardous waste disposal.

The Authority will also consider the pricing models used by other similar facilities in the region, considering local economic conditions and the ability of residents and businesses to pay these fees. It may opt for a tiered-fee structure, where different rates are applied based on the type of service (e.g., residential vs. commercial waste) or the amount of waste generated. This structure allows the Authority to ensure that fees are both fair and sufficient to cover the costs without imposing undue financial strain on certain groups.

In addition to covering operational and capital costs, the Authority will need to ensure that its fees are competitive and reflect the value of the services provided. Public engagement will be necessary to gauge community support for the fee levels, especially if fee increases are required to cover growing operational needs or expansions.

Lastly, the Authority will need to review the fees periodically to ensure they remain sufficient as the facility grows and as costs change. This could involve adjusting the fee structure to account for labor cost inflation, changes in waste volume, or new services that the facility begins to offer. The overall goal is to ensure that the facility generates enough revenue to meet its operational and financial goals without burdening the community it serves.

8.6 SEEKING EXTERNAL FUNDING

In some cases, the projected revenue may not be sufficient to cover all the anticipated costs, and the level of rate/fee increases required may be too high to be reasonably implemented. The Authority may need to seek external funding for critical capital projects through loans, grants, or bonds. The analysis will identify potential funding sources and assess their impact on the Authority's financial stability. By diversifying its funding streams, the Authority can mitigate financial risks and ensure the successful implementation of its projects.

8.7 EXTERNAL FUNDING OPPORTUNITIES

There are a significant number of federal and private grant opportunities that can be used on capital equipment for waste diversion activities and outreach programs. **Table 46** presents a summary of available grants that have been offered for one (1) or more years. Grant programs, particularly at the Federal level, are dynamic and may change from year to year.

Table 46. Previously Available Grant Programs

Name	Amount Range	Description	Due Date
Sustainable Materials Management Grants: EPA Region 4	Up to $250,000	Must address municipal and/or industrial recycling markets, or strategies for preventing food loss and waste through source reduction. Must include research, investigation, experiments, education, training, studies and/or demonstration of innovative techniques.	Dec 2, 2024
USDA Community Food Projects	$25,000 - $50,000	Integrate actionable plans or activities that would reduce food loss and waste within the local food system by keeping food in the human food supply chain and ensuring that such actions are directly tied to reducing community food insecurity.	Nov. 7, 2025; Oct. 30, 2025
USDA Composting and Food Waste Reduction Pilot Project	$75,000 - $400,000	Projects that meet one (1) or more of the following objectives: • Reduce municipal food and waste • Divert residential and commercial food waste from landfills. • Increase agricultural producers' access to compost • Reduce reliance on, and limit the use of, chemical fertilizer • Improve soil quality • Encourage waste management and permaculture business development.	Sept 4, 2024

Name	Amount Range	Description	Due Date
Recycling Partnership Cart Grants	Up to $825,000 Cart funding typically ranges from $5 to $15 per cart and funding is also available to support the education and outreach expenses associated with a cart project, typically at $1 per household.	Funds residential recycling curbside carts and outreach activities associated with roll-out for communities implementing a new cart-based curbside recycling program; Converting existing bin or bag-based program to carts; or Expanding service area to improve access and equity	Rolling
Recycling Partnership Residential Recycling Drop Off Program Grants	Not listed	Development and expansion of residential drop-off recycling programs, especially for projects Focus is to increase volume of collected household recyclables.	Rolling
Recycling Partnership Multifamily Recycling Program Grants	Not listed	To advance recycling and increase equity at multifamily properties to develop new and improve existing recycling programs	Rolling
Closed Loop Fund	$1 – 5 million Loans	For RMPFs, drop sites, trucks, and curbside. Low interest capital infrastructure loans.	Rolling/ongoing
EPA Solid Waste Infrastructure for Recycling (SWIFR)	$500,000 - $5M	Collection, RMPF, and AD facility funding	Dec. 2024; Funds may be available Annually through FY 26
Industry Grants	$5,000 – 500,000	Material specific support for recycling; often for equipment upgrades at RMPFs or drop off; may include outreach allocation	Varies

8.8 FUTURE CONSIDERATIONS

As new programs and services are developed and facilities are constructed, it will be essential for the Authority to continually review and refine its fee structure and revenue sufficiency analysis to maintain financial stability and effectively address its evolving needs. This ongoing process will be necessary to account for potential discrepancies between initial projections and actual operating costs, as well as to identify new revenue opportunities that may arise as services expand.

At the outset, the Authority will make assumptions regarding the costs associated with facility construction, including capital expenditures (such as building and equipment costs) and operational expenses (such as staffing, maintenance, and utilities). However, as design work concludes and construction begins, capital costs may fluctuate. Once the facilities are operational, the Authority will gain a clearer understanding of actual day-to-day costs, including unforeseen expenses such as equipment breakdowns, higher-than-expected energy consumption, or unanticipated staffing needs.

As real operating data becomes available, the Authority will need to update its financial models and adjust fees to reflect the actual cost of services. This might include increasing fees to cover any cost increases or re-adjusting the allocation of expenses across different services, ensuring that the overall revenue meets operational and capital needs.

As more facilities are constructed and new services are introduced, the Authority will likely have to expand its revenue model. If the Authority begins offering composting, yard waste processing, or specialized services for hazardous waste, it will need to determine appropriate fees for each service, considering factors such as service volume, equipment costs, and labor requirements.

In addition to adjusting operational costs, the Authority will need to evaluate the various revenue mechanisms available as services expand. This could include exploring revenue from new sources, such as grants, P3s, or fee-for-service models for specific waste types (e.g., a different fee for commercial waste or bulk pick-up). If the Authority can access state or Federal grants or other external funding, these can be incorporated into the revenue model to offset some of the facility costs, reducing the pressure on residents and businesses to cover the full cost through fees.

Over time, the Authority may also encounter opportunities for operational efficiencies, such as automation of sorting processes or the use of renewable energy at its facilities. These efficiencies can help reduce costs, and the Authority will need to assess how they impact the revenue and fee structure.

The Authority will need to periodically refine its revenue sufficiency and fee structures as it gains more operational data, expands its services, and explores new revenue mechanisms to ensure that it can adequately support the Authority's ongoing operational and capital needs while maintaining fairness and sustainability.

8.9 COST COMPARISON

As part of the future needs assessment project, the SCS Team was engaged to compare current costs and revenue projections for Broward with Miami-Dade County and Palm Beach County, which are presented in Table 47. Where there are both cost and revenue items, these are presented as net cost. For the annual operational costs of MSW collection and processing, Broward's costs are comparable to Palm Beach County and higher than Miami-Dade. For the operational costs of recyclables collection and processing, Broward's costs are lower than Palm Beach County and higher than Miami-Dade County. Based on current analysis, the difference in operational cost is unlikely to be because of varying county practices in terms of owning assets, P3s, or through contracted arrangements. Land acquisition and facility construction costs were not included.

Table 47. Comparison of Operating Costs between County Waste Programs

Overall MSW Collection + Processing	Quantitative Units	Broward[36] (Current)	Palm Beach[37] County	Miami-Dade[38]
	$/HH/year	$169.61	$165.67	96.32
Recyclables Collection	$/Ton ($/HH/year)	$161.6 ($70.55)	$406.49 ($130.47)	$47.06 ($24)[39]
Recycling Program Administration/ Education	$/Ton ($/HH/year)	$11.37 (4$.96)	$44.83 ($14.39)	$2.06 ($1.05)[40]
Recycling Processing (Sorting Efficiency)	$/Ton ($/HH/year)	$105.99 ($46.27)	$71.11 ($22.82)	$78.5 ($40.04)[41]
Overall recyclables collection + processing	**$/Ton ($/HH/year)**	**$278.96 ($121.78)**	**$522.43 ($167.68)[42]**	**$127.62 ($65.09)**
Recyclables	Annual Tons	194,122	111,093	178,507
Number of households (total)	# of Units	802,183	692,251	1,040,743
Participating in recycling	# of Units	444,655[43]	346,126[44]	350,000[45]
Recyclables received per household	Tons/Units	0.44	0.32	0.51

36 Based on data provided by the Authority.
37 Based on reported costs unless otherwise stated https://swa.org/DocumentCenter/View/4799/2021-Component-Cost-Summary---FY-2020-Issued-January-2022
38 Based on adopted budget for program unless otherwise stated https://www.miamidade.gov/global/management/budget/adopted-fy-2024-budget-neighborhood-infrastructure.page
39 Kessler Consulting, Inc. Recycling Analysis and Program Planning July 2021 Table 5 $/HH/month for EOW SS collection
40 Difference between adopted budget reported figure and those estimated by Kessler Consulting
41 Kessler Consulting, Inc. Recycling Analysis and Program Planning July 2021 Table 6 Cost per ton for SS
42 Only considers collection, transfer, recovered materials processing facility and recycling programs administration costs for comparison with data available for other counties
43 https://floridadep.gov/sites/default/files/Broward_2020.pdf
44 https://floridadep.gov/sites/default/files/Palm_Beach_2.pdf
45 https://www.miamidade.gov/global/management/budget/adopted-fy-2024-budget-neighborhood-infrastructure.page

9.0 FACILITY RISK ASSESSMENT MATRIX

9.1 INTRODUCTION TO FACILITY RISK ASSESSMENT

Effective infrastructure planning requires a thorough understanding of the risks and barriers associated with both current initiatives and proposed strategies. Section 9 presents a comprehensive facility risk assessment matrix designed to evaluate the long-term impacts and potential success of infrastructure approaches.

The assessment considers a range of critical factors, including[46]:

- **Cost:** Financial feasibility - including initial investments, ongoing maintenance expenses, and funding sources.
- **Cultural Barriers:** Societal acceptance and adaptability to changes introduced by the strategy.
- **Political Barriers:** Legislative and regulatory challenges, stakeholder support, and policy alignment. Low mean minimal political barriers
- **Geographic Constraints:** Physical and environmental limitations that may impact implementation and sustainability.
- **Environmental Justice:** Ensuring equitable distribution of benefits and burdens across all communities, particularly marginalized or disadvantaged groups, while avoiding disproportionate negative impacts. Low means minimal negative impact on disadvantaged groups.
- **Likelihood of Success:** Assessing the probability of achieving desired outcomes based on resource availability, stakeholder cooperation, and potential risks or obstacles.

Each facility type is analyzed within this framework to determine its likelihood of success, offering a clear, evidence-based opinion on its potential outcomes. The matrix presented in **Table 48** provides decision-makers with a structured approach to prioritize investments, mitigate risks, and align infrastructure planning with long-term goals.

[46] While diversion potential is included in the scenario screening factors, it is not included in the facility risk assessment as it makes most sense to view diversion potential as part of a comprehensive strategy rather than at the level of the facility.

Table 48. Facility Risk Assessment Matrix

Facility	Cost	Cultural Barriers	Political Barriers	Environmental Justice	Likelihood Of Success
WTE	High	Medium	Medium	High	Medium/Low
Landfills	Medium	High	High	High	Low
SS RMPF	Low	Low	Low	Low	High
Dry MRF	Low	Medium	Low	Medium	Medium
Compost / Mulch	Low	Medium	Medium	Low	High
Pyrolysis	Low	Medium	Medium	Low	Medium
ADs	Medium	Medium	Medium	Low	Medium
MWP	High	Medium	High	High	Low
C&D Processing Facility	Medium	Low	Medium	Medium	Medium
Drop-Off Centers: Textiles, HHW & Electronics	Low	Low	Low	Low	High

9.2 WASTE-TO-ENERGY

- **Costs: High**
  - Building and maintaining WTE facilities requires significant reoccurring capital investments, as well as ongoing operational costs. Costs are also high due to additional air quality control systems required to meet permit standards, as well as disposal of ash residue at a landfill/monofill, and heavy usage of consumables (i.e., lime, activated carbon, urea, etc.) needed to process solid waste at a WTE facility.
- **Cultural Barriers: Medium**
  - Floridians show moderate to high resistance to new WTE projects. After a fire that burned down the Dade Covanta facility in Miami-Dade County, environmental groups and residents have been actively opposing the replacement of a $1.5 billion WTE facility.[47] Not-In-My-Backyard (NIMBY) concerns are also the case for any new development projects for WTE.
- **Political Factors: Medium**
  - WTE systems receive mixed political support. In Broward County, the high cost of land makes WTE an appealing option due to its ability to significantly reduce municipal solid waste (MSW) tonnage through metals recovery and the residual ash, which

[47] https://www.theguardian.com/us-news/2024/sep/30/florida-airport-trash-incinerator-plant

requires far less space compared to traditional landfills. While some policymakers advocate for WTE as a practical alternative to space-intensive landfills, others express opposition due to environmental justice concerns.

- **Environmental Justice: High**
  - WTE facilities may raise environmental justice concerns, dependent upon the proximity to population centers; therefore, WTE is given a high rating. Historically, WTE facilities were successfully permitted based on stringent air emissions limits and utilizing robust and state-of-the-art air pollution control technologies, however, pollution from these facilities is still a perceived environmental and public health concern. Particulate matters, Sulfur oxides (SOx), Nitrogen Oxides (NOx) pollutants are linked to respiratory issues such as asthma and as such, they are scrutinized by permitting agencies. These emissions concerns are mitigated through selective catalytic reduction (SCR) systems, scrubbers, filters, and other state-of-the-art advanced and emerging technologies.

- **Likelihood of Success: Medium/Low**
  - WTE is one of the main methods of MSW disposal in Broward County. Given the existing infrastructure, the likelihood of continued success in Broward County is Medium. Ensuring the existing facility maintains permits, Best Available Control Technology (BACT), transparent reporting, continued education and outreach, and facility monitoring will be critical to WTE operations.
  - The probability of successfully establishing a new WTE facility in Broward County is medium/low, given the significant challenges related to land scarcity, public opposition, and environmental considerations outlined above.

9.3 LANDFILLS

- **Costs: Medium**
  - While landfills generally have lower capital and operational costs compared to WTE facilities, the most significant financial challenge is related to siting. The scarcity of suitable land and the high cost of property in Broward County create substantial barriers.

- **Cultural Barriers: High**
  - Public opposition to new landfills in Florida is significant, driven by Not-In-My-Backyard (NIMBY) concerns. Common objections include issues related to odors, reduced property values, and perceived environmental impacts.

- **Political Factors: High**
  - Political resistance to landfills and reliance on landfill-based waste management is considerable. Geographically, Florida's high groundwater tables and flood-prone regions exacerbate the challenge of preventing groundwater contamination, making the siting and operation of landfills more difficult.

- **Environmental Justice: High**
  - Landfills raise substantial environmental justice issues due to their association with air and groundwater pollution, diminished property values, and contributions to climate change. Methane emissions from landfills, which are far more potent as a greenhouse gas than carbon dioxide, further diminish their standing compared to WTE, which ranks higher on the U.S. EPA's waste management hierarchy. WTE is given a high rating for environmental justice due to these concerns.
- **Likelihood of Success: Low**
  - The probability of successfully establishing new landfills in Florida is low, given the significant challenges related to land scarcity, public opposition, and environmental considerations outlined above.

9.4 SINGLE-STREAM RMPF

- **Costs: Low**
  - Net cost per ton of processing recyclables at a single stream RMPF typically is cheaper than WTE and landfill disposal options. Please see net processing costs per ton in **Table 19**.
- **Cultural Barriers: Low**
  - SSR is convenient and easier to participate in compared to DS recycling. Because SS requires only one (1) container vs. multiple that DS recycling requires, residents typically favor this system.
- **Political Factors: Low**
  - SSR facilities tend to have political support as they divert materials from WTE and landfills. Some communities in Broward County have suspended SSR due to increased costs over the years, causing additional political pressures.
- **Environmental Justice: Low**
  - Because SSR diverts materials away from landfills and WTE facilities, environmentally this system is preferred compared to disposal of materials and siting of additional disposal facilities
- **Likelihood of Success: High**
  - Historically and presently, SSR has a high likelihood of success. Continued education and outreach is essential to bringing awareness to the public on the benefits of recycling.

9.5 DRY MRF

- **Costs: Low**
  - The net cost per ton of processing recyclables at a SS RMPF is typically lower than the cost of WTE and landfill disposal options, but higher than the cost of SS RMPFs where recyclables are source-separated at the point of disposal. Please see net processing costs per ton in **Table 19**.
- **Cultural Barriers: Medium**
  - Dry MRFs are convenient and easier to participate in than SSR. However, there may be some barriers to Dry MRFs due to the lack of familiarity with the system compared to SSR.
- **Political Factors: Low**
  - Dry MRF facilities tend to have political support as they divert materials from WTE and landfills. Some communities in Broward County have suspended SSR due to increased costs over the years, causing additional political pressures.
- **Environmental Justice: Medium**
  - Because Dry MRFs divert materials away from landfills and WTE facilities, environmentally this system is preferred compared to disposal of materials and siting of additional disposal facilities. Dry MRFs however, have a higher residue and contamination rate. Compared to a SSR MRF, a dry MRF would capture less materials.
- **Likelihood of Success: High**
  - A Dry MRF has a high likelihood of success as technology continues to improve. For example, most new SSR MRFs with significant processing capacity are designing to manage up to 30% inbound contamination levels and similar technology is being deployed in Dry MRFs. Continued education and outreach are essential to bringing awareness to the public on the benefits of recycling.

9.6 COMPOST/MULCH

- **Costs: Low**
  - Composting and mulch facilities have lower initial costs and processing costs than WTE facilities and landfills. Please see **Table 19** for additional information on capital costs, operating costs, and net cost per ton processed.
- **Cultural Barriers: Medium**
  - The cultural barrier to composting facilities is medium. Not-In-My-Backyard (NIMBY) concerns and residents' concerns about odors from composting facilities contribute to cultural barriers being rated as a medium. CASP system and proper management

of facilities can prevent odors. Resident education is important to facilitate the siting process.

- **Political or Geographic Barriers: Medium**
  - The warm climate of Florida makes it ideal for composting, as it accelerates the breakdown of organic material. However, fibrous yard trimmings may pose a challenge. The biggest political barrier potentially to compost facilities may be NIMBY concerns and/or finding suitable land for development. The large footprint also makes siting challenging.
- **Environmental Justice: Low**
  - Environmental justice concerns are typically low for composting facilities as it supports diverting materials away from landfills and WTE facilities. Some environmental concerns include dust, noise, and potentially odors. Depending on the distance of the compost facility, the net greenhouse gas emissions benefit may favor WTE due to fugitive emissions. The large scale of the operation increases the risk of mismanagement and increased odor or emissions. NIMBY issues may be present regarding siting facilities.
- **Likelihood of Success: High**
  - Compost/mulch facilities are likely to succeed due to the relatively moderate barriers. End markets for materials may present a challenge where a skilled and creative salesforce and biochar may mitigate risk. A strong education and outreach program, controlling odors and pests (e.g., birds), and ensuring the finished compost finds an end market will be critical to its success.

9.7 PYROLYSIS

- **Costs: Low**
  - Pyrolysis initial and operating costs compared to WTE facilities and landfills costs is the reason for the low-cost rating. However, low process capacity makes this a complementary solution rather than a primary solution. Please see **Table 19** for additional information on capital costs, operating costs, and net cost per ton processed.
- **Cultural Barriers: Medium**
  - As a relatively new technology to the general public, the cultural barrier is medium. Resident education is important to facilitate the siting process and to distinguish it from other forms of pyrolysis/gasification technology.
- **Political or Geographic Barriers: Medium**
  - Political attitudes toward pyrolysis to create biochar are currently positive. However, as an emerging waste management technology there is some risk of emerging regulations.

- **Environmental Justice: Low**
  - Environmental justice concerns are typically low for yard waste management facilities as it supports diverting materials away from landfills and WTE facilities. Carbon sequestration provides environmental benefits as does the potential for mitigation of microplastics, PFAS or other contaminants. Emerging understandings of fugitive emissions may introduce risk. NIMBY issues may be present regarding facility siting which can be overcome by education.
- **Likelihood of Success: Medium**
  - As an emerging technology in waste management, there is some risk. Market outlook for end products as well as the upside for the sale of attributes/offsets is bullish but may experience volatility in the long term.

9.8 ANAEROBIC DIGESTERS

- **Costs: Medium**
  - ADs are rated medium for costs. Please see **Table 19** for additional information on capital costs, operating costs, and the net cost per ton processed.
- **Cultural Barriers: Medium**
  - The cultural barrier for ADs is medium due to the lack of familiarity of residents with the technology. NIMBY concerns due to lack of familiarity with the technology may be present. Resident education and understanding of the technology can assist with alleviating these concerns and is important to facilitate the siting process.
- **Political or Geographic Barriers: Medium**
  - The small footprint and enclosed nature of AD systems results in low political/geographic barrier rating. Political risk related to the Federal Renewable Fuel Standard program, or the state Low Carbon Fuel Standard program, may impact upside potential.
- **Environmental Justice: Low**
  - Environmental justice concerns are typically low for composting facilities as it supports diverting materials away from landfills and WTE facilities. Some environmental concerns include dust, noise, and potentially odors. Depending on the distance of the compost facility, the net greenhouse gas emissions benefit may favor WTE due to fugitive emissions from compost piles. NIMBY issues may be present with regard to siting facilities.
- **Likelihood of Success: Medium**
  - Large scale AD facilities for source separated municipal solid waste organics is an emerging technology with existing U.S. implementations having to overcome some initial challenges. Current RNG incentives provide significant upside potential but

may be subject to political or market risks. Digestate management and PFAS concerns must also be considered.

9.9 MIXED WASTE PROCESSING FACILITY

- **Costs: High**
  - MWP Facilities require significant capital and operational costs due to specialized technology for sorting mixed waste. Contamination and the mixed nature of materials coming in require additional processing and/or disposal costs.
- **Cultural Barriers: Medium**
  - MWP facilities may provide convenience and reduce the burden on the public to sort waste. There is, however, moderate public opposition due to potential pollution, odors, and costs. As with any solid waste facility, MWPFs also face NIMBY concerns.
- **Political or Geographic Barriers: High**
  - Political barriers for MWPFs can be high, due to high costs and the reduced quality of recyclable output. There is also little awareness of MWPFs from the general public. In addition, there are examples of several failed facilities with investments lost. MWPFs are P3 in most cases so public funds must be leveraged. Flow control is typically necessary to ensure recovery of cap-ex.
- **Environmental Justice: High**
  - Environmental justice concerns are high due to potential air quality, noise, and odor. Low recovery rate compared to cleaner streams (i.e., those that don't have organics mixed with solid waste).
- **Likelihood of Success: Low**
  - The likelihood of success of MWPF is low to moderate given the significantly high costs, lack of awareness, and associated cultural and political barriers.

9.10 C&D PROCESSING FACILITY

- **Costs: Medium**
  - C&D recycling facilities have moderate capital and operational costs compared to WTE facilities. C&D Recycling facilities also require less land compared to C&D landfill capacities for processing. Capital costs may be more than projected if C&D must be done in a fully enclosed building. Similarly, but on the positive side, C&D is a complementary land use to yard waste recovery, and siting adjacent facilities saves transportation costs for clean wood to be processed. C&D recycling facilities are able to generate a small amount of offset revenues through recovery of materials. C&D facilities typically have less state-reportable diversion than WTE (50%).

- **Cultural Barriers: Low**
  - As with any solid waste facility, C&D recycling facilities also face NIMBY concerns. However, with growing support for green buildings (e.g., LEED and other certifications), the continued growth of new construction and remodeling of residential units will help offset neighbors' concerns.
- **Political or Geographic Barriers: Medium**
  - Political barriers for C&D facilities are low to moderate. Siting any new solid waste facility is challenging in urban southern Florida, especially in Broward and Miami-Dade County. However, C&D facilities can help provide assets needed during a large storm event.
- **Environmental Justice: Medium**
  - Environmental justice concerns are moderate given dust and noise. In addition, C&D sites must be monitored for arsenic and strychnine from pressurized lumber and vegetative debris, hydrogen sulfide (H2S) health alert and odor emissions from drywall, and stormwater quality before release. In the future, PFAS/PFOE issues from crushing and sizing materials may also be a challenge.
- **Likelihood of Success: Medium**
  - The likelihood of success of a new C&D facility is moderate given the existing C&D processing infrastructure in the region.

9.11 DROP-OFF CENTERS: HHW & ELECTRONICS, TEXTILES, RECYCLING

- **Costs: Low**
  - Capital Costs for Drop-Off Centers for HHW, electronics, textiles, and recycling are low. Operating costs depend on the level of staffing required and the cost recovery model used.
- **Cultural Barriers: Low**
  - There are low cultural barriers associated with additional drop-off centers. Increasing convenience of safe disposal options for special waste will likely be favored by the community.
- **Political or Geographic Barriers: Low**
  - Political barriers to increasing drop-off access are low for the same reason as cultural barriers.

- **Environmental Justice: Low**
  - There are very little environmental justice concerns for increasing drop-off centers for the same reasons as cultural barriers. Increasing access is a benefit to residents and communities.
- **Likelihood of Success: High**
  - The likelihood of success of drop-off centers is high given the low cultural, political, and environmental justice barriers. Broward County currently has five (5) drop-off centers in operation, serving 1.98 million residents. Increasing access will be seen as a positive step for recovery.

10.0 TECHNOLOGY ALTERNATIVES

Technological alternatives and innovative solutions are essential to effectively manage the growing volume of waste, evolving consumption patterns, labor shortages, and environmental concerns. Key technological needs include specific solid waste apps for users, enabling feedback loops from the waste system to residents, collection trucks, and contractors. These apps can help improve process efficiency and contamination reduction. Additionally, collector apps that facilitate precise customer service (e.g., retrieving full containers) and support real-time tracking of data collection, compilation, and storage are crucial for providing system feedback focused on reducing contamination and enhancing supply chain efficiency.

Technological innovations are transforming waste collection and hauling through the integration of smart systems, automation, and sustainability-driven designs. IoT-enabled sensors in bins and AI-powered scheduling systems optimize routes and reduce operational costs, while autonomous and electric vehicles reduce emissions and noise pollution. Furthermore, new systems designed to incentivize and educate system users about waste reduction and responsible consumer behavior will require significant investment. These advancements streamline operations and help municipalities meet their environmental goals.

Recycling technologies are also advancing, utilizing optical sorters, AI, and robotics to enhance sorting accuracy and reduce contamination in recyclables. Digital platforms improve transparency and efficiency through blockchain and GPS tracking, while data analytics provide valuable insights for refining waste management policies and optimizing routing and transfer operations. These technologies all focus on better resource recovery and facilitating the transition to a circular economy.

Table 49 presents a cross-section of key innovative technologies paired with the scenarios discussed in this Task 4 White Paper. For a more detailed discussion of these technologies, please refer to the Task 9 White Paper.

Table 49. Key Innovative Technologies by Scenario

Scenario	Interactive Community &/or Authority-wide Waste Services Portal	Smart Waste Management Apps	Smart Multi-Family Collection Tools	Advanced MWP	Biochar	AI/RFID Monitoring of Cart Images During Dumping / Enforcement
A	X	X	X		X	X
B	X	X	X		X	X
C	X	X	X		X	X
D	X	X	X	X	X	X
E	X	X	X	X	X	X

Appendix A

Review of Single-Stream Vs. Dual-Stream Recycling

Current Residential Recycling System

In 2009, Broward County transitioned from a DS recycling collection system to a SS system, with the rollout of cart-based collection programs for SS recyclables commencing in 2011. Among the County's 31 municipalities, 26 currently operate single-family residential curbside recycling programs. These programs utilize a once-weekly, containerized, SS collection system.

However, five (5) municipalities, Coconut Creek, Deerfield Beach, Margate, Davie, and Pembroke Pines, have suspended or terminated their curbside recycling programs. In these areas, recyclables are now collected with regular garbage and directed to WTE facilities. The reasons cited for discontinuing curbside services include declining recycling market conditions, high contamination rates, and significant increases in collection and processing costs driven by the area's sole service provider. For example, Coconut Creek reported a dramatic financial impact. While the recycling program previously generated $40,000 in annual revenue, by the time of its suspension, it was costing the city more than $200,000 annually. Additionally, approximately one-third of the collected recyclables were being sent to landfills due to contamination.

A limited number of lower-density multifamily residences are included in these municipal curbside collection programs. For larger multifamily units and homeowner associations, recycling services are available through private providers on an opt-in basis. Despite some legislative frameworks being in place, mandatory recycling collection is not enforced. Relevant laws and regulations can be referenced in **Table 50.**

Table 50. Laws Governing Multifamily Recycling Services in Broward County

Municipality	Website Instructions	Mandatory or Voluntary
Pompano Beach	Residential collection includes duplex and tri-plex properties. "Residents of condominiums and multi-family neighborhoods should check with their homeowners' association or property manager for their particular recycling rules."	Voluntary[48]
Broward County	"Residents of multifamily communities (condos, apartments) in Broward County are encouraged to recycle. SSR makes that easy because you can put recyclable items together in the same container. There's no need to sort. If recycling isn't available where you live, watch our new multifamily recycling video, then talk to	Voluntary. Mandatory only for the unincorporated areas of

[48] https://www.pompanobeachfl.gov/government/solid-waste-and-recycling/recycling-program#:~:text=Participation%20in%20a%20recycling%20program,Coordinator%20by%20phone%20at%20954.545.

Municipality	Website Instructions	Mandatory or Voluntary
	your property manager or HOA about getting a program started.	Broward County [49]
Ft. Lauderdale	Duplex, tri-plex, and cottages on properties are included. "If your property offers SSR you can mix all of your recyclables together, but if not, then you will have to separate paper from other recyclables." Many buildings offer SSR at this time. • If your recycling is sent down a chute system, you may have difficulty fitting certain larger recyclables, such as cardboard boxes. Please check with building or property management to determine where they should be placed. • Because your recycling bins are shared, they will become full very quickly. Please separate caps and lids so that you can crush the air out of plastic and paper containers. This saves space in the dumpster and in the truck. • Please also be respectful of your neighbors who live near the container. Keep your recycling clean. Rinse plastic, glass, and metal recyclables. And remember, no food in the recycling containers please!"	Voluntary. Mandatory only for Multifamily[50]
Plantation	"… Plantation requires all non-multifamily residents, single-family homes, townhouses, duplexes and triplexes (other than those located in Plantation Acres or Melaleuca Isles) to use Plantation's clear recycling bags for their solid waste recycling."	Voluntary[51]

Recyclable materials collected by each member municipality are either consolidated prior to being transported to the Reuter Facility or delivered by SS collection trucks. Authority members have various contracts with private companies for the collection and transfer of materials for processing and marketing of the materials. Approximately 240,000 TPY are collected and processed at the 800 TPD Reuter Facility as reflected in **Table 51.**

[49] https://library.municode.com/fl/broward_county/codes/code_of_ordinances?nodeId=PTIICOOR_CH14GATR
[50] https://gyr.fortlauderdale.gov/home/showpublisheddocument/5721/635507713464070000
[51] https://www.plantation.org/government/departments/public-works/recycling-guidelines

Table 51. Single-Stream Recycling Tons received by WM Reuter Facility

Facility Name	Facility Type	Address	City	SSR (Tons)
WM Reuter Facility	RMPF - Class I & III	20701 Pembroke Road	Pembroke Pines	800 TPD (~240,000 TPY)

Correspondingly, the recycling hauler and percent of SSR received from residential curbside recycling programs of each municipality in Broward County are presented in **Table 52.**

Table 52. Residential Curbside Recycling Programs by Municipality

Municipality	Recycling Hauler	SSR % of tons received[52]
Coconut Creek **Recycling suspended**	Republic Services	2%
Cooper City	Coastal	0%
Coral Springs	Coastal	3%
Dania Beach	Waste Management	11%
Davie **Recycling suspended**	Coastal	3%
Deerfield Beach **Recycling suspended**	Deerfield Beach	0%
Fort Lauderdale	Waste Management	0%
Hillsboro Beach	Waste Pro	7%
Hollywood	Waste Pro	0%
Lauderdale-By-The-Sea	Waste Pro	12%
Lauderdale Lakes	Waste Management	2%
Lauderhill	Waste Management	0%
Lazy Lake	Waste Management	5%
Lighthouse Point	Waste Management	0%
Margate **Recycling suspended**	Republic Services	1%
Miramar	Waste Pro	0%
North Lauderdale	Waste Management	12%
Oakland Park	Oakland Park	4%
Parkland	Waste Management	4%
Pembroke Park **Recycling suspended**	Waste Management	4%
Plantation	Waste Management	0%
Sea Ranch Lakes	Waste Management	8%
Southwest Ranches	Waste Management	0%

[52] Based on Task 2 Mass Balance SSR (for year 2023)

Municipality	Recycling Hauler	SSR % of tons received[52]
Sunrise	Republic Services	1%
Tamarac	Waste Management	8%
West Park	Waste Pro	6%
Weston	Republic Services	1%
Wilton Manors	Coastal	6%
	Total	100%

Overview of Single-Stream Collection and Processing Systems

There are two (2) main types of curbside recycling collection programs operating in the United States today, namely, SS and DS collection systems.

SSR is a system in which all recyclables, including newspaper, cardboard, junk mail, paper packaging, plastic packaging, aluminum and steel packaging, etc., are placed in a single container for recycling. These recyclables are collected by a single truck and taken to a RMPF to be sorted into various commodity streams for sale to end markets which can be used for re-manufacturing in useful products.

SS programs may utilize the same mobile collection equipment as containerized solid waste and containerized yard waste, usually an automated side loader or a semi-automated (cart flippers) rear load vehicle. The compactor trucks that collect the recyclables typically have one (1) compaction compartment.

SS offers several benefits that simplify the recycling collection process but may result in additional costs further down the supply chain. Key advantages and disadvantages are summarized in **Table 53**.

Table 53. Advantages and Disadvantages of Single-Stream Recycling

SS Advantages	SS Disadvantages
• **Payload** o Trucks utilizing a single compaction container body can maximize compaction storage versus DS collection. In modern trucks the collection capacity for SS is up to 15-tons per load. Having more than one (1) compaction body on a truck for DS means the split bodies will fill up at different rates with the one that fills fastest dictating productive time on routes. • **Stop Time** o Less time is spent for each collection stop, and service time per household is	• **Contamination** o SSR collection may underperform in terms of quality when compared to its counterpart, DSR. Mixing materials often crushes them during collection, making them harder to recover. o While SS may be perceived to have higher participation rates and higher contamination rates as compared to DS, studies are largely inconclusive as other factors such as outreach and education, frequency of collection, as well as container types may also impact performance.

SS Advantages	SS Disadvantages

reduced by at least 50% because only one (1) container needs to be loaded into the truck and the action does not need to be repeated as in DS or multi-stream.
• **Automation**
  ○ With the advent of automated cart collection, a dangerous job of manually dumping recyclables, and repeating that process twice at each stop for DS collection (whether manual or split body truck) vs. one (1) dump of recyclables in a large container for SS (usually 48-gallon, 64-gallon, or 96-gallon containers).
• **Route Cost per Household**
  ○ Maximum households per route day and truck body utilization (see **Table 47**)
• **Lower Collection Operating Costs**
  ○ In addition to the aforementioned efficiencies, SSR typically requires a fewer number of trucks and staff since only one (1) recycling container needs to be collected, rather than multiple in a DS system. As such, overall operating costs of the collection system, including labor, vehicle maintenance, fuel, and containers, are reduced.
	• **Reduced Quality of Recyclables**
	  ○ Paper pierced with glass and aluminum and plastic cans crushed together must be diverted to landfills. Because it requires more attentive separation from consumers, DSR generally has less contamination, meaning purer materials, less contamination, and higher prices.
	• **Higher Processing Costs**
	  ○ Due to higher contamination rates within SS operations, there tends to be higher sorting and processing costs at RMPF. Typically, additional time, workers, or sorting technologies are required to remove contaminants, consequently, higher costs.

Overview of DS Collection and Processing Systems

Under the DS system, residents usually combine all their food and beverage containers (aluminum and steel cans, glass jars and bottles, and some or all plastic bottles) in one (1) bin, and they put their newspapers and/or mixed paper (such as junk mail, cereal boxes, and home office paper) in another bin, or in a brown paper grocery bag.

The two material streams are picked up and placed in separate compartments on the recycling truck and taken to a RMPF. The fiber is sent to market with little or no processing, and the containers go through a variety of automated sorting equipment and hand-picking before being baled or containerized and sent to market.

The DS system generally offers the converse benefits and drawbacks from the SSR process. Key advantages and disadvantages are summarized in **Table 54.**

Table 54. Advantages and Disadvantages of Dual-Stream Recycling

DS Advantages	DS Disadvantages
• **Reduced Technical and Financial Barriers for Recycling Facilities** o Given the materials are pre-sorted, facilities are less complicated and may not require additional workers or sorting technologies to separate materials. • **Less Contamination** o DS recycling tends to have less contamination of materials. Higher quality recyclables are favored by RMPFs and end markets, which makes the business more attractive for operators. To reduce contamination of recyclables, California amended their code in 2020 (through AB815) to encourage municipalities to switch from SSR to DSR. • **Lower Processing Costs** o Because materials are sorted at the source, processing costs may be lower than SSR. In one case in New Jersey, the cost of processing materials from DS collection was found to be $40 per ton less to process compared to SSR. A higher quality of recyclables means RMPFs can sell bales to end markets at a higher financial value, leading to potentially higher profits for facilities.	• **Inconvenience** o Because generators are asked to source-separate recyclables into multiple bins, more effort is required from consumers. This added inconvenience can lead to lower participation rates. For those who find the process too complicated, it could lead to some not participating in recycling at all. • **Space Limitations** o DS recycling requires multiple containers, taking a larger container footprint. For urban and dense communities, space limitations for additional containers are a concern for residents and businesses. If additional streams are looking to be added, resulting in another container (e.g., yard waste collection or food waste collection), the limited footprint becomes increasingly important. • **Increased Vehicular Traffic** o With additional trucks required for collections, there is increased greenhouse gas emissions from trucks, a concern for communities focused on climate and emission goals. Additional trucks will also mean greater wear and tear on the roads and increased vehicular traffic. • **Higher Collection Costs** o Collection costs tend to be significantly higher in a DSR system. DS requires multiple trucks to collect the two (2) streams or split-body trucks with a 60/40 split, which tend to be more expensive. With multiple trucks, additional resources for collections are required including staffing, vehicle maintenance, and containers. • **Increased Outreach Costs** o To combat contamination and getting materials in the right container, municipalities may spend additional funding on outreach resources (campaigns, container labels, mailers, cart tags, etc.).

Summary Comparison of Single and DS Collection

Table 55 compares the impacts of different characteristics for SSR and DSR programs on municipal operations, costs, processing revenues and residents.

Table 55. Overall Considerations of Single vs Dual-Stream Recycling

Overall Considerations	Characteristic	Collection Method	
		SS	DS
Operations	Staffing	2- Driver and collectors	1 FTE- Automated, driver 2 FTE- Rear Loader with Flipper- 2- Driver and collectors
	Equipment	Materials mixed in one (1) truck	Paper and commingled materials in separate trucks, or one (1) specialized split-body truck
	Pace/Speed	Fast	Fast/medium
	Households per Route Day	900-1200 avg. Saves from 20-45% of a route vs. DS	650-800
	Automated vs. Manual Collection	Automated, but some manual	Two (2) manual automated dumps per household or two (2) separate drive-bys per household per week.
Cost	Collection Cost based on $925/rt./day (varies between $650 and $1,200 per day per route NOT INCLUDING PROFIT)	$.88/HH/WK	$1.27/HH/WK.
	Contamination Cost	10-40%	5-15%
	Processing cost (HH cost based on avg. 280#/HH/yr. ranges from 150-500# based on community)	$100-120 per ton (including disposal costs from contamination) $14 to $16.80/HH/yr.	$50-85 per ton including disposal $7 to $11.20/HH per year
Processing Revenues	Material Commodity	Most SS programs generate more volume due to more participation due to convenience.	Higher quality bales with lower contamination
Residents	Convenience	High	Medium

DS Case Studies

Palm Beach County, FL

Palm Beach County is the largest county by total land area and 4th largest in population in Florida, with approximately 1.5 million residents. Palm Beach County stands out as a DS proponent within the state, with the City of Lake Worth Beach (Lake Worth) even converting back from SS to DS operations citing cost savings of almost $200,000 a year[53]. In recent years, Palm Beach County has the highest recycling rate in the State standing at 80% and 84% in 2022 and 2023 respectively.[54 & 55] This ranking however, is based on the adjusted recycling rate where per Chapter 403.706(4)(a) F.A.C., each megawatt-hour produced by a renewable energy facility using solid waste as a fuel shall count as one (1) ton of recycled material. For comparison, as summarized in **Table 56**, data from the Florida DEP for FY2020 shows a relatively smaller (% vs. %) discrepancy in terms of the unadjusted County Recycling Rate by means other than renewable energy.[56 & 57]

Table 56. County Recycling Rate With and Without Renewable Energy

	Broward County	Palm Beach County
Unadjusted County Recycling Rate by means other than renewable energy	30.94%	46.58%
Unadjusted County Recycling Rate (including renewable energy)	42.04%	74.41%

Materials Collected

In Palm Beach County, yellow containers are utilized to collect fiber and blue containers are used to collect commingled items.[58] **Table 57** presents the list of items accepted for each category of items.

[53] https://www.wastedive.com/news/dual-stream-recycling-wilkes-barre-lake-worth-beach/611493/; https://www.wastedive.com/news/lake-worth-florida-dual-stream-collection/531504/
[54] https://floridadep.gov/waste/waste-reduction/documents/2023-total-county-recycling-credits
[55] FLDEP 62-716.480 Methods and Criteria for Calculating County Recycling Rates: total amount of municipal solid waste generated within its boundaries that is recycled, divided by the total amount of municipal solid waste generated within its boundaries that is recycled, land disposed, or combusted.
[56] https://floridadep.gov/sites/default/files/Broward_2020.pdf
[57] https://floridadep.gov/sites/default/files/Palm_Beach_2.pdf
[58] https://swa.org/192/Recycling-at-Home

Table 57. Items Accepted for Recycling in Palm Beach County

	Accepted Fibers	Accepted Commingled
Items Accepted	• Cardboard • Newspapers and inserts • Dry Food and Pizza Boxes (no food stains) • Mixed Paper • Cardboard Paper Rolls • Mail • Magazines • Paper Bags	• Plastic bottles and containers – lids on; 2 gallons or less • Food and beverage cans • Glass bottles and jars (lids off) • Milk and juice cartons (lids on) • Drink boxes (no pouches, no straws) • Mixed Bulky Rigid Plastics

Collection Infrastructure

Palm Beach County Solid Waste Authority (SWA) offers wheeled carts for multifamily and condominium complexes with dumpster service. Wheeled carts for multifamily complexes are collected mechanically.

For residential recycling services, SWA provides blue and yellow recycling bins for curbside customers. For blue recycling containers, residents have a choice of an 18-gallon or 25-gallon bin. Residents living in certain areas are offered a 35-gallon wheeled recycling cart. Yellow recycling bins, which are used to collect fiber, are offered only in an 18-gallon bin. Materials are collected in a split body 40/60 truck manually for bins. Recycling bins are provided to residents at no charge.

Additionally, SWA provides free waste reviews for businesses to assess garbage and recycling needs. Fees are associated with implementing commercial recycling, however, the SWA shares that these costs may be offset by a reduction in garbage fee.

Processing (Sorting) Infrastructure

Materials are consolidated into one (1) of six (6) transfer stations, strategically placed to consolidate waste in the county to transport to the Renewable Energy Park (two (2) WTE, chemical recycling center, class I landfill, class III landfill, biosolids facility, and recovered materials processing facility). Materials are collected in tractor trailers from the transfer stations and brought to the SWA's Recovered Materials Processing Facility (RMPF).

The RMPF was originally established on a 35-acre site located in West Palm Beach, Florida. The 138,000 square foot facility is comprised of an Administration Area, an Education Center, a 30-ton-per-hour Residual Fiber System, a 15-ton-per-hour commercial fiber system, a 15-ton-per-hour commingled container system, and supporting maintenance shop and storage areas. The facility has a processing capacity of approximately 900 tons per day, with three (3) tip floors feeding three (3) processing systems.

The RMPF facility is split into two (2) areas, "yellow bin side" and the "blue bin side," separating the fibers from the commingled items.

On the "yellow bin side" paper and mixed cardboard is tipped out of vehicles. Tractor trailers from transfer stations unload onto the tip floor using a walking floor mechanism, which pushes the materials out rather than tipping the materials. Split body trucks collecting in closer proximity to the facility are directly tipped onto the tip floor. When cardboard alone is present in collection vehicles, they are dumped in a separate pile on the tip floor from the mixed paper pile.

A loader then collects materials and loads it onto the conveyor belt and takes it to a negative sort. Workers then remove any visible contaminants (e.g., plastic film or wood). Star screens separate mixed paper from cardboard before going through a negative sort, where workers pull additional materials that do not belong. Materials are then taken to a trommel and particulates removed.

The remaining materials move up a conveyor belt, then a loader moves the sorted materials to silos before they are ready for the baler. Three (3) different paper products, regular, premium, and cardboard. Bales are stored inside the facility to prevent moisture and protect from the rain.

On the "blue bin side" or the "container" side of the RMPF, plastics, metals, glass, and cartons are tipped on to the tipping floor. A loader picks up the materials from the tip floor onto a conveyor belt and magnets pick up steel cans.

Workers pick out any contaminants in a negative sort before the materials move into a glass crusher. Glass shatters and falls through into a separate silo, these materials are used in road cover. An eddy current picks up aluminum for separation.

Remaining items are cartons and plastics, which are further separated through optical sorters. #1PET, natural #2 HDPE, and colored #2 HDPE, and mixed plastics are separated and baled. Plastic bales are stored outside and eventually sold to a recycler for new material.

Participation Rates & Contamination Rates

The FDEP[59] released an annual report on participation rates of recycling across single-family, multifamily, and commercial populations.

Palm Beach County, with a population of 1.5 million residents, has 314,000 single-family units in the county with approximately four (4) residents per unit. Fifty percent of the units participate in service, representing 41% of the total population participating in recycling.

For multi-family, 50% of the units, approximately 185,000 out of 370,000 participate in recycling. Sixty percent of the commercial units representing nearly 19,000 entities participate in the County.

For all sectors, there is recycling access for 100% of the county's single-family, multifamily, and commercial generators. **Table 58** summarizes the recycling participation rates of Palm Beach County.

[59] https://floridadep.gov/waste/waste-reduction/content/2023-solid-waste-management-report

Table 58. Recycling Participation Rates in Palm Beach County

	Single-Family	Multi-Family	Commercial
Number of Units	314,187	369,936	31,184
Residents per Unit	4	2	N/A
% Total Units with Service Available	100%	100%	100%
# Units Participating in Service	157,094	184,968	18,710
% of Units Participating in Service	50%	50%	60%
% Total Population Participating in Service	41%	24%	N/A

The SWA of Palm Beach County notes that the County contamination rate is between 8-9%,[60] pointing to low contamination rates to a DSR system.

Montgomery County, MD

Montgomery County, Maryland is another example of a DSR system. The Maryland Recycling Act (MRA) outlines the types of waste that are credited toward a county's recycling rate. Montgomery County, Maryland is required to meet a mandatory recycling rate of 35%.

In CY 22, Montgomery County achieved a 39.76% MRA rate, which is calculated with the following formula: MRA Recycling Rate = (MRA recycling tonnage + RRF credit tonnage) ÷ (MRA recycling tonnage + MRA waste tonnage) x 100.[61]

Recycling rates are calculated with credit from Resource Recovery Facilities (RRFs), which process waste to generate energy and recycle materials. The County's recycling rates without the RRF credit tonnages are not reported by the Maryland Department of Environment's annual Solid Waste Management and Diversion Report. Maryland calculates a separate waste diversion rate which also accounts for additional percentage points for source reduction. For comparisons with Broward County, the MRA County Recycling Rate which includes renewable energy are presented in **Table 59.**

Table 59. Recycling Rate Comparison, Adjusted for Renewable Energy

	Broward County	Montgomery County, MD
Unadjusted County Recycling Rate (including renewable energy)	42.04%	39.76%

60 https://swa.org/FAQ.aspx?QID=237
61 https://mde.maryland.gov/programs/land/Documents/Maryland%20Solid%20Waste%20Management%20and%20Diversion%20Report.pdf

Materials Collected

Montgomery County accepts mixed paper and cardboard in a blue recycling wheeled cart, a paper bag, a cardboard box, or bundled with twine, as well as glass, plastic, and metal bottles, jars, cans, and containers in the blue recycling bin. A list of items accepted are presented in **Table 6060.**

Table 60. Items Accepted for Recycling in Montgomery County, MD

	Accepted Fibers	Accepted Commingled
Items Accepted	• Newspapers and inserts • Boxes (cardboard, cereal, juice and drink, pizza boxes, produce and fruit, shoe, snack and cookie, pasta) • Mixed Paper • Mail • Magazines • Aseptic Cartons, Tetra Packs • Egg Cartons • Paper cups • Ice cream containers and lids • Thermal paper • Non-food grade coated paper • Political or yard signs • Wrapping Paper • Paper Bags	• Foil wrap • Pie plates • Other aluminum food trays • All metal food, beverage, and pet food cans • Tins from cookies, popcorn and similar items • Aerosol cans from non-hazardous products • Glass bottles and jars • Plastic bottles (#1-7) • Plastic containers, tubs and lids, pails and buckets • Tupperware or Rubbermaid durable plastic containers and lids • Nursery and flowerpots • Plastic beverage cups

Collection Infrastructure

Montgomery County services residents living in single-family and townhouses with its DSR program. Materials are collected on a weekly basis in split body rear loader trucks equipped with lifters for carts. Collections are typically done with a driver and one (1) or two (2) helpers.

Processing (Sorting) Infrastructure

Montgomery County Recycling Center sits on approximately nine (9) acres of land and is a 57,000 square foot facility that processes the DSR materials. The facility is a P3, with Maryland Environmental Service (MES) as the facility operator. Currently this facility processes 130 to 150 tons per day. Over the years, the facility has added an addition to the tip floor to increase capacity and allow for additional commingled materials for processing.

Once the recyclables are collected from the split-body trucks, recyclables are dumped onto the tip floor, separating the mixed paper and cardboard in one (1) pile, and the commingled (glass, plastic, metals) in another pile. Front-end loaders load these materials onto a conveyor belt, taken to a pre-sort station where workers remove contaminated non-recyclable items.

Magnets remove ferrous metals, vibrating screen catches broken glass, trommel screens catches paper, broken bottles and other smaller items, and an air classifier pushes the aluminum and plastic with air currents. Workers further sort items in lines. Eddy current magnets capture aluminum, and blowers continue to separate materials further via air pressure.

Materials that are processed into separate material categories are stored in silos until they are baled. Glass is also separated by color by workers and sent to a processor. The remaining residue is compacted and taken to the transfer station near the RMPF for disposal.

Participation Rates and Contamination Rates

Montgomery County has a team of three (3) recycling contamination specialists who inspect the commingled and mixed paper recycling containers before they are collected to estimate contamination rates. This assessment also helps capture the participation rates for County residents. In two (2) of the county's 13 collection areas, the County found that approximately 52% of the houses have recycling containers set out for collection. Fourteen percent of the recycling containers set out were found to have contamination present and were rejected. The contamination specialists provide information and educate the residents on the materials considered contaminants to change behavior. They report that after visiting the same route one (1) and two (2) weeks after the initial inspection, the contamination is reduced due to this dedicated outreach.

RMPF Upgrades to Allow for Single-Stream

Following a Facility Condition Assessment, Montgomery County is working toward updating the RMPF between FY 24-27. The project will include new equipment to increase commingled processing capacity to 200 – 240 tons per day (TPD) from the current processing capacity of 130-150 TPD.

According to Montgomery County's Capital Improvement Plan project sheet: "A full upgrade of the existing recycling center complex"[62] - the majority of the system components have been deemed to have operated beyond their useful life and causing frequent downtime and high repair and maintenance costs. Project justification details that replacement parts are also increasingly difficult to source for some equipment.

The project aims to reduce operating costs, increase revenues from the sale of recyclables, and increase processing efficiency. Furthermore, the design and upgrades to the RMPF will be built to consider allowing for future addition of SS processing equipment within the facility to potentially receive recyclables from out-of-county, if expansion to a regional concept is supported to improve the recycling program's cost-benefit ratio.

The existing RMPF building will be modified to increase storage capacity for both incoming and baled material. The updates will allow the facility to have greater operation uptime (expected to reach 90% rather than the current 83%) and expected to produce a higher quality product, which would yield greater market values.

The facility upgrades will also include bringing glass to the beginning of the sorting line, a best practice adopted by many modern RMPFs in the country, which will reduce wear and tear on the equipment. Additional upgrades include improved sorting screens, optical sorting, high efficiency

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[62] https://www.montgomerycountymd.gov/OMB/Resources/Files/omb/pdfs/fy25/cip_pdf/P802201.pdf

electric motors, and reduced reliance on labor for sorting. Montgomery County is also looking to upgrade the electrical capacity dependent on load needs following renovations.

Outagamie County, WI

Outagamie County, Wisconsin is an example of a SSR system. Together with Brown County and Winnebago County, Outagamie formed the Tri-County Partnership in 2001 to provide waste management services to the three (3) Northeast counties in Wisconsin. The Tri-County Single-Stream Recycling Facility, one of the largest publicly own and operated RMPFs in the country was operationalized in 2009 and is located in Appleton, a city in Outagamie County. In 2023, Outagamie County Recycling and Solid Waste was awarded for its Outstanding Social Media Campaign as part of the Solid Waste Association of North America (SWANA) Technical Divisions Awards (Recycle More Outagamie, 2010). These education efforts are cited as key to keeping contamination rates low.

Materials Collected

Outagamie County accepts paper, plastics, metals and glass in a blue recycling wheeled cart. A list of items accepted, and items not accepted are presented in **Table 61**.

Table 61. Items Accepted for Recycling in Outagamie, WI

	Accepted (Commingled)	Not Accepted

Items Accepted	• **Paper**
	  ○ Cardboard & Paperboard (Food Boxes) – Must flatten and cut cardboard boxes to 2' X 2' or smaller.
	  ○ Newspapers & Inserts
	  ○ Office & School Paper
	  ○ Envelopes, Junk Mail & Catalogs
	  ○ Books & Magazines
	  ○ Milk, Juice & Soup Cartons
	• **Plastics**
	  ○ Household Bottles, Jars & Jugs
	  ○ Dairy Containers & Lids
	  ○ Produce, Bakery & Deli Containers
	• **Metal & Glass**
	  ○ Aluminum Bottles & Cans
	  ○ Steel & Tin Cans
	  ○ Glass Food & Beverage Bottles & Jars
		• **Paper**
		  ○ No Paper Cups
		  ○ No Shredded Paper
		  ○ No Tissue Paper
		  ○ No Pet Food Bags
		• **Plastics**
		  ○ No Plastic Cups & Lids
		  ○ No Plastic Bags, Wraps & Films
		  ○ No Motor Oil (May be dropped off in resource recovery park)
		  ○ No Styrofoam (May be dropped off in resource recovery park)
		• **Metal & Glass**
		  ○ No Aerosol Cans
		  ○ No Propane Tanks (drop off only in resource recovery park)
		  ○ No Aluminum Pans or Foil
		  ○ No Empty Paint Cans
		  ○ No Scrap Metal (May be dropped off in resource recovery park)
		  ○ No Metal Cookware (May be dropped off in resource recovery park)
		  ○ No Mirrors
		  ○ No Window Glass
		  ○ No Ceramics & China
		  ○ No Drinking Glassware

Collection Infrastructure

Outagamie County provides curbside recycling collection for approximately 66,000 households within the county, including all of Appleton and New London residents who live in single family, duplex, tri-plex and 4-plex units. By law, property owners of five (5) units or more must provide adequate recycling for their tenants.[63] Materials are collected on a fortnightly basis in rear loader trucks equipped with lifters for carts. The Tri-County recycling program cites the City of De Pere (Brown County) as an example of how SSRs use of "large poly recycling carts" allows for automated side-loaders to be used, reducing labor requirements.[64]

Processing (Sorting) Infrastructure

The Tri-County Single-Stream Recycling Facility received a SWANA Recycling Excellence Award in 2010. The equipment layout of the facility is one (1) football field long and three (3) stories high, within a 50,000 square-foot building. While it originally served 65 communities (200,000 households), processing almost 50,000 tons per year from the three (3) counties when it first started operations in 2009, it has since grown to serve most of Northeast Wisconsin as well as parts of Upper Michigan. As of 2021, the facility was reported to have the ability to process more than 100,000 tons of recyclables annually (Waste Advantage Magazine, 2021).

About 800,000 pounds of recyclables are dumped by trucks onto the tip floor daily. These are fed onto a metering bin that provides a consistent material flow into the system from the tip floor to the pre-sort area. Sorters (typically two (2) to four (4) workers) remove trash (particularly plastic bags that may damage equipment) and also large metals and large plastics, both of which are recycled.

Next, cardboard is removed from the material stream with the OCC Separator and other materials fall through to a patented Debris Roll Screen which separates glass from the stream. The removal of glass results in cleaner commodities and less wear and tear on subsequent processing equipment.

After cardboard and glass is removed, paper is further sorted into newspaper and mixed paper. This stream goes through a manual quality control post-sort process to ensure optimum marketability of the recovered commodities.

Aluminum, plastics, tin and steel are further sorted at the container sort line. Aluminum is sorted utilizing an Eddy Current separator and ferrous metals are separated by an Electro-Magnetic Separator. Optical sorting is used to separate PET bottles from other residuals. Manual quality checks are also used to increase material recovery. This minimizes the material that eventually ends up as residual. Sorted materials are baled and stored for shipment.[65 & 66]

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[63] https://www.recyclemoreoutagamie.org/curbside-recycling-2/
[64] https://www.recyclemoreoutagamie.org/about-us/what-we-do/
[65] https://www.recyclemoreoutagamie.org/wp-content/uploads/2015/01/Tri-County-Single-Stream-Recycling-Facility-SWANA-Award-Submission.pdf
[66] A Virtual Tour of the Tri-County Recycling Facility in Appleton, Wisconsin, Outagamie County Recycling & Solid Waste YouTube Channel https://www.youtube.com/watch?v=GTGTIddHIFs

Participation Rates and Contamination Rates

According to the Wisconsin Department of Natural Resources, 94% of Wisconsin households recycle.[67] For Outagamie County, curbside recycling serves 66,000 households out of 76,237 occupied housing units, as reported by the 2020 US census, which means that approximately 87% of the households have access to recycling.

The Tri-County Recycling Program cites a contamination rate of less than 8% (calculated as residual over the volume of incoming recyclables collected). They attribute the low contamination rates to an effective educational plan, efficient sorting and processing, as well as effective staff on the conveyor lines (training). [68]

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[67] https://dnr.wisconsin.gov/topic/Recycling/facts.html

[68] Tri-County Recycling Program, Outagamie County Recycling & Solid Waste YouTube Channel https://www.youtube.com/watch?v=S_qsr9nxIh4&t=77s

Appendix B

Annual Collection Cost for Scenarios

Scenario A - Automated-Side-Loader (ASL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	105	$78,000.00	$8,200,000
		Collectors	-	$-	$-
	Equipment (Annualized Costs)	Vehicle	105	$43,750.00	$4,600,000
		Carts	390,000	$6.64	$2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	105	$40,000.00	$4,200,000
		Cart Distribution, Maintenance	390,000	$10.00	$3,900,000
				Total	**$23,600,000**
SSR (1x/week)	**Cost Item**	**Description**	**# of Units**	**Unit Cost**	**Extended Cost**
	Collection Labor	Drivers	15	$78,000.00	$1,100,000
		Collectors	-	$ -	$ -
	Equipment (Annualized Costs)	Vehicle	15	$43,750.00	$ 600,000
		Carts	80,000	$6.64	$1,900,000
	O&M	Vehicle Maintenance, Repairs, Fuel	52	$40,000.00	$2,000,000
		Cart Distribution, Maintenance	80,000	$10.00	$2,800,000
				Total	**$3,700,000**

For Yard Waste Collections, rear-end loader (REL) vehicles, rather than automated side loaders (ASLs), are assumed for this service to accommodate the manual collection of paper-bagged and/or containerized/bundled yard waste.

Scenario A - Rear-End-Loader (REL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	135	$78,000	$ 10,500,000
		Collectors	270	$ 71,000	$ 19,200,000
	Equipment (Annualized Costs)	Vehicle	135	$43,750	$ 5,900,000
		Carts	390,000	$6.64	$2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	135	$40,000	$5,400,000
		Cart Distribution, Maintenance	390,000	$10.00	$3,900,000
				Total	$ 47,600,000

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
SSR (1x/week)	Collection Labor	Drivers	19	$78,000	$1,500,000
		Collectors	38	$71,000	$2,700,000
	Equipment (Annualized Costs)	Vehicle	19	$43,750	$800,000
		Carts	80,000	$6.64	$500,000
	O&M	Vehicle Maintenance, Repairs, Fuel	67	$40,000	$800,000
		Cart Distribution, Maintenance	80,000	$10.00	$800,000
	Total				$ 7,100,000
Yard Waste Composting (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	45	$78,000	$3,500,000
		Collectors	90	$71,000	$6,400,000
	Equipment (Annualized Costs)	Vehicle	45	$43,750	$2,000,000
		Carts	315,000	$6.64	$2,100,000
	O&M	Vehicle Maintenance, Repairs, Fuel	45	$40,000	$1,800,000
		Cart Distribution, Maintenance	315,000	$10.00	$3,200,000
	Total				$ 18,900,000

Scenario B - Automated-Side-Loader (ASL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	105	$78,000.00	$8,200,000
		Collectors	-	$-	$-
	Equipment (Annualized Costs)	Vehicle	105	$43,750.00	$4,600,000
		Carts	390,000	$6.64	$2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	105	$40,000.00	$4,200,000
		Cart Distribution, Maintenance	390,000	$10.00	$3,900,000
				Total	**$23,600,000**
SSR (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	15	$78,000.00	$1,100,000
		Collectors	-	$ -	$ -
	Equipment (Annualized Costs)	Vehicle	15	$ 43,750.00	$ 600,000
		Carts	80,000	$6.64	$1,900,000
	O&M	Vehicle Maintenance, Repairs, Fuel	52	$40,000.00	$2,000,000
		Cart Distribution, Maintenance	80,000	$10.00	$2,800,000
				Total	**$3,700,000**

For Yard Waste Collections, rear-end loader (REL) vehicles, rather than automated side loaders (ASLs), are assumed for this service to accommodate the manual collection of paper-bagged and/or containerized/bundled yard waste.

Scenario B - Rear-End-Loader (REL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	135	$78,000	$10,500,000
		Collectors	270	$ 71,000	$19,200,000
	Equipment (Annualized Costs)	Vehicle	135	$43,750	$5,900,000
		Carts	390,000	$6.64	$2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	135	$40,000	$5,400,000
		Cart Distribution, Maintenance	390,000	$10.00	$3,900,000
				Total	$ 47,600,000
SSR (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	19	$78,000	$1,500,000
		Collectors	38	$ 71,000	$2,700,000
	Equipment (Annualized Costs)	Vehicle	19	$43,750	$800,000
		Carts	80,000	$6.64	$500,000
	O&M	Vehicle Maintenance, Repairs, Fuel	67	$40,000	$800,000
		Cart Distribution, Maintenance	80,000	$10.00	$800,000
				Total	$ 7,100,000
Yard Waste Composting (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	45	$78,000	$3,500,000
		Collectors	90	$71,000	$6,400,000
	Equipment (Annualized Costs)	Vehicle	45	$43,750	$2,000,000
		Carts	315,000	$6.64	$2,100,000
	O&M	Vehicle Maintenance, Repairs, Fuel	45	$40,000	$1,800,000
		Cart Distribution, Maintenance	315,000	$10.00	$3,200,000
				Total	$18,900,000

Scenario C - Automated-Side-Loader (ASL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	105	$78,000.00	$8,200,000
		Collectors	-	$-	$-
	Equipment (Annualized Costs)	Vehicle	105	$43,750.00	$4,600,000
		Carts	390,000	$6.64	$2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	105	$40,000.00	$4,200,000
		Cart Distribution, Maintenance	390,000	$10.00	$3,900,000
	Total				**$23,600,000**
SSR (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	15	$78,000.00	$1,100,000
		Collectors	-	$ -	$ -
	Equipment (Annualized Costs)	Vehicle	15	$43,750.00	$600,000
		Carts	80,000	$6.64	$1,900,000
	O&M	Vehicle Maintenance, Repairs, Fuel	52	$40,000.00	$2,000,000
		Cart Distribution, Maintenance	80,000	$10.00	$2,800,000
	Total				**$3,700,000**

For Yard Waste Collections, rear-end loader (REL) vehicles, rather than automated side loaders (ASLs), are assumed for this service to accommodate the manual collection of paper-bagged and/or containerized/bundled yard waste.

Scenario C - Rear-End-Loader (REL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	135	$78,000	$10,500,000
		Collectors	270	$71,000	$19,200,000
	Equipment (Annualized Costs)	Vehicle	135	$43,750	$5,900,000
		Carts	390,000	$6.64	$2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	135	$40,000	$5,400,000
		Cart Distribution, Maintenance	390,000	$10.00	$3,900,000
				Total	$47,600,000

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
SSR (1x/week)	Collection Labor	Drivers	19	$78,000	$1,500,000
		Collectors	38	$71,000	$2,700,000
	Equipment (Annualized Costs)	Vehicle	19	$43,750	$800,000
		Carts	80,000	$6.64	$500,000
	O&M	Vehicle Maintenance, Repairs, Fuel	67	$40,000	$800,000
		Cart Distribution, Maintenance	80,000	$10.00	$800,000
				Total	$ 7,100,000
Food + Yard Waste Composting (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	45	$78,000	$ 3,500,000
		Collectors	90	$ 71,000	$ 6,400,000
	Equipment (Annualized Costs)	Vehicle	45	$43,750	$ 2,000,000
		Carts	315,000	$ 6.64	$ 2,100,000
	O&M	Vehicle Maintenance, Repairs, Fuel	45	$ 40,000	$ 1,800,000
		Cart Distribution, Maintenance	315,000	$ 10.00	$ 3,200,000
				Total	$ 18,900,000

Scenario D - Automated-Side-Loader (ASL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	210	$78,000.00	$16,400,000
		Collectors	-	$-	$-
	Equipment (Annualized Costs)	Vehicles	210	$43,750.00	$9,200,000
		Carts	390,000	$6.64	$2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	210	$40,000.00	$14,700,000
		Cart Distribution, Maintenance	390,000	$10.00	$5,900,000
				Total	**$48,900,000**
SSR (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	15	$78,000.00	$1,100,000
		Collectors	-	$ -	$ -
	Equipment (Annualized Costs)	Vehicle	15	$ 43,750.00	$ 600,000
		Carts	80,000	$ 6.64	$1,900,000
	O&M	Vehicle Maintenance, Repairs, Fuel	52	$ 40,000.00	$ 2,000,000
		Cart Distribution, Maintenance	80,000	$ 10.00	$ 2,800,000
		Total			**$3,700,000**

For Yard Waste Collections, rear-end loader (REL) vehicles, rather than automated side loaders (ASLs), are assumed for this service to accommodate the manual collection of paper-bagged and/or containerized/bundled yard waste.

Scenario D - Rear-End-Loader (REL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	270	$78,000	$ 21,100,000
		Collectors	541	$ 71,000	$ 38,400,000
	Equipment (Annualized Costs)	Vehicle	270	$43,750	$ 11,800,000
		Carts	390,000	$ 6.64	$ 2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	270	$ 40,000	$ 18,900,000
		Cart Distribution, Maintenance	390,000	$ 10.00	$ 5,900,000
				Total	$ 98,800,000
SSR (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	19	$78,000	$ 1,500,000
		Collectors	38	$ 71,000	$ 2,700,000
	Equipment (Annualized Costs)	Vehicle	19	$43,750	$ 800,000
		Carts	80,000	$ 6.64	$ 500,000
	O&M	Vehicle Maintenance, Repairs, Fuel	67	$ 40,000	$ 800,000
		Cart Distribution, Maintenance	80,000	$ 10.00	$ 800,000
				Total	$ 7,100,000
Yard Waste Composting (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	45	$78,000	$ 3,500,000
		Collectors	90	$ 71,000	$ 6,400,000
	Equipment (Annualized Costs)	Vehicle	45	$43,750	$ 2,000,000
		Carts	315,000	$ 6.64	$ 2,100,000
	O&M	Vehicle Maintenance, Repairs, Fuel	45	$ 40,000	$ 1,800,000
		Cart Distribution, Maintenance	315,000	$ 10.00	$ 3,200,000
				Total	$ 18,900,000

Scenario E - Automated-Side-Loader (ASL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	105	$78,000.00	$8,200,000
		Collectors	-	$-	$-
	Equipment (Annualized Costs)	Vehicle	105	$43,750.00	$4,600,000
		Carts	390,000	$6.64	$2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	105	$40,000.00	$4,200,000
		Cart Distribution, Maintenance	390,000	$10.00	$3,900,000
				Total	**$23,600,000**
SSR (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	15	$78,000.00	$1,100,000
		Collectors	-	$ -	$ -
	Equipment (Annualized Costs)	Vehicle	15	$ 43,750.00	$ 600,000
		Carts	80,000	$ 6.64	$1,900,000
	O&M	Vehicle Maintenance, Repairs, Fuel	52	$ 40,000.00	$2,000,000
		Cart Distribution, Maintenance	80,000	$ 10.00	$2,800,000
				Total	**$3,700,000**

For Yard Waste Collections, rear-end loader (REL) vehicles, rather than automated side loaders (ASLs), are assumed for this service to accommodate the manual collection of paper-bagged and/or containerized/bundled yard waste.

Scenario E - Rear-End-Loader (REL) Option

	Cost Item	Description	# of Units	Unit Cost	Extended Cost
MSW (1x/week)	Collection Labor	Drivers	135	$78,000	$ 10,500,000
		Collectors	270	$ 71,000	$ 19,200,000
	Equipment (Annualized Costs)	Vehicle	135	$43,750	$ 5,900,000
		Carts	390,000	$ 6.64	$ 2,600,000
	O&M	Vehicle Maintenance, Repairs, Fuel	135	$ 40,000	$ 5,400,000
		Cart Distribution, Maintenance	390,000	$ 10.00	$ 3,900,000
				Total	$ 47,600,000
SSR (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	19	$78,000	$ 1,500,000
		Collectors	38	$ 71,000	$ 2,700,000
	Equipment (Annualized Costs)	Vehicle	19	$43,750	$ 800,000
		Carts	80,000	$ 6.64	$ 500,000
	O&M	Vehicle Maintenance, Repairs, Fuel	67	$ 40,000	$ 800,000
		Cart Distribution, Maintenance	80,000	$ 10.00	$ 800,000
				Total	$ 7,100,000
Food + Yard Waste Composting (1x/week)	Cost Item	Description	# of Units	Unit Cost	Extended Cost
	Collection Labor	Drivers	48	$78,000	$ 3,700,000
		Collectors	96	$ 71,000	$ 6,800,000
	Equipment (Annualized Costs)	Vehicle	48	$43,750	$ 2,100,000
		Carts	330,000	$ 6.64	$ 2,200,000
	O&M	Vehicle Maintenance, Repairs, Fuel	48	$ 40,000	$ 1,900,000
		Cart Distribution, Maintenance	330,000	$ 10.00	$ 3,300,000
				Total	$ 20,100,000

Assumptions

Tables 62 and 63 summarize the key assumptions used in the scenario analysis, including the unit cost and annualized cost of carts and collection vehicles.

Table 62. One-Time and Annualized Cart Cost Assumptions Used in Scenario Analysis

Lifespan (years)	10	
Cart Prices	**One-Time Cost**	**Annualized Cost**
35-gallon	$ 48.26	$4.83
65-gallon	$ 58.33	$5.83
95-gallon	$ 66.42	$ 6.64
Cart pricing from Miami-Dade County, Florida Sourcewell Contract[69]		

Table 63. One-Unit and Annualized Vehicle Cost Assumptions Used in Scenario Analysis

Lifespan (years)	8	
New Collection Vehicle Cost	**Unit Price**	**Annualized Cost**
Fully Automated Side Loader (ASL)	$350,000.00	$43,750.00
Rear-Loader (REL)	$350,000.00	$43,750.00

Collections Assumptions

Additional cost-related assumptions used in the Scenario analysis are detailed below.

- Labor costs provided by U.S. Bureau of Labor Statistics May 2023 National Industry-Specific Occupational Employment and Wage Estimates – Heavy and Tractor-Trailer Truck Drivers (53-3032) and Refuse and Recyclable Material Collectors (53-7081)
- 44% Fringe Benefit rate assumed on drivers and collectors
- 20% Spare Vehicle Ratio
- 700 households per MSW REL route, once a week collection
- 900 households per MSW ASL route, once a week collection
- 1,000 households per SS REL route, once a week collection
- 1,300 households per SS recycling ASL route, once a week collection
- 1,680 households per yard waste REL route, once a week collection

69 https://www.miamidade.gov/apps/isd/StratProc/ProcurementNAS/pdf_files/RFP00254/Award_Addendum_No._23.pdf

Appendix C

Additional Industrial Food Waste Diversion Options

Anaerobic Co-Digestion of Industrial Food Waste or Commercial Food Waste at WWTPS

Scenario E emphasizes the co-collection and composting of food waste alongside green waste or the AD of recovered wet organics in a standalone AD. However, anaerobic co-digestion of food waste at wastewater treatment plants (WWTP) has potential as an alternative or supplemental method for diverting food waste.

Co-digestion of food waste at WWTPs is a widely adopted food waste diversion method that has been extensively studied and implemented globally. This approach is both practical and cost-effective, leveraging existing infrastructure and personnel and utilizing energy produced to reduce CapEx and operational costs. Constructing and operating a standalone AD facility for food waste.

ADs at WWTPs can capture biogas during the digestion process, offsetting demand for heat and electricity. The dewatered solids can be composted afterward, thereby reducing reliance on landfilling and nutrients from liquid digestate can be recovered enabling discharge.

Incorporation of industrial food waste, that have low solids content and high energy content, including certain food processing wastes or fats, oils and greases (FOG) are common. These materials increase biogas production while the sewage wastewater provides buffering capacity. Front-end food receiving, and biogas utilization capacity will need to be added to the WWTP, and long-term contracts should be secured to manage process parameters and maintain consistency. An example would be the recent project at Broward County Water and Wastewater Division to collect FOG for processing in its AD with biogas utilized for cogeneration to offset utility power purchases (ENGIE North America, 2021).

Recently we have seen an increase in WWTPs that co-digest SSO with sewage sludge to increase biogas production and improve waste management with examples in California, New York and Toronto. To take in food waste at large scale, it is necessary to establish pre-processing facilities capable of converting source-separated food waste into a slurry for efficient digestion.

Broward County operates an extensive network of WWTPs with varying capabilities. Many of these facilities could be adapted to accommodate food waste co-digestion.

Typically, larger WWTPs have a greater opportunity for biogas capture. The U.S. EPA recommends a threshold of greater than 1MGD influent wastewater flow (US EPA, 2024a). Assessing the potential to co-digest industrial, commercial or source-separated food waste at these facilities includes evaluating the existing and potential capacities, operational capabilities, and costs associated with retrofitting the facilities as well as pre-treatment infrastructure.

Leveraging existing WWTP facilities for biogas capture, followed by the composting of biosolids, may offer an efficient alternative for parts of the County where food waste composting is not feasible. However, evaluating the potential for specific facilities, determining the financial impacts of increased sludge levels resulting from food waste addition and integration into WWTP per- and polyfluoroalkyl substances (PFAS) mitigation strategies (see Task 9 Innovative Future Technologies White Paper) is outside the scope of this plan.

Direct Land Application of RGW

The direct land application of raw shredded green waste (RGW) through soil incorporation—mixing green waste into the topsoil at specified loading rates using plows or mixers—presents a promising non-landfill solution for the County's western agriculturally-depleted legacy citrus grove plots. This method could also benefit other crop soils, such as sugarcane and cotton, and potentially extend to adjacent County agricultural lands once proven successful.

California has set a precedent for RGW land application, driven by stringent regulations. The practice has become increasingly common and well-studied in that state. While implementing this approach in Florida may require state or university research, its potential benefits are significant. These include reduced processing costs compared to composting, restoration of depleted soils, and diversion of green waste from landfills, where it would otherwise decompose into greenhouse gases. Implementing this strategy may necessitate obtaining a solid waste or specialized state permit.

This approach could be a highly effective and environmentally beneficial strategy for managing South Florida's lignin-rich yard waste while supporting the restoration of Central Florida's agricultural lands. However, the method remains unproven in Florida and was not included as a scenario component due to the need for demonstration and monitoring. Ensuring appropriate loading rates and soil chemistry after incorporation is critical to success. Once established, this approach could reclaim valuable agricultural acreage by enriching soils with separated, plastic-free yard waste.

Appendix D

Warm Model Inputs, Assumptions and Summary Results

Assumptions:

- Only SSR, Food Waste, and Yard Waste were modeled - expected to underestimate benefit by 20-30% due to special recycling, reuse, and other diversion.

- SSR modeled under general category of Mixed Recyclables

- Recovered Fiber modeled as newspaper recycling

- Biochar and Mulching of Yard Waste modeled as composting. This underestimates the benefit as lower operational impacts are incurred and benefits of carbon sequestration are likely underestimated.

Results Summary

Model inputs:

To account for the avoided electricity-related emissions in the landfilling and combustion pathways, the U.S. EPA assigns the appropriate regional "marginal" electricity grid mix emission factor based on your location.

- Florida
- South Atlantic

To estimate the benefits from source reduction, the U.S. EPA usually assumes that the material that is source reduced would have been manufactured from the current mix of virgin and recycled inputs.

- Current Mix

The emissions from landfilling depends on whether the landfill where your waste is disposed of has a landfill gas (LFG) control system. If you do not know whether your landfill has LFG control, select:

- LFG recovery

If your landfill has gas recovery, does it recover the methane for energy or flare it?

- Recover for energy (based on Broward County Landfill, Monarch flares)

For landfills that recover gas, the landfill gas collection efficiency will vary throughout the life of the landfill. Based on a literature review of field measurements and expert discussion, a range of collection:

- Worst-case collection (based on collection efficiency of 50% - GHG Summary Report)

Which of the following moisture conditions and associated bulk MSW decay rate (k) most accurately describes the average conditions at the landfill?

- Wet k=0.06 (>40" /yr Yearly Average Rainfall in Florida - Current Results)

For AD of food waste materials (including beef, poultry, grains, bread, fruits and vegetables, and dairy products), please choose the appropriate type of AD process used.

- Wet digestion

WARM assumes that digestate resulting from AD processes will be applied to land. In many cases, the digestate is cured before land application.

- Cured- DEFAULT

Emissions that occur during transport of materials to the management facility are included in this model. You may use default transport distances, indicated in the table below, or provide information:

- Use default distances

WARM Results

Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons AD	Total $MTCO_2E$	Material	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total $MTCO_2E$	Change (Alt - Base) $MTCO_2E$
Scenario A															
Food Waste	NA	790k	-	4.8k	-	540k	Food Waste	-	NA	780k	10k	6k	-	530k	(9k)
Yard Trimmings	NA	480k	-	-	-	(45k)	Yard Trimmings	NA	NA	120k	-	370k	-	(30k)	15k
Mixed Recyclables	360k	560k	530k	NA	NA	(1.3M)	Mixed Recyclables	NA	930k	-	520 k	NA	NA	(2,861,6 49)	(1.5M)
												Total Change in GHG Emissions (MTCO2E):			**(1.5M)**
Scenario B															
Food Waste	NA	790k	-	4.8k	-	540k	Food Waste	-	NA	750k	10k	36k	-	510k	(33k)
Yard Trimmings	NA	480k	-	-	-	(45k)	Yard Trimmings	NA	NA	120k	-	370k	-	(30k)	15k
Mixed Recyclables	360k	560k	530k	NA	NA	(1.3M)	Mixed Recyclables	NA	930k	-	520 k	NA	NA	(2.9M)	(1.6M)
												Total Change in GHG Emissions (MTCO2E):			**(1.6M)**
Scenario C															
Food Waste	NA	790k	-	4.8k	-	540k	Food Waste	-	NA	440k	10k	340k	-	260k	(280k)
Yard Trimmings	NA	480k	-	-	-	(45k)	Yard Trimmings	NA	NA	120k	-	366,582	-	(30k)	15k
Mixed Recyclables	360k	560k	530k	NA	NA	(1.3M)	Mixed Recyclables	NA	930k	-	520 k	NA	NA	(2.8M)	(1.6M)
												Total Change in GHG Emissions (MTCO2E):			**(1.8M)**
Scenario D															
Food Waste	NA	790k	-	4.8k	-	540k	Food Waste	-	NA	670k	-	4.8k	120k	450k	(88k)
Yard Trimmings	NA	480k	-	-	-	(45k)	Yard Trimmings	NA	NA	120k	-	370k	-	(30k)	15k
Mixed Recyclables	360k	560k	530k	NA	NA	(1.3M)	Mixed Recyclables	NA	220k	530k	700 k	NA	NA	(970k)	340k
												Total Change in GHG Emissions (MTCO2E):			**260k**

Scenario E																	
Newspaper	-	76k	-	NA	NA	(72k)		Newspaper	-	76k	-	-	NA	NA	(200k)		(130k)
Food Waste	NA	790k	-	4.8k	-	540k		Food Waste	-	NA	670k	-	4.8k	120k	270k		(55k)
Yard Trimmings	NA	480k	-	-	-	(45k)		Yard Trimmings	NA	NA	120k	-	370k	-	(47k)		67k
Mixed Recyclables	360k	560k	530k	NA	NA	(1.3M)		Mixed Recyclables	NA	1M	-	360 k	NA	NA	(3M)		(1.7M)
													Total Change in GHG Emissions (MTCO2E):				**(1.8M)**

Appendix E

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