




**SOLID WASTE GENERATION
AND COMPOSITION STUDY**

July 23, 2021



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July 23, 2021



Mr. Kevin Kelleher
Assistant County Administrator
115 S. Andrews Avenue, Room 409
Fort Lauderdale, FL 33301

Ms. Notosha Austin
Assistant Director, SWRS
1 North University Drive, Suite 400
Plantation, FL 33324

Subject: Proposal for Solid Waste Generation and Composition Study

Dear Mr. Kelleher and Ms. Austin:

MSW Consultants is pleased to provide this proposal to Broward County (County) to perform a comprehensive Solid Waste Generation and Composition Study on behalf the County and its municipal Solid Waste Working Group (SWWG). Thank you for this opportunity to propose on this study and share our qualifications.

MSW Consultants is an Orlando-based management consulting firm with offices in Pennsylvania and Maryland, specializing in the waste and recycling industry. We are a national leader in planning and conducting large-scale waste stream analyses for cities, counties, and state agencies. In the past five years alone, MSW Consultants has performed more than 30 waste characterization studies and materials audits. Going back further, our overall portfolio ranges from statewide studies in Pennsylvania (ongoing), California, Maryland, Missouri, Connecticut, Delaware and Vermont, and some of the largest local governments in the U.S. including New York City, Phoenix, Philadelphia, San Jose, Franklin County, OH, Hennepin County, MN, Orange County, FL and Louisville-Jefferson, KY.

We have designed customized approaches to characterize various material streams. In particular, our protocol now includes the following technical enhancements which are not available from other competitors in the market:

- **Mobile Data Management:** We have migrated our data collection to mobile, rugged tablet computers with built-in QA/QC capabilities. These tools increase the accuracy and efficiency of our field data collection efforts and allow field data to be uploaded to the cloud for added protection against loss of data.
- **Cloud-based Data Access for Clients:** Sample data is now managed on MSW Consultants' cloud-based platform, *WasteInsight™*. The *WasteInsight™* platform includes not only numerical data but also pictures of samples to provide our clients with robust access throughout the project.
- **Real-time Density Conversion of Visual Volumetric Surveys:** MSW Consultants has developed the industry's only mobile app that allows visual surveyors to validate the estimated weight of visually surveyed loads against scale data. We have field-tested this approach at over 15 landfills in a recent statewide study for the Missouri Department of Natural Resources and recently launched the client use capability in Boulder County, CO.

We also wish to highlight other items of importance, including:

- **The scale and complexity of our waste characterization study work:** As noted above, MSW Consultants has performed some of the largest and most extensive studies in the

U.S., including in jurisdictions with large and complex solid waste systems and streams. With a population approaching 2 million people, and a solid waste stream of 4 million tons, we believe Broward County's system fits that bill.

- **Understanding of Florida's Solid Waste Dynamics:** Our team has a deep understanding of the state's waste management and recycling market dynamics, having provided solid waste management planning services ranging from cart monitoring services, procurement support, PAYT program design, and material characterization studies in jurisdictions such as Orange County, Polk County, Gainesville, Alachua County, etc. We believe it is also worth noting that this project's client liaison is Phil Bresee, who served as Broward County's recycling program manager from 2004 until mid-2012.

Full details are contained in our proposal as well as in the proposal matrix form we are required to complete. Please do not hesitate to contact me at (407) 380-8951 or at jculbertson@mswconsultants.com if you have any questions.

Thank you again for this opportunity to propose and for your consideration.

Sincerely,

MSW CONSULTANTS



John Culbertson
Vice President



Solid Waste Generation and Composition Study

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PROPOSAL

ABOUT MSW CONSULTANTS



MSW Consultants is a specialized consulting company whose key management staff have over 100 years combined experience providing municipal solid waste management planning, recycling program assessment, collection program productivity analysis and routing, solid waste cost-of-service and rate development, waste composition and generation studies, litter and marine debris management, procurement assistance, and implementation assistance for local governments and institutions across the nation. MSW Consultants was created in name in 2002 and legally established as a Maryland Limited Liability Company (LLC) in 2004. The firm's client base has expanded to over 125 city, county, state and private organizations across the U.S., served by 15 staff and associates. MSW Consultants provides the following menu of solid waste consulting services:



Solid Waste Management Plans

- SWMPs and Zero Waste Plans
- Overview of waste management systems and technologies
- Stakeholder committee facilitation
- Public education and outreach strategies



Recycling/Composting

- Yard waste collection/Diversion/Processing
- Food waste collection/Diversion/Processing
- Compost facility layout and permitting
- Residential/Commercial recycling programs
- Single stream recycling analysis
- Volume-based pricing (Pay-As-You-Throw)
- Recycling and compost service procurement



Collection Optimization

- Refuse, recycling, yard waste and bulky waste productivity analysis and improvement
- Automated and single-stream collection conversion assistance
- Front-load and roll-off efficiency analysis and service rate development
- GPS, event tracking, RFID and onboard data collection system development
- Route development, route balancing, and area/path re-routing



Financial Analysis

- Solid waste system full-cost-of-service studies
- Enterprise fund development
- Lifecycle cost development
- Solid waste enterprise fund service rate development



- Facility processing/tip fee analysis
- User fee and non-ad valorem assessment rate development

Collection, Disposal and Recycling Procurement Services

- Solid waste, recycling, yard waste and bulky waste collection procurement assistance
- Contract/franchise system analysis
- Managed competition assistance
- Contract negotiation assistance

Waste Composition and Generation Analysis

- Sampling plan development
- Waste composition field sampling and sorting
- Statistical analysis
- Waste generation rate studies
- Institutional and commercial waste audits and recycling program improvement
- Visible litter studies and litter/illegal dumping research

Solid Waste Engineering

- Facility permitting and permit modifications
- Plans and specifications, construction management and contract monitoring
- Transfer station facility siting, design and optimization
- Compost facility siting, design and operations support
- Recyclables drop-off and MRF design, equipment procurement

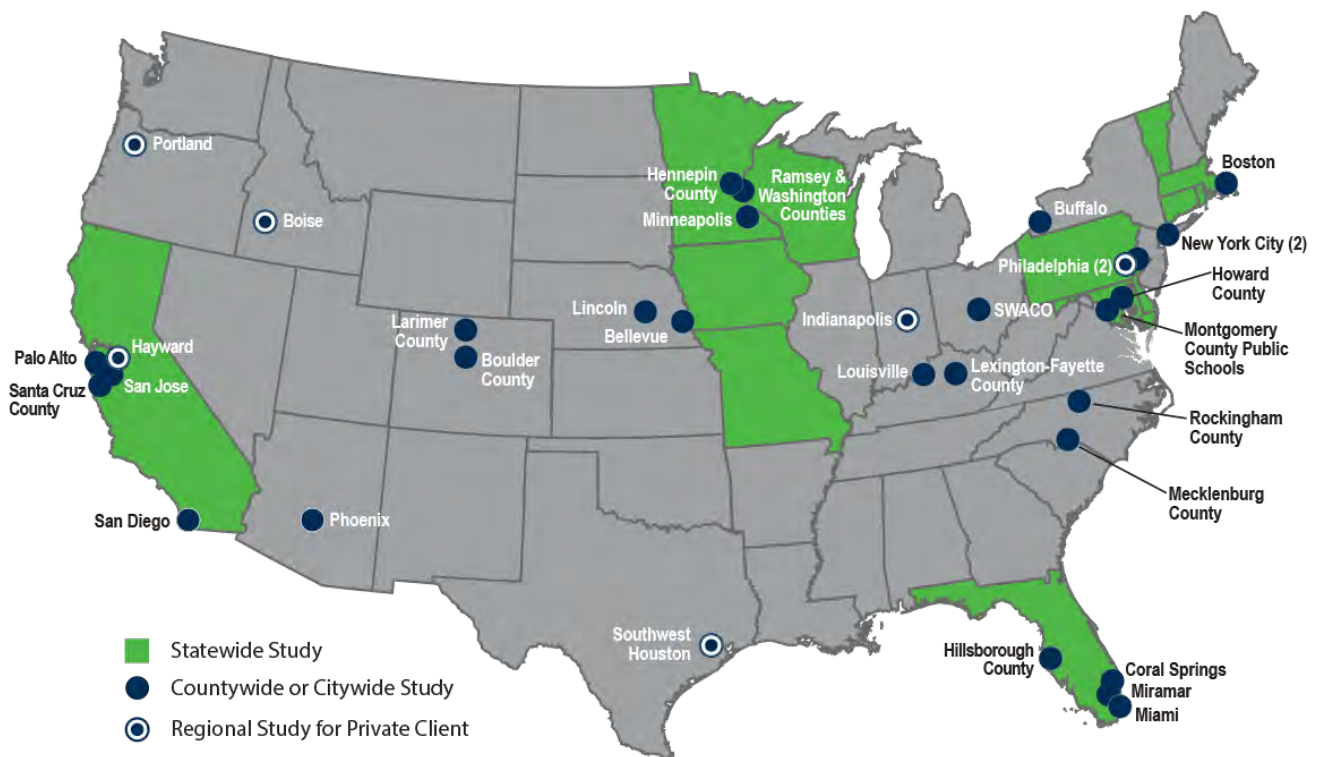
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MATERIAL CHARACTERIZATION QUALIFICATIONS

MSW Consultants, LLC is a leading national provider of large-scale, multi-season, multi-stream waste characterization services for state agencies, counties, cities, and large institutional and commercial waste generators. **MSW Consultants has participated in the majority of the statewide waste characterization studies performed in the U.S. over the past ten years and has assisted major U.S. cities and counties to characterize their waste and recycling streams in the pursuit of increased diversion and an assessment of current recycling program effectiveness.** We are increasingly assisting recycling processors, facility developers, and specialty equipment manufacturers to design sampling and sorting methodologies needed to answer increasingly complex questions about materials streams in the pursuit of zero waste. The map shown below presents MSW Consultants' extensive experience in designing and implementing waste characterization studies.

MSW Consultants Large-Scale Waste Characterization Experience

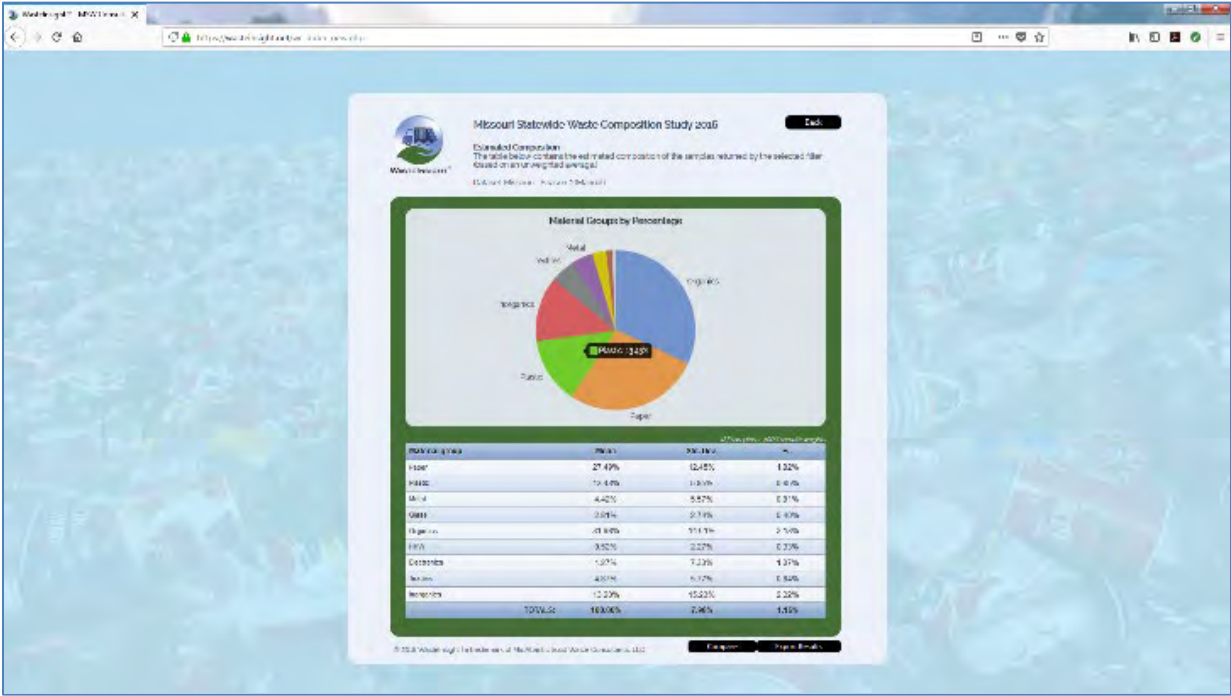


Note: Florida and Pennsylvania statewide studies were performed by key MSW staff while working for prior employers.

MSW Consultants provides an unparalleled value in the performance of waste characterization studies. Our experience offers clients a host of benefits, including:

- ◆ **An understanding of the reasons why local governments opt to perform waste stream analyses.** Broward County's proposed study will quantify the characteristics of the disposed wastes throughout the county. In so doing, the results of the study will inform all facets of waste diversion planning, including how to influence and improve diversion behaviors, as well as how to take advantage of emerging energy recovery and mechanical processing technologies for back-end recovery.

- ◆ **A commitment to health and safety.** MSW Consultants maintains a customized, written Safety and Health Plan specifically to govern our operational practices and PPE requirements for the performance of waste characterization studies and waste audits. Our health and safety program for waste characterization studies at landfills, waste-to-energy plants, transfer stations and MRFs has been independently certified through ISNetwork.
- ◆ **A detailed understanding of the markets and specifications for recycled fibers, containers, and other materials** that can be recovered from the waste stream. This leads to a keen understanding of the basis for material category definitions that achieve the desired specifications.
- ◆ **Accurate and efficient sorting procedures.** MSW Consultants has developed the industry’s most transparent and verifiable system for achieving highly accurate results. We will train locally-based laborers to sort materials for the MSW and recycling study, sorters to place materials into clearly labeled bins, which are monitored by our crew chiefs for accuracy throughout the study.
- ◆ **Specialized data management.** MSW Consultants has developed its *WasteInsight™* online resource to provide user-friendly, organized access to material stream characterization data, including sample weights and photographs. It also allows clients to generate and download composition results filtered by location, date, material stream, and other attributes.
- ◆ **Real-time app-based data management:** MSW Consultants has developed the industry’s leading apps for waste characterization data entry and management. Armed with rugged tablet computers, our field operation staff have the benefit of a suite of data entry tools that provide real-time QA/QC for both manually sorted and visually surveyed samples.

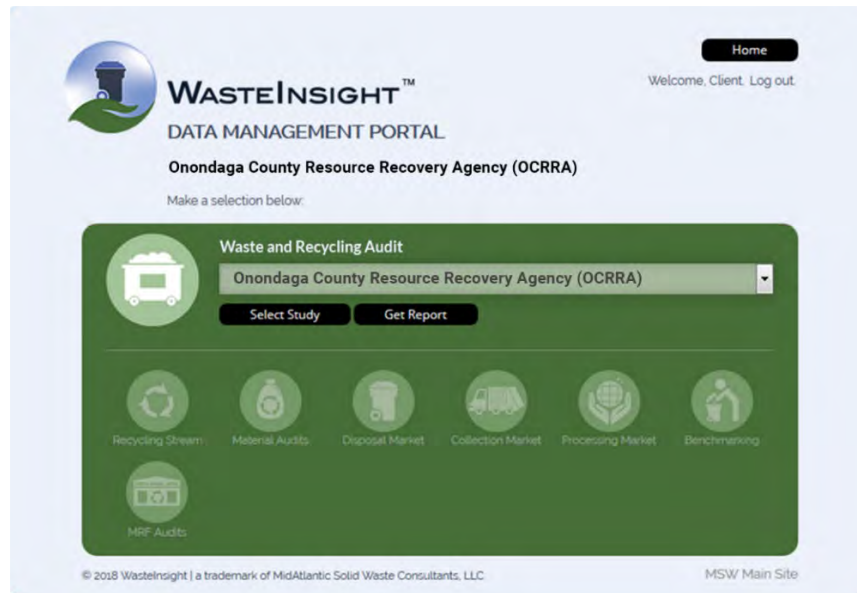


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PROJECT ENHANCEMENTS & VALUE-ADDED SERVICES

WasteInsight™

WasteInsight™ is a uniquely informative market intelligence service that helps waste generators, haulers, processors, facility developers, manufacturers, trade associations, and state and local governments to accumulate, track and analyze selected hard-to-find, technically complex, and market-critical data to enhance their waste management performance. *WasteInsight™* is an ever-expanding work-in-progress brought to you by MSW Consultants, LLC.



GAP System

The Grading and Purity (GAP) Program is the recycling Industry's most innovative and effective program to provide you and your upstream and downstream material supply partners with the ability to compile and analyze the data needed to improve material quality at every step of the recycling process. Created in 2015, this is a data management platform focusing on material quality, program benchmarking, and contract management. Clients subscribe to use and receive analytical results of their audit data, with added consultant oversight.

