Wake County

2020 Comprehensive Solid Waste Management Plan

APEX · CARY · FUQUAY-VARINA · GARNER · HOLLY SPRINGS
KNIGHTDALE · MORRISVILLE · RALEIGH · ROLESVILLE
WAKE COUNTY · WAKE FOREST · WENDELL · ZEBULON

August 2020

CDM Smith

Executive Summary

Purpose of the Plan

Many of the factors influencing solid waste management have changed since the County's Plan was updated eight years ago. To address these changes and maintain a cost-effective, sustainable and environmentally responsible solid waste management system for the next 20 years, Wake County has collaborated with its 12 municipal partners to develop this Comprehensive Solid Waste Management Plan. This Plan focuses on identifying and evaluating solutions for both near-term challenges such as recycling, special waste management, and improving waste transfer, and long-range challenges such as identifying and evaluating future options for waste management and disposal.

Plan Priorities

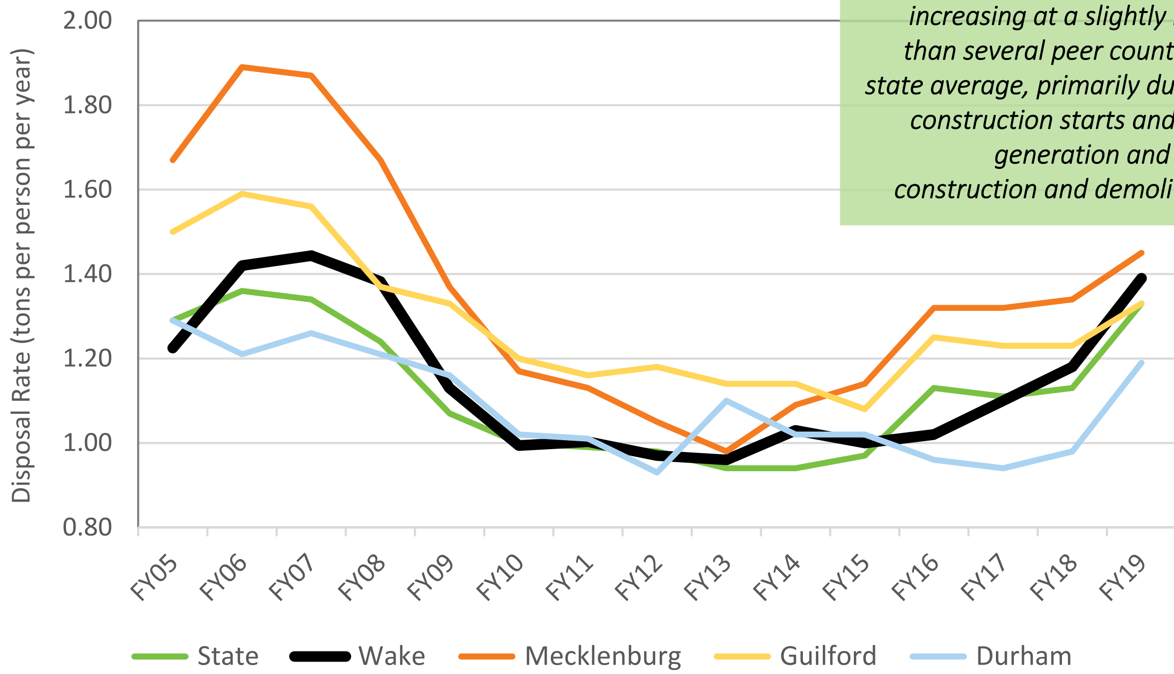
Solid waste and public works representatives of the 13 Wake County local governments ranked the following four planning elements as the top priorities to be addressed in the Plan:

1. **Identifying and evaluating long-term waste management and disposal options**
2. **Evaluating recycling options**
3. **Minimizing solid waste program costs**
4. **Enhancing waste reduction and diversion to extend the life of the South Wake Landfill**

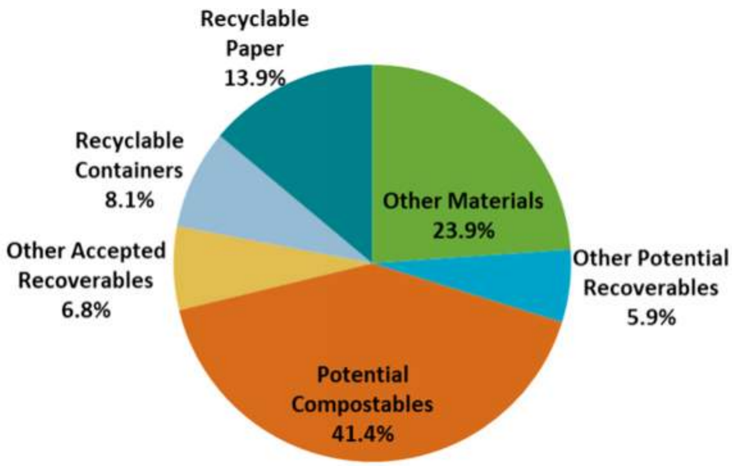
Solid Waste Facts, Figures and Trends

The analysis of solid waste facts, figures and trends helps to understand what programs are working well, where improvements can be made, and what challenges that may be looming on the horizon. The following facts, figures, and trends characterize solid waste management in Wake County.

Per capita waste disposal rates (the amount of waste that is placed in landfills) decreased during the Great Recession but slowly increased as the economy strengthened. Wake County's per capita disposal rate is increasing at a slightly higher rate than several peer counties and the state average, primarily due to strong construction starts and the higher generation and disposal of construction and demolition waste.



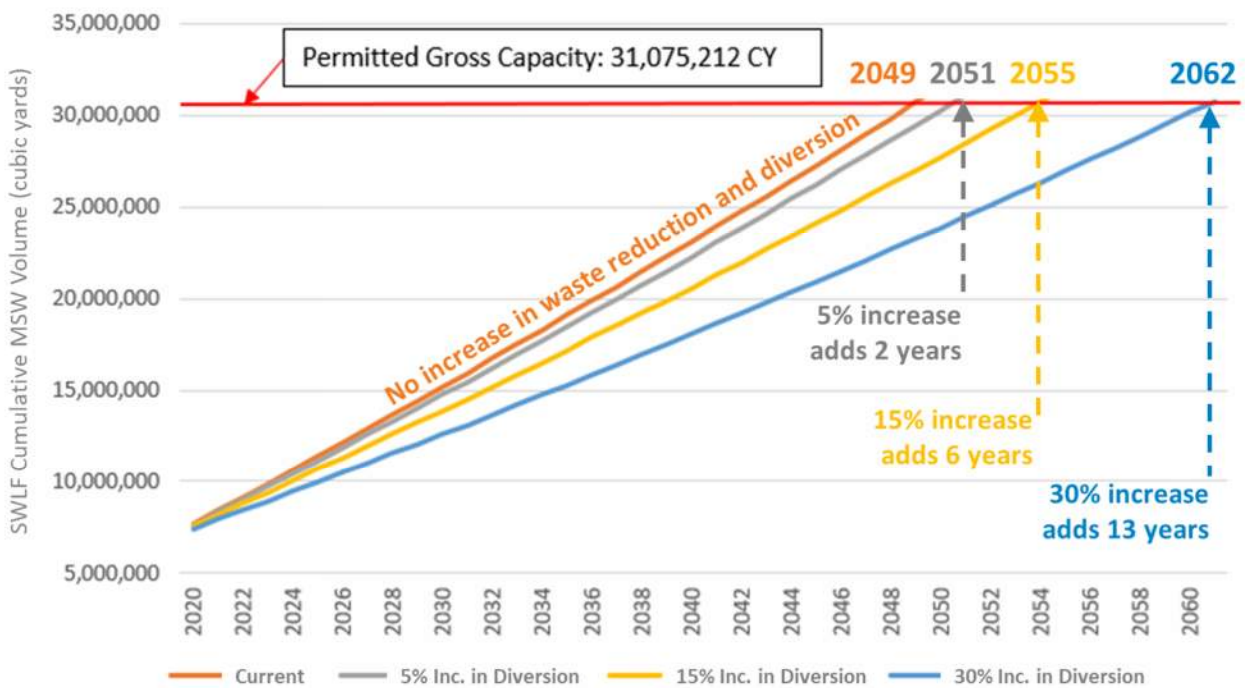
Composition of the Single-Family Waste Stream in 2019



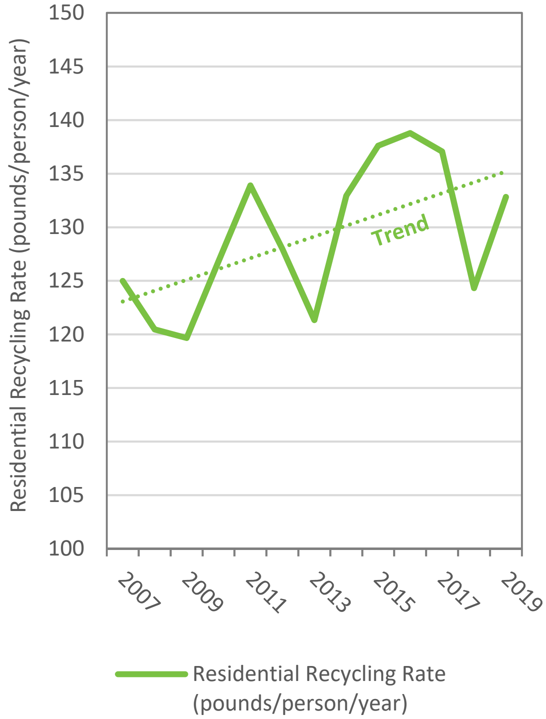
The characterization of waste being disposed at the South Wake Landfill suggests that there are still significant opportunities for waste reduction and diversion. Within the single-family residential waste stream, potential recyclables such as paper, plastics, metals, glass, electronics, and other recoverable materials account for almost 35 percent of the total waste being landfilled. Similarly, over 41 percent of the single-family waste stream consists of organic matter that is compostable.

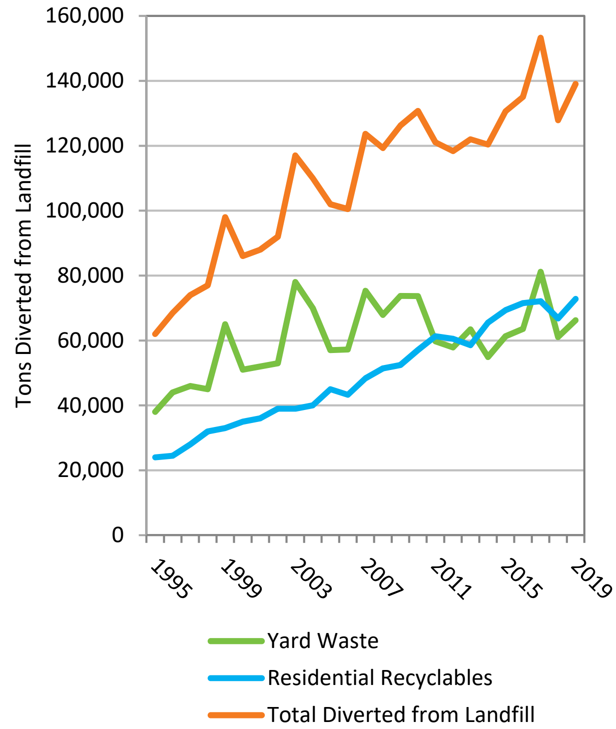
FACT

Wake County awarded 15 Commercial Waste Reduction Grants totaling $104,612 in 2018–2020. The grants were used to expand food waste collection, enhance composting, increase recycling participation, and support education efforts focused on waste reduction and diversion. Improvements in waste reduction and diversion in the commercial and industrial sector will play a big role in reducing the amount of waste sent to landfills, since it makes up more than 50 percent of the MSW stream.

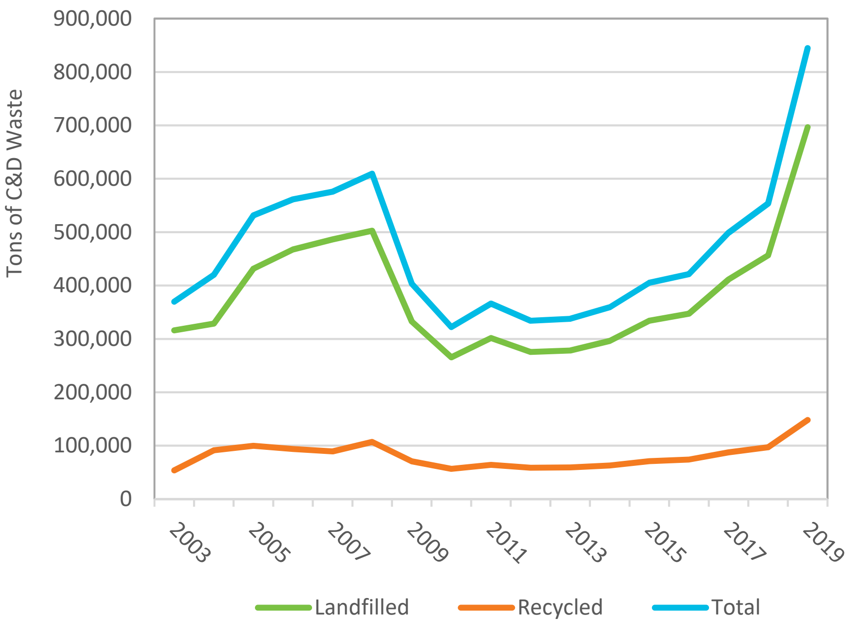


The benefit of improving waste reduction and diversion rates is the extension of the South Wake Landfill operating life, and ultimately, lower long-term costs for solid waste management and disposal. For each year that the landfill is extended, the local governments could collectively expect to save at least $6M to $7M annually in disposal cost. The savings are even higher when factoring in the annual rebate that the South Wake Landfill Partners receive.



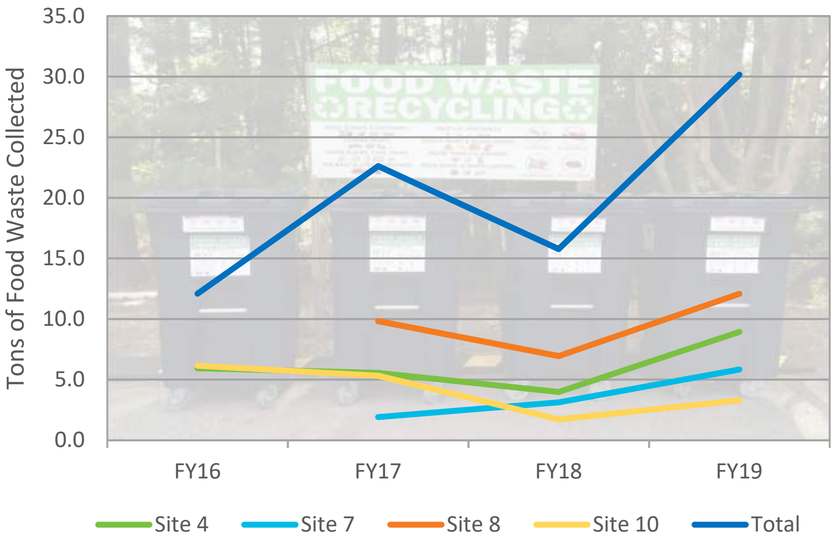


The amount of waste diverted from the landfill continues to grow. Since 1995, residential recyclables collected through curbside and drop-off programs have more than tripled. On a per capita basis, the residents of Wake County have demonstrated a modest increase in recycling over the past 13 years. Although there are year-to-year fluctuations, each resident of Wake County is recycling about 1 additional pound each year.



The generation of construction and demolition (C&D) waste in Wake County has mirrored economic conditions. Following a sharp decline in 2009 and 2010, there has been a steady increase in C&D waste generation. In FY19, the amount of C&D waste increased by 53 percent, reflecting strong construction starts. Because there are four C&D landfills in Wake County, there is very little incentive for generators to recycle C&D materials.

To divert more organics from the residential waste stream, Wake County has been piloting food waste collection at four Convenience Centers. The pilot program has seen increasing participation but has resulted in a relatively minor amount (93 tons) of waste diverted from the landfill to date.

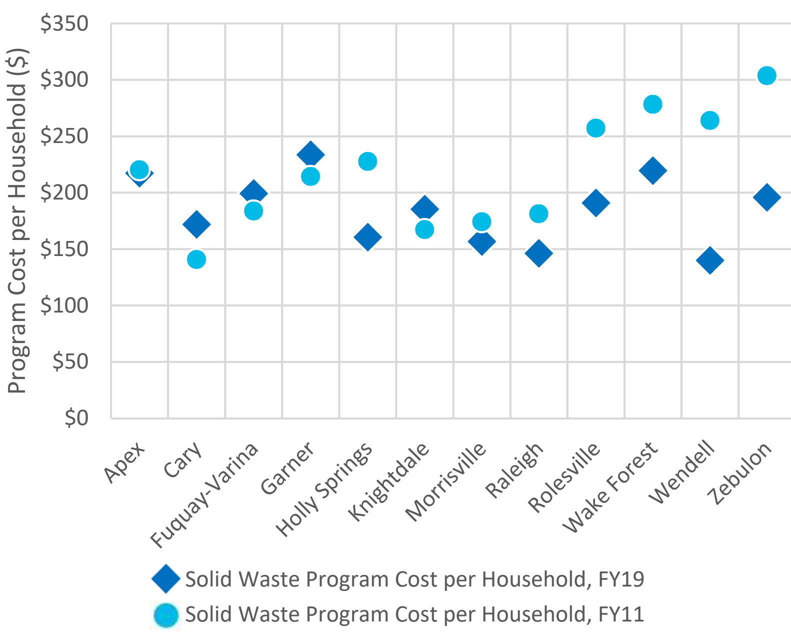


FACT

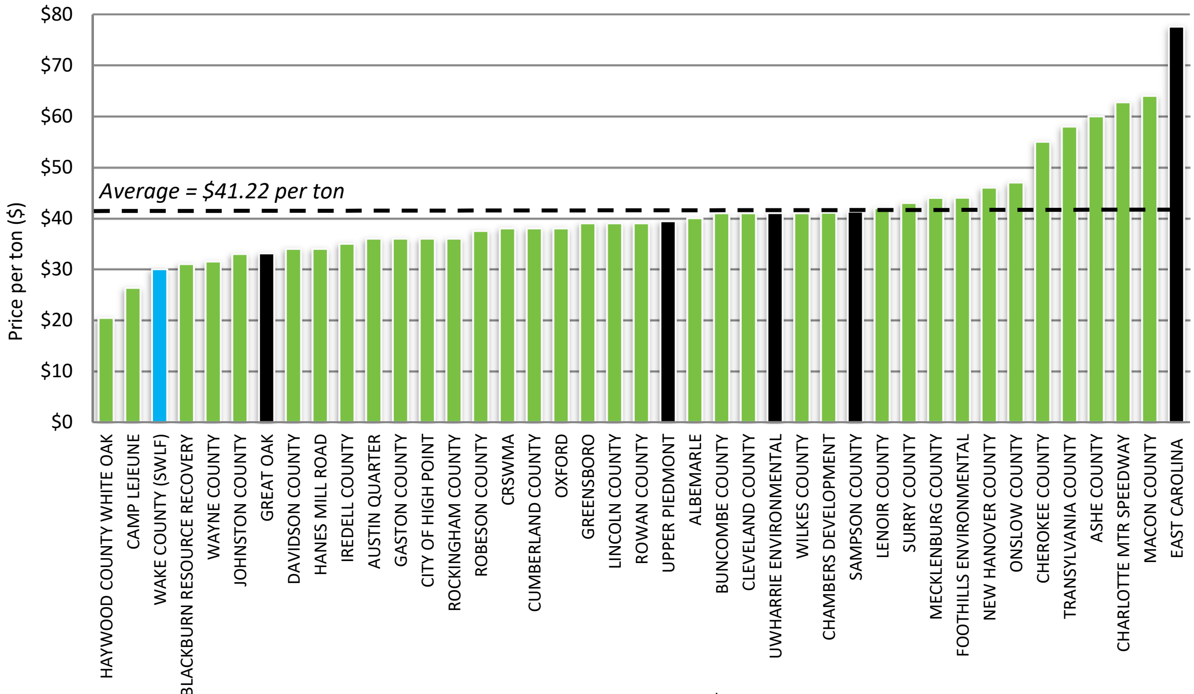
On average, over 50 mattresses per day are disposed at the South Wake Landfill. Mattresses do not compact as well as typical MSW, resulting in a lower waste disposal density. The lower density means that mattresses consume more available landfill airspace per ton of material.

FACT

Wake County collected 20,256 tons of tires in FY 2019 at a total cost of $1,807,753. Although the County receives an annual scrap tire tax distribution from the state, it has not kept up with the County's growing expense to manage tires.



The current average annual solid waste program cost for all twelve municipalities of $185 per household is 15 percent lower than the FY11 average of $218 per household. Eight of the 12 municipalities have lower current solid waste program costs on a per household basis than in FY11. The local governments have been very successful in minimizing waste management costs, in part due to the low cost for disposal at the South Wake Landfill.



Price per ton shown does not include the $2 State Solid Waste Tax
Tipping fees of NC regional landfills within 100 miles of Wake County are shown in black

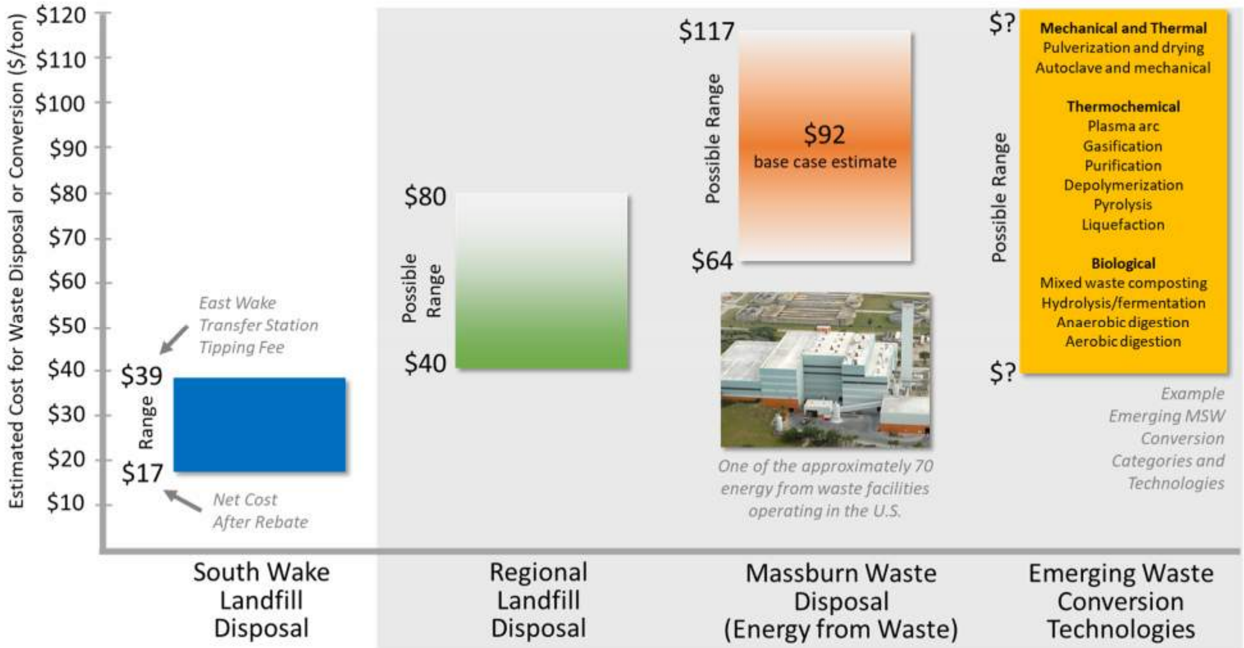
Disposal costs are a significant component of the overall cost of solid waste services. Disposal costs remain very low in Wake County, compared to other areas of the State, driven by a South Wake Landfill tipping fee that is among the lowest the State. The 12 local governments that joined the SWLF Partnership also share in excess revenue that is generated from tipping fees at the landfill. The excess revenue is returned to the partners and used to fund existing and future solid waste programs. In FY19, the $3.6M rebate effectively lowered the cost of disposal for the partners by $15 per ton.

FACT

In fiscal year 2019, 506,581 tons of MSW were generated in Wake County and disposed at the South Wake Landfill. The majority of the remaining 286,674 tons of MSW generated in Wake County was hauled to three regional landfills in North Carolina and Virginia.

In fiscal year 2019, Wake County residents dropped off just under 2,000,000 pounds of household hazardous waste (HHW) at the County's three HHW Facilities and over 4,500,000 pounds of electronics at the County's three Multi-Material Recycling Facilities.

FACT



The next, long-term solid waste management and disposal option will very likely be more expensive than the current cost for MSW disposal at the South Wake Landfill. The feasibility of MSW disposal at a regional privately-owned landfill, incineration at an energy from waste facility, or the use of other emerging waste conversion technologies should continue to be explored and evaluated based on cost and other criteria that are important to the residents, businesses and institutions of Wake County.

The Path Forward

To address the solid waste management challenges over the next 20 years and beyond, the Plan outlines a variety of actions that the local governments intend to take or have already started and offers numerous recommendations for future actions. Some of the recommended actions come from studies recently completed by Wake County. The recommendations are listed by planning element in the following table and are further detailed within the Plan. The recommendations are categorized as "In Progress", "Near-term" actions, and "Long-term" actions. Near-term actions are those which are recommended for implementation within the next five years. Long-term actions are generally not needed in the next five years and/or they may require further consideration and evaluation.

Recommended Actions	In progress	Near-term (in 5 years)	Long-term or Further Consideration
Waste Diversion and Reduction			
Assist Municipalities with Residential Recycling Wake County can help implement and coordinate programs that may increase recycling for the entire County.	●		
Continue Recurring Inter-Local Collaboration Wake County can continue to prioritize recurring meetings with the municipalities to discuss waste strategy and policy and improve interlocal collaboration.	●		
Audit/Perform Data Analysis of Landfill Loads As was done in 2019, the County should continue to assess the quality and quantity of materials that can potentially be diverted from the landfill for reuse, recycling or conversion.	●		
Collaborate with Stakeholders to Promote Recycling The County should continue to communicate and develop synergistic relationships with potential stakeholders such as public institutions, private sector entities, citizen action groups or environmental organizations.	●		
Offer Awards to Haulers and Others for Material Diversion The County could create a recognition system for commercial waste haulers, businesses, and other organizations as an effort to increase the amount of material diverted from the waste stream.			●
Explore Municipal Recycling Facility Possibilities for C&D Debris Developing a C&D materials recovery facility would result in reduced C&D quantities entering landfills.			●
Incentivize Private Haulers Serving Multi-Family Complexes Incentivize private haulers to provide recycling services to multi-family complexes through public recognition, discounts or subsidies, as an effort to divert discards away from disposal.		●	
Target Student Multi-Family Complexes/University Collaboration The County could improve its multi-family recycling rates with community based social marketing techniques, including asking for commitments, prompting actions and creating norms.		●	
Target Small Businesses and Perform Business Waste Audits Develop a business-by-business approach to increase the implementation of material reduction and diversion strategies and conduct waste audits at to characterize the unique waste streams and implement site specific recycling programs.		●	
Expand Food Waste Education and find Post Consumer Food Waste Partners Encourage local establishments, through educational efforts, to follow the US EPA Food Recovery Hierarchy when possible and initiate dialog with resources available for organics recycling in the state.		●	

Recommended Actions	In progress	Near-term (in 5 years)	Long-term or Further Consideration
Expand Composting Continue expanding pilot programs into regional facilities or invest in a central, full-scale composting system. Also, investigate expanding the Raleigh Yard Waste Center to accept organics.		●	
Lead by Example The Wake County Solid Waste Division and other County departments can serve pilot specific solid waste reduction and diversion policies or practices such as on-site composting; expand purchasing requirements with preference for recycled content and/or locally produced products; and implementing a rewards program for employees to incentivize waste minimization.		●	
Stimulate Source Reduction and Reuse Organize pilot programs to incentivize groups or neighborhoods to generate less waste and practice reuse, similar to those that are already being piloted in the Triangle Region.		●	
Implement New Policy Consider new policy and ordinances mandating commercial recycling; implementing save-as-you-throw (SAYT) programs; and implementing material bans that keep certain items out of the SWLF or assessing fines for items that are intended to be kept out of the SWLF.		●	
Long-Term Waste Management Options			
Continue to Evaluate and Implement Strategies that Extend the Life of the Landfill In addition to the waste reduction and diversion strategies, increasing the landfill side slopes is a relatively low cost, but effective way to gain several years of additional landfill life.	●		
Continue to Consider Energy from Waste as a Potential Method of Waste Disposal Before the South Wake Landfill Begins to Reach Capacity Because of the potentially long lead time associated with identifying a sufficient waste stream, siting, designing, permitting, negotiating an energy contract, procurement, financing, constructing, and startup testing of an energy from waste facility, this option deserves thorough consideration at least 7 to 10 years in advance of when it is actually needed.	●		
Participate in Discussions with other Triangle-area Governments to Investigate Regional Solutions Leveraging resources of other triangle area Governments and combining waste streams may improve the economics of the next waste management option.		●	
Monitor and Track Changes in Factors that Will Affect the Feasibility of Long-Term Waste Management Options Factors such as renewable energy policy; the terms of power purchase agreements and revenue; the success (or failure) of emerging waste conversion projects; full-scale implementation of new waste conversion technology; transportation fuel markets; markets for end-use products; and new or changing regulations should be increasingly monitored over time.		●	

Recommended Actions	In progress	Near-term (in 5 years)	Long-term or Further Consideration
Agree on the Criteria that are Important to the Selection of the Next Long-Term Waste Management Option Short and long-term cost; greenhouse gas and priority pollutant emissions; power generation; revenue from power and environmental attributes; sociodemographic impacts; vehicle collisions and worker safety; and resiliency and other factors should be considered and prioritized to effectively evaluate and select the next long-term waste management option.		●	
Recycling and Reuse			
Consider Separate Collection Containers for Glass Bottle and Jars at Drop off Sites Local Governments, and especially Wake County who collects by far the most recyclables at drop off sites may be able to improve the economics of recycling by asking residents to place glass bottles and jars in separate containers at drop-off sites.			●
Promote and/or Incentivize Recycling in Unincorporated Wake County Wake County should consider ways to promote and/or incentivize curbside recycling or use of the Convenience Centers for the more than 31,000 households in unincorporated Wake County that do not actively recycle.		●	
Implement Steps to Reducing Contamination Continue to educate residents about what can and can be recycled to lower contamination rates and reduce the cost of recycling.	●		
Improve Household Capture Rates A collaborative, countywide outreach and education program that promotes recycling, provides a consistent message, and targets those items such as paper and plastics that are not being routinely recycled may improve capture rates.		●	
Consider Incentives, Grants or Tax Breaks to Lure Companies that Use Recyclable Material Incentives, grants or tax breaks may help establish local end-use markets by attracting and retaining companies that use recyclable materials as feedstocks.			●
Consider Incentives, Grants or Tax Breaks to Lure Companies with Emerging Conversion Technologies that Convert Plastics to Fuel, Syngas and Other Useful Outputs Wake County, and the Research Triangle Region which is known for innovation, should seek to attract through business tax credits or other incentives, one or more transformational technology providers that convert plastics to fuel and other useful outputs.			●
Consider Making Recycling Mandatory for Businesses that Generate Large Amounts of Wastes Establishing mandatory recycling for businesses based upon the amount of waste generated can have a significant impact in keeping recyclable materials out of the landfill.		●	

Recommended Actions	In progress	Near-term (in 5 years)	Long-term or Further Consideration
Continue to Explore Opportunities for Cooperative Contracting In the past, Wake County local governments have had success negotiating more favorable contract terms for solid waste services when combining waste streams to achieve a greater economy of scale.	●		
Continue Expansion of the WCPSS Recycling Program Wake County should complete the conversion of all participating schools to commingled collection; rebrand and market educational offerings to teachers; and collaborate with the WCPSS on a waste audit.	●		
Consider a C&D Waste Deposit System A C&D waste deposit system would promote more C&D recycling and encourage development of more C&D recycling facilities.			●
Organics Management			
Continue to Explore ways to Reduce Food Waste Collection Costs from Convenience Centers Due to a lack of qualified and interested haulers, high collection costs have hindered the ability to provide food waste collection.	●		
Increase Education and Outreach Focused on Backyard Composting If effective, this strategy eliminates the costs associated with collecting, hauling and converting food and other organics to compost. However, it is recognized that backyard composting only applies to single family housing and is also more restrictive of the types of food that can be composted.		●	
Research and Explore Other Options to Keep Food Waste Out of the Landfill Wake County should investigate communities that maintain successful food waste programs and evaluate other ways to divert food waste from the landfill such as drop-off sites at community gardens.		●	
Education and Outreach			
Implement the Near-Term Goals Established by Wake County's Outreach Team Near term goals include redesigning County web pages to provide clear, consistent information; increasing virtual education such as videos and podcasts; and introduce consistent evaluations to measure the impact of landfill and MRF tours.		●	
Provide a Consistent Message Regarding Recycling All of Wake County's recyclables generally go to one of the two local MRFs which accept the same list of materials, yet there remains an inconsistent message about what can and cannot be recycled.	●		
Conduct Coordinated Outreach to Reaffirm the Collective Commitment of the Wake County Local Governments to Keeping Recyclables Out of the Landfill Messaging should consistently emphasize the recycling "truths" that recycling: creates jobs; returns valuable resources to beneficial use; preserves virgin materials; saves energy and water and reduces GHG emissions; and conserves valuable landfill space.		●	

Recommended Actions	In progress	Near-term (in 5 years)	Long-term or Further Consideration
Special Wastes			
Implement a Special Tip Fee for Bulk Loads of Mattresses A special tip fee of around $110 to $115 per ton should be considered for bulk loads of mattresses, given that they pose significant operational challenges and take up a more airspace that most other materials.		●	
Pursue Shredding Mattresses and Select Tires Prior to Disposal at the South Wake Landfill By shredding mattresses and some tires, the County could save over $300,000 annually, accounting for recommended mattress tip fees, and based on airspace savings.		●	
Reassess the Tire Management and Disposal Contract Evidence suggests that other North Carolina counties are not being charged at the same high rate that Wake County currently pays for oversize tires by the companies that collect, transport and process scrap tires.		●	
Illegal Disposal/Litter			
Implement Recommendations from the 2019 86it Campaign Evaluation An evaluation of the 86it campaign conducted by Kessler Consulting identified numerous opportunities for improvement that should be pursued including shifting resources away from paid advertising to build awareness of short-term cleanup projects; conducting a pilot partnership with Litterati to gather better data on littering within the County; and renewing collaborations with municipalities and Keep NC Beautiful.		●	
Improve Litter Collection and Monitoring Around the South Wake Landfill Entrance Holly Springs has identified the need to reduce litter and debris coming from waste hauling trucks along Highway 55 and at its' intersection with Old Smithfield Road at the entrance to the landfill.		●	
Waste Transfer			
Wake County, the City of Raleigh, and other South Wake Landfill Partners should continue to collaborate on the need and the timing of a new transfer station in western Wake County The East Wake Transfer Station is currently at or near capacity and operational issues at the facility will worsen if the privately-operated Garner Transfer Station continues at a reduced capacity or closes within the next few years. A new transfer station located in the western part of the County will be necessary if current trends continue or if the Garner Transfer Station closes.		●	
Program Costs and Funding			
Work collectively to integrate and coordinate services and programs or collaboratively bid out services to achieve potential economy of scale savings. Integration and coordination of services and programs and collaborative contracting may help reduce cost.		●	

Recommended Actions	In progress	Near-term (in 5 years)	Long-term or Further Consideration
Participate in regional planning and decision-making activities to address regional opportunities for reducing cost. Wake County, Raleigh and Cary have already been doing this, through regular meetings with other Triangle-area solid waste programs.	●		
Monitor changes in waste flow, waste generation rates, and market-based tipping fees Monitoring these elements is important to ensure that the tipping fee at the SWLF is appropriately set, relative to other disposal alternatives in the region.		●	
Consider Adjusting the SWLF Rebate Formula to Incentivize Waste Diversions and Reduction Adjustments will incentive the local governments to spend more money on outreach and education and waste diversion and reduction programs and may pay off through extending the life of the landfill.		●	
Consider Adjusting the South Wake Landfill Rebate Formula to Establish a Fund for Studying and Potentially Developing the Next Long-Term Disposal Option Investigating the next disposal option should be performed well before the South Wake Landfill reaches capacity.		●	

Table of Contents

Appendices

List of Figures

List of Tables

Acronyms and Abbreviations

BOCC	Board of County Commissioners
C&D	construction and demolition
CBD	Central Business District
cy	cubic yards
DEACS	Division of Environmental Assistance and Customer Service
DWM	Division of Waste Management
EfW	energy from waste
EWTS	East Wake Transfer Station
FY	fiscal year
GDP	gross domestic product
HHW	household hazardous waste
LCID	land clearing and inert debris
MMRF	Multi-material Recycling Facilities
MSW	municipal solid waste
NCDEQ	North Carolina Department of Environmental Quality
NCSU	North Carolina State University
PPA	power purchase agreement
RDF	refuse-derived fuel
SAYT	save-as-you-throw
SWLF	South Wake Landfill
TAC	Solid Waste Technical Advisory Committee
tpd	tons per day
WCPSS	Wake County Public School System

Section 1
Introduction

Wake County's previous Solid Waste Management Plan (Plan) was completed in 2012 in accordance with the Division of Waste Management's (DWM) Ten Year Solid Waste Management Plan Guide. Shortly after, the State's solid waste rules and regulations were revised and the requirement for Plan updates every three years was eliminated. Although solid waste planning is no longer mandated by the state, most communities still recognize that effective planning is integral to maintaining affordable, resilient, and sustainable solid waste programs.

In Wake County, many of the factors influencing recycling, waste transfer, disposal, and other program elements have changed since the Plan was last updated eight years ago. To address these changes and continue to plan for solid waste management over the next 20 years, Wake County has collaborated with its 12 municipal partners to develop an updated Comprehensive Solid Waste Management Plan. This Plan focuses on both near-term challenges, including recycling, expanding options for special waste management, and improving waste transfer, and long-range challenges such as identifying future options for waste management disposal.

1.1 Organization

The Plan is organized into five sections as noted below:

- Section 1 discusses the priorities for the Plan.
- Section 2 presents a summary of the local governments shared waste reduction and management goals.
- Section 3 characterizes the County's changing solid waste stream, discusses current challenges with waste transfer and delivery to the South Wake Landfill (SWLF), and provides recommendations for future waste transfer improvements.
- Section 4 presents a summary of the local governments solid waste programs and focuses on specific planning elements, including future disposal options and management of special wastes.
- Section 5 provides information about the current cost of solid waste programs for the County and local governments and discusses potential SWLF Partnership revenue sharing adjustments to better incentivize waste reduction and diversion and support the evaluation and implementation of future solid waste management options.

Appendices to this Plan provide supporting information used in developing the Plan.

1.2 Participants

This Plan addresses the solid waste management planning needs and requirements of Wake County and all 12 municipal governments which include:

- Town of Apex
- Town of Cary
- Town of Fuquay-Varina
- Town of Garner
- Town of Holly Springs
- Town of Knightdale

- Town of Morrisville
- City of Raleigh
- Town of Rolesville
- Town of Wake Forest
- Town of Wendell
- Town of Zebulon

The municipal governments participated in the Plan preparation by meeting individually with the County's consultants to review their solid waste programs, provide updates on actions and initiatives taken since the last Plan update, and discuss planned actions and initiatives. The Solid Waste Technical Advisory Committee (TAC), which is comprised of representatives from the local governments in Wake County, also participated in the Plan's development by providing feedback on Plan-related topics presented and discussed at quarterly TAC meetings.

1.3 Plan Priorities

At the initiation of the planning process in late 2019, all participating local governments were surveyed to help establish priorities for the Plan update. Solid waste and public works representatives of the local governments were asked to rank nine solid waste priorities in order of importance, with 1 being the most important and 9 being the least important. They were also given the opportunity to list any additional solid waste priorities that are important to their communities. The survey results for all participating local governments were reviewed individually, then combined to understand which priorities were most important and thus should be considered as an area of focus for the Plan update. As shown in Table 1-1, the need to *identify and evaluate long-term disposal options* was deemed to be the highest priority. Five local governments ranked it as the most important, and four others ranked it within the top three. The need to *evaluate recycling options* and *minimize solid waste program costs* were identified as the second and third priorities, respectively. The desire *to enhance waste reduction and diversion to extend the life of the SWLF* was also ranked as a top-three priority by six local governments; however, five other local governments ranked it in the bottom three. Holly Springs identified several other priorities in addition to the nine listed. These included: (1) *cleaning up litter along Highway 55 and at its intersection with Old Smithfield Road*; (2) *eliminating odors at the SWLF*; and (3) *developing alternative plans for disposal including relocation of the landfill and waste-to-energy*. Morrisville identified one additional priority, which was to *identify local options for the recycling of paint, light bulbs and batteries.* Apex identified several additional priorities, including (1) *converting operations to 100% renewable energy sources*; (2) *expanding the food waste recycling program*; (3) *helping municipalities develop compost programs*; (4) *encouraging and offering financial support for backyard composting*; and (5) *changing the formula for giving rebates for the SWLF to a fixed rate so that potential revenue surplus is diverted to funding goals like recycling, education, and the next long-term disposal option*.

Survey responses specific to each local government are included in Appendix A.

Table 1-1. Prioritization of Solid Waste Planning Elements

Priorities Ranked Highest to Lowest	Average Rank	Ranked as top three priority by:	Priority
Identifying and evaluating long-term waste management and disposal options	2.8	Apex, Cary, Fuquay-Varina, Holly Springs, Rolesville, Wake County, Wake Forest, Wendell and Zebulon	Highest Priority
Evaluating recycling options (reducing contamination, improving the economics, etc.)	4.1	Apex, Cary, Garner, Holly Springs, Morrisville and Raleigh	
Minimizing solid waste program costs	4.5	Fuquay-Varina, Garner, Knightdale, Morrisville, Raleigh and Rolesville	
Enhancing waste reduction and diversion to extend the life of the SWLF	4.7	Apex, Cary, Fuquay-Varina, Wake County, Wendell and Zebulon	
Reducing illegal dumping and litter	5.4	Garner, Knightdale, and Rolesville	
Identifying waste transfer options to alleviate East Wake Transfer Station (EWTS) overuse and minimize long-term collection costs	5.5	Wake County, Wake Forest and Wendell	
Enhancing solid waste education and outreach	5.7	Morrisville and Raleigh	
Identifying and increasing options for yard waste management	5.8	Holly Springs, Knightdale and Wake Forest	Lowest Priority
Improving management of special wastes such as electronics, mattresses, tires, household hazardous waste (HHW), food waste, construction and demolition (C&D) waste, etc.	6.4	Zebulon	

Section 2
Waste Reduction and Management Goals

Wake County and its municipal partners continue to support and refine the vision and goals for managing solid waste that were established during previous Plan Updates. Their shared vision supports a solid waste management system serving residents, institutions, and businesses that:

- Provides the maximum opportunity practicable for waste reduction, reuse, and recycling using appropriate incentives, disincentives, and policies to motivate residents, institutions, and businesses;
- Ensures the availability of economical, long-term municipal solid waste (MSW) disposal capacity;
- Maintains an efficient system for collection, processing, recovery, diversion, transfer and delivery of all solid waste streams;
- Offers a convenient method for residents to recycle a wide range of marketable materials including special wastes and yard wastes;
- Communicates easily understood information regarding opportunities for all residents to reduce and recycle waste;
- Employs effective methods to reduce illegal dumping and littering, and to monitor and enforce regulations prohibiting such behavior;
- Provides a plan and adequate facilities for the proper management of disaster debris;
- Is supported by a long-term, sustainable, transparent, and equitable funding system to cover the cost of the current and future solid waste management programs, as outlined in this Plan; and
- Realizes increased efficiencies and cost savings through inter-governmental partnerships and the most appropriate mix of public and private sector services and facilities.

2.1 Solid Waste Management Goals

Solid waste management goals established to achieve the shared vision of this Plan are presented below. These goals, established as part of previous Plan updates, were reviewed with each of the local governments during preparation of this Plan, to confirm that they remain representative and applicable.

Collection

- Provide cost-effective means of collecting MSW, recyclables, bulky waste, yard waste, and certain special wastes including HHW at approved service levels, from primarily single-family residential customers served by the participating jurisdictions.
- Ensure that solid waste management and recycling collection services are made available to all solid waste generators, including multi-family dwellings, businesses and institutions.

Transfer and Disposal

- Operate the SWLF in an efficient and environmentally sound manner using appropriate and innovative methods to ensure maximum use of airspace while considering reuse of landfill gas for energy and possible beneficial end uses at the site

- Continually evaluate SWLF and EWTS tip fees to achieve a level of in-county disposal that keeps costs reasonable for the residents and businesses of Wake County but does not result in so much commercial waste being disposed at the SWLF that it reaches capacity quickly.

Waste Reduction, Recycling, and Reuse

- Reduce, reuse, and recycle MSW to the maximum extent practicable in all participating jurisdictions, with the overall objective of extending the life of the SWLF while minimizing waste management costs.

- Provide incentives, disincentives, and policies to motivate Wake County residents, businesses, and institutions to reduce, reuse, compost, and recycle solid waste.

- Support economic development efforts aimed at enhancing existing and developing “sustainable” businesses, including those that can utilize local secondary material feedstocks as an alternative energy source or supply.

Composting/Mulching

- Continue to provide convenient opportunities for Wake County residents to learn about the benefits and techniques for backyard composting of yard debris, food scraps, and other suitable organic wastes.

- Investigate and pursue appropriate opportunities for food waste composting and other means to reduce food waste disposal at the SWLF.

- Consider initiatives to work with surrounding counties and states on larger projects such as organic waste composting and regional disposal alternatives.

Management of Special Wastes

- Continue to provide opportunities and the necessary services and facilities for Wake County to properly manage waste requiring special handling.

Education

- Continue to fund and maintain programs that provide residents, businesses, government facilities and institutions with information on how to reduce, reuse, and recycle waste in their homes, places of work, and throughout the community.

- Develop public awareness regarding the implications of over-consumption on solid waste generation and the environment and inform residents, businesses, industry and institutions about consumption practices that result in less waste generation as well as more efficient, environmentally sound use of resources.

- Continue to provide a consistent and coordinated message of proper solid waste management and environmental stewardship for students, local government employees, and the general public.

- Provide environmental education and recycling services to every public school in the Wake County Public School System (WCPSS).

Prevention of Illegal Dumping and Litter

- Make measurable and steady progress toward reducing illegal dumping and littering, including increased enforcement of the N.C. covered truck requirements.

Purchasing

- Promote business, institutional, and consumer involvement in buying products made from recycled materials.
- Expand County and municipal recycled products purchasing programs via establishment of formal policies on procurement of recycled content and other "green" products and supplies by Wake County local governments.

Disaster Response

- Institute an effective disaster debris management system consisting of facilities and services reflecting coordination among County, municipal, state, and federal agencies.

Management and Financing

- Utilize full cost accounting practices for identifying and monitoring all solid waste management program costs.
- Institute a balanced, sustainable, and equitable funding system to cover current and future costs associated with the programs and services needed to meet the County's solid waste reduction and management goals.
- Identify opportunities to reduce or control costs and increase revenue opportunities associated with solid waste disposal and recycling services for County and municipal buildings.
- Work collectively between local governments to integrate and coordinate services and programs, and to realize increased efficiencies and cost savings that result from these joint efforts.
- Strengthen partnerships with private sector service providers and between local governments, to ensure appropriate and effective use of both public and private sector services and facilities in the most environmentally sound and cost-effective manner practicable.
- Participate in regional planning and decision-making activities to address regional opportunities for enhancing the effectiveness and efficiency of recycling and sold waste management operations.
- Establish program measures and an evaluation system to monitor progress toward attaining local solid waste management goals.
- Ensure that there is a process and a place for public input into solid waste management plans and facility siting decisions.
- Comply with all state and federal solid waste management regulations.

Additional complementary goals or strategies have also been developed and promoted by various County Task Forces, the Growth and Sustainability Committee of the Board of County Commissioners (BOCC), and the former Growth, Land Use and Environment Committee of the BOCC. For example, in 2010 and 2011, Wake County's Sustainability Task Force developed one dozen recommendations and strategies supporting the following solid waste management goals:

- Financial and environmental benefits of the SWLF will be extended;
- Waste reduction, reuse, and recycling for C&D waste will be increased; and
- Investigations for the next generation waste management system will be initiated.

Many of the recommendations to achieve the goals provided by the Sustainability Task Force have been pursued over the last decade. For example, the County completed an Organic Waste Strategy Report[1] and has implemented food waste recycling at four convenience centers. Over the last five years, and as a component of this Plan update, evaluations of the next generation waste management system have been performed, including a comprehensive solid waste life-cycle analysis conducted by North Carolina State University (NCSU). In addition, and as part of this Plan update, the feasibility of a modern energy-from waste (EfW) facility was re-evaluated to consider a variety of technological and economic changes over the last decade. The results of these evaluations are summarized in Section 4 of this Plan Update. Supporting technical memoranda are included in the appendices.

2.2 Waste Disposal Reduction Goals

The 1991 amendment to the Solid Waste Management Act of 1989 established a statewide goal to reduce the amount of landfilled material 40 percent by 2001 (on a per capita basis). Statewide, the goal has not been met. At 1.33 tons per person per year, the statewide disposal rate is now 25 percent above the baseline fiscal year (FY) rate of 1.07. A steady seven-year reduction occurred beginning in 2007; however, this reduction proved to be largely attributed to the declining economic conditions associated with the Great Recession. As the economy recovered, both waste generation and waste disposal rates have trended higher. The per capita disposal rates surpassed the baseline rate in FY16.

In Wake County, the annual per capita disposal rates have generally mirrored the trend statewide. From FY07 to FY14, Wake County's per capita waste disposal rate declined from 1.44 to 0.92 tons per person per year, as shown in Table 2-1; however, since FY14, the rate has increased to 1.39 tons per person per year in FY19, which is 7 percent above the goal set in FY92 of 1.29.

The trend of declining then increasing per capita disposal rate is also evident in peer counties, including Mecklenburg, Guilford, and Durham (Figure 2-1). As the economy expanded, the impact of waste diversion measures, such as increased recycling, have been overshadowed by growing construction starts, increased industrial output, and greater consumption of goods. In Wake County, the increase in construction has been the biggest contributor to the increase in per capita disposal rates. The amount of C&D waste landfilled in FY19 increased by 162 percent compared to FY10. In contrast, there has only been a 27 percent increase in MSW over that time. C&D waste has grown from representing only 30 percent of the total amount of C&D plus MSW waste disposed in FY10, to 47 percent in FY19.

---

[1] HDR, 2014. Organics Diversion Strategy Report - Residential Food and Yard Waste, Parts 1 through 4.

Table 2-1. Wake County Waste Disposal Rates

Fiscal Year	MSW and C&D Disposed (tons)	Wake Co. Population[2]	Waste Disposal Rate (tons/person/year)	% Change from Baseline[1]
2005	999,535	723,708	1.38	7%
2006	1,071,973	755,034	1.42	10%
2007	1,140,479	790,007	1.44	12%
2008	1,151,050	832,590	1.38	7%
2009	976,762	864,429	1.13	-12%
2010	886,814	892,409	0.99	-23%
2011	910,034	907,314	1.00	-22%
2012	898,505	925,938	0.97	-25%
2013	911,610	945,143	0.96	-25%
2014	886,456	964,616	0.92	-29%
2015	986,438	985,310	1.00	-22%
2016	1,029,973	1,007,631	1.02	-21%
2017	1,126,903	1,026,748	1.10	-15%
2018	1,242,117	1,052,120	1.18	-8%
2019	1,487,916	1,073,993	1.39	7%

[1] Wake County's baseline rate from FY91-92 was 1.29 tons per person per year.

[2] Population estimates from NCDEQ County Per Capita Reports

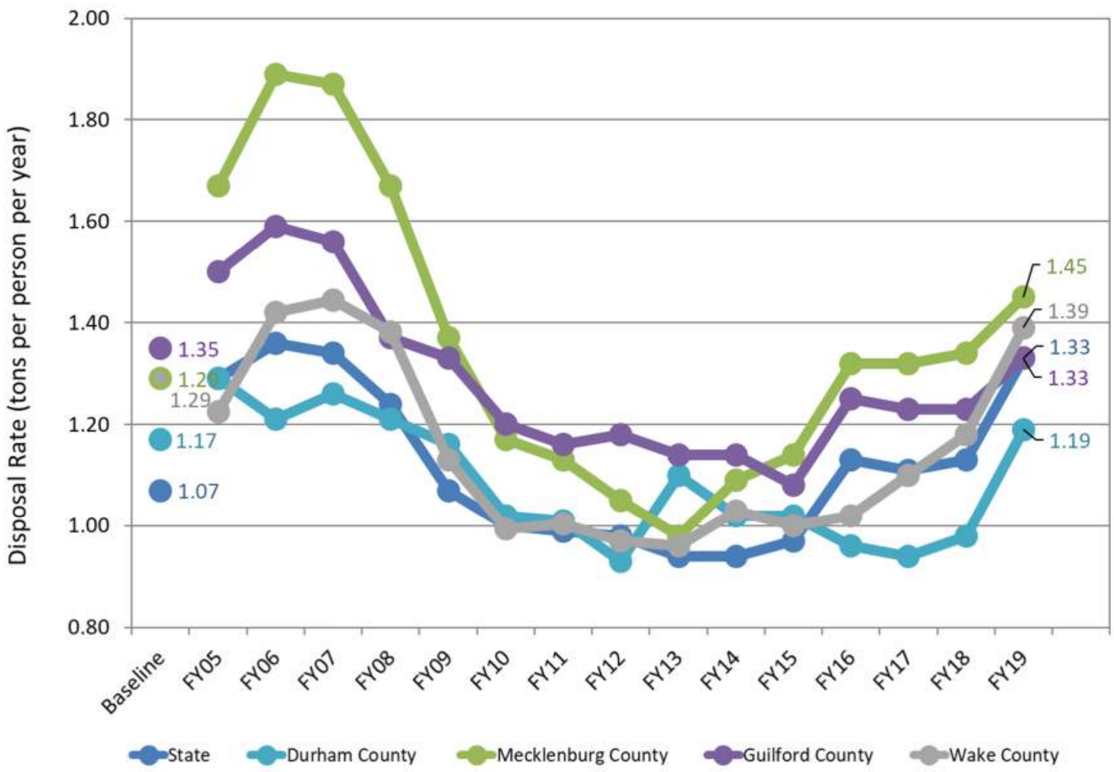


Figure 2.1. North Carolina and Major County Per Capita Waste Disposal Rates

Through effective planning and commitments from its municipal partners, Wake County developed the SWLF, which provides long-term disposal capacity at low cost, compared to other available options. While it is the County's primary goal to implement measures that will reduce waste generation, improve waste diversion and preserve landfill airspace (thus extending the life of the landfill), it is also a goal to provide for cost-effective solid waste disposal to citizens, businesses, and institutions. The cost of solid waste management generally increases for the local governments, on a per ton basis, when the amount of waste being disposed decreases. As such, there is a continual balancing of priorities (disposal cost vs. waste reduction and diversion) that must occur.

Section 3
Solid Waste Generation, Composition and Flow

For the County and local jurisdictions to reach the goals defined in Section 2, it is important to understand the types, quantities, sources, and flow of waste materials generated in the County. To facilitate this understanding, the NCDEQ DWM requires all jurisdictions and certain types of facilities that manage waste to report annual solid waste statistics. The statistics are compiled and made available on the DWM website. These databases provide valuable insight into waste generation and disposal trends throughout the County and State. In addition, Wake County continues to perform waste composition studies, including a 2019 study to characterize waste disposed at the SWLF. Waste composition studies provide information necessary to improve existing and develop new waste reduction, diversion, and management programs. The following sections summarize the most recent information available for the County regarding waste generation, composition and flow.

3.1 Waste Generation

Residential dwelling units, businesses, industries, government entities and institutions all generate waste that is collected, processed and disposed through solid waste service providers (both public and private). The following sections summarize available data for MSW, C&D debris, and land clearing and inert debris (LCID).

3.1.1 Municipal Solid Waste

The distribution of MSW is primarily driven by population growth patterns in the County and plays an important role in how efficiently solid waste services can be provided. Table 3-1 shows current and projected population estimates for each of the local jurisdictions and the County. The Office of State Budget and Management projects Wake County's population to grow from approximately 1,096,000 in 2020, to over 1,637,000 by the year 2040. Wake County's population is expected to grow by an average annual rate of 2.4 percent between now and 2040, resulting in an additional 541,000 residents. Despite efforts to reduce waste generation, this projected growth is expected to significantly increase waste generation throughout the County.

Table 3-2 shows the tons of MSW managed by each municipality for fiscal year (FY) 2019. This includes residential waste, recyclables, white goods, and yard waste. Left out of this assessment is commercial waste and recyclables (except for a small amount of commercial waste collected by municipalities), used tires, HHW, and other special wastes. The County jurisdictions managed 412,297 tons of waste in FY19, a 9 percent increase from FY11 of 378,783 tons. Per capita waste generation increased for 8 of the 13 local jurisdictions; however, the county-wide average declined by 10 percent. Because yard waste is included in the totals, there is a lot of year-to-year change in total MSW managed due to hurricanes and other storms which can generate large amounts of yard debris.

Table 3-1. Estimated Populations of the Wake County Local Governments

Local Government	Population					
	2019[1]	2020[2]	2025[2]	2030[2]	2035[2]	2040[2]
Apex	52,909	65,740	89,395	121,562	165,303	184,304
Cary	162,341	169,563	189,053	210,785	235,014	262,028
Fuquay-Varina	26,936	28,687	33,581	39,309	46,014	53,862
Garner	30,787	33,299	40,514	49,291	59,970	72,963
Holly Springs	34,071	45,711	52,992	61,432	71,216	82,559
Knightdale	15,305	16,237	18,823	21,821	25,297	29,326
Morrisville	26,041	27,627	32,027	37,128	43,042	49,897
Raleigh	464,435	483,198	533,490	589,016	650,321	718,007
Rolesville	6,638	7,042	8,164	9,464	10,972	12,719
Wake Forest	37,279	39,549	45,848	53,151	61,617	71,430
Wendell	7,132	7,744	9,512	11,685	14,354	17,632
Zebulon	4,986	5,269	5,417	5,568	5,724	5,885
Wake County Total[3]	**1,096,408**	**1,119,165**	**1,235,046**	**1,351,791**	**1,468,625**	**1,637,440**

Notes:
1. The 2019 population estimates are from demographic data found on a jurisdiction's website or from the US Census.
2. Population projections were developed from average annual growth rates.
3. From the North Carolina Office of State Budget and Management (OSMB). Some local governments have reported higher than expected growth, therefore the OSMB estimates may be low in some cases.

3.1.2 C&D Waste

Based on the FY19 DWM annual disposal reports, 696,558 tons of C&D waste were generated in Wake County – a 53 percent increase since FY18. There are currently four permitted and active C&D landfills in Wake County, all of which are privately operated. Nearly 100 percent of the C&D waste generated in Wake County was either disposed in one of the four in-County C&D landfills or was recycled during FY19. Wake County accepts C&D waste generated by homeowners at Convenience Center Sites 1, 2, 4, 7, 10 and 11. C&D waste collected at those sites is disposed of at one of the privately-operated C&D landfills.

3.1.3 LCID and Yard Waste

Land clearing operations produce such waste as trees, tree parts, stumps, rock, soil, stone and other materials not permitted by the State for disposal in MSW landfills. There are currently four permitted and active LCID landfills in Wake County.

The municipalities reported collection of 68,158 tons of yard waste in FY19. Most of the yard waste was delivered to one of several operations within and outside Wake County (e.g. the City of Raleigh Yard Waste Facility) that grind it for mulch and/or compost. It is unclear how much yard waste and vegetative matter from commercial-scale site clearing ended up in Wake County LCID landfills since the State does not track this information.

Table 3-2. MSW Managed by Local Government in Wake County (includes Landfilled Waste, Recyclable Materials, and Yard Waste)

Local Government	Population 2019	MSW Managed FY19 (Tons)	MSW Managed per Person (pounds/person)		
			2011	2019	Percent Change, 2011 to 2019
Apex	52,909	27,281	1,056	1,031	-2%
Cary	162,341	66,349	818	817	-0.1%
Fuquay-Varina	26,936	13,383	893	994	10%
Garner	30,787	14,702	848	955	11%
Holly Springs	34,071	33,752	661	1,981	67%
Knightdale	15,305	13,190	475	1,724	72%
Morrisville	26,041	5,342	378	410	8%
Raleigh	464,435	138,467	618	596	-4%
Rolesville	6,638	4,063	577	1,224	53%
Wake Forest	37,279	17,686	1,152	949	-21%
Wendell	7,132	3,800	1,532	1,066	-44%
Zebulon	4,933	3,884	1,546	1,575	2%
Unincorporated Area	227,601	70,398	617	619	0.3%
Total County	1,096,408	412,297	827	752	-10%

Notes:

MSW estimates from Solid Waste Management Annual Reports, FY11 and FY19.

Tons of materials delivered to Wake County convenience centers (does not include tires).

3.1.4 Waste Generation Summary

Based on a review of facility reports provided to the DWM and reports provided by the local jurisdictions, just under 1.7 million tons of waste was generated in Wake County in FY19. This includes MSW and C&D sent to disposal facilities or transferred to out-of-county, in-state landfills and landfills located in South Carolina and Virginia as well as recyclables, yard waste, and white goods recovered by local government programs. However, the actual amount of waste generated in Wake County is greater since business and institutional recycling is not included as it is not monitored or controlled by local governments. A summary of solid waste generation is provided in Table 3-3. The locations of waste management facilities in Wake County are shown in Figure 3-1.

As shown in Table 3-2, the 13 local governments of Wake County managed 441,233 tons of MSW in, which is only 28 percent of the 1.7 million tons of MSW generated in the County. The fact that such a small percentage of MSW is under direct control by the local governments lessens their ability to significantly improve overall waste reduction and diversion in Wake County.

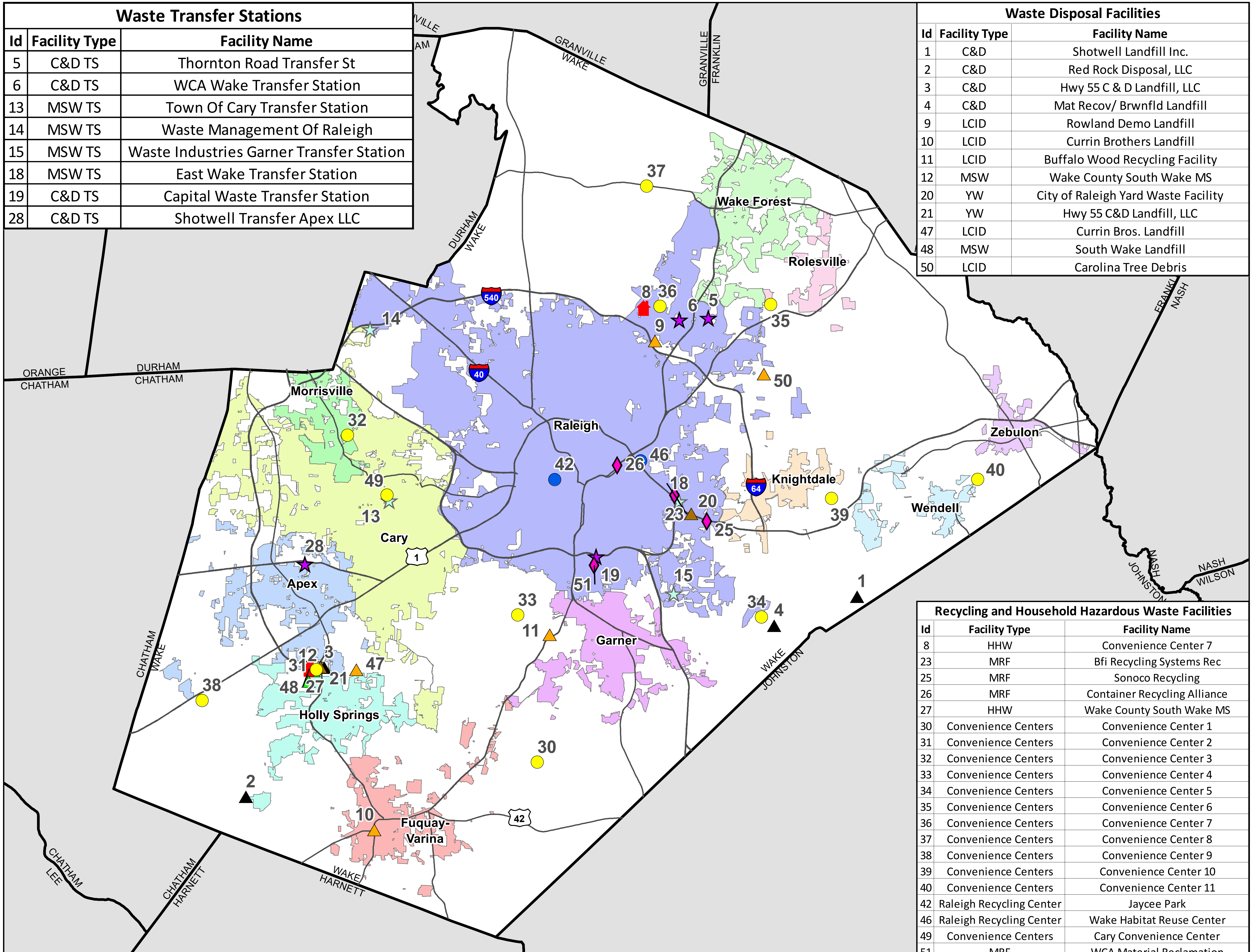
Table 3-3. Management of Solid Waste Generated in Wake County, FY19

Facility	Facility Location	Weight (Tons)	Percent of Category	Percent of All Waste
Landfilled MSW				
South Wake Landfill (SWLF)	Apex, NC	506,581	63.9%	
WI-Sampson County Disposal Inc.	Roseboro, NC	170,271	21.5%	
Brunswick Landfill	Lawrenceville, VA	77,396	9.8%	
Great Oak Landfill	Randleman, NC	34,884	4.4%	
Upper Piedmont Reg. Landfill	Rougemont, NC	2,743	0.3%	
Waste Management - Hickory Hill Landfill	Ridgeland, SC	976	0.1%	
Richland Landfill, Inc.	Elgin, SC	272	0.0%	
BFI-Charlotte Motor Speedway Landfill	Concord, NC	74	0.01%	
Uwharrie Env. Reg. Landfill	Mt. Gilead, NC	32	0.00%	
East Carolina Reg. Landfill	Aulander, NC	10	0.0013%	
Rowan County Landfill	Woodleaf, NC	8.9	0.0011%	
Oxford Subtitle D Landfill	Oxford, NC	8	0.001%	
Union County Landfill	Wingate, NC	0.8	0.0001%	
Total Tons MSW Landfilled		***793,255***	***100%***	***46.9%***
C&D Landfilled and/or Recovered				
Red Rock Disposal, LLC	Raleigh, NC	270,356	63.4%	
Brownfield Road C&D Landfill	Raleigh, NC	199,988	46.9%	
Shotwell Landfill	Wendell, NC	137,809	32.3%	
Greenway Waste Solutions of Apex	Apex, NC	88,405	20.7%	
WI-Sampson County C&D Unit	Roseboro, NC	1	0.000%	
Total Tons C&D Waste Landfilled and/or Recovered		***696,558***	***100%***	***41.2%***
Recyclables Recovered[1]				
Household Recyclables (glass, metal and plastic containers, household grades of paper)		110,887	61.5%	
White Goods[2]		1,238	0.7%	
Yard Waste[2]		68,158	37.8%	
Total Tons Recycled		***180,284***	***100%***	***10.7%***
Tires[3]				
Tons Tires Recycled		16,436	80.0%	
Tons Tires Landfilled		3,698	18.0%	
Tons Tires Reused		411	2.0%	
Total Tire Tons - Central Carolina Tire Monofill	Cameron, NC	***20,545***	***100%***	***1.2%***
HHW[3]				
Wake County HHW Facility	Raleigh, NC	998	100.0%	
Total Tons HHW		***998***	***100%***	***0.06%***
Wake County Total MSW Generated		***1,691,641***		***100.0%***

Notes: Primary Source: County Waste Disposal Report, NC DENR, Solid Waste Program

1. Recyclables tonnage includes program recyclables, white goods, and yard waste recovered through jurisdictions' programs. Additional materials are recovered by the private sector; however, records are not kept regarding these materials.
2. White Goods and yard waste data provided by local jurisdiction staff for FY19.
3. Landfilled Tires and HHW data provided by Wake County for FY19. Tire percentages provided by Central Carolina Holdings.

Figure 3-1
Waste Management Facilities in Wake County



Waste Transfer Stations

Id	Facility Type	Facility Name
5	C&D TS	Thornton Road Transfer St
6	C&D TS	WCA Wake Transfer Station
13	MSW TS	Town Of Cary Transfer Station
14	MSW TS	Waste Management Of Raleigh
15	MSW TS	Waste Industries Garner Transfer Station
18	MSW TS	East Wake Transfer Station
19	C&D TS	Capital Waste Transfer Station
28	C&D TS	Shotwell Transfer Apex LLC

Waste Disposal Facilities

Id	Facility Type	Facility Name
1	C&D	Shotwell Landfill Inc.
2	C&D	Red Rock Disposal, LLC
3	C&D	Hwy 55 C & D Landfill, LLC
4	C&D	Mat Recov/ Brwnfld Landfill
9	LCID	Rowland Demo Landfill
10	LCID	Currin Brothers Landfill
11	LCID	Buffalo Wood Recycling Facility
12	MSW	Wake County South Wake MS
20	YW	City of Raleigh Yard Waste Facility
21	YW	Hwy 55 C&D Landfill, LLC
47	LCID	Currin Bros. Landfill
48	MSW	South Wake Landfill
50	LCID	Carolina Tree Debris

Recycling and Household Hazardous Waste Facilities

Id	Facility Type	Facility Name
8	HHW	Convenience Center 7
23	MRF	Bfi Recycling Systems Rec
25	MRF	Sonoco Recycling
26	MRF	Container Recycling Alliance
27	HHW	Wake County South Wake MS
30	Convenience Centers	Convenience Center 1
31	Convenience Centers	Convenience Center 2
32	Convenience Centers	Convenience Center 3
33	Convenience Centers	Convenience Center 4
34	Convenience Centers	Convenience Center 5
35	Convenience Centers	Convenience Center 6
36	Convenience Centers	Convenience Center 7
37	Convenience Centers	Convenience Center 8
38	Convenience Centers	Convenience Center 9
39	Convenience Centers	Convenience Center 10
40	Convenience Centers	Convenience Center 11
42	Raleigh Recycling Center	Jaycee Park
46	Raleigh Recycling Center	Wake Habitat Reuse Center
49	Convenience Centers	Cary Convenience Center
51	MRF	WCA Material Reclamation

CDM Smith

WAKE COUNTY NORTH CAROLINA

3.2 Waste Composition

3.2.1 2019 Waste Composition Study

The previous update to the Solid Waste Management Plan included a comparison of the 1998 and 2011 waste composition studies performed for Wake County. The studies provided statistical information to characterize and quantify the County's solid waste stream received at the now closed North Wake Landfill (for 1998) and the SWLF (for 2011). In 2019, Wake County commissioned another study to characterize waste disposed within the County[1]. Table 3-4 presents a summary of the countywide aggregate waste composition comparison from the 2011 and the 2019 studies, as presented in the study. The aggregate waste composition was calculated by multiplying the average composition of each generator sector by the relative percentage of total waste. The sectors assessed included single-family residential, commercial, convenience centers and North Carolina State University.

Although differences exist between the methods used and waste categories selected during the 2011 and 2019 studies, a comparison of the landfilled waste characterization results suggest some notable changes in waste composition. These include:

- Paper accounted for 17.1 percent (by weight) of the overall waste composition in 2011, compared to 13.7 percent in 2019. This might suggest that paper recycling has increased over the years, but one must also consider that fewer print publications are circulated today due to the availability of electronic information.
- Recyclable container composition decreased from 10.3 percent in 2011 to 8.3 percent in 2019. Containers in this category include plastic, metal and glass. Polyethylene (PET) and glass containers had the highest percentages in the sector.
- The percentage of potentially compostable material increased from 34.3 percent in 2011 to 38.2 percent in 2019. The largest percent increase was food waste, increasing from 15.1 percent in 2011 to 22.5 percent in 2019.

The 2019 waste characterization results indicate there are significant opportunities for waste diversion. Within the single-family residential waste stream, potential recyclables/recoverables account for 34.7 percent of the total (Figure 3-2). Potential recyclables include paper, plastics, metals, glass, electronics, and other materials. Similarly, nearly 41.4 percent of the single-family waste stream is considered compostable.

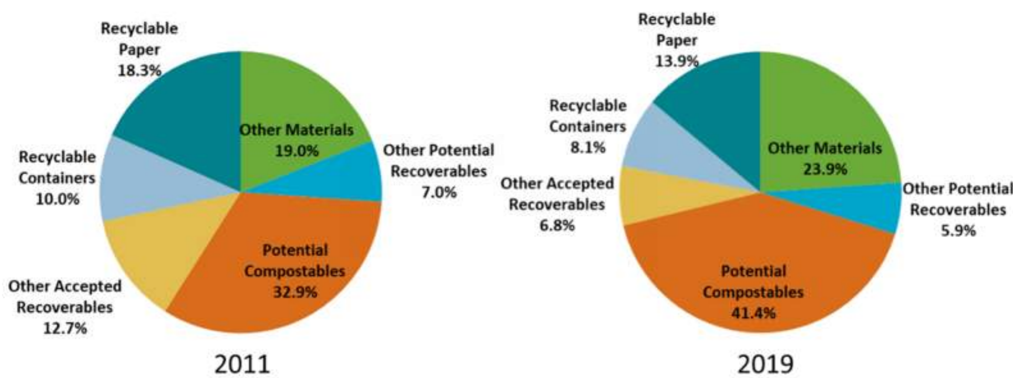


Figure 3-2. Composition of the Single-Family Waste Stream, 2011 and 2019

[1] Kessler, 2019. Wake County, North Carolina Waste Characterization Study. July 2019.

Table 3-4. Waste Characterization of Disposed Solid Waste in Wake County (2011 to 2019 Comparison)

Category	2011 SWLF Mean Composition	2019 SWLF Mean Composition	Change in Percent from 2011 to 2019
Recyclable Paper	**17.1%**	**13.7%**	**-3.4%**
Newspaper	1.8%	0.4%	-1.4%
Corrugated Cardboard	3.5%	3.7%	0.2%
Office Paper	1.6%	0.1%	-1.5%
Mixed Recyclable Paper	10.2%	9.2%	-1.0%
Bagged Shredded Paper	--	0.2%	N/A
Recyclable Containers	**10.3%**	**8.3%**	**-2.0%**
Aseptic Containers/Cartons	0.6%	0.3%	-0.3%
PET Bottles (#1)	1.9%	1.9%	0.0%
HDPE Bottles (#2)	0.9%	0.8%	-0.1%
Recyclable Plastic Cont (#3-#5 & 7)	1.8%	1.1%	-0.7%
Tin/Steel Cans	1.3%	0.8%	-0.5%
Aluminum Cans	0.5%	0.6%	0.1%
Aluminum Foils and Trays	0.4%	0.5%	0.1%
Glass Containers	2.9%	2.4%	-0.5%
Other Accepted Recoverables	**11.9%**	**9.4%**	**-2.5%**
Hard Cover Books	0.6%	0.1%	-0.5%
Bulky Rigid Plastics	2.4%	1.3%	-1.1%
Other Ferrous Metals	1.0%	1.2%	0.2%
Other Non-Ferrous Metals	0.5%	0.2%	-0.3%
Textiles and Leather	5.9%	5.3%	-0.6%
Vehicle Tires	--	0.0%	N/A
Hazardous/Special Wastes	0.2%	0.2%	0.0%
Electronics	0.2%	0.3%	0.1%
Sm. Appliances & Other Elec. Dev.	1.1%	0.8%	-0.3%
Potential Compostables	**34.3%**	**38.2%**	**3.9%**
Food Waste	15.1%	22.5%	7.4%
Yard Waste	2.3%	6.7%	4.4%
Other Organics	7.9%	1.6%	-6.3%

Category	2011 SWLF Mean Composition	2019 SWLF Mean Composition	Change in Percent from 2011 to 2019
Pizza Boxes	--	0.3%	N/A
Compostable Paper	6.9%	6.4%	-0.5%
PLA (#7) Plastic Containers	--	0.0%	N/A
Clean Wood Waste	2.1%	0.6%	-1.5%
Other Potential Recoverables	**7.5%**	**6.2%**	**-1.3%**
Non-Bottle PET Containers (#1)	--	0.5%	N/A
Non-Bottle PET Containers (#2)	--	0.0%	N/A
All Plastic Drink Cups	--	0.5%	N/A
Other Non-Accepted Plastic Cont.	0.1%	0.3%	0.2%
Packaging EPS Foam	1.7%	0.2%	-1.5%
Food Container EPS Foam	1.7%	0.9%	-0.8%
Recyclable Plastic Film	2.1%	1.6%	-0.5%
Other C&D Debris	0.3%	1.8%	1.5%
Furniture and Mattresses	3.1%	0.3%	-2.8%
Other Rubber	0.2%	0.0%	-0.2%
Other Materials	**18.0%**	**24.2%**	**6.2%**
Paper Cups	0.4%	0.5%	0.1%
Non-Compostable Paper	0.5%	1.9%	1.4%
All Other Plastics	0.1%	1.6%	1.5%
Non-Recyclable Plastic Film	6.3%	8.1%	1.8%
Non-Recyclable Glass	0.1%	0.7%	0.6%
Treated Wood Waste	0.9%	1.5%	0.6%
Household Batteries	0.1%	0.1%	0.0%
Diapers	3.6%	4.5%	0.9%
Composite Materials	3.0%	3.8%	0.8%
Liquids	--	0.7%	N/A
Grit	3.2%	0.9%	-2.3%

Source: Wake County, North Carolina Waste Characterization Study, Kessler Consulting Inc, July 2019

3.2.2 Public School System Waste Composition Study

In 2008, Wake County completed a waste composition study for the WCPSS. The study determined the types and amounts of recyclable materials being disposed of by the students, faculty, and staff of the school system. The Wake County Solid Waste Division used the information to gauge the effectiveness of the County school recycling program and identify actions to increase waste diversion from disposal.

In 2014, Wake County completed another waste composition study of the waste stream generated by the WCPSS. Table 3-5 compares the results of the two studies. In 2008, approximately 22 percent of the waste disposed consisted of materials that could have been recycled in the existing recycling program. This includes recyclable paper (mixed paper, newspaper, corrugated cardboard, catalogs and magazines, telephone books, and text books totaling 15.9 percent), containers (HDPE and PET containers, aluminum cans, and tin/steel cans totaling 3.9 percent), and expanded polystyrene foam (not necessarily cafeteria trays, totaling 1.5 percent).

In 2014, recyclable paper increased to 28.6 percent of the waste stream, containers reduced to 9.8 percent and polystyrene reduced to 1.3 percent. Food waste increased from 13.9 percent in 2008 to 20.6 percent in 2014. Plastic film also increased to 12 percent in 2014. Based on the study results, several opportunities were identified to help maximize waste diversion and increase the effectiveness of the WCPSS recycling program. The following is a list of primary recommendations from the study:

- Provide education targeted for high-school students;
- Expand materials recovery to include chipboard/paperboard, cardboard and organics; and
- Consider modifications to existing contracts to obtain more cost-effective services.

Table 3-5. Composition of Waste Disposed by WCPSS (% by weight)

Material Categories	2008 Percentage	2014 Percentage
Other Non-Recyclable Trash	49.1%	22.7%
Food Waste	13.9%	20.6%
Mixed Recyclable Paper	9.2%	10.3%
Compostable Paper	-	14.0%
Aseptic Containers	6.7%	6.8%
Plastic Film	6.1%	12.0%
PET Containers	2.5%	2.3%
Catalogs and Magazines	2.4%	1.1%
Corrugated Cardboard	2.3%	2.1%
Newspaper	1.7%	0.3%
Polystyrene	1.5%	1.3%
C&D Debris	1.2%	1.3%
Scrap Metals	0.6%	1.6%

Material Categories	2008 Percentage	2014 Percentage
HDPE Containers	0.6%	0.1%
Glass Containers	0.5%	0.3%
Aluminum Cans	0.4%	0.2%
Yard Waste	0.3%	0.6%
Tin/Steel Cans	0.3%	0.1%
Electronics	0.3%	0.3%
Telephone Books	0.2%	0.1%
Textiles	-	1.2%
Text Books	0.1%	0.7%
TOTALS	**100%**	**100%**

3.3 Tracking Waste Flow

Waste generated within the County and its jurisdictions flows through multiple channels and is processed or disposed of at a number of facilities. Many factors influence waste flow from the point of generation to the point of disposition. These factors may include the following:

- Waste type;
- Collection service cost;
- Facility tipping fees;
- Value of recovered materials;
- Proximity of disposal/processing facilities and the ease of facility ingress and egress;
- Relationship of each facility owner/operator to the hauling entity;
- Existing service agreement terms; and
- Hauler preferences

The sections below summarize waste flow for the residential and non-residential sectors.

3.3.1 Residential Waste Flow

Residents of Wake County and its jurisdictions have multiple options for managing MSW, recyclables, yard waste and C&D waste as shown in Figure 3-3.

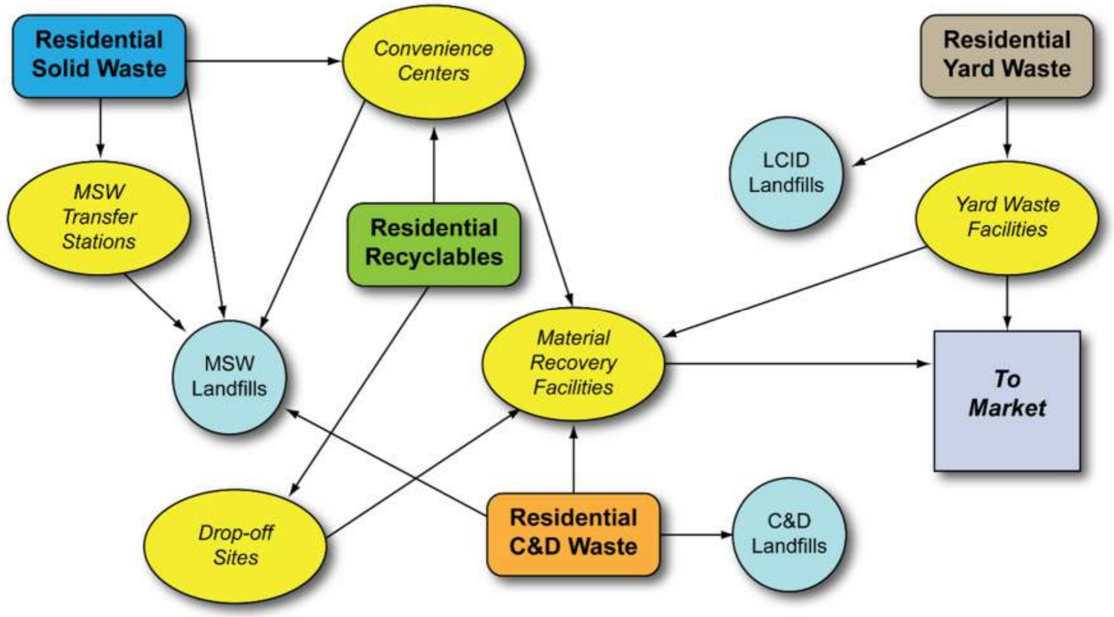


Figure 3-3. Residential Waste Flow

In order to support development of the SWLF and create the most cost-effective MSW disposal option for the citizens of Wake County, 12 of the 13 local governments entered into an inter-local agreement (ILA). Through the agreement, the jurisdictions agreed to pool their residential MSW waste streams for disposal at the SWLF in return for improved economy and predictability in waste disposal costs. As a result, all residential waste that is collected by the participating local governments or from Wake County's convenience centers is directed to the SWLF. Municipalities that contract with waste collection and hauling firms include provisions in their contracts requiring that the waste be delivered to the SWLF. Residential waste that is collected by private haulers in the unincorporated portions of Wake County may be delivered to the SWLF or may end up at an out-of-county landfill.

3.3.2 Commercial, Industrial and Institutional (CII) Waste Flow

The flow of CII waste often differs from residential waste, which is true for the local governments of Wake County. CII waste collected by private haulers can be taken to any facility of their choosing including the SWLF as shown in Figure 3-4. Waste haulers that own and operate private landfills in the region often bring waste that is collected by their forces to their own landfills. The six private landfills in North Carolina and Virginia located within a 100-mile radius of Wake County include:

- Republic Services' Upper Piedmont Regional Landfill (Rougemont, NC)
- GFL Environmental's Sampson County Landfill (Roseboro, NC)
- Waste Management's Great Oak Landfill (Randleman, NC)
- Republic Services' Uwharrie Environmental Regional Landfill (Mt. Gilead, NC)
- Republic Services' East Carolina Regional Landfill (Aulander, NC)
- Republic Services' Brunswick Landfill (Lawrenceville, VA)

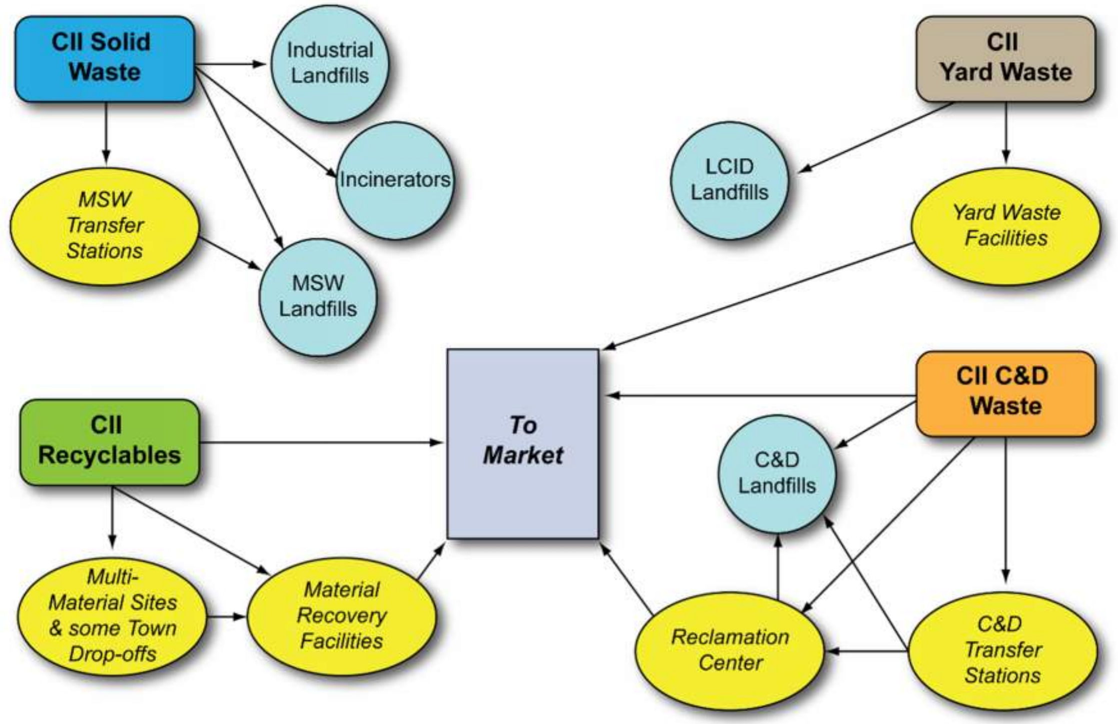


Figure 3-4. CII Waste Flow

Three of these landfills – Sampson County, Brunswick, and Great Oak – received 282,551 tons, or 36 percent of the total tons of MSW landfilled in FY19 that originated in Wake County. The other three, and six additional landfills further away in North Carolina and South Carolina, together received less than 1 percent of the total MSW.

3.3.3 Waste Transfer

In FY19, 57 percent (449,352 tons) of the total landfilled MSW from Wake County was delivered to one of four state-permitted transfer stations operating in Wake County. Just over 74 percent (332,233 tons) of the transferred MSW went through the EWTS. Because of the EWTS location (just east of downtown Raleigh), and in part due to its ease-of-use compared to the SWLF, 157,885 tons more MSW went through the EWTS than was directly hauled to the SWLF in FY19.

The economics of solid waste management can be impacted by changes to the existing waste transfer system. The addition, improvement, deterioration, or closure of local, privately-operated waste transfer stations can result in changes in the amount of CII MSW being delivered to the SWLF. While minor changes in waste flow tend to have little impact on the economics and lifespan of the SWLF, more significant changes can impact the economics and lifespan.

The EWTS saw a substantial increase in waste flow during FY19 due to the deterioration of the Garner Transfer Station owned and operated by GFL Environmental (Figure 3-5). The Garner Transfer Station uses a block pack to compact waste prior to loading transfer trailers. The block pack is nearing the end of its useful life therefore GFL began diverting waste to the EWTS in 2018 to prolong the life of the system. GFL has not decided if it will continue to operate at a reduced capacity, make repairs and stop diverting waste to the EWTS, or close the facility and divert all waste to the EWTS. Because of this uncertainty, an evaluation of future waste transfer options was conducted to determine the need, timing, and potential users of a new transfer station in another part of the County (see *Subtask 3A – Waste Transfer Evaluation Technical Memorandum* in Appendix B). The evaluation built upon an earlier analysis conducted by the City of Raleigh, which estimated the potential waste flow and cost savings for a new transfer facility located within Raleigh's municipal boundary, just south of I-540 and west of Leesville Road.

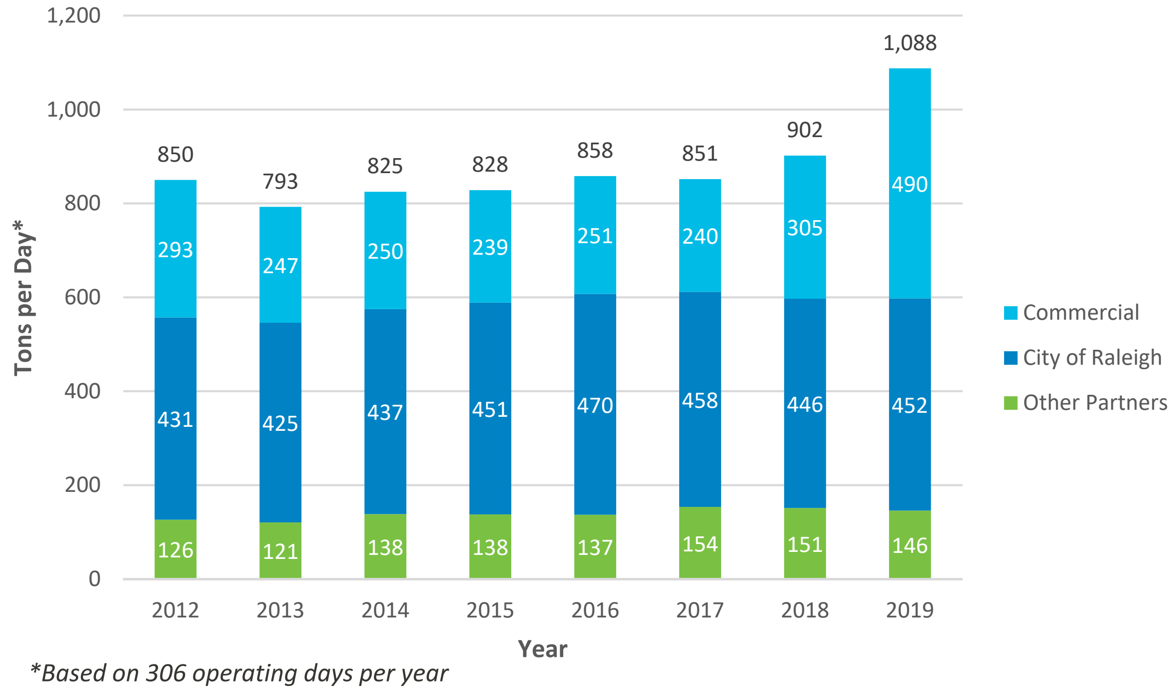


Figure 3-5. EWTS Historical Tonnage, FY 2012-2019

The results of the evaluation confirmed that the EWTS is currently at or near capacity and operational issues at the facility will worsen if the Garner Transfer Station continues to operate at a reduced capacity or closes within the next few years. A new transfer station located in the western part of the County will be necessary if current trends continue or if the Garner Transfer Station closes.

It was estimated that a West Wake Transfer Station (WWTS) would receive approximately 36 percent of the City of Raleigh's residential waste, 100 percent of residential waste from the Town of Morrisville, 30 to 50 percent of commercial tonnage currently going to the EWTS, and waste from two of the County's convenience centers.

Based on the results of the evaluation, it is recommended that the County, City of Raleigh, and other partners to the ILA continue to collaborate to confirm the need and further evaluate the timing of a new transfer station in western Wake County. The following steps are recommended:

- Wake County and the City of Raleigh should regularly check in with GFL regarding their plans for rehabilitation or closing of the Garner Transfer Station.
- If GFL decides to close the Garner Transfer Station within the next several years (and before a WWTS is constructed and in operation), Wake County will need to implement operational changes at the

EWTS, including adding another haul truck and driver for peak days. Other actions that might be considered include:

- Increasing the tipping fee at the EWTS to (temporarily) discourage commercial use and encourage more direct hauling to the SWLF. The implications of this change would need to be evaluated to ensure enough commercial waste is received so as not to increase the disposal cost for the municipalities that use the EWTS.
- Temporarily banning delivery of loads that are primarily or exclusively mattresses, and possibly other bulky items that significantly lower the tons of waste per haul truck.
- Consider a change in EWTS operating hours to keep waste tonnage at a manageable level, especially on peak days. This would encourage more waste delivery directly to the SWLF.

- The City of Raleigh is conducting a route optimization study. Once the study is complete, any route changes that might result in changes to the timing of waste received at the EWTS should be evaluated. The need for a new transfer station may be delayed if new routes are developed which result in a more even daily distribution of waste delivered to the EWTS.
- The City of Raleigh should confirm the amount of waste they anticipate sending to the proposed WWTS is consistent with the estimates made in the City of Raleigh evaluation.
- The City of Raleigh and Wake County should begin the process of identifying and evaluating potential sites to accommodate a transfer station with an 18,000 square foot tipping floor. Siting, permitting, design and construction of a new transfer station is likely to take at least 2 years, and likely closer to 3 to 4 years. If GFL takes no action at their Garner Transfer Station, then a WWTS would be needed by 2025, based on the assumed 1 to 1.5 percent increases in annual tonnage.

Section 4
Waste Management and Reduction Programs

The review of current waste management and reduction programs helps to identify challenges that may keep the County from reaching its near-term and long-term goals, while also identifying options to overcome those challenges. To that end, this section inventories and analyzes the following planning elements:

- Waste Diversion and Reduction (Section 4.1)
- Long-term Waste Management Options (Section 4.2)
- Recycling and Reuse (Section 4.3)
- Organics Management (Section 4.4)
- Education and Outreach (Section 4.5)
- Special Wastes (Section 4.6)
- Illegal Disposal/Litter (Section 4.7)

Each planning element concludes with a discussion of "the path forward" outlining planned actions and recommendations developed as part of this Plan update or studies recently completed by Wake County. Section 4.8 provides a list of other challenges, goals and initiatives identified by the local governments during the Plan update process that do not fall into one of the planning elements discussed below.

4.1 Waste Diversion and Reduction

Waste diversion programs are focused on diverting various components of the waste stream from landfills. Waste reduction, or not creating waste in the first place, is preferred over diversion since it reduces the amount of waste needing to be managed and potentially disposed.

One way to evaluate the success of waste diversion and reduction efforts in Wake County is through analysis of long-term per-capita disposal rates. Wake County's annual per capita waste disposal rate has steadily increased since FY11, from 1.00 to 1.39 tons per person in FY19. Increased industrial production, increased construction, and higher public consumption of goods as a result of the strengthening economic conditions during the that time period played a large role in this trend. The strong correlation between economic conditions and waste disposal is evident in Figure 4-1, which shows the annual trend in the Wake County per capita MSW and C&D waste disposal and the North Carolina per capita gross domestic product (GDP). In Wake County, C&D waste disposal has tracked closely with economic conditions over the past 15 years. MSW waste disposal in Wake County shows a similar declining then increasing trend, but it less correlated with per capita GDP. Because economic conditions strongly influence waste generation (and disposal), it is difficult to assess with confidence whether waste diversion and source reduction efforts have been effective simply by looking at per capita waste disposal trends. However, over time, waste diversion and source reduction efforts can play a significant role in determining how quickly the SWLF will reach capacity, and when the next – likely more expensive – waste management option is needed.

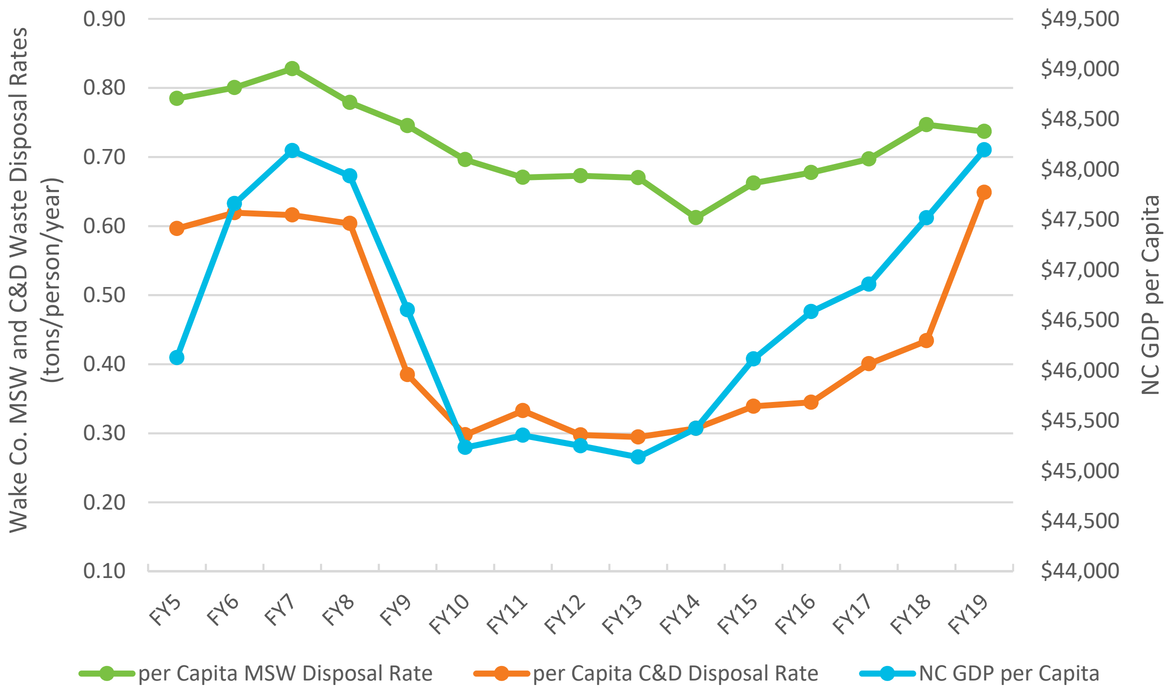


Figure 4-1. Comparison of Wake County per capita MSW and C&D waste disposal and economic strength, as represented by North Carolina per capita GDP

4.1.1 Current Activities

Residential Waste Reduction and Diversion

Wake County and the municipal governments continue to provide waste reduction and diversion programs to the residents of Wake County. Four local governments offer backyard composting programs and/or composting classes. Several offer composting bins for sale at a reduced price and nearly 900 bins were distributed to residents in FY18. Five of 13 local governments offer one or more source reduction programs, such as junk mail reduction. The City of Raleigh is the only local government currently operating a waste exchange (swap shop). Current waste reduction and diversion programs for all Wake County local governments are summarized in Table 4-1.

Many of the local governments have focused more on diversion programs, such as recycling, than on source reduction. Over the last decade, the local governments typically increased the number of recyclable materials accepted and improved the collection methods by offering larger, roll-out carts. Recycling is discussed further in Section 4.3.

Commercial, Institutional, and Industrial (CII) and C&D Waste Reduction and Diversion

Wake County continues to award Commercial Waste Reduction Grants to businesses and the municipalities to start or expand their waste reduction and/or recycling program. In 2018, 2019 and 2020 the County awarded 15 grants totaling $104,612 to expand food waste collection, enhance composting, increase recycling participation, and support various education efforts focused on waste reduction and diversion. A list of the 15 grants awarded over the last three years are provided in Table 4-2.

Table 4-1. Source Reduction and Diversion Programs

Local Government	Backyard Composting Program?	No. of Compost Bins Distributed	Source Reduction Program Targeted to Public?	Waste Exchange or Reuse Program?
Apex	No	--	Yes	No
Cary	Yes	226	Yes	No
Fuquay-Varina	No	--	No	No
Garner	No	--	No	No
Holly Springs	No	--	No	No
Knightdale	No	--	No	No
Morrisville	No	--	No	No
Raleigh	Yes	--	Yes	Yes
Rolesville	No	--	No	No
Wake Forest	No	--	Yes	No
Wendell	No	--	No	No
Zebulon	Yes	NA	No	No
Wake County	Yes	670	Yes	No
Total:	**4 of 13**	**896**	**5 of 13**	**1 of 13**

Improvements in waste reduction and diversion in the CII sector will play a significant role in reducing the amount of waste sent to the SWLF and other, regional landfills, since it makes up more than 50 percent of the waste stream (not including C&D waste)[1]. The largest barrier to recycling in the CII sector is the fact that waste service plus recycling costs more than waste service alone, harming the business case for recycling. Strong incentives, new building requirements that require designated space for recycling, or ordinances changes that require haulers providing CII sector service to also provide recycling, is necessary to substantially improve waste reduction and diversion in the CII sector.

4.1.2 The Path Forward

The benefit of improving waste reduction and diversion rates is the extension of the SWLF operating life, and ultimately, lower long-term costs for solid waste management and disposal. The benefits are demonstrated in the following example: Assuming no increase in waste reduction and diversion, and a 1.5 percent annual increase in the amount of waste disposed at the SWLF (due to population growth, primarily), the SWLF is expected to reach capacity around 2049, based on reasonable estimates for final in-place waste density. If additional waste diversion and reduction efforts, such as an increase in recycling rates, were implemented today and resulted in a 5 percent decrease in the amount of waste going to the SWLF, the SWLF would not reach capacity until 2051 – 2 years later than currently projected. A 15 percent increase in waste reduction

[1] The total amount of waste (not including C&D waste) generated in Wake County and sent to the SWLF and other regional landfills in FY19 was 793,255 tons. The amount of residential waste collected by the municipalities and Wake County in FY19 and disposed at the SWLF (or potentially the Sampson County Landfill in the case of Holly Springs) was 283,141 tons, which is 36 percent of the total. Therefore, it is estimated that between 50 and 64 percent of the waste generated in Wake County is from CII sources. The range is due to the unknown amount of residential waste collected curbside in the unincorporated area.

and diversion would add 6 years of life, and a 30 percent reduction would add 13 years of life, as shown in Figure 4-2.

Table 4-2. Wake County Commercial Waste Reduction Grants Awarded in 2018 - 2020.

Grantee	Fiscal Year	Amount Awarded	Project Name	Project Description
Abbotts Creek Elementary School	2020	$8,600	Enhanced Composting and Environmental Education	Expand composting efforts in cafeteria.
North Carolina State University	2020	$9,984	Food Waste Diversion in Apartment Communities	Pilot food waste collection in apartment-style residence halls.
North Ridge Elementary	2020	$4,600	Green Team – North Ridge Elementary Waste Reduction	Reduce cafeteria waste through composting.
Poe Center for Health Education	2020	$7,540	ComPOEst, Poe Center Waste Reduction Project	Expand composting and educate visitors and staff about reducing wasted food.
Triangle Repair Network	2020	$2,970	Capacity Building 2020	Purchase tools and promote repair events.
Locals Seafood	2019	$10,000	Locals Seafood for Pets	Turn fish waste into a boutique pet treat.
Sonoco Recycling	2019	$10,000	Sonoco Raleigh MRF CCTV System	Improve tours by replacing cameras in the education center.
Friends of NC Museum of Natural Sciences	2019	$6,000	NCMNS CARES: Composting and Recycling Education Series	Compost organic waste at cafes and educate museum staff.
North Carolina State University	2019	$7,800	Zero Waste Workplace at Schaub Food Science	Divert waste through improved recycling and composting collection.
Live Nation	2019	$5,000	Zero Waste – Parking Lots	Implement a recycling program for parking lots at amphitheater.
First United Methodist Church-Cary	2019	$1,200	Creation Care Lending Library	Establish a free lending library for cutlery and linens; purchase recycling signage for church.
Every Tray Counts	2018	$9,000	NC School kit for Composting	Create a guide and videos to help schools reduce waste in their lunchrooms
North Carolina State University	2018	$10,000	Lake Wheeler Compost Site	Offset the cost of purchasing a compost screener for a new composting site.
WRAL Soccer Park	2018	$10,000	Recycling	Improve recycling by increasing and standardizing recycling bin locations.
Fletcher Academy	2018	$1,918	Recycling and Waste Reduction	Increase participation in school recycling program
Total, 2018-2020:		**$104,612**		

For each year that the landfill is extended, the local governments could collectively expect to save a minimum of $6M to $7M annually in disposal cost. This level of savings is based on comparison to a $40 per ton cost for hauling to an out-of-county landfill, like the City of Durham currently pays to transfer, haul and dispose their MSW at the Sampson County Landfill, versus the current SWLF tipping fee of $32 per ton. Note that the municipalities that are partners to the ILA also typically receive an annual rebate, effectively lowering their cost to well below $32 per ton. Using this conservative comparison and not considering the rebate, the local governments could expect to save a total of $13.6M, $42.2M or $96.5M by increasing the waste reduction and diversion by 5, 15 or 30 percent respectively. Of course, there are costs associated with diversion and reduction programs that would be incurred and are not included in this analysis. Even with recycling costs on the rise, the potential cost savings from enhanced waste reduction and diversion efforts are hard to ignore.

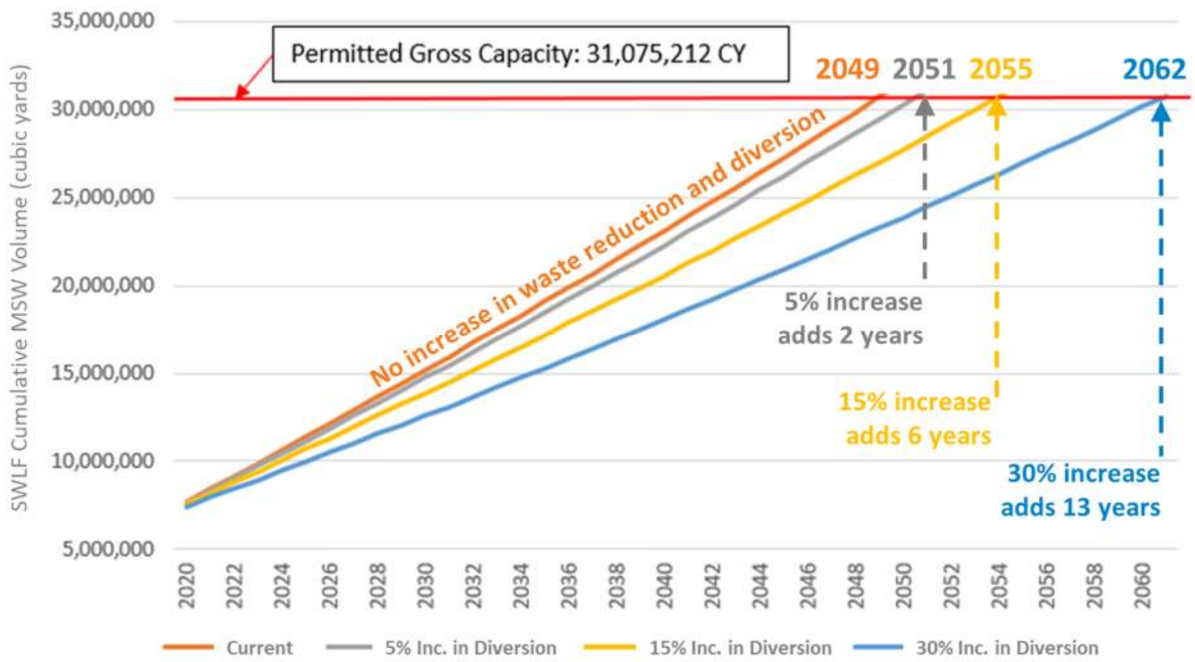


Figure 4-2. Greater Waste Reduction and Diversion Extends SWLF Operating Life

Recognizing the benefits of extending the life of the SWLF, the BOCC directed the Wake County Solid Waste Management Division to evaluate options and strategies to extend the landfill's life through recycling, technology, and other related initiatives. SCS Engineers was retained to conduct a landfill life extension study[2]. A 2019 follow-up study titled *Landfill Life Extension Study: Exploring Recommended Actions* was prepared to further explore potential strategies for waste reduction and waste diversion from the SWLF. The study recommended seventeen strategies for further evaluation and potential implementation. Below, the five waste diversion and reduction strategies that were recommended for implementation are summarized first, followed by 12 additional recommendations that merit additional evaluation or could be considered in the long-term (beyond five years).

Assist Municipalities with Residential Recycling

Municipalities within Wake County currently maintain their own curbside recycling programs. Wake County could help implement and coordinate programs that may increase recycling for the entire County. The following are steps the County can take in order to improve municipal and County recycling programs:

- Develop metrics to measure progress and effectiveness of recycling programs including recycling rates, proportions of waste that should be recycled, contamination rates, and capture rates.

[2] SCS Engineers, 2018. Landfill Life Extension Study.

- Identify a municipality to aid in a pilot study.
- Hire a part time County employee to serve as a liaison to the municipalities to determine recycling efforts.
- Expand outside contractor/consulting services to implement recycling and waste diversion. Examples include increased education and outreach efforts, policy changes and showcasing examples of municipality recycling successes.
- Establish metrics of success to track progress of successful and non-successful recycling efforts.

An overarching recycling program will be most effective by enabling a consistent message and approach throughout the municipalities. Developing a consistent set of guidelines, accepted materials, education and outreach, etc. can increase diversion while minimizing contamination. Wake County has started implementing some of these recommendations through the development of a recycling subcommittee of the TAC consisting of representative from Cary, Garner, Morrisville, NC State University, Raleigh and Wake County. The subcommittee has focused on developing and promoting common language for recyclable materials and improving the messaging surrounding shredded paper, which should not be included in commingled, residential recycling.

Continue Recurring Inter-Local Collaboration

Wake County can continue to prioritize recurring meetings with the municipalities to discuss waste strategy and policy. As the unifying jurisdiction, Wake County can initiate a formal schedule and improve interlocal collaboration. Collaborative contracting should be encouraged, and the County can play a role in advancing this concept.

Establish Mattress Diversion Program

While mattresses make up a small percentage of the overall waste stream, managing and disposing of mattresses is costly and presents many operational issues during collection and disposal. Options for mattress recycling and alternative mattress disposal methods are further discussed in Section 4.6.

Audit/Perform Data Analysis of Landfill Loads

A waste audit/data analysis can be performed on incoming waste at the SWLF in order to determine the quantity and origin of the waste. The analysis can be performed using the following strategies:

- Analyze scale house tonnage data
- Launch new data collection efforts including waste load compositions
- Use the findings to prevent unacceptable loads from being disposed of at the SWLF

With a better understanding of the types of waste streams being disposed of at the SWLF, the County can assess the quality and quantity of materials that can potentially be diverted from the landfill for reuse, recycling or conversion. Wake County has already implemented this recommendation. A Waste Characterization Study was performed by Kessler Consulting Inc. in July 2019, as summarized in Section 3.

Collaborate with Stakeholders to Promote Recycling

Collaboration with various stakeholders can strengthen diversion and reduction efforts in Wake County's waste stream. The County should continue to grow effective communication and synergistic relationships with potential stakeholders such as public institutions, private sector entities, citizen action groups or environmental organizations. Implementing collaboration among stakeholders will vary. One potential pathway:

- Survey municipalities for priorities and interests
- Initiate meetings and create an email list serve to facilitate conversation
- Develop expectations and procedures in a guidance document
- Discuss solid waste management and material reduction and diversion topics in each meeting
- Issue Request for Information (RFI) or Request for Qualifications (RFQ) for difficult or burdensome internal collaboration initiatives

Wake County has started implementing some of this recommendation through the development of the Recycling subcommittee of the TAC, as previously noted.

The following 12 waste reduction and diversion strategies were recommended for further evaluation:

Offer Awards to Haulers and Others for Material Diversion

The County could create a recognition system for commercial waste haulers, businesses, and other organizations in an effort to increase the amount of material diverted from the waste stream. This recommendation will require further consideration given its complexity and potential cost.

Explore Municipal Recycling Facility Possibilities for C&D Debris

Developing a C&D materials recovery facility (MRF) through creative financing such as a public-private partnership would result in reduced C&D quantities entering landfills. This is a long-term consideration, given the current abundance of C&D landfills in Wake County.

Incentivize Private Haulers Serving Multi-Family Complexes

Incentivize private haulers to provide recycling services to multi-family complexes through public recognition, discounts or subsidies, as an effort to divert discards away from disposal.

Target Student Multi-Family Complexes/University Collaboration

The County could improve its multi-family recycling rates with community based social marketing techniques, including asking for commitments, prompting actions and creating norms.

Target Small Businesses

Develop a business-by-business approach to increase the implementation of material reduction and diversion strategies.

Perform Business Waste Audits

Conduct waste audits at different businesses to characterize the unique waste streams and implement site specific recycling programs.

Expand Food Waste Education

Encourage local establishments, through educational efforts, to follow the US EPA Food Recovery Hierarchy when possible.

Find Post-Consumer Food Waste Partners

Initiate dialog with a wide range of resources available for organics recycling in North Carolina.

Expand Composting

Continue expanding pilot programs into regional facilities or invest in a central, full-scale composting system. Also, investigate expanding the Raleigh Yard Waste Center to accept organics.

Lead by Example

The Wake County Solid Waste Division can serve as a pilot for specific solid waste reduction and diversion policies or practices, and other Wake County departments and institutions, such as the WCPSS, can help lead by example through implementation of numerous policies and actions such as eliminating use of bottled water; identifying County facilities that can do on-site composting; expand purchasing requirements with preference for recycled content and/or locally produced products; and implementing a rewards program for employees to incentivize waste minimization.

Stimulate Source Reduction and Reuse

Stimulating source reduction and reuse is potentially a high impact method of diverting and reducing material away from the SWLF. Diverted material equates to money saved by the County which can be used to benefit the community. Pilot programs to incentivize groups or neighborhoods to generate less waste and practice reuse are already being piloted in the Triangle Region.

Implement New Policy

Implementing new policies can be controversial. Two things to consider with any proposed legislation are public opinion and mode of enforcement. Potential steps that could be taken include passing an ordinance mandating commercial recycling; implementing save-as-you-throw (SAYT) programs; and implementing material bans that keep certain items out of the SWLF or assessing fines or surcharges for items that are intended to be kept out of the SWLF, such as cardboard.

4.2 Long-Term Waste Management Options

Many factors will influence the timing of when the next waste management option will be needed, including but not limited to the rate of Wake County population growth and the strength of the local economy; the success of waste diversion and reduction efforts; and decisions made by private haulers who collect commercial waste and can chose between disposal at the SWLF or an out-of-county landfill. If the amount of MSW waste delivered to the SWLF increases by 1.5 percent annually, the landfill will reach capacity around 2049, assuming the in-place waste density continues to increase by about 0.5 percent annually. At a 4 percent annual increase in waste tonnage, the landfill will reach capacity around 2042. Since 2009, the year-over-year change in waste tonnage has ranged from a decrease of 5.2 percent from 2010 to 2011, to an increase of 9.3 percent from 2018 to 2019. Since 2010, there has been an average year-over-year increase of 1 percent in waste tonnage.

The closure date of the landfill can be extended if waste diversion and reduction efforts are successful, or by increasing the capacity of the SWLF, as examined in the *Landfill Life Extension Study* (see Section 4.2.4). Taking a conservative approach, and because development of the next long-term waste management option could take many years, it is best to assume for planning purposes that the SWLF will reach capacity around year 2040. If a waste conversion technology such as massburn is selected, maintaining space in the SWLF for long-term ash disposal (a residual of the combustion process) would be beneficial. This would require that the SWLF stop receiving MSW well before 2040 – further shortening the planning horizon for the County's next waste management option.

The local governments of Wake County have recognized the need to identify and evaluate long-term options for managing the County's waste stream, as evidenced by the fact they collectively ranked it as the most important element to be addressed by this Plan. To that end, the two most common waste management options in the U.S. (not including recycling) – combustion with energy recovery and landfilling[3] were evaluated as long-term options for Wake County. Combustion with energy recovery – or energy from waste (EfW), as it is referred to in this Plan – was previously examined as part of Wake County's 2012 Solid Waste Management Plan. That evaluation was updated and expanded for this Plan update. A summary of these two options is presented below along with a discussion of potential other emerging waste conversion technologies that may merit consideration in the future. Options for extending the life of the SWLF by increasing its capacity, and further delaying when the next long-term waste management is needed, are also presented. A more detailed discussion of long-term waste management options is included in the Technical Memoranda contained in Appendix C, *Subtask 3B – Energy-from-Waste Evaluation and Identification of Other Disposal Options* and Appendix D, *Subtask 3B – Identification of Other Disposal Options.*

4.2.1 Energy from Waste (EfW)

Wake County began evaluating EfW as an alternative to landfill disposal nearly 20 years ago. A 2002 study determined that while EfW was technically feasible, it would result in significantly higher costs compared to landfilling within or outside of the county. It was also determined that regional cooperation would be necessary to establish a sufficient waste stream. In 2004, Wake County further opened the door for the possibility of alternative disposal options, including EfW, when they released a Request for Expressions of Interest for MSW Waste Disposal. No interest from the private sector was identified as only firms interested in managing Wake County's waste stream through landfilling options responded.

CDM Smith prepared an evaluation of the estimated costs of an EfW facility for the Plan update in 2012. The decision was made to evaluate massburn waterwall combustion technology, as this is the most widely implemented and commercially proven waste conversion technology. A detailed financial model was prepared which required numerous assumptions to be made for the performance, cost and revenues of an 1,800 tpd massburn EfW facility. This size facility is well within the normal range of facility sizes, which vary between 500 – 3,300 tpd in the U.S. The base case analysis in 2012 estimated the year 1 cost for the massburn EfW facility at $81.25 per ton of MSW processed. Several key parameters were adjusted in a sensitivity analysis which estimated the best-case (lowest cost) at $48.93 per ton, and the worst-case (highest) cost at $100.71 per ton.

Since 2012, there have been several changes and advancements in the EfW industry, including the following:

- Slight increases in capital, operation and maintenance costs. Most EfW facilities in the U.S. are municipally owned and privately operated. The contractors which operate EfW facilities are typically selected under design, build, and operate contracts.

[3] In 2017 over 139.6 million tons of MSW were landfilled, 34.0 million tons were combusted for energy recovery, 67.2 million tons were recycled, and 27.0 million tons were composted in the US. (Source: USEPA, National Overview: Facts and Figures on Materials, Wastes and Recycling).

- Advancements in post-combustion metal recovery with greater recovery rates of ferrous and non-ferrous metals. Recovery of metals from ash residue is a necessary step toward beneficially recycling a portion of the ash as construction aggregates and chemical feedstocks, such as to produce Portland cement.
- The value of recovered metals from ash residue have also changed significantly over the past eight years, unfortunately in a downward trend due to the global demand and tariffs on commodity metals.
- Lower electrical payments and shorter power purchase agreements (PPA), which result in a higher degree of financial uncertainty in later years.
- The cost of chemicals and reagents have changed.

These key variables were evaluated for the same size EfW facility utilizing the massburn waterwall combustion system. Table 4-3 shows the changes in the key variables used for the updated financial model. Additional changes were made to other variables which have less impact on the overall cost, such as usage rates and costs of reagents and utilities.

Table 4-3. Summary of EfW Financial Model Results

Model Variable	2012 Analysis (Base Case)	2020 Analysis (Base Case)
Capital Cost	$250,000 per tpd of capacity	$285,00 per tpd of capacity
O&M Fee	$32.50 per tpd of capacity	$37.50 per tpd of capacity
Interest Rate	5%	4.5%
Financing Term	20 years	25 years
Sales Price of Electricity	6 cents per kWh	3 cents per kWh
Sales price of Ferrous Metal	$150 per ton	$100 per ton
Sales price of Non-Ferrous Metal	$1,000 per ton	$500 per ton
Ferrous Metal Recovery Rate	2.0%	4.0%
Non-ferrous Metal Recovery Rate	0.35%	0.70%
Sale of Renewable Energy Credits	None	None
Model Output	**2012 Analysis**	**2020 Analysis**
Base Case Cost (year 1)	$81.25 per ton	$91.53 per ton (increase of 13%)
Best Case Cost (year 1)	$48.93 per ton (includes sale of RECs at $10 per REC)	$64.62 per ton (includes sale of RECs at $10 per REC)
Worst Case Cost (year 1)	$110.71 per ton	$116.51 per ton

Not surprisingly, the results of the updated financial analysis show higher costs for all three scenarios (low cost, base case cost, and high cost), compared to the 2012 evaluation. The significant decline (50 percent) in projected revenues from the sale of electricity and recovered metals and increased capital and O&M costs were only slightly offset by the reduced borrowing and project development costs. The 2020 base case cost increased by about 13 percent from that estimated in 2012. Under best of conditions (additional 1 cent per kWh electrical payment, -0.5 percent interest rate, 5-year increased bond term, and 10 percent lower capital cost), the year-1 cost of $64.62 per ton is estimated to be approximately 30 percent lower than the base case cost.

The key variables in this financial analysis are the selling price of electricity, and whether the environmental attributes of electricity from EfW facilities can be monetized. At this point in time, the long-term outlook for receiving higher payments from the sale of EfW electricity is unclear. Furthermore, investor-owned utilities are not offering long-term (20-25 years) PPAs which were common in the 1980s and 1990s, when the majority of existing EfW facilities in the U. S. were developed.

The estimated costs of an EfW facility are higher than the cost of landfills, but lower or comparable with costs associated with other recycling and emerging waste conversion technologies, such as anaerobic digestion and mixed waste material recovery facilities. There are many compelling reasons to consider EfW technology as part of a community's long-range plan for integrated solid waste management. These include extension of the service life of the SWLF; stable and predictable costs over the 45 to 50 year service life of an EfW facility; and reduced environmental impacts including waste diversions from the landfill, reduction of greenhouse gas emissions, and improved recycling rates due to the recovery of ferrous and non-ferrous metals which are not normally collected in curbside and drop-off recycling programs. The EfW residue will simplify landfill operations by providing a material that is easy to manipulate and stabilize, reduce odors, reduce the need for cover material and reduce the treatment of leachate and concerns for landfill gas capture. Future additional benefits that would significantly extend the remaining service life of the SWLF could result from recycling of bottom ash in beneficial reuse projects (construction aggregates, mineral feedstocks, recovery of precious and rare earth metals, etc.). These benefits are currently being demonstrated in numerous European EfW projects.

Massburn furnace designs and flue gas cleaning technology have evolved over the years to cope with increasingly stringent environmental regulations. According to the U.S. Environmental Protection Agency (EPA), modern EfW facilities have an emission profile considerably better than coal based electric power. Recent trends in flue gas cleaning technology have demonstrated the ability to reduce NOx emissions by more than 50 percent. Even greater reductions of NOx emissions can be achieved with use of Selective Catalytic Reduction (SCR) technology which can achieve NOx emissions in the range of 45 to 50 ppm, representing approximately a 75 percent reduction compared to the current generation of operating EfW facilities. Emissions profile of EfW facilities with modern air pollution controls are similar to power produced from natural gas. An additional advantage reported by the U.S. EPA notes that for every ton of municipal solid waste processed at modern massburn EfW facilities, greenhouse gas emissions are reduced by approximately one ton, compared to landfill disposal. This reduction is due to the avoidance of methane from landfills, along with the offset of greenhouse gases from reduced fossil fuel electrical production and the recovery of metals for recycling.

Finally, EfW facilities have been demonstrated to be the workhorses of integrated solid waste management systems, serving as the final stop for wastes that cannot be readily recycled or marketed. Other than removal of bulky and prohibited items, no pre-processing of waste is required for massburn EfW. Additional benefits can be provided to a host community with its ability to process wastewater treatment plant biosolids, used tires, combustible fraction of C&D wastes, residuals and contaminants from recycling programs, and special wastes in need of assured destruction. Some of the above materials can be processed at significantly higher fees, thereby generating additional revenues which can help reduce the overall cost of EfW to the local rate payers. One final advantage of EfW is that the issues with odors at the SWLF will be minimized due to the processing of problematic odor generating putrescible waste at the EfW facility.

4.2.2 Emerging Waste Conversion Technologies

There are many emerging waste conversion technologies currently being promoted for the conversion of wastes in the U.S. based upon novel processes deployed in other industrial applications, including: pyrolysis, gasification, and fermentation. None of these technologies are currently widely used, not all deal with the entire MSW waste stream, and their long-term feasibility is still being evaluated.

Many of the chemical recycling processes will require pre-processing MSW to prepare the proper blend of waste materials suitable for their process. The source of some of these materials may initially originate from curbside recycling programs, along with source separated commercial and industrial streams. Ultimately, Mixed Waste Processing Facilities (MWPF) may become commercially viable as the technologies mature and markets for the by-products are established. Although it is sound advice for counties and municipalities to be cautious about "being first" for implementing new and emerging technologies, there are several operating, or soon to be operating waste-to-biofuels facilities that are worth monitoring, and several examples are highlighted below. Upon commercial development of these processes, they may be quickly replicated in other communities, especially those near nearby markets for the process by-products.

4.2.2.1 Waste-to-Biofuels

One of the more promising alternative waste conversion technologies is currently in operation in Edmonton Canada. Inaugurated in 2014, Enerkem Alberta Biofuels is the world's first major waste-to-biofuels producer. The facility is designed to produce 100,000 metric tonnes of refuse-derived fuel (RDF) using a thermochemical process to convert non-recyclable and non-compostable household waste into biofuels and green chemicals, such as ethanol and methanol. In 2017, it became the first waste-to-biofuel facility to sell its ethanol under the U.S. Renewable Fuel Standard. Enerkem has also announced plans with Air Liquide, Shell, Nouryon and the Port of Rotterdam for the development of a project in Rotterdam, Netherlands to be the first of its kind in Europe to make chemicals and biofuels out of non-recyclable waste materials.

Other developers which have been developing waste-to-fuel projects include Fulcrum BioEnergy, with their first waste-to-fuels facility (Sierra BioFuels) currently under construction near Reno, NV. Fulcrum plans to use gasification and Fischer-Tropsch (FT) processes to convert MSW which has been processed to remove recyclable products and other materials not suitable for processing into a synthesis gas. This syngas is reacted in the FT process with a proprietary catalyst to form a FT product which can then be upgraded to transportation fuel.

4.2.2.2 Conversion of Plastics

One branch of the emerging waste conversion technology arena is focused on "chemical recycling" by processing select fractions of MSW and mixed plastic wastes into a variety of liquid fuels and chemical feedstocks. Plastics waste is a huge untapped resource. Using recycled plastics has benefits in many applications: it can be cheaper than virgin plastics; pricing is less volatile than virgin plastics; and using it does not depend on new extraction of non-renewable fossil fuel resources. A 2019 report by the Center for the Circular Economy at Closed Loop Partners[4] identified over 60 technology providers currently developing processes at the lab-stage or beyond to recycle waste plastics. Reportedly, more than 40 of these technology providers are operating early commercial scale plants in the U.S. and Canada or have plans to do so in the next two years.

One such company, Vadxx has started up its first facility in Akron, Ohio. Because plastics are derived from hydrocarbons and have a high energy content, Vadxx has developed a process to convert them into energy products without reportedly producing any hazardous by-products. The facility is designed to convert 40 million pounds of waste plastic by converting all of it to 4 million gallons of what Vadxx calls EcoFuel™. These are crude oil and fuels, synthetic gas and other energy products.

Another company, Agylix which is based in Oregon, is processing non-recyclable plastics into crude oil using a chemical process called pyrolysis. The process heats waste plastic into a syngas which is then condensed into synthetic crude oil. Impurities are removed to allow further refining into fuel. Agylix's technology is being used at a demonstration facility in Tigard, Oregon along with two commercial-scale projects in development, one at the Agri-Plas recycling facility in Brooks Oregon, and one at a Waste Management facility in Portland, Oregon. The Agri-Plas facility will process materials that wouldn't otherwise be recyclable, such as plastic planting pots used in agriculture and turn them into a synthetic crude-oil that can be sold to refineries. The facility would be able to produce roughly 2.6 million gallons of oil a year from 23 million pounds of plastic.

One advantage that the emerging chemical recycling projects may have over traditional EfW projects which generate and sell electricity to the local grid is that there may be significantly higher revenues from the sale of the liquid fuels and chemical by-products. However, until the overall process is known and developed at full scale with known production costs, it is still too early to predict the winning technologies.

4.2.3 Landfill Disposal Options Outside of Wake County

Landfilling – the more traditional method of waste disposal in North Carolina – remains as another long-term option. Since it is not currently anticipated that another publicly or privately-owned Subtitle D landfill will be sited and developed in Wake County, disposal at out-of-county regional landfills is the most likely landfill disposal scenario.

If no other in-county waste disposal or conversion options are developed, one or more regional private landfills could be used for future disposal of Wake County-generated MSW. There are currently five privately-owned Subtitle D landfills within a 100-mile radius of Wake County, as shown in Figure 4-3. The Upper Piedmont Environmental Landfill is the closest to most municipalities, ranging from 40 to 63 miles. The Sampson County Landfill (59 to 86 miles) and the Great Oak Landfill (55 to 89 miles) are the next closest. Each landfills' permitted capacity, permitted waste stream, and amount of waste received in 2018 are provided in Table 4-4. Based on current capacity projections, these three landfills would have 25, 20 and 33 years of capacity remaining in year 2040, respectively. Accepting all or a portion of Wake County's waste would markedly increase these landfills annual tonnage and significantly lower their remaining capacity projections. It is unknown if any of these facilities have plans to purchase additional, adjacent land and expand beyond what is currently permitted.

[4] 2019, Closed Loop Partners, Closed Loop Plastics – Accelerating Circular Supply Chains for Plastics.

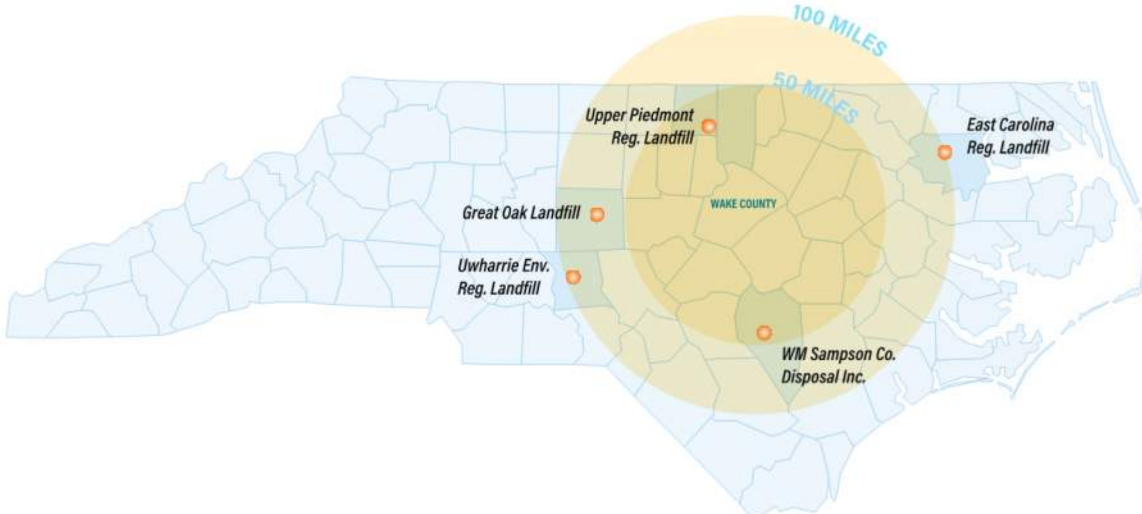


Figure 4-3. Regional MSW Landfills within 100 Miles of Wake County

Table 4-4. Regional Landfill Capacity and Lifespan Information

Out-of-County Private Landfill	Owner	Permitted Capacity (cy)	Remaining Capacity (cy)	Permitted Waste Stream (tpd)	Waste Tons Received in 2018	Projected Lifespan (years)
Upper Piedmont Environmental Landfill	Republic Services	17,400,000	11,265,831	660	243,291	40
Sampson County Landfill	GLF Environmental	56,600,000	33,548,512	5,000	1,767,087	45
Uwharrie Environmental Landfill	Republic Services	33,785,715	15,817,293	3,000	464,672	20
East Carolina Regional Landfill	Republic Services	24,200,000	10,965,317	1,600	495,068	21
Great Oak Landfill	Waste Management	37,801,000	36,411,140	4,000	556,126	53

Values estimated from NCDEQ FY18-19 Landfill Capacity Report and Solid Waste Management Facility Permits.

The cost for out-of-county waste disposal will depend of numerous factors including the construction and operation of transfer stations, hauling costs, and landfill tipping fees. The Wake County local governments are likely to pay more for out-of-county disposal than they pay for disposal at the SWLF, simply due to the cost associated with hauling the waste 40 miles or more. They will also be subject to larger price fluctuations compared to waste disposal at the SWLF, since changes in fuel prices are typically included as a variable in long-term hauling and disposal contracts. Using the City of Durham's Waste Disposal Services Contract with GFL and the current fuel, labor and equipment costs, the local governments of Wake County could expect to pay between $35 to $45 per ton for hauling and disposal at an out-of-county landfill in 2020. Future (2040) costs would be higher simply owing to inflation. Other factors that may influence out-of-county pricing include the available disposal capacity, amount (tonnage) of waste to be disposed, level of collaboration among local governments, and contract length.

Based on current conditions, the $35 to $45 per ton cost range for out-of-county disposal at a regional landfill is below the estimated $65 to $117 per ton cost range for waste conversion at an 1,800 tpd massburn EfW facility built in Wake County. The per ton price for processing at an EfW facility could potentially decline over time, once the debt was paid off (e.g., after 20 years). A slightly lower cost per ton might also be expected if a larger massburn facility was constructed (e.g. 3,000 tpd) that would receive waste from outside Wake County.

4.2.4 Increasing the capacity of the SWLF

Increasing the capacity of the SWLF will extend the time when the next, and likely more expensive, solid waste management option is needed. SCS Engineer's 2019 study *Landfill Life Extension Study: Exploring Recommended Actions* recommended that the County consider increasing the landfill's 4:1 side slopes to 3.5:1. A change in side slope to 3.5:1 for areas that are not already closed would provide approximately 2 million cubic yards (cy) of additional airspace, and extend the life of the landfill another two years, at a cost of about $0.09 per cy. If the already-closed portions were included, approximately 3 million cy of additional airspace would be created, adding three years of life, but at a cost of $1.39 per cy.

Other strategies that were recommended for additional study included construction of a mechanically stabilized earth berm; temporarily overfilling the landfill; and lowering the base grades of future disposal areas to expand the landfill vertically.

4.2.5 The Path Forward

Because the next solid waste management option will likely be a more expensive solution than the SWLF, the County should continue to evaluate and implement strategies that extend the life of the landfill – while taking steps to mitigate odor issues, as they arise. In addition to the waste reduction and diversion strategies identified in Section 4.1, increasing the landfill side slopes has been shown to be a relatively low cost, but effective way to gain approximately 2 years of additional life. The County should consider this, and other identified options in terms of the avoided cost savings from having to develop and use the next long-term solid waste management option.

Wake County should continue to consider EfW as a potential method of waste disposal before the SWLF begins to reach capacity, thereby reserving space for long-term disposal of ash from the massburn process. Because of the potentially long lead time associated with identifying a sufficient waste stream, siting, designing, permitting, negotiating an energy contract, procurement, financing, constructing, and startup testing of an EfW facility, this option deserves thorough consideration well in advance of when it's actually needed. Current estimates for development of an EfW facility from concept through start-up are in the range of seven years – and potentially greater, depending on a variety of factors.

The local governments of Wake County should also participate in discussions with other Triangle-area governments to investigate regional solutions. Although Wake County is likely to have a large enough waste stream to support an 1,800 tpd EfW facility, one with a capacity of 3,000 tpd would likely result in lower per ton costs and should be considered as a regional solution.

As part of an ongoing evaluation of the next long-term waste management option, the County should monitor and track changes in factors that will affect the feasibility of the options. This includes renewable energy policy; the terms of power purchase agreements and revenue; the success (or failure) of emerging waste conversion projects; full-scale implementation of new waste conversion technology; transportation fuel markets; markets for end-use products; and new or changing regulations.

While informative, the direct comparison of estimated costs per ton for waste disposal at an out-of-county landfill versus waste conversion at an in-county EfW facility or other waste conversion technology overlooks other factors that deserve consideration when evaluating long-term MSW disposal options. The environmental implications of each option, such as criteria pollutant and greenhouse gas (GHG) emissions, as well as sociodemographic impacts should also be considered. An evaluation of life-cycle costs that consider the entire solid waste management system can provide a more comprehensive assessment and comparison of potential long-term options. NC State's SWOLF model has already been used in this regard and can continue to be applied to evaluate various scenarios as conditions change. If the NC State SWOLF model is again applied to evaluate long-term waste management options, the addition of an out-of-county landfilling option is recommended. The addition of this scenario would help demonstrate the comparative cost implications of transporting waste long distances, to the base case and other scenarios, accounting for mitigation costs associated with GHG emissions.

Prior to conducting future evaluations of long-term disposal options, the criteria that are deemed important to the citizens of Wake County should be agreed upon. Some potential criteria to consider include:

- Short and long-term cost
- GHG and priority pollutant emissions
- Power generation
- Revenue from power and environmental attributes (and stability of that revenue)
- Sociodemographic impacts
- Vehicle collisions and worker safety
- Duration (i.e., how long will the solution last until a new solution is needed?)
- Resiliency (i.e., how likely is it that the solution will be impacted by a disruption?)

Once evaluation criteria are selected, a decision support tool can be used to help assess both quantitative and qualitative criteria, and more effectively compare options. Assessment and comparisons should consider the importance of the selected criteria. Weights can be assigned to each criterion so that the most important criteria have more impact in determining the assessment results, compared to lower-weighted criteria.

4.3 Recycling and Reuse

4.3.1 Residential Recycling and Reuse Programs

The total tons of material recycled and waste disposed by each local government's residential sector during FY19 is shown in Table 4-5. Since the last Plan update (which reported FY11 data) the amount of residential recyclables collected has increased from 61,444 to 72,625 tons. As a percent of waste disposed, there has also been an increase from 23.9 to 27.5 percent for all local governments combined; however, the County's overall per capita recycling rate has declined slightly, dropping from 134 to 132 pounds per person.

Compared to other North Carolina counties, Wake County ranks 20th in the in the amount of common household recycled per capita[5].

All 12 of Wake County municipalities provide curbside recycling collection programs. In addition to curbside programs, five municipalities (Cary, Raleigh, Wake Forest and Wendell) operate one or more drop-off centers that accept recyclable materials. Rolesville operates a site for source separated recyclable materials. Holly Springs operates drop-off sites for electronics batteries and Fuquay-Varina operates an electronic recycling convenience center. Several municipalities including Apex, Morrisville, Raleigh, and Wake Forest have experimented with curbside textile recycling programs, as offered through a private company, Simple Recycling.

Table 4-5. Waste Disposed and Recycled by Wake County Local Governments, FY19

Jurisdiction	2018 Population	Tons of Waste Disposed	Tons Recycled	Pounds Recycled per Person	Percentage of Waste Recycled 2019	Change in Percent from 2011
Apex[1]	52,909	15,177	4,241	160	27.9%	-4%
Cary	162,341	36,460	11,512	142	31.6%	-5%
Fuquay-Varina	26,936	9,369	1,690	125	18.0%	0%
Garner	30,787	8,030	2,825	184	35.2%	11%
Holly Springs	34,071	9,917	2,353	138	23.7%	-5%
Knightdale	15,305	5,383	806	105	15.0%	-4%
Morrisville	26,041	3,731	1,347	103	36.1%	3%
Raleigh	464,435	92,524	27,966	120	30.2%	11%
Rolesville	6,638	3,045	530	160	17.4%	-19%
Wake Forest	37,279	10,865	3,089	166	28.4%	1%
Wendell	7,132	2,667	525	147	19.7%	-2%
Zebulon	4,986	1,783	288	116	16.2%	-5%
Wake County (unincorporated)	227,548	64,697	15,453	136	23.9%	-2%
Overall	**1,096,408**	**263,648**	**72,625**	**132**	**27.5%**	**3.7%**

Source: FY19 Solid Waste Management Annual Reports.

Waste disposed and tons recycled shown in the table reflects residential waste, and a small amount of commercial waste collected by municipalities. The recycling tonnage for unincorporated Wake County does not include the following materials that were also recycled: tires (20,256 tons) and HHW (998 tons).

[1] Apex totals were reported incorrectly in their Solid Waste Management Annual Report. FY18 totals are shown instead.

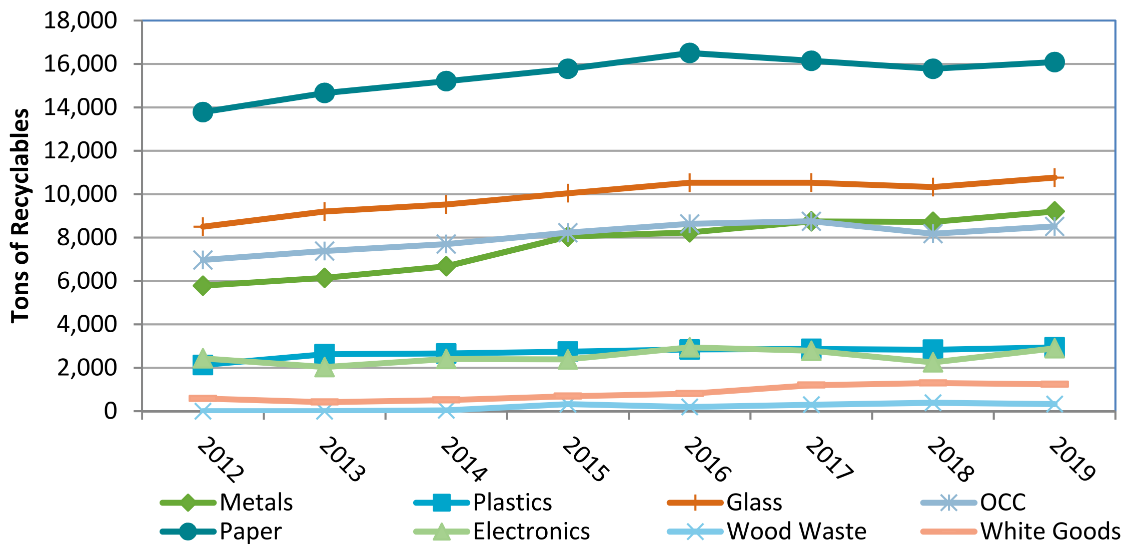
Curbside recycling collection in the unincorporated area of the County is available from private contractors. A 2017 survey[6] of 1,275 homes in 11 neighborhoods in unincorporated Wake County found that 31 percent of residents have curbside collection of recyclables, provided by one of eight different private contractors.

[5] NCDEQ Division of Environmental Assistance and Customer Service Annual Report, 2017. County per Capita Recycling Performance.

[6] CDM Smith, 2017. Solid Waste and Recycling Collection Franchising Study

Residents in unincorporated Wake County that do not pay for curbside collection of recyclables can make use of the 11 Convenience Centers. Any resident of the County can drop-off commingled recyclables and other items at these staffed-sites. The County also operates three Multi-Material Recovery Facilities (MMRF) for electronics, white goods, scrap metal, tires and materials that are banned from landfill disposal and three HHW facilities.

Annual totals of the type of materials recycled through the curbside and drop-off programs are shown in Figure 4-4. Cary, Garner, Morrisville and Wake Forest only report total commingled tons of recyclables on their Solid Waste Management Annual Reports; therefore, the material type totals shown do not reflect the amount collected by all municipalities.



Most of the materials recovered by Cary, Garner, Morrisville and Wake Forest are not included in these totals.
Source: FY2019 Solid Waste Management Annual Reports.

Figure 4-4. Materials Recovered from Curbside and Drop-off Recycling Programs, FY12-FY19.

Figure 4-5 shows the trend in recyclables collected on a per capita basis from residential programs (curbside and drop off) since FY07. Although there has not been consistent improvement from year-to-year, the overall trend reflects an average annual growth in per capita residential recyclables collected of about 1 pound per person.

Figure 4-6 shows the amount of recyclables and yard waste recovered annually in Wake County over the last 25 years. As with the previous tables and figures, these amounts reflect materials recovered through residential programs only and do not account for materials recycled through commercial establishments or yard waste generated and recovered by commercial landscapers. While the amount of recyclables recovered continues to rise on an annual basis, yard waste generation and recovery shows more variability due to storm events. Over the past three fiscal years, an average of 140,059 tons per year of recyclables and yard waste were diverted from the landfill through residential collection and drop-off programs.

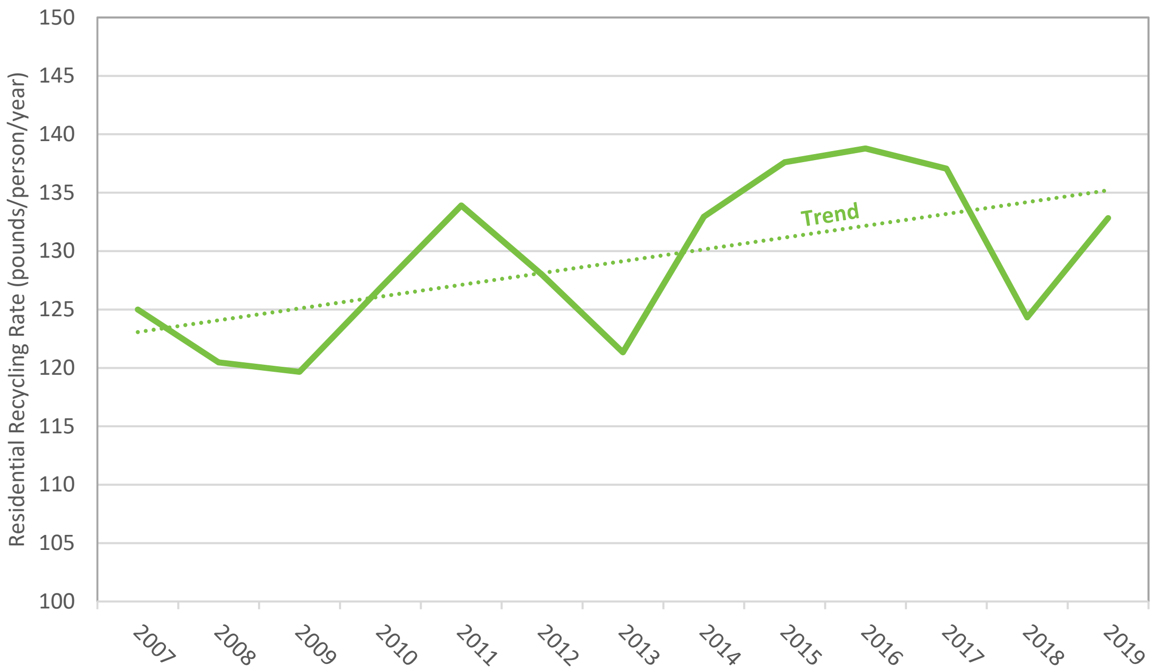


Figure 4-5. Per Capita Trend in Residential Recyclables Collected, FY07-FY19

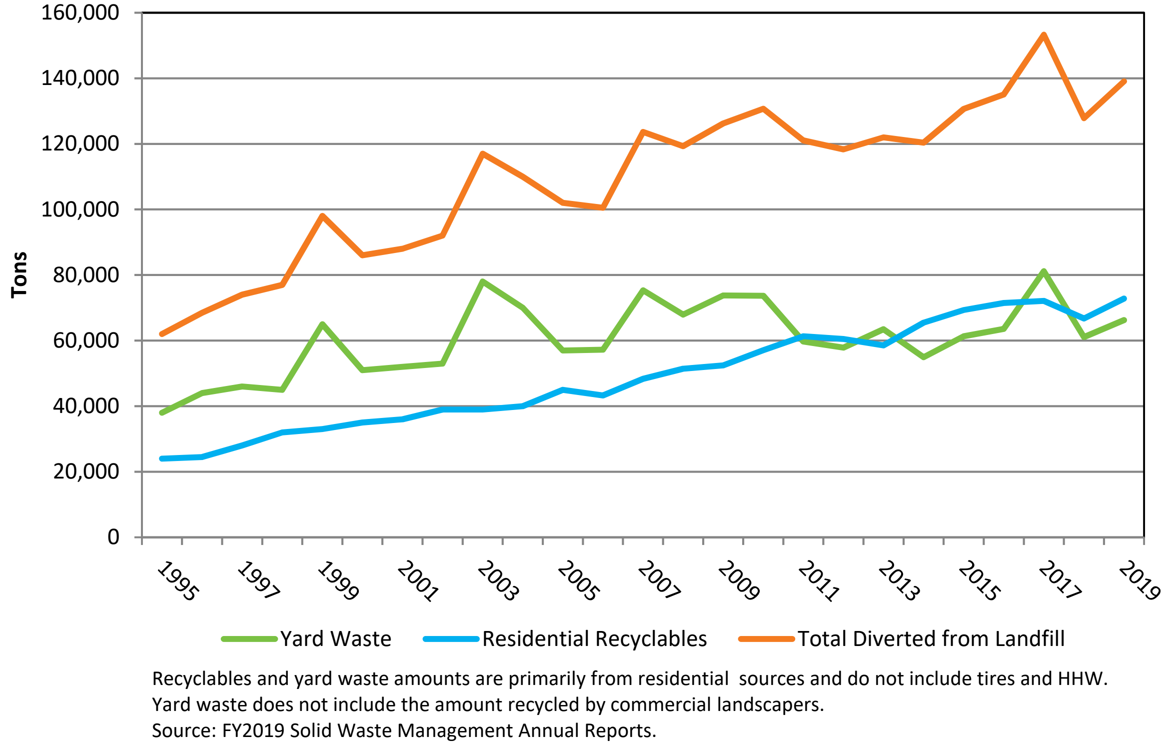


Figure 4-6. Recyclables and Yard Waste Recovered, FY95-FY19

Based on the statistics and trends noted above, residential participation in recycling continues to be strong, resulting in a significant amount of waste diverted from the SWLF. However, there is still room for improvement. Wake County's 2019 waste characterization study[7] found that over 20 percent of the waste from single family residential units was made up of materials accepted in curbside single stream collection programs. Another 7 percent was other materials that are accepted for drop off by the County. Most of this was textiles. Furthermore, based on estimates developed by the Recycling Partnership[8], the 12 municipalities in Wake County collectively lag the U.S. average of 141 pounds per person per year collected through curbside recycling programs, by about 10 pounds per person.

4.3.2 CII Recycling and Reuse Programs

Local government-offered recycling programs that serve the CII sector include:

- Wake County's three MMRFs accept several types of materials from businesses, including cardboard, computers, electronics, and scrap metal. The City of Raleigh allows businesses to use its' three recycling drop off centers.
- The City of Raleigh offers curbside recycling in the Central Business District (CBD). Paper, cardboard, chipboard, glass, and plastic are all accepted. The City has distributed 64-gallon carts and offers collection service both six and seven times a week. Over 150 businesses had joined the program to date.
- The Town of Fuquay Varina offers cardboard collection for the commercial accounts that also receive refuse collection. Commercial accounts can purchase up to two 96-gallon recycling carts for cardboard to be serviced every week.
- Several municipalities allow certain small businesses to participate in their residential curbside collection program.
- Wake County's Feed the Bin program offers recycling and environmental education opportunities to students of the WCPSS at over 194 school sites. The program initially focused on mixed paper recycling, but since FY18, has been transitioning schools to mixed recycling. As of January 2020, all Wake WCPSS schools in Fuquay-Varina, Garner, Holly Springs, the southwest Apex, southeast Raleigh, Knightdale, Rolesville, Wake Forest and Zebulon have switched to commingled recycling. Schools in Cary, Morrisville and the remaining portions of Apex and Raleigh will be switched over by the end of FY21. In FY18, 757 tons of paper and other recyclables were diverted from landfill disposal from all WCPSS schools. In FY19, tons of paper and other recyclables diverted increased to 794 tons.
- Wake County offers free on-site waste assessments to businesses and assistance in establishing recycling programs.
- CII establishments may participate in recycling by using one or more local haulers or recycling processors. Collection services for conventional recyclables are relatively available for both large and small establishments; however, small establishments are less likely to participate due to cost factors, uncooperative landlords, or lack of an agency for which to make recycling arrangements.

---

[7] Kessler Consulting, Inc., 2019, Wake County, North Carolina Waste Characterization Study.

[8] The Recycling Partnership, 2017. The 2016 State of Curbside Report.

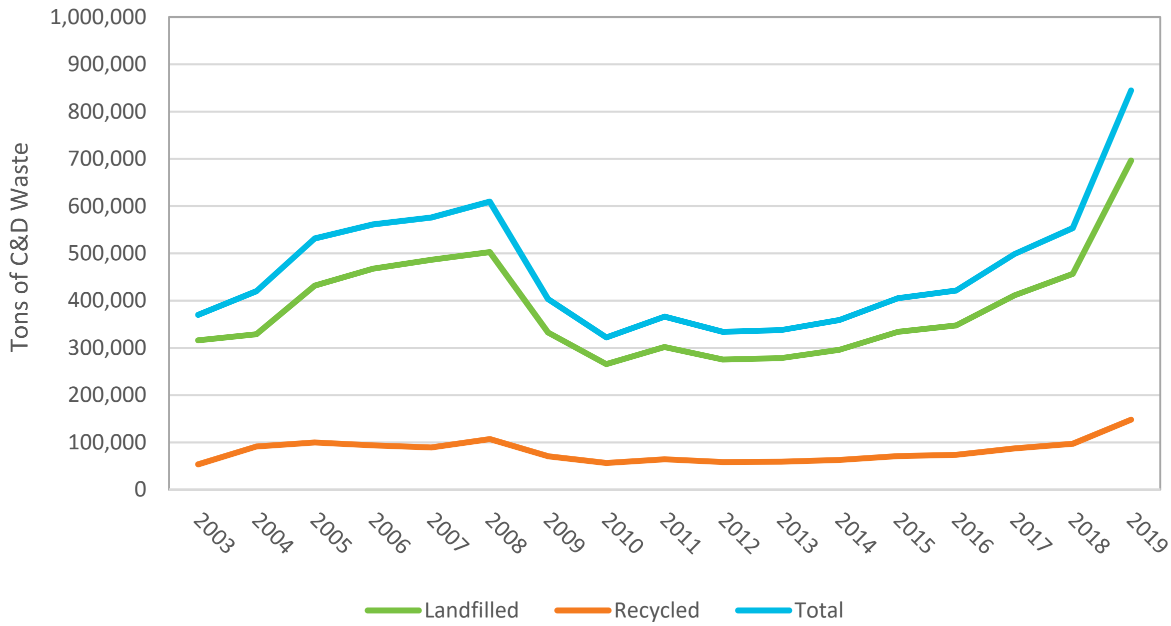
- To discourage disposal of corrugated cardboard, waste loads that have more than 10 percent cardboard are required to pay double the per ton tipping fee at the SWLF and EWTS.
- North Carolina State University, one of the largest institutions in Wake County, offers a comprehensive group of recycling programs aimed at faculty, staff, students, and visitors. Some of these programs include:
  - A Zero Waste Wolfpack program that unites the pre-game tailgate and stadium recycling program called WE Recycle with Carter-Finley Composts, the in-game compost collections program. The Zero Waste Wolfpack program has been effective in reducing the amount of waste generated in the tailgate lots and stadium from 49,680 pounds per game during 2015, to 33,009 pounds during 2019.
  - Bring Your Own (BYO) and #GoStrawless campaigns focused on reducing waste and reliance on single-use disposables, including cups and straws.
  - On-campus paper shredding and electronics recycling events and composting education opportunities during America Recycles Day;
  - Recyclemania, a competition and benchmarking tool for college and university recycling programs to promote waste reduction activities to their campus communities; and
  - The Wolf Pack-n-Give collaborative program between University Housing and NC State Waste Reduction and Recycling to divert the materials often discarded by students moving off of campus at the end of each year. Collected items are donated to TROSA, Feed the Pack Food Pantry, and the Food Bank of Central and Eastern North Carolina.

Even with the CII recycling programs, a significant opportunity exists to enhance county-wide recycling by increasing participation in the CII sector. Counties that have established mandatory recycling ordinances for businesses, including Mecklenburg, Durham, and Fairfax Virginia, have reported gains in recycling. Others have developed requirements for public events to provide waste containers to encourage recycling.

4.3.3 C&D Recycling and Reuse

The amount of C&D waste recycled and landfilled is shown in Figure 4-7. The amount recycled each year is based on a 2008 GB&B study[9] which found that C&D recycling between 2003 and 2007 ranged from 15 to 22 percent, for a five-year average of 17.5 percent. This percentage was applied to the 2008-2019 landfilled amounts to develop approximate C&D recycling estimates. The amount of C&D waste landfilled has increased each year since 2013, reflecting steady growth in construction starts.

[9] GB&B, 2008. Wake County C&D Waste Assessment



Sources: 2008 GB&B Wake County C&D Waste Assessment and County Waste Disposal Reports. 2008-2019 recycling rates assume a 17.5 percent recycling rate, which was the estimated average from 2003-2007 per the GB&B study.

Figure 4-7. C&D Waste Landfilled and Recycled, FY03-FY19

Most contractors monitor recycling markets and segregate materials with marketable value from C&D waste at the construction site. These materials are then transported directly to recyclers, bypassing the processing facility. C&D recovery rates are impeded by the low market value of large volume waste materials including wood waste and drywall. Where wood waste provides some opportunities in the composting and energy market, processors have struggled to find a way to effectively recycle drywall. Much of the drywall that enters processing facilities ultimately is disposed in a landfill. Mecklenburg has developed their own drywall recycling program. Drywall is processed, at the landfill, and marketed as an agricultural supplement for farmers.

There are two material recovery facilities in Wake County with active permits: WCA Material Reclamation in Raleigh and Elite Waste Services Pristine Water Facility in Apex. WCA processes C&D waste for concrete, metal, shingles and wood. Collectively the facilities received 112,152 tons of waste in FY2019.

The 2008 GB&B study found that the large amount of C&D landfill space in Wake County is a detriment to achieving increases in C&D recycling – and that still holds true today. Many local options exist for C&D waste haulers to dispose their material. The study identified nearly 26 million tons of permitted capacity for C&D waste available in the area providing more than 50 years of disposal life. There are four C&D landfills in Wake County with active permits. Since 2008, just over 4.1 million tons of C&D waste has been landfilled in in the County. Due to the number of active disposal sites, the current marketplace is highly competitive with several alternatives, which keeps disposal costs relatively low. Furthermore, the large amount of permitted capacity provides little incentive for C&D recycling, outside of materials that are easily recovered and reused, or can be recovered, processed, and used in new applications.

NC State University requires a minimum of 75 percent of C&D waste to be diverted from the landfill through reuse or recycling. Few, if any institutions or local governments in Wake County have similar reuse and recycling requirements for building construction and demolition projects, but ultimately this approach may be the only way to increase C&D recycling.

4.3.5 The Path Forward

While recycling has seen modest growth in Wake County over the past decade, there are significant challenges ahead. In 2013, China initiated “Operation Green Fence” which was aimed at reducing waste importation and contamination in recyclables. These policies reduced the amount of recyclables going to China. As demand dropped, cost of U.S. recycling programs increased. Then, in 2018, China’s National Sword Policy banned mixed paper and plastics coming from all countries and reduced the level of contamination in scrap and recyclable materials not banned to 0.5 percent – a virtually unattainable level that effectively bans other materials that must undergo separation before recycling. Shortly after the National Sword Policy took effect, China imposed tariffs on many recyclables coming from the U.S., including cardboard, metals, plastics, and other recovered fiber[10].

The loss of China as a major market for U.S. recyclables has driven up costs and erased what used to be a source of revenue for many communities. For example, the Town of Cary received over $395,000 in revenue from recyclables in FY11 and $331,000 in FY12. In FY19, Cary had to pay $505,000 to WM Recycle America, who receives their recyclables. As a result, the Town’s per household cost for recyclables, which covers collection by Town staff and disposal at the WM Recycle America facility, more than doubled from $20.72 in FY12 to $43.56 in FY19. The Town went from paying $82 per ton of recyclables managed in FY12, to $197 per ton in FY19. At the same time, the Town’s cost for collecting and disposing MSW has moved in the opposite direction, declining from $174 per ton in FY12 to $132 per ton in FY19. The increasing cost of recycling has driven some North Carolina local governments to reassess whether recycling is worthwhile. Some, as noted below, have either dropped their recycling programs altogether, eliminated certain materials, or made changes to reduce cost.

- Effective July 1, 2019, the City of Greensboro banned glass from residential curbside collection, as well as large plastic items and pots and pans. The changes to Greensboro’s program were driven by higher costs, increasing contamination levels, and few, viable end-use markets.

- Effective April 1, 2020 the City of Kings Mountain suspended residential and commercial recycling collection citing the decreased market demand for raw recyclable materials such as plastic, glass, and paper. The City also eliminated the monthly household recycling fee of $2.75, saving households $33 per year.

- Orange County has developed a “Glass On The Side” (GOTS) program at its Waste and Recycling Centers (WRCs). Beginning May 1, 2020, a separate dumpster or carts were placed at all WRCs to accept separated glass bottles and jars. Separating glass reduces the single stream tonnage that the County pays to have processed. The County receives revenue for glass at Strategic Materials in Wilson, North Carolina where it is converted to feedstock for bottles, fiberglass, reflective paint and sandblasting abrasives. The County intends to add separate glass containers at the unstaffed recycling drop off sites later in 2020. No change has been made to the residential curbside recyclables collection program, however.

---

[10] SWANA, 2019. Resetting Curbside Recycling Programs in the Wake of China.

In Wake County, while it has been a topic of discussion with City and Town councils, the local governments continue to maintain their support for recycling programs. In late 2019, Raleigh's City Council unanimously agreed to pay $1.5 million to Sonoco Recycling to continue taking Raleigh's recyclable materials for six months, while a new, longer contract was negotiated. Prior to that point, Sonoco had been losing between $100,000 and $150,000 every month under the terms of their existing contract, due to the declining market for most recyclable materials[11].

Several recommendations geared toward improving recycling and reuse were presented in Section 4.1. The following additional recommendations are offered considering the current challenges facing recycling in Wake County.

Consider Separate Collection Containers for Glass Bottle and Jars at Drop off Sites

Local Governments, and especially Wake County who collects by far the most recyclables at drop off sites may be able to improve the economics of recycling by asking residents to place glass bottles and jars in separate containers. As noted above, Orange County has found a market for glass that provides a small revenue source. With glass removed from the rest of the commingled recyclables, the recyclables may potentially be subject to a reduced processing fee at MRFs.

Promote and/or Incentive Recycling in Unincorporated Wake County

The 2017 survey of 1,275 homes in 11 neighborhoods in unincorporated Wake County found that only 31 percent of households have curbside collection of recyclables. A 2013 survey of 2,238 residents visiting Wake County's Convenience Centers found that only 34 percent of the those visiting the Convenience Centers were dropping off recyclables[12]. Even if half of the households that do not have curbside recyclables collection bring their recyclables to a Wake County Convenience Center or other drop off site, that leaves approximately 31,000 households in unincorporated Wake County who do not actively recycle. If 31,000 households were to begin recycling, that would result in an additional 5,000 tons of recyclables diverted from the SWLF. Wake County should consider ways to promote and/or incentive curbside recycling or use of the Convenience Centers for residents living in unincorporated Wake County. Potential options to consider include:

- Offering incentives or subsidies to private haulers who offer residential recyclables collection to increase curbside participation.
- Initiate an education campaign focused on unincorporated residents that promotes recycling and encourages participation in curbside recyclables collection or emphasizes the accessibility and ease of use of the County's 11 Convenience Centers.

Implement Steps to Reducing Contamination

Contamination of recyclables further increases cost. For example, Cary's contract with WM Recycle America in Raleigh specifies an increase in the $91.50 per ton processing fee to $150 per ton when non-recyclables

[11] Brown, Trent. November 18, 2019. "Why Raleigh is going to pay $1.5 million for recycling (And it's not all China's fault)" https://www.newsobserver.com/article236821623.html.
[12] CDM Smith, 2014. Task 2 Memorandum – Service Benefit Analysis.

are in excess of 12 percent per load[13]. Similarly, the processing fee charged to Fuquay-Varina increases by 20 percent when contamination exceeds 10 percent per load.

The anti-contamination strategies recommended by The Recycling Partnership[14] should be considered by all local governments. These include:

- cart tagging (putting "oops" tags on carts that tells a resident what materials were found in their carts that don't belong);
- rejecting contaminated carts (not picking them up and leaving them on the curb);
- sending direct mailers or bill inserts to residents on what recyclables are and are not accepted; and
- using general advertising to promote what recyclables are and are not accepted.

In leu of sending direct mailers or bill inserts to residents, some municipalities are actively trying to avoid costs by adopting "ReCollect" technology.

Improve Household Capture Rates

Wake County's 2019 waste characterization study found that over 20 percent of the waste from single family residential units was made up of materials accepted in curbside single stream collection programs. Of the 20 percent, nearly half was mixed paper and recyclable plastic containers were another 4 percent. Furthermore, Wake County collectively trails other North Carolina communities in the set-out rate. A UNC School of Government survey[15] identified recycling set-out rates for Asheville, Charlotte, Concord, Greensboro, Hickory, High Point, and Winston Salem as all being above Wake County's FY19 rate (for all 13 local governments) of approximately 6.3 pounds per household per week. These figures suggest that Wake County households who participate in recycling, can do a better job. A collaborative, countywide outreach and education program that promotes recycling, provides a consistent message, and targets those items such as paper and plastics that are not being routinely recycled may improve capture rates. This recommendation is discussed further in Section 4.5 – Outreach and Education.

Consider Incentives, Grants or Tax Breaks to Lure Companies that Use Recyclable Material as Feedstocks.

Establishing local end-use markets helps to alleviate the pressure of China's restrictions on traditional recyclables while also expanding the market for more materials that are recyclable. Incentives, grants or tax breaks are a way to attract and retain companies that use recyclable materials. Having these companies local may ultimately lower the cost of recycling programs.

Consider Incentives, Grants or Tax Breaks to Lure Companies with Emerging Conversion Technologies that Convert Plastics to Fuel, Syngas, Polymers, Monomers and Other Useful Outputs

As noted in Section 4.2.2.2, there are numerous emerging conversion technologies that use sorted and/or mixed plastic wastes as feedstock to produce a variety of liquid fuels and other useful outputs such as

---

[13] The $150 per ton fee applies to each ton in excess of 12 percent per load. For example, with 20 percent contamination, Cary pays an additional charge of $150.00 X 8 percent or $12.00 per ton.

[14] The Recycling Partnership, 2020. State of Curbside Recycling Report.

[15] UNC School of Government, 2018. Final Report on City Services for FY 2016–2017.

naphtha, fuels, syngas, polymers, and monomers. A variety of processes including thermal conversion, chemical decomposition, biological decomposition, and purification are being tested, refined and developed by at least 60 technology providers. Many of these have moved beyond lab scale and are being applied, or will soon be applied, at more than 40 early commercial scale plants in the U.S. and Canada[16]. Wake County, and the Research Triangle Region which is known for innovation, should seek to attract through business tax credits or other incentives, one or more of these transformational technology providers. Turning what is increasingly seen as a hinderance and drag on recycling into an asset, may help encourage more recycling and keep plastics out of the landfill.

Consider Making Recycling Mandatory for Businesses that Generate Large Amounts of Wastes

Municipalities often establish mandatory recycling for businesses based upon the amount of waste generated at the business. This strategy can have a big impact in diverting waste from the landfill where large businesses are currently not recycling, or not recycling effectively.

Continue to Explore Opportunities for Cooperative Contracting

There are 13 local governments in Wake County and 13 different contracts for recycling, yet only two major recycling processors – WM Recycle America and Sonoco Recycling. Nine of the 13 local governments hold contracts with private haulers, who in turn, deliver recyclables to one of these two providers. The other four – Cary, Fuquay Varina, Raleigh and Wake County – deliver their recyclables directly to the MRFs and hold contracts directly with the processors. The result is a variety of contract terms with different processing fees, acceptable levels of contamination, material minimums and maximums, and lengths. In the past, Wake County local governments have had success negotiating more favorable contract terms for solid waste services when combining waste streams to achieve a greater economy of scale. This idea is also currently being pursued at a regional scale through on-going discussions between Triangle-area municipal and county solid waste programs including the Town of Cary, City of Raleigh, City of Durham, and the counties of Durham, Wake, Orange, Chatham and Alamance.

Continue Expansion of the WCPSS Recycling Program

Wake County has established several near-term goals for the Feed the Bin school recycling program. These include completing the conversion of all participating schools to commingled collection; rebrand and market educational offerings to teachers; and collaborating with the WCPSS on a waste audit.

Consider a C&D Waste Deposit System

With four C&D landfills in Wake County and only one major C&D recycling facility, the cost of landfilling C&D materials is relatively inexpensive. There is little incentive for builders to participate in recycling. One system that has worked in other locations is a C&D waste deposit system. A deposit is submitted with a building permit application. When the builder demonstrates they have met recycling requirements, the deposit is returned. As another option, the County could consider an ordinance update that requires a minimum percent of waste from construction and demolition projects be diverted from the landfill through reuse or recycling.

---

[16] Closed Loop Partners, 2019. Accelerating Circular Supply Chains for Plastics.

4.4 Organics Management

4.4.1 Yard Waste Programs

All municipalities offer curbside yard waste collection weekly, every-other-week or bi-monthly except for Fuquay-Varina, which offers service upon request, on a weekly basis. All municipalities offer seasonal loose leaf collection. The amounts of yard waste collected and processed, the end-use, and the destination of the yard waste is shown in Table 4-6. In FY19, less than 4 percent of yard waste collected was sent to a LCID landfill.

Two municipal programs currently process yard waste and offer it back to citizens. Zebulon offers mulch free of charge to residents, farms and businesses at certain times of the year. The City of Raleigh offers mulch, compost, and wood chips for sale to the general public and businesses. Nearly one-half of the total amount of yard waste collected in Wake County is processed by the City of Raleigh and sold back for beneficial reuse. The Town of Cary annually offers three free bags of compost to its residents free of charge, that sign up for their annual compost giveaway workshops.

Table 4-6. Municipal Yard Waste Program Summary, FY19

Jurisdiction	Tons Processed	Tons Landfilled	End Use	Destination
Apex	6,100	0	Private mulch or compost facility	Greenway Waste of Apex
Cary	18,377	0	Private mulch or compost facility	McGill Environmental, Merry Oaks - Brooks Contractor, Bear Creek
Fuquay-Varina	2,324	466	Private mulch or compost facility, Farmer or Homeowner or Landfilled	Greenway Solutions of Apex, Bryant Landfill
Garner	3,847	2,114	Farmer or Homeowner, Energy/Fuel Use or Landfilled	Shotwell, Buffaloe Landfill
Holly Springs	21,480	2,424	Composted/Mulched, Landfilled	Earth Tech, Bryant Landfill
Knightdale	3,600	0	Mulched/Composted, Local Government Facility	Hopkins Grading, Town of Knightdale
Morrisville	264	0	Composted/Mulched	City of Raleigh Yard Waste Center
Raleigh	65,774	0	Farmer or Homeowner, Composted/Mulched, Local government facility	City of Raleigh Yard Waste Center, Capital Mulch Company
Rolesville	488	0	Composted/Mulched	*Not provided*
Wake Forest	3,731	0	Farmer or Homeowner, Composted/Mulched, Private Facility	City of Raleigh, Rowland Landfill
Wendell	608	0	Composted/Mulched	Carolina Tree Debris, Waste Industries
Zebulon	2,861	0	Farmer of Homeowner, Local Government Facility	Town Yard Waste Facility
Total	**129,454**	**5,004**		

Source: FY19 Solid Waste Management Annual Reports

4.4.2 Food Waste Programs

Wake County continues to consider alternatives for food waste disposal. The waste characterization studies of 2011 and 2019 show that food waste increased from 15.1 percent of the waste stream going to the SWLF in 2011, to 22.5 percent in 2019. This indicates a significant opportunity to reduce the amount of food waste landfilled through composting or other means such as anaerobic digestion or co-digestion with wastewater treatment plant sludge.

To evaluate potential residential organics diversion opportunities and develop a strategy around organic waste management, Wake County initiated a four-part study in 2014[17]. In Part 1 of the study, a waste characterization assessment found that food waste and soiled paper products comprise 25 percent of residential waste. A survey of convenience center customers combined with other county data was used to compare an organics drop-off program at convenience centers and multi-material recycling facilities to a countywide organics curbside collection program. The conclusion was that use of convenience centers and multi-material recycling facilities for organics diversion would have a marginal impact on removing organics from the MSW waste stream. The study estimated that 3,000 tons per year of organics would be diverted from the SWLF using drop-off only; whereas a countywide curbside collection program would divert approximately 100,000 tons per year (30,000 tons per year of food waste and 70,000 tons per year of yard waste). A curbside collection program that served only the unincorporated areas would divert an estimated 9,000 tons per year of food waste and up to 14,000 tons per year of yard waste.

Part 2 of the study addressed processing options for collected organics. For the small quantity of organics that would be collected by a drop-off program, the City of Raleigh's yard waste facility was identified as an option for yard waste and one of the existing Type 3 or Type 4 composting facilities were identified as options for food waste. If food and yard waste were collected together, the study recommended that all of the material be taken to an existing Type 3 or Type 4 composting facility such as McGill Environmental. The study also suggested that a County-owned windrow composting facility could be established at the SWLF or other County property for processing materials from a drop-off program. If a county-wide organic curbside collection program were implemented, the study found that it would generate more material than could be processed at the existing composting facilities in the area. Existing facilities would need to be expanded or a new facility would be required.

Part 3 of the study provided a framework and best management practices for a residential organics diversion pilot program. The study notes that nearly 200 communities in the US operate a curbside collection program for organics at a cost of $5 to $6 per household per month. Organics collection can be commingled food waste and yard waste in one cart or collected separately using two carts. Food waste-only programs often include soiled paper products such as paper towels and napkins but avoid items like household plants and pet waste. The study recommended using separate containers at each residence but commingling the materials in one collection truck because separate containers provide much higher capture rates and commingled collection provides considerable cost savings. The pilot program was recommended to run for at least one year to collect sufficient data for assessment of participation, identifying areas of needed improvement and program costs. Food waste containers would be 8 to 13 gallons and cost $12 to $25 per container. Processing would be performed at one of the existing Type 3 or Type 4 composting facilities with selection procurement done through a bidding process. The study estimates processing costs would range from $55 to $60 per ton of mixed material. Program metrics would include tracking participation rates,

---

[17] HDR, 2014-2015. Organics Diversion – Residential Food and Yard Waste, Wake County, North Carolina.

organics vs MSW tonnages, visual inspection for contamination, and at least one curbside waste audit. Participants would be surveyed at the mid-point of the program to gauge awareness and collect comments.

Part 4 of the study outlined a pilot program for food waste diversion within the WCPSS. The study estimated that food waste generated by WCPSS cafeterias is in the range of 4,000 to 5,500 tons per year. The capture rate would range from 40 to 80 percent, depending on the level of monitoring. Collection carts would need to be serviced daily to avoid odor issues. The study recommended the use of a private service provider to perform the daily collection. Assuming a pilot targets 5 to 10 percent of the student population, the quantity of food waste to be processed would range from 150 to 300 tons for a one-year program. A pilot committee consisting of staff from the County and WCPSS including cafeteria and custodial staff was recommended as an overall guidance group for assigning roles and responsibilities.

Building on recommendations from the organics diversion study, Wake County began piloting food waste drop off at Convenience Centers 2 and 4 in August 2015. In August 2016, the pilot was expanded to Convenience Centers 7 and 8. Over four years, 93 tons of food waste has been collected at the four sites. In FY19, an average of 7.5 tons was collected from each of the four sites. Through April of FY20, a total of 34 tons at all four sites has been collected, surpassing the previous high of 30.2 tons in FY19. The annual tons of food waste collected during the pilot programs first four years are shown in Figure 4-8.

Expansion to three additional sites in FY19 was postponed when a change in haulers led to a doubling of collection costs. Challenges encountered during the pilot have been associated with haulers (three companies in four years) and recurring issues with contamination, mostly from packaged food. Feedback from users has been largely positive, as captured both anecdotally and through online surveys of the 150 residents who received kitchen waste pails as an incentive to try the program. Over the past year, the County has been working with the hauler and outreach staff to increase participation and reduce contamination and is currently evaluating next steps.

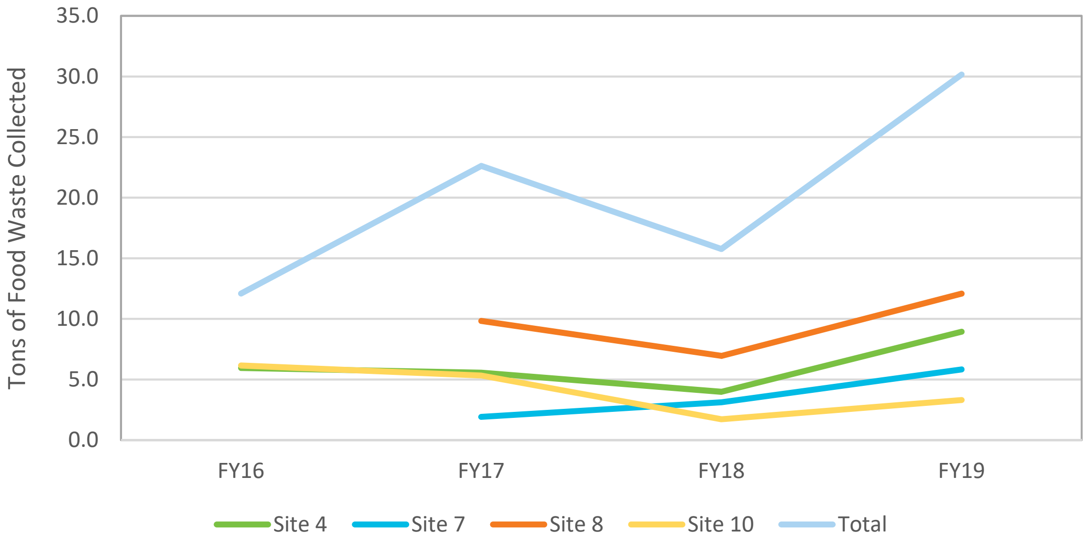


Figure 4-8. Food Waste Collected at Wake County Convenience Centers, FY16-FY19

4.4.3 The Path Forward

Three recommendations to enhance organic waste reduction and diversion were presented in Section 4.1: *Expand Food Waste Education*, *Find Post-Consumer Food Waste Partners*, and *Expand Composting*. All three were identified in the SWLF Life Extension Study as potential mid-term or mid to long-term options which merit further consideration.

Organic waste diversion programs can have both positive and negative impacts on solid waste systems and the local communities they serve. It is important to understand and evaluate the benefits and drawbacks before considering whether to implement or expand organic waste diversion programs. Several of the aspects to consider are summarized below.

- The benefits of diverting food waste from the landfill, in terms of saving landfill airspace, are not as significant as diverting other wastes, such as recyclables. Food waste has a much higher moisture content (approximately 73 percent) than mixed waste (20 percent). Food waste will occupy less airspace than mixed waste after it has been biodegraded in a landfill[18]. The diversion of food waste from disposal at the SWLF would likely result in a decrease in the density of the remaining landfilled waste, and a lessening in the rate of landfill settlement.

- A food waste diversion program may help reduce intermittent odor issues at the SWLF; however, a significant reduction in the amount of food waste going to the SWLF would likely be needed to have a noticeable effect.

- The food waste collection pilot at four Wake County Convenience Centers has seen increasing participation but has resulted in a relatively minor amount of waste diversion from the SWLF (30 tons in FY 19) at increasing costs due to the lack of qualified haulers willing to participate. This result has been consistent with Part 1 of the County's Organics Diversion Report, which suggested that the use of drop-off sites for organics diversion would have only marginal impact on removing organics from the MSW waste stream.

At a time of increasing costs for recycling services and a weakened economy due to impacts from the COVID-19 pandemic, it will be a difficult proposition to generate significant residential or commercial interest in a curbside organic waste diversion program. With average residential program costs of $5 to $6 per household per month, this would represent a more than doubling of the costs for the waste reduction, reuse and recycling programs that currently average about $3 per household per month in Wake County. Furthermore, existing compost facilities would need to be expanded and/or a new facility would be required. Recently, several municipalities, including Cary and Wake Forest, have expressed interest in developing food waste programs.

Wake County has established several near-term goals for its food waste recycling program, including exploring ways to reduce collection costs; researching successful drop-off programs from communities outside of Wake County; and evaluating other ways to divert food waste from the landfill such as drop-off sites at community gardens or educational campaigns aimed at households. Increasing education and outreach efforts focused on backyard composting is a relatively low-cost strategy that should be further pursued by the County and municipalities to help keep organics out of single-family residential waste. As previously noted, the Town of Cary incentivizes attendance at composting workshops by giving away free

---

[18] Obrien, Jeremy, 2016. The Landfill Impacts of Food Waste Diversion Programs. MSW Management, August 18, 2016.

bags of compost, along with composting guide books. Each year, Wake County offers residents the ability to order backyard compost bins at 50 percent below retail cost during the month of May.

Other goals associated with organics management include:

- The Town of Fuquay-Varina is considering the possibility of a Town-owned and operated compost site.
- The City of Raleigh is hoping to eliminate the use plastic bags for yard waste.
- The Town of Knightdale is evaluating additional ways to dispose of yard waste.

4.5 Education and Outreach

4.5.1 Current Activities

Wake County local governments have long understood the importance and impact of solid waste-related education and outreach activities. Recycling requires frequent, clear, and concise instructions to effect long-term participation and build familiarity with types of recyclable materials. Some of the recent and current education and outreach initiatives and efforts are discussed below.

4.5.1.1 Wake County's Outreach Team

Wake County's outreach team consists of an Outreach & Marketing Supervisor and three Environmental Education Program Coordinators. Major activities the team supports include the Feed the Bin School Recycling Program, 86it Anti-Litter Campaign and Food Waste Recycling Program. Team members provide non-formal environmental education to Wake County residents (and citizens of other Triangle counties) through a myriad of activities including landfill tours, presentations, festivals and social media. Outreach staff work closely with the Solid Waste Management Division operations staff and the Wake County Communications Office to inform customers about changes to facilities and collection programs. The team also strives to advance initiatives such as reducing recycling contamination by participating actively in informal, regional alliances including Solid Waste Environmental Educators of the Triangle (SWEET) and the Triangle MRFShed. The Wake County outreach team reached more than 5,000 people in the first nine months of FY20.

4.5.1.2 Education for Residents

All Wake County jurisdictions use their web sites to convey information regarding basic solid waste services including pickup schedules, procedures, acceptable materials, special waste pickups, fees, and contact information. Approximately half of the jurisdictions offer a more comprehensive selection such as information on reuse, tips on generating less waste, and the location of public and privately-operated sites to recycle or dispose special waste items. Wake County has tailored its recycling and solid waste web site to inform residents, businesses, and schools about a variety of solid waste issues. Through both a print brochure and web site table, the County offers a recycling guide offering facility locations and acceptable material lists. Many municipalities have established links to Wake County's web site as a means of providing a consistent and clear message for disposal and recycling opportunities available to all citizens of the County. Likewise, Wake County offers links to all 12 municipal curbside collection websites.

In an effort to simplify and standardize what can and cannot be recycled, many of the local governments have been posting on their websites and/or distributing recycling and reuse outreach materials (like the one shown on this page) made available by the North Carolina Division of Environmental Assistance and Customer Service (DEACS). Zebulon has indicated their intent to increase education efforts to reduce misinformation around recycling.

Recognizing that mobile phones are becoming ubiquitous and the most common way people now access the internet, several municipalities have moved to, or are considering custom apps that provide waste and recycling collection scheduled, provide information on materials that are and are not recyclable, and provide other useful information about solid waste programs. The Town of Cary recently launched the "Cary Collects" app, which uses the "ReCollect" platform. The app includes schedules and the Waste Wizard, which includes disposal guidelines for hundreds of materials. Wake Forest rolled out the "ReCollect" app in 2016 and is continuing to conduct outreach to increase its use. Apex also uses the "ReCollect" app.

4.5.1.3 Education for CII Establishments

As discussed under the recycling planning element, Wake County offers free on-site waste assessments to businesses and provides assistance in establishing recycling programs. The County also provides information specifically tailored to businesses on its web site. As Wake County does not have an ordinance requiring recycling of certain materials by the CII sector, education and outreach activities geared toward this sector are critical to improve on the overall recycling rate in Wake County.

4.5.1.4 Education for Schools

Education for schools has been delivered through Wake County's Feed the Bin school recycling program. The program includes an environmental stewardship education component to promote composting, recycling, and other desired behaviors. The approach is to use the practical experience of recycling at schools to reinforce the learning of environmental topics. The program is executed and promoted through newsletters geared to different grade levels; curriculum workshops held for teachers and administrators; lesson plans, games, and activities offered via the County web site; and a poster as well as other means.

The municipalities of Wake County also recognize the importance of rewarding positive behaviors with regard to recycling, littering, and other aspects at an early age. Several, including Raleigh, Cary, Apex, and Zebulon have also participated in or supported school education programs.

4.5.2 The Path Forward

Wake County's outreach team is actively exploring ways to move beyond one-time engagement toward opportunities that encourage Wake County residents to change their behavior. In addition, the group is following Wake County Environmental Services Department guidance to focus on quantifiable metrics and to creatively plan for adapting to the current COVID-19 pandemic. Near-term goals established by the team include the following:

- Redesign web pages to provide clear, consistent information (a Wake County Government initiative)

- Increase virtual education such as videos and podcasts
- Introduce consistent evaluations to measure impact of landfill and MRF tours

County and municipal solid waste managers should continue to provide a consistent message regarding recycling. All of Wake County's recyclables generally go to one of the two local MRFs which accept the same list of materials, yet there remains inconsistency about what can and cannot be recycled. For example, one town's website lists yogurt cups as recyclable, while another town's website (that uses the same private hauler for recyclables collection) says that yogurt cups should be thrown in the trash. The Recycling subcommittee of the TAC should continue to advance this initiative, and work with all local governments to provide a consistent message on what can and cannot be recycled. Given that other communities in North Carolina have dropped recycling or eliminated certain materials from curbside collection, the local governments of Wake County should conduct coordinated outreach to reaffirm their collective commitment to keeping recyclables out of the SWLF. Messaging should consistently emphasize the recycling "truths", promoted by DEACS, that recycling: *creates jobs; returns valuable resources to beneficial use; preserves virgin materials; saves energy and water and reduces GHG emissions; and conserves landfill space*.

4.6 Special Wastes

Wake County currently receives a variety of special wastes at the South Wake Landfill (SWLF), East Wake Transfer Station (EWTS), the 11 Convenience Centers, and the 3 Multi-Material Recycling Facilities (MMRFs). Special wastes include mattresses, tires, household hazardous waste (HHW), white goods, used motor oil, e-waste, lead acid batteries and antifreeze. Special wastes can take additional time, equipment, and staff to handle, dispose and manage, which can cost the County money. Special wastes such as mattresses can cause delays and problems at the landfill.

At the beginning of the Plan update process, County Solid Waste Management Division staff identified two special wastes which have historically generated challenges for the County – mattresses and tires. The challenges associated with these materials, and options to divert, process or recycle these items are summarized below. A more detailed discussion of special waste management issues and potential solutions is included in the Technical Memorandum contained in Appendix E, *Subtask 3C – Special Waste Evaluation*.

4.6.1 Mattresses

4.6.1.1 Background

It is estimated that over 14,600 mattresses were disposed at the SWLF between February 2018 and April 2019, averaging about 50 mattresses per day. This quantity is based on bulk commercial loads of mattresses only and does not include mattresses delivered in mixed loads to the EWTS or the 11 Convenience Centers. Many mattresses are delivered to County facilities comingled with other bulky materials, making the mattresses difficult to track. Therefore, it is anticipated that the 50 mattresses per day average is a conservative estimate. Since mattress recycling facilities do not exist within or nearby Wake County, most of the discarded mattresses in Wake County end up in the SWLF or other regional landfills.

The disposal of mattresses within a Subtitle D landfill creates several operational challenges and an increased burden on the facility due to the difficulty associated with handling, placing and covering these bulky items. The greatest challenge is associated with compaction and airspace usage. Mattresses are typically lightweight and do not compact as well as typical MSW, resulting in a lower waste disposal density. The lower density means that mattresses consume more available landfill airspace per ton of material. Due to their low disposal density, mattresses generate substantially less revenue per cubic yard of airspace utilized than typical MSW when per ton tip fees for both materials are the same. Mattresses can also become drainage conduits for leachate when placed near side slopes. The application and retention of daily cover soil materials over mattresses is difficult due to their smooth surface. Additionally, extra cover material is typically needed to sufficiently cover mattresses, resulting in additional time, labor, and cost. Mattresses, specifically metal springs, can become entangled in equipment, thus causing equipment downtime and extra labor and maintenance costs.

Mattresses are currently accepted at the SWLF, EWTS and at all of Wake County's 11 Convenience Centers. Residents can drop off up to two mattresses per load at the Convenience Centers, six mattresses per load at the EWTS, and any amount per load at the SWLF. Mattresses collected at Convenience Centers are comingled with other bulk wastes. Mattresses from commercial, institutional, or industrial sources must be brought directly to the EWTS or SWLF. Bulk shipments typically arrive in a box truck, with some loads containing up to 100 mattresses. In September 2019, the County implemented a policy that limits haulers to 40 mattresses per load to help mitigate the operational challenges associated with managing and burying mattresses at the SWLF.

Mattresses dropped off by residents at the Convenience Centers are free of charge while mattresses disposed of at the SWLF and EWTS are charged based upon the current garbage tipping fees of $32 per ton and $41 per ton respectively. The County does not apply any extra fees or surcharges for handling and disposing of mattresses, as a special waste, at the SWLF or EWTS. There are several North Carolina counties that implement a separate fee for disposing of individual or bulk mattresses brought directly to the landfill. Mecklenburg, Harnett, Davidson and New Hanover all charge additional fees for bulky items or mattresses ranging from $2 to $28.50, depending on the number. For bulk loads of mattresses, Mecklenburg County charges $110 per ton.

4.6.1.2 Mattress Management Options

Shredding, establishing mattress disposal fees, and partnering with a mattress recycling firm were evaluated as options to alleviate some of the issues associated with the management and disposal of mattresses at the SWLF.

Shredding

Shredding mattresses can save valuable airspace and increase overall landfill revenue. Assuming a box truck holds 40 mattresses, using a shredder can reduce the mattress volume by 80 to 90 percent, which can save the SWLF around $461 to $541 in airspace per box truck, or approximately $144,000 to $169,000 per year assuming one box truck of mattresses per operating day.

Implementing Mattress Disposal Fees

The value of airspace consumed by a mattress is correlated to the compaction rate. Assuming mattresses do not get compacted as well as typical MSW, the value of airspace used by a mattress ranges from $12 to $18, depending on the compaction rate. The net cost to landfill a mattress is calculated by adding the value of airspace used by a mattress, plus extra equipment and labor cost (estimated to be $5 per mattress), minus the tip fee revenue for mattress disposal. Therefore, the net cost to landfill a mattress ranges from $15 to $20, depending on compaction. Depending on the volume reduction of the mattresses, a suitable tipping fee for bulk loads of mattresses would range between $76 to $149 per ton. For non-bulk loads (6 mattresses or less), a per mattress fee of $15 is appropriate. Implementing a special tipping fee for bulk loads of mattresses and non-bulk loads would help account for the value of airspace used, and the time and effort of shredding the mattresses.

Partnering with a Mattress Recycling Firm

Although there are no local mattress recyclers in the Triangle region, several located to the west have expressed interest in taking mattresses generated in Wake County. One such firm, Carolina Dry Heat (CDH) in Thomasville, NC submitted a proposal in response to Wake County's 2019 Mattress Management and Recycling Request for Information. CDH proposed to collect mattresses dropped off at the SWLF Transfer Station in two 53-foot trailers. The trailers, when filled with 80 mattresses, would be hauled to their facility in Thomasville. At the facility, CDH would remanufacture the reusable mattresses and haul the remaining unused mattresses to another remanufacturer in Chicago, IL. CDH proposed a fee of $15 per mattress for the service.

4.6.2 Scrap Tires

4.6.2.1 Background

In North Carolina, the counties are responsible for the management of scrap tires. In an effort to assist counties with the extensive cost of safely disposing scrap tires, the NCDEQ DWM – Solid Waste Section administers a Scrap Tire Disposal Program. For every new tire sold, a scrap tire disposal tax is applied to provide funds for the disposal of scrap tires. Thirty percent of the scrap tire disposal tax proceeds are credited to the State General Fund and the remaining 70 percent is distibuted to counties on a per capita basis. Starting in FY15, additional money allocated to counties changed from 17 percent of the State General Fund scap tire proceeds to $420,000, ultimately decreasing the money available for the scrap tire disposal program. $200,000 of the $420,000 is distributed each grant cycle, and the remaining is used for scrap tire cleanups. The monies allocated each fiscal year since FY 2015 have remained the same.

According to NCDEQ, for the scrap tire disposal account fund grant period from October 2018 through March 2019, grant requests totaled $778,547. The grant amount awarded to individual qualifiying counties varied between a quarter to a third of the requested amount, which resulted in a funding total of just $233,000. Currently, NCDEQ is not aware of additional funds earmarked for transfer from the State General Fund to the Scrap Tire Disposal Fund Grant account for distribution to counties. The shortage of grant funding will keep the burden of paying for any excess scrap tire disposal costs on the counties and in particular, county solid waste departments.

The scrap tire tax distribution does not typically cover the Wake County's cost of tire disposal. Figure 4-9 compares Wake County's costs for tire disposal and the scrap tire tax distribution revenues over the past five years. It is anticipated that the cost for tire disposal will continue to increase, while the scrap tire disposal tax distribution will remain steady or potentially decrease.

The scrap tire disposal tax distribution is based on the population of the County. However, it is expected that a significant number of residents who live outside Wake County, especially those that commute to Wake County regularly, get their tires changed in Wake County. This increases the County's tire disposal cost but does not result in additional tax distribution from the State.

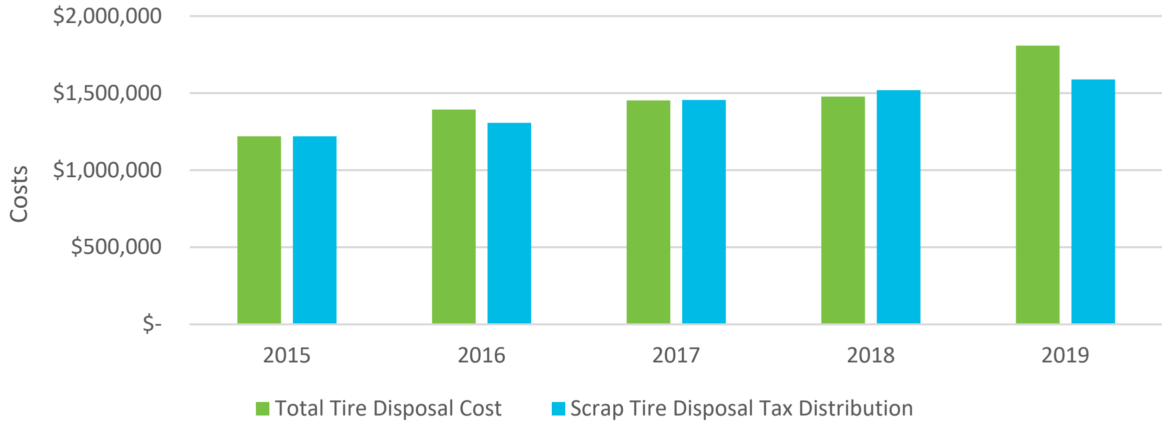


Figure 4-9. Wake County Scrap Tire Disposal Costs vs Tax Distribution

Tires are currently accepted at the North Wake, South Wake and East Wake MMRFs. Residential and business customers can drop off passenger vehicle tires and lightweight truck tires generated in-state at any of these facilities free of charge. Wake County contracts with Central Carolina Holding, LLC (CCH) to collect, transport and process scrap tires from the MMRFs and numerous other locations around the County. These locations generally include discount tire shops, wholesale warehouses, and auto care facilities. CCH reports the numbers of tires and tonnage to the County, and hauls them to the Central Carolina Monofill in Cameron, North Carolina for disposal. In FY19, 20,256 tons of tires were collected at a total cost of $1,807,753. The total cost of the County's scrap tire program includes costs for labor, hauling, disposal fees, utilities per rentals and other miscellaneous costs. Over the past five years, the number of scrap tires disposed has generally increased as well as the cost of tire handling and disposal. The County's scrap tire disposal cost in FY19 was $85.96 per ton. This cost includes the contract disposal fee of $54 per ton for passenger and lightweight truck tires and additional labor costs. Oversized tires, i.e. tractor trailer tires or larger, are charged $457 per ton. The oversized tire fee is a new surcharge that was added to the CCH contract in 2018. In FY19, 157 tons of oversized tires were collected at a cost to the County of $71,749.

4.6.2.2 Permitted Disposal Facilities

There are currently six permitted scrap tire treatment or disposal facilities in North Carolina. These include the following:

- US Tire Recycling Partners LP in Concord, NC (Landfill and Treatment and Processing)
- CCH in Cameron, NC (Landfill and Treatment and Processing)
- PRTI, Inc. in Franklinton, NC (Treatment and Processing by Pyrolysis)
- New River Tire Recycling LLC in Pilot Mountain, NC (Treatment and Processing)

Due to the low number of permitted scrap tire treatment and disposal facilities, Wake County has limited options for tire disposal. During the last request for qualifications for tire collection and disposal, Wake County only received one bid from CCH. The limited supply of permitted treatment and processing facilities creates favorable market conditions for the few service providers to charge high prices to collect, transport and process scrap tires. Based on the current market conditions, the cost for tire disposal is anticipated to increase annually.

4.6.2.3 Scrap Tire Disposal Options

Shredding

The NCDEQ Rules prevent the disposal of whole tires within a Subtitle D landfill; however, tires that have been cut can be disposed in a permitted MSW landfill. As a supplemental approach to managing scrap tire disposal, shredding a portion of the tires and placing them in the SWLF can provide a cost savings to the County.

In FY 2019, 2,615 tons of tires were disposed of at the South Wake MMRF. With an average disposal cost of $90 per ton, the total cost of disposal was approximately $235,000. If the same number of tires were shredded and disposed of in the SWLF, the value of the airspace consumed would be approximately $99,000. As a result, the cost saved by shredding the tires from the South Wake MMRF would be approximately $136,000.

Shredding oversized tires would also be a significant cost savings for the County. Currently, CCH collects and disposes of all oversized tires in the County and charges the County $457 per ton. In FY 2019, 157 tons of oversized tires were collected and disposed by CCH, resulting in an annual disposal cost of $71,964. If the same number of tires were shredded and disposed of in the SWLF, the value of the airspace consumed would be approximately $6,000. As a result, the cost (excluding capital and operational costs) saved by shredding oversized tires would be approximately $66,000.

4.6.3 The Path Forward

For both mattresses and tires, shredding prior to disposal in the SWLF may reduce airspace consumption associated with mattresses and lower management costs for tires. The estimated net cost savings for shredding mattresses and tires ranges from approximately $380,000 to $440,000 annually, depending on the reduction of mattress volume, and accounting for recommended mattress tip fees. At this rate of savings, the County could pay back the capital cost of a shredder in approximately 2 to 3 years. A short-term lease or rental of a shredder as a pilot test should be considered before implementing a shredding program.

Currently, Mecklenburg County shreds tires collected at their four convenience center sites at the Foxhole landfill using a TANA Shark Waste Shredder. They estimate that less than 10 percent of scrap tires generated within the County are shredded at the landfill, with the rest collected by US Tire at a cost of $81 to $85 per ton for regular tires, and $129.09 for oversized tires. The TANA shredder can be operated to shred tires and mattresses at the same time.

For mattresses, a special tip fee of around $110 to $115 per ton should be considered for bulk loads. Assuming one box truck of mattresses (weighing 1.1 tons) is disposed per operating day at a $113 per ton fee, the County would generate $38,800 per year. For non-bulk loads (6 mattresses or less), a per mattress fee of $15 would be appropriate to account for the lost airspace and operational challenges. Assuming 10 non-bulk load mattresses are disposed per operating day at a $15 disposal fee, the SWLF can generate $46,800 per year.

Wake County should continue efforts to make sure tires disposed at the MMRFs are only from county residents. The County may also benefit by having discussions with the State about increasing the funding received from the Scrap Tire Disposal Tax Distribution due to the expected large amount of out of county tires being disposed within Wake County. Finally, evidence suggests that other North Carolina counties are not being charged at the same high rate for oversize tires by the companies that collect, transport and process scrap tires.

4.7 Illegal Disposal/Litter

4.7.1. Current Activities

Curbside solid waste services are available to just under 80 percent of Wake County's residents. All residents have access to the 11 convenience centers and 3 MMRFs to drop-off refuse, recyclables, and special wastes. Together, the curbside and drop-off opportunities help reduce the amount of illegal dumping and littering in the County.

Unfortunately, litter and illegal dumping still occurs and in response, the local jurisdictions have taken actions to better understand and prevent these activities from recurring and have initiated efforts to clean-up after they occur. Some of the programs addressing litter and illegal dumping in Wake County include: Wake County's 86it Campaign; NC DOT's Adopt-A-Highway, Sponsor-A-Highway, Litter Sweep and Swat-a-Litterbug; North Carolina Big Sweep; Raleigh's Adopt-a-Stream; and Wake County Solid Waste Facility Contracts which address litter and debris around the landfill and 11 Convenience Centers.

In 2010, 2013 and again in 2019, Wake County partnered with the NC State University Center for Urban Affairs and Community Services to conduct surveys of Wake County residents focusing on attitudes, behaviors, and perceptions relating to litter. The earlier survey results suggested that campaigns can work to better involve the relatively young and transient in collective efforts to prevent littering and mobilize the enthusiasm of those already invested in environmental change. Building from this knowledge, the County expanded their approach to reducing litter to more effectively involve Wake's citizens in the solution. The four-pronged approach focuses on cleanup, enforcement, education and connection. Wake's 86it campaign, which was launched in 2010, is intended to adopt this approach and thoughtfully engage citizen participation and support. Outreach is accomplished through social media strategies to encourage involvement and unique promotions such as fold-up trash can posters to reinforce the message and reward desired behavior.

Many municipalities also support, promote and organize groups to participate in the Wake County Big Sweep events and other seasonal or annual events.

4.7.2 The Path Forward

In 2019 Wake County commissioned a study by Kessler Consulting to evaluate the effectiveness and cohesiveness of the 86it campaign. The evaluation identified several strengths of the campaign, including: effective use of positive reinforcement; a good mix of traditional and new technologies and media outlets for communication; the use of pledges (over 31,720 have taken the 86it "pledge" as of May 2020), public events, and direct interaction to help change behavior; targeting the 18-34 age group which is most likely to litter; and establishing a variety of partnerships with local organizations and businesses. Opportunities for improvement were also identified. These included:

- Conducting resident surveys. Wake County already acted on this recommendation in 2019, working with NC State as previously noted.
- Establishing quantifiable tracking mechanisms. The Litter Index and Big Sweep tonnage data were identified as examples of quantifiable metrics that might be better tracked.
- Identifying additional program targets, such as specific geographic areas and specific items (e.g. tires, cigarette butts, etc.)

- Increasing community interaction by focusing on elements that involve direct community interaction, such as participatory games, poster contests, clean-up contests and Adopt-a-Block programs.
- Expanding Facebook and Twitter audience by creating posts that are more interesting and appealing. This will spur engagement and reach a broader audience.
- Exploring the use of other social media platforms such as YouTube and Snapchat.
- Securing and expanding partnerships and support from businesses and institutions.
- Developing a well-defined market plan.
- Keeping the message familiar but fresh. This involves striking a balance between repetition and evolution.
- Exploring additional funding. Obtaining additional monetary resources through government funding, grants, or sponsorships would enable allow the campaign to expand and grow.

Wake County's outreach team intends to act on many of these recommendations and has set near term goals to (1) shift resources away from paid advertising to build awareness of short-term cleanup projects; (2) conduct a pilot partnership with Litterati to gather better data on littering within the County; and (3) renew collaborations with municipalities and Keep NC Beautiful.

Several municipalities have also identified actions and goals focused on reducing illegal disposal and litter. These include:

- Using their social media accounts, Knightdale intends to increase awareness about the ramifications of illegal dumping, with support from the Wake County Solid Waste Management Division. The Town also intends to partner with the Upper Neuse Riverkeeper for a cleanup day.
- Holly Springs has identified the need to reduce litter and debris coming from waste hauling trucks along Highway 55 and at its intersection with Old Smithfield Road at the entrance to the SWLF and seeks support from Wake County in this effort.

4.8 Other Waste Management Challenges, Goals and Initiatives

During interviews with solid waste managers and public works directors conducted as part of this Plan update, additional goals, challenges, planned actions, and initiatives were identified that fall outside the planning elements previously discussed in this section. These goals, challenges, actions and initiates are summarized below.

Apex

- *Initiative:* Developing a Sustainability Action Plan that includes solid waste management goals.
- *Initiative:* Tracking, analyzing and reporting Town waste data.
- *Goal:* Setting operational and community-wide waste reduction goals.

Fuquay-Varina

- *Goal:* Purchasing a small collection vehicle to service townhomes.

Garner

- *Challenge:* Finding ways to continue providing special services with limited staff resources. For example, electronics collection has moved to a semi-annual drop-off event rather than curbside service due to staff limitations.

Holly Springs

- *Challenge:* Encouraging Wake County and GFL Environmental, the operator of the SWLF, to enhance odor control and mitigation measures at the landfill.
- *Initiative:* Create a Town Solid Waste Manager Position to oversee garbage, recycling and yard waste management.
- *Initiative:* Development of a new public works complex and yard waste transfer site.
- *Initiative:* Consider joining the South Wake Landfill Partnership.

Knightdale

- *Challenge:* Identifying opportunities to improve service and implement citizen "wish lists" (e.g. cleanup day for bulky items) with existing staff and resources.

Raleigh

- *Initiative:* Collection route optimization study (by outside consultant).
- *Initiative:* Convert 25 percent of the collection fleet to compressed natural gas (CNG) by 2023.
- *Initiative:* Full conversion to a solid waste enterprise fund.
- *Challenge:* Identifying opportunities for the use of Molok® underground waste containers in the CBD.
- *Initiative:* Development of a design manual to assist with ease of access of collection vehicles in multi-family units.
- *Goal:* Implementing a new vehicle mounted camera system for code enforcement and verification of services.

Rolesville

- *Challenge:* Maintaining existing level of customer service is the primary concern.

Wake County

- *Initiative:* Continue identifying, evaluating and implementing measures to mitigate intermittent odor issues at the SWLF. This includes development of an Odor Management Plan and working closely with GFL Environmental to implement effective odor control measures.
- *Initiative:* Evaluate using county employees to operate the Convenience Centers to improve customer service.

- *Initiative:* Considering implementing web cams at Convenience Centers for citizen access to avoid and reduce wait times during peak periods.
- *Goal:* Identify a more efficient (more economical) way to transfer white goods.
- *Goal:* Complete a comprehensive review of existing solid waste ordinances.

Wake Forest

- *Challenge:* Restructuring programs to sustain current operations and manage costs.
- *Goal*: Increasing partnerships and collaboration among municipalities.

Zebulon

- *Challenge:* Implementing new programs under tight budget conditions.
- *Goal:* Increase the frequency of the Community Recycling Day from once to twice per year.

Section 5
Solid Waste Program Costs and Funding

The solid waste management goals established by the local governments regarding solid waste program costs and funding include:

- utilizing full cost accounting practices;
- identifying opportunities to reduce or control costs and increase revenue opportunities;
- working collectively to integrate and coordinate services and programs;
- making effective use of both public and private sector services;
- participating in regional planning and decision-making activities to address regional opportunities for enhancing program effectiveness and efficiency; and
- establishing program measures to monitor progress toward attaining these goals.

While many of these goals have been achieved, others are still evolving. This section presents a summary of program costs and funding mechanisms currently in place, discusses progress made toward achieving goals, and provides recommendations.

5.1 Program Costs and Funding Mechanisms

All thirteen local governments provide essential solid waste services, some of which are self-performed while others are contracted to private firms. The following paragraphs and tables present and compare total solid waste program costs, costs per household, funding sources and residential user fees.

5.1.1 Program Costs and Trends

Table 5-1 presents the local governments FY19 costs for MSW collection and disposal. Recycling and yard waste program costs for FY19 are presented in Table 5-2. The primary source of data was the FY19 Solid Waste Management Annual Reports, with clarifications provided by local government solid waste directors, where necessary. It should be noted that each program's operation practices and costs are unique depending on the types of services they provide, how the service is delivered, and how costs are grouped and reported on the State's forms. Also, collection contract costs may include limited service to commercial entities which may artificially raise unit costs. Therefore, caution should be exercised when comparing these costs. In some cases (e.g., Holly Springs), the local governments do not provide a breakdown for MSW, recycling and yard waste, but do report total program costs.

Figure 5-1 plots the local municipal governments' total program costs for FY19 and cost per household. The total program costs range from $140 per household (for Wendell) to $234 per household (for Garner). The average annual program cost for all twelve municipalities is $185 per household, which is 15 percent lower than the FY11 average of $218 per household reported in the previous Plan update. Eight of the 12 municipalities (Apex, Holly Springs, Morrisville, Raleigh, Rolesville, Wake Forest, Wendell, and Zebulon) reported lower program costs on a per household basis in FY19, compared to FY11. Of the four that reported higher total program costs on a per household basis (Cary, Fuquay-Varina, Garner, and Knightdale), the increase was limited to between 8 and 22 percent. Three of the four increases were less than the 12

Table 5-1. MSW Collection and Disposal Costs, FY19

Local Government	FY19 MSW Collection and Disposal Costs				
	MSW Collection Cost	MSW Disposal Cost	SWLF Rebate	Number of Households (HH)	MSW Collection and Disposal ($/HH/YR)
Apex	$1,091,420	$621,988	$208,032	17,841	$84.38
Cary	NP[2]	$1,222,445	$537,162	52,000	$82.34
Fuquay-Varina	$1,501,746	$299,816	$135,545	10,706	$155.62
Garner	$1,063,465	$224,710	$111,068	9,368	$125.65
Holly Springs	NP	NP	NP	12,003	NP
Knightdale	$685,584	NP[1]	$31,730	5,249	$124.57
Morrisville	$670,780	NP[1]	$56,152	6,263	$98.14
Raleigh	$8,801,451	$3,990,335	$1,780,511	129,962	$84.73
Rolesville	$266,048	NP[1]	$16,061	2,748	$90.97
Wake Forest	$1,700,051	NP[1]	$70,545	13,436	$121.28
Wendell	$353,919	NP[1]	$19,593	3,225	$103.67
Zebulon	$288,713	NP[1]	$13,756	2,215	$124.13
Wake County	$1,045,375	$2,093,819	$688,634	431,086	$5.68

Notes:

NP = Not provided

[1] - Disposal Costs are lumped with the collection costs

[2] - Collection Costs are lumped with the disposal costs

Source: Solid Waste and Materials Management Annual Reports, July 1, 2018- June 30, 2019

Rebate numbers provided from County - 2018 actual rebates

Certain Towns also provide services to some commercial entities, and the total costs shown includes that cost.

percent increase in the Consumer Price Index (CPI)[1] from FY11 to FY19. This means that, after adjusting for inflation, 11 of the 12 local governments have reduced their solid waste program costs since FY11.

As shown in Table 5-2, 10 of the 12 local jurisdictions charge a user fee for service (excluding Wake County). In FY11, 8 of the 10 jurisdictions which charge a user fee, charged less than the FY11 program cost per household; one jurisdiction charged the same amount as its FY11 program cost per household; and one jurisdiction charged more than its FY11 program cost per household. Jurisdictions which charged less rely on property taxes and their general fund to make up the difference. Wake County continues to charge a $20/year per household availability fee to its residents for use of the convenience centers and multi-material and household hazardous waste facilities.

[1] CPI all Urban Consumers – South, U.S. Bureau of Labor Statistics. https://www.bls.gov/regions/mid-atlantic/data/consumerpriceindexhistorical_south_table.htm

Table 5-2. Recycling and Yard Waste Program Costs, FY19

Local Government	*Summary of Program Service Costs for FY19*						
	Recycling Collection Cost	Recycling Processing Cost	Number of Households (Recycling)	Recycling ($/HH/YR)	Yard Waste Program Cost	Number of Households (Yard Waste)	Yard Waste Program ($/HH/YR)
Apex	$709,620	$0	17,838	$39.78	$1,662,240	17,838	$94.18
Cary	NP[2]	$505,299	52,000	$43.56	$2,391,181	52,000	$45.98
Fuquay-Varina	NP[2]	$28,743	10,706	$2.68	$438,327	10,706	$40.94
Garner	$258,105	$33,523	9,359	$31.16	$720,016	9,359	$76.93
Holly Springs	NP	NP	NP	NP	NP	NP	NP
Knightdale	$286,200	NP[1]	5,249	$54.52	$33,100	5,249	$6.31
Morrisville	$285,205	NP[1]	6,263	$45.54	$81,861	6,263	$13.07
Raleigh	$4,213,397	NP[1]	189,633	$22.22	$3,772,050	189,633	$29.02
Rolesville	$103,463	NP[1]	2,748	$37.65	$170,925	2,748	$62.20
Wake Forest	$551,210	$45,671	13,436	$44.42	$723,485	13,436	$49.83
Wendell	$104,861	NP[1]	3,225	$32.52	$12,120	3,225	$3.76
Zebulon	$96,237	NP[1]	2,215	$43.45	$62,528	2,215	$28.23
Wake County	$3,547,569	NP[1]	431,086	$8.23	NA	NA	NA

Notes:

NP = Not provided; NA = Not applicable

[1] - Disposal Costs are lumped with the collection costs

[2] - Collection Costs are lumped with the disposal costs

Source: Solid Waste and Materials Management Annual Reports, July 1, 2018- June 30, 2019

The reduction in program costs on a per household basis is somewhat surprising, given the increasing cost to provide curbside recycling service. As noted in Section 4, the revenue that many local governments were getting revenue from recyclables in FY11 has disappeared. This trend is also surprising given that the county-wide disposal rates of MSW increased from 0.67 to 0.74 tons per person per year from FY11 to FY19 and local governments have generally not reduced the level of solid waste services that they provide. The reduction in total program costs on a per household basis may be attributed to several possible factors:

- While disposal costs have remained constant (no increases in SWLF tip fees), the annual rebate provided to the SWLF Partners has increased since 2011, due to an increase in tonnage going to the SWLF.
- Municipalities that contract with private haulers have been able to negotiate favorable pricing with recent contracts.
- As the population of each Town has increased, there is an economy-of-scale effect, which tends to decrease the cost of service on a per household basis.

Ultimately, the comparison of FY11 and FY19 costs suggest that the local governments have been successful identifying opportunities to reduce or control costs. Many have also been making effective use of both public and private sector services.

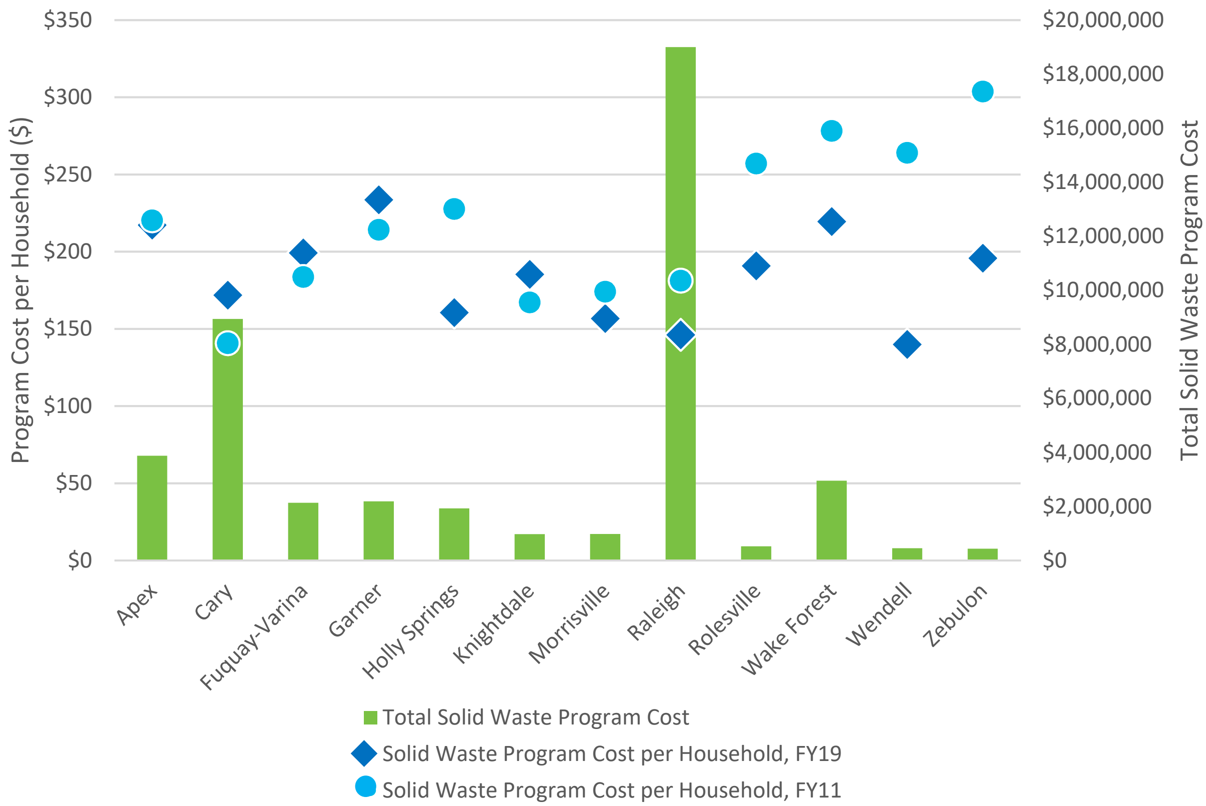


Figure 5-1. Total Program Costs (FY19) and Cost per Household (FY19 and FY11)

5.1.2 Funding Sources

Funding sources used by each local government are listed in Table 5-3. Where household user fees are used as a funding source, they are also listed. Most municipalities use a combination of funding sources, including user fees, property taxes and general fund contributions. The sale of recyclables is not currently a source of revenue for the local governments. The City of Raleigh is evaluating a move to functioning solely as an enterprise fund.

Wake County, which operates as an enterprise fund, has been successful in keeping the countywide Waste Reduction Fee (also called the Recycling Fee) at $20 per household for the past 20 years, while maintaining, and in some instances, expanding the services offered at its Convenience Centers, MMRF and HHW facilities. In addition to the services offered at these facilities, the fee also supports the Feed the Bin school recycling program; extensive public education, awareness, and anti-liter programs such as the 86it campaign; research and planning studies; and maintenance at the North Wake District Park. However, the increasing costs for programs such as tire management and operation of the Convenience Centers which are receiving more materials, and reduced revenue from recyclables will likely require that the household fee is increased in the near-term.

Table 5-3. Solid Waste Program Funding Sources and User Fees, FY19

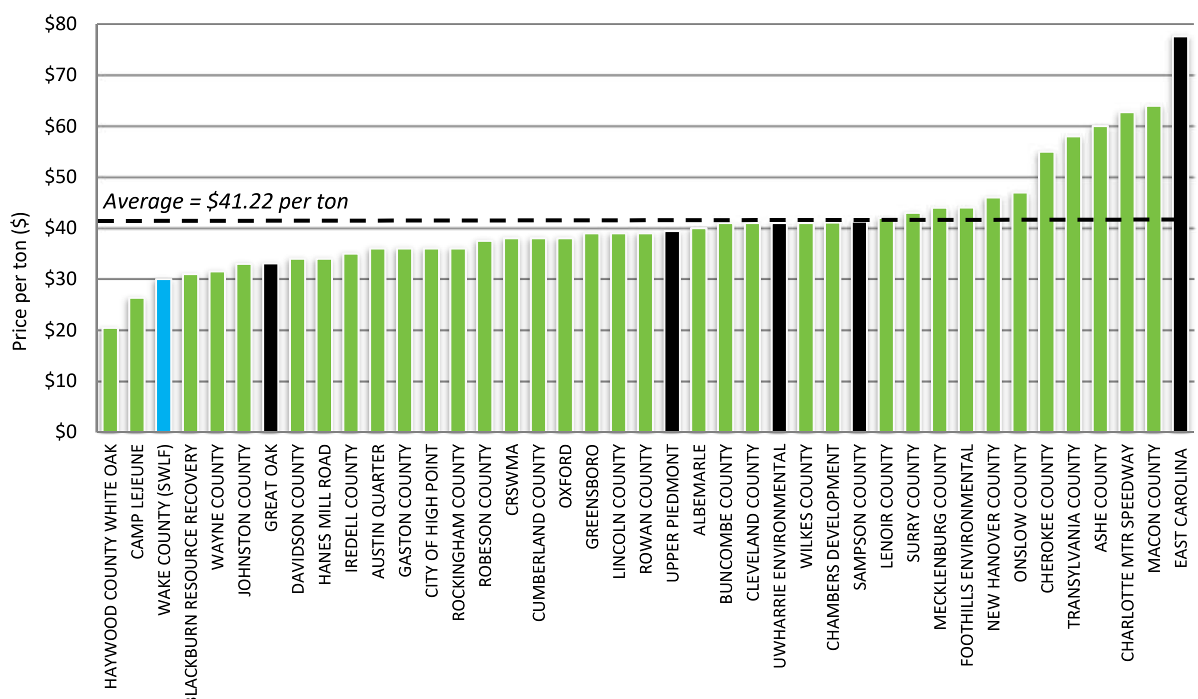
Local Government	Solid Waste Program Funding Sources	Household User Fees for FY19					
		Solid Waste User Fee ($/month)	Recycling User Fee ($/month)	Yard Waste User Fee ($/month)	Bulky Waste User Fee ($/month)	Availability Fee ($/month)	Total Residential User Fees ($/HH/YR)
Apex	Property Tax/General Fund, Per Household Charge and Grants	$8.30	$3.44	$7.83	--	--	$235
Cary	Property Tax/General Fund and per Household Charge	$17.00	--	--	$15.00	--	$204
Fuquay Varina	Property Tax/General Fund and per Household Charge	$14.25	--	--	--	--	$171
Garner	Property Tax/General Fund	--	--	--	--	--	--
Holly Springs	Per Household Charge	$9.88	$5.22	$3.00	--	--	$217
Knightdale	Per Household Charge	$11.08	$3.75	--	--	--	$178
Morrisville	Property Tax/General Fund	--	--	--	--	--	--
Raleigh	Tipping Fees, Property Tax/General Fund, Sale of Recyclables, White Goods Tax, per Household Charge	$12.95	$2.60	--	--	--	$187
Rolesville	Per Household Charge	$9.79	$3.69	$8.52	--	--	$264
Wake Forest	Property Tax/General Fund	--	--	--	--	--	--
Wendell	Per Household Charge	$22.00	--	--	--	--	$264
Zebulon	Property Tax/General Fund, per Household Charge and Grants	$10.62	$3.46	--	$5.17	--	$231
Wake County	Tipping Fees/Sale of Recyclables/Per Household Charge/Tire Tax/White Goods Tax/Grants	--	--	--	--	$20.00	$20

5.2 SWLF Tipping Fees

Disposal costs (i.e. tipping fees), are a significant component of the overall cost of solid waste services. Disposal costs remain very low in Wake County, compared to other areas of the State, as a result of a SWLF tipping fee that is among the lowest the State (see Figure 5-1). The 12 local governments that joined the SWLF Partnership share excess revenue that is generated from tipping fees at the SWLF. The excess revenue is returned to the partners and used to fund existing and future solid waste programs. In the last four fiscal years, between $3.3 and $3.6 million was returned to the partners each year. In FY19, the $3.6 million rebate effectively lowered the cost of disposal for the partners by $15 per ton.

Historically, several regional private landfills have been the recipient of a portion of the waste collected primarily from the CII sector in Wake County. The six private landfills within 100 miles of the SWLF (including the Brunswick Waste Management Facility in Virginia) received 36 percent of the total MSW generated in Wake County in FY19. Private landfill disposal pricing varies depending upon several factors, some of which include: capital and operating costs; volume and types of materials received; hauling distance; available airspace; fuel surcharges; and contract terms. The average reported FY18 tipping fee at the five North Carolina regional landfills within 100 miles of Wake County ranged from $33.09 to $79.59 per ton and averaged $47.68 per ton. Note that the reported tipping fee does not necessarily reflect what is charged to customers who maintain a contract with the landfill for disposal.

Private firms, including GFL Environmental and Republic, which operate regional landfills and maintain collection contracts, will weigh each one of these factors when deciding where to deliver and dispose of the waste they collect. In many instances, this decision is not strongly influenced by the currently established tipping fee at the SWLF, assuming it is within a reasonable, market-based range.



Price per ton shown does not include the $2 State Solid Waste Tax
Tipping fees of NC regional landfills within 100 miles of Wake County are shown in black

Figure 5-1. North Carolina MSW Landfill Tipping Fees at End of FY18 ($ per ton)

5.3 SWLF Rebate Evaluation

With development of the SWLF in 2008, Wake County secured a very affordable waste disposal solution that is expected to last for another 20 to 30 years. Unfortunately, the relatively inexpensive cost for waste disposal in Wake County does not incentivize waste reduction and diversion. In fact, the more waste that is disposed at the SWLF, the higher the potential annual rebate to SWLF partners. As noted previously, the FY19 rebate that was driven by increasing tons being delivered to the SWLF effectively lowered the disposal cost of the partners that direct haul to the SWLF from $32 to $17 per ton. While the near-term implications of reduced disposal costs are a benefit to the partners, the long-term, negative implications should also be considered. As noted in Section 4, the next disposal option after the SWLF reaches capacity is likely to be more expensive. For example, the City of Durham currently pays over $40 per ton to haul and dispose of their waste at the Sampson County Landfill. Waste conversion via a massburn facility located in Wake County or the Triangle region would likely be even more expensive.

Improving waste diversion and reduction in Wake County may help achieve a better balance of current and future disposal costs by increasing the lifespan of the SWLF. Additionally, and as recognized by the SWLF partners, it is prudent to begin investigating the next disposal option well before the SWLF reaches capacity. With these two goals in mind, several adjustments to the formula that is used to determine the partner's annual rebate were evaluated. The potential adjustments are meant to (1) incentivize and/or promote waste diversion and (2) set aside money that can be used to investigate future disposal options. Two scenarios were evaluated, as described below.

Scenario 1

Under this scenario, 4 percent of the total available rebate would be reserved for future study of long-term disposal options. Of the remaining amount, 97 percent would be distributed according to the current formula, which is based on tonnage. The remaining 3 percent would be distributed to partners who achieve a per capita disposal rate that is lower than their baseline per capita disposal rate. The distribution would be weighted based on the partner's respective tonnage. The intent would be to reward (and incentivize) partners who are successful in lowering their per capita waste generation rate. Partners that want to receive more rebate may decide to increase education and outreach efforts focused on waste reduction and diversion, with the goal of lowering their per capita disposal rate. An example based on the FY18 rebate is shown below.

Example: 2018 Rebate = $3,668,788

- 4 percent ($146,752) goes into a "Future Disposal Options Fund"
- $3,522,037 remains
- 3 percent of remaining amount ($105,661) is distributed to the partners who had a FY18 per capita disposal rate below their baseline rate.
- 97 percent of remaining amount ($3,416,375) is distributed to all partners based on their FY18 tonnage.

The percentages proposed in this scenario could also be adjusted up or down to create more or less of an incentive to improve waste reduction and diversions, or to fund the study of future disposal options at a higher or lower level.

Scenario 2

Under this scenario, the partners would agree to reserve a portion of the available annual rebate for future study and development of long-term disposal options. There would be no allocation of the remaining rebate to incentivize waste reduction. Examples using different reserve percentages, based on the FY18 rebate are shown below. The remaining amount, after reserving a portion for study and development of future disposal options, would be distributed based on each partner's respective tonnage.

Examples: 2018 Rebate = $3,668,788

- Reserve 1 percent ($36,688) for "Future Disposal Options Fund"
- Reserve 2 percent ($73,376) for "Future Disposal Options Fund"
- Reserve 3 percent ($110,064) for "Future Disposal Options Fund"
- Reserve 4 percent ($146,752) for "Future Disposal Options Fund"

Other scenarios, including variations of these two scenarios described above are also possible, and should be considered by the partners to both enhance waste reduction and diversion and begin effectively planning for the next disposal option.

5.4 The Path Forward

Many of the Wake County local governments have been successful in achieving the established goals related to solid waste program costs and funding. Eight of 12 municipalities have lowered their waste management program costs from FY11, while maintaining the same level of service. The local governments also continue to effectively use a mix of both public and private forces, where best suited.

Several potential challenges lie ahead regarding program costs and funding. The loss of revenue from recycling programs may strain budgets and require an increase in household fees or property taxes. Similarly, the cost to manage special wastes, such as tires and electronics continues to rise, and is outpacing funding mechanisms established by the State. The onset of the COVID-19 pandemic is causing a temporary contraction of the economy, resulting in less (primarily commercial) waste being generated and disposed at the SWLF. While this extends the life of the landfill, the SWLF partners may see a short-term reduction in their annual rebate, and therefore an increase in their overall cost for disposal.

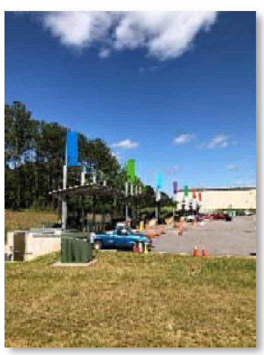
The County and other local governments can take steps to mitigate these challenges. Some potential actions include:

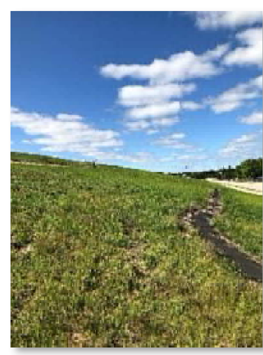
- Work collectively to integrate and coordinate services and programs or collaboratively bid out services to achieve potential economy of scale savings.
- Participate in regional planning and decision-making activities to address regional opportunities for reducing cost. Wake County, Raleigh and Cary have already been doing this, through regular meetings with other Triangle-area solid waste programs.
- Monitor changes in waste flow, waste generation rates, and market-based tipping fees at both public and private regional landfills in Central and Eastern North Carolina to ensure that the tipping fee at the SWLF is appropriately set, relative to other disposal alternatives in the region.
- Consider adjusting the SWLF rebate formula to incentivize the local governments to spend more money on outreach and education and waste diversion and reduction programs.
- Consider adjusting the SWLF rebate formula to establish a fund that could be used to study and develop the next long-term waste management and disposal strategy.

Appendix A

Solid Waste Priorities Survey







Results of the Wake County Local Government Solid Waste Priorities Survey

Local Government	Wake County	Apex	Cary	Fuquay-Varina	Garner	Holly Springs	Knightdale	Morrisville	Raleigh	Rolesville	Wake Forest	Wendell	Zebulon	Average Rank	Highest Priority	Lowest Priority	Number of Times Ranked in the Top Three
Solid Waste Element	**Rank**																
1. Identifying waste transfer options to alleviate EWTS overuse and minimize long-term collection costs	2	9	9	9	5	6	9	9	4	4	2	1	5	**5.7**	1	9	3
2. Enhancing waste reduction and diversion to extend the life of the SWLF	3	1	2	2	4	9	7	4	9	9	7	2	2	**4.7**	1	9	6
3. Minimizing solid waste program costs	8	6	7	1	1	8	3	2	2	3	4	8	6	**4.5**	1	8	6
4. Evaluating recycling options (reducing contamination, improving the economics, etc.)	4	3	3	5	2	2	4	1	1	6	8	7	7	**4.1**	1	8	6
5. Identifying and increasing options for yard waste management	9	8	8	8	9	3	1	7	6	5	3	5	4	**5.8**	1	9	3
6. Reducing illegal dumping and litter	6	7	4	7	3	4	2	8	7	1	9	4	8	**5.4**	1	9	3
7. Enhancing solid waste education and outreach	5	4	6	5	7	5	5	3	3	7	6	6	9	**5.5**	3	9	2
8. Identifying and evaluating the next long-term disposal options	1	2	1	3	6	1	6	5	5	2	1	3	1	**2.8**	1	6	9
9.Improving management of special wastes (electronics, mattresses, tires, HHW, food waste, C&D, etc.)	7	5	5	4	8	7	8	6	8	8	5	9	3	**6.4**	3	9	1

Issues are ranked in order of importance with "1" being the most important and "9" being the least important.

Ranking of 1, 2 or 3 (Highest Priority)

Ranking of 7, 8 or 9 (Lowest Priority)

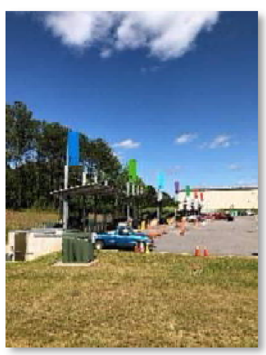
Other issued listed, but not ranked include:

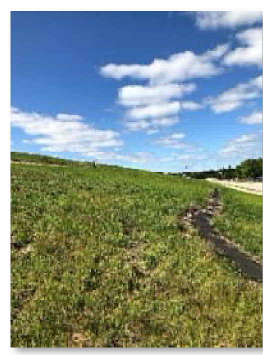
- Addressing the litter issues along Highway 55, specifically at the intersection of Highway 55 and Old Smithfield Road.
- Odor elimination at the SWLF.
- Developing alternative plans for the SWLF (relocation) and future waste-to-energy.
- Converting operations to 100% renewable energy sources.
- Expanding the food waste recycling program; Helping municipalities develop compost programs; encouraging and offering financial support for backyard composting.
- Changing the formula for giving rebates for the SWLF to a fixed rate so that potential revenue surplus is diverted to funding goals like recycling, education, and the next long-term disposal option.

Appendix B

Subtask 3A – Waste Transfer Evaluation







Technical Memorandum

To: *Mr. John Roberson, P.E.*

From: *CDM Smith*

Date: *May 4, 2020*

Subject: *Wake County, North Carolina*
Comprehensive Solid Waste Management Plan (CSWMP) Update
Subtask 3A – Waste Transfer Evaluation

The East Wake Transfer Station (EWTS) has seen a substantial increase in municipal solid waste (MSW) flow during recent years primarily due to the deterioration of the Garner Transfer Station owned and operated by GFL Environmental (formerly Waste Industries). As part of the Comprehensive Solid Waste Management Plan (CSWMP) Update, CDM Smith conducted an evaluation of future waste transfer options to determine the need, timing, and potential users of a new transfer station in another part of the County. The evaluation builds upon an earlier analysis conducted by SCS Engineers on behalf of the City of Raleigh, which estimated the potential waste flow and cost savings for a new transfer facility located within Raleigh's municipal boundary, just south of I-540 and west of Leesville Road[1].

Section 1 of the memorandum includes an overview of the EWTS. Section 2 discusses the proposed West Wake Transfer Station (WWTS) and potential waste amounts for four future scenarios. Section 3 provides a summary and recommendations for next steps.

1.0 East Wake Transfer Station

1.1 Background and Current Operations

The publicly-owned EWTS is located at 820 Corporation Parkway in Raleigh and operates six days a week from 6 am to 3 pm. The EWTS serves as a transfer point for residential and commercial waste generated primarily in the eastern and northeastern portions of the County. All waste brought to the EWTS is consolidated and delivered to the South Wake Landfill (SWLF). Both facilities are part of the Wake County Interlocal Solid Waste Management System, as defined by a 2006 Interlocal Agreement (ILA). Except for Holly Springs, all local governments in Wake County signed on to the ILA, which stipulates that residential solid waste generated within the municipalities must be disposed at the SWLF.

The EWTS receives commercial waste from various haulers and residential waste from the following municipalities: Garner, Knightdale, Raleigh, Rolesville, Wake Forest, Wendell, and Zebulon in addition to 7 of the County's 11 convenience centers (**Figure 1**). The municipalities

[1] SCS, 2019. SCS Engineers. Development of the West Wake Transfer Station. April 19, 2019.

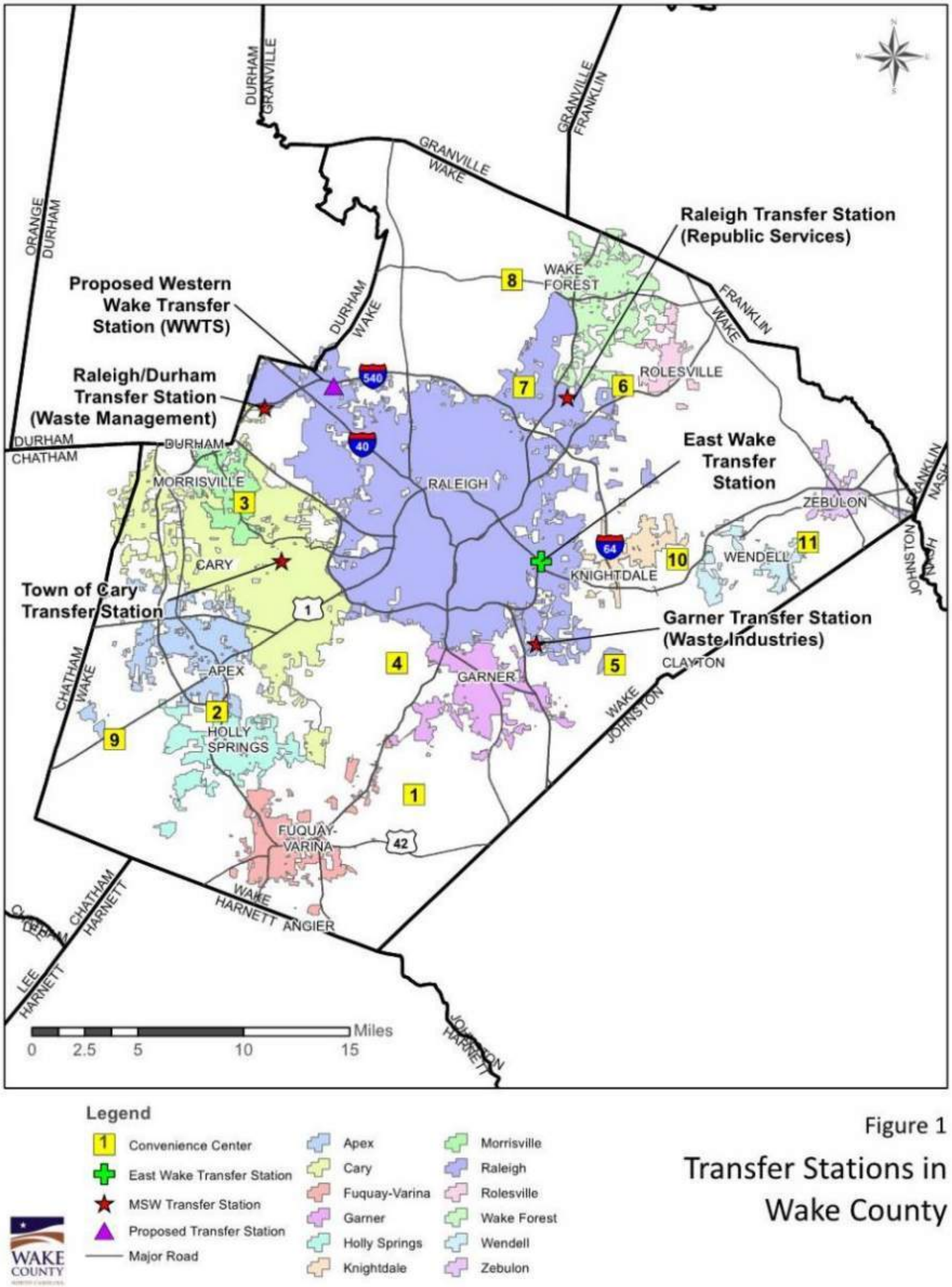


Figure 1
Transfer Stations in Wake County

listed above haul 100 percent of their residential waste to the EWTS except for Garner which hauls on average 11 percent of its residential waste to the EWTS with the rest hauled directly to the SWLF. Historically, most of the waste managed at the EWTS (70 percent, on average) is residential waste from the municipalities and County. From 2012-2017[2], the EWTS averaged 834 tons per day (tpd), but daily tonnage has increased by 28 percent in the past two years to 1,088 tpd in 2019 due to an increase in commercial waste (**Figure 2**). Average tonnages at the EWTS increased from 1,012 tpd for July through December 2018 to 1,163 tpd for January through June 2019. The increase in commercial waste was a result of a decision by GFL to reduce the amount of waste managed at their Garner Transfer Station which has decreased from an average of 424 tpd in 2017 to an average of 162 tpd between January and June 2019.

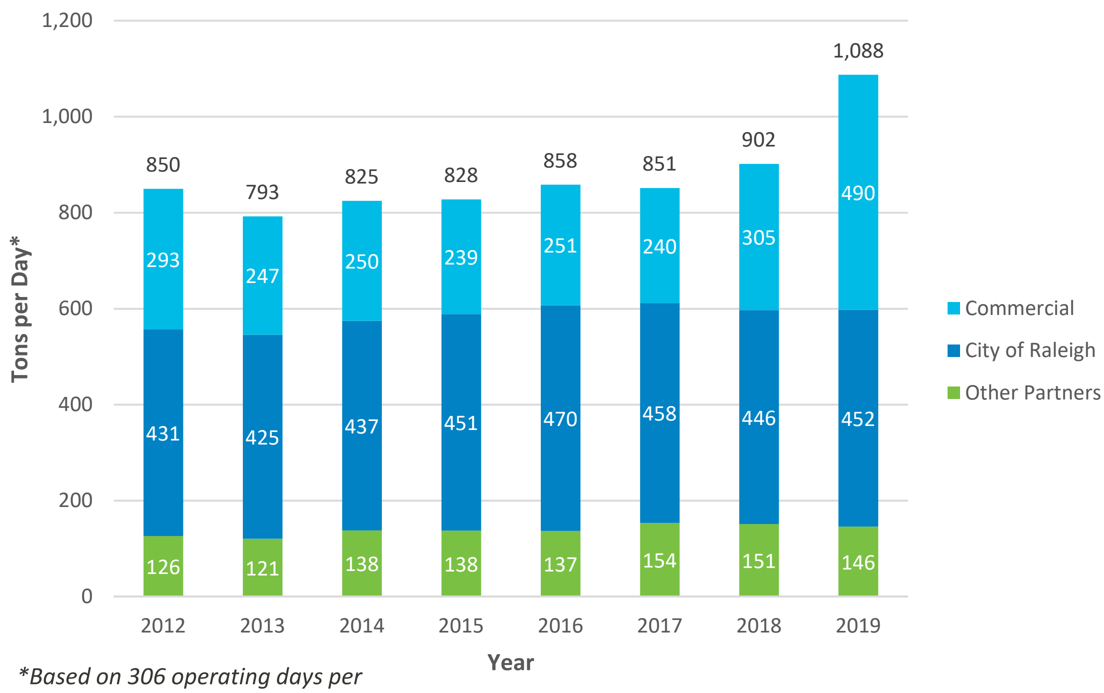


Figure 2. EWTS Historical Tonnage, 2012-2019

According to GFL representatives[3], the Garner Transfer Station uses a block pack to compact waste prior to loading transfer trailers. The block pack is nearing the end of its useful life therefore GFL began diverting waste to the EWTS in 2018 to prolong the life of the system. GFL outlined several potential options for the facility over the next 10 years. The options are:

- Continue to operate at a reduced capacity of approximately 160 tpd;
- Replace the block pack;
- Remove the block pack and install a new concrete tipping floor; or

---

[2] Fiscal years used throughout the memo.
[3] Personal communication, Nick Zdeb, General Manager – GFL Environmental, March 30, 2020.

- Close the transfer station and divert all waste to the EWTS.

Although this decision is still subject to change, GFL indicated that the block pack will not be replaced but they have not decided on a course of action beyond that. GFL noted that installing a new concrete tipping floor would allow them to return to an average waste processing rate (approximately 425 tpd in 2017) and could handle up to a maximum of 600-700 tpd. GFL also noted that it is not necessarily financially beneficial to route additional waste through their Garner Transfer Station.

1.2 EWTS Capacity

The EWTS has a theoretical design capacity of approximately 1,800 tpd based on the size of the tipping floor (18,600 square feet) and use of the two push pits; however, this does not account for operational constraints, such as the timing of waste flow, number of transfer trucks and trailers, operating hour limitations at both the transfer station and SWLF, and other factors. According to representatives from Wake County and Stafford, the operator of the EWTS, the EWTS is already at or above capacity, due to the timing of waste flow during certain peak days and peak hours[4]. For example, although the facility currently averages 1,163 tpd (as of January through June 2019), much more waste is received on Tuesdays, Wednesdays and Fridays, due to how the City of Raleigh operates their waste collection program. **Figure 3** shows the minimum, 25th percentile, 75th percentile, and maximum tons managed per day for FY 2019. On 25 percent of Tuesdays during FY 2019, between 1,422 and 1,910 tons were managed. Similarly, on 25 percent of Wednesdays, between 1,469 and 1,693 tons were managed. The average amount of waste managed on all weekdays was 1,237 tpd.

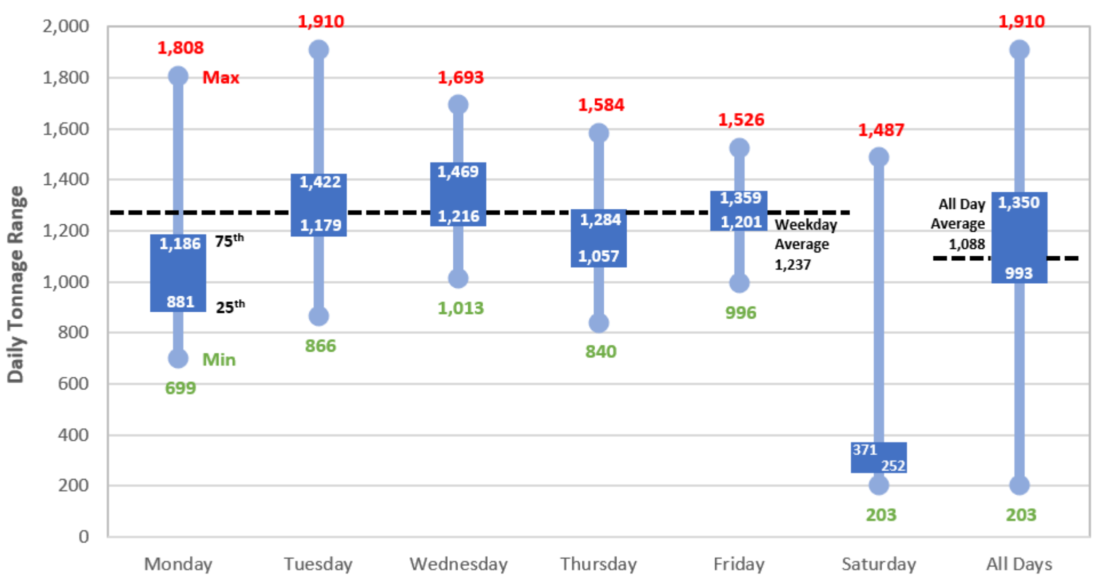


Figure 3. EWTS Daily Tonnage for FY 2019

[4] Personal communication, Roy Baldwin, Wake County Solid Waste Facilities Manager and Wendy Allred, EWTS Operator, Stafford, April 14, 2020.

Stafford currently operates 15 transfer trucks and attempts to complete up to 5 trips per day at approximately 22 to 23 tons per load (depending on the number of bulky items such as mattresses). At an average of 22 tons per load, 15 transfer trucks, and 5 trips per day, 1,650 tons per day is loaded and hauled. If the same number of daily loads averages 23 tons, 1,725 tons per day is loaded and hauled. In FY 2019, there were two days when the daily tonnage was above 1,725 and four days above 1,650.

1.3 Projected Tonnages

Four scenarios were developed to estimate the potential range of future waste amounts that might be expected at the EWTS, based on decisions made by GFL at the Garner Transfer Station. Data provided in Wake County's 5200 Fund Financial Planning Model and Annual Facility Reports submitted to the North Carolina Department of Environmental Quality Solid Waste Section were used to support the evaluation. The four scenarios include:

- #1: Garner Transfer Station continues to operate at reduced capacity (~160 tpd);
- #2: Garner Transfer Station closes in 2021;
- #3: Garner Transfer Station installs a new concrete tipping floor in 2020 and begins to accept 450 tpd in 2021; and
- #4: Garner Transfer Station installs a new concrete tipping floor in 2023 and begins to accept 475 tpd in 2024. It should be noted that GFL did not offer a timeline for installing the new concrete tipping floor. 2023 was selected for planning purposes in this evaluation.

The projected future tonnage for all Scenarios assumed 1 percent annual growth for commercial waste and 1.5 percent for residential waste, based on long-term projections included in the County's Fund Model. Similarly, the projected future tonnage for Scenario #2 was determined by assuming 1 percent annual growth from the combined commercial tonnage received in 2019 for the EWTS and Garner Transfer Station (750 tpd). Projected future tonnages for Scenarios #3 and #4 assumed that the EWTS would receive 40 percent of the combined commercial tonnage from Scenario #2 consistent with data from 2014–2017.

Projected EWTS tonnages for each scenario are provided in **Figure 4**. Average daily tonnages in 2030 range from 1,042 tpd in Scenarios #3 and #4 (a 10 percent decrease from 2019) to 1,543 tpd in Scenario #2 (a 33 percent increase from 2019).

For the purpose of this evaluation, the maximum daily average capacity of the EWTS is assumed to be 1,275 tpd which is 112 tpd more than the current daily average of 1,163 tpd. This value is based on conversations with Wake County and Stafford and accounts for an additional transfer truck hauling 110 to 115 tpd. The analysis does not account for potential future changes in daily tonnages throughout a week due to factors beyond the County's control (i.e. route changes by Raleigh and/or private haulers). Extending hours of the EWTS is not likely to provide additional capacity given that Stafford is routinely onsite 2 hours after the scales close and the SWLF operating hours would likely need to be extended. Extending the operating hours at the SWLF is also unlikely due to concerns regarding adjoining neighborhoods and traffic along NC-55.

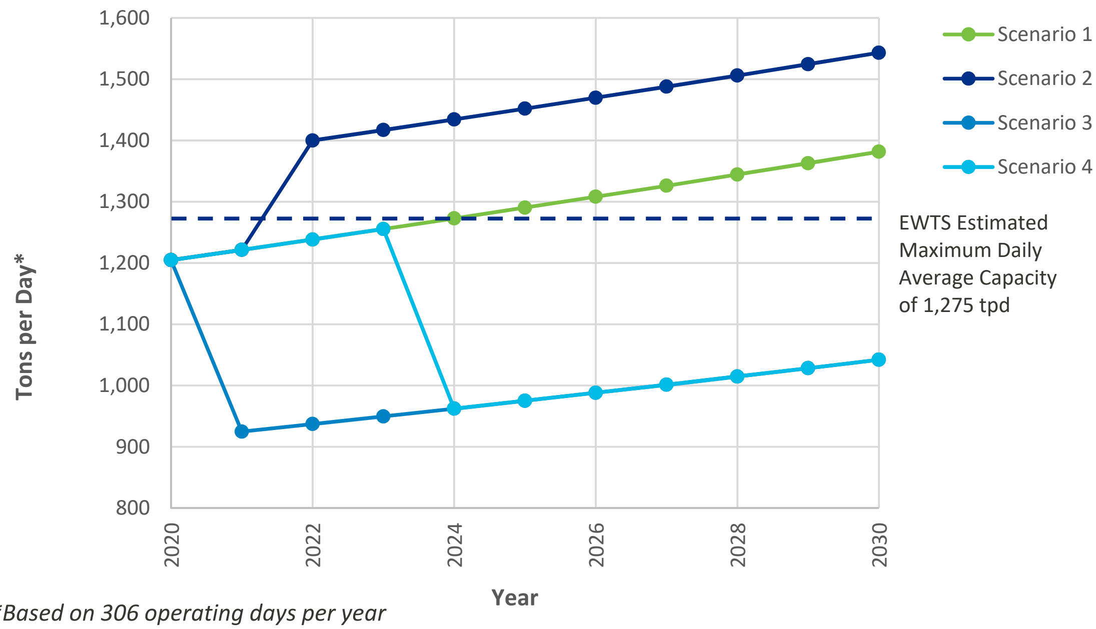


Figure 4. EWTS Projected Tonnage

Using 1,275 tpd as a trigger point, an additional transfer station may not be needed until sometime after 2030 if GFL installs a new concrete tipping floor at the Garner Transfer Station within the next few years (Scenarios #3 and #4). Tonnages under Scenario #4 would increase by 92 tpd over current values in 2023, but then drop and stay below existing rates until at least 2030. An additional transfer station would likely be necessary as early as 2022 under Scenario #2 or 2025 under Scenario #1. If the Garner Transfer Station closes (Scenario #2), the EWTS could see an additional increase of 235 tpd over current values in 2022 and over 375 tpd by 2030.

2.0 Proposed West Wake Transfer Station

2.1 Overview of the Previous WWTS Evaluation

On behalf of the City of Raleigh, SCS Engineers conducted an evaluation to assess the need and potential cost savings of a proposed WWTS located in the northwest portion of the city. A potential transfer station site was identified at 8851 Westgate Park Drive in Raleigh (see Figure 1). Based on this potential location, SCS developed estimates for:

- Waste expected to be transferred at the WWTS, including residential waste from Raleigh, Cary, and Morrisville; residential waste from County convenience centers; and commercial waste from various haulers.
- Potential cost savings to the collection programs for Raleigh, Cary, and Morrisville.
- Preliminary cost for transfer station development.

Some of the more important data sources, assumptions and parameters that were used in the analysis included:

- EWTS and SWLF scale records by origin and City of Raleigh tonnage by collection route.
- A reference time frame of 11/1/17 through 10/31/18.
- A per capita waste generation rate of 1.1 tons per year (tpy), based on Environmental Research and Education Foundation (EREF) data sources. It was noted that this included residential and commercial MSW, construction and demolition (C&D) waste, and yard waste.
- For estimating potential savings for the City of Raleigh collection program, several key locations within various city quadrants were identified.

Using these assumptions and parameters, waste quantity estimates were developed for Raleigh, Cary, Morrisville, Wake County, and private sources based on population, the 1.1 tpy waste generation rate, scale records, recycling rates (generally 25 percent), and the City of Raleigh growth rate. An analysis was performed to estimate the amount of waste from each source that would be expected to be delivered to the WWTS. The assumptions and resulting waste amounts are summarized below, by source.

- **Raleigh** – Of an estimated 383,000 tpy of solid waste disposed in the City of Raleigh, 24 percent, or 91,920 tpy was assumed to be managed by Raleigh Solid Waste Services (SWS). Of that amount, an analysis of collection routes by quadrant resulted in an estimate of **36,100 tpy** that would be delivered to the WWTS. Tonnage going to the EWTS from Raleigh SWS would be reduced by the same amount.
- **Cary** – It was estimated that **33,000 tpy** would be delivered to the WWTS instead of being direct-hauled to the SWLF, as occurs now. Note that this reflects all residential waste which is collected by the Town's own collection program.
- **Morrisville** – It was estimated that **4,400 tpy** would be delivered to the WWTS instead of being direct-hauled to the SWLF, as occurs now. This estimate was based on SWLF scale records.
- **Wake County Convenience Centers** – It was estimated that **6,000 tpy** would be delivered to the WWTS from Convenience Centers 3, 8 and 7.
- **Private Haulers** – It was estimated that **177,000 tpy** of privately-hauled waste would be delivered to the WWTS. This estimate assumed that private haulers manage 76 percent of the waste sent for disposal (or 708,000 tpy) and 25 percent of that amount would be delivered to the WWTS, with another 25 percent going to the EWTS.

In total, SCS estimated that **256,500 tpy** would be delivered to the WWTS. Based in this estimate, accounting for future increases in waste volumes, and assuming the same operating days in the year as the EWTS, a 1,000 to 1,200 tpd capacity was assigned to the proposed WWTS for cost estimating purposes. A conceptual site plan was prepared for the 8851 Westgate Park Drive location which included an 18,000 square foot pre-engineered steel structure and single tunnel for waste transfer trailers. Using the City's Preliminary Budget Development Tool, a cost estimate of $6.8 million was developed, which included facility design, permitting, construction and a 10 percent contingency. The land purchase was estimated to add another $2.2 million, based on the tax-assessed value of the land.

Estimated savings solely due to the reduction in waste hauling distances were developed for the Raleigh, Cary and Morrisville residential waste collection programs. The estimate savings per year were: Raleigh at $450,000; Cary at $68,000; and Morrisville at $19,000. The savings estimates did not consider the likely higher tipping fee at the WWTS compared to the SWLF. This would apply to both Cary and Morrisville, certain Raleigh collection routes, and potentially some private haulers who would otherwise direct haul to the SWLF.

2.2 WWTS Waste Quantity Estimates

For this evaluation, CDM Smith selected to use the waste quantity estimates previously developed by SCS which pertain to the City of Raleigh SWS collection program but developed updated estimates for all other sources based on EWTS and SWLF scale data (provided by Wake County) and discussions with representatives from Cary, Morrisville, and Wake County. The updated waste quantity estimates and their supporting assumptions are detailed below.

2.2.1 City of Raleigh

The City's collection routes are divided into five areas consisting of the central business district and the northeast, northwest, southeast, and southwest quadrants. SCS estimated that all the waste from the northwest quadrant and one-third of the waste from the northeast and southwest quadrants could be diverted to the WWTS which equates to 36 percent of the City's single and multi-family collections. Assuming 1.5 percent annual growth, the City would contribute 49,950 tons (163 tpd) in 2020 and 58,000 tons (190 tpd) in 2030 to the WWTS.

2.2.2 Town of Cary

Based on discussions with the Town Solid Waste Director and Operations staff, it was determined that the Town would not be likely to haul to the WWTS at its proposed location on Westgate Park Drive. Direct haul to the SWLF was deemed to be preferable for even the most northern of the Town's collection routes. A transfer station located further west on I-540, perhaps west of NC 147, would potentially be used by the Town's northern collection routes; however, this general location would become less advantageous for the City of Raleigh SWS collection program. Therefore, for this evaluation, it was assumed that no Town of Cary residential waste would be delivered to the WWTS.

2.2.3 Town of Morrisville

From discussions with the Town Public Works Director and Operations staff, it was determined that the Town's solid waste hauler, GFL Environmental, may find it advantageous to deliver the Town's residential waste to the proposed WWTS at the proposed location on Westgate Drive, rather than direct haul to the SWLF. Therefore, for this evaluation, it was assumed that all of Morrisville's residential waste would be delivered to the proposed WWTS. Assuming 1.5 percent annual growth, the Town would contribute 3,800 tons (12 tpd) in 2020 and 4,400 tons (14 tpd) in 2030 to the WWTS.

2.2.4 Wake County Convenience Centers

Based on the locations of the County's Convenience Centers, it was determined that it would be advantageous for the County's contracted Convenience Center operator, GFL Environmental, to haul from Convenience Centers 7 and 8 to the proposed WWTS, rather than haul to the EWTS or direct haul to the SWLF. These two convenience centers account for approximately 50 percent of the convenience center waste currently sent to the EWTS. Assuming 1.5 percent annual growth, convenience centers would contribute 10,250 tons (33 tpd) in 2020 and 11,900 tons (39 tpd) in 2030 to the WWTS. It would also be an estimated 8 miles and 10 minutes less to haul from the Convenience Center 3 location to the proposed WWTS, compared to direct hauling to the SWLF; however, hauling to proposed WWTS would add additional cost in tipping fee. Therefore, waste from Convenience Center 3 was not included in the estimated WWTS tonnage.

2.2.5 Wake Forest

Wake Forest is the only other municipality that might realize a slight benefit from delivering to the proposed WWTS, as opposed to the EWTS, where the Town's contracted hauler, Republic Services currently delivers their residential waste. Although the proposed WWTS is approximately 2 miles further from the center of Town than the EWTS (18.4 vs. 16.4 miles), the estimated drive time to the proposed WWTS is approximately 26 to 30 minutes, compared to 30 to 34 minutes to the EWTS, under average traffic conditions. For this evaluation, it was assumed that Wake Forest would continue to haul to EWTS; however, it should be recognized that hauling to WWTS would be a nearly identical option, assuming the tipping fee at each facility was the same.

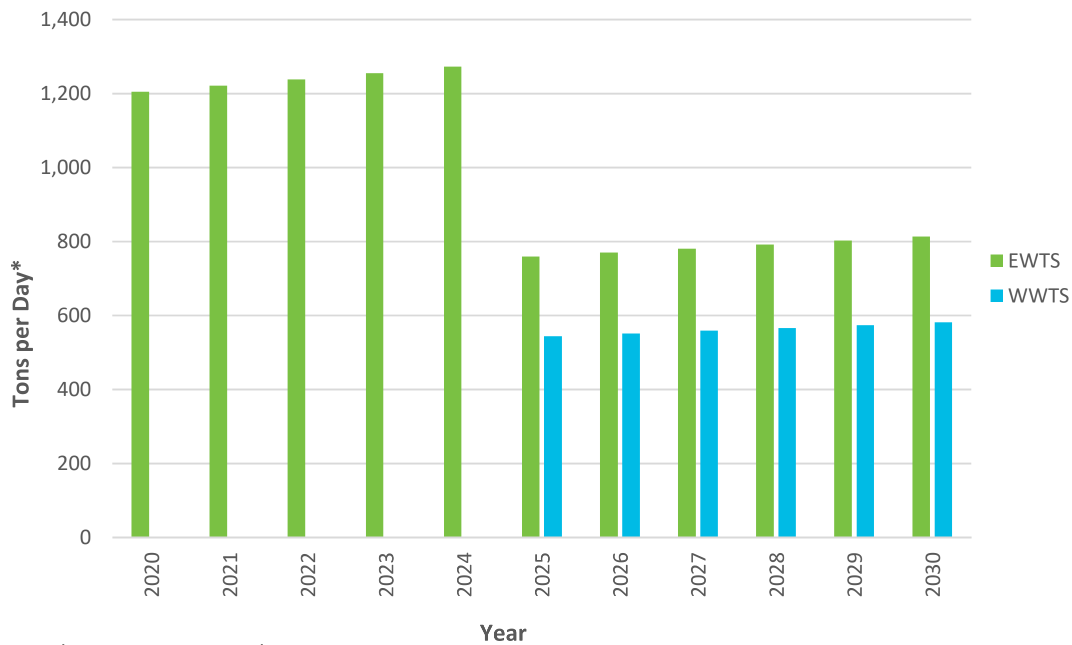
2.2.6 Private Haulers

Commercial waste has historically been evenly split between direct haul to the SWLF and the EWTS with 48 percent of commercial waste coming through the EWTS from 2012 through 2017. For this evaluation it was assumed that half of the commercial waste routed to the EWTS would be diverted to the WWTS. This estimate may be high given the presence of several private transfer stations in proximity to the WWTS. GFL indicated they may use the proposed WWTS, but Waste Management stated they would not. The estimated potential use of the WWTS by commercial haulers has a relatively high level of uncertainty.

2.2.7 Summary of Waste Quantity Estimates

The projected daily tonnages estimated to be delivered to the proposed WWTS and the EWTS are shown in **Figures 5** and **6** through 2030 based on the need for an additional transfer station for Scenarios #1 and #2 as described in Section 1.3.

By 2030, the WWTS is estimated to receive from 580 to 665 tpd dependent upon if the Garner Transfer Station operates at a reduced capacity (Scenario #1) or closes (Scenario #2). A tipping floor of 14,000 to 16,000 square feet is expected to be enough to handle the estimated tonnages in 2030, but a larger transfer station similar in size to the EWTS (18,000 square feet) is recommended, given the difficulty in projecting future tonnages and to allow for continued use of both the EWTS and WWTS well beyond 2030.



**Based on 306 operating days per year*

Figure 5. Projected Tonnages for Scenario #1 – Garner Transfer Station continues to operate at 160 tpd.

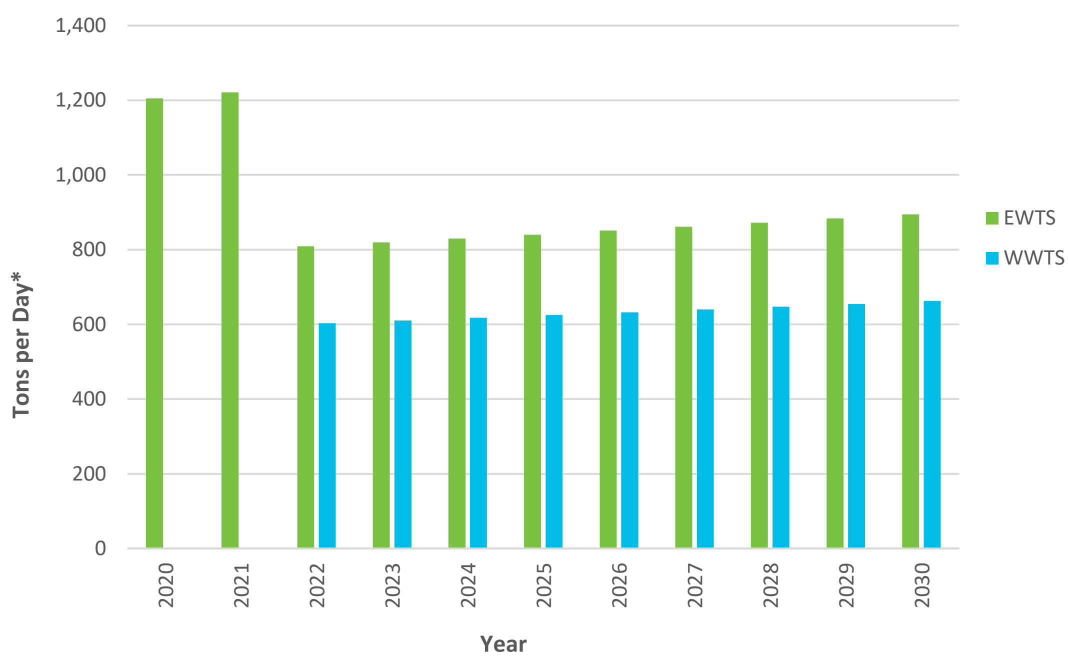


Figure 6. Projected Tonnages for Scenario #2 – Garner Transfer Station closes in 2021.

3.0 Summary and Recommendations

The EWTS is currently at or near capacity and operational issues at the facility will worsen if the Garner Transfer Station continues to operate at a reduced capacity or closes within the next few years. A new transfer station located in the western part of the County will be necessary if current trends continue or if the Garner Transfer Station closes.

It is estimated that the proposed WWTS would receive approximately 36 percent of the City of Raleigh's residential waste, 100 percent of residential waste from the Town of Morrisville, 30 to 50 percent of commercial tonnage currently going to the EWTS, and waste from two of the County's convenience centers for an estimated total of 500 to 700 tpd in 2030.

It is recommended that the County, City of Raleigh, and other partners to the ILA continue to collaborate to confirm the need and further evaluate the timing of a new transfer station in western Wake County. The following steps are recommended:

1. Wake County and the City of Raleigh should regularly check in with GFL regarding their plans for rehabilitation or closing of the Garner Transfer Station.

2. If GFL decides to close the Garner Transfer Station within the next several years (and before a WWTS is constructed and in operation), Wake County and Stafford will need to implement operational changes, including adding another haul truck and driver for peak days. Other actions that might be considered include:

    a. Increasing the tipping fee at the EWTS to (temporarily) discourage commercial use and encourage more direct hauling to the SWLF. The implications of this change would need to be evaluated to ensure enough commercial waste is received so as not to increase the disposal cost for the City and Towns that use the EWTS.

    b. Temporarily banning delivery of loads that are primarily or exclusively mattresses, and possibly other bulky items that significantly lower the tons of waste per haul truck.

3. CDM Smith understands that the City of Raleigh is conducting a route optimization study. Once the study is complete, any route changes that might result in changes to the timing of waste received at the EWTS should be evaluated. For example, if new routes are developed which result in a more even daily distribution of waste delivered to the EWTS, that may delay the need for a new transfer station. It is assumed that the City's route optimization study is only currently evaluating routes for delivery to the EWTS, but that should be confirmed.

4. The City of Raleigh should confirm the amount of waste they anticipate sending to the proposed WWTS is consistent with the estimates made in the SCS evaluation.

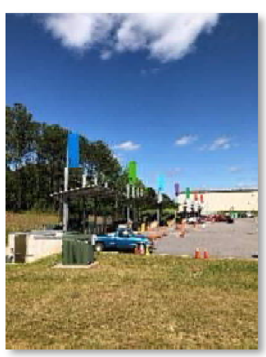
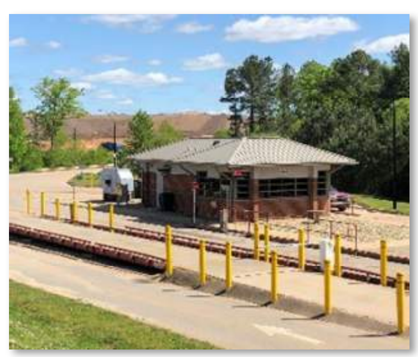
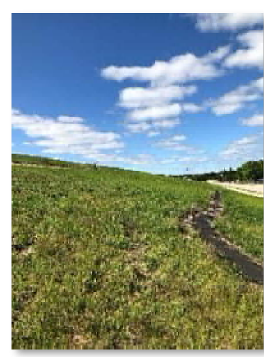
5. The City of Raleigh and Wake County should begin the process of identifying and evaluating potential sites to accommodate a transfer station with an 18,000 square foot tipping floor. Siting, permitting, design and construction of a new transfer station is

likely to take at least 2, and likely closer to 3 to 4 years. If GFL takes no action at their Garner Transfer Station, then a WWTS would be needed by 2025, based on the assumed 1 to 1.5 percent increases in annual tonnage.

Appendix C

Subtask 3B – Energy-from-Waste Evaluation and Identification of Other Disposal Options



Technical Memorandum

To: *Mr. John Roberson, P.E.*

From: *CDM Smith*

Date: *January 24, 2020*

Subject: *Wake County, North Carolina*
Comprehensive Solid Waste Management Plan (CSWMP) Update
Subtask 3B – Energy-from-Waste Evaluation and Identification of Other Disposal Options

1.0 Executive Summary

CDM Smith prepared an evaluation of the costs associated with an Energy from Waste (EfW) facility for the Wake County (County) Solid Waste Department as part of their Solid Waste Management Plan update in 2012. The evaluation included a summary of the various waste conversion technologies, the municipal solid waste (MSW) pre-treatment requirements associated with each technology, and the state of commercial development of waste conversion technologies. The decision was made to evaluate massburn waterwall combustion technology, as this is the most widely implemented and commercially proven waste conversion technology. A detailed financial model was prepared which required numerous assumptions to be made for the performance, cost and revenues of an 1,800 tons per day (tpd) massburn EfW facility. This size EfW facility is well within the normal range of facility sizes, which vary between 500 – 3,300 tpd in the U.S.

The base case analysis in 2012 estimated the year 1 cost for the massburn EfW facility at $81.25/ton of MSW processed. Several key parameters were adjusted in a sensitivity analysis which estimated the best-case (lowest cost) at $48.93/ton, and the worst-case (highest) cost at $100.71/ton. The key financial parameters used in this analysis are noted in **Table 1**.

Over the past eight years since the original evaluation, significant changes have occurred in the U.S. and globally which affect the cost of EfW. These key variables were evaluated for the same size EfW facility utilizing the massburn waterwall combustion system. Table 1 shows the changes in the key variables used for the updated financial model. Additional changes were made to other variables which have less impact on the overall cost, such as usage rates and costs of reagents and utilities.

Table 1. Summary of EfW Financial Model Results

Model Variable	2012 Analysis (Base Case)	2020 Analysis (Base Case)
Capital Cost	$250,000 per tpd of capacity	$285,00 per tpd of capacity
O&M Fee	$32.50 per tpd of capacity	$37.50 per tpd of capacity
Interest Rate	5%	4.5%
Financing Term	20 years	25 years
Sales Price of Electricity	6 cents/kWh	3 cents/kWh
Sales price of Ferrous Metal	$150/ton	$100/ton
Sales price of Non-Ferrous Metal	$1,000/ton	$500/ton
Ferrous Metal Recovery Rate	2.0%	4.0%
Non-ferrous Metal Recovery Rate	0.35%	0.70%
Sale of Renewable Energy Credits	None	None
Model Output	**2012 Analysis**	**2020 Analysis**
Base Case Cost (year 1)	$81.25/ton	$91.53/ton (increase of 13%)
Best Case Cost (year 1)	$48.93/ton (includes sale of RECs at $10/REC)	$64.62/ton (includes sale of RECs at $10/REC)
Worst Case Cost (year 1)	$110.71/ton	$116.51/ton

Not surprisingly, the results of the updated financial analysis show higher costs for all three scenarios (low cost, base case cost, and high cost), compared to the 2012 evaluation. The significant decline (50%) in projected revenues from the sale of electricity and recovered metals and increased capital and O&M costs were only slightly offset by the reduced borrowing and project development costs. The 2020 base case cost increased by about 13% from that estimated in 2012. Under best of conditions (additional 1 cent/kWh electrical payment, -0.5% interest rate, 5-year increased bond term, and 10% lower capital cost), the year-1 cost of $64.62 per ton is estimated to be approximately 30% lower than the base case cost.

The key variables in this financial analysis are the selling price of electricity, and whether the environmental attributes of electricity from EfW facilities can be monetized. At this point in time, the long-term outlook for receiving higher payments from the sale of EfW electricity is unclear. Furthermore, Investor Owned Utilities (IOUs) are not offering long-term (20-25 years) power purchase agreements (PPA) which were common in the 1980s and 1990s, when the majority of existing EfW facilities in the U. S. were developed.

The estimated costs of an EfW facility are higher than the cost of landfills, but lower or comparable with costs associated with other recycling and emerging waste conversion technologies, such as anaerobic digestion and mixed waste material recovery facilities. There are many compelling reasons to consider EfW technology as part of a community's long-range plan for integrated solid waste management. These include extension of the service life of the South Wake Landfill (SWLF); stable and predictable costs over the 45-50 year service life of an EfW facility; and reduced environmental impacts including waste diversions from the landfill, reduction of greenhouse gas emissions, and improved recycling rates due to the recovery of ferrous and non-ferrous metals which are not normally collected in curbside and drop-off recycling programs. The EfW residue will simplify landfill operations by providing a material that is easy to manipulate and stabilize, reduce vermin attraction, reduce the need for cover material and reduce the treatment of leachate and concerns for landfill gas capture. Future additional benefits that would significantly extend the remaining service life of the SWLF could result from recycling of bottom ash in beneficial reuse projects (construction aggregates, mineral feedstocks, recovery of precious and rare earth metals, etc.). These benefits are currently being demonstrated in numerous European EfW projects.

Massburn furnace designs and flue gas cleaning technology have evolved over the years to cope with increasingly stringent environmental regulations. According to the U.S. Environmental Protection Agency (EPA), modern EfW facilities have an emission profile considerably better than coal based electric power. Recent trends in flue gas cleaning technology have demonstrated the ability to reduce NOx emissions by more than 50 percent. Even greater reductions of NOx emissions can be achieved with use of Selective Catalytic Reduction (SCR) technology which can achieve NOx emissions in the range of 45 - 50 ppm, representing approximately a 75% reduction compared to the current generation of operating EfW facilities. Emissions profile of EfW facilities with modern air pollution controls are similar to power produced from natural gas. An additional advantage reported by the U.S. EPA notes that for every ton of municipal solid waste processed at modern massburn EfW facilities, greenhouse gas emissions are reduced by approximately one ton, compared to landfill disposal. This reduction is due to the avoidance of methane from landfills, along with the offset of greenhouse gases from reduced fossil fuel electrical production and the recovery of metals for recycling.

Finally, EfW facilities have been demonstrated to be the workhorses of integrated solid waste management systems, serving as the final stop for wastes that cannot be readily recycled or marketed. Other than removal of bulky and prohibited items, no pre-processing of waste is required for massburn EfW. Additional benefits can be provided to a host community with its ability to process wastewater treatment plant (WWTP) biosolids, used tires, combustible fraction of construction and demolition (C&D) wastes, residuals and contaminants from recycling programs, and special wastes in need of assured destruction. Some of the above materials can be processed at significantly higher fees, thereby generating additional revenues which can help reduce the overall cost of EfW to the local rate payers. One final advantage of EfW is that the issues with odors at the SWLF will be minimized due to the processing of problematic odor generating putrescible waste at the EfW facility.

2.0 Background

This Technical Memorandum (TM) is an update of the EfW evaluation which was completed by CDM Smith in 2012 as part of the 2012 Solid Waste Management Plan Update. The intent of this TM is to re-evaluate EfW based on changes in the industry over the past eight years; discuss the timeline and phasing of project development; and summarize other emerging waste conversion technologies. A separate TM is being developed to conceptually discuss another future waste disposal option – hauling waste generated in Wake County to one or more privately owned and operated out-of-county landfills.

Since 2012, there have been several changes and advancements in the EfW industry, including the following:

- Slight increases in capital, operation and maintenance costs. Most EfW facilities in the U.S. are municipally owned and privately operated. The contractors which operate EfW facilities typically selected under design, build, operate (DBO) contracts.
- Advancements in post-combustion metal recovery with greater recovery rates of ferrous and non-ferrous metals. Recovery of metals from ash residue is a necessary step toward beneficially recycling a portion of the ash as construction aggregates and chemical feedstocks, such as to produce Portland cement.
- The value of recovered metals from ash residue have also changed significantly over the past eight years, unfortunately in a downward trend due to the global demand and tariffs on commodity metals.
- Lower electrical payments and shorter PPAs, which result in a higher degree of financial uncertainty in later years.
- The cost of chemicals and reagents have changed.

CDM Smith prepared this update to the 2012 EfW evaluation, focusing on the aspects identified above, and other key financial parameters. CDM Smith also reviewed Solid Waste Optimization Life-Cycle Framework (SWOLF) work completed by NC State University on behalf of Wake County. Some of the findings from the NC State study are incorporated, along with a discussion of key differences as they relate to the use of EfW.

This analysis estimates the year 1 cost of a best-fit EfW facility, based on current costs, interest rates, and sale prices of electricity and commodities. No attempt was made to project these costs 15 to 20 years into the future, when an EfW facility would be constructed and operating. As an item of note, the majority of EfW plants in the U.S. are now operating beyond their originally planned 20-year operating period, with some even in their mid-thirties. The benefit of the longer service life is now being recognized and should an EfW facility be considered by Wake County, a formal cost analysis could be evaluated over a 45 to 50-year period.

This TM summarizes CDM Smith's investigation into the following aspects of EfW:

- Confirmation of prior sizing of EfW facility based upon updated population and waste generation data.
- Update of financials of an EfW (massburn type) facility.
- Discussion of opportunity for conversion of specific materials namely scrap tires, construction and demolition (C&D) wood waste, dirty plastics, yard waste and sewage sludge into energy through combustion. Additional options for co-combustion in an EfW facility are also discussed in this updated report, including biosolids from WWTPs, along with special waste in need of assured destruction. Several other emerging waste conversion technologies currently being evaluated and promoted in the U.S., based upon novel processes deployed in other industrial applications, are also discussed.
- Summary of environmental emissions from EfW facilities.

Section 3.0 presents the updated results of an EfW financial model that was developed and used to estimate the base economics of a modern massburn EfW facility. **Section 4.0** discusses the major features and advancements in massburn EfW technology. **Section 5.0** provides a summary of potential benefits and limitations that EfW technology provides that are not quantified in the financial analysis. **Section 6.0** provides a summary of options for using EfW technology (other than massburn) to convert select materials into energy. **Section 7.0** provides basic information about air emissions from massburn EfW facilities. **Section 8.0** summarizes previous work conducted by NC State which used the SWOLF model to evaluate EfW as part of a future integrated solid waste system in Wake County.

3.0 Updated Financial Evaluation of EfW Facility

3.1 Introduction

This section presents a conceptual financial model of an EfW facility sized to handle MSW generated within Wake County. Early in the 2012 evaluation, it was determined that a simple case study would not suffice as an effective evaluation tool primarily because no new EfW plants had been built in the U.S. since 1996, although there had been several expansions at existing EfW facilities in the prior 7 years. In 2015, the first new EfW facility was put into commercial operation in Palm Beach County Fl. This facility is now the “gold standard” by which future EfW projects in the U.S will be benchmarked. Many of the innovative and sustainable elements of this project have been factored into this updated TM. Massburn technology, along with residue processing systems has improved over the past 20 years. The energy market, the primary source of revenue for an EfW plant, has also evolved and no longer resembles the market two decades ago. Therefore, CDM Smith has updated the 2012 financial model for a greenfield EfW facility to more accurately reflect current market conditions.

The data for this model has been obtained from several relevant sources:

- Operating data from the Hillsborough County Resource Recovery Facility (HCRRF), which is comparable in size to a potential facility in Wake County. The HCRRF was originally constructed in 1985–1987 as a 1,200 tpd facility with three combustion units capable of processing 400 tpd. An additional 600 tpd combustion unit was later added in 2007-2009 to accommodate local growth. Further information characterizing Hillsborough County's integrated solid waste program, including costs, are provided in **Exhibit A**.
- "Benchmarking Massburn WTE Facility Performance" paper by Anthony LoRe (CDM Smith) and Kelsi Oswald (Pinellas County) presented at the 17th Annual North American Waste-to-Energy Conference (NAWTEC 17 Conferences) in 2009.
- Current operating data from several other operating massburn EfW facilities in the Tampa Bay area, including the Pasco and Pinellas County Resource Recovery Facilities.
- Interviews and meetings with vendors offering advanced metal recovery systems.

3.2 Economic Model Input Data

The following section identifies the key parameters by which the EfW facility performance, cost, and benefits can be evaluated.

3.2.1 Waste Generation Data

Significant population growth in the Triangle region has occurred over the past seven years. The current population has grown by approximately 15% over the past seven years and is projected to be over 1.5 million in 2020. Approximately 1.28 million (M) tons of waste from the Triangle region is currently being disposed of in landfills annually, which equates to approximately 3,500 tpd. Historical and future population estimates based on North Carolina Office of State Budget and Management (OSBM) for the three Triangle region counties are shown in **Table 2**.

Table 2. Triangle Region Population Overview, 2010-2038

County	Population						
	July 2010	July 2015	July 2020	July 2025	July 2030	July 2035	July 2038
Durham	271,854	297,278	320,933	344,143	367,357	390,566	404,491
Orange	133,951	140,841	147,451	155,122	162,754	170,348	174,886
Wake	906,494	1,007,641	1,119,165	1,235,046	1,351,791	1,468,625	1,538,731
Triangle Region	**1,312,299**	**1,445,760**	**1,587,549**	**1,734,311**	**1,881,902**	**2,029,539**	**2,118,108**

Source: https://www.osbm.nc.gov/demog/county-projections

Correspondingly with population growth, the solid waste disposal rates for FY2017-2018 in the three Triangle region counties have also significantly grown from the prior reporting period and are shown in **Table 3**, along with estimated future disposal rates.

Table 3. Triangle Region Estimated Solid Waste Disposal, FY 2017-2018

County	FY 2017-18 Per Capita Rate (tons/yr)	Per Capita Rate (lbs/day)	July 2020 Estimated (tons/yr)	July 2025 Estimated (tons/yr)	July 2030 Estimated (tons/yr)	July 2035 Estimated (tons/yr)	July 2038 Estimated (tons/yr)
Durham	0.98	5.4	314,514	337,260	360,010	382,755	396,401
Orange	0.58	3.2	85,522	89,971	94,397	98,802	101,434
Wake	1.18	6.5	1,320,615	1,457,354	1,595,113	1,732,978	1,815,703
Composite	**1.08**	**5.9**	**1,720,651**	**1,884,585**	**2,049,521**	**2,214,534**	**2,313,538**

Source: DWM's Per County Per Capita Waste Disposal Report FY 2017-2018

Given the long duration of time it takes to develop a modern EfW project (7-10 years), CDM Smith used 2035 population estimates and waste generation data for sizing of the EfW facility. This is currently about 5 to 10 years before the SWLF could reach capacity. Using a 2035 waste generation estimate of 6.5 pounds per person per day (lbs/person/day) (Wake's FY2017-2018 rate), and assuming 37.3% of the waste generated in Wake County is available for EfW processing, then the EfW facility would be sized at 1,771 tpd – basically the same size that was evaluated in 2012. Keeping the EfW facility size at 1,800 tpd is reasonable for several reasons:

1. It allows a direct comparison of the financial projections originally estimated in the 2012 report,
2. It is a reasonably sized EfW facility which is cost-effective in both capital and O&M costs, and
3. It allows alternate recycling technologies to be implemented, helping to reduce claims that EfW discourages development of recycling programs.

If a regional facility (Orange, Durham and Wake) were to be considered, the amount of waste available for EfW processing in 2035 would be approximately 3,034 tpd, assuming 50% of the regional waste is available for processing. This size of EfW facility has been successfully constructed and remain in operation in several communities in the U.S., including Pinellas County, FL (1982), Fairfax County, VA (1991), and most recently in Palm Beach County, FL (2015).

3.2.2 EfW Cost and Revenue Parameters

The following is a description of the cost and revenue parameters considered for an EfW facility. All the parameters were built into an Excel-based spreadsheet that considers operational cost, capital cost and revenues to estimate the initial year 1 cost per ton based on the debt service requirements associated with the selected bond terms. The financial analysis does not account for changes in operational costs and revenues past the first year. The inputs and assumptions for both the 2012 and the updated 2020 financial analysis are summarized in tabular form in **Exhibit B**.

<u>Cost Parameters – Facility Size, Availability and Capital Cost</u>

- The conceptual EfW facility design capacity remains at 1,800 nominal tons of MSW to be processed per day.

- The EfW facility annual availability has been maintained at 90% of design capacity for annual MSW processed. Many of the private operators of first generation EfW facilities were contractually bound to maintain the annual availability guarantee of 85%. The percent of time in which a modern EfW facility is available to process solid waste has steadily increased over the past decade due to advancements in the industry. Operational philosophies and consistent and proactive maintenance activities were implemented to reduce the number of unscheduled shutdowns. The usage of Inconel overlay (an alloy of nickel containing chromium and iron, resistant to corrosion at high temperatures) on boiler tubes and better refractory coverage also reduced the number of unscheduled shutdowns. The current annual availability for a massburn EfW facility is in the range of 90 – 92%, which is high compared to modern fossil power plant industry standards. As an item of note, the NC State SWOLF analysis assumed a 91% capacity factor.
- The estimated capital cost has been increased from $250,000 of daily design capacity (tons per day) by 10% to $275,000 due to inflation since 2012. The most recent greenfield EfW constructed in the U.S. was in Palm Beach County Florida with ground breaking in2012 and commercial operation in 2015. This facility is a large 3,000 tpd plant and the unit capital cost for the successful contractor was approximately $223,000 per ton of daily capacity. This figure enjoyed an economy of scale benefit due to its large size. As a result of this industry wide hiatus, there is some uncertainty in the capital cost estimate. The capital cost of EfW projects is highly dependent upon local, national, and global markets which affect the price of many of the components which are sourced from the global market. The marketplace for the EfW industry may be more competitive in the future, especially if European and Asian firms are invited to submit their qualifications and proposals. An additional $10,000/tpd of capital cost was added to account for the Advanced Metal Recovery (AMR) process to be housed inside of the ash management building, increasing the capital cost to $285,000/tpd
- Bond Issuance Cost was not specifically included in the 2012 analysis. An estimate of 5% was assumed to cover the cost of issuance along with cost of an insurance policy to meet cash flow requirements.
- Debt Service Coverage has been eliminated from the updated analysis. The prior 2012 report assumed 20% debt service coverage, but this has since been determined to be an obligation on the overall solid waste system bond coverage.
- Debt service period has been increased from 20 years to 25 years. Many of the first generation EfW massburn facilities were financed for 20 years. However, the EfW industry has evolved over the past 25 – 30 years, and many of these facilities remain in operation today. The current estimated service life for modern EfW facilities is 45 – 50 years. A 25-year debt service period should be compatible with the reduced risk factors associated with the modern EfW industry.
- Debt service interest rate has been reduced from 5.0% to 4.5%. The current economic global conditions continue to keep interest rates lower than in the past, and it is likely that an EfW

project based upon proven massburn technology can be financed at the above interest rate. For reference, the Hillsborough County EfW project was financed at 7.6% interest in 1985, while the recent plant expansion project was financed at 4.75% in 2006.

- Technical and legal fees of 2.5% of the capital cost were added to the revised EfW financial analysis for consultant expenses expected during the project development and construction period.

Electrical Generation and Revenue Parameters

- The gross electrical generation rate has been increased from 650 kWh/ton of MSW processed to 700 kWh/ton to reflect the trend of increasing steam pressure and temperature conditions. The industry-wide trend has been toward greater electrical output as boiler operating conditions (pressure/temperatures) have increased over the past years to result in higher gross electrical generation rates. In addition, the typical waste stream composition has changed over time. Low heating value materials, such as yard waste, metals, and C&D materials have been reduced by recycling programs and waste segregation, while high heating value materials such as mixed plastics have become more prevalent, driving up the heating value of MSW. The most recent EfW facility publicly procured in the U.S. resulted in an estimated gross electrical generation of 736 kWh/ton. The HCRRF by comparison, is a first generation RRF facility constructed in 1985-1987 and produces only 432 kWh/ton from low pressure steam (600 psi). The new Palm Beach County EfW guarantees 575 kWh /ton net generation from steam pressure of 865 psi.
- Internal use of electricity for EfW plant operations remains at 13% of gross electrical generation. Often referred to as parasitic load, this portion of the electric generation is used to power the motors which are necessary to operate the EfW process equipment and supporting facilities. Typical parasitic loads range from 11 – 15%, depending upon the processes employed at the EfW facility.
- Net electrical energy generation rate for a modern EfW facility in Wake County has been calculated at 609 kWh/ton of MSW processed based upon the above two assumed parameters (700 kWh/ton gross electric generation and 13% parasitic load).
- Average electrical energy sales price has been reduced from 6 cents per kWh to 3 cents per kWh for the updated analysis. The average PPA executed by EfW projects varies widely, primarily affected by the current cost of electricity and demand for future additional electricity in the local community served by IOUs. On September 19, 2019 the Federal Energy Regulatory Commission (FERC) initiated rulemaking to revisit Public Utility Regulatory Policies Act of 1978 (PURPA) rules, with the intent of helping reduce the cost of electricity in the U.S. FERC voted to issue a notice of proposed rulemaking (NOPR) to revisit its rules and regulations implementing the PURPA. Most of the EfW projects in the U.S were developed under the guidelines of PURPA, which requires investor-owned electric companies, public power utilities, and electric cooperatives to purchase energy from qualifying facilities (QFs)

for up to 80 megawatts in size at the "avoided cost" the utility would otherwise pay to purchase or generate the electricity itself. The impact of the new rulemaking will likely affect the pricing of future PPAs for EfW projects.

- States such as North Carolina, with mandates for renewable energy and anticipated growth in population, may result in future higher rates of payment or premiums for renewable electricity. A federal energy policy with a strong mandate for renewable, green, or low carbon electricity could significantly benefit future EfW projects, both nationally and at the state and local levels. However, the above noted incentives do not seem to be imminent. There is a myriad of contracting strategies for the sale of renewable energy that are beyond the scope of this analysis, therefore an average overall price of 3 cents per kWh of electricity sold is used in this preliminary analysis. As an item of note, the NC State SWOLF project assumed the sale of electricity at 5 cents per kWh.
- There are additional nuances associated with PPAs, such as annual facility availability, restrictions on when planned outages can occur, and other issues which can affect the terms, conditions, and payments that is beyond the scope of this analysis.
- Electric energy revenue sharing percentage of 10% remains for the 2020 updated analysis. Typical EfW operator service agreements in the past have included a revenue sharing percentage for electrical sales. This is typically included as an incentive for the operator to operate the facility in an optimal manner.
- Renewable Energy Credit (REC) payments represent the value of the environmental attributes of EfW and have been conservatively assumed at zero ($0.00 per REC) for the Base Case analysis. However, additional revenues from the sale of RECs at $10 per REC has been considered in the Best Case (low cost) sensitivity analysis scenarios. A conversation with Travis Payne, Renewables and Distributed Energy Technology Business Development Manager for Duke Energy, was made on September 16, 2019. Mr. Payne noted that in North Carolina, EfW facilities do count as renewable, but the renewable carve-out for Duke Energy is lumped in with solar photovoltaics (PV). North Carolina has a large build-out of utility scale solar facilities and is currently not actively seeking any more general RECs. Furthermore, a PPA with Duke Energy would be on a 5-year contract at the avoided cost at the establishment of a Legally Enforceable Obligation (LEO) date. Current rates are $25-$30/MWh (2.5 – 3.0 cents per kWh). An EfW project must also show that it has a viable path to interconnection which is challenging due to buildout of other renewable resources in the state.

<u>Recovered Metals and Revenues</u>

- Ferrous metal recovery rate has been increased from 2.0% of processed MSW to 4.0% based upon the incorporation of an AMR process. For comparison, the HCRRF averaged 1.8% for fiscal year (FY) 2011, whereas the industry average has been 1.9% based upon the LoRe/Oswald study. The use of high-strength rare earth permanent magnets has been proven to increase the amount of ferrous metal recovered. Vendors operating AMR processes have reported ferrous metal recovery rates in the 4-5% range due to their use of multiple high strength permanent magnets.

- Ferrous metals sales price has been reduced from $150/ton to $100/ton based upon current market conditions. The price of recycled metal has fluctuated wildly over the past 25 years of EfW projects, however the recent downward trend for commodity prices is primarily affected by the global demand for resources, and lately compounded by international trade wars and tariffs.
- Non-ferrous metal recovery rate has been increased from 0.25% of processed MSW to 0.70% based upon modern EfW projects. Non-ferrous metal recovery systems have been adopted by more and more EfW facilities in response to reliable eddy current separation technology which has evolved over the past decade, primarily in the scrap automobile metal recovery industry. Non-ferrous metals in the MSW stream originate from a wide variety of sources, many of which are not collected as a part of curbside recycling programs due to the non—ferrous metal being bound with other materials. These sources include: small household appliances, automobile parts, toys, patio furniture and household components. The use of high-strength eddy current separators and improved screening systems has been proven to increase the amount of non-ferrous metal recovered. Vendors operating AMR processes have reported non-ferrous metal recovery rates in the 1.0-1.5% range due to their use of multiple high strength permanent magnets.
- Non-ferrous metals sales price has been reduced from $1,000/ton to $500/ton. The price of non-ferrous metals has also fluctuated wildly over the recent past and is strongly affected by the global demand for aluminum. Due to the continuing global population growth and increase in the standard of living, the long-term outlook for non-ferrous metals is positive; however, the current market has seen a downward trend in the prices primarily affected by the reduced global demand for resources, and lately compounded by international trade wars and tariffs.

There are also options to improve the revenues from recovered non-ferrous metals by sorting techniques to separate the higher valued red metals (brass, bronze, copper) from the white metals (aluminum). Other options for additional revenue include coin recovery from the recovered non-ferrous metals. Additional processing of EfW ash to recover non-ferrous "fines" is also practiced in European EfW facilities which can be marketed to cement kilns and special aluminum smelters.

<u>EfW Operation and Maintenance Costs – Reagent Usage</u>

- Lime is typically slaked and used to remove acid gas constituents and control sulfur dioxide emissions from the combustion flue gas. For this analysis, a pebble lime consumption rate has been maintained at the previously conservative rate of 20 pounds/ton MSW. As a reference, the HCRRF consumed 14.3 lbs/ton of MSW processed during FY2011 and 12.4 lbs/ton in FY2018, while the new EfW in Palm Beach County, Fl guarantees pebble lime usage at less than 11.9 lbs/ton processed.

- Pebble lime cost has been increased from $120 to $200/ton delivered based upon current operating EfW data.
- Powder activated carbon (PAC) consumption rate has been increased from 1.0 to 1.2 lbs/ton MSW processed based upon current EfW operating data. PAC is pneumatically injected into the flue gas stream to capture mercury and dioxin/furan emissions. As a reference, HCRRF consumed 1.05 lbs/ton of MSW processed during FY 2011 and 1.24 lbs/ton in FY 2018, while the new EfW in Palm Beach County guarantees PAC usage at 0.38 lbs/ton processed. However, in CDM Smith's opinion, it is better to maintain a conservative approach for PAC which is effective in capture of mercury compounds and other regulated pollutants.
- PAC cost has been reduced from $900 to $600/ton delivered based upon current operating EfW data.
- Ammonia consumption rate has been estimated at 2 lbs/ton MSW processed. Ammonia is typically injected in dilute concentrations into the furnace and boiler sections of the combustion process to reduce the nitrogen oxide emissions. As a reference, HCRRF consumed 1.05 lbs/ton MSW processed in FY 2012 and 1.33 lbs/ton in FY 2018, while the new EfW in Palm Beach County guarantees ammonia usage at 0.95 lbs/ ton processed. The new EfW facility in Palm Beach County is equipped with SCR technology to meet the more restrictive limits on the amount of nitrogen oxides emitted from this facility.
- Ammonia cost has been increased from $300 to $500/ton delivered based upon current operating EfW data.

EfW Facility Operation and Maintenance Costs – Utilities Usage and Costs

- Potable water consumption rate has been reduced from 75 gallons/ton MSW processed to 50 gallons/ton. This water supply is assumed for domestic potable uses and makeup supply for boiler water treatment system. The HCRRF used 47.3 gallons/ton MSW processed in FY 2012 and 101.7 gallons/ton in FY 2018. The new EfW facility in Palm Beach County uses a minimal amount of potable water because of an elaborate water reuse scheme, which includes rainwater harvest from 7.5 acres of roof, along with recycling groundwater that is withdrawn to maintain an inward gradient at the adjacent landfill.
- Potable water cost of $7.50/1,000 gallons has been maintained for the 2020 updated analysis. The trend within the EfW industry has been to reduce potable water by using lower quality waters for plant cooling needs. In many cases where locally available, reclaimed water is used as makeup water for cooling towers, fire water storage tanks, and plant irrigation. The Hillsborough County RRF has used reclaimed water for cooling since its commercial acceptance in 1987. The rate for the cost of reclaimed water can be estimated at 50% of the cost of potable water. The most recent EfW project in Palm Beach County uses an air-cooled condenser in lieu of an evaporative cooling tower to minimize the use of local water supplies.

- Wastewater disposal treatment rate has been maintained at 100 gallons/ton MSW processed. For reference, HCRRF used 89 gallons/ton MSW processed in FY2012 and 65.6 gallons in FY2018.
- Wastewater disposal cost has been maintained at $7.50/1,000 gallons for treatment by a local WWTP.

<u>EfW Facility Operation and Maintenance Costs – Ash and Bypassed Waste Disposal Costs</u>

Ash is a byproduct of the combustion process and includes the bottom and fly ash. Bottom ash is dense and is the bulk (~90%) of combustion ash, while fly ash consists of finer particles (10%).

The combined ash is typically disposed in a Subtitle D landfill, both monofills and combined waste (MSW and ash) landfills.

- Ash generation rate has been reduced from 25% of MSW processed to 22%. For comparison, the combined ash generation rate at the HCRRF was 24.0% in FY2012 and 21.72% in FY2018. There has been a gradual reduction in ash residue generation rate over the recent years due to the improved ability of the metal recovery systems and attention paid to moisture content of the ash discharged from the expellers.
- An ash recycling rate of 0.0% has been assumed for the preliminary base case analysis. There are viable options for recycling ash residue for use as an alternate daily cover (ADC) on existing lined landfills, along with other technologies for beneficial use of ash residue as construction aggregates or feedstock for production of Portland cement. None of these options were considered for the 2012 analysis and will not be included in this updated analysis. However, on-going ash recycling research by Dr. Timothy Townsend of the University of Florida Hinkley Center has led to approval by Florida Department of Environmental Protection (FDEP) for use of bottom ash in Pasco County, Fl for public works projects, including road base and asphalt and concrete aggregates. Current research is continuing for investigation of the feasibility of using a certain fraction of bottom ash for use as a substitute feedstock in production of Portland cement. Using a fraction of the bottom ash in the future will improve landfill diversion, reduce greenhouse gasses, and likely reduce disposal costs.

  InAshCo (located in the Netherlands) reports that, based upon tests they performed under the watch of a regulatory committee, up to 50% of aggregates in concrete without reinforcement may be substituted with treated bottom ash, and up to 20% of the aggregates may be substituted in concrete with reinforcement. Examples of applications include blocks, blocks, bricks and water conveyance pipes. None of these advanced ash recycling options are included in this conceptual economic analysis as they do not represent significant revenues.
- The landfill disposal tipping fee has remained at $20.00/ton for transportation and disposal of ash residue and any bypassed or non-processible waste. This value assumes that the municipality owns its own landfill and will only pay the incremental cost, or the contracted

landfill operator processing fee for ash disposal. This assumption is supported because EfW ash is often recycled as an ADC in lieu of soil for daily cover and other approved uses on lined landfill sites. This beneficial use of ash residue can result in minor system wide cost savings but has not been factored into this conceptual analysis. Currently in North Carolina, ash is not an approved ADC.

EfW Facility Operation and Maintenance (O&M) Costs – Labor Costs

- The driver of the O&M cost is the contract operator's O&M fee. The O&M fees at EfW facilities depend upon many variables ranging from size of plant; risks shared between owner and operator; pass-through costs for utilities and reagents; and sharing of revenues associated with the sale of electricity, steam, and recovered metals. The year 1 O&M contractor service fee has been increased from $32.50/ton of MSW processed to $37.50/ton to account for impact of inflation and additional O&M expense of operating and maintaining the AMR process. This fee does not include the cost of ash disposal, reagents or utilities, which are accounted for elsewhere in the model.
- Internal (Wake County or other managing entity) project management staff costs remain at 0.05% of the EfW capital cost to cover the cost of special solid waste staff to administer the contract terms and conditions for the EfW facility operated by a private contractor. This value includes wages and benefits.
- Environmental consultant fees remain at 0.05% of EfW capital cost for the contract services of a qualified consulting engineer to assist the solid waste staff with independent inspections and monitoring of plant performance, technical and contractual administration of the EfW project.
- Miscellaneous annual fee of $50,000 has been assumed for a Title V air permit fee which is administered by the state.

3.2.3 Preliminary Economic Analysis

Based upon the parameters noted above, the following year 1 conceptual results have been estimated by the updated 2020 financial model:

EfW Performance

- EfW size = 1,800 tpd at an annual availability of 90%
- Total MSW processed = 591,705 tons/year
- Total net electrical production (sold) = 360,348 MWh/year
- Total potential RECs based upon total electricity generated = 360,348 RECs
- Total ferrous metals recovered = 23,668 tons/year
- Total non-ferrous metals recovered = 4,142 tons/year

- Total ash residue generated for disposal = 130,175 tons/year
- Total ash residue diverted for beneficial reuse = 0 tons/year

<u>EfW Revenues</u>

- Revenue from sale of net electricity @ 3 cents/kWh & 90% revenue share = $9,729,405
- Revenue from sale of RECs = $ 0.00
- Revenue from sale of recovered ferrous metals at $100/ton = $2,366,820
- Revenue from sale of recovered non-ferrous metals at $500/ton = $2,070,968
- Revenue from sale of ash for beneficial reuse = $0.00
- Estimated total year 1 EfW revenues =$14,167,193 (base case)

<u>EfW Cost</u>

- EfW plant capital cost = $551,475,000 (includes debt service, consultant fees, and issuance of debt fees)
- Capital debt service cost of EfW facility = $37,190,938/year (25 years at 4.5% interest)
- O&M fee =$24,654,375/year (typically escalates annually thereafter against published indices)
- Ash disposal cost = $2,603,502/year
- Total reagents cost = $1,618,313/year
- Total utility cost = $1,694,864/year
- Total miscellaneous cost = $563,000/year
- Estimated annual cost of EfW process = $68,324,992/year (base case)

3.2.4 Base Case Economic Analysis

An 1,800 tpd massburn EfW facility has been selected as the base case option due to the expected population growth in Wake County over the next 15 years and large combustible waste stream. Based upon the above assumed parameters, the estimated net cost (after revenues) of the EfW facility is $54,157,799 in year 1. This equates to an average unit cost of $91.53/ton of MSW processed, assuming 90% availability. This is an increase of 12.7% compared to the 2012 analysis.

The primary reason for the increase in estimated annual cost is due to the 50% reduction in the price paid for electricity in the current electrical market. This loss of revenue was only partially offset by the extension of the bond period from 20 to 25 years, 0.5% reduction in borrowing costs, and increase in metal recovery rates. Like the decline in electricity payments, commodity metals have also experienced a decline in prices paid for ferrous and non-ferrous metals.

Figures 2 and **3** graphically present the percentages of revenue sources and costs in year 1.

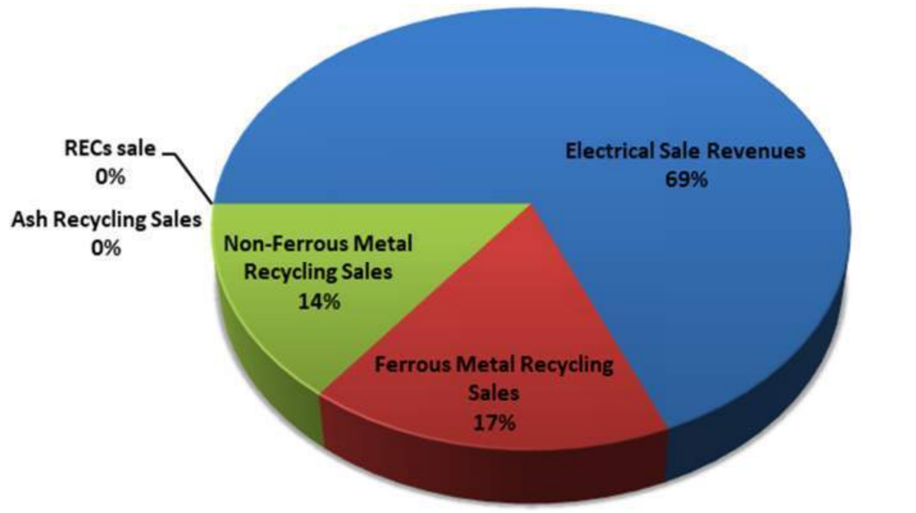


Figure 2. Base Case Revenue

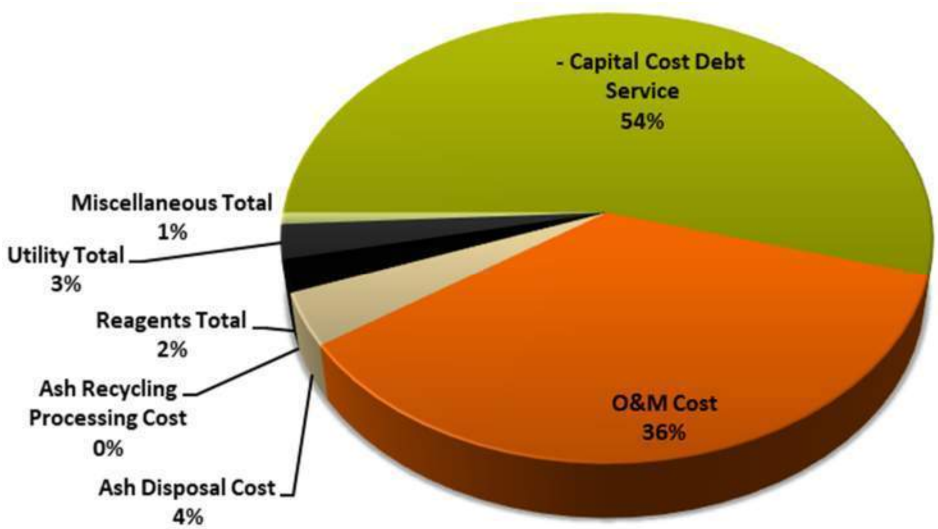


Figure 3. Base Case Costs

3.2.5 Sensitivity Analysis

A series of better case and worse case alternate scenarios were developed to evaluate the sensitivity of changing inputs on the average unit MSW processing cost per ton. These cases vary the parameters that would have major impact on the final year 1 cost per ton. For example, increasing the electrical sale rate from 3¢/kWh to 4¢/kWh decreases year 1 cost by $5.48/ton. Revenues from the sale of RECs at $10/REC would reduce year 1 cost by $7.00/ton. Decreasing the capital cost by 10% would reduce year 1 cost by $6.37/ton. The results are summarized in **Table 4.** **Figure 4** displays the different costs per ton in a bar chart for easy comparison. Although not included in the sensitivity analysis, every $1,000,000 in revenues derived from sale of assured destruction of special wastes results in the reduction of approximately $1.70 in cost per ton (see **Section 4.4** for further discussion of special waste destruction). In summary, the estimated cost of processing MSW based upon the assumptions in this financial model for a modern massburn EfW facility ranges between $65/ton to $117/ton.

Additional analysis of the overall solid waste management system on a life cycle basis would be necessary to calculate the overall cost and benefit of an EfW project. As an item of note, a report (December 2011) was published by the Applied Research Foundation (ARF) of the Solid Waste Association of North America (SWANA) titled "*The Economic Development Benefits of Waste-to-Energy Systems."* This report evaluated the long-term performance of EfW facilities over a 40-year lifecycle compared to disposal at remote regional landfills. The analysis showed a significant overall lifecycle cost benefit due to the predictable nature of costs and benefits of EfW over a 40-year period. The retirement of the EfW project revenue bonds occurs at the mid-point of the project life, which translates into overall project benefits.

An example of the impact of retiring the debt of EfW facilities occurred approximately 9 years ago in Kent County Michigan. The Kent County Department of Public Works burned the mortgage for the EfW which it opened two decades ago. By paying off the debt, the county was able to reduce the tipping fee it charges waste haulers by 35%. On January 1, 2011, the rate per ton paid by haulers at the facility was decreased from $73.24 to $47.37/ton.

Table 4. Sensitivity Analysis Summary

Parameters	Base Case	Better Case (Lower Cost)		Worse Case (Higher Cost)	
	Original Values	Parameter Variation from Base Case	Individual Cost Difference ($/ton)	Parameter Variation from Base Case	Individual Cost Difference ($/ton)
Electrical Sale Rate (¢/kWh)	3.00	4.00	$86.05	2.00	$97.01
Sale of RECs @ $10 (% of gross electric used for REC Sale)	None	100%	$84.53	None	$91.53
Project Interest Rate (%)	4.5%	4.0%	$88.33	5.0%	$94.80
Project Capital Cost ($/ton)	285,000	256,500	$85.16	313,500	$97.90
Financing Period (years)	25	30	$85.89	20	$100.32
	Base Case Cost per Ton with all parameters above ($/ton)	**Better Case Cost per Ton with all parameters above ($/ton)**		**Worse Case Cost per Ton with all parameters above ($/ton)**	
	$91.53 (was $81.25 in 2012 analysis, +15%)	**$64.62** (was $48.93 in 2012 analysis, +35%)		**$116.51** (was $100.71 in 2012 analysis, +18%)	

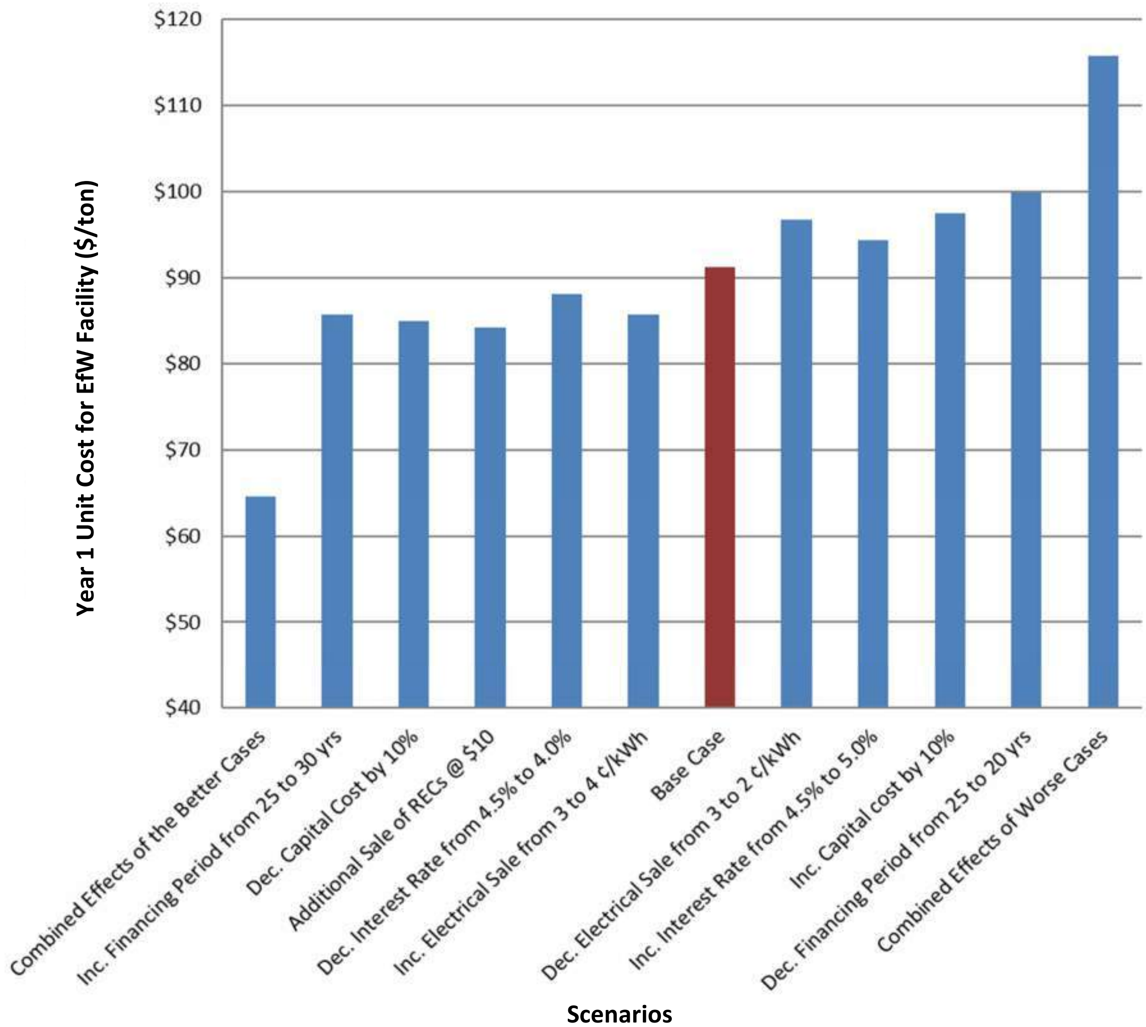


Figure 4. Sensitivity Analysis – Year 1 Scenario Costs

3.3 Summary of Financial Analysis

Estimated year 1 cost for an 1,800 tpd EfW facility built in 2020 has increased by around 13% from $81.25/ton to $91.53/ton due to rising project costs and reduced revenues, as summarized below.

- Major cost increases are due to increased capital cost associated with inflation and addition of an AMR system. Unit capital costs increased from $250,000/ton of daily capacity to $285,000/ton.
- Major revenues reductions are from the sale of electricity, ferrous and non-ferrous metals. All three of these revenue sources have declined since the 2012 analysis. The sale of electricity has dropped 50% from 6¢/kWh to 3¢/kWh. The long-term outlook for improvements in these revenue streams is not clear due to lack of federal energy policy and state incentives for

electricity derived from MSW. Evolving climate change concerns may have some impact on the electric markets in the coming decade.

- A lower cost of financing is assumed. The interest rate has been reduced from 5.0% to 4.5% and bond term increased from 20 to 25 years. Additional cost savings may be achievable if interest rates continue to drop. Sensitivity analysis with 4.0% interest rate and 30-year bond term results in a 10% reduction in estimated cost at $82.57/ton, which is very close to the $81.25/ton estimated in 2012.
- AMR system improvements will result in recovery of ~5% of ferrous and non-ferrous metals from processed MSW, helping to improve local recycling and landfill diversion rates.

4.0 Major Features and Advancements in EfW Industry

4.1 Evolution of Massburn EfW Technology

Energy from waste (EfW) technologies are increasingly being considered as a potential key part of an overall integrated solid waste management system. The role of EfW technology is to provide a system that can process the remaining portion of the waste stream after recycling, composting, and reuse into an alternative form of energy (e.g., steam and electricity). The value EfW provides is that the portion of the solid waste stream that has typically been thrown away in a landfill can be used to generate renewable energy. In the prior 2012 study, CDM Smith identified massburn waterwall combustion technology as the best fit proven EfW technology for Wake County.

Massburn EfW is not sensitive to the makeup of the feedstock, both in composition and physical characteristics, and can typically process solid waste with heating values ranging from 4,000 to 6,000 British thermal units (Btu)/pound. Massburn technology does not require any pre-processing or sorting of the incoming wastes, other than the removal of bulky items which may not pass through the width of the feed hopper, or prohibited items. Bulky materials, which are waste with dimensions greater than 4 feet in size (e.g. white goods, 55-gal drums, rolls of carpets, large tree stumps) are typically removed from the process to avoid plugs in the feeding system or ash expellers.

Modern EfW trends have made significant strides in the pursuit of advancing efficiency, improving facility aesthetics, and meeting goals of sustainability. These trends include reduced air emissions, reagent consumption and water consumption, along with improvements in gross and net electric generation.

Worldwide, Europe continues to lead with many advancements in massburn EfW technology. The evolution of the entire process continues to advance, from introduction of the MSW fuel to the treatment of flue gas. These improvements include: advanced computer based intelligent combustion controls, water and air cooling of the high wear zones of the grates and boiler, improved boiler metallurgy and refractories, improved operation and maintenance techniques such as on-line boiler cleaning, and optimized flue gas treatments (wet flue gas treatments are often provided in European EfW facilities, whereas the dry/semi-dry treatments are more often provided in the U.S.). Options for incorporation of higher heat recovery boiler pressures to increase the amount of energy and greater capacity turndown ratio are also available. Other enhancements include AMR systems, which have accelerated the beneficial reuse of ash residue as construction aggregates and feedstocks for manufacture of Portland cement in Europe. Widespread use of distributed heating, including use of hot water for community benefits, such as heating community centers, pools, greenhouses, and adding community specific unique architectural features that offer new economic opportunities, such as the ski slope/hiking trail feature which has been constructed over much of a new EfW facility in Copenhagen, Denmark. There are facilities in Spain and Finland which produce much more power by combining a natural gas fired turbine-generator with an EfW steam water cycle, raising the overall efficiency to more than 40%, compared to 22 to 25% of a conventional EfW facility. The largest EfW facility in the world is currently under construction in Shenzhen China (5,600 tpd) and will be co-located with a desalinated water treatment plant rated at 125 million gallons per day. Electricity from the EfW facility will be used to power the desalination water treatment plant. Advancements in Europe are typically implemented in the U.S. after demonstrated success.

Technical trends in the U.S. include the ability of EfW to meet more stringent emission limits and GHG reporting, ability to process MSW with higher heating values (HHV), automated refuse cranes, increased boiler and turbine-generator availability, use of reclaimed water for cooling, use of air cooled condensers in lieu of water cooling, use of SCR technology for minimization of NOx compounds in flus gas, AMR systems and continuing research for the beneficial reuse of ash.

Many of the U. S. EfW facilities have been in operation for over 30 years, with a service life expected to provide service for 45 to 50 years with proper attention to operation and maintenance. There have been a handful of facility expansions in the U.S. by municipal owners, and one new state of the art facility commissioned in 2015 in Palm Beach County Florida. Greater attention is paid to aesthetics/LEED®/innovation in the new construction projects, with first class public education centers and visitor facilities.

Many communities in the U.S. and worldwide have also found innovative approaches to obtain greater benefits from their investment in EfW technology. These ancillary processes include: Co-combustion of WWTP biosolids, combustible wastes from C&D debris, used tires and oils, bulky wastes after resizing, USDA regulated wastes (i.e., International Wastes), special wastes in need of assured destruction, leachate disposal and material recovery facility (MRF) residuals and rejects. Several communities which own EfW plants use the electricity from the EfW facility to power their adjacent water treatment facilities and other public works/municipal infrastructure. Additional information describing how Hillsborough County has successfully used electricity from their EfW facility to power several of their Public Works operations is provided in **Exhibit C**. Several EfW owners have had success in the sale of carbon credits on their new expansion units which are sold on the U.S. voluntary carbon markets.

In October 2019, the City of Tampa announced their intention to take over the day-to-day operation and maintenance of their 40+ year old 1,000 tpd EfW facility which has been operated by

Wheelabrator for the prior 30+ years. While it is not unusual for municipalities to operate and maintain smaller size EfW facilities, there are risks and rewards to their operation of larger sized facilities. A similar event took place in November 2014 in Spokane Washington at another EfW facility operated by Wheelabrator. In both above cases, the municipality essentially hired, or plans to hire most of the Wheelabrator employees to maintain a seamless transition. The benefit of municipal ownership is that there is not a need to generate profit from the facility; however, there are several institutional changes which are necessary for municipal ownership to attract and maintain qualified personnel at the level of pay that is appropriate for operation and maintenance of this sophisticated industry. At this stage of evaluation, CDM Smith does not recommend municipal operation of a future EfW facility in Wake County.

CDM Smith's recommendation for a best fit EfW facility for Wake County is further described in **Section 4.5**.

4.2 EfW in Europe versus the U.S.

EfW is currently not as prevalent in the U.S. as it is in Europe. To fully explain this difference, it is important to understand the directives that govern the European Union (EU) for the management of waste. The stated goal in Europe for phasing out landfilling is not due to the lack of available space but is in response to the scientific understanding that putting waste into landfills is not an appropriate solution when considering environmental impacts over time. The reasons are obvious and compelling: landfilling of municipal waste poses inherent risks to human health (leachate into groundwater, emissions into the air), the release of climate damaging gases (CO2, CH4, NH3, etc.) and the squandering of resources that otherwise could replace primary raw materials or fossil fuels (energy raw materials).

The Waste Framework Directive of 2008 (Waste Framework Directive 2008/98/EC) established formal legislation regarding landfills. The regulation established the following hierarchy (order of priority):

1. Avoidance of Waste
2. Preparation for Reuse
3. Recycling (material utilization)
4. Other utilization (use for the production of energy and recovery of materials)
5. Landfill

The adaptation of the principles established in EU directives is an ongoing process. Recent amendments of the Landfill Directive included future quantitative mandated goals for recycling of MSW and packaging materials, along with a maximum of 10% of municipal waste allowed to be landfilled. The main target in view of sustainability is the prevention of direct disposal of reactive organic waste in landfills. The tools to comply with these principles are recycling, material recovery, and waste incineration with energy recovery for the sterilization and rendering of inert materials.

The waste framework directives in Europe have provided impetus for member countries to move up the waste hierarchy by constructing EfW facilities to produce energy and recover material resources. This type of legislation has not yet been adopted in the U.S., and consequently landfill disposal is still the low-cost solution for waste disposal. In Europe, there is a substantial surcharge assessed to MSW going to a landfill that results in a strong economic disincentive to landfill. EU's sustainable waste management policies have also resulted in substantial landfill taxes being established in many EU countries that leveled the playing field for EfW. While the Mediterranean countries are not aggressive in curtailing landfilling, the more affluent countries like Austria, Belgium, Denmark, France, Ireland, Sweden and the United Kingdom have landfill taxes exceeding 50 Euro/tonne. Germany opted to skip a tax and instituted a strongly enforced ban of unprocessed MSW landfilling. These are the countries with most of the EfW plants.

One major factor in the EfW industry in the U.S. is due to the decline in prices paid for the sale of electrical energy by IOUs and other bulk energy purchasers. In the past, long-term (20 year) PPAs were commonplace and based upon the avoided cost of the IOU's next power production unit, which was typically coal fired. Today's generation of base loaded power plant is powered by natural gas at a significantly lower cost than coal.

Aside from lack of a national or state energy policy, other impediments to EfW in the U.S. include short election cycles for politicians (results in a project not being able to be completed before the next election), existing landfills which offer lower cost disposal alternative, and an entrenched opposition from environmental groups to the concept of combustion as a viable treatment for waste.

4.3 Options for Combined Heat and Power (CHP)

An increase in the energy and cost efficiencies can result from the synergistic use of the energy, both heat and power from EfW facilities to help improve operating revenues. Typically referred to as a combined heat and power (CHP) projects, the synergistic use of heat and power can be beneficially used at publicly owned facilities, such as the community's utilities (water and wastewater treatment plants), public works and other institutional facilities. Typically, these facilities would need to be co-located to avoid conflicts with transmission of electricity on IOU power lines. As an alternate, a dedicated transmission line could be constructed to connect the facilities, but this adds a significant layer of complexity to an EfW project. The U.S. Department of Energy (DOE) is promoting CHP projects and willing to help communities in their first step toward finding a use for CHP by funding the community's initial feasibility study.

This type of project can also be developed with power only as a microgrid project. A microgrid is a local energy grid that can operate autonomously and connect and disconnect from the traditional energy grid at will. Microgrids are being promoted by the DOE to ensure greater reliability of electric power to critical municipal services (utilities, emergency response, power, etc.), and may also prove to be of value in securing improved revenues and/or reduced costs to the owner. As an example, Hillsborough County, Florida, is currently operating one of its wastewater treatment plants and water treatment plants with electricity generated by its 1,800 tpd EfW facility. They are also currently evaluating additional “behind the meter” uses for the internal use of power to include an adjacent public works campus.

CHP projects have been widely deployed in Europe as a way of increasing the overall EfW facility thermal efficiency from 20 to 30% to more than 85% by using waste heat from the production of electricity. In traditional power plants with electricity production only, the overall thermal efficiency is approximately 20 to 30%. In this arrangement, excess heat is discharged to the atmosphere via the cooling system and stack gasses. CHP can create various forms of energy including electricity, heat for district heating purposes, steam for process use, cooling for air-conditioning, or energy for water treatment (desalination, and other alternate supply sources). By also extracting energy from the flue gas by condensation and heat pumps, it is possible to achieve up to 100% energy efficiency (based on the net calorific value). In the U.S., district heating systems are generally located in the northern tier states, although the City of Nashville has a heating and cooling district which serves many of the buildings in the downtown district. It was once powered by the Nashville Thermal EfW facility, which has been replaced by a natural gas-powered facility since early 2000. The Hennepin County Minnesota EfW facility was recently refurbished and now provides supplemental steam to the downtown heating district.

Several U.S. EfW facilities were developed as steam exporting facilities. The City of Indianapolis’ EfW facility was originally developed as a steam exporting facility with medium pressure steam sold to an adjected pharmaceutical production facility. This project has been reconfigured as an electric generating facility and no longer exports steam. The City of Huntsville Alabama is another currently operating EfW facility which exports steam to the U.S. Army Redstone Arsenal, located approximately 8 miles from the EfW facility. Steam can be used for district or industrial heating, or as a source of motive power for chilled water systems. In this configuration, EfW steam can be used to help meet the cooling demands for a municipal chilled water district or other industrial processes.

Obstacles and challenges for developing EfW as CHP projects include finding a steam or chilled water host which closely matches steaming conditions of the EfW facility on an annual basis. Since an EfW facility typically operates at full power throughout the year, a steam or chilled water host should likewise have a steady demand that is predictable and closely follows the EfW facility. An EfW facility which provides steam or chilled water to offsite facilities may also need to be configured with redundant steam and chilled water sources to provide uninterrupted service for planned and/or unplanned maintenance outages. While all of this may seem daunting, there may be synergistic opportunities in the region. In the late 1990s, a startup EfW firm named Vedco developed several projects in North Carolina in which they proposed to use refuse derived fuel (RDF) from mixed waste processing facilities to generate steam for use at Dupont manufacturing facilities in North Carolina. Several projects were developed, but problems with the fuel preparation system ultimately led to bankruptcy and closure.

Other obstacles which complicate the development of CHP type project include the need to provide redundancy of the steam supply system to ensure that the host facility will not be adversely affected during planned or unplanned EfW outages. This redundancy may be provided by the host facility. If required at the EfW facility, it will add to the cost and complexity of the project.

CDM Smith has not analyzed the financial impacts of a CHP project at this time because it would require numerous site-specific parameters to accurately assess the financial benefits of such a project. Nevertheless, there may be opportunities to develop CHP as part of a future business park or eco-campus which is dedicated to the processing, recovery and reuse of recyclables and recovered materials from MSW.

4.4 Enhanced Revenues from Special Waste Programs

Many elements of the local and regional waste stream can be co-combusted in EfW facilities as part of a special waste service. Many of these materials may currently be collected separately to prevent these materials from being deposited in the landfill but are difficult and costly to recycle or dispose of. An EfW facility provides a safe, economical, and sustainable treatment process for these types of acceptable materials. If acceptable to Wake County, a future EfW facility could be sized to allow additional capacity for processing special wastes which could provide a regional benefit to local industry and institutions to generate additional revenues to help offset the costs borne by the facility rate payers.

Many of the special wastes listed below command higher tipping fees when available EfW capacity exists and can generate significant revenues to help offset the costs to the system ratepayers. On a service basis, EfW provides a disposal market that can meet the demands for discrete, convenient (24/7 operation) and assured destruction of materials. For example, the Lancaster (PA) Solid Waste Authority constructed a dedicated building adjacent to their tipping building for receiving and storage of special wastes that are sourced for assured destruction in their 1,200 tpd EfW facility. This program has generated significant revenues on an annual basis since its inception more than ten years ago. Many EfW facilities charge higher rates for disposal during off-hours and do receive significant amounts of waste materials during that time period. Many of the municipally-owned EfW plants also offer assured destruction of contraband that is collected by their police and fire departments. On a similar note, Covanta Energy also offers assured destruction services at many of their merchant plants.

The list of special wastes which can be co-combusted at an EfW facility includes:

- WWTP residuals and biosolids (in the range of 5 to 10% of MSW throughput)
- Used oils (<5% of MSW throughput)
- Used tires (whole or preferably shredded into 6-12" pieces)

- USDA regulated garbage (also referred to as "International Waste")
- Auto shredder residue
- Animal carcasses
- Contraband collected by law enforcement agencies
- Recycling facility rejects and residues
- Bulky waste (after size reduction)
- Combustible fractions of C&D waste
- Special liquid waste, such as discarded fats, oils and grease (FOG) and paints
- Other special waste in need of assured destruction
  - Expired and discarded pharmaceuticals
  - Confidential documents and papers
  - Uniforms
  - Industrial wastes
  - Illegal drugs and contraband
  - Unsalable manufactured products
  - Out of spec or out of date products

4.5 Best Fit EfW Facility Configuration for Wake County

The following summarizes a conceptual, best fit EfW facility configuration in Wake County.

- The EfW facility would be capable of processing a minimum of 1,800 tpd in three combustion lines of 600 tpd each. If a regional facility were to be considered that accepts waste from outside of Wake County, a facility as large as 3,000 tpd has been proven in several communities in the U.S., including Pinellas County Florida (1983), Fairfax County Virginia (1990), and most recently, Palm Beach County Florida (2015).
- The EfW facility layout should allow for future expansion of one additional combustion train of the same general size as the original facility (600-750 tpd size). The expansion would require the addition of the new combustion and flue gas treatment system, turbine generator and associated electrical controls and distribution, cooling system and stack flue.
- The EfW site would require approximately 15 acres for the EfW processes and related buildings, plus additional acreage required for buffering and meeting local stormwater collection, storage and treatment requirements. One potential 15-acre location adjacent to the SWLF is shown in **Figure 5**. The location is within the 47.7-acre County-owned area that

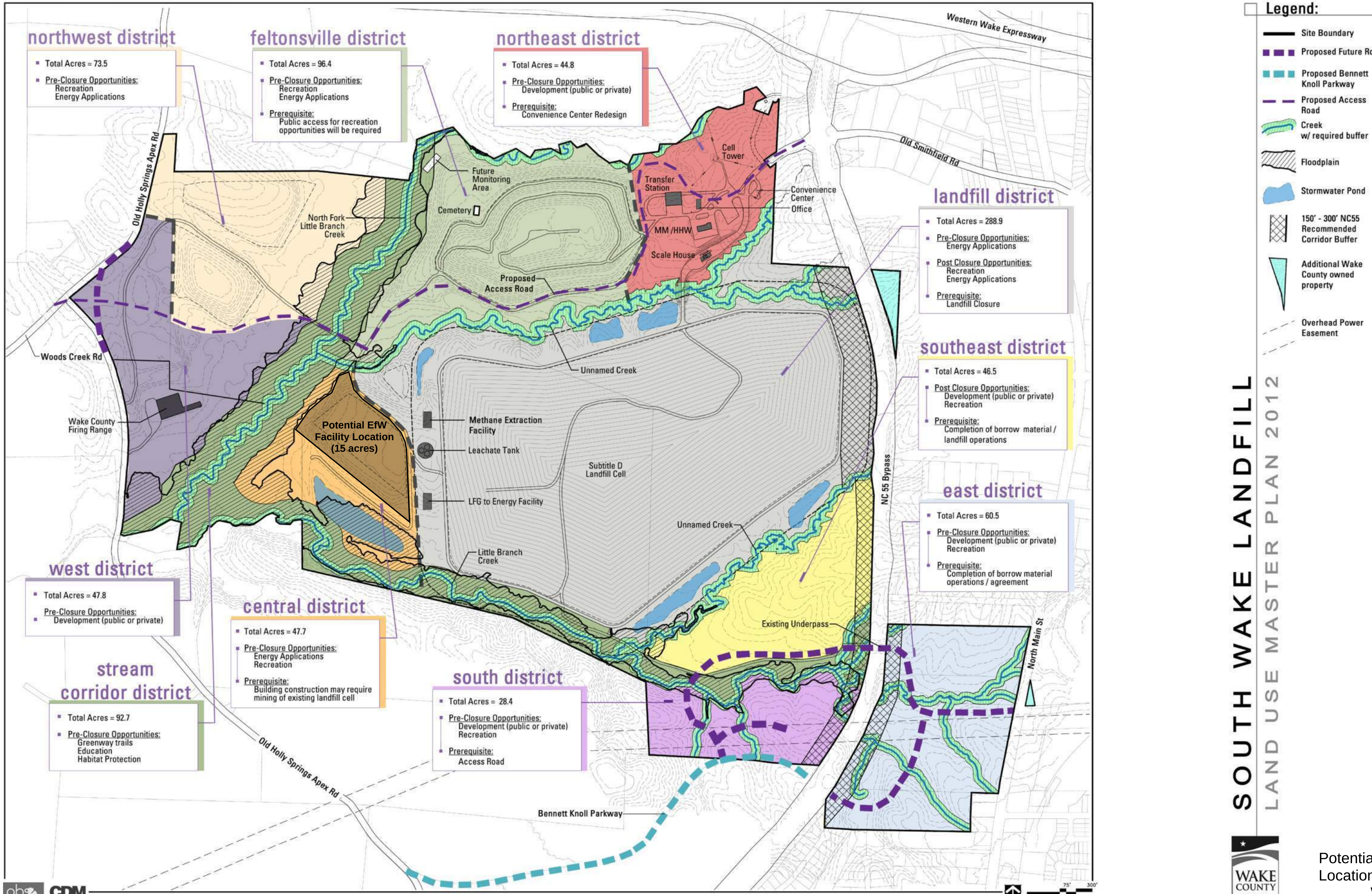


Figure 5.
Potential EfW Facility Location at the South Wake Landfill

Source: 2012 South Wake Landfill Land Use Master Plan was identified as the Central District in the 2012 SWLF Land Use Master Plan. This location offers the following potential benefits:

- Adjacent to the existing SWLF which could be used for ash disposal.
- Adjacent to the existing SWLF Landfill Gas (LFG) to Energy Facility. Excess LFG (when available) could be used as a supplemental fuel source for the EfW facility.
- Adjacent to the existing SWLF Leachate Tank, which offers the potential for leachate use (after appropriate treatment) at the EfW facility.
- Adjacent to an existing stormwater retention pond, which could be used for management of stormwater runoff from facility parking lots and roofs.

Portions of the Northwest District (73.5 acres) and West District (47.8 acres) may also offer the opportunity for siting EfW facility buildings and ancillary structures.

- An EfW facility buildings and ancillary structures would include:
  - Weigh scales (two inbound scales and one outbound scale minimum) including scale house for administration staff.
  - Refuse receiving hall - fully enclosed with fire protection. The building will have rapid opening and closing rollup doors to minimize escape of odors. The receiving area will have an adequate number of tipping bays/positions to allow efficient packer truck and transfer trailer deliveries, with turnaround time of less than 15 minutes.
  - Refuse storage pit – fully enclosed with fire protection and designed for minimum of 7 days of storage. Space would be provided at one end of the pit to accommodate future expansion of the facility. Multiple overhead bridge cranes would allow manual to fully automatic control.
  - Boiler building – fully enclosed with fire protection. Boiler combustion technology will be provided by multiple massburn wall units, complete with computerized combustion controls, wet ash expeller and NOx control injection (urea or hydrous ammonia).
  - Air pollution control building – fully enclosed to house best available control technology, which will include spray dryer absorbers (SDA) with powdered activated carbon and slaked lime injection, fabric filters, and SCR technology. This treatment system models the most recently constructed system in Palm Beach County Florida and should meet current federal air regulations, including low NOx emissions.
  - Continuous emission system enclosure – for continuous monitoring of regulated pollutants (CO, SOx, NOx, possibly mercury and HCl).
  - Ash management building – fully enclosed with advanced metal recovery system for optimized recovery of ferrous and non-ferrous metals. Adequate number and size of

bunkers will be provided to allow storage of materials for up to 4 days of production to accommodate weekends and holidays.

- Turbine-Generator building – fully enclosed and configured to allow for future addition of expansion project turbine-generator.
- Electrical switch gear room – fully enclosed with fire protection.
- Control room – fully enclosed with fire protection.
- Fenced switchyard for export of electricity to local electrical grid.
- Air-cooled condenser in lieu of wet cooling tower to significantly reduce water usage.
- Stack with multiple flues, including a spare for future facility expansion.
- Water treatment building and storage tank(s) for treatment of source waters for auxiliary cooling, boiler makeup and scrubber dilution and slaking water.
- Maintenance building – fully enclosed with fire protection and interior fenced storage, small air-conditioned storage room for electronic and other special parts. Building would also include air-conditioned offices, lockers and shower facilities for O&M staff. Maintenance bays and overnight parking spaces for dedicated plant mobile equipment also to be provided.
- Administration building – fully enclosed with air conditioning and fire protection. This facility will provide space for contractor operation and administration staff, along with area dedicated for County staff, along with meeting/conference rooms.
- Visitor Center – this facility is optional and could be combined with the Administration Building discussed above. If provided, the facility is typically provided with rest rooms, conference and meeting rooms, and educational displays for public education.
- Ancillary process equipment – includes fire pump house, wastewater and firewater tanks, fueling station, wastewater settling basin, chemical storage area and tanks.
- Utilities – typically include potable water, sanitary sewer, reclaimed water, natural gas and/or treated landfill gas.
- Rainwater harvesting system from building rooftops consisting of collections system, and harvested storage tanks and associated pumps and piping for supply to EfW water uses, including landscaping.
- Network of roads and driveways for delivery of MSW, reagents and parts, hauling of ash and recovered metals, and access for visitors and staff.
- Pavements for employee, visitor, contractor and special needs parking. Also, will include hot load discharge area with containment for leachate.

- Site landscaping using xeriscaping and native vegetation and ground covers to minimize need for mowing.

4.6 Time Line for EfW Project Development

A representative timeline for a typical EfW project is optimistically shown in **Figure 6** for an estimated duration of 7 years from start to commercial operation. This duration can become longer, especially in Phase 1 due to the site selection and public involvement processes.

Activity	Duration (days)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Phase 1											
Project Feasibility and Scoping	365-730										
Permitting	365										
Project Technical Specifications	365										
Public Input	365										
Phase 2											
Procurement (Select Design, Build, Operate Contractor)	180-270										
Financing	120										
Phase 3											
Construction	1,000-1,500										
Startup and Comissioning	90										
Commercial Operation	20 year (initial)										

Figure 6. Representative EfW Project Timeline

EfW Project Development Process

The development process for an EfW project can be divided into many discrete steps and can take from 5 to 10 years or more to complete, depending upon the extent of the project planning, scoping, and public comment activities. The implementation schedule for an EfW project typically consists of three general steps; (1) Project Feasibility, Permitting and Financial Planning; (2) Procurement and Financing; and (3) Design, Construction, Commissioning, Acceptance Testing and Long-term

Operations Oversight. The Feasibility step of the process allows key decisions to be made which ultimately affect the development of the project technical specifications and request for proposals by an independent consultant. Permitting should be initiated early in the process and the permits be near completion prior to issuing solicitation documents. This allows the contracting community to understand that the project is "real", not subject to delay, and define what environmental regulations must be met.

The construction of a new EfW facility will require many permits, licenses, and an extensive public participation and approval process under the State Environmental Policy Act (SEPA). The SEPA process will require that a comprehensive Environmental Impact Statement (EIS) be prepared to evaluate environmental impacts associated with the EfW project. A site for the EfW facility will need to be selected by the County to allow site-specific environmental impacts and mitigation measures to be evaluated in the EIS. Major permits required for a modern EfW facility include a Prevention of Significant Deterioration (PSD) air construction permit prior to construction, and a Title V operating permit and solid waste processing permit once the facility is operational, along with other environmental regulations such as stormwater and other local environmental controls.

As noted above, the addition of the PSD permit can add time to the Feasibility, Permitting and Financial planning permitting phase. Procuring the Title V operating permit and solid waste handling will take place during the construction phase and should not affect the critical path of the schedule. Financing, often using system revenue bonds to achieve the lowest interest rates, is usually undertaken following the selection of the EfW DBO vendor (most EfW facilities are implemented via the design/build/operate (DBO) mechanism) and receipt of required permits. This step involves working with the county's financial advisor, investment counsel, underwriter(s) and the feasibility engineer to develop the Bond Prospectus used to sell the bonds. Procurement includes the preparation of design/build construction and service agreement documents, developing and issuing solicitation documents such as prequalification packages, and request for proposals and vendor negotiations.

The final technical performance requirements are refined and become part of the construction agreement during this step. There are many variations, to the procurement outlined, that can be used under this phase of work. The final phase is for final design, construction, startup, commissioning and performance testing to demonstrate that the facility meets all performance guarantees. A detailed description and guidelines for EfW development process follows. Major questions and considerations that need to be answered and addressed during each phase are noted.

Phase 1 EfW Feasibility, Permitting and Preliminary Financing

A. Solid Waste System Evaluation

1. How is waste collected (may be different for single family, multi-family, institutional and commercial)?
2. Who collects the waste (public or private haulers)?

3. Who owns the waste (flow control issue)?
4. How is waste recycled, what types of waste are recycled and where are the recycled materials sent?
5. Where is non-recycled waste sent/disposed of?
6. Are there feasible programs to improve the recycling quantity?
7. What is the amount of non-recyclable waste?
8. What are the characteristics of the non-recyclable waste (moisture content, organics/inorganics percentages, heat content)?

B. Non-Recyclable Waste Disposal Options

1. Where does the non-recyclable waste currently go?
2. What is the cost for transport and disposal of this non-recyclable waste?
3. Is this disposal option viable in the long run?

C. EfW Facility Configuration

1. Based on the amount of non-recyclable waste (see A.7 above) – define the size of the EfW facility.
2. Does the EfW facility need to serve any other purpose (transfer station, central recycling facility, etc.) – helps determine truck traffic numbers.
3. Does the EfW facility sell/export electric power, steam (to a heating system or business) or both?
4. Does the envisioned EfW need significant utility services (e.g., gas, water, reclaimed water)?

D. Energy Markets

1. Electric power sale – where are potential connection locations? The traditional grid (typically a substation near a major transmission line) or local microgrid .
2. Value of electric power (including conditions like peak/off-peak hours, weekend/holiday discounts, etc.).
3. Steam sale – define steam values and interconnection issues, determine value of steam and other conditions.

E. Determine EfW Location

1. Define site land area required based on above.
2. Define buffer zones (airports, water bodies, flood plains, underlying geology, etc.)

3. Use combination of: a) waste collection routes, b) main roads and c) energy purchaser locations to identify corridors and general areas where EfW could/should be located.
4. Begin site search using multiple factors to identify potential EfW locations – likely require advisory group input.
5. Ultimately identify site and determine costs for: a) land purchase and b) site improvements.

F. Determine Best Financing Option

1. Public financing (sell bonds) – depends on whether bonding capacity exists and whether bonding capacity is available for EfW or other purposes (roads, schools, etc.) – usually results in the lowest interest rate.
2. Private financing – financing can be provided by the EfW DBO vendor but the interest rate will be higher.
3. Blend of above.

G. Select EfW Technology

1. Could go with most prevalent technology (massburn), likely least expensive.
2. Could look at alternative technologies (fluidized bed, gasification, etc.) but far fewer operating facilities and likely higher cost.
3. The use of multi-criteria evaluation matrix may be useful to rank and select approved waste conversion technology(ies).
4. Develop technical specifications for best fit EfW process configuration.

H. Decide on Facility Life, Implementation and Operations

1. What is life of the facility (many plants last forever but there may be an initial period defined as how long it takes to pay back the capital costs – often 20 years)
2. Consider design/build/operate (DBO) – one entity designs, constructs and operates the facility; after the initial contract period, rebid the operation – or retain the original DBO operator if performance was satisfactory.
3. Consider design/build (DB) with municipality taking over operations (not common but there are a few examples).
4. Different blends of above.

I. Environmental

1. Conduct thorough environmental evaluation.
2. Consider air (emissions), land (disposal of ash) and water (site run-off) impacts.

3. Determine if facility can meet all requirements.

J. Permitting

1. Conduct permitting services which will occur concurrently with the feasibility, decision and procurement as the EfW site impacts permitting.
2. Permitting services would likely occur through one central agency, SEPA process.
3. Additional to the typical environmental impacts (air, water, solid waste), considerations and permitting will occur with noise, wildlife impacts, traffic impacts, etc.

K. Decision

1. Based on capital costs, operating costs, expected revenues and financing mechanism, calculate the "tipping fee" over the life of the facility (could be defined as 20 years, 30 years or longer).
2. Compare costs with other options for the disposal of non-recyclable waste.
3. The above comparison can and should be done (present worth) over different system lives – for example, the tipping fee for the EfW facility will likely be higher during the initial 20 year period where the capital cost is being paid off, but drastically reduces after the capital is paid off; compared to alternatives where the tipping cost gradually increases over time due to inflation.
4. Comparison should not be based solely on cost, there are other factors such as longevity of alternative disposal methods, public preferences and other factors as identified by municipal leaders and/or a citizens advisory committee. The use of multi-criteria evaluation matrix (possibly using structured decision making) may be useful to evaluate the project.

Phase 2 EfW Procurement and Financing

A. Seeking Expressions of Interest and Shortlisting

1. A "Request for Expressions of Interest" would be prepared and sent to the vendor community – would include a request for information (technology, experience, ability to design/build/operate (as applicable), who is designer/contractor/operator, etc.).
2. Develop minimum requirements to be a qualified vendor.
3. Based on feedback from the vendor community in their Expressions of Interest, develop shortlist of vendors that meet minimum requirements.

B. Negotiations with Electric Power Utility

1. Determine conditions under which utility will purchase power.
2. Develop preliminary PPA – covers all cost (capital expenses and operation expenses) and technical considerations (high voltage interconnections at EfW, all protective systems, etc.).

C. Develop Financial Plan

1. Preliminary financial plan will have been defined during Feasibility Study.

2. Assume municipality-backed funding (municipality sells bonds or backs private bonds - this is the most typical scenario):

   a. Hire bond council (County may have one on retainer).

   b. Hire financial advisor (County may have one on retainer), needs to include tax advisory services.

   c. Establish financial parameters (amount, life span, interest rates, repayment details, etc.)

   d. Finalize mechanism to sell bonds (may need to approach Wall Street, may need one of the financial houses, etc.).

D. Conduct Legal Services

1. Develop DBO agreement that covers the design, construction and long-term operation; sometimes called the "Service Agreement" (must be done by experienced team).
2. Develop legal mechanisms within the County to back bond sale.
3. May need to revise waste collector licensing regulations to include EfW.
4. Finalize EfW ash disposal location.

E. Revise Waste Collection System and Arrange for Ash Disposal

1. Rerouting waste to EfW facility will require rerouting waste collection trucks, if not adjacent to existing disposal facility.
2. Agree on acceptable disposal terms for EfW ash.
3. County arranges for EfW ash disposal or may include this task within the DBO contract (this is often done to require the EfW ash be acceptable environmentally. The storage, handling and trucking are part of the DBO contract. Finding an acceptable disposal site and delivering the ash to this site are also part of the DBO contract). In Wake County, the SWLF could serve as an ash disposal site, assuming airspace is reserved.

F. Perform Environmental Evaluations

1. Determine which environmental analyses need to be performed and to what extent (varies by state and locality).
2. Perform all required environmental analyses and identify all environmental requirements (air, water, land, etc.) – these environmental requirements become part of the operating agreement (EfW vendor must meet all environmental requirements all the time).

G. Issue RFP to Shortlisted EfW Vendors and Select Vendor

1. Issue RFP to short-listed vendors (must include agreed environmental requirements).
2. Evaluate vendor proposals and select best vendor (there are multiple ways to conduct this task).

H. Finalize all Documents

1. Sign DBO service agreement with selected vendor (includes design, construction and long-term operation).
2. Sell bonds.
3. Finalize all other legal documents.

Phase 3 EfW Design, Construction, Commissioning, Acceptance Testing and Long-term Operations Oversight

A. EfW Detail Design

1. Establish inhouse team to review EfW vendor design and shop drawings.
2. EfW vendor to complete final design drawings and specifications
   a. Process flow diagrams, piping and instrumentation diagrams, and technical specifications
   b. General arrangement drawings
   c. Site layout, paving, grading and drainage drawings
   d. Civil structural and foundation design and drawings
   e. Mechanical and process design and drawings
   f. Electrical design and drawings
   g. Instrumentation and controls design and drawings
   h. Building architectural design and drawings
   i. Site landscaping

B. Monitor Construction

1. EfW vendor begins construction while detailed design progresses.
2. Ensure all building permits are acquired (some may be local).
3. Use CPM schedule to monitor compliance with construction progress.
4. Inspect construction to ensure good quality (minimum weekly).
5. Conduct monthly progress meetings with EfW vendor, Wake County and independent consultant.

C. Prepare for Commissioning

1. EfW vendor to develop commissioning plan and seek agreement by all parties (all requirements should be in the operating agreement) – all parties review & concur.
2. Assemble team to oversee commissioning.

D. Conduct Acceptance Test

1. Prepare acceptance test plan (all requirements should be in the operating agreement).
2. Assemble acceptance test team to oversee EfW vendor acceptance test.
3. EfW vendor conducts acceptance test, Wake County (with assistance from independent consultant) oversees the test.
4. Acceptance test report is written and, assuming passage, EfW vendor begins formal operations.

E. Long-term Operations Oversight

1. Establish oversight team, schedule and description of tasks (all requirements should be in the operating agreement).
2. Conduct long-term operations oversight (minimum annually).
3. Convert environmental permitting from construction to operations.

5.0 Limitations and Benefits of Massburn EfW

Aside from the financial aspects of a massburn EfW facility summarized in **Section 3.0**, there are other potential benefits, limitations and hurdles which may be attributed to MSW disposal at a massburn EfW facility in Wake County. Some of these potential benefits and limitations are summarized in the following sections.

5.1 Environmental Benefits of EfW

Environmental benefits of massburn EfW include:

- Demonstrated ability to meet continually restrictive environmental air emission limits, based on proven and robust waste combustion technology with over 500 installations world-wide.
- Requires a minimum of 20 acres of land, significantly reducing amount of land necessary for long-term sustainable waste management, compared to traditional landfill disposal.
- Aesthetically pleasing, landscaped architectural design and other social benefits can enhance public acceptance without impacting local property values.
- Can extends the useful life of existing landfill disposal capacity by a factor of approximately eight due to 90% volume reduction of MSW into ash residue and higher density of ash versus compacted MSW.

- Creates a chemically benign and biologically inert ash residue that does not generate landfill gas with minimal leaching characteristics (with exception of chlorides).
- Allows recovery of significant amounts of ferrous and non-ferrous metals which increase local recycling rates and provide source of additional project revenues.
- Net reduction of greenhouse gas emissions compared to MSW landfill disposal.
- Significantly less truck miles, compared to hauling waste out-of-county. Reduced truck miles hauling waste for disposal lessens air emissions, improves safety, and reduces wear-and-tear on roads and highways.

5.2 Local / Regional Economic Benefits of EfW

Potential economic benefits of massburn EfW include to the local/regional economy include:

- Creates hundreds of high-quality jobs and a positive economic impact to local economy during 30 to 42-month construction period.
- Creates approximately 50-70 high quality full-time employment positions during long-term 45 to 50-year life of project.
- Provides stable and predictable costs for long-term management of a community's waste.
- High annual reliability (>90%) and base load renewable electrical production facility helps local electric utilities plan and deliver reliable supply of renewable electricity at a price which helps offset the production of fossil power.
- If co-located at other municipal facilities, such as water/wastewater treatment processes, can provide synergistic arrangement for both municipal processes when steam or electricity from the EfW facility is used to power the other municipal infrastructure.

5.3 Limitations and Hurdles of EfW

Some of the potential limitations of massburn EfW and hurdles to overcome include:

- As the financial analysis has shown, EfW has a higher capital and operating cost, compared to traditional landfill disposal over the initial 20- to 25-year financing period; however, once the initial debt has been paid off, the cost for disposal may drop significantly. As previously noted, Kent County Michigan was able to reduce the tipping fee it charges waste haulers by 35% once it retired its debt.
- Successful development of an 1,800 tpd EfW facility will require consensus, coordination and a long-term commitment between the County, City of Raleigh, and the towns. A partnership defined by an interlocal agreement will be necessary to secure the tonnage needed for a financially viable EfW facility. This would be similar to the partnership formed during development of the SWLF.

- The County's and municipal partner's long-term approach to waste reduction and recycling/landfill diversion activities and programs must be thoughtfully considered when committing to an appropriately-sized EfW facility. EfW financials would likely be impacted more by wide swings in waste generation (due to economic conditions, for example), waste reduction and recycling rates, than would landfill disposal.

- Changing economic conditions, such as the recession that occurred beginning in 2008 may elicit reduced growth and reduced waste generation, resulting in less MSW tonnage going to an EfW facility. When less than expected MSW is delivered, other materials such as yard waste, tires or C&D debris may need to be brought to the facility to maintain capacity and prevent a drop in revenue or avoid contract-specified "put or pay" penalties levied by the operator. Having extra capacity to accept other materials can also be a benefit, as discussed in **Section 6**.

- Facility siting and public perception challenges would likely be greater than sending waste outside the county for disposal. While there is a demonstrated ability to meet environmental air emission limits in the U.S. and abroad, some level of public opposition would be expected to a local massburn facility. More effort would be needed to educate and inform the public, given that North Carolina does not have much of a history with massburn EfW facilities.

6.0 Feasibility of EfW Processing Alternative Fuel Sources and Identification of Other Disposal Options

A final aspect of EfW that was examined pertains to the conversion of alternative fuel sources and the identification of other emerging waste conversion technologies. The list of alternative fuel sources includes scrap tires, combustible C&D waste, combustible bulky waste, yard and wood waste, dirty plastics, and sewage sludge (biosolids) – all of which can be converted into energy through combustion. The following sections provide a summary of the potential advantages, and disadvantages of processing these materials in an EfW facility. **Section 6.7** introduces other emerging waste conversion technologies.

Higher heating value (HHV) has the biggest impact on the feasibility of alternative fuels. For reference, MSW is generally estimated at 4,800 – 5,200 Btu/pound. The fraction of plastics in the MSW stream potentially impacts the HHV value the most. The characteristics of each fuel are described below.

6.1 Scrap Tires

The U.S. EPA recognizes that the use of tire-derived fuel (TDF) is a viable alternative to the use of fossil fuels. There are approximately 100 facilities throughout the U.S. that burn scrap tires for energy recovery. These facilities include cement kilns, fossil coal power plants which employ grate combustion systems, industrial and institutional boilers, dedicated tire-to-energy plants, and facilities which combust both tires and biomass. Most of these facilities import scrap tires from the regional counties surrounding the facility. A radius of 100 miles is generally regarded as the most economical range for TDF. The approximate HHV of scrap tires is about 15,000 – 16,000 Btu/pound. For each ton of tires processed at an EfW facility, approximately 3 tons of MSW will be displaced. For facilities which are not at full capacity, the addition of tires is beneficial. However, for facilities at capacity, tires will reduce the amount of MSW that can be processed. For maximum burnout, scrap tires should be chipped or quartered. Whole tires do not burn well in massburn EfW facilities due to the limited residence time and the downward angle of the grate.

As previously noted, 1 ton of MSW generates approximately 700 kWh/ton of electricity. Given that one ton of scrap tires has the equivalent heat content of 3 tons of MSW, a simple economic analysis reveals that the combustion of one ton of tires results in the generation of 2,100 kWh of electricity and approximately $63.00 in electrical revenues, assuming electricity is sold at 3 cents/kWh. The economic viability of using scrap tires as an alternative fuel source is heavily dependent upon the revenues which can be derived from their combustion.

As an example, Hillsborough County processes approximately 9,000 – 10,000 tons per year of tires which are deposited at their citizen drop off centers. The tires are shredded into approximately 2-inch pieces and stockpiled on the landfill. On a regular basis, the chipped tires are then delivered to the massburn EfW facility via transfer truck for energy recovery. The estimated cost of processing waste tires in this fashion is approximately $60/ton, which is approximately the electrical revenues which can be derived from the combustion of used tires. On the other hand, Hillsborough County currently charges $115/ton to accept used passenger tires without rims, $185/ton for passenger tires with rims, and $120/ton for semitruck tires, resulting in net revenues for the solid waste system.

One advantage of accepting and processing used tires at an EfW facility is that these high heating value materials can be used to supplement the processible waste during wet periods of the year.

6.2 C&D Combustible Waste

The HHV of C&D wood waste ranges from 7,000 – 8,000 Btu/pound as these materials often contain dry dimensional lumber, pallets, and other engineered wood products, all of which are highly combustible materials. These materials, while being suitable for massburn EfW facilities will likely require size reduction to limit the potential for waste plugs in the feed hoppers and allow for efficient mixing with other MSW stored in the refuse pit. C&D wood wastes are not typically delivered to modern EfW facilities primarily due to the cost of special handling, transportation, and the cost of EfW tipping fees. Properly sized C&D wood wastes may be well suited for processing at future gasification and pyrolysis waste conversion facilities. One particularly attractive process which may use C&D wood waste is called torrification. This is a pyrolysis process in which heat is used to drive off the volatile gasses from the wood wastes, resulting in a carbon rich char that can be used as an alternate to coal in fossil power plants. However, this technology is not commercially proven in the U.S. at this time.

A simple mass-balance analysis reveals that every ton of C&D wood waste is equivalent to approximately 1.8 tons of MSW in terms of electricity generating potential. The combustion of one ton of C&D wood waste results in 1,260 kWh of electricity and approximately $38.00 in electrical revenues assuming electricity is sold at 3 cents/kWh. It will be economically viable to process C&D wood waste if the cost to receive, transfer, process, and transport the wood waste is less than the revenues which can be derived from their combustion. If the proper incentives are provided, it may be economical to process C&D wood wastes at an EfW facility. Lee County Florida currently operates a C&D recycling facility on their solid waste campus which also employs an 1,836 tpd EfW facility. This facility was constructed primarily to extract combustibles for energy production and recyclables for sale to markets due to the current availability of excess processing capacity at the EfW.

6.3 Bulky Waste

Similar in composition to C&D waste discussed in **Section 6.2**, EfW facilities can also process the combustible portion of bulky wastes to further minimize the amount of problematic waste disposed of in landfills. Bulky wastes include mattresses, carpets and furniture. By incorporating a shear shredder integral with the mass burn waste pit, EfW can process significant quantities and sizes of bulky wastes. Many of the metallic components of bulky wastes liberated during the combustion process can also be recovered and recycled from the ash residue.

6.4 Dirty Plastics and MRF Residuals

Dirty, or reject plastics which are removed from curbside recycling facilities, along with other non-marketable grades of plastics (rigid and heavy plastics) can also be processed in modern EfW facilities. Plastics are like tires in their heating value, ranging from 14,000 – 18,000 Btu/pound. Plastics are a significant component of the mixed MSW waste stream which is routinely processed at the EfW facility. The addition of “dirty plastics” and other non-marketable heavy plastics from recycling programs will generate similar energy revenues as used tires. Again, it will be economically viable to process dirty plastics if the cost to receive, transfer, process, and transport the tires is less than the revenues which can be derived from their combustion.

6.5 Yard Waste

Yard and wood waste (also known as biomass) can also be processed in modern EfW facilities. Prior to the era of curbside recycling and source separated recyclables, yard and wood waste were typically co-mingled and collected from the curbside in many communities. Biomass waste heating values can range widely as noted below:

- Mixed greens: 2,700 Btu/pound
- Green wood and vegetation: 4,000 Btu/pound
- Dry leaves and wood: 8,000 Btu/pound

The addition of yard and wood waste from recycling programs will generate energy revenues like those with MSW. For facilities which are not at full capacity, the addition of yard waste is beneficial. However, for facilities operating at full capacity, yard waste will reduce the amount of MSW that can be processed, and alternate recycling and/or energy conversion processes should be considered. Alternate waste conversion processes include stand-alone biomass EfW facilities and waste to biofuels conversion processes. There are currently two competing waste to biofuels processes, one which employs a wet fermentation of sugars which are released from the hydrolysis of biomass, and one which employs gasification to produce syngas which can be converted by catalysts and/or biological organisms into a variety of alcohol fuels, including methanol and ethanol. There is currently no commercially proven waste-to-biofuel facility in the U.S.

In the past, several of the EfW facilities in Florida were operating at less than full capacity due to reduced generation of solid waste. Many of these facilities decided to divert a portion of their municipal yard waste to their EfW facility to avoid the “put or pay” penalties to the operator of the EfW facility, and to generate additional electrical revenues. When available, the preferred yard waste is vegetative branches, limbs, and trunks that have been reduced in size (3- to 6-inches) and screened of sand and dirt.

6.6 Sewage Sludge (Biosolids)

WWTP Biosolids are typically not burned at an EfW plant for the primary reason that biosolids are high in moisture. They need to be about 50% solids to be energy neutral. Typical WWTP biosolids are produced at 16 to 20% solids and are low in heating value (~1,200 Btu/pound), requiring additional heating for drying before the biosolids are suitable for an EfW plant. Bone dry sludge is estimated to have an 8,490 btu/lb heat value, with lower reported values around 6,500 btu/lb for digested sludge. High moisture biosolids can be co-combusted in an EfW at limited quantities due to the higher heating value of MSW. If biosolids are to be combusted in EfW facilities, special receiving facilities are generally needed unless the biosolids are dried to greater than 50% solids. As an example, the new massburn EfW facility (operational since 2015) in Honolulu Hawaii processes up to 10% WWTP biosolids with MSW. The facility was constructed with a dedicated receiving, storage and biosolids delivery system

Combustion of biosolids can be a revenue enhancement option for areas of the country with high landfill tip fees, or limited markets for beneficial use of biosolids in agricultural applications. Additionally, the current interest in treating wastes which contain per- and polyfluoroalkyl substances (PFAS) may ultimately improve the market for co-combustion of biosolids in EfW facilities.

6.7 Emerging Conversion Technologies

There are many emerging waste conversion technologies currently being promoted for the conversion of wastes in the U.S. based upon novel processes deployed in other industrial applications, including: pyrolysis, gasification, and fermentation. As discussed below, none of these technologies are currently widely used, not all deal with the entire MSW waste stream, and their long-term feasibility is still being evaluated.

Arguably, one of the more promising alternative waste conversion technologies is currently in operation in Edmonton Canada. Inaugurated in 2014, Enerkem Alberta Biofuels is the world's first major waste-to-biofuels producer. The facility is designed to produce 100,000 metric tonnes of RDF using an exclusive thermochemical process to convert non-recyclable and non-compostable household waste into biofuels and green chemicals, such as ethanol and methanol. Over the past several years, the facility has been recognized for sustainability and has qualified as a low carbon fuel. In 2017, it became the first waste-to-biofuel facility to sell its ethanol under the U.S. Renewable Fuel Standard after receiving registration approval from U.S. EPA. Within the past year, Enerkem has announced plans with Air Liquide, Shell, Nouryon and the Port of Rotterdam for the development of a project in Rotterdam, Netherlands to be the first of its kind in Europe to make chemicals and biofuels out of non-recyclable waste materials.

One branch of the emerging waste conversion technology arena is focused on "chemical recycling" by processing select fractions of MSW and mixed plastic wastes into a variety of liquid fuels and chemical feedstocks. Plastics waste is a huge untapped resource. Using recycled plastics has benefits in many applications: it can be cheaper than prime plastics; pricing is less volatile than prime; and using it does not depend on new extraction of non-renewable fossil fuel resources.

One such company, Vadxx has started up its first facility in Akron, Ohio. Because plastics are derived from hydrocarbons and have a high energy content, Vadxx has developed a process to convert them into energy products without reportedly producing any hazardous by-products. The facility is designed to convert 40 million pounds of waste plastic by converting all of it to 4 milliongallons of what Vadxx calls EcoFuel™. These are crude oil and fuels, synthetic gas and other energy products that the company defines in 4 different categories:

- EcoFuel-I™: A diesel stock for use as a blending agent to improve the overall quality of Ultra Low Sulfur Diesel, as well as distillate fuels blended with diesel for on-road use.
- EcoFuel-II™: A Naphtha that can be used as a gasoline additive to increase octane.
- EcoFuel-SNG™: A Synthetic Natural Gas produced for the exclusive use by the Vadxx process.
- EcoFuel-S™: A carbon powder that can be used as a low-grade fuel source.

Agylix is an Oregon based company currently processing non-recyclable plastics into crude oil using a chemical process called pyrolysis. The process heats waste plastic into a syngas which is then condensed into synthetic crude oil. Impurities are removed to allow further refining into fuel. Agylix's technology is being used at a demonstration facility in Tigard, Oregon along with two commercial-scale projects in development, one at the Agri-Plas recycling facility in Brooks Oregon, and one at a Waste Management facility in Portland, Oregon. The Agri-Plas facility will process materials that wouldn't otherwise be recyclable, such as plastic planting pots used in agriculture and turn them into a synthetic crude-oil that can be sold to refineries. The facility would be able to produce roughly 2.6 million gallons of oil a year from 23 million pounds of plastic.

Other developers which have been developing waste to fuel projects include Fulcrum BioEnergy, with their first waste-to-fuels facility (Sierra BioFuels) currently under construction near Reno, NV. Fulcrum plans to use gasification and Fischer-Tropsch (FT) processes to convert MSW which has been processed to remove recyclable products and other materials not suitable for processing into a synthesis gas. This syngas is reacted in the FT process with a proprietary catalyst to form a FT product which can then be upgraded to transportation fuel.

The Center for the Circular Economy at Closed Loop Partners issued a report titled "Closed Loop Plastics – Accelerating Circular Supply Chains for Plastics" in 2019. This report identified over 60 technology providers currently developing processes to recycle waste plastics. Reportedly, more than 40 of these technology providers are operating early commercial scale plants in the U.S. and Canada today, or have plans to do so in the next two years.

Many of the chemical recycling processes will require pre-processing MSW to prepare the proper blend of waste materials suitable for their process. The source of some of these materials may initially originate from curbside recycling programs, along with source separated commercial and industrial streams. Ultimately, Mixed Waste Processing Facilities (MWPF) may become commercially viable as the technologies mature and markets for the by-products are established. Although it is sound advice for municipalities to be cautious about "being first" for implementing new and emerging technologies, there are several operating, or soon to be operating waste-to-biofuels facilities that are worth monitoring. Upon commercial development of these processes, they may be quickly replicated in other communities, especially those near nearby markets for the process by-products.

One advantage that the emerging chemical recycling projects may have over traditional EfW projects which generate and sell electricity to the local grid is that there may be significantly higher revenues from the sale of the liquid fuels and chemical by-products. However, until the overall process is known and developed at full scale with known production costs, it is still too early to predict the winning technologies.

A new concept is slowly unfolding in Kent County Michigan, which also has a 650 tpd EfW that went into commercial operation in 1990. Due to several factors, including opposition to the expansion of their landfill and constrictions in the international recycling markets, the county's Department of Public Works is implementing a Sustainable Business Park Master Plan in pursuit of sustainable material management that embraces and incentivizes a circular economy. The sustainable business park concept was born out of Kent County's vision to divert 90% of waste from its landfill by 2030. The Sustainable Business Park Master Plan for Kent County was finalized and officially adopted in 2018. This plan offers a roadmap for how the regional community and the Department of Public Works can work cooperatively to implement a shared vision for reclaiming and converting former waste materials into new products or renewable energy. The master plan evolved after months of research, public meetings with the regional community members and other stakeholders, including collaboration with local, state and national experts. Such a plan may be worth investigation and consideration in the Wake County region, as future waste disposal options are evaluated.

Section 7.0 Environmental Emissions

Massburn furnace designs and flue gas cleaning technology have evolved over the years to cope with increasingly stringent environmental regulations. Modern plants routinely exceed the most stringent federal and state requirements for stack emissions and residue quality.

According to the U.S. EPA, EfW facilities have an emission profile considerably better than coal based electric power. The advent of modern flue gas cleaning systems has evolved within the U.S. EfW industry which typically incorporates the following control technologies:

- Advanced combustion controls and flue gas recirculation for carbon monoxide control
- Ammonia or urea injection into boiler for improved NOx control
- Activated powder carbon injections for mercury and dioxin/furan controls
- Atomized slaked lime injection in spray dryer absorber for control of acid gasses
- Fabric filter for removal of particulate
- Fly ash residue recirculation for maximized acid gas control

A summary of the significant reduction of EfW emissions since the advent of the modern era from large and small municipal waste combustor flue gas emissions is illustrated in **Table 5**.

Table 5. Historical Emission Comparison from U.S. EfW Facilities

Pollutant	1990 Emissions (TPY)	2005 Emissions (TPY)	Percent Reduction
CDD / CDF TEQ Basis*	44	15	99+%
Mercury	57	2.3	96+%
Cadmium	9.6	0.4	96%
Lead	170	5.5	97%
Particulate Matter	18,600	780	96%
HCL	57,400	3,200	94%
SO2	38,300	4,600	88%
NOx	64,900	49,500	24%

Source: EPA, August 2007
**Dioxin / furan emissions are in units of grams per year toxic equivalent quantity (TEQ), using 1989 NATO toxicity factors, and all other pollutant emissions are in units of tons per year.*

Recent advancements in combustion air controls have reduced NOx emissions by up to 50% of the current generation of EfW facilities. Even greater reductions of NOx emissions can be achieved with use of Selective Catalytic Reduction (SCR) technology which can achieve NOx emissions in the range of 45 - 50 ppm, representing approximately a 75% reduction compared to the current generation of operating EfW facilities. The use of SCR technology has recently been applied in the U.S. on the new

3,000 tpd massburn waterwall EfW facility in Palm Beach County, Florida. There is also one EfW facility in Canada which has added SCR control technology.

EfW generates electricity cleaner than coal or oil. Emissions profile of EfW facilities with modern air pollution controls are similar to power produced from natural gas. **Table 6** shows pounds of pollutant produced per megawatt hour of electricity generated. Proven EfW technology deployed in the U.S. continues to evolve with reduced air emissions that continue to exceed the regulatory requirements.

As reported by the U.S. EPA, for every ton of municipal solid waste processed at EfW, greenhouse gas emissions are reduced by approximately one ton. This reduction is due to the avoidance of methane from landfills, along with the offset of greenhouse gases from reduced fossil fuel electrical production and the recovery of metals for recycling.

Table 6. Comparison of Air Emissions from EfW and Fossil Fuel Power Plants (Pounds Emission per MWh)

Fuel	Carbon Dioxide	Sulfur Dioxide	Nitrogen Oxides
MSW (EfW)	837	0.8	5.4
Coal	2249	13	6
Oil	1672	12	4
Natural Gas	1135	0.1	1.7

Source: Comparison of Air Emissions from Waste to Energy Facilities to Fossil Fuel Plants, Jeremy K. O'Brien, SWANA; NAWTEC Proceedings, 2006 pg. 74

Section 8.0 Review of North Carolina State's Solid Waste Lifecycle Modeling

The SWOLF life-cycle model was developed by North Carolina State University (NC State) to allow future informed decisions on solid waste management strategies to be made with a focus on system cost and environmental impacts which included diversion of waste from the landfill and reduction of greenhouse gas (GHG) emissions. On behalf of Wake County, NC State applied the SWOLF model to evaluate several future alternative waste conversion technologies in various combinations for comparison with the Base Case system. The future alternate waste conversion technologies evaluated in the model included: Anaerobic Digestion, EfW, and a Mixed Waste Material Recovery Facility (MW MRF). Cost and operating data for the EfW process was extracted from a 2002 WTE Feasibility Report by HDR and updated by information verbally shared by Covanta. Candidate sites for the three future proposed technologies were identified and used in the model to allow estimation of transportation costs. Waste composition assumptions for Wake County were based upon a 2010 study performed by SCS Engineers.

CDM Smith conducted a review of the various papers and presentations developed by NC State and provided by Wake County, which summarize the results of the study. The purpose of CDM Smith's review was to consider and incorporate the NC State study findings (where applicable) into the current EfW evaluation and discuss any key differences as they relate to the use of EfW. The documents reviewed by CDM Smith are listed below and referenced by number (1 through 5) in the following discussion.

1. Solid Waste Management Planning for Wake County in Consideration of Cost, Energy, and Environmental Emissions power point dated August 22, 2018 (35 pages)
2. Solid Waste Life-Cycle Modeling power point presentation dated November 1, 2017 (26 pages)
3. Solid waste management policy implications on waste process choices and systemwide cost and greenhouse gas performance (26 pages)
4. Solid waste management policy implications on waste process choices and systemwide cost and greenhouse gas performance supporting information (47 pages)
5. Wake County Waste Characterization Study prepared by Kessler Consulting, Inc dated July 2019.

Key findings from the NC State study are summarized below.

- Wake County does not control collection of municipal waste and commercial waste, and these waste streams will significantly affect the sizing of future waste conversion technologies.
- Collecting residential food waste with yard waste is predicted to decrease landfill GHG emissions by 20%, but only has a small impact on landfill diversion rate (3% improvement) and increased landfill life. The least cost option is for food waste to be composted with yard waste, with the mitigation cost estimated at $98/metric ton of carbon dioxide equivalent (MTCO2e). The least GHG option is for food waste to be anaerobically digested (wet process is assumed) at a much higher cost of $840/MTCO2e. The study found that Anaerobic Digestion is costly and suggested that dry digestion could be cheaper; however, this option was not evaluated.
- The combination of EfW with a MW MRF resulted in the highest diversion of waste from the landfill, increasing from Base Case value of 28% to 81%. This combination also resulted in the highest reduction of GHG emissions. However, it was noted that the results are sensitive to assumptions of material separation efficiency and processing cost of the MW MRF.
- The current collection scheme limits potential for cost and GHG improvement. The Base Case scenario indicates that three separate collections are performed for MSW, recyclables, and yard waste. Alternate collection schemes were suggested as one approach which results in more cost-effective reductions of GHG emissions.

CDM Smith's general comments on the above documents are summarized below, followed by a discussion of the EfW components. Findings from the EfW portion of the NC State study which were incorporated into CDM Smith's EfW evaluation are noted. Key differences in assumptions between the NC State study and the EfW evaluation are explained.

- The NC State Study using the SWOLF model is a comprehensive solid waste system and life cycle analysis, whereas the CDM Smith model is a detailed evaluation of the performance and financials of a medium size 1,800 tpd EfW facility.
- Waste collection contribution (as reported in document 4, line 237) noted that waste collection contributes 84% to costs in the Base Case. This is high for an integrated system that uses single stream MRF, composting, and landfill, unless the costs of the privately-operated components of the integrated system are not included.
- Proposed Future Facility Locations
  - The proposed location of the EfW facility at the existing SWLF is a natural choice, with many existing EfW facilities located on landfill sites. This site also allow easy and affordable access to the local electric grid and other municipal utilities, such as water and sanitary sewer, and natural gas.
  - The Anaerobic Digestion system is also suggested to be located at the existing landfill. An alternate, more cost-effective location(s) may be at existing WWTPs, especially those already equipped with digesters. In this arrangement, co-digestion of WWTP biosolids with food waste could be performed. Such an arrangement would provide greater flexibility and potentially reduce the transportation costs for delivery of residuals to the EfW facility.
  - The MW MRF is suggested to be located at the existing privately-operated Sonoco single stream MRF. It is not clear as to whether this existing facility has adequate real estate and buffer to allow greater vehicle trips and a potentially more odorous process. An alternate more cost-effective location may be adjacent to the new EfW facility on the landfill site. Such an arrangement would provide improved odor controls, greater flexibility and potentially reduce the transportation costs for delivery of the residuals from the MW MRF residuals to the EFW facility.
- The study reports note that Anaerobic Digestion is costly. It is assumed that this is referring to the wet digestion process. It was noted that a less costly approach may be used with a dry process, however this option was not evaluated for good reasons. There are limited commercially viable dry digestion processes currently in operation in the U.S., with one private operation located in San Jose California in operation for since 2015.
- A review of the utilization cost associated with each process ($/Mg) listed in Table S18 of document 4 reveals a wide range of processing costs for the various materials proposed for separation at the MW MRF, ranging from $5 to $166/ton, with most in the range of $5 to 10/ton. These values seem low based on our experience. CDM Smith was not able to find where the capital costs for the MW MRF were noted.

- Annual cost of $45M for the "+MW" scenario (Base Case with MW MRF enabled, reported on Line 193 and 194 of document 2) seems low when compared to $42M for the Base Case. MW processing facilities typically have a significant capital cost and high operating cost.
- Regarding cost assumptions for the three future waste conversion technologies, the model may not be accurately estimating the capital and O&M costs. The unit cost of all the listed facilities will vary by size (design capacity). Typically, the larger the design processing capacity, the lower the unit capital cost due to "economy of scale" benefits.
- Specific Comments to EfW component include:
  - Both the NC State study and CDM Smith evaluation assumed a 90% availability factor for the EfW facility.
  - For the NC State study, Covanta suggested $560 per design tons per year of capacity. In CDM Smith's opinion, Covanta's capital cost estimate may be appropriate for larger EfW units in the 1,500 – 2,000 tpd range. The unit cost would be significantly greater for smaller capacity units suggested in the SWOLF model (~160-200 tpd range appears to be estimated, with a maximum 1,200 size facility noted). Line 253 – Cost ($/Mg-year) reported in Table S12 of document 4 noted a value of $560/Mg-yr, whereas Table S19 reported the units differently ($560/design tons per year). There is an approximately 10% difference between these units, which should be reconciled as to which units are correct.
  - The NC State study capacity factor (reported in Line 301 of document 4, Table S12) at 0.91 is reasonable. The typical contractual obligation is 0.85 and a normal operating range is 0.90 to 0.94. Years in which major turbine-generator outages are performed will be slightly lower depending upon duration of outage (10-30 days). For the above reason, CDM Smith used 0.90 as the capacity factor (annual availability) in our analysis.
  - The NC State study unit O&M Cost of $40/year (design tons per year noted in Line 301 of document 4, Table S12) may be low for smaller size 160 -120 tpd EfW facility, but reasonable for 1,200 tpd facility. CDM Smith used $37.50 for the updated 2020 analysis with an 1,800 tpd massburn EfW facility.
  - The electricity price of $0.05 per MWh used for the NC State study (reported in Line 301 of document 4, Table S12) is optimistic in today's electric utility market but may have been appropriate when the NC State study was completed. CDM Smith used $0.03 per MWh in the updated analysis, based on discussions with Duke Energy.
  - Electricity production (reported in Line 301 of document 4, Table S12) is reportedly for a state-of-the art EfW facility; however, state-of-the art is not defined in the NC State study. The gross efficiency (state-of-the-art) value of 27% suggested by Covanta appears to be for a high-pressure boiler and steam conditions (note, Covanta's Durham York facility operates at 1,350 psi/800 °F, and is the most recent facility built by Covanta in North America). Net electrical efficiency of 24% is also in line with use of high-pressure boiler

and steam conditions. CDM Smith did not assume the use of high-pressure boilers and steam conditions, but rather maintained a more conservative approach with medium pressure boilers.

- The NC State study assumed a metal recovery rate (reported in Line 301 of Table S12) for bottom ash of 90%; aluminum recovery rate from bottom ash at 65%; and copper recovery rate from bottom ash at 65%. All these values are reasonable, but what is not stated and needed to compute the amount of metal recovered is the amount of each metal in the processed MSW. Based upon a SWANA ARF Report (2016 Innovations in Waste to Energy Ash Management), the EPA estimates that following source separation recycling, MSW contains 7% ferrous metals, 1.4% aluminum, and 0.4% other non-ferrous metals. When the MSW containing these metals are processed through an EfW facility, it is estimated that approximately one third of the iron and aluminum and one fifth of the other non-ferrous metals in the waste are thermally oxidized and therefore are not recoverable from an economic standpoint. This results in approximately 4.7% ferrous, 1.1 non-ferrous and 0.3% other non-ferrous for a total potentially recoverable 6.1% of the processed MSW.
- The fraction of ash that becomes fly ash (reported in Line 301 of document 4, Table S12) at 5% is optimistic. This parameter typically ranges between 10% to 20% depending upon the type of air pollution control system used. Generally, the overall combined ash (bottom ash and fly ash) is 22% to 27% of the incoming processed MSW. It is not clear as to exactly how this parameter is used in the SWOLF analysis.
- Several of the values of the non-metal emissions at the state-of-the-art EfW facility (reported in Line 301 of document 4, Table S12) are quite low, beyond normal ranges. These parameters may be used in some form of GHG emission calculations by SWOLF, and include:
  - HCL – at 2 ppm is much lower than normal. It should be around 15-25 if SOx is at 2 ppm.
  - NOx – at 35 ppm, would suggest SCR and cool combustion techniques as part of the "state-of-the-art" description.
  - CO – at 20 ppm is appropriate for cool combustion techniques.
  - PM 1 - at 1.5 mg/dscm – Though this number is achievable, the federal permitted limit is 25 mg/dscm. A more reasonable assumption would should be in the range of 5 to 10 mg/dscm.
  - Dioxin/Furan – at 1.5 ng/dscm is achievable but not realistic. Regulatory limits are at 15 ng/dscm. Most facilities emit between 5 to 10 ng/dscm. in order to enjoy the federal allowance of testing one unit instead of all units. Durham York (Canada) had its regulatory limit set at 60 pg/dscm for reference.

- Methane - at 1.1 ppm is reasonable, but the concentration is close to below detection limit
- Nitrous Oxide – at 1.3 ppm is very optimistic and may not be achievable.
- Hydrocarbons – at 1 ppm is achievable.

Exhibit A
Hillsborough County, Florida Solid Waste Program Data

Below are the major services and features of the Hillsborough County, Florida integrated solid waste management system.

- 1,800 tpd Resource Recovery Facility (EfW, massburn)
- Two Transfer Stations with citizen drop off facilities for bulky waste, white goods, yard and wood waste
- Central processing facility for yard and wood waste (recycled as mulch, soil amendment or biomass fuel)
- Community Collection Centers (5) for drop off solid waste materials
- Household Chemicals and Electronics Collection Centers (3) for citizen drop of materials (not available to commercial customers)
- Waste Tire Processing Program (shredded into chips <2" in size) for recycling as alternate daily cover or supplemental fuel at the EfW facility
- Class I raw waste landfill (179 acres)
- The following collection services are provided by three private franchised contractors throughout the unincorporated areas of the County:
  - Residential collection of solid waste twice a week
  - Residential collection of yard waste once a week
  - Residential collection of curbside recyclables once a week (cardboard, newspaper, and mixed paper; plastic and glass bottles, steel and aluminum containers)
- The posted FY 2019/2020 full costs for the Solid Waste Management System are:
  - Residential MSW and recyclables collection: $131.43 /household/year (effective Jan 1, 2020)
  - Residential disposal: $102.89 /household/year (effective Jan 1, 2020)
  - Landfill disposal tipping fee: $61.54 / ton
  - Passenger Tires disposal (without rims): $115 / ton
  - Yard and wood waste disposal: $37.06 / ton

Exhibit B
Basis for Wake County Financial Analysis Model Assumptions

Model Input Assumptions	Wake County 2012 Analysis (Base Case)	Hillsborough County RRF Data (FY 2011)	Wake County 2020 Analysis (Base Case)
Population and Waste Generation Data			
Size of EfW Facility (tpd)	1,800 tpd	1,800 tpd	Maintained at 1,800 tpd to allow direct comparison
EfW Financial Data – Debt Service			
Debt service period	20 years	23 years original facility 27 years expansion facility	Increased to 25 years as public works such as EfW projects are attractive to investors
Debt service interest rate	5.0%	7.6 % original facility (1985 bonds) 4.75% expansion (2008 bonds)	Lowered to 4.5%, borrowing costs have decreased
Debt Service Coverage	20%	20%	This parameter has been deleted for updated analysis, it is often required by agencies in order to sell bonds. Typically requires annual system revenues to cover an additional 20% of their debt payment each year. However, this is potentially a one-time cost if money is set aside in escrow or reserve account.
Bond Issuance Cost	Not included		5% of capital cost
EfW Financial Data – Electrical Generation and Tipping Fee Revenues			
Gross electrical generation rate	650 kWh/ton MSW	540 kWh/ton actual	Increased to 700kWh gross, based upon recent new EfW in Palm Beach County FL
Internal use of electricity	13.0%	14.9%	Maintained at 13%
Net electrical generation rate	566 kWh/ton MSW	469 kWh/ton actual 434 kWh/ton guarantee	Increased to 609 kWh, calculated based upon above two parameters
Average electric energy sales price	$0.06/kWh	$0.06/kWh (average)	Reduced to $0.03 assuming avoided cost payments in 2020, $0.05 used by NC State SWOLF analysis in 2018
EfW Financial Data – Recovered Metal Revenues			
Ferrous metal recovery rate	2.0% of MSW processed	1.8% actual	Increased to 4.0% due to improvements in magnet technology and advanced metal recovery (AMR) process. Theoretical limit is ~5%.
Ferrous metal recovery sales price	$150/ton		Reduced to $100/ton due to current global commodity market conditions

Model Input Assumptions	Wake County 2012 Analysis (Base Case)	Hillsborough County RRF Data (FY 2011)	Wake County 2020 Analysis (Base Case)
Non-ferrous metal recovery rate	0.20%	0.12% actual	Increased to 0.70% due to improvements in eddy current separators and AMRprocess. Theoretical limit is ~1.4%.
Non-ferrous metal sales price	$1,000/ton		Reduced to $500/ton due to current global commodity market conditions
EfW Facility Operation & Maintenance Cost - Reagents			
Pebble lime consumption rate	20 pounds/ton MSW processed	16.3 pounds/ton actual 21.7 pounds/ton guarantee	Maintained at 20 pounds/ton based upon current EfW experience
Pebble lime cost	$200/ton	$210 (Pinellas County)	Maintained at $200/ton based upon current EfW experience
Powered activated carbon consumption rate	1.0 pounds/ton MSW processed	1.2 pounds/ton actual 3.0 pounds/ton guarantee	Increased to 1.2 pounds/ton to ensure passing mercury test
Powered activated carbon cost	$1,100/ton	$1,110 (Pinellas County)	Reduced to $600/ton based upon current EfW experience
Ammonia consumption rate	2.0 pounds/ton MSW processed	1.2 pounds/ton actual 3.0 pounds/ton guarantee	Reduced to 1.5 pounds/ton based upon current EfW experience
Ammonia cost	$300/ton		Reduced to $500/ton based upon current EfW experience
EfW Facility Operation & Maintenance Costs - Utilities			
Water consumption rate	50 gallons/ton	54 gallons/ton actual 115 gallons/ton guarantee	Maintained at 50 gallons /ton
Water cost	$7.50 / 1,000 gallons		Maintained at $7.5/gallon
Wastewater disposal rate	100 gallons/ton	102 gallons/ton actual 315 gallons/ton guarantee	Maintained at 100 gallons/ton
Wastewater cost	$7.50 / 1,000 gallons		Maintained at $7.50/1,000 gallons
Natural gas consumption	35,000 MMBtu	35,278 MMBtu actual 15,000 MMBtu guarantees	Maintained at 35,000 MMBTU based upon current EfW experience
Natural gas cost	$4.00/MMBtu	$4.00 / MMBtu	Maintained at $4.00/MMBTU
EfW Facility Operation & Maintenance Costs – Ash Disposal			
Ash Generation (%)	25%	24% actual	Reduced to 22% based upon more efficient metal recovery and improved ash moisture management

Model Input Assumptions	Wake County 2012 Analysis (Base Case)	Hillsborough County RRF Data (FY 2011)	Wake County 2020 Analysis (Base Case)
Landfill ash tipping fee	$20.00/ton	~$15.00/ton	Maintained at $20/ton assuming local Landfill owned by Wake County
EfW Facility Operation & Maintenance Costs – Labor and Markups			
Base O&M contractor service fee	$32.50/ton	$34.76 Fiscal year 2011 (includes ash transportation to landfill, but does not include cost of reagents and utilities, which are pass-through costs to the County).	Increased to $37.50/ton due to inflation and AMR costs (does not include cost of ash disposal, reagents and utilities, which are accounted for elsewhere in the model).
Wake County (or other managing entity) project management staff			Maintained at 0.05% of Capital Cost
Consulting fees (project development phase)	Not included		2.5% of Capital Cost (legal and technical consultants)
Consulting fees (operation phase)	0.05% of Capital Cost		Maintained at 0.05% of Capital Cost (Independent Engineer)
EfW Facility Data and Capital Costs			
EfW facility design processing capacity	1,800 tpd	1,800 tpd	Maintained at 1,800 tpd
EfW facility annual availability percentage – normal maintenance cycle	90%	85% contractual 92 - 94% Actual	Maintained at 90% based upon current industry experience (NS State SWOLF used 91% Capacity Factor)
EfW Capital Cost ($ per tpd of design capacity)	$250,000		Increased to $285,000 due to inflation and cost of O&M for AMR process

Exhibit C
Hillsborough County Florida RRF Success Story
Internal Use of Electricity

An example of the internal use of renewable energy has been demonstrated in Hillsborough County, Florida. In late summer of 2009, approximately 2 MW of electricity from the Hillsborough County Resource Recovery Facility (RRF) was connected to an adjacent 12 MGD advanced wastewater treatment plant (AWWTP). In this synergistic arrangement, the solid waste department generates greater revenues than if they sold renewable energy to the local utility, while the water resources department saves money by avoiding the purchase of higher cost electricity at the full commercial rate from the same local utility. This win-win arrangement for internal use of renewable energy generated from wastes is anticipated to save local rate payers approximately $700,000 per year.

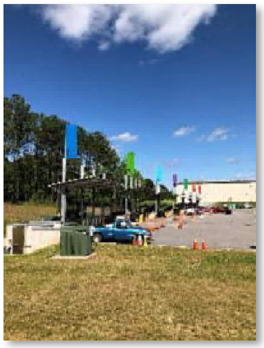
In order to avoid “demand charges” imposed by the local utility if the AWWTP facility remained connected to the grid, a backup electric power system was provided at the AWWTP to ensure uninterrupted electric service for the critical infrastructure. The Hillsborough County AWWTP has 100% backup diesel generation to ensure that this vital municipal service will operate when the RRF facility is temporarily out of service for planned or unplanned maintenance. Figure 1 below is a recent aerial photograph of the two adjacent municipally owned facilities.

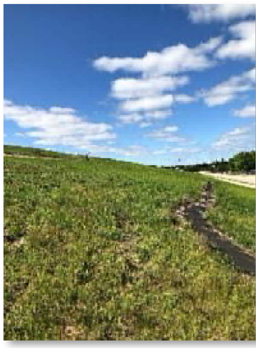
Figure 1. Hillsborough County, Florida RRF Facility provides 2 MW of Renewable Electricity to 12 MGD AWWTP and other adjacent Public Works

Appendix D

Subtask 3B – Identification of Other Disposal Options







Technical Memorandum

To: *Mr. John Roberson, P.E.*

From: *CDM Smith*

Date: *May 6, 2020*

Subject: *Wake County, North Carolina*
Comprehensive Solid Waste Management Plan (CSWMP) Update
Subtask 3B –Identification of Other Disposal Options

1.0 Background and Purpose

As part of the Comprehensive Solid Waste Management Plan (CSWMP), CDM Smith is evaluating the long-term waste disposal options available to Wake County following closure of the South Wake Landfill (SWLF). An evaluation of the current economics and other aspects of a conceptual Energy from Waste (EfW) facility located in Wake County was previously prepared and detailed in the memo *Energy-from-Waste Evaluation and Identification of Other Disposal Options* dated January 24, 2020. The evaluation focused on the economics, development timeline, opportunities, and constraints of an 1,800 tons per day (tpd) massburn EfW facility. A summary of other emerging waste conversion technologies, the municipal solid waste (MSW) pre-treatment requirements associated with each technology, and the state of commercial development of waste conversion technologies was also presented.

The purpose of this memorandum is to evaluate landfilling – the more traditional method of waste disposal in North Carolina – as a long-term option. Since it is not currently anticipated that another publicly or privately-owned Subtitle D landfill will be sited and developed in Wake County, the evaluation focuses on disposal at the currently available out-of-county regional landfills.

Assuming an MSW tonnage growth of 1.5 percent annually, the SWLF is projected to reach capacity between 2040 and 2050, depending on the level of waste density achieved; however, many factors will influence the timing of when the next disposal option will be needed, including but not limited to the rate of Wake County population growth; the success of waste diversion and reduction efforts; and decisions made by private haulers who collect commercial waste and can chose between disposal at the SWLF or an out-of-county landfill. The closure date of the landfill can be extended if waste diversion and reduction efforts are successful, or by increasing the capacity of the SWLF. Wake County has already identified and evaluated numerous strategies to extend the life of the SWLF as part of the *Landfill Life Extension Study*[1].

[1] SCS Engineers, 2018. Landfill Life Extension Study.

For the purpose of this evaluation, the SWLF is assumed to reach capacity in year 2040, but it is recognized that could change significantly depending on the factors identified above.

2.0 Out-of-County Disposal Options and Costs

2.1 Nearby Subtitle D Landfills

There are currently five privately owned Subtitle D landfills within a 100-mile radius of Wake County, as shown on **Figure 1**. Since there are multiple potential options within 100 miles of Wake County, the evaluation did not include landfills beyond 100 miles.

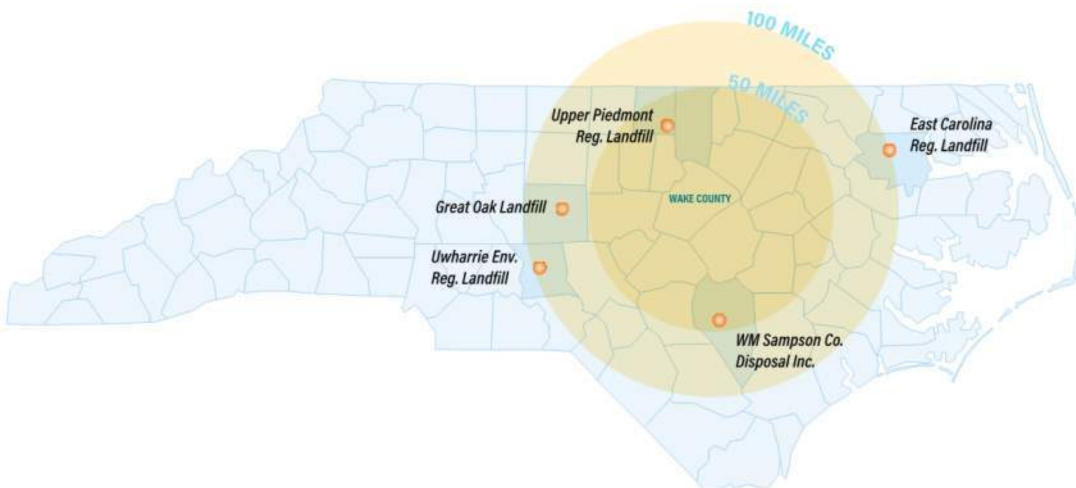


Figure 1. Private Subtitle D Landfills within 100 Miles of Wake County

The closest private regional landfill to most municipalities within Wake County is the Upper Piedmont Environmental Landfill owned and operated by Republic Services. The Town of Fuquay-Varina is slightly closer to the Sampson County Landfill, which is owned and operated by GFL Environmental (formerly Waste Industries). All four existing public and private Wake County MSW transfer stations are located closest to the Upper Piedmont Environmental Landfill. A potential future transfer station located in western Wake County, near the RDU Airport, I-540, I-40 area would also be located closest to the Upper Piedmont Environmental Landfill.

According to the NCDEQ FY 18-19 Landfill Capacity Report, the Upper Piedmont Environmental Landfill has approximately 40 more years of permitted landfill capacity remaining. However, the landfill is currently permitted to receive only 660 tons/day. The permitted waste stream tonnage would have to be increased for Wake County to dispose waste at the Upper Piedmont Environmental Landfill. According to the *Solid Waste Disposal Franchise Ordinance* adopted by Person County in November 2019, the landfill may accept waste from Wake County[2].

[2] Person County Board of Commissioners November 18, 2019 Meeting Minutes (https://www.personcountync.gov/home/showdocument?id=13667)

The next closest options are the Sampson County Landfill and the Great Oak Landfill owned and operated by Waste Management. Both landfills have a larger permitted waste stream tonnage but similar projected lifespans to the Upper Piedmont Environmental Landfill. Additional information on each private landfill regarding capacity and lifespan is shown in **Table 1**. The mileage from each municipality to each out-of-county landfill is shown in **Table 2**. Since the mileage from each municipality to the nearest out-of-county landfill is at least 40 miles in all instances, it is expected that all municipalities would rely on current and potential future transfer stations to cost effectively haul the waste. The distance from existing public and private, and a potential future public transfer station located in western Wake County, to each out-of-county landfill, is shown **Table 3.**

Table 1. Private Landfill Capacity and Lifespan Information

Out-of-County Private Landfill	Owner	Permitted Capacity (CY)	Remaining Capacity (CY)	Permitted Waste Stream (tpd)	Waste Tons Received in 2018	Projected Lifespan (years)
Upper Piedmont Environmental Landfill	Republic Services	17,400,000	11,265,831	660	243,291	40
Sampson County Landfill	GLF Environmental	56,600,000	33,548,512	5,000	1,767,087	45
Uwharrie Environmental Landfill	Republic Services	33,785,715	15,817,293	3,000	464,672	20
East Carolina Regional Landfill	Republic Services	24,200,000	10,965,317	1,600	495,068	21
Great Oak Landfill	Waste Management	37,801,000	36,411,140	4,000	556,126	53

Values estimated from NCDEQ FY18-19 Landfill Capacity Report and Solid Waste Management Facility Permits.

The Sampson County Landfill, Upper Piedmont Environmental Landfill, and Great Oak Landfill are the three closest out-of-county landfills to Wake County, and based on current capacity projections, would have 25, 20 and 33 years of capacity remaining in year 2040. Their capacity projections account for currently permitted airspace. It is unknown if any of these facilities have plans to purchase additional, adjacent land and expand beyond what is currently permitted. Accepting all or a portion of Wake County's waste would markedly increase these landfills annual tonnage and significantly lower their remaining capacity projections.

Table 2. Distance in Miles to Private Landfills from Municipalities

Municipality	Upper Piedmont	Sampson	Uwharrie	East Carolina	Great Oak
Apex	51	82	83	125	55
Cary	47	79	91	121	59
Fuquay - Varina	62	59	86	128	66
Garner	60	64	98	115	71
Holly Springs	58	71	84	128	61
Knightdale	54	77	107	100	80
Morrisville	43	85	90	128	60
Raleigh	48	72	95	113	69
Rolesville	46	84	109	101	86
Wake Forest	40	86	115	100	84
Wendell	63	82	112	96	85
Zebulon	54	86	116	90	89

Mileage determined using Google Maps, from center of municipality to the landfill using the quickest route.

Table 3. Distance in Miles to Private Landfills from Existing and Proposed Wake County Transfer Stations

MSW Transfer Station	Waste Tons Transferred FY 18-19	Upper Piedmont	Sampson	Uwharrie	East Carolina	Great Oak
Waste Management of Raleigh/Durham Globe Road; Morrisville (private)	34,306	57	88	95	127	65
GFL Environmental, Garner (private)	80,185	59	65	99	109	72
East Wake, Raleigh (public)	332,205	50	72	101	108	74
Republic Waste Services, Thorton Rd. Raleigh (private)	84,243	45	80	111	108	80
West Wake (proposed, public)	*Not applicable*	41	91	98	125	67

2.2 Out-of-County Hauling and Disposal Costs

The cost for out-of-county waste disposal will depend of several factors including the construction and operation of transfer stations, hauling costs, and landfill tipping fees. Due primarily to the cost associated with hauling the waste 40 to 100 miles, the County and municipalities are likely to pay more for out-of-county disposal than they pay for disposal at the SWLF. The County and municipalities will also likely be subject to larger price fluctuations compared to waste disposal at the SWLF, since changes in fuel prices are typically included as a variable in long-term hauling and disposal contracts, so that neither party benefits or is harmed should fuel prices increase or decrease.

To estimate a disposal cost for an out-of-county landfill option, CDM Smith obtained the City of Durham's Waste Disposal Services Contract with GFL Environmental and used it as a baseline estimate. The City's contract with GFL runs from 2013 to 2023. The City has the option to renew the contract for two additional five years terms. The City owns a transfer station, located at their Waste Disposal and Recycling Center, which is operated by GFL. As of December 2019, The City of Durham paid GFL $40.17 per ton for loading, hauling and disposal at the Sampson County Landfill. Hauling fees are subject to a monthly fuel price adjustment such that for every $0.08 change in the selected fuel price index, the haul fee adjusts in the same direction by 1 percent. Load and haul fees are also adjusted annually (no more than 5 percent) based on annual changes in the Consumer Price Index (CPI). Load and haul fees make up about 60 to 65 percent of the total fee for loading, hauling and disposal, based on data provided by the City of Durham.

The landfill is located 97 miles from the transfer station. In 2019, the City of Durham disposed of 173,483 tons of waste at the Sampson County Landfill at a total cost of $6,965,093 for an average rate of $40.14 per ton.

There are several factors that can affect the overall cost for out-of-county landfill disposal including:

- cost of labor, equipment and fuel;
- current and future available landfill disposal capacity (i.e., the competition for waste, or lack thereof);
- collaboration among participating local governments (volume-based economy of scale); and
- hauling and disposal contract length.

Using the City of Durham's Waste Disposal Services Contract with GFL and the current fuel, labor and equipment costs, the local governments of Wake County could expect to pay between $35 to $45 per ton for hauling and disposal at an out-of-county landfill in 2020. Future (2040) costs would be determined by the elements identified above but would likely be higher simply owing to inflation. This price range assumes that the existing East Wake Transfer station would be used to support several municipalities with waste transfer and that a second transfer station in western Wake County would be constructed and used. Attempts at collaborative contracting among the Wake County local governments would likely result in lower costs due to economy of scale savings.

3.0 Comparison of Out-of-County Landfilling and EfW

3.1 Cost

The base case analysis estimated the Year 2020 cost for an 1,800 tpd massburn EfW facility at $92 per ton of MSW processed. Several key parameters were adjusted in a sensitivity analysis which estimated the best-case at $65 per ton, and the worst-case cost at $117 per ton. The key variables in the EfW cost analysis were the selling price of electricity, and whether the environmental attributes of electricity from EfW facilities can be monetized. The per ton price for processing at an EfW facility could potentially decline over time, once the debt was paid off. The $65 to $117 cost per ton range for disposal at a Wake County EfW is clearly higher than the estimated $35 to $45 cost per ton range for disposal at one or more out-of-county landfills. As previously noted, these estimates are based on a wide set of current assumptions and should continue to be re-evaluated over time.

3.2 Other Criteria

In addition to cost, a variety of other criteria should be considered when evaluating long-term MSW disposal options. Other criteria may include the environmental implications of each option, such as criteria pollutant and greenhouse gas (GHG) emissions, as well as sociodemographic impacts and the generation of renewable energy. Future study is recommended to further evaluate the life-cycle implications of these long-term disposal options using a set of criteria that is deemed most important to the citizens of Wake County. Two studies, one in Wake County and one in Fairfax County, Virginia, are highlighted below as examples of how two long-term waste disposal options could be further evaluated.

3.2.1 North Carolina State's Solid Waste Lifecycle Modeling

In 2017-2018, Wake County, working with North Carolina State University, completed a study using the Solid Waste Optimization Lifecycle Framework (SWOLF) model to evaluate various solid waste system policies and strategies. SWOLF estimates the full system costs and emissions associated with waste management processes, including waste collection through final disposal. The model also considers benefits from recycling and energy recovery.

The evaluation focused on Wake County's solid waste system cost, energy, GHG emissions, and the cost to mitigate GHG emissions associated with current and potential future facilities and processes including anaerobic digestion, EfW, a Mixed Waste Material Recovery Facility (MW MRF) and landfilling. A base case (existing conditions) scenario and five future scenarios were modeled to evaluate various alternatives for residential MSW management. Multiple landfill diversion targets and budget levels were considered for each scenario. Changes to the collection system were also evaluated. None of the scenarios assumed waste would be hauled out of Wake County to a regional landfill or other waste management facility. Wake County's current and potential future solid waste management system, as represented in the modeling scenarios, are shown in **Figure 3**. Several of the more significant findings of the study included:

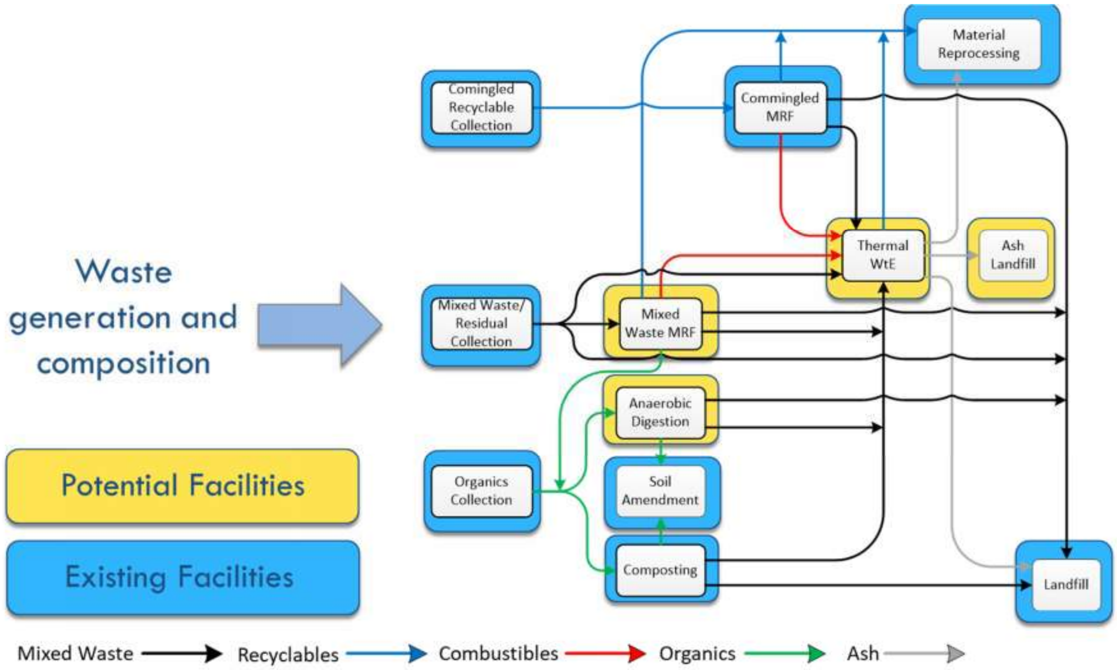


Figure 3. Representation of Wake County's Current and Modeled Future Solid Waste Management System. *(Source: NC State University)*

- Co-collection of residential food waste with yard waste is predicted to decrease landfill GHG emissions by 20 percent but has a modest effect on the overall waste diversion rate (about 1 percent) and landfill life (less than 1 year).
- Increasing residential recycling participation will increase landfill diversion but the impacts on GHG emissions depend on the materials recycled and the changes to the collection system.
- The extension of landfill life is limited by the current waste composition (what can be diverted) and level of recycling participation.
- Increasing diversion does not necessarily decrease GHG emissions. With EfW mass-burn combustion, the maximum diversion from the landfill is 81 percent. The minimum level of GHG emissions occur with 79 waste diversion made possible by a combination of EfW and MW MRF.
- The existing residential collection scheme used by the County and municipalities limits the potential for lowering cost and reducing GHG emissions.
- Municipalities seeking to cost-effectively increase landfill diversion while reducing greenhouse gas emissions should consider the combination of EfW, mixed waste separation, and changes to their collection system.

The SWOLF model should be considered for future use, as the local governments of Wake County continue to evaluate the cost and environmental implications of long-term disposal management options. Since the study did not evaluate any scenarios which included out-of-county landfilling, the addition of this scenario would help in determining the comparative cost implications of transporting waste long distances to the base case and other scenarios, accounting for mitigation costs associated with GHG emissions.

3.2.2 Fairfax County Virginia Evaluation of MSW Management Scenarios

CDM Smith recently completed a study for Fairfax County Virginia that identified and compared the cost, environmental performance, and other criteria of out-of-county landfilling versus EfW. In February 2017, a fire at the Covanta Fairfax Inc. energy/resource recovery facility (Covanta Fairfax) resulted in the facility being shut down for 11 months. Fairfax County and other counties and municipalities that send MSW to this facility, disposed of their MSW at multiple landfills in Virginia for the duration of the facility outage. This unplanned event created a unique opportunity to examine waste management alternatives by comparing empirical data collected during the outage to data collected from the restored operation of Covanta Fairfax in 2018. Results of this study are being used to help make informed decisions for future planning of the County's solid waste management program.

The evaluation criteria selected for the study included: criteria pollutants, GHGs, sociodemographics, power generation and vehicle collisions (**Figure 3**). Criteria pollutant and GHG sources considered in the study included waste hauling vehicles, the Covanta Fairfax facility, the King George and Shoosmith landfills, and emissions from processing recycled materials. The USEPA WARM and MOVES models were used for computing criteria pollutant and greenhouse gas emissions.

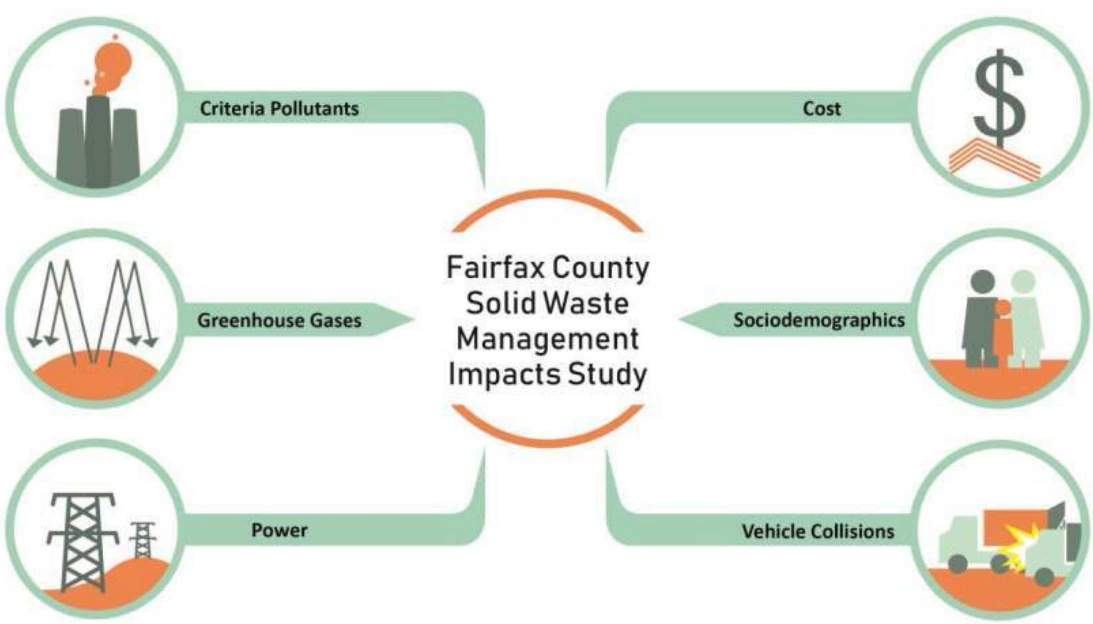


Figure 3. Criteria considered in the Fairfax County Solid Waste Management Impacts Study

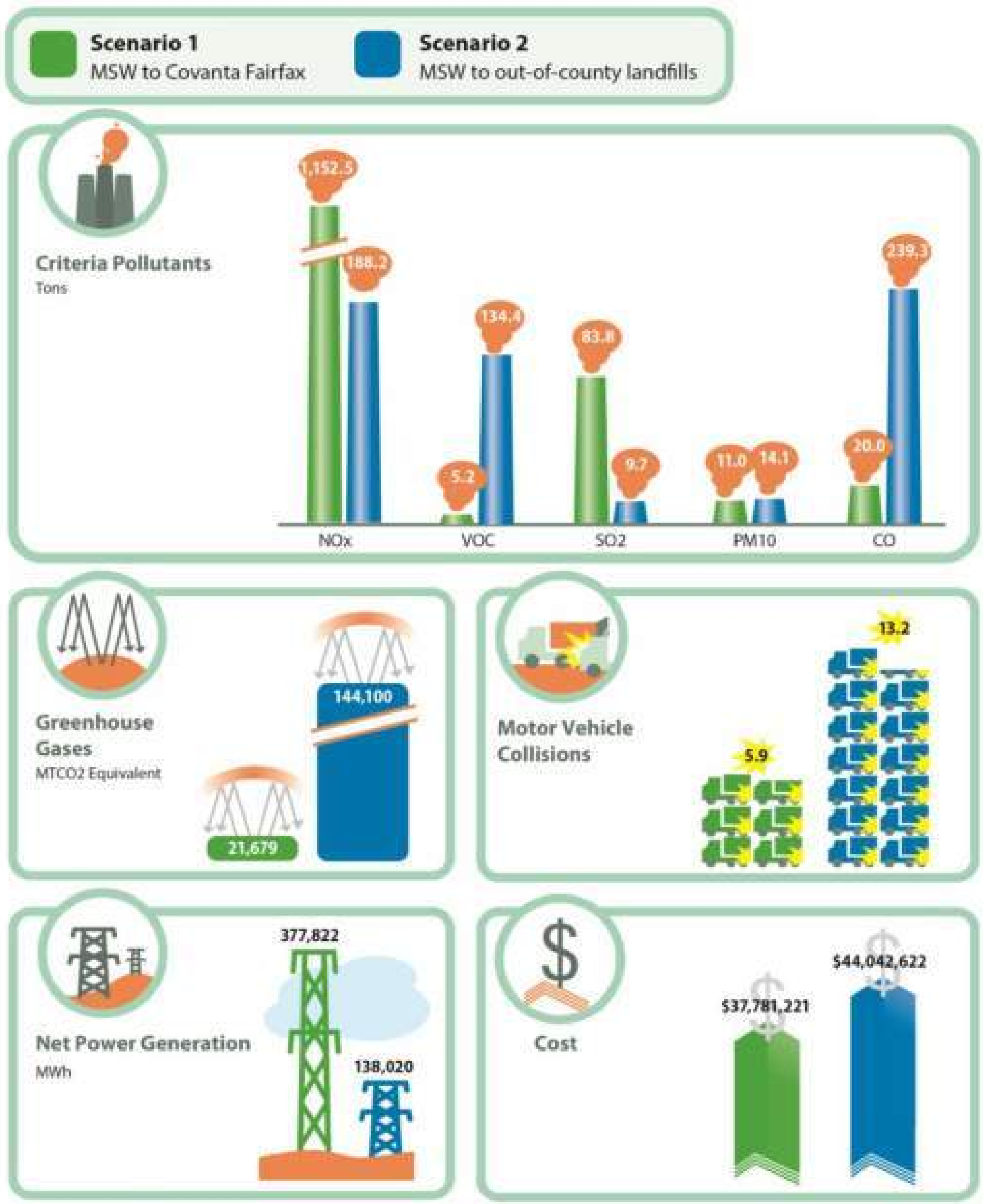
The selected criteria were evaluated for several scenarios – the primary scenarios being residential and commercial MSW direct hauled or transferred then hauled and disposed at (1) the Covanta Fairfax EfW facility and (2) two out-of-county landfills, the King George and Shoosmith landfills. The study found that Scenario 1 (EfW) performed better than Scenario 2 (landfilling) for all the study criteria except for two priority pollutant emissions, nitrogen oxides (NOx) and sulfur dioxide (SO2). For these two pollutants, Scenario 1 was 6 and 9 times greater, respectively, than Scenario 2. If Fairfax County were to have shifted from combusting MSW at Covanta Fairfax to sending MSW to out of county landfills in 2018:

- Volatile organic compound (VOC) emissions would have increased by a factor of 26
- Particulate matter (PM10) emissions would have increased by 28%
- Carbon monoxide (CO) emissions would have increased by a factor of 12
- GHG emissions would have increased by a factor of 6
- Annual expected collisions would have doubled, due to a more than doubling of hauling vehicle miles travelled from Scenario 1 versus Scenario 2
- Power generation from waste would have decreased by 250%.
- Costs would have increased by 15%.

Review of population and household income within five miles of Covanta Fairfax and the two receiving landfills showed that:

- Population and average median household income near Covanta Fairfax grew at a slightly higher rate than for Fairfax County at large between 1990 and 2017.
- Near the Shoosmith Landfill, population and average median household income grew at a slower rate than Chesterfield County at large.
- Near the King George Landfill, insufficient income data was available for comparison. Population growth within five miles of King George landfill outpaced King George County's average rate.

Figure 4 presents a graphic comparison of the criteria considered in the study. The study provides another example of how Wake County can comprehensively evaluate future long-term waste disposal options.



Key:
NOx = nitrogen oxides, VOC = volatile organic compound, SO2 = sulfur dioxide, PM10 = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, CO= carbon monoxide, MTCO2 = metric tons of carbon dioxide, MWh = megawatt hour

Figure 4. Comparison Scenarios 1 and 2, Fairfax County Solid Waste Management Impacts Study

4.0 Conclusions and Recommendations

4.1 Conclusions

Assuming an MSW tonnage growth of 1.5 percent annually, the SWLF is projected to reach capacity between 2040 and 2050, depending on the level of waste density achieved. If no other in-county waste disposal or conversion options are developed, one or more regional private landfills could be used for future disposal of Wake County-generated MSW. There are currently five privately-owned Subtitle D landfills within a 100-mile radius of Wake County. The Upper Piedmont Environmental Landfill is the closest to most municipalities, ranging from 40 to 63 miles. The Sampson County Landfill (59 to 86 miles) and the Great Oak Landfill (55 to 89 miles) are the next closest. Based on current capacity projections, these three landfills would have 25, 20 and 33 years of capacity remaining in year 2040, respectively. Accepting all or a portion of Wake County's waste would markedly increase these landfills annual tonnage and significantly lower their remaining capacity projections, accounting for their currently permitted airspace. It is unknown if any of these facilities have plans to purchase additional, adjacent land and expand beyond what is currently permitted.

The cost for out-of-county waste disposal will depend of numerous factors including the construction and operation of transfer stations, hauling costs, and landfill tipping fees. The Wake County local governments are likely to pay more for out-of-county disposal than they pay for disposal at the SWLF, simply due to the cost associated with hauling the waste 40 miles or more. They will also be subject to larger price fluctuations compared to waste disposal at the SWLF, since changes in fuel prices are typically included as a variable in long-term hauling and disposal contracts. Using the City of Durham's Waste Disposal Services Contract with GFL and the current fuel, labor and equipment costs, the local governments of Wake County could expect to pay between $35 to $45 per ton for hauling and disposal at an out-of-county landfill in 2020. Future (2040) costs would be higher simply owing to inflation. Other factors that may influence out-of-county pricing include the available disposal capacity, level of collaboration among local governments, and contract length.

Based on current conditions, the $35 to $45 per ton cost range for out-of-county disposal at a regional landfill is below the estimated $65 to $117 per ton cost range for waste conversion at an 1,800 tpd massburn EfW facility built in Wake County. The per ton price for processing at an EfW facility could potentially decline over time, once the debt was paid off (e.g., after 20 years). A slightly lower cost per ton might also be expected if a larger massburn facility was constructed (e.g. 3,000 tpd) that would receive waste from outside Wake County.

4.2 Recommendations

While informative, the direct comparison of estimated costs per ton for waste disposal at an out-of-county landfill versus waste conversion at an in-county EfW facility overlooks other factors that deserve consideration when evaluating long-term MSW disposal options. The environmental implications of each option, such as criteria pollutant and GHG emissions, as well as sociodemographic impacts should also be considered. An evaluation of life-cycle costs that consider the entire solid waste management system can provide a more comprehensive assessment and comparison of potential long-term options. NC State's SWOLF model has already been used in this regard and can continue to be applied to evaluate various scenarios as conditions change. If the NC State SWOLF model is again applied to evaluate long-term waste management options, the addition of an out-of-county landfilling option is recommended. The addition of this scenario would help demonstrate the comparative cost implications of transporting waste long distances, to the base case and other scenarios, accounting for mitigation costs associated with GHG emissions.

Prior to conducting future evaluations of long-term disposal options, the criteria that are deemed important to the citizens of Wake County should be agreed upon. Some potential criteria to consider include:

- Short and long-term cost
- GHG and priority pollutant emissions
- Power generation
- Revenue from power and environmental attributes (and stability of that revenue)
- Sociodemographic impacts
- Vehicle collisions and worker safety
- Duration (i.e., how long will the solution last until a new solution is needed?)
- Resiliency (i.e., how likely is it that the solution will be impacted by a disruption?)

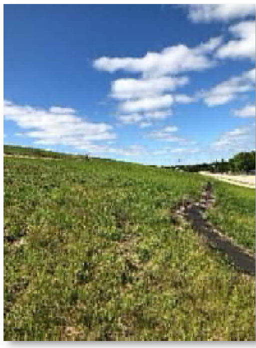
Once evaluation criteria are selected, a decision support tool can be used to help assess both quantitative and qualitative criteria, and more effectively compare options. Assessment and comparisons should consider the importance of the selected criteria. Weights can be assigned to each criterion so that the most important criteria have more impact in determining the assessment results, compared to lower-weighted criteria.

Appendix E

Subtask 3C – Special Waste Evaluation







Technical Memorandum

To: *Mr. John Roberson, P.E.*

From: *CDM Smith*

Date: *March 31, 2020*

Subject: *Wake County, North Carolina*
Comprehensive Solid Waste Management Plan (CSWMP) Update
Subtask 3C – Special Waste Evaluation

Wake County currently receives a variety of special wastes at the South Wake Landfill (SWLF), East Wake Transfer Station (EWTS), the 11 Convenience Centers, and the 3 Multi-Material Recycling Facilities (MMRFs). Special wastes include mattresses, tires, household hazardous waste (HHW), white goods, used motor oil, e-waste, lead acid batteries and antifreeze. Special wastes can take additional time, equipment, and staff to handle, dispose and manage, which can cost the County money. Special wastes such as mattresses can cause delays and problems at the landfill.

As part of the Comprehensive Solid Waste Management Plan (CSWMP) Update, CDM Smith evaluated two special wastes identified by County Solid Waste Division staff, which have historically generated challenges for the County – mattresses and tires. CDM Smith reviewed County-provided data, researched approaches taken by other communities/counties, and evaluated costs in order to identify possible means to divert, process or recycle these items. This Technical Memorandum (TM) presents the results of the special waste evaluation for mattresses and tires.

1.0 Mattresses

1.1 Background and Current Operations

Mattresses are currently accepted at the SWLF, EWTS and at all of Wake County's 11 Convenience Centers. Residents can drop off up to two mattresses per load at the Convenience Centers, six mattresses per load at the EWTS, and any amount per load at the SWLF. Mattresses collected at Convenience Centers are comingled with other bulk wastes. Mattresses from commercial, institutional, or industrial sources are not accepted at the Convenience Centers. The SWLF receives bulk shipments of mattresses from commercial and institutional sources. Bulk shipments typically arrive in a box truck, with some loads containing up to 100 mattresses. Bulk loads account for most of the mattresses received at the SWLF, and significantly more than mattresses collected at Convenience Center sites, which are then brought to the SWLF. In September 2019, the County implemented a policy that limits haulers to 40 mattresses per load. Mattresses dropped off by residents at the Convenience Centers are free of charge while mattresses disposed of at the SWLF and EWTS are charged based upon the current garbage tipping fees of $32/ton and $41/ton respectively. The County does not apply any extra fees or surcharges for handling and disposing of mattresses, as a special waste, at the SWLF or EWTS.

There are several North Carolina counties that implement a separate fee for disposing of individual or bulk mattresses brought directly to the landfill. A few examples include:

- Mecklenburg County (July 2019 – June 2020 Fee Schedule): Residential: One bulky item, free; More than one bulky item, $15/unit (up to 6 units); Commercial: One bulky item, $16/unit; more than one bulky item, $28.50/unit; or $110/ton for bulk loads of mattresses.
    - For the FY 2020 budget year, Mecklenburg County implemented new fees for bulky items including mattresses. Mecklenburg County has not seen a decline in mattress disposal since implementing the new fees.
- Harnett County: $5/mattress (full and larger) and $2/mattress (twin or smaller)
- Davidson County: $10/mattress or $13/cubic yard
- New Hanover County: $48/ton tip fee plus $5 surcharge/mattress

According to historical data provided by the County, a minimum of 14,607 mattresses were disposed at the SWLF between February 2018 and April 2019, averaging about 50 mattresses per day. This quantity is based on bulk commercial loads of mattresses only and does not include mattresses delivered in mixed loads to the EWTS or the 11 Convenience Centers. Many mattresses are delivered to County facilities comingled with other bulky materials, making the mattresses difficult to track. Therefore, it is anticipated that the 50 mattresses per day average is a conservative estimate.

Currently, mattress recycling facilities do not exist within or nearby Wake County; therefore, all mattresses collected by the County are disposed of in the SWLF.

1.2 Disposal Challenges

The disposal of mattresses within a Subtitle D landfill creates several operational challenges and an increased burden on the facility due to the difficulty associated with handling, placing and covering these bulky items. The greatest challenge is associated with compaction and airspace usage. Mattresses are typically lightweight and do not compact as well as typical municipal solid waste (MSW), resulting in a lower waste disposal density (tons per cubic yards). The lower density means that mattresses consume more available landfill airspace (volume) per ton (weight) of material. Due to their low disposal density, mattresses generate substantially less revenue per cubic yard of airspace utilized than typical MSW when per ton tip fees for both materials are the same.

Other challenges with mattress disposal include:

- Mattresses can become drainage conduits for leachate when placed near side slopes. Therefore, landfill operators are often required to handle loads of mattresses separately to ensure they are disposed of in the interior of the landfill.

- The application and retention of daily cover soil materials over mattresses is difficult due to their smooth surface. Extra cover material is typically needed to sufficiently cover mattresses, resulting in additional time, labor, and cost.
- Since mattresses do not compact well, they leave air pockets within the landfill which can aid in the spread of underground fires.
- Mattresses, specifically metal springs, can become entangled in equipment, thus causing equipment downtime and extra labor and maintenance costs.

1.3 Case Study – Mecklenburg County

Mecklenburg County, which has a comparable population to Wake County, had taken a different approach on handling mattresses. CDM Smith met with Mecklenburg County Solid Waste Division (Division) staff to discuss current operations of mattress disposal at the Foxhole Landfill. Based on discussions with Division staff, Mecklenburg County generates approximately 75,000 mattresses per year. Approximately 60,000 to 65,000 mattresses are estimated to be disposed at the Foxhole landfill per year.

Since August 2018 the Division has been using a TANA Shark Waste Shredder to shred mattresses before disposing of them in the Foxhole Landfill. The processing rate for mattresses is approximately 6 tons/hour or about 95-100 mattresses per hour over an 8-hour day. Staff typically process mattresses one to three times a week, depending on the number of mattresses received. Mattresses are stockpiled and processed adjacent to the working face which allows the material to easily be combined with other materials for disposal. The process utilizes one equipment operator to load the shredder with an excavator. The shredder is operated by a remote control from within the excavator cab.

The TANA Shark Waste Shredder capital cost was $875,000 and the operational costs are estimated to be approximately $25,000 per year. The operational costs cover labor, maintenance, repairs, fuel and other miscellanies costs. The County has not had to perform any major repairs on the shredder since operations began; therefore, major repair and replacement costs were not available for the Mecklenburg County shredder.

The County also uses the TANA Shark Waste Shredder to grind tires. This is discussed in Section 2.0 of this memo.

In addition to the operational changes implemented for managing mattresses, the Division has recently implemented a new fee for mattresses. Bulk loads of mattresses are charged $110/ton compared to the C&D tipping fee of $49.50 and residential customers are charged $15/unit for more than one bulky item and commercial customers are charged $16/unit for one bulky item, and $28.50 for more than one bulky item. The County has also started to use dedicated containers to collect mattresses separately at all Convenience Centers.

1.4 Management Options

As stated previously, mattresses take up a disproportionate amount of airspace and generate less revenue than typical MSW. CDM Smith conducted an analysis of alternative operational methods and disposal fees associated with landfill disposal of mattresses. Based on our analysis, CDM Smith recommends the County consider the following options for managing mattresses.

1.4.1 Shredding

CDM Smith recommends the County evaluate the use of a TANA Shark Waste Shredder, HAAS Tryon 2000XL mobile shredder or similar machine, for shredding bulk loads of mattresses at the SWLF. The shredder can be stationed adjacent to the working face for easy disposal of the shredded material or be stationed at a remote location at the SWLF. The shredder can also be managed by one staff member. Based on the estimate of 50 mattresses a day and a processing rate of 95-100 mattresses per hour, the County will only need to shred mattresses 3-4 hours per week.

The use of a shredder can also allow for recovery of recyclable materials, such as metals. The County should continue to track recycling markets and determine if separating metals is cost efficient. Recovering metals from shredded materials could result in the need to add a part time staff position.

Shredding mattresses can save valuable airspace and increase overall landfill revenue. Assuming a box truck holds 40 mattresses, using a shredder can reduce the mattress volume by 80 to 90 percent, which can save the SWLF around $461 to $541 in airspace per box truck, or approximately $144,000 to $169,000 per year assuming one box truck of mattresses per operating day. A comparison between typical mattress compaction methods (using a compactor) vs shredding mattresses in shown in **Table 1**. CDM Smith's calculation for revenue saved by shredding mattresses is presented in Appendix A.

Table 1. Airspace Revenue Value Comparison

	Typical Compaction	Shredding	
Percent Volume Reduction	25%	80%	90%
Value of Airspace Used per Box Truck of Mattresses	$626	$165	$84
Value of Airspace Saved by Shredding Mattresses (per Box Truck of Mattresses)		$461	$541
Volume of Airspace Saved per Year by Shredding Mattresses (per Box Truck of Mattresses)		6,240 cy	7,332 cy
Value of Airspace Saved per Year by Shredding Mattresses		$144,000	$169,000

1.4.2 Implementing Mattress Disposal Fees

CDM Smith recommends implementing separate fees for bulk and individual mattress disposal at the SWLF. The value of airspace consumed by a mattress is correlated to the compaction rate. Assuming mattresses do not get compacted as well as typical MSW, the value of airspace used by a mattress ranges from $12 to $18, depending on the compaction rate. The net cost to landfill a mattress is calculated by adding the value of airspace used by a mattress, plus extra equipment and labor cost (estimated to be $5 per mattress), minus the tip fee revenue for mattress disposal. Therefore, the net cost to landfill a mattress ranges from $15 to $20, depending on compaction. CDM Smith's calculation for determining a per mattress disposal fee is attached as Exhibit A.

Assuming a box truck containing 40 mattresses is being disposed and compacted by typical compaction methods, CDM Smith determined that the bulk load of mattresses consumes approximately $625 worth of airspace but is only receiving $35 of weight revenue. As previously discussed, using a shredder can significantly reduce the mattress volume and can save the SWLF approximately $144,000 to $169,000 per year. Despite the value of airspace saved from shredding mattresses, CDM Smith recommends implementing a surcharged tipping fee for bulk mattresses in order to account for the value of airspace used and the time and effort of shredding the mattresses.

Depending on the volume reduction of the mattresses, a suitable tipping fee for bulk mattresses would range between $76 to $149 per ton, as shown in the calculation in Exhibit A. Using the average, CDM Smith recommends implementing a special waste mattress tipping fee of around $113/ton. Assuming one box truck of mattresses (weighing 1.1 tons) is disposed per operating day at a $113/ton fee, the County would generate $38,800 per year.

For non-bulk loads (6 mattresses or less), CDM Smith recommends charging customers disposing of mattresses at the SWLF a per mattress fee of $15. Assuming 10 non-bulk load mattresses are disposed per operating day at a $15 disposal fee, the SWLF can generate $46,800 per year.

1.4.3 Cost Savings from Mattress Shredding

Assuming the County saves $144,000 to $169,000 per year in airspace by shredding mattresses and implements a $15 per mattress fee and a $113/ton surcharge bulk mattress tipping fee, CDM Smith estimates that the total cost savings for shredding mattresses ranges from $229,600 to $284,600. These values do not consider operational costs. Operational costs assume that costs would be shared across shredding both mattresses and tires and is discussed in Section 2.7.

Table 2. Total Cost Savings from Shredding Mattresses

	80% Volume Reduction	90% Volume Reduction
Value of Airspace Saved per Year by Shredding Mattresses	$144,000	$169,000
Annual Revenue from $15 Mattress Disposal Fee	$46,800	$46,800
Annual Revenue from $113/ton Bulk Load Tipping Fee	$38,800	$38,800
Total Revenue generated per year	$229,600	$284,600

These costs assume the shredder is located at the working face of the SWLF and do not consider transportation or labor fees associated with the shredder being located at a remote location at the SWLF.

1.4.4 Partnering with a Mattress Recycling Firm

Wake County can also partner with a mattress recycling firm to deter disposing of mattresses in the landfill such as Carolina Dry Heat (CDH) in Thomasville, NC which submitted a proposal in response to Wake County's 2019 Mattress Management and Recycling Request for Information. CDH proposed to collect mattresses dropped off at the SWLF Transfer Station in two 53-foot trailers. The 53' trailers, when filled with 80 mattresses, would be hauled to their facility in Thomasville, NC. At the facility, CDH would remanufacture the reusable mattresses and haul the remaining unused mattresses to another remanufacturer in Chicago, IL. CDH proposed a fee of $15 per mattress for the service.

Wake County, partnering with a mattress recycling firm, can apply for a Recycling Business Development Grant every year, through the North Carolina Department of Environmental Quality (NCDEQ), Recycling Business Assistance Center (RBAC). The Recycling Business Development grant program offers up to $40,000 towards the purchase of equipment or facility infrastructure. The grant requires a minimum 50% match from the company, so a $40,000 grant would require $20,000 in matching funds making it a $60,000 project. It is a reimbursement grant and purchases must be made within the grant contract period. The request for proposals is released in the fall (mid-September) with proposals due in November. Decisions are typically made by December to get contracts in place to run from March 1 – December 31.

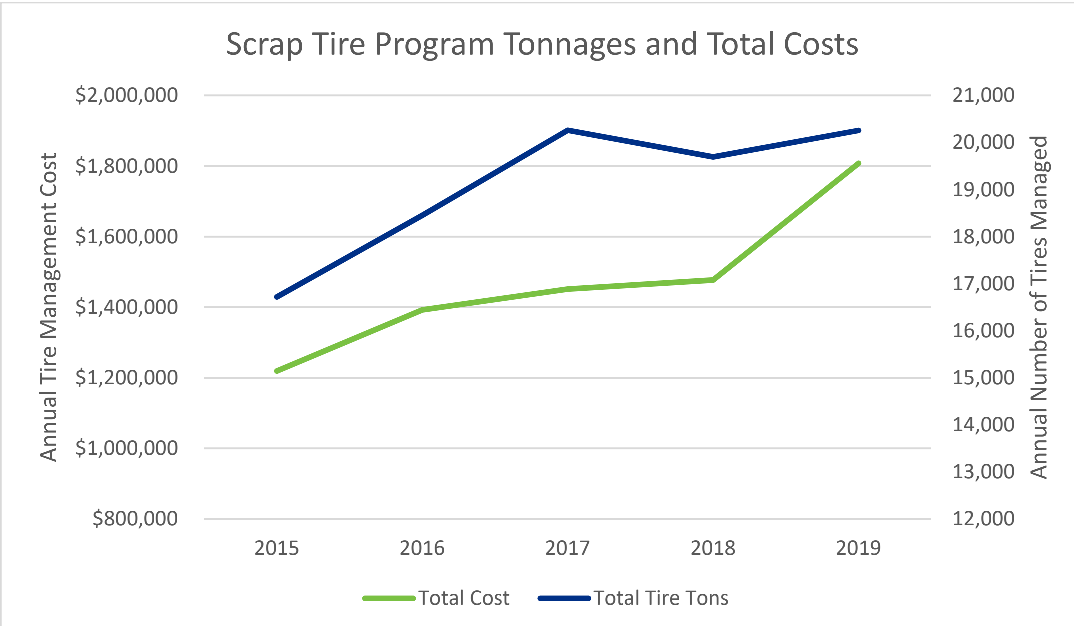
If the County decides to partner with a Mattress Recycling Firm, the Recycling Business Development Grant may be used to support the infrastructure needed for a mattress collection site. The grant supports a one-time expenditure to buy equipment and improve mattress recycling operations for the County.

2.0 Tires

2.1 Background and Current Operations

Tires are currently accepted at the North Wake, South Wake, and East Wake MMRFs. Residential and business customers can drop off passenger vehicle tires and lightweight truck tires generated in-state at any of these facilities free of charge. Rims must be removed from all tires delivered to any of the three MMRFs. If customers are disposing of five or more tires, they must also submit a North Carolina Scrap Tire Certification form in order to be eligible for free disposal. Commercial, Institutional, Industrial (CII) – generators can deliver tires if the tire identification number and certification form is provided.

Wake County contracts with Central Carolina Holding, LLC (CCH) to collect, transport and process scrap tires from the MMRFs and numerous other locations around the County. These locations generally include discount tire shops, wholesale warehouses, and auto care facilities. CCH reports the numbers of tires and tonnage to the County, and hauls them to the Central Carolina Monofill in Cameron, North Carolina for disposal. Based upon County-provided FY 2019 data, 20,256 tons of tires were collected at a total cost of $1,807,753. The total cost of the County's scrap tire program includes costs for labor, hauling, disposal fees, utilities/rentals and other miscellaneous costs. Over the past five years, the number of scrap tires disposed has generally increased as well as the cost of tire handling and disposal, as shown in **Figure 1**. The County's scrap tire disposal cost in FY 2018-2019 was $85.96 per ton. This cost includes the contract disposal fee of $54 per ton for passenger and lightweight truck tires and additional labor costs. Oversized tires, i.e. tractor trailer tires or larger, are charged $457 per ton. The oversized tire fee is a new surcharge that was added to the CCH contract in 2018. In FY 2019, 157 tons of oversized tires were collected at a cost to the County of $71,749.



Source: FY21 Fund 5100 Model V1 provided by Wake County.

Figure 1. Scrap Tire Program Tonnage and Total Costs

2.2 Scrap Tire Disposal Program

In an effort to assist counties with the extensive cost of safely disposing scrap tires, the North Carolina Department of Environmental Quality, Division of Waste Management – Solid Waste Section (NCDEQ) administers a scrap tire disposal program. For every new tire sold, a scrap tire disposal tax is applied to provide funds for the disposal of scrap tires. Thirty percent of the scrap tire disposal tax proceeds are credited to the State General Fund and the remaining 70 percent is distibuted to counties on a per capita basis. Starting in FY 2015, additional money allocated to counties changed from 17 percent of the State General Fund scap tire proceeds to $420,000, ultimately decreasing the money available for the scrap tire disposal program. $200,000 of the $420,000 is distributed each grant cycle, and the remaining $20,000 is used for scrap tire cleanups. The monies allocated each fiscal year since FY 2015 have remained the same.

According to NCDEQ, for the scrap tire disposal account fund grant period from October 2018 through March 2019, grant requests totaled $778,547. The grant amount awarded to individual qualifiying counties varied between a quarter to a third of the requested amount, which resulted in a funding total of just $233,000. Currently, NCDEQ is not aware of additional funds earmarked for transfer from the State General Fund to the Scrap Tire Disposal Fund Grant account for distribution to counties. The shortage of grant funding will keep the burden of paying for any excess scrap tire disposal costs on the counties and in particular solid waste departments.

The scrap tire tax distribution does not typically cover the County's cost of tire disposal. **Figure 2** compares the costs of tire disposal verse the scrap tire tax distribution revenues over the past five years. It is anticipated that the cost for tire disposal will continue to increase, while the scrap tire disposal tax distribution will remain steady or potentially decrease.

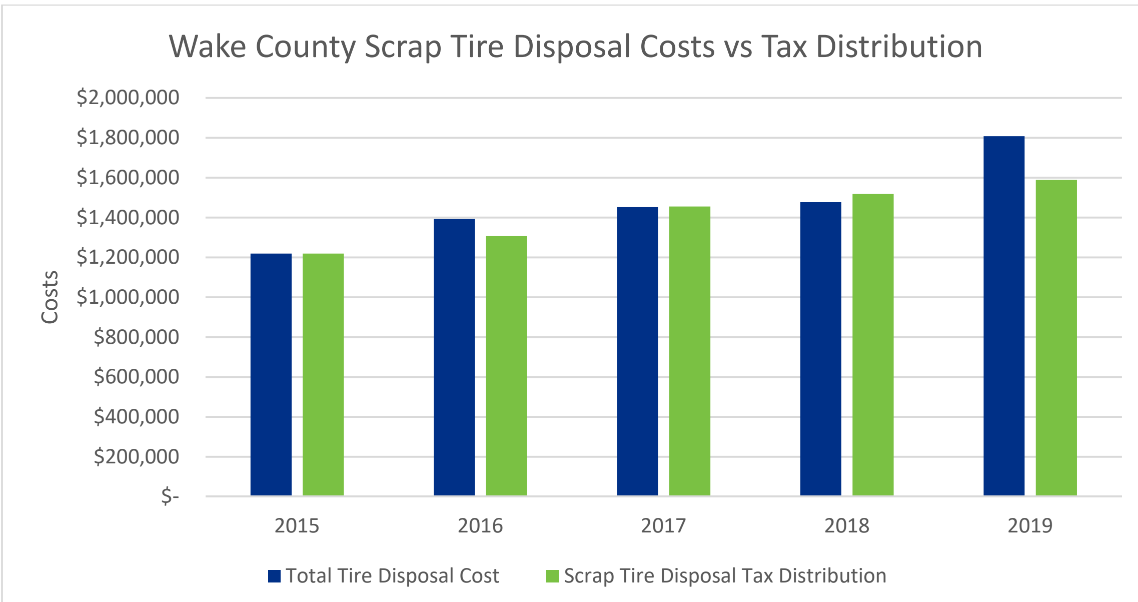


Figure 2. Wake County Scrap Tire Disposal Costs vs Tax Distribution

2.3 Out of County Tires

The scrap tire disposal tax distribution is based on the population of the County. However, many out-of-county residences dispose of tires within Wake County. CDM Smith recommends Wake County continue their efforts in making sure tires disposed at the MMRFs are only from county residents. Wake County may also benefit by having discussions with the state about increasing the funding received from the Scrap Tire Disposal Tax Distribution due to the large amount of out of county tires being disposed within Wake County.

2.4 Case Study - Mecklenburg County

Mecklenburg County also shreds tires at the Foxhole landfill using the TANA Shark Waste Shredder previously discussed in Section 1.3. Mecklenburg County only shreds tires collected, using County staff, at their four convenience center sites. Mecklenburg County estimates that less than 10% of scrap tires generated within the County are shredded at the landfill and the rest are collected by US Tire, at a cost of $81 to $85 per ton for regular tires, and $129.09 for oversized tires. The Foxhole Landfill staff estimate the processing rate for shredding tires is approximately 8 tons/hour. The shredder can shred all sizes of tires with and without metal rims. Landfill staff recommend the use of a 6" screen to keep the shredder from clogging. The TANA shredder can be operated to shred tires and mattresses at the same time.

2.5 Permitted Disposal Facilities

There are currently six permitted scrap tire treatment or disposal facilities in North Carolina. These include the following:

- US Tire Recycling Partners LP – Landfill, Concord, NC
- US Tire Recycling Partners LP – Treatment and Processing, Concord, NC
- Central Carolina Tire Monofill – Landfill, Cameron, NC
- Central Carolina Tire Processing – Treatment and Processing, Cameron, NC
- PRTI, Inc. - Treatment and Processing (Pyrolysis), Franklinton, NC
- New River Tire Recycling LLC – Treatment and Processing, Pilot Mountain, NC

Due to the low number of permitted scrap tire treatment and disposal facilities, Wake County has limited options for tire disposal. During the last request for qualifications for tire collection and disposal, Wake County only received one bid from Central Carolina Holding. The limited supply of permitted treatment and processing facilities creates favorable market conditions for the few service providers to charge high prices to collect, transport and process scrap tires. Based on the current market conditions, the cost for tire disposal is anticipated to increase annually.

2.6 Scrap Tire Disposal Option

The NCDEQ Rules prevent the disposal of whole tires within a Subtitle D landfill; however, tires that have been cut can be disposed in a permitted MSW landfill. As a supplemental approach to managing scarp tire disposal, shredding tires and placing them in the South Wake Landfill can provide a cost savings to the County. CDM Smith has assumed that not all scrap tires can practically be diverted to the landfill and shredded. The diversion of all scrap tires would result in higher transportation and labor costs along with a significant increase in landfill airspace consumption, which will shorten the landfill's life span. Therefore, CDM Smith analyzed the cost savings of shredding only the tires collected at the South Wake MMRF since it is adjacent to the landfill. Scrap tires collected at the South Wake MMRF are collected in the South Wake Transfer Station facility bay.

In FY 2019, 2,615 tons of tires were disposed of at the South Wake MMRF. With an average disposal cost of $90/ton[1], the total cost of disposal was approximately $235,350. If the same number of tires were shredded and disposed of in the SWLF, CDM Smith determined that the value of the airspace consumed would be approximately $99,176, as shown in the calculation in

[1] Approximate value from discussions with Wake County Staff

Exhibit A. As a result, the cost saved by shredding the tires from the South Wake MMRF would be approximately $136,174.

Shredding oversized tires would also be a significant cost savings for the County. Currently, CCH collects and disposes of all oversized tires in the County and charges the County $457 per ton. In FY 2019, 157 tons of oversized tires were collected and disposed by CCH, resulting in an annual disposal cost of $71,964. If the same number of tires were shredded and disposed of in the SWLF, CDM Smith determined that the value of the airspace consumed would be approximately $5,972, as shown in the calculation in Exhibit A. As a result, the cost (excluding capital and operational costs) saved by shredding oversized tires would be approximately $65,991.

2.7 Operational Costs

In order to develop a net cost savings for shredding special wastes, CDM Smith estimated operational costs based on the assumption that costs would be shared across both tires and mattresses. Based on TANA's financial model for the Tana Shark Waste shredder, the operation cost per hour is estimated to be $127.98. This cost includes routine maintenance, service repairs, fuel costs and operator costs. Assuming the County receives one box truck of 40 mattress per operating day, and shreds the tires received at the South Wake MMRF, the County will process approximately 350 tons of mattresses per year and 2,615 tons of tires per year. Using a typical processing rate of 6 tons per hour for mattresses and 8 tons per hour for tires, CDM Smith estimated that the County will have to run the shredder for approximately 385 hours per year. Therefore, the annual operational cost for the shredder is estimated to be approximately $49,300 per year.

CDM Smith estimates the net cost savings for shredding mattresses and tires ranges from approximately $382,464 to $437,464 annually, depending on the reduction of mattress volume. A summary of net annual cost savings is presented in the **Table 3** below.

Table 3. Annual Net Cost Savings from Shredding Mattresses and Tires

Operation	Net Cost Savings	
Mattresses Reduction Percentage	80%	90%
Mattress Shredding Revenue	$229,600	$284,600
Cost Savings – SW MMRF Tires	$136,173	
Cost Savings – Oversized Tires	$65,991	
Operational Cost	$49,300	
Total Net Cost Savings	**$382,464**	**$437,464**

Assuming the capital cost for a TANA Shark Waste Shredder is ~$900,000, CDM Smith estimates that the County can pay back the capital cost of the shredder in approximately 2 to 3 years, based on the net annual cost savings.

Exhibit A

Mattress and Tire Calculations

CDM Smith

CLIENT	Wake County	JOB NO.	6172-240464	COMPUTED BY	B.Wlosek
PROJECT	CSWMP	DATE CHECKED	3/30/2020	DATE	
DETAIL	Mattress vs MSW Disposal Revenue Comparison	CHECKED BY	J. Boyer	PAGE NO.	1 of 1

Objective

Estimate the value of landfill airspace consumed by an average full-sized mattress at the South Wake Landfill (SWLF) and determine price of a per mattress fee.

Givens/ Assumptions

SWLF Tipping Fee	32	$/ton
Average SWLF Compaction Rate	0.72	ton/cy
	1440	lbs/cy
Estimated density of average full size mattress	66	lbs/cy
Extra equipment and labor cost per mattress[1]	$5	

Determine revenue of MSW per CY

Revenue of MSW = Tipping Fee x Compaction Rate / 2000

Revenue of MSW 23.04 $/cy

Value of landfill airspace consumed by a mattress

Value of airspace used by 1 mattress = Airspace used by one mattress x value of 1 cy of landfill airspace

Compaction rate of 25% = 0.75 cy of airspace used by 1 mattress

Compaction rate of 50% = .50 cy of airspace used by 1 mattress

Value of airspace used by mattress at 25% compaction =	**$**	**17.28**
Value of airspace used by mattress at 50% compaction =	**$**	**11.52**

Net Cost to Landfill a mattress

Net Cost to Landfill a mattress = Value of landfill airspace + Value of extra handling - weight revenue for mattress disposal

Weight Revenue for mattress disposal = Tipping Fee x Weight of mattress

Weight revenue for mattress disposal =	$	1.20
Net Cost to Landfill a mattress at 25% compaction =	**$**	**21.08**
Net Cost to Landfill a mattress at 50% compaction =	**$**	**15.32**

Conclusion

- To recover the value of airspace consumed by a typical mattress, the County would need to charge approximately $15-$20 per mattress.

[1] $5 extra handling fee determined from "What does it really cost to landfill a mattress?" article by 7 Rivers Recycling. This cost may be higher or lower for Wake County

Objective

Determine airspace value saved by shredding mattresses and determine bulk load surcharge

Givens/ Assumptions

Volume of 20 ft long box truck:	45	cy
Density of average full sized mattress:	66	lbs/cy
Weight of average full sized mattress:	56	lbs
Revenue of MSW[1]	23.04	$/cy
SWLF Tipping Fee	32	$/ton

Determine Average Number of Mattresses per Truck

Assume 75% of truck volume is utilized, or 34 cy

Number of mattresses = (Truck Volume utilized * Density of mattress)/ weight of mattress

Number of mattresses = 40 mattresses/truck

Weight Revenue Generated per Truck

Weight Revenue = Number of mattresses * Weight of Mattress * Tipping Fee

Weight Revenue = $ 35.64

Value of Airspace Consumed by Traditional Compaction Methods

Assume 25% compaction, mattresses would use approximately 27 cy of airspace

Value of Airspace = (Weight of load / Density of mattresses * 1.25) * Revenue of MSW

Value of Airspace = **$ 625.57**

Therefore, for every truckload of mattresses, the landfill sells $625 worth of airspace but is only receiving $35 at a 25% compaction rate.

Value of Airspace Saved by Shredding Mattresses

Assume 90% Volume Reduction, a truckload of mattresses would take up 3.5 cy of airspace, saving 23.5 cy of airspace

Value of Airspace Saved = Volume of Airspace saved * Revenue of MSW

Value of Airspace Saved = **$ 541.44**

Assume 80% Volume Reduction, a truckload of mattresses would take up 7 cy of airspace, saving 20 cy of airspace

Value of Airspace Saved = Volume of Airspace saved * Revenue of MSW

Value of Airspace Saved = **$ 460.80**

Value of Airspace Saved per Year

Assume one truck load per operating day (312 days/year)

Value of Airspace Saved per Year = Value of Airspace saved * 312 days

Value of Airspace Saved per Year at 90% Volume Reduction = **$ 168,929.28**

Value of Airspace Saved per Year at 80% Volume Reduction = **$ 143,769.60**

Surcharge Tipping Fee for Bulk Mattress Loads

Surcharge Tipping Fee = (Value of Airspace Used - Weight Revenue) / tonnage rate + tipping fee

Surcharge Tipping Fee at 90% Volume Reduction **$ 76.08**

Surcharge Tipping Fee at 80% Volume Reduction **$ 149.39**

Average Surcharge Fee = **$ 112.74**

[1]Revenue of MSW determined in *Mattress vs MSW Disposal Revenue Comparison* calculation.

CLIENT	Wake County	JOB NO. 6172-240464	COMPUTED BY B.Wlosek
PROJECT	CSWMP	DATE CHECKED 3/30/2020	DATE
DETAIL	Cost Savings of Shredding Tires	CHECKED BY J. Boyer	PAGE NO. 1 of 1

Objective

Determine the cost savings of shredding tires collected at the South Wake MMRF.

Givens/Assumptions

SW MMRF Tires disposed in FY 2019	2,615	tons/year
Density of Compacted Tire Shreds[1]	45	lb/cf
CCH Tire Disposal Cost	90	$/ton
Revenue of MSW[2]	23.04	$/cy

Value of Airspace Consumed by Shredded Tires

Value of Airspace = (Weight of tires / Density of compacted tire shreds) * Revenue of MSW

Value of Airspace =	**$**	**99,176.30**
Value per ton	$	37.93

Cost Savings of Shredding Tires

Cost of disposing with CCH $ 235,350.00

Cost Saved by Shredding = Cost of Disposing with CCH - Value of Airspace Consumed

Cost Saved by Shredding = **$ 136,173.70**

[1]*User Guidelines for Waste and By-Product Materials in Pavement Construction* , Federal Highway Administration, FHWA-RD-97-148, April 1998
[2]Revenue of MSW determined in *Mattress vs MSW Disposal Revenue Comparison* calculation.

CLIENT	Wake County	JOB NO.	6172-240464	COMPUTED BY	B.Wlosek
PROJECT	CSWMP	DATE CHECKED	3/30/2020	DATE	
DETAIL	Cost Savings of Shredding Tires	CHECKED BY	J. Boyer	PAGE NO.	1 of 1

Objective

Determine the cost savings of shredding oversized tires.

Givens/Assumptions

FY 18-19 Number of Tires Disposed	157	tons/year
Density of Compacted Tire Shreds[1]	45	lb/cf
CCH Oversized Tire Disposal Cost	457	$/ton
Revenue of MSW[2]	23.04	$/cy

Value of Airspace Consumed by Shredded Tires

Value of Airspace = (Weight of tires / Density of compacted tire shreds) * Revenue of MSW

Value of Airspace = **$ 5,972.20**

Value per ton $ 37.93

Cost Savings of Shredding Tires

Cost of disposing with CCH $ 71,963.79

Cost Saved by Shredding = Cost of Disposing with CCH - Value of Airspace Consumed

Cost Saved by Shredding = **$ 65,991.59**

[1]*User Guidelines for Waste and By-Product Materials in Pavement Construction*, Federal Highway Administration, FHWA-RD-97-148, April 1998

[2]Revenue of MSW determined in *Mattress vs MSW Disposal Revenue Comparison* calculation.

CLIENT	Wake County	JOB NO.	6172-240464
PROJECT	CSWMP	DATE CHECKED	3/30/2020
DETAIL	Operational Costs for a Shredder	CHECKED BY	J. Boyer
COMPUTED BY	B.Wlosek	DATE	
PAGE NO.	1 of 1		

Objective

Determine operational costs based on the estimated amount of mattresses and tires to be shredded.

Givens/Assumptions

Operational Cost (Provided by TANA)	127.98	$/hour

Typical Processing Rates

Mattresses	6	tons/hour
Tires	8	tons/hour

Total Tons of Materials

Tons of mattresses per year (1 box truck (40 mattresses) per operating day)	349	tons
Tons of Tires per year (assume SW MMRF tires only)	2615	tons

Total Shredding Hours

Total hours per year shredding mattresses	58.24	hours
Total hours per year shredding tires	326.875	hours
Total hours per year	385.115	hours

Total Annual Operational Costs **$ 49,287.02**

Shown above is the partially closed Phase 1 unit of the South Wake Landfill where landfill gas is collected and used to run engines that generate around 7.5 Megawatts of energy—enough to power 7,500 homes during times of peak demand. To learn more visit: http://www.wakegov.com/recycling/division/swl/Pages/gas.aspx.

CDM Smith®
cdmsmith.com