The process flow is depicted below, from the point of material audit characterization input to cloud-based analytical output.



RELATED PROJECT EXPERIENCE & REFERENCES

The following table summarizes relevant waste characterization experience over the last 10 years.

MSW Consultants Waste Characterization Project Experience

Client/Project/Year	Client/Project/Year
Boulder County, CO (2019) Waste Characterization Study	City of Decatur, GA (2021) Waste Characterization Study
Chittenden Solid Waste District (CSWD), VT (2020) Residential Waste Composition Study	City of Philadelphia, PA (2020) Recyclables Composition Study and Contaminated Loads Rejection Review
Howard County, MD (2019) Residential Waste Composition Study	Vermont Dept. of Environmental Conservation (2018) Statewide Waste Composition Study
New York City Sanitation Dept. (2018, 2017, 2014, 2013) Various Waste Characterization Studies	CalRecycle, CA (2018, 2014) Statewide Disposal Facility Waste Characterization Studies
Missouri Department of Natural Resources (2017) Statewide Waste Composition Study	City of Philadelphia, PA (2017) Residential Waste Characterization Study
ReCommunity/City of Philadelphia, PA (2014-2018) Quarterly Single Stream Recycling Composition Studies	Northeast Maryland Waste Disposal Authority (2017) Maryland Statewide Waste Sort Project
Dakota County, MN (2017) 12 Municipal Bldg. Sorts (Trash, Recycling, Organics)	Progressive Waste Solutions/City of Miramar, FL (2017) Single Stream Recycling Composition Analysis
Progressive Waste Solutions/City of Miami, FL (2016) Single Stream Recycling Composition Analysis	Hennepin County, MN (2016) Residential Waste Audit and Recycling Analysis
Delaware Solid Waste Authority (2016) Statewide Waste Characterization Study	Louisville Metro Government, KY (2016) Waste Characterization Study
MassDEP/Wheelabrator, MA (2016, 2013) WTE Facility Waste Characterization Studies	MassDEP/Covanta Energy, MA (2016, 2013) WTE Facility Waste Characterization Studies
City of Philadelphia/ReCommunity (2015) Single Stream Composition Analysis	Connecticut Dept. of Energy & Environmental Protection (2016) Statewide Waste Characterization Study
Confidential Client, FL (2015) Waste Plastics Composition Study	Rhode Island Resource Recovery Corporation (2015) Statewide Waste Characterization Study
City of Boston, MA (2014) Residential Food Waste Diversion Pilot test	City of Phoenix, AZ (2015) Residential Waste Characterization Study
Progressive Waste Disposal/Hillsborough County, FL (2014) Waste Characterization Study	Waste Management/City of Hayward, CA (2014) MRF Audit
Confidential Client, NY (2014) Zoo Waste Characterization Study	Lexington-Fayette Urban County Government, KY (2014) Countywide Waste Stream Analysis
Ramsey County, MN (2014) Waste Composition Study	City of Coral Springs, FL (2011) Waste Characterization Study

In addition, the table below depicts specifically C&D debris (and other bulky) characterization studies performed by MSW Consultants over the past five years.

C&D Waste Characterization Project Summary

Client	Client
Boulder County, CO	Minnesota Pollution Control Agency (MPCA)
Vermont Dept. of Environmental Conservation, VT	CalRecycle, CA
Missouri Dept. of Natural Resources, MO	Louisville Metro Government, KY
Lexington-Fayette Urban County Government, KY	Mecklenburg County, NC
City of San Jose, CA	Delaware Solid Waste Authority, DE
Larimer County, CO	

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We have included profiles and contact information for several reference projects below:

Orange County, FL: Single Stream Recycling Audits (2020)

Orange County is the 5th-largest County in Florida with more than 1.4 million residents, and solid waste stream of 3.3 million tons. The County's Solid Waste Division oversees the residential curbside collection of refuse and recyclables for over 217,000 households within its 1,005 square miles geographic area. Historically, high levels of contamination in the County's recycling stream have led to rejections of many recycling loads coming into County facilities. To combat this, the County partnered with The Recycling Partnership and MSW Consultants in the rolling out of a Recycling Quality Improvement Program. As part of this program, MSW was tasked with providing a specialized and well-trained team of cart monitors to provide direct feedback on resident recycling behaviors at the curb, as well as performing composition audits of inbound recycling loads before and after cart monitoring occurred in order to measure the effectiveness of the program.

The first of these audits occurred in October 2020. MSW coordinated with the County to develop a sampling plan which would capture routes from neighborhoods directly impacted by the cart monitoring activities. These samples were collected at the County's MRF and a County-owned transfer station to capture the universe of routes. Over 50 samples were captured and sorted into 40 County-approved material categories. All data were recorded into a tablet computer using MSW Consultants' proprietary cloud-based data management platform. Upon the completion of the audit, results were compiled into a brief report which detailed MSW's findings. Cart monitoring was conducted at over 31,000 households between October 19, 2020, and March 8, 2021. A post-monitoring audit was completed the week of March 22, 2021, sorting 56 samples taken from across 29 impacted routes serving the targeted neighborhoods.

This post-audit report successfully confirmed a meaningful improvement in the recycling quality had resulted in the neighborhoods that had been monitored, particularly in the reduction of plastic bags and film observed.

Ada County, ID: Landfill Waste Stream Analysis (2020)

Ada County is home to more than 480,000 residents and generates approximately 475,000 tons of MSW. This four-season study addressed the composition of single-family and multi-family residential waste, commercial waste, and construction and demolition (C&D) waste throughout the Ada County waste-shed, which primarily included the cities of Boise, Meridian, and Garden City. Sample collection was performed at the Ada County Landfill, and the Meridian Transfer Station. Waste characterization was performed by manual sorting procedures for residential and commercial MSW, while visual characterizations were made of C&D samples. Data analysis was performed by applying the waste composition data to the most recent annual waste volumes as reported by Ada County Landfill.

Onondaga County Resource Recovery Agency (OCRRA), NY: County-Wide Waste Characterization Study (2020)



Onondaga County, NY is home to approximately 460,000 residents, generating more than 800,000 tons of refuse, recyclables, and C&D each year. MSW Consultants was retained to perform a comprehensive update of the client's 2006 study, applying industry-standard sampling and sorting protocols. The 2020 Study update also integrated a robust visual survey of the construction and demolition (C&D) waste stream using a proprietary, app-based surveying process to validate estimated composition against known load weights.

MSW Consultants performed two seasons of manual sorting of municipal solid waste from the residential and commercial sectors, as well as single-stream curbside recyclables. A total of 320 samples were ultimately obtained for analysis. Data from both the manual sorts and visual surveys were uploaded into MSW Consultants' proprietary *WasteInsight*[™] data management platform to undergo QA/QC and to statistically analyze material stream composition.

The characterization study concluded with a comprehensive report to document the methodology and composition data for waste, recyclables, and C&D debris. Recycling capture rates were also estimated, as well as a comparison to previous studies.

Final Report:

https://ocrra.org/wp-content/uploads/1/2020/05/WasteQC_2019_Final_KRL_050720.pdf

Reference:

Andrew Radin, Director of Recycling and Waste Reduction
(315) 453-2866 | aradin@ocrra.org

Boulder County, CO: Countywide Waste Composition Study (2019)

Boulder County (326,000 residents and an MSW stream of 420,000 tons) has long been at the forefront of progressive waste management and recycling. In November 2005 the Board of County Commissioners passed a resolution seeking to achieve Zero Waste (or "darn near") by 2025. Doing so requires an acute focus on changing an entire mindset from waste management to materials management.



To aggressively pursue a zero-waste goal, it is critical to understand the amount and composition of the waste stream that is currently being disposed of. If wastes are to be turned into resources, it is imperative to know what those resources are. Anecdotal information and available market data suggest that recent history – including the economic downturn in late 2008 and 2009, disruption in the markets for recyclable materials, a crash in the housing and construction market, and the continued changes in product packaging and consumption trends, to name examples – appear to have impacted both waste volume and composition on a national and local scale.

The County retained MSW Consultants to conduct a statistically representative analysis of the County's disposed waste stream. This study characterized disposed wastes from the residential, commercial, and multi-family sectors, with field data collection performed at two privately-owned disposal facilities that receive the majority of waste generated in the County. The Study was completed in 2010. MSW Consultants is currently working on an update to the study which also includes visual characterization of C&D loads.

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New York City Department of Sanitation, NY: Residential Waste and Recycling Characterization Study (2017)



With more than 8.25 million residents, New York City is the most populated city in the U.S. and generates more than 3 million tons of residential MSW each year. MSW Consultants has collaborated with the New York Department of Sanitation on multiple large scale residential waste characterization studies since 2012. In both 2012 and again in 2017, MSW Consultants performed comprehensive residential waste and recycling characterization study from the five boroughs of New York City in a project that was jointly funded by the New York Department of Sanitation and Sims Municipal

Recycling of New York. These projects updated the City's prior comprehensive study, conducted in 2004-05, and also was designed for use in updating the City's contract with Sims for processing of residentially generated Paper and Metals, Glass and Plastic (MGP) from the City's dual stream recycling program.

MSW Consultants led the project, which entailed sampling of over 400 Refuse, Paper and MGP routes over two seasons to characterize the waste stream. This project required all plastics to be sorted by use and by resin, making it one of the most comprehensive characterization studies ever performed with a total of over 300 categories.

Results of this effort are available on the DSNY website.

Reference:

Bridget Anderson, Deputy Commissioner
Bureau of Waste Prevention, Rescue and Recycling
(212) 437-4672 | banderson@dny.nyc.gov

City of Philadelphia, PA: Waste and Recyclables Characterization Study (2017)

The City of Philadelphia is the 6th largest city in the U.S. with nearly 1.6 million residents. It generates more than 2 million tons of total MSW each year, which includes approximately 600,000 tons of residential MSW. With more than 200 daily collection routes, it is one of the largest municipally operated solid waste systems in the U.S. In 2017 MSW Consultants performed a two-season (winter and summer) composition study of the City's residential refuse and recyclables. This project required a review of the City's residential refuse and recycling collection routes for the purposes of developing a statistically representative sampling plan for analyzing waste and recyclables generation and composition.



MSW Consultants developed a sampling plan and study design document to guide field data collection, which took place over two seasons at the City's transfer station and at a private material recovery facility that accepts the City's single-stream recyclables. The study included 43 materials categories with 229 refuse and 180 recyclables samples analyzed during the two seasons. MSW Consultants compared the 2017 findings with those from the City's 2010 (also performed by MSW Consultants) and 2000 studies to examine trends and impacts of expanded residential recycling. The 2017 study also featured a recycling capture rate analysis and compared solid waste composition findings with other large U.S. cities. The final report was issued in 2018.

MSW Consultants has since analyzed the generation and composition of multiple City waste streams including:

- ◆ A 2021 **Recycling Capture Rate Study** performed in conjunction with a **Recycling Bin Monitoring Program** supported by **The Recycling Partnership**.
- ◆ An **organics feasibility study** to determine the potential to increase diversion of yard waste and food waste through a multi-pronged strategy.
- ◆ **City single-stream recyclables**, in an ongoing series of intermittent audits to support the City's processing contract.
- ◆ **Big Belly litter cans** in the downtown area to evaluate efficiency and incidence of recyclable materials.

Reference:

Scott McGrath, Planning & Environmental Services Director
Department of Streets, Sanitation Division
(215) 686-5095 | scott.mcgrath@phila.gov

Missouri Department of Natural Resources (DNR), MO: Statewide Waste Characterization (2017)



The Missouri Department of Natural Resources (DNR) has sponsored statewide waste characterization projects on two occasions dating back to 1996. In 1996-98 and again in 2006-08, DNR has performed comprehensive studies to manually sort residential and commercial wastes at disposal facilities across the state, and also to survey construction and demolition and industrial waste loads to understand the range of solid wastes being disposed in Missouri's landfills.

Missouri is home to more than 6 million residents and generated some 15 million tons of MSW in 2016. MSW Consultants was retained in 2016 to conduct a study to update the previous information by performing two seasons of manual sorting of Municipal Solid Waste loads as well as a season of Visual Surveying including gate surveys and field evaluations of Construction, Demolition and Industrial type loads. Fifteen landfills and transfer stations are involved for each phase of the project, some being visited for both phases, with a total of twenty-two facilities involved overall. Eight samples of 200-250 pounds each are hand-sorted into 48 material categories during the MSW Manual Sort visits at each facility. During the Visual Surveying phase, loads are gate surveyed one day to cover the population of all vehicle and load types utilizing the location and a second day is spent quantifying the material types comprising sample loads evaluated at the working face. Data from both Manual Sorts and Visual Surveys is uploaded into proprietary software for QA/QC checks, to analyze aggregate and use in reporting.

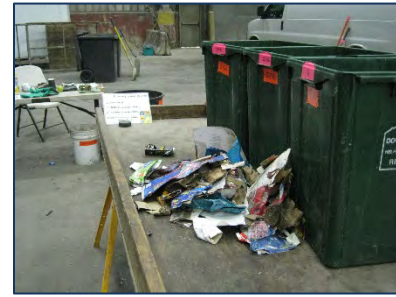
Reference:

Chris Nagel, Solid Waste Program Director
Department of Natural Resources - Solid Waste Management Program
(573) 526-9940 | Christopher.Nagel@dnr.mo.gov

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Hennepin County, MN: Residential Waste Audit and Recycling Potential Analysis (2016)

Hennepin County is the largest County in Minnesota, with nearly 1.3 million residents. There are more than 40 municipalities, including Minneapolis, which is the largest city and the county seat. In 2015, Hennepin County's (County) total recycling rate was 44 percent from the combined residential and commercial sectors. The County retained a project team to quantitatively evaluate the likelihood of achieving Minnesota's state-mandated 75% diversion goal if it applied solely to the residential sector of the City of Minneapolis. The County was also interested in an innovative analysis of the origin of waste plastics.



MSW Consultants, working as a subconsultant, was tasked with formulating the waste characterization protocol and the subsort analysis of waste plastics.

MSW Consultants developed a study design for this innovative project, which included sampling residential wastes from three different regions within the City. MSW Consultants was responsible for coordinating the three work crews needed to perform the main sort and subsort processes. MSW Consultants subsequently performed the detailed statistical analysis, the analysis of waste plastic origin, and also developed maximum theoretical and maximum achievable recycling rates to guide the County and City in the pursuit of state-mandated goals.

Reference:

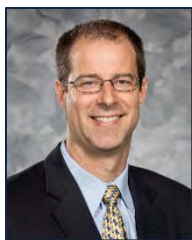
Ben Knudson, Recycling Coordinator
Hennepin County Environment and Energy Department
(612) 596-1176 | Ben.Knudson@hennepin.us

KEY STAFF

We are pleased to introduce the following MSW Consultants key staff members who will lead and perform this project. Full resumes are included in Appendix A.

John Culbertson, Vice President

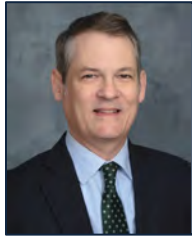
Principal-in-Charge



Mr. Culbertson is a Principal of MSW Consultants with a background in solid waste management and recycling planning, financial analysis, procurement, and program optimization. Mr. Culbertson has 20 years of experience providing waste management consulting services to federal, state, county and city organizations across the nation. He specializes in helping municipalities implement integrated waste management strategies that align policy, education, revenue mechanisms, service contracts, and programs for effective diversion and environmentally sound waste management. Mr. Culbertson has developed sampling plans and performed detailed statistical analysis for numerous large-scale, complex waste characterization studies for states (Wisconsin, Iowa, Pennsylvania, Georgia), cities (Boston, San Jose, Philadelphia, New York City) and counties (Montgomery County, MD; Boulder County, CO; Lexington County, KY), and is regarded as an expert in the field.

Phil Bresee, Senior Consultant

Project Manager and Client Liaison



Phil Bresee joined MSW Consultants in late 2018 after more than 25 years developing and leading recycling and solid waste management programs at the city and county levels and serving in leadership roles in state recycling organizations. He specializes in recycling and solid waste planning, program benchmarking and research, recyclables processing contracts, technical writing, and state and local government policies. Just prior to joining MSW Consultants, Phil was division chief for Arlington County, VA’s Solid Waste Bureau where he managed solid waste, recyclables and organics collections and processing contracts, public education and outreach, solid waste planning, and the county’s commercial and multi-family recycling system. Just prior to his stint in Arlington, Phil was the recycling director for the City of Philadelphia (2012 to 2016).

From 2004 until 2012, Phil was the recycling manager for Broward County where he directed programs and initiatives on behalf of the county its 26 partner cities, and the Broward public schools system. He was the architect of the \$20 million grants project which used solid waste system reserves to help cities improve their residential recycling programs and led the county’s innovative project that studied the feasibility of using recycled glass for beach erosion control. Phil served on the Board of Recycle Florida Today (RFT) from 2005 until 2011, including as its chair from 2007 until 2009, as well as the City of Pembroke Pines’ Green City Commission in 2008 and 2009.

Cynthia Mormile, Senior Project Manager

Operation Specialist



Cynthia Mormile joined MSW Consultants after spending over 20 years working in the solid waste industry for public sector and non-profit organizations. She most recently served as the Solid Waste Utility Manager for the City of Columbia (Missouri), where she managed the operational and financial aspects of residential and commercial trash and recoverables collection, a Class I bioreactor landfill, a compost facility and material recovery facility (MRF). Her expertise encompasses all aspects of a full-service collection, disposal, and recovery solid waste utility, including planning and budgeting; personnel management; procurement/contracts; capital projects; rolling fleet and routing; heavy equipment; subtitle D and bioreactor landfill; waste analysis, minimization, and sustainability programs; facility operation and regulatory compliance. A former resident of Middletown, Connecticut (2017), she has served on multiple industry association boards, presented at numerous state and national conferences and is currently an active member of SWANA and MORA, having served on the board and committees for all three during her career.

Joe Vetrano, Project Manager, LEED AP

Project Field Supervisor

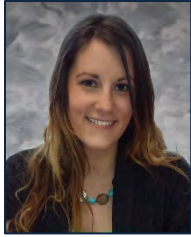


Joe Vetrano is an environmental professional with a diverse skill set that encompasses project management, strategic planning, recycling, zero waste systems design, environmental permitting, and contingency planning. He has conducted sustainability assessments, environmental compliance audits, property condition surveys, waste stream analyses, and environmental due diligence. Mr. Vetrano has served on the MSW Consultants waste characterization field operations management team since joining the firm in 2012, and has performed large-scale studies for New York City, Philadelphia (PA), Lexington-Fayette County (KY), Phoenix (AZ), and statewide studies for Rhode Island, California, and Massachusetts, as well as waste audits for schools, transit authorities, hotels, and a variety of retail and office properties.

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Natalee Mannion, Analyst

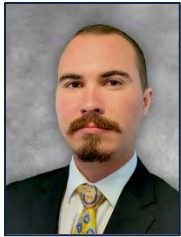
Project Field Supervisor



Natalee has been in the industry for twelve years, specializing in recycling and diversion program development and implementation; solid waste and zero waste planning; waste characterization analyses; and stormwater management. Having previously worked on the West Coast for both municipal government and private consulting firms, Natalee now works out of the Philadelphia area on behalf of MSW Consultants. She has worked with MSW Consultants for over five years as an accomplished analyst, working on a large variety of projects related to planning, operational, and financial analysis while specializing in leading the firm's waste characterization studies across the U.S.

Carl Muth, Analyst

Project Field Supervisor



Carl Muth is a results-oriented professional specializing in field data collection and analysis for the company's material characterization and capture rate studies. Carl is a graduate of the University of Central Florida where he studied Social Science and Marketing. Carl has extensive experience developing study designs and training materials for use with the *WasteInsight*TM GAP System, MSW's proprietary data management platform. Additionally, Carl conducts benchmarking efforts to support a wide variety of MSW projects and acts as field supervisor for MSW's recycling cart monitoring program for clients throughout the US.

Greg Lenaz, Analyst

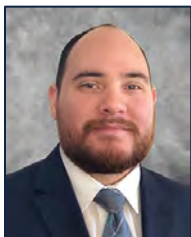
Data Analyst



Greg is an expert in combining client-provided data with industry knowledge. Greg is a graduate of the University of Central Florida where he studied Statistics and Computer Science. Since joining the firm in 2017, Greg has worked on the development of Solid Waste Management Plans for Carbon County (PA), Wayne County (PA), and the City of Buffalo (NY). In each of these projects, Greg has forecasted waste and recycling generation over a ten-year period, as well as modeled the effects of potential diversion programs. Greg was also the project manager for the Massachusetts Materials Management Capacity Study, conducted for the Massachusetts Department of Environmental Protection, where he compiled and analyzed local and state data that spanned 9 states, 1,160 facilities, and 27 million tons of MSW. Greg is proficient in Excel, SAS, SQL, and numerous programming languages.

Frank Canepa, Financial Analyst

Data Analysis



Frank is an experienced member of MSW Consultants with an academic background in economics and a passion for creating positive impacts on the environment. Frank is the firm's lead financial analyst and has created the firm's cost-of-service and rate model used on projects for multiple public sector clients. He has also developed MSW Consultants' transportation cost model, conducted financial feasibility studies, and performed field work for various projects across the United States. He previously spent nine months working as a research intern for *WasteInsight*TM, MSW Consultants' proprietary waste market database.

UNDERSTANDING & APPROACH

Project Understanding

Broward County, through its Solid Waste and Recycling Services agency (SWRS), and its municipalities as represented by the Solid Waste Working Group (SWWG) of the Broward League of Cities, seek a consultant to perform a comprehensive generation and characterization study of its solid waste, including the refuse, recyclables and construction and demolition debris (C&D) streams. This study is part of the ongoing planning efforts among the County and the SWWG towards reconstituting an intergovernmental approach to solid waste management, perhaps similar to the Broward County Resource Recovery System (RRS), which sunset in 2013.

The last comprehensive system-wide waste characterization study was performed in or around 2003 on behalf of the then RRS. Recent planning efforts by the County and SWWG have utilized waste composition data culled from more recent studies performed for other large Florida counties, as well as from individual Broward cities such as Coral Springs and Oakland Park. The estimates of the County's C&D waste stream were also informed by review of US EPA data. The solid waste and recyclables streams have changed considerably since the 2003 study and since the studies from the other Florida counties were performed. Among these changes have been the “evolving recycling ton” – a development that has placed considerable pressure on the viability of curbside recycling programs in Broward County – and more recently the impacts from the COVID-19 pandemic.

With nearly 2 million residents, Broward County is more populated than 14 U.S. states and the District of Columbia. Its 31 municipalities stretch from the Atlantic Coast to the Everglades, it includes the 6th largest school district in the U.S., and is home to both a major international airport, and seaport. The County's diverse population, institutions, public facilities, and economy all add complexity to its 4-million-ton solid waste stream.

Given the size and complexity of the County's waste management system and given the numerous changes to the waste stream over the past 20 years, MSW Consultants is proposing an ambitious, comprehensive, statistically representative waste generation and characterization study. Our approach to this initiative offers a preliminary sampling plan framework that, if accepted by the County, would bring extensive insight and clarity to the amount and composition of MSW and C&D wastes as well as single-stream recyclables originating across all 31 incorporated municipalities and the County's unincorporated area. MSW Consultants has proven methods for recruiting host facilities, managing large waste composition datasets, and applying the latest analytics not only to identify available materials for increased diversion, but also to calculate the economic benefits to additional diversion through both avoided disposal costs and through commodity price indices.

Project Approach – Waste and Recyclables Characterization Study

MSW Consultants' proposed project approach is detailed below. The overall tasks are named and organized per the County's July 20, 2021 e-mail, which included the proposal matrix.

Task 1: Project Planning and Preparation

MSW Consultants proposes to perform the following subtasks as part of the overall Project Planning and Preparation Task:

Subtask 1.1 – Information Request: Within five days of receipt of a notice to proceed from the County, MSW Consultants will submit a request for information needed to inform the study design plan and data management. This request may include, but not be limited to the following:

- ◆ Reported solid waste tonnage data by solid waste facility located in Broward County from the past three years, as well as facilities who reported receiving solid waste generated in Broward County.

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Assuming confidentiality concerns can be addressed, this would include reports issued to SWRS from the Florida Department of Environmental Protection (FDEP), as well as reports maintained by the County’s Environmental Protection Department (EPD) and shared with SWRS.

- ◆ A description of solid waste and recyclables tonnages as well as summaries of collection services by municipality, including service provider, service type, whether the municipality has an exclusive franchise, etc.;
- ◆ County and city demographic data, including population estimates for the County and municipalities (2019 U.S. Census data is acceptable); household counts by municipality, including delineation between single-family households and multi-family households to the extent available;

Subtask 1.2 – Participate in a Kick-off Meeting: MSW Consultants will propose to schedule and lead a kick-off meeting with County staff and SWWG representatives to initiate the project. The purposes of this meeting will be to confirm points of contact, communication, and correspondence protocols, discuss data and informational requests, project milestones, deliverables and ensure overall understanding. The kick-off meeting will also allow the County to further articulate program and project goals and concerns to MSW Consultants.

We propose that MSW Consultants’ Principal-in-Charge and Project Manager/Client Liaison attend the kick-off meeting in person, with other MSW staff participating via conference call. This subtask will include preparation of the kick-off meeting agenda, and preparation of notes/minutes that summarize discussions and action items.

Subtask 1.3 – Facility Confirmation and Selection: The 2018 Solid Waste and Recycling Issues Study identified 30 facilities in Broward County that receive MSW from Broward County generators. The facilities by type are detailed in the table below:

Broward County-Based MSW Facilities

Facility Type	Number
C&D/Bulky/Yard Trash	9
MRF	3
Paper Processors	3
Organics Processors/Transfer	7
MSW Transfer	5
WTE	1
Landfill	2
Total:	30

MSW Consultants will attempt to confirm which facilities receive MSW from which municipality using data requested in Subtask 1.1. MSW Consultants will utilize these results to identify the appropriate facilities to host the various components of field data collection. We understand that this subtask may require some recruitment of host facilities. If that is indeed necessary, MSW Consultants will request support from the County.

Upon confirmation of the host facilities, MSW Consultants will submit an information request to the management of each of the facilities to collect data necessary to develop the sampling plan. Examples of the types of data in the information request may include:

- ◆ Average daily tonnages delivered, and daily fluctuations in deliveries at each facility;
- ◆ Information on vehicle traffic (by time of day) including delivery patterns, and numbers of vehicles arriving, by vehicle type and/or by waste subsector.

- ◆ Information on haulers including origin and type of waste collected by the haulers.
- ◆ For MRFs, information about the mix of inbound materials, the commodities sorted, and the various ejection points where residuals are generated (typically the pre-sort stations and one or more end-of-line residue ejection points).
- ◆ Information about available space for sampling and sort crews and the availability of operational resources, such as a bucket loaders and roll-off containers for sample disposal.
- ◆ Required insurance and waiver of liability that may be needed by the facility owner.

Following the data requests, MSW's Project Manager or Designated Field Supervisor will schedule site visits at each facility. SWRS staff and SWWG members are invited to attend if interested. These proposed site visits will serve the following crucial functions:

- ◆ Introducing the Project Manager or Field Supervisor to participating facility personnel.
- ◆ Clarifying information provided in response to the information request.
- ◆ Finalizing locations for setting up the work area, taking samples, queuing samples, discarding sorted samples, and other in-process activities.
- ◆ Confirming availability of facility operations staff and equipment (bucket loaders) for sample acquisition and discard.
- ◆ Confirming procedures requiring coordination between host facility personnel and the Project Team.
- ◆ Reviewing facility-specific health and safety procedures and emergency contact numbers.
- ◆ Answering any questions or addressing concerns of the Facility Managers.

MSW Consultants maintains a customized Safety and Health Plan, included in this proposal, which will be provided to host facilities as a precursor to performing any sorting.

Subtask 1.4 – Validate/Refine Material Categories: MSW Consultants accepts the materials categories as identified in Exhibit B of the RFP document. We understand the importance of balancing two key objectives: (1) maintaining the ability to track waste and recyclables composition over time, and (2) adapting the categories to provide the most useful data for use by recycling and solid waste planners. However, we will propose that the materials categories be expanded to conform with standard waste characterization study best practices. Proposed updates may include:

- ◆ Expansion of categories that can be composted or processed via anaerobic digestion,
- ◆ Separation of plastic films into two or more subcategories,
- ◆ Addition of several categories of rigid plastic,
- ◆ Inclusion of several special categories for recyclables, including “bagged materials” and “tangles.”

A ~60 item materials category list from a recent assignment is shown in the table below although MSW Consultants understands the final list of material categories will be determined with input from the County. Note that examples of potential material categories for C&D and recyclables characterization are shown in project Tasks 4 and 5, respectively, but will be developed under this subtask.

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Potential Refuse Materials Categories

Paper	Recoverability Class	Organics	Recoverability Class
Corrugated Cardboard/Kraft Paper	Targeted Fibers	Food Waste-Edible Packaged	Contaminant
Newspaper	Targeted Fibers	Food Waste-Edible Non-packaged	Recoverable Organics
Newspaper in Sleeves	Contaminant	Food Waste-Inedible	Recoverable Organics
Office/High Grade Paper	Targeted Fibers	Yard Waste—Grass	Recoverable Organics
Magazine & Catalogs	Targeted Fibers	Yard Waste—Other	Recoverable Organics
Aseptic Boxes & Gable Top Cartons	Targeted Fibers	Wood—Unpainted	Contaminant
Mixed Recyclable Paper (Low Grade)	Targeted Fibers	Wood—Painted	Contaminant
Compostable Paper	Contaminant	Textiles & Leather Products	Recoverable - Drop-off
Non-recyclable Paper	Contaminant	Diapers & Sanitary Products	Contaminant
		Animal By-Products	Contaminant
		Other Organics	Contaminant
Glass	Recoverability Class	Inorganics & Other	Recoverability Class
Glass Bottles and Jars	Targeted Containers	Electronics - Covered Devices	Recoverable - Drop-off
Non-Recyclable Glass	Contaminant	Other Electronics	Recoverable - Drop-off
Plastics	Recoverability Class	Carpet & Carpet Padding	Contaminant
#1 PET Bottles & Jars	Targeted Containers	Drywall/Gypsum Board	Contaminant
#1 PET Non-Bottles & Containers	Targeted Containers	Concrete, Rock, Brick	Contaminant
#2 HDPE Natural Bottles	Targeted Containers	Asphalt Roofing	Contaminant
#2 HDPE Colored Bottles	Targeted Containers	Asphalt Paving	Contaminant
#3 - #7 Bottles	Targeted Containers	Other C&D	Contaminant
#2-#7 Non-Bottle Rigid Containers	Targeted Containers	Medically-Related Waste	Contaminant
Expanded Polystyrene	Contaminant	Lithium Batteries	Recoverable - Drop-off
Clean Retail Plastic Bags	Contaminant	Automotive Batteries	Recoverable - Drop-off
Industrial Film	Contaminant	Other Batteries	Recoverable - Drop-off
All Other Film	Contaminant	Other HHW	Recoverable - Drop-off
Durable/Bulky Rigid Plastics	Targeted Containers	Bulky Materials	Contaminant
Remainder/Composite Plastic	Contaminant	Furniture	Contaminant
Metals	Recoverability Class	Other Inorganics	Contaminant
Steel Cans	Targeted Containers	Fines-1/2" minus	Contaminant
Aluminum Cans	Targeted Containers	Fines-2" minus	Contaminant
Other Aluminum	Contaminant	Tanglers	Contaminant
Other Ferrous Metals	Contaminant	Bagged Recyclables	Contaminant
Other Non-Ferrous Metals	Contaminant	PPE	Contaminant

Subtask 1.5 – Finalize Study Design: The following bullets present our preliminary study design:

- ◆ **Generator Sectors:** Consistent with the annual tonnage reporting classification specified by FDEP, MSW Consultants proposes to sample and differentiate solid wastes by:
 - ◆ **Single Family Residential:** Municipal or commercially collected and self-hauled wastes generated in single family residential households, which may include parcels with up to four housing units.
 - ◆ **Multi-family Residential:** Municipal or commercially collected wastes generated in apartments condominiums, and possibly some trailer parks, that have more than four housing units per parcel.
 - ◆ **Industrial/Commercial/Institutional (ICI):** Municipal or commercially collected and self-hauled waste generated in commercial, industrial, and institutional establishments.
 - ◆ **Construction and Demolition (C&D) Waste:** Commercially collected or self-haul waste from construction, demolition, and remodeling activities, whether performed at residential or commercial structures.

- ◆ **Sampling Targets:** According to the 2020 report to FDEP, Broward County’s MSW generation by sector is shown in the table below:

MSW Generation by Sector 2020

Generator Sector	2020 Tons	By %
Single-Family Residential	708,963	17.3%
Multi-Family Residential	232,012	5.7%
Commercial/Institutional	1,376,003	33.6%
C&D	1,783,869	43.5%
Total	4,100,847	100.0%

- ◆ **Sample Allocation - Single-Family Residential, Multi-Family and Commercial:** Based on Broward County’s population, the number of cities, and the County’s desire to achieve statistically valid and representative samples, MSW Consultants’ preliminary sampling plan includes obtaining a total of 372 samples during a two-season study. The preliminary sampling plan for these sectors is shown in the table below:

Preliminary Sampling Plan – Residential and Commercial MSW

Name	Population	Proportion	Samples – Proportional Allocation	Sampling Plan
Broward Co Unincorporated	15,375	0.8%	2.4	3
Coconut Creek	58,803	3.0%	9.1	9
Cooper City	34,006	1.8%	5.3	5
Coral Springs *	129,263	6.7%	20.1	30
Dania Beach	32,215	1.7%	5.0	5
Davie *	105,050	5.4%	16.3	30
Deerfield Beach	80,178	4.1%	12.4	12
Fort Lauderdale *	189,321	9.8%	29.4	30
Hallandale Beach	39,945	2.1%	6.2	6
Hillsboro Beach	1,937	0.1%	0.3	1
Hollywood *	151,818	7.9%	23.6	30
Lauderdale-by-the-Sea	6,305	0.3%	1.0	1
Lauderdale Lakes	36,527	1.9%	5.7	6
Lauderhill	72,507	3.8%	11.3	11
Lazy Lake	28	0.0%	0.0	0
Lighthouse Point	10,536	0.5%	1.6	2
Margate	59,351	3.1%	9.2	9
Miramar *	138,873	7.2%	21.6	30
North Lauderdale	45,549	2.4%	7.1	7
Oakland Park	45,709	2.4%	7.1	7
Parkland	35,438	1.8%	5.5	6
Pembroke Park	6,373	0.3%	1.0	1
Pembroke Pines *	168,949	8.7%	26.2	30
Plantation	90,802	4.7%	14.1	14
Pompano Beach *	112,941	5.8%	17.5	30
Sea Ranch Lakes	682	0.0%	0.1	1
Southwest Ranches	7,786	0.4%	1.2	1
Sunrise *	94,333	4.9%	14.6	30
Tamarac	66,089	3.4%	10.3	10

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Weston	67,438	3.5%	10.5	11
West Park	15,228	0.8%	2.4	2
Wilton Manors	12,857	0.7%	2.0	2
Totals:	1,932,212	100.0%	300	372

* Larger cities have upwardly adjusted sampling targets to achieve customized composition estimate.

- ◆ **Sample Allocation – C&D Waste:** MSW Consultants proposes to perform a total of 600 visual samples taken at up to five facilities as depicted in the table below:

Preliminary Sampling Plan - C&D

Facility	Sampling Targets
Facility 1	120
Facility 2	120
Facility 3	120
Facility 4	120
Facility 5	120
Total:	600

- ◆ **Sample Allocation – Recyclables:** MSW Consultants is aware that the cities of Coral Springs, Coconut Creek, Davie, Deerfield Beach and Sunrise have suspended curbside recycling due to contract pricing challenges. Accordingly, our proposed sampling plan for curbside recyclables will be limited to the larger cities and a blending of other cities and Unincorporated Broward County.

Preliminary Sampling Plan - Recyclables

Name	Sampling Plan
Fort Lauderdale	30
Hollywood	30
Pembroke Pines	30
All Other Cities & Unincorporated Broward	30
Total	120

Subtask 1.6 – Issue Project Study Design: At the conclusion of Task 1, MSW Consultants will deliver a Study Design document summarizing the sampling plan, field methods, field forms, and other procedures to be followed for this study. We will incorporate comments from the County prior to finalizing this document.

Task 2: Quantifying Solid Waste and Recyclables Generation

MSW Consultants’ proposed approach to Task 2 is detailed below:

Subtask 2.1 – Compile and Review FDEP Reports: MSW Consultants will compile, and review FDEP county overview reports as published on the department’s website for the past 10 years (2010-2020). Key data and metrics to be reviewed and analyzed will include:

- ◆ County population,
- ◆ Disposition of MSW in tons and by percent including:
 - ◆ Tons recycled

- ◆ Tons combusted
- ◆ Tons landfilled
- ◆ MSW generation levels in lbs. per capita,
- ◆ Quantification of County’s traditional recycling rates and renewable energy credits, and
- ◆ Quantification and analysis of participation in recycling among single-family, multi-family and C/I sectors.

Subtask 2.2 – Examine Impacts of COVID-19 on MSW Generation: The stay at home orders and decreased commercial activity associated with the COVID-19 pandemic have impacted solid waste generation around the U.S. MSW Consultants has performed research on these impacts on behalf of other clients, and will apply this knowledge and experience, and generate some high-level analysis and assumptions on the impacts felt in Broward County. The following table shows examples from research performed on behalf of a municipal client.

Sample of COVID-19 Impacts Research

City	Increase (in %)	Notes:
A	17.40%	Tonnage change through October; includes recyclables disposed of with trash during program suspensions.
B	6.60%	Tonnage change through October; city reported initial increase of 25%. Total includes trash only.
C	9.60%	Tonnage change through October; reported increase of 15% during first month of stay-at-home order. Total includes trash only.
D	15 - 20%	City also services commercial accounts which have seen decreases in tonnage generation.
E	10.90%	Change over 2019; 2020 pre-COVID vs. post-COVID increase is 19.3%. Total includes trash only.
F	14.20%	Tonnage change through 1st quarter of FY 2021 & includes all MSW; trash increase of 24.4%
G	8%	Tonnage change reported in April.

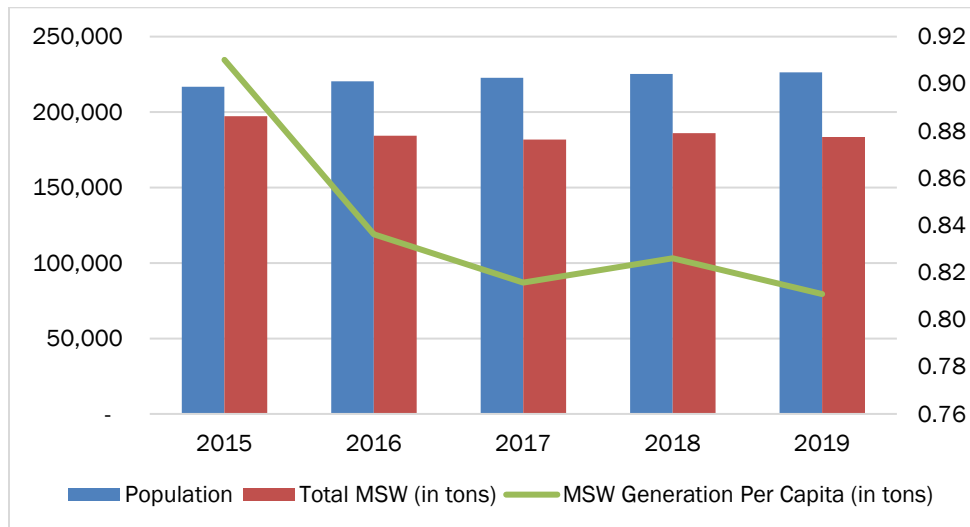
Subtask 2.3 – Technical Memorandum: At the conclusion of Task 2, MSW Consultants will issue a Technical Memorandum that presents data collected, MSW Consultants’ methodology, and provides analysis. The technical memorandum will be organized in both a narrative and tabular/graphic format. Examples from similar client deliverables are shown below:

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Sample MSW Generation Table

Year	Population	Residential Waste Generation (tons)	Per-Capita Rate (tons/person/year)
2010	1,526,006	619,268	0.41
2011	1,534,293	636,027	0.41
2012	1,542,581	642,680	0.42
2013	1,550,868	624,287	0.40
2014	1,559,156	623,474	0.40
2015	1,567,443	575,883	0.37
2016	1,576,390	601,938	0.37
2017	1,580,221	570,521	0.36
2018	1,584,138	618,513	0.39

Sample MSW Generation Trends Chart



Task 3: Quantifying Solid Waste and Recyclables by Generator Type

MSW Consultants is aware of the challenges associated with adequately measuring MSW generation by sector or generator type. In the RRS era, tonnages collected from municipalities were not distinguished by residential or commercial classifications. MSW Consultants will apply its understanding of solid waste generation to this project task, including:

Task 3.1 – Review and Analyze Generator Data From FDEP Reports: MSW Consultants will review and analyze the already retrieved FDEP reports to quantify solid waste and recyclables by the following generator types:

- ◆ **Single Family Residential:** Municipal or commercially collected and self-hauled wastes generated in single family residential households.
- ◆ **Multi-family Residential:** Municipal or commercially collected wastes generated in apartments, condominiums, and possibly some trailer parks.
- ◆ **Industrial/Commercial/Institutional (ICI):** Municipal or commercially collected and self-hauled wastes generated in commercial, industrial, and institutional establishments.

- ◆ **Construction and Demolition (C&D) Waste:** Commercially collected or self-haul waste from construction, demolition, and remodeling activities, whether performed at residential or commercial structures.

MSW Consultants will review and analyze this data over a 10-year period, reporting on generation trends in tons and percentage, households, and commercial establishments eligible for service, and generation rates (such as per-capita).

Subtask 3.2 – Perform High-Level Comparative Analysis: MSW Consultants will examine solid waste and recyclables generation levels among Broward County’s residential single-family, residential multi-family, and commercial generators and compare those with generation levels among other jurisdictions. A truncated example of a similar analysis performed on behalf of another client is shown below:

Sample Benchmarking Table

Jurisdiction	Type	State	Population (2017 U.S. Census Estimates)		Reporting Period	Total Residential MSW Generation	MSW Generation Per Household	MSW Generation Per Capita
			Estimates	Est. Households Served				
New York	City	NY	8,622,698	3,100,000	FY 2018	3,067,636	1,979	0.36
Chicago	City	IL	2,716,450	600,000	CY 2017	913,712	3,046	0.34
Philadelphia	Consolidated City-County	PA	1,560,297	522,000	FY 2018	603,987	2,314	0.39
Austin	City	TX	950,715	199,448	FY 2018	219,795	2,204	0.23
Washington	City	DC	702,445	105,282	FY 2018	129,263	2,456	0.18
Boston	City	MA	685,094	351,000	CY 2017	239,338	1,364	0.35
Baltimore	City	MD	611,648	210,000	FY 2017	188,520	1,795	0.31

Subtask 3.3 – Technical Memorandum: At the conclusion of Task 2 MSW Consultants will issue a Technical Memorandum that presents data collected, MSW Consultants’ methodology, and provides analysis.

Task 4: Waste Material Composition and Generation Stream

MSW Consultants’ proposed Task 4 will include two components, including the actual waste composition study and the visual sampling of the C&D stream.

Refuse Composition Study Approach

Subtask 4.1 – Project Mobilization: It will be critical to make appropriate arrangements for the personnel and equipment needed to execute the field data collection portion of this project. MSW Consultants will arrange for the experienced staff and provide all sorting equipment (table, bins, carry cans, scale, small tools, and personal protective equipment) needed for the project.

MSW Consultants’ approach to staffing the project is further detailed below:

- ◆ **Staffing and Training:** MSW Consultants proposes to use a two-person professional staff to manage and supervise all sampling and sorting activities, supported by local light industrial laborers to conduct actual sorting. For this approach to be effective, it is important to configure the work area, label material containers, and have appropriate roles and consistent procedures in place. The MSW Consultants field data collection team will include the following individuals:

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- ◆ **Field Supervisor:** MSW Consultants will provide a dedicated Field Supervisor who will have lead responsibility for planning each sampling and sorting event, and for interacting with the facility personnel whose cooperation will be needed throughout the field data collection. The Field Supervisor will generally lead the sampling selection process and will oversee the physical taking of samples. The Field Supervisor is ultimately responsible for the successful completion of the project, and we commit to providing an experienced Field Supervisor for the duration of the study.
- ◆ **Crew Chief:** MSW Consultants will supply a dedicated Crew Chief for each host facility. The Crew Chief will be the second professional staff person. The Crew Chief is responsible for managing the manual sorting area, including crew management, sorting productivity and accuracy, data recording, work site health and safety, and cleaning up at the end of the day. We commit to providing an experienced Crew Chief for the duration of the study.
- ◆ **Sorting Labor:** MSW Consultants holds a national contract with People Ready for sorting labor. If not available locally, we will team with a local staffing firm to supply the labor for this engagement.
- ◆ **Training:** MSW Consultants is proposing that training take place the morning of the first sort day of each seasonal event. Our professional supervisory staff have proven success in training and managing temporary employee sorters to follow a clear and consistent methodology. With built-in quality control practices, we have found that the use of temporary laborers for sorting is extremely successful for week-long sorting events like those included in this project.

The training session for all sorting personnel will include:

- ◆ An overview of the work area and site rules;
- ◆ A thorough review of the Site-Specific Health and Safety Plan;
- ◆ Detailed descriptions of categories, with physical examples;
- ◆ Weigh out of sorted materials and field data recording.

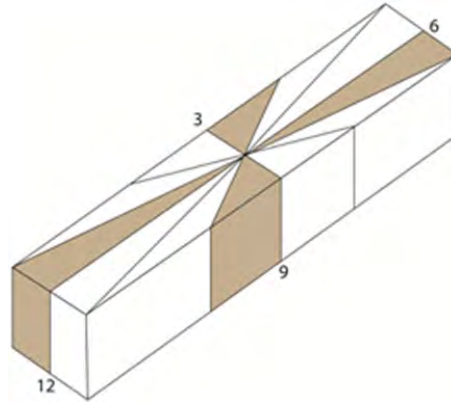
We welcome County, municipal and host facility personnel to attend any training session and to participate in any phase of the project side-by-side with MSW Consultants.

Subtask 4.2 – Sample Acquisition and Material Sorting: Accurate characterization of solid waste is a complex and demanding undertaking, which requires precise coordination and planning among team members and rigorous adherence to standards of quality. **For refuse and recyclables, MSW Consultants uses a “grab sampling”, or “back of truck” methodology**, which is explained below:

- ◆ **Sample Selection:** Upon targeted truck arrivals at the designated sorting area, MSW’s Field Supervisor will interview incoming drivers for basic information which is noted to identify and verify the load origin. Information from the weight ticket for each vehicle will be obtained for every incoming truck either from the driver, or through communication with the scale house.
- ◆ **Sorting Area:** MSW Consultants typically requires a work area measuring at least 20’x20’ and in close enough proximity to the load discharge area in order to conduct sampling, sorting, and material discard procedures in a safe and efficient manner. This will include room for a screened sorting platform, sorting bins and barrels, the portable scale, and data recordation device, as well as an area for materials discharge once the containers are weighed out.
- ◆ **Taking Samples from Selected Loads:** MSW Consultants understands that a bucket loader and operator will be available to assist with sample acquisition and moving materials from each selected load. Samples of organic materials will be selected based on systematic “grabs” from the perimeter

of the load. For example, if the tipped pile is viewed from the top as a clock face with 12:00 being the part of the load closest to the front of the truck, the first samples will be taken from 3 o'clock, 6 o'clock, 9 o'clock, 12 o'clock, and then from 1, 4, 7, and 10 o'clock, and so-on. This concept of systematically rotating around subsequent loads is shown in the figure below.

Systematic Sampling Guide for Tipped Loads



The figure below shows a typical tipping and sample acquisition process.

Sampling of Inbound MSW



Once the section of the load designated for sampling is identified, MSW Consultants’ Field Supervisor will label it with a placard and digitally photograph it prior to obtaining the sample. At that point, MSW Consultants’ Field Supervisor will request that facility staff collect the sample using its bucket loader for loading into 30-to 35-gallon barrels, which are weighed, and then brought closer to the sorting platform for sorting. The remainder of the load can then be removed for regular materials processing.

- ◆ **Average Sample Size:** MSW Consultants will target samples of MSW materials between 200 to 250 pounds, weights that are consistent with industry standard methodologies, including ASTM D 5231-92 (Reapproved 2016), “Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste.”
- ◆ **Materials Sorting:** MSW Consultants will provide the sorting equipment, which includes a sorting platform, labeled bins, and labeled barrels for the most prevalent materials. Sorters are typically instructed to specialize in certain material groups so they can become more knowledgeable in a short period of time as to the definitions of individual material categories. The Field supervisor will monitor the bins as each sample is sorted, rejecting materials that may be

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improperly classified. Open bins allow the field supervisor to see the material at all times. A picture of a typical sorting platform and bins is shown below.

Sorting Platform and Bins



The Field Supervisor or the Crew Chief will also verify the purity of each component during the weigh-out (discussed below). The materials will be sorted to particle size of 2-inches or less by hand, until no more than a small amount of homogeneous fine material (“mixed residue”) remains. This layer of mixed 2-inch-minus material will be allocated to the appropriate categories based on the best judgment of the Crew Chief—most often a combination of Other Paper, Other Organics, Food Waste, or Miscellaneous. The overall goal is to sort each sample directly into component categories in order to reduce the amount of indistinguishable fines or miscellaneous categories.

- ◆ **Sample Weigh-outs and Data Recording:** MSW Consultants believes that the weigh-out and data recording process can be most critical process of the sort. Once each sample has been sorted, the weigh-out will be performed. Each bin containing sorted materials will be weighed with a digital scale provided by MSW Consultants. A rugged tablet computer will be used to record the composition weights. The tablet allows for samples to be tallied in real time so that field data collection can immediately identify and rectify errors associated with light sample weights. The tablet synchronizes with the cloud via cellular signal, providing excellent data security. For Quality Assurance/Quality Control (QA/QC) purposes, each sample will be cross-referenced against the Field Supervisor’s sample sheet to assure accurate tracking of the samples each day. The real-time data entry offers several important advantages:

- ◆ The template contains built-in logic and error checking to prevent erroneous entries.
- ◆ The template sums sample weights in real time so the Field supervisor can confirm achievement of weight targets for each and every sample.
- ◆ Except where host facilities are outside of cell phone range, the data file syncs routinely and can be accessed and checked by MSW Consultants QA/QC staff back at the office. For remote facilities that cannot synchronize during the workday, it is usually possible to sync in the evening upon returning to the hotel.

A screen shot of a typical electronic weigh-out form is shown below.

Weigh-Out Form Screen Shot

Current Date/Time: 3/19/2021 10:36:01 AM

WASTEINSIGHT™ PA DEP Waste Audit (Recycling)

Field ID: Sample Notes:

Submit Sample

TOTAL PRE-WEIGH (lbs):

SORTED (lbs): 0.0

Item	Material Category	TOTAL PRE-WEIGH (lbs)	SORTED (lbs)
1	Corrugated Cardboard/Kraft Paper (Uncoated)	4.00	0.00
2	Newspaper	4.00	0.00
2R	Newspaper in Sleeves	4.00	0.00
3	Office/High Grade Paper	4.00	0.00
4	Magazine & Catalogs	4.00	0.00
5	Aseptic Boxes & Gable Top Cartons	4.00	0.00
6	Mixed Recyclable Paper (Low Grade)	4.00	0.00
7	Compostable Paper	4.00	0.00
8	Non-recyclable Paper	4.00	0.00
9	#1 PET Bottles & Jars	4.00	0.00
10	#1 PET Non-Bottles & Containers	4.00	0.00
11	#2 HDPE Natural Bottles	4.00	0.00
12	#2 HDPE Colored Bottles	4.00	0.00
13	#3 - #7 Bottles	4.00	0.00

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- ◆ **Sample Discard, Site Maintenance and Cleanup:** MSW Consultants will coordinate with the facility hosts for sample discards. This typically is accomplished either by spotting roll-off containers for sample discard, or by facility hosts removal of the material using a front-end loader. To the extent feasible, MSW Consultants will also ensure sampled recovered materials are kept separate from sampled refuse material and managed accordingly.

MSW Consultants will be responsible for clean up around the work area at the end of each workday. This will generally involve the removal of any residual debris from the sorting work, as well as organizing the overnight storage of the sorting table, bins, and other equipment.

These procedures will be discussed and confirmed with the facility hosts during Task 1 (Host Facility Confirmation).

Subtask 4.3 – Data Analysis: The following statistical measures will be calculated to determine the overall composition of each waste generator sector.

- ◆ **Sample Mean:** The sample mean, or average, composition is considered the “most likely” fraction for each material category in the waste stream.
- ◆ **Standard Deviation:** The standard deviation measures how widely values within the data set are dispersed from the sample mean. A higher standard deviation denotes higher variation in the underlying samples for each material, while a lower standard deviation reflects lower variation among the individual samples.

PROPOSAL

- ◆ **Confidence Intervals:** A confidence interval is a statistical concept that attempts to indicate the likely range within which the true value lies. The confidence intervals reflect the upper and lower range within which the population mean can be expected to fall. Confidence intervals are customarily calculated at a 90 percent level of confidence, meaning that we can be 90 percent sure that the mean falls within the upper and lower confidence intervals shown. However, prior studies have used a 95 percent level of confidence. We can discuss the advantages and disadvantages of different confidence levels with the County. In general, the higher the level of confidence chosen, the wider the confidence intervals.

Subtask 4.4 – Technical Memorandum: At the conclusion of these Subtasks, MSW Consultants will prepare a draft technical memorandum that describes the purpose, study methodology, and sampling plan, and that summarizes the essential composition findings for each waste sector. Specifically, the report will include:

- ◆ An executive summary providing key findings;
- ◆ Introduction and background for the study, including objectives;
- ◆ A description of the methodology used in the study and a summary of the sampling and sorting plan;
- ◆ A description of the data collection and analytical techniques used;
- ◆ A summary of findings, conclusions, and supporting documentation, including by generator type and by city to extent possible;
- ◆ A summary of the numbers of samples characterized;
- ◆ Raw data in an approved format; and
- ◆ Photos of samples, clearly labeled with a sample placard, delivered separately.

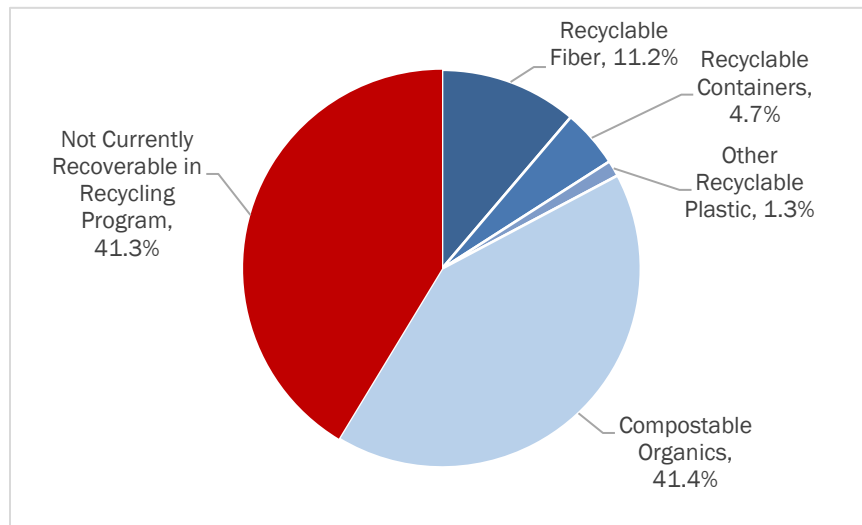
MSW Consultants will provide a draft memorandum for review and comment by SWRS. We have budgeted for one round of reviews by the County and will integrate comments into the final memorandum. MSW Consultants specializes in the tabular and graphical presentation of waste characterization data. Samples of results presented are below.

Sample Waste Composition Tabular Results

Material Category	Est. Percent	Conf. Int (+/-)	Tonnage	Material Category	Est. Percent	Conf. Int (+/-)	Tonnage
Paper	26.0%	1.4%	1,001,551	Plastic	15.3%	2.8%	590,979
OCC/Kraft	8.5%	1.1%	326,094	PET (#1) Bottles/Jars	1.4%	0.1%	54,764
Newsprint	1.5%	0.5%	56,588	PET (#1) Non-Bottle Containers	0.2%	0.1%	8,321
Magazines	0.9%	0.2%	35,327	HDPE (#2) Natural Containers	0.4%	0.0%	15,399
High Grade Office Paper	1.3%	0.3%	51,027	HDPE (#2) Colored Containers	0.5%	0.1%	19,462
Mixed Recyclable Paper	4.0%	0.4%	155,827	Clean Film Bags	0.3%	0.1%	11,948
Compostable Paper	8.1%	0.5%	312,127	Clean Ind'l/Com'l Film	0.7%	0.3%	26,524
Remainder/Composite Paper	1.7%	0.6%	64,562	Contaminated Film/Other Film	5.9%	0.8%	229,256
Glass	2.8%	0.3%	108,996	Plastic Containers #3 thru #7	1.0%	0.1%	38,140
Clear Glass Containers	1.4%	0.2%	53,206	Expanded Polystyrene #6	0.7%	0.1%	27,908
Brown Glass Containers	0.8%	0.2%	32,428	Bulky Durable Plastic Products	1.9%	0.3%	72,746
Green Glass Containers	0.2%	0.0%	8,310	Remainder/Composite Plastic	2.2%	0.4%	86,510
Remainder/Composite Glass	0.4%	0.1%	15,052	Textiles	4.8%	1.2%	186,773
Metal	4.4%	0.5%	168,079	Textiles - Clothing	2.3%	0.4%	87,347
Aluminum Cans & Containers	0.6%	0.1%	24,498	Textiles - Non-Clothing	1.9%	0.3%	73,652
Other Aluminum	0.3%	0.0%	11,985	Shoes/Belts/Leather	0.7%	0.1%	25,775
Tin/Steel Containers	1.0%	0.1%	39,365	Inorganics	12.7%	0.9%	491,013
Other Ferrous	1.8%	0.4%	70,018	Fines	1.7%	0.2%	65,106
Other Non-Ferrous	0.5%	0.2%	20,802	Drywall/Gypsum Board	0.6%	0.3%	23,013
Oil Filters	0.0%	0.0%	1,411	Asphalt, Brick, Concrete & Rocks	0.5%	0.2%	18,639
Organics	32.4%	0.6%	1,248,872	Carpet & Carpet Padding	2.6%	0.7%	100,713
Food Waste	15.0%	1.3%	578,315	Other Construction & Demolition	1.6%	0.5%	60,431
Wood - Clean/Untreated	3.7%	1.2%	141,024	Bulky Items/Furniture	3.1%	0.6%	121,343
Wood - Painted/Stained/Treated	4.5%	1.0%	173,266	Mattresses/Boxsprings	0.7%	0.3%	26,118
Disposable Diapers & Sanitary Prod.	3.1%	0.4%	118,429	Tires	0.8%	0.4%	31,399
Yard Waste	2.6%	0.7%	101,921	Other/Not Classified	1.1%	0.9%	44,249
Remainder/Composite Organic	3.5%	0.6%	135,918	HHW	0.4%	0.1%	15,974
Electronics	1.2%	0.4%	46,216	Household Hazardous Waste	0.4%	0.1%	15,974
Electronic Waste	1.2%	0.4%	46,216				
				Grand Total	100%		3,858,452
				No. of Samples	254		

Confidence intervals calculated at the 90% confidence level. Percentages for materials may not exactly equal category subtotals due to rounding.

Sample Divertibility Assessment



Note: If the County selects the two-season study option, MSW Consultants will provide an interim report at the conclusion of season 1 and a final report at the conclusion of the project.

PROPOSAL

Subtask 4.5 – C&D Waste Composition Study: MSW Consultants proposes to integrate a C&D characterization effort into Task 4's Waste Materials Composition Study. C&D debris is by nature very different in composition compared to residential and commercial waste collected in compacting vehicles. Where residential and commercial waste loads consist of waste from dozens (commercial) or hundreds (residential) generators, and since most particles are relatively small (less than 12 inches), physical grab sampling and sorting is both practical from an operations standpoint and is also statistically appropriate. However, C&D debris is very different in several important ways:

- ◆ It contains many large and/or heavy particles – such as sheets of plywood, concrete, 2x4s, drywall sections, etc. It may take only two or three unique items in a load of C&D debris to make the 200 to 300-pound sample size that is customary for MSW sorts.
- ◆ The composition of individual loads varies widely – one load may be all dimensional lumber, the next load drywall, and the next roofing shingles, etc. This means the standard deviations of waste constituents are much higher compared to MSW, which in turn implies much larger sample sizes.
- ◆ It is often not possible to obtain a representative sample by extracting only 200, 300, or even a 1,000-pound sample from a load. As such, manually sorting substantial amounts of large loads would result in only a handful of loads analyzed per day and would require extended sampling periods.

The pictures below illustrate the dramatic variance from load to load of C&D debris.

Variation in the Composition of Inbound C&D Debris Loads



As a consequence of these issues, it would require potentially thousands of 200 to 300 pounds of manually sorted samples of C&D to arrive at an estimated composition to the same level of certainty achieved in a typical MSW composition study.

The shortfalls of manual sampling and sorting for C&D debris have been extensively documented by research from the Hinkley Center for Solid Waste Management (see particularly *Generation and Composition of Construction and Demolition Debris in Florida*, Reinhart et.al., December 2002) and by CalRecycle. Both of these organizations have explored visual surveying methods and found such methods to offer a better means of estimating C&D composition. CalRecycle has even published the California state standard methodology for visual characterization of C&D debris (*Method of Visual Characterization of Disposed Waste from Construction and Demolition Activities*, CalRecycle, 2006).

MSW Consultants has first-hand experience comparing and contrasting manual and visual characterization methods for C&D dating to the mid-2000s. In particular, we supported an extensive waste characterization study (working as a subcontractor) for the Delaware Solid Waste Authority. As part of this study, MSW Consultants manually sorted entire loads of C&D debris which were also visually surveyed, so that it was possible to compare the results of both methods. Ultimately the visual survey accuracy was found to be quite high, especially if the C&D load could be spread out somewhat by a loader so that the visual surveyor could see the interior of the tipped load (in effect, making sure to spot the denser items like concrete block and soil that tend to fall to the bottom of the pile).

Further, as described in our enclosed experience and qualifications, **MSW Consultants has developed the nation's only visual survey app that helps the enumerator by converting visual, volumetric composition estimates into weight-based estimates derived from density factors and calibrated with actual scale weights of the C&D load. We used this method for a statewide study in Missouri and recently for the Boulder County, Colorado study and were able to realize a significant reduction in the variance between actual and estimated load weight. We believe our system provides unmatched accuracy for weight-based C&D and other bulky waste characterization studies.**

Based on our professional experience and on widely vetted industry literature, we are therefore offering a **weight-calibrated visual surveying approach** for this project. This method can be performed at much lower cost, will obtain far more samples, and will provide more representative characterization estimates.

C&D characterization project planning and preparation will be completed in conjunction with the Waste Material Composition and Generation Stream Task (Task 4). The following bullets summarize the critical elements that will be undertaken for completion of the C&D study.

- ◆ **Location(s):** TBD at up to five facilities based on outcomes of Task 1.
- ◆ **Staffing:** MSW Consultants professional management staff will conduct the field data collection.
- ◆ **Material Categories:** Potential material categories are in the table below. These will be presented and confirmed with SWRS in Task 1.

Potential C&D Materials Categories

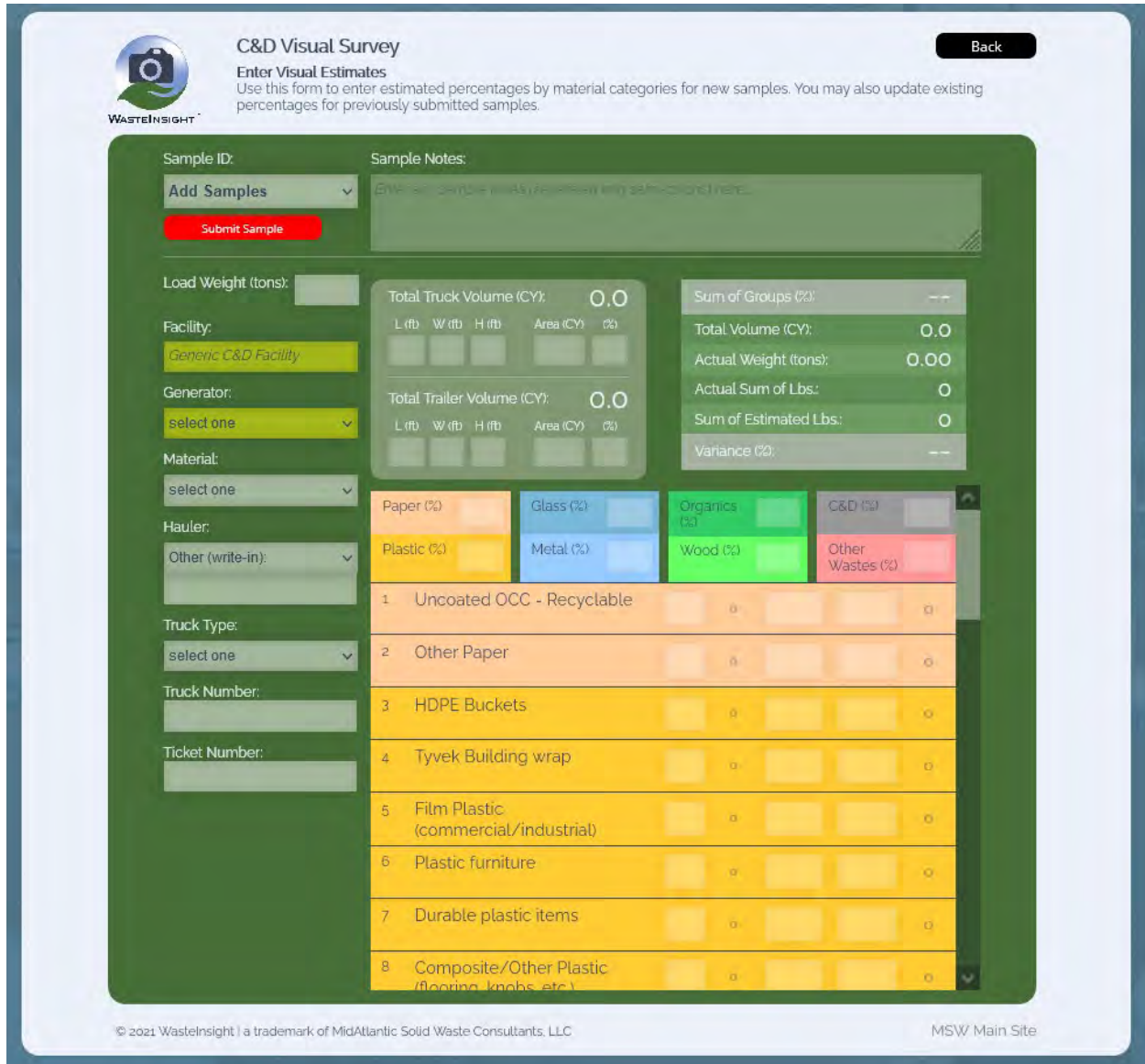
C&D	Paper	Plastic
Rock/Gravel	Untreated OCC-Recyclable	HDPE Buckets
Concrete	Other Paper	Tyvek Building Wrap
Brick	Wood	Film Plastic
Asphalt	Untreated Dimen. Lumber	Plastic Siding/Decking
Gypsum Wallboard - Clean	Untreated Engineered Wood	Plastic Furniture
Gypsum Wallboard - Painted	Painted/Stained Wood	Durable Plastic Items
Roofing Shingles	Treated Wood	Plastic Piping
Carpet	Wood Pallets/Crates/Spools	R/C and Other Plastic
Carpet Padding	Wood Furniture	
Acoustic Tiling	Organics	Glass
Ceramics/Porcelain Fixture	Yard Waste	Flat Glass
HVAC Ducting	Dirt/Sand	R/C and Other Glass
Tires	Metals	Other Wastes
Appliances	Ferrous Scrap	E-Waste
Other C&D	Non-Ferrous Scrap	Asbestos
Insulation	Composite Metal (wires)	Bulky Items
Rubber Products		Mixed MSW

- ◆ **Sample Surveying:** Our assigned staff will coordinate with the scale house, tip area spotter, and inbound deliveries to select loads for surveying. It is understood a loader and operator will be available to assist in spreading the loads from time to time if they are not spread during the offload so we can see the interior of the loads. On most occasions, the driver is able to spread the load out as he tips.
- ◆ **Number of Samples:** MSW Consultants anticipates visually characterizing roughly 25 samples per day per facility over a six-day season (300 samples per season).
- ◆ **Distribution of Samples:** MSW Consultants will request historical scale or tonnage information from facility hosts and allocate samples in proportion to the waste generating sectors and truck types delivering to the facilities.
- ◆ **Sample Selection:** We will select the Nth vehicle based on estimated daily arrivals of C&D debris loads.
- ◆ **Data Collection:** The following methodology is used with our accurate visual surveying protocol:
 - ◆ Measure and record the dimensions of the incoming load prior to tipping and (if possible) estimate the percent full of the vehicle/container.
 - ◆ Tip the load. If it is a large load of non-homogeneous materials, have a loader spread out the material so that it is possible to discern dense materials such as block, brick, and dirt that tend to sink to the bottom of the pile.
 - ◆ Make a first pass around the load marking the major material categories that are present in the load—Wood Waste, Organics, Fiber, etc. Estimate the percentage of the load made up of these major materials.
 - ◆ Make a second pass around the load, noting the secondary material categories contained in the load—Wooden Pallets, Sawn Lumber, OCC, etc. Estimate the percentage of the load made up of these materials.
 - ◆ Validate that the estimated percentages sum to 100 percent, and that the sum of estimated weight is within acceptable range and realistic given the overall truck dimensions and volume.

- ◆ Compare the calculated weight of the load to the actual scale weight of the load, identify possible sources of discrepancy, and make adjustments to volumetric estimates and/or density factors to reduce the degree of difference. This last step is critical to the accuracy of the data.

For the Visual Surveying activity for the C&D material stream, a proprietary field form has been developed to provide real-time balancing based on vehicle/container size, consumed capacity and material densities to allow immediate data quality control. An example of a typical data entry screen for our waste characterization studies is shown in the exhibit below.

Example of Visual Survey Entry Tablet Screen



- ◆ **Data Recording:** The data files are synced routinely while in the field if good cell service is available. In the least, the data is synced each evening and can be accessed and checked by MSW Consultants QA/QC staff back at the office.

Data for each load is input on the field tablet as the Field Supervisor visually characterizes the load as described above. Data is later uploaded to the company portal for quality checking and analysis.

PROPOSAL

Statistical analysis will be completed similar to the process for the MSW and recycling study as described in Task 4 above.

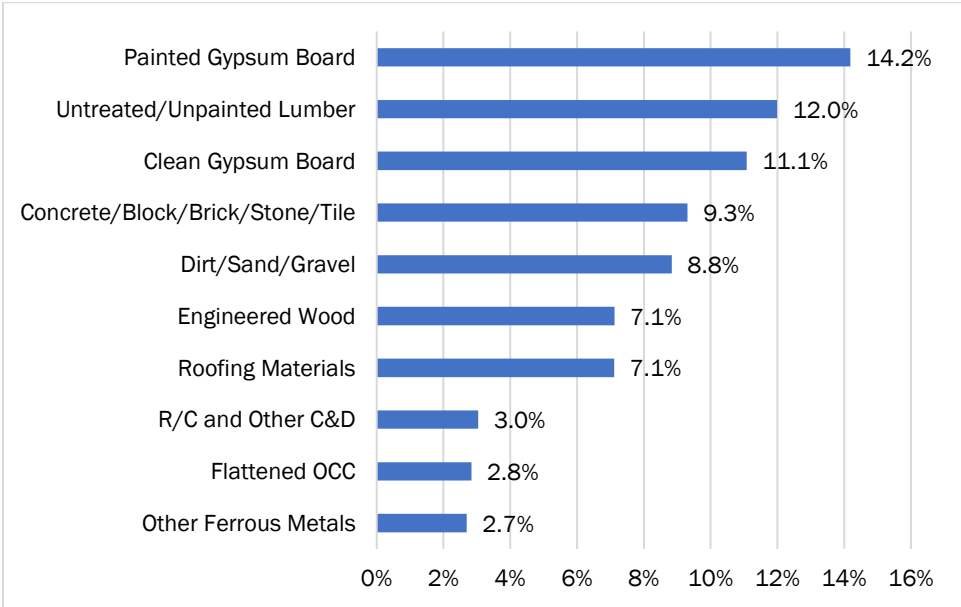
Subtask 4.6 – Technical Memorandum: The results of the C&D material characterization will be issued in a format similar to that described for the Waste Material Composition and Generation Stream memorandum. Samples of tabular and graphical presentation of the C&D waste characterization data are provided below.

Sample Detailed C&D Waste Composition

Material Category	Est. Percent	Conf. Int (+/-)	Est. Tonnage	Material Category	Est. Percent	Conf. Int (+/-)	Est. Tonnage
MSW/Other Waste	7.3%	3.9%	26,108	Roofing Materials	8.0%	2.5%	28,687
Flattened OCC	0.7%	0.2%	2,533	Roofing Materials	8.0%	2.5%	28,687
Unflattened OCC	0.1%	0.0%	514	Dirt/Sand/Gravel	4.7%	3.0%	16,884
R/C and Other Paper	0.2%	0.2%	888	Dirt/Sand/Gravel	4.7%	3.0%	16,884
All Glass	0.5%	0.2%	1,668	Other C&D	5.2%	1.6%	18,644
Electronics	0.9%	0.2%	3,194	Carpet	2.5%	0.5%	8,951
Items with CRTs	0.3%	0.1%	1,025	Carpet Padding	0.3%	0.1%	959
Tree Trunks		<i>Not Found</i>		Asphalt Paving	0.6%	0.3%	2,144
Fines/Mixed Residue	2.4%	1.1%	8,659	Ceiling Tiles	0.3%	0.1%	930
Mixed MSW	2.1%	0.3%	7,626	Insulation	0.8%	0.2%	2,892
Agricultural Waste		<i>Not Found</i>		R/C and Other C&D	0.8%	0.3%	2,768
Plastic	5.6%	5.6%	20,252	Special Wastes	14.4%	5.5%	51,759
Plastic Bottles (Recyclable)		<i>Not Found</i>		Bulky Wastes/Furniture	14.3%	2.3%	51,526
HDPE Buckets (stacked)		<i>Not Found</i>		Tires - Cut	0.0%	0.0%	135
HDPE Buckets (unstacked)	0.0%	0.0%	62	Tires - Whole	0.0%	0.0%	30
Clean Recoverable Film	0.0%	0.0%	139	All HHW	0.0%	0.0%	68
R/C and Other Plastic	5.6%	2.5%	20,051	Contaminated Soil		<i>Not Found</i>	
Metal	3.7%	1.7%	13,243	Wood	19.7%	6.8%	70,935
Appliances	0.1%	0.1%	314	Pallets - Standard	1.0%	0.3%	3,449
Other Ferrous Metals	3.1%	0.8%	11,306	Pallets/Crates/Heavy	0.0%	0.0%	92
Other Non-ferrous Metal	0.3%	0.1%	951	Untreated/Unpainted Lumber	3.4%	0.9%	12,134
HVAC Ducting	0.2%	0.1%	672	Treated/Painted/Processed Wood	6.8%	1.4%	24,490
Organics	2.5%	5.8%	9,041	Engineered Wood	3.0%	0.7%	10,783
Leaves/Grass/Mixed Yard Waste	0.3%	0.1%	1,110	Wood Furniture	3.2%	0.9%	11,586
Branches/Limbs	0.1%	0.1%	302	Other Wood	2.3%	1.4%	8,401
R/C and Other Organics	2.1%	3.3%	7,629	Concrete/Brick/Rock	17.7%	4.5%	63,781
Gypsum Board	11.3%	3.3%	40,738	Concrete/Block/Brick/Stone/Tile	17.7%	4.5%	63,781
Clean Gypsum Board	1.8%	0.8%	6,358				
Painted Gypsum Board	9.5%	2.2%	34,380	Grand Total	100.0%		360,073
				No. of Samples	109		

Confidence intervals calculated at the 90% confidence level. Percentages for materials may not exactly equal category subtotals due to rounding.

Sample Top 10 Most Prevalent Materials in C&D Waste



Note: If the County selects the two-season study option, MSW Consultants will provide an interim report at the conclusion of season 1 and a final report at the conclusion of the project.

Task 5: Source-Separated Recyclable Material Composition

With many of Broward County’s largest cities electing to suspend curbside recycling programs due to poor market values and purported high-contamination levels, MSW Consultants understands the importance of this task.

From a task execution standpoint, with some considerations, the Subtasks associated with Task 4 will generally apply to sampling of source separated recyclables. Key considerations and subtasks follow:

- ◆ **Materials Categories:** The recyclables materials categories should parallel the refuse material categories to allow for recyclables capture rate analyses. However, the contaminants fraction can be consolidated in order to arrive at a more manageable and practical list of recyclables categories. A potential ~40 item recyclables material category list is shown in the table below although it will be presented and validated with SWRS as part of Subtask 1.3.

Potential Recyclable Materials Categories

Paper		Recoverability Class	Glass	Recoverability Class
Corrugated Cardboard/Kraft Paper		Targeted Fibers	Glass Bottles and Jars	Targeted Containers
Newspaper		Targeted Fibers	Non-Recyclable Glass	Contaminant
Newspaper in Sleeves		Contaminant	Metals	Recoverability Class
Office/High Grade Paper		Targeted Fibers	Steel Cans	Targeted Containers
Magazine & Catalogs		Targeted Fibers	Aluminum Cans	Targeted Containers
Aseptic Boxes & Gable Top Cartons		Targeted Fibers	Other Aluminum	Contaminant
Mixed Recyclable Paper (Low Grade)		Targeted Fibers	Other Ferrous Metals	Contaminant
Compostable Paper		Contaminant	Other Non-Ferrous Metals	Contaminant
Non-recyclable Paper		Contaminant	Contaminants	Recoverability Class
			Food Waste	Contaminant
			Yard Waste	Contaminant
Plastics	Recoverability Class		Electronics	Contaminant
#1 PET Bottles & Jars	Targeted Containers		HHW & Med Waste	Contaminant
#1 PET Non-Bottles & Containers	Targeted Containers		Lithium Batteries	Contaminant
#2 HDPE Natural Bottles	Targeted Containers		Other Batteries	Contaminant
#2 HDPE Colored Bottles	Targeted Containers		C&D Waste	Contaminant
#3 - #7 Bottles	Targeted Containers		Bulky Metals	Contaminant
#2-#7 Non-Bottle Rigid Containers	Targeted Containers		Tanglers	Contaminant
Expanded Polystyrene	Contaminant		Fines-1/2" minus	Contaminant
Clean Retail Plastic Bags	Contaminant		Fines-2" minus	Contaminant
Industrial Film	Contaminant		Other Inorganics	Contaminant
All Other Film	Contaminant		Bagged Recyclables	Contaminant
Durable/Bulky Rigid Plastics	Targeted Containers		PPE	Contaminant
Remainder/Composite Plastic	Contaminant			

Subtask 5.1 – Project Mobilization: This subtask will follow the same approach described in Subtask 4.1 for the Waste Materials Composition task.

Subtask 5.2 – Sample Acquisition and Material Sorting: This subtask will generally follow the approaches detailed in Subtask 4.2, with the following exceptions:

◆ **Taking Samples from Selected Loads:** Grab sampling of inbound single-stream loads will be slightly modified to capture representative material from the dense inner section of the load and the lighter exterior of the tipped load. It is important to note that grab sampling of single stream material requires some additional expertise. This is because the denser recyclables – primarily glass and mixed fibers, tend to sink to the bottom of the tipped load while plastics and corrugated containers tend to get pushed to the sides and top of the tipped load. MSW Consultants’ protocol for sampling single-stream material consequently relies on taking cross-sectional samples to assure a representative and random mix of all tipped recyclables.

For the single stream loads, before the grab sample is obtained, the Field Supervisor will direct a loader or skid steer to cut off a cross section of the tipped load, so that the inner section and outer edges are exposed, prior to taking the grab sample.

It will be important to confirm that host MRFs have suitable equipment to obtain representative grab samples. Specifically, loaders must not have large rubber bumpers, which have the effect of pushing glass rather than capturing glass in the scoop. MSW Consultants will work closely with each host facility and investigate the appropriateness of mobile equipment during the site visit.

◆ **Average Sample Size:** MSW Consultants will target recyclables samples between 100 to 125 pounds, weights that are consistent with industry standard methodologies, including ASTM D 5231-92 (Reapproved 2016), “Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste.”

Subtask 5.3 – Data Recording and Analysis: Data will be uploaded to MSW Consultants’ portal for quality checking and analysis. Statistical analysis will be completed similar to the process for the refuse and C&D portions of the study as described in Task 4 above.

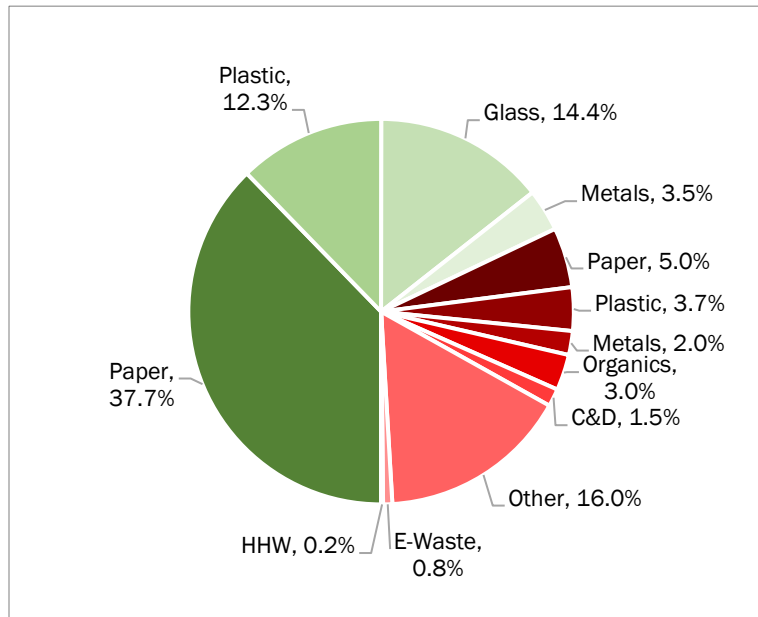
Subtask 5.4 – Technical Memorandum: At the conclusion of these Subtasks, MSW Consultants will prepare a draft technical memorandum that describes the purpose, study methodology, and sampling plan, and that summarizes the essential composition findings as detailed in Subtask 4.4. MSW Consultants will also calculate the recyclables average market value (AMV) based on the composition results.

Table and chart-based examples from other MSW Consultants project deliverables are shown below:

Sample Recyclables Composition Tabular Results

Material	Class	Percent	Confidence Intervals	
			Lower	Upper
Paper		50.0%	45.9%	54.0%
Corrugated Cardboard	Targeted	26.8%	23.6%	30.0%
Residential Mixed Paper	Targeted	17.5%	14.7%	20.3%
Aseptic Packaging and Gable-Top Cartons	Recoverable	0.5%	0.4%	0.7%
Non-Recyclable Paper	Contaminant	5.2%	4.3%	6.0%
Plastics		13.8%	12.3%	15.3%
#1 PET Plastics	Targeted	6.7%	5.7%	7.7%
#2 HDPE Plastics Natural	Targeted	1.1%	0.9%	1.3%
#2 HDPE Plastics Colored	Targeted	1.7%	1.4%	2.0%
#4, #5, #7 Plastics	Targeted	1.0%	0.7%	1.4%
Bulky Rigid Plastics	Targeted	0.7%	0.1%	1.3%
#6 Expanded Polystyrene	Contaminant	0.2%	0.1%	0.2%
#3 PVC	Contaminant	0.0%	0.0%	0.0%
Small Rigid Plastics	Contaminant	1.4%	1.2%	1.7%
Plastic Bags/Film	Contaminant	1.0%	0.8%	1.2%
Glass		23.1%	19.5%	26.8%
Glass Bottles & Jars	Targeted	23.1%	19.5%	26.8%
Metals		5.0%	4.4%	5.6%
Aluminum Beverage Cans & Trays	Targeted	1.8%	1.5%	2.1%
Steel/Aerosol Cans	Targeted	2.8%	2.3%	3.3%
Other Scrap Metal	Contaminant	0.4%	0.3%	0.5%
Other Wastes		8.1%	6.1%	10.1%
Diapers & Sanitary Products	Contaminant	0.0%	0.0%	0.1%
Medical Waste	Contaminant	0.0%	0.0%	0.0%
Bagged Wastes	Contaminant	2.2%	0.9%	3.5%
Loose/Other Wastes	Contaminant	5.8%	4.7%	7.0%
Total		100.0%		
Number of Samples		22		
<i>Targeted Recyclables</i>		<i>83.2%</i>	<i>80.6%</i>	<i>85.9%</i>
<i>Contaminant</i>		<i>16.2%</i>	<i>13.5%</i>	<i>18.9%</i>
<i>Recoverable</i>		<i>0.5%</i>	<i>0.4%</i>	<i>0.7%</i>

Sample Recyclables Composition Chart



Note: If the County selects the two-season study option, MSW Consultants will provide an interim report at the conclusion of season 1 and a final report at the conclusion of the project.

HEALTH & SAFETY PLAN

MSW Consultants is committed to maintaining the health and safety of sort and host facility personnel and property, including third party personnel and property throughout the course of the field study. MSW Consultants will be chiefly responsible for health and safety in the field and has developed a full Safety and Health Plan (SAHP) for waste characterization studies that addresses the challenges associated with these projects. A copy of MSW Consultants' complete SAHP will be provided upon award of this project.

PROJECT BUDGET

Per the RFP, MSW Consultants presents proposed costs and level of effort for both a one-season study, as well as a two-season study. Note that Tasks 1 through 3 are not seasonal in nature.

Proposed Budget: One-Season Study

Tasks	Hours	Labor	Expense	Total
1 - Project Planning & Preparation	129	\$15,000	\$2,400	\$17,400
1.1 - Information Request	14	\$1,600	\$0	\$1,600
1.2 - Kick-off Meeting	20	\$2,700	\$1,100	\$3,800
1.3 - Host Facility Confirmation	48	\$5,300	\$1,200	\$6,500
1.4 - Validate Material Categories	6	\$700	\$0	\$700
1.5 - Finalize Study Design	41	\$4,700	\$100	\$4,800
2 - Quantifying Solid Waste & Recyclables Generation	90	\$10,700	\$100	\$10,800
2.1 - Compilation and Review of FDEP Reports	12	\$1,400	\$0	\$1,400
2.2 - Analysis & COVID-19 Comments	50	\$5,600	\$100	\$5,700
2.3 - Technical Memorandum - Draft	22	\$2,900	\$0	\$2,900
2.4 - Technical Memorandum - Final	6	\$800	\$0	\$800
3 - Quantifying Solid Waste & Recyclables by Generator Type	78	\$10,000	\$200	\$10,200
3.1 - Analysis	40	\$4,900	\$100	\$5,000
3.2 - Technical Memorandum - Draft	32	\$4,300	\$100	\$4,400
3.3 - Technical Memorandum - Final	6	\$800	\$0	\$800
4 - Waste Material Composition Study (One Season)	714	\$55,800	\$19,100	\$74,900
4.1 - Project Mobilization & Demobilization	48	\$5,000	\$2,100	\$7,100
4.2 - Sample Acquisition & Sorting	480	\$28,900	\$14,700	\$43,600
4.3 - Data Analysis	40	\$4,400	\$100	\$4,500
4.4 - Technical Memorandum - Refuse	43	\$5,700	\$100	\$5,800
4.5 - C&D Visual Audits	40	\$4,100	\$1,900	\$6,000
4.6 - Data Analysis	30	\$3,300	\$100	\$3,400
4.7 - Technical Memorandum - C&D	33	\$4,400	\$100	\$4,500
5 - Source-Separated Recyclable Material Composition (One Season)	279	\$21,900	\$5,000	\$26,900
5.1 - Sample Acquisition & Sorting	200	\$12,300	\$4,800	\$17,100
5.2 - Data Analysis	36	\$3,900	\$100	\$4,000
5.3 - Technical Memorandum - Recyclables	43	\$5,700	\$100	\$5,800
Grand Total	1290	\$113,400	\$26,800	\$140,200

PROPOSAL

Proposed Budget: Two-Season Study

Tasks	Hours	Labor	Expense	Total
1 - Project Planning & Preparation	129	\$15,000	\$2,400	\$17,400
1.1 - Information Request	14	\$1,600	\$0	\$1,600
1.2 - Kick-off Meeting	20	\$2,700	\$1,100	\$3,800
1.3 - Host Facility Confirmation	48	\$5,300	\$1,200	\$6,500
1.4 - Validate Material Categories	6	\$700	\$0	\$700
1.5 - Finalize Study Design	41	\$4,700	\$100	\$4,800
2 - Quantifying Solid Waste & Recyclables Generation	90	\$10,700	\$100	\$10,800
2.1 - Compilation and Review of FDEP Reports	12	\$1,400	\$0	\$1,400
2.2 - Analysis & COVID-19 Benchmarking	50	\$5,600	\$100	\$5,700
2.3 - Technical Memoranda - Draft	22	\$2,900	\$0	\$2,900
2.4 - Technical Memoranda - Final	6	\$800	\$0	\$800
3 - Quantifying Solid Waste & Recyclables by Generator Type	74	\$9,600	\$200	\$9,800
3.1 - Analysis	36	\$4,500	\$100	\$4,600
3.2 - Technical Memoranda - Draft	32	\$4,300	\$100	\$4,400
3.3 - Technical Memoranda - Final	6	\$800	\$0	\$800
4 - Waste Material Composition Study (Two Seasons)	1388	\$106,500	\$36,300	\$142,800
4.1 - Project Mobilization & Demobilization	96	\$10,000	\$4,300	\$14,300
4.2 - Sample Acquisition & Sorting	960	\$57,800	\$27,700	\$85,500
4.3 - Data Analysis	70	\$7,700	\$100	\$7,800
4.4 - Technical Memoranda - Refuse	74	\$9,800	\$100	\$9,900
4.5 - C&D Visual Audits	80	\$8,200	\$3,900	\$12,100
4.6 - Data Analysis	52	\$5,700	\$100	\$5,800
4.7 - Technical Memoranda - C&D	56	\$7,300	\$100	\$7,400
5 - Source-Separated Recyclable Material Composition (Two Seasons)	532	\$40,600	\$9,800	\$50,400
5.1 - Sample Acquisition & Sorting	400	\$24,600	\$9,600	\$34,200
5.2 - Data Analysis	60	\$6,500	\$100	\$6,600
5.3 - Technical Memoranda - Recyclables	72	\$9,500	\$100	\$9,600
Grand Total	2213	\$182,400	\$48,800	\$231,200

PROPOSED SCHEDULE

The proposed project schedule is shown in the Gantt chart below. This assumes a two-season study, in which we propose to sample and sort MSW during S. Florida’s “wet season” first and then during the “dry season”. Accordingly, we are proposing that season 1’s sampling begin in mid-September and carry into mid-October. The season 2 sampling and sorting would occur in January and February under this scenario.

This is an aggressive schedule and would require rapid review of MSW Consultants’ data requests and study design. In addition, MSW Consultants may also require support from the County in ensuring potential facility hosts are responsive and willing to participate. MSW Consultants is of course open to reversing this order to allow for more planning and mobilization. If the County selects a one-season study, MSW Consultants is also open to discussion on timing.

Project Schedule

Task Description	2021 - Season 1				2022 - Season 2 (if applicable)		
	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1 Project Planning & Preparation	1	2					
2 Quantifying Solid Waste & Recyclables Generation				4			
3 Quantifying Solid Waste by Generator Type				4			
4 Waste Material Composition & Generation Stream			3				5
5 Source-Separated Recyclable Materials Composition			3				5
Milestones/Deliverables:							
1 Project Commencement							
2 Study Design Issued							
3 Interim Technical Memorandums							
4 Technical Memorandums							
5 Technical Memorandums							

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APPENDIX A

RESUMES

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Experience Summary

- ✓ 26 years as a planning consultant in the waste management and recycling industry
- ✓ Successfully performed and managed consulting engagements for over 100 municipalities nationally

Education/Certifications

- ✓ B.A. Economics, **Yale University**
- ✓ SWANA Certified **Municipal Solid Waste Management Systems Manager**

Select Professional Affiliations

- ✓ Technical Advisor for Waste Management Industry, **Gerson Lehman Group Council of Advisors**, 2004-2016
- ✓ Member, **Solid Waste Association of North America**, 2000-present

Key Skills

- ✓ Strategic/Master Planning
- ✓ Financial Analysis and Rate Development
- ✓ Procurement Assistance and Contract Negotiation
- ✓ Waste and Recycling Composition Analysis

Mr. Culbertson has dedicated his career to providing waste management and recycling consulting services to public, private and institutional sector organizations in Florida and across the nation. His expertise encompasses all aspects of the waste management industry, including solid waste system planning and strategic analysis; financial analysis and system funding; procurement assistance and contract negotiation; collection efficiency and routing; transfer and long-haul logistics; MRF operations and efficiency; waste stream and waste generation analysis; and a wide range of information management and statistical analysis.

Mr. Culbertson is the architect of the firm's online market data repository and analytics platform, *WasteInsight.net*. He manages the firm's Orlando, Florida headquarters.

Project Experience

City of Charleston (WV), Recycling Optimization Evaluation (Ongoing): Mr. Culbertson is directing this project to optimize the residential curbside recycling program for the West Virginia capital city.

Orange County (FL), Recycling Cart Monitoring Program (Ongoing): Mr. Culbertson is the client manager for an ambitious program to deploy teams of recycling cart monitors across the County's residential neighborhoods to tag problematic and contaminated setouts for the purpose of reducing plastic film/bags and other forms of contamination.

Orange County (FL), Recyclables Contamination Audits (Ongoing): Mr. Culbertson developed a sampling plan and is managing "before and after" audits of the composition of Orange County single stream recyclables to evaluate the effectiveness of a direct education program.

City of Philadelphia (PA), Visual Evaluation Methodology Development for Inbound Recyclables (Ongoing): Mr. Culbertson is leading a technical and operations team in the design of a tablet-based app to be used for estimating contamination levels of inbound single stream recycling loads.

Boston Mountain Solid Waste District & the Northwest Arkansas Council, Waste Reduction & Recycling Plan (Ongoing): Mr. Culbertson is on a project management team that is facilitating a master plan to standardize recycling programs, develop organics processing infrastructure, and establish strategies for increasing diversion of C&D debris in a three-county region in Northwest Arkansas.

City of Poughkeepsie (NY), Collection System Evaluation (2020): Mr. Culbertson is Technical Advisor on a project to optimize the City's collection system, update user fees, and evaluate the potential for the City to expand its collection services to multi-family properties and government buildings.

City of Oviedo (FL), Residential Collection, Disposal and Processing Procurement Support (2020): Mr. Culbertson performed a program and recycling market analysis for the City in advance of a collection and processing procurement to identify the service options to be included in the RFP package.

CULBERTSON (continued)

Onondaga County (NY) Resource Recovery Authority, County Waste and Recycling Characterization Study (2019): Mr. Culbertson developed the study design and guided the statistical analysis of this comprehensive characterization study that included disposed wastes and recyclables from the residential and commercial sectors, as well as C&D debris generated and managed within the County's integrated system.

Minnesota Pollution Control Agency, Statewide C&D Debris Characterization Study (2019): Mr. Culbertson developed the sampling plan and study design and served as Technical Advisor on this project to compile visual surveys of C&D load composition at facilities across Minnesota.

District of Columbia (DC), Desktop Waste Characterization Study (2019): Mr. Culbertson developed the research methodology and served as Technical Advisor on a project that compiled extensive historical waste collection, disposal and recycling data for the purpose of projecting future waste generation and estimating the composition of the District's disposed and recycled waste streams.

City of Casselberry (FL), Commercial Franchise Consolidation Study (2019): Mr. Culbertson directed a financial and market analysis of the impact of the City converting from a non-exclusive to an exclusive commercial franchise system. He worked collaboratively with City staff to educate the City's elected officials through a series of individual meetings.

Summit County (UT), Waste Characterization Study (2019): Mr. Culbertson designed the sampling protocol and managed a county-wide waste characterization study.

MassDEP/Covanta (MA), WTE Facility Waste Characterization Study (2019): Mr. Culbertson served as the Project Manager to assist three WTE facilities perform two-season waste characterization studies in compliance with state permitting requirements.

University of Kentucky, Waste Characterization Study (2018): Mr. Culbertson developed the study design and performed the statistical analysis of a campus waste characterization study.

University of Massachusetts at Amherst, Solid Waste Master Plan (2018): Mr. Culbertson developed a protocol and subsequently managed a waste and recycling composition audit to evaluate recycling and organics program diversion performance within five building types on campus.

New York City Department of Sanitation, Residential Curbside, Schools and Public Housing Waste Characterization (2018): Mr. Culbertson developed the sampling plan and study design for a large-scale, 3-season analysis of multiple City-managed waste streams, recyclables, and organics. He is currently overseeing the data analysis and development of a project report.

Louisville Metro Government (KY), Comprehensive Solid Waste Plan (2017): Mr. Culbertson managed three major phases of this solid waste management planning project for LMG. He designed a two-season waste characterization study which was completed in 2016; and performed a collection system cost-of-service analysis for the Urban Service District. Mr. Culbertson was also on the team that facilitated a series of four stakeholder outreach meetings to identify elements of a 10-year solid waste master plan for Louisville and Jefferson County.

Missouri Department of Natural Resources (MO), 2017 Statewide Waste Characterization Study Update (2017): Mr. Culbertson developed a comprehensive update for the protocol and data collection methods for two large-scale studies last performed in 2006-08. He subsequently managed the comprehensive statistical analysis of the Missouri waste stream and oversaw the preparation of the project report.

Maryland Department of the Environment (MD), 2016 Statewide Waste Characterization Study (2017): Mr. Culbertson developed the study design and managed the state of Maryland's first statewide composition study focusing on disposed MSW from across the state. He managed the statistical analysis to determine the state's overall waste composition and authored the project report.

Progressive Waste & the Cities of Miami and Miramar (FL), Single Stream Curbside Material Composition Studies (2016): Mr. Culbertson developed sampling plans and served as the Technical Advisor for recycling characterization studies to be used by these cities and their processor to establish processing contracts.



PHIL BRESEE

Senior Consultant

Experience Summary

- ✓ Over 25 years of experience developing and leading recycling and solid waste management programs at the city and county levels.
- ✓ Leadership roles in state recycling advocacy organizations.

Education/Certifications

- ✓ B.S. in Political Science, **Towson University**; graduate level work in business administration.

Select Professional Affiliations

- ✓ Maryland Recyclers Network Board of Directors
- ✓ Professional Recyclers of Pennsylvania Board of Directors
- ✓ Virginia Recycling Association (member)
- ✓ Recycle Florida Today (board member 2005-2011, chair 2007-2009)
- ✓ Solid Waste Association of North America
- ✓ National Recycling Coalition

Key Skills

- ✓ Solid Waste and Recycling Master Plans
- ✓ Best Management Practices and Benchmarking
- ✓ Regulatory and Legislative Initiatives
- ✓ Procurement Assistance and Contract Negotiation

Mr. Bresee joined MSW Consultants in late 2018 bringing more than 25 years of experience developing and leading solid waste management programs at the city and county levels, as well as serving in leadership roles in state recycling organizations. He came to MSW Consultants from Arlington County, VA where he managed solid waste, recyclables and organics collections and processing contracts, public outreach, solid waste planning, and the County's commercial and multi-family recycling system.

Bresee previously worked as the recycling director for the City of Philadelphia, PA, helping to lead solid waste and recycling programs and planning for the sixth-largest city in the U.S. He also served as a member of the city's solid waste and recycling advisory committee.

From 2004 until mid-2012, Bresee was the recycling program manager for Broward County, FL. Here he directed programs and initiatives on behalf of the County and its 26 partner cities, and the Broward public schools' system. He was the architect of a \$20 million grants project which used solid waste system reserves to help cities improve their residential recycling programs, and led the county's innovative project that studied the feasibility of using pulverized recycled glass for beach erosion control.

Mr. Bresee is a Maryland native, and stated his career with Frederick County. He then spent seven years with Howard County, including as its recycling division chief until his move to Florida in early 2004.

Select Program and Project Experience

City of Philadelphia (PA), Solid Waste System Optimization and Benchmarking Study (Ongoing): Bresee is leading MSW Consultants' high-level review of the City's solid waste system, including collection efficiencies, costs-of-service, facilities, etc. This study also includes a benchmarking comparison of the impacts of COVID-19 on solid waste generation and service delivery in five other large U.S. cities.

Charleston (WV), Recycling Program Analysis and Feasibility Study (2020-2021): Bresee served as project manager for study of City's solid waste services, with a particular focus on its curbside recycling program. MSW Consultants reviewed

regulatory requirements, the City's collection operations, and system costs, as well as benchmarked services with similarly sized regional cities, and two other state capitals. Deliverables included a final report and presentations to City's mayor and city council.

Arlington County (VA), Recyclables Processing and Markets Analysis (2020): Bresee led MSW Consultants' comprehensive analysis of the Washington, DC metropolitan area recycling marketplace, including researching regional MRF tonnage throughput, processing systems and local program contract terms. The study also examined national and regional recycling market disruptions precipitated by China's National Sword as well as identified planned domestic recovered materials processing capacity that might serve the region.

BRESEE (continued)

City of Reading (PA), Solid Waste Services Procurement Support and Waste Composition Study (2020): Facing persistent litter and illegal dumping issues, the City of Reading (the fifth-largest city in Pennsylvania) engaged MSW Consultants to help its transition to a City-wide collection system with comprehensive residential trash and recycling services. Tasks included a solid waste market assessment, benchmarking of peer cities, development of the city's collection and processing services RFP documents and contract, and reviews and updates to City ordinances. MSW Consultants also performed a subsidy analysis that calculated the financial impacts and inequity borne by existing ratepayers from the City's non-exclusive waste system in which customers could "opt-out" of trash service. MSW's subsidy analysis and development of public messaging for City officials proved to be extremely valuable. In July 2020, City Council voted and approved City-wide trash collection to include the delivery of comprehensive trash and recyclables collection services to nearly 30,000 households and small businesses.

City of Philadelphia (PA), Municipal Waste Management Plan Update (2019-2020): Bresee served as MSW Consultants' project manager for the update to the City's 10-year solid waste management plan. The project includes completion of the plan, data analyses, and stakeholder engagement.

City of Tucson (AZ), Solid Waste and Recycling Study (2019): Mr. Bresee led comprehensive study of programs and services from 10 large U.S. cities as part of a benchmarking analysis for the Tucson. City staff referenced project findings in report and recommendations to their mayor and council in February, 2020. The city also commissioned MSW Consultants to perform a follow-up and more detailed analysis of city MRF contracts.

Waste and Recyclables Characterization Studies (Multiple), (2019-current): While with MSW Consultants, Mr. Bresee has taken part in multiple waste and recyclables characterization studies, including the Materials Innovation and Recycling Authority (MIRA) in CT, the Solid Waste Authority of Central Ohio (SWACO), in the City of Philadelphia, and for the Chittenden Solid Waste District (CSWD) in VT.

Howard County (MD), Waste Characterization Study (2019): Bresee managed one-season residential waste characterization study for Howard County, a suburban jurisdiction in between Baltimore, MD, and Washington, DC. Responsibilities included management of field activities, as well as data analysis and report generation.

Broward County (FL), Recyclables Processing Procurement (2011-2012): Bresee developed and led the initial phase of the procurement for new MRF services for 75,000 ton per year volume. Process included vendor workshops, market assessments, technology reviews, benchmarking and development of the RFP. Led pre-proposal conference and managed proposal review team. Also negotiated and managed \$100,000 consultant work authorization for project support.

Broward County (FL), Solid Waste Collections Workshops (2010): Bresee directed consultant-performed recycling and solid waste collections efficiencies workshops series and report for Broward cities during fall 2010.

Broward County (FL), Single-Stream Recycling and Recyclables Processing Procurement (2008-2010): Mr. Bresee guided county's 2008 transition to single-stream recycling which included program research and benchmarking analyses, contract negotiations, hauler meetings, outreach planning, and city-based workshops. MRF services request for proposals process included market assessments, vendor workshops, review of private vs. publicly owned options, and consultant management. Negotiated final contract which included high net revenue rate, annually adjusted market values, development of contractor recyclables transfer stations, term extension, "most favored nation" revenue terms.

Broward County (FL), Beach Renourishment Project (2004-2011): Mr. Bresee served as project lead (along with County's Environmental Protection and Growth Management Department) for Broward County Beach Demonstration Project, which sought to determine feasibility of using pulverized recycled glass for use as beach erosion "hot-spot" fill material.

Broward County (FL), Electronics Recycling Program (2004-2012): Bresee directed county's electronics recycling program which includes mix of four permanent drop-off stations and 12-15 annual remote drop-off events. Program recovered nearly 1.8 million lbs. of e-waste during FY 2010 from 20,000 participants. Negotiated lower e-Cycling contract pricing and "most favored nation" terms, more flexible program services, and end-markets reporting due-diligence.



CYNTHIA M. MORMILE

Senior Project Manager

Experience Summary

- ✓ 20 years serving the City of Columbia Public Works and Utilities Department
- ✓ Successfully managed Collection, Bioreactor Landfill, Composting and Material Recovery Facility Operations
- ✓ Manages operations analyses, waste characterization and capture rate studies, and cost of service and rate study projects

Education

- ✓ B.S. Business Administration- Finance, **Northeast Missouri State University**
- ✓ MBA, **William Woods University**
- ✓ Engineering Coursework, **University of Missouri - Columbia**

Select Professional Affiliations

- ✓ Member, **Missouri Recycling Association (MORA)**
- ✓ Member, **Solid Waste Association of North America (SWANA)**, 1998-2007, 2010-current

Key Skills

- ✓ Project Management
- ✓ Financial Analysis, Budgeting/Capital Planning
- ✓ Collections Analysis
- ✓ Facility Planning
- ✓ Waste Minimization & Sustainability
- ✓ Landfill & Recovery Facilities Operation

Mrs. Mormile has dedicated her career to being a resource to officials responsible for integrated solid waste management in governmental, institutional, and commercial entities.

Mrs. Mormile's experience encompasses all aspects of a vertically integrated collection, disposal, and recovery solid waste utility. She has the unique understanding of all facility operations, including planning and budgeting, personnel management, procurement/contracts, and capital projects; landfill operations, including regulatory compliance, heavy equipment, subtitle D, and bioreactor operation; collections, including rolling fleet and routing; and recovery, including waste analysis, minimization, and sustainability programs.

Select Project Experience

Orange County (FL), Recycling Improvement Program (Ongoing): The County was experiencing high contamination and resulting MRF load rejection and initiated a cart monitoring program to assess carts curbside and educate households for improving the quality of recyclables set out. Mrs. Mormile coordinates project phasing, staffing, and reporting and acts as liaison with County staff, subcontractors, and daily operations.

Sevier Solid Waste, Inc. (SSWI) (TN), Solid Waste Consulting Services (2021): SSWI operates the only flow-control sourced MSW composting facility in the country, sending all MSW generated in Sevier County, TN through the biodigesters prior to landfilling remaining inerts. Mrs. Mormile managed a project to evaluate the operations and costs of SSWI as well as its owner members – Sevier County and the Cities of Gatlinburg, Pigeon Forge and Sevierville.

Boston Mountain Solid Waste Management District (AR), Waste Reduction and Recycling Master Plan (Ongoing): This northwest region of Arkansas desires to move forward recyclables, organics, and C&D diversion for the region. Mrs. Mormile is managing the planning project through exploration and laying out feasible materials management for the future of the region.

Northwest Arkansas Council (AR), Benton County Regional Recycling Plan (Ongoing): Mrs. Mormile is managing the completion of a plan for Benton County to capitalize on the synergies of the planning process underway for the Boston Mountain Solid Waste District.

Grand Rapids (MI), Materials Management Study (2021):

The City of Grand Rapids provides rare non-exclusive PAYT service funded through a unique pre-pay system to its citizens, accompanied with curbside recycling collection offered to all through millage funding. Mrs. Mormile managed the project to identify the full cost of services by program and analysis of various collection system alternates.

Casselberry (FL), Commercial Collection Consolidation Procurement (2020): Mrs. Mormile managed a commercial collection franchise evaluation study followed by the procurement phase for the City to transition existing non-exclusive franchise system for commercial trash collection to exclusive

MORMILE (continued)

provider. The transition allows more thorough and efficient City oversight, decreases traffic and road wear, and provides consistent commercial services throughout the City.

Georgia Institute of Technology (GA), Materials Management & Conservation Plan (2020): Mrs. Mormile supported the prime consultant on campus waste management and future initiatives, including procurement assistance, on-campus processing, and cost of service review.

Poughkeepsie (NY), Sanitation System Study (2020): The City of Poughkeepsie provides trash, recycling and yard waste collection for its citizens and public areas. Mrs. Mormile managed the project, conducting route observations, analyzed the system to provide efficiency and managerial recommendations for consideration, and an add-on citizen survey.

University City (MO), Solid Waste Rate Study (2020): The City was faced with increasing recyclables processing costs and needed to know whether existing rates covered program expenses appropriately, or what rates would do so. Mrs. Mormile managed the cost of service and rate study for the City, who provides residential and commercial collection services and operates a transfer station.

Flagler Beach (FL), Collections Operations Analysis (2019): The City of Flagler Beach is a small coastal community that provides trash, recycling and yard waste collection for its citizens, businesses, and public areas. Mrs. Mormile managed a project for the prime contractor, conducting route observations, and analyzing the system to provide efficiency and managerial recommendations for consideration.

Minnesota Pollution Control Agency (MN), C&D Waste Generation and Composition Study and Analysis (2019): Mrs. Mormile managed a project to characterize construction and demolition waste at C&D disposal facilities as well as quantify the amount of similar materials flowing through recycling and reuse operations. Mrs. Mormile conducted two weeklong seasons of characterization around the state, managing all aspects of the project, including an online survey. The results will be used for future program development in efforts to increase statewide diversion.

U. S. Chamber Foundation (DC), Beyond 34 Project (2019): The USCF conducted a pilot project in the Orlando, FL area in efforts to move the national diversion average upwards. Mrs. Mormile managed a project to conduct pre- and post-audits at area high school football stadiums to help establish replicable processes, infrastructure and BMPs for diverting recyclables at high school sporting events.

Onondaga County Resource Recovery Authority (NY), C&D Characterization (2019): As part of a larger study, Mrs. Mormile conducted two seasons of C&D characterization at the OCRRA Ley Creek Transfer Station utilizing MSW Consultants' proprietary visual characterization volume-weight balancing app.

Dakota County (MN), 5 Facility Waste Sorts (2019): The Dakota County Environmental Department wanted to learn the status of the diversion programs at five county facilities. Mrs. Mormile managed the project, coordinating sort activities and reporting for trash, recycling, and organics stream sorts at three County office/service complexes, a County campground, and an events center.

Fayetteville (AR), Recycling and Trash Collection Rate Study (2018): Mrs. Mormile managed this study to evaluate trash and recycling collection, transfer station, compost facility and recycling center operations to determine associated service costs and rate sufficiency. A five-year model was provided to the City for future planning purposes.

Lawrence (KS), Downtown Solid Waste Rate Model (2018): The City of Lawrence determined several accounts sharing downtown alley waste and recycling receptacles were not being charged appropriately. Mrs. Mormile managed the project to confirm the full cost of service for this service area and provide a rate model framework by customer classification and size.

Logan City (UT), Cost of Service Rate Study (2018): Evaluated collection and disposal operations including an existing landfill, a recently opened landfill and transfer station operations to determine associated service costs and rate sufficiency. Logan City provides residential and commercial waste services to all 19 communities of Cache County.

Mattress Recycling Council (VA), Mattress Age Study and RI Origin Study (2018): Mrs. Mormile gathered data in three states (CT, RI, and CA) and analyzed ages of recycled mattresses and foundations and studied incoming loads in Rhode Island to determine the origin, providing various analyses to the MRC.



JOSEPH VETRANO, LEED AP

Project Manager

Experience Summary

- ✔ Extensive environmental experience in the management and design of sustainability programs and initiatives
- ✔ Advancement of core environmental values and corporate excellence

Education

- ✔ B.S. Biology/Marine Biology, **Fairfield University**
- ✔ Post Graduate work, Endangered Habitats, **California State University**

Specialized Training & Certifications

- ✔ Leadership in Energy & Environmental Design Accredited Professional (LEED AP)
- ✔ Forty-Hour OSHA HAZWOPER Program, 29 CFR 1910.120.
- ✔ Asbestos Inspector / Management Planner
- ✔ IAQ/IEQ Mold & Bioaerosols Investigations Training Program
- ✔ Community Design Collaborative (CDC), Resource Advisor

Mr. Vetrano is an environmental professional with a diverse skill set that encompasses project management, strategic planning, recycling, zero waste systems design, environmental permitting, and contingency planning. He has conducted sustainability assessments, environmental compliance audits, property condition surveys, waste stream analyses, and environmental due diligence.

Select Experience

Ada County, Idaho, Landfill Waste Stream Analysis (2020): Mr. Vetrano served as the project manager of data collection, analysis, and report preparation on this four-season study, which addressed the composition of single and multi-family residential waste throughout the Ada County waste-shed, which primarily included the cities of Boise, Meridian, and Garden City.

New York City Housing Authority (NYCHA)/InSinkErator, Food Waste Diversion Study (2020): Mr. Vetrano served as the project manager on this study, which assessed the impact of food waste disposer installation on the incidence of discards in the solid waste stream. This study involved the cooperation of over 400 households across two public housing developments, only one of which had food disposers installed. After data collection, a comparative analysis was made between the facilities, as well as NYCHA data collected during the 2017 New York City Waste Composition Study.

Chittenden Solid Waste District (CSWD) of Vermont, Residential Waste Composition Study (2020): Mr. Vetrano managed this two-season project which characterized residential waste at the Casella Waste Systems Transfer Station in Williston, Vermont. MSW Consultants targeted representative communities in proportion to the volume each community contributed to the CSWD's overall waste stream.

Solid Waste Authority of Central Ohio (SWACO) 2018-2019 Waste Characterization Study: Mr. Vetrano served as the project manager of field team operations on this four-season study, which serves to assess the composition of commercial and residential waste throughout the City of Columbus, Ohio and the surrounding area.

Vermont Statewide Waste Characterization Study (2018): Performed for the State of Vermont Department of Conservation, Mr. Vetrano served as the project manager of field team operations on this two-season study, which characterized municipal solid waste (MSW) generated within the State of Vermont.

City of Buffalo, New York Waste Composition Study (2018): The City of Buffalo was in the process of completing an updated Comprehensive Recycling Analysis (CRA) for the city to comply with New York State Department of Environmental Conservation (NYSDEC) regulations. The last CRA was developed in 1995 and finalized in 1999. As part of the update to the CRA, the City of Buffalo engaged MSW Consultants to perform its first ever citywide Waste Characterization Study (WCS). Mr. Vetrano managed the Waste Composition Study portion of the project, developing the study design and sample collection strategy, leading the data collection effort, as well as drafting the report and offering critical inputs and baseline recycling system data needed for the CRA update.

City of Austin Texas, Department of Resource Recovery, Citywide Waste Composition Study (2018): Mr. Vetrano trained three sort teams totaling 15 people as part of the first waste composition study for the City

VETRANO (continued)

of Austin. Mr. Vetrano conducted training in material category definitions, as well as general health and safety during the field work.

CalRecycle (CA), 2018 Statewide Waste Characterization Study (2014 & 2018): Mr. Vetrano served as a Field Team Leader on this comprehensive project that extended throughout the 2018 calendar year, encompassing characterization analysis, and waste hauler surveys at disposal facilities and businesses across California.

Maryland Department of the Environment (MDE) Food Waste Reduction Technical Assistance (2018): Mr. Vetrano served as project manager on this USEPA-funded project for the MDE which assisted two organizations, a university, and a produce supplier, in assessing their food waste generation, recognizing the means by which food waste could be reduced, and providing the tools to track reduction of food waste by utilizing concrete strategies customized for each facility.

New York City Transit Authority (NYCT), Waste Characterization Study (2018): Mr. Vetrano served as project manager and field team leader on this project which determined the composition of wastes generated at multiple NYCT facilities. NYCT was interested in determining the composition of sort residue from their processor, as well as assessing the capture rate for targeted recyclable materials.

New York City, NY Waste Characterization Study (2017): Mr. Vetrano recently served as a field data collection manager and sorting crew chief of this comprehensive five-borough study, which will provide important input to the City's understanding of its residential waste and recycling streams. Sample analysis occurred over three seasons and included intensive sorting of residential waste, traditional recyclables as metals, glass, plastic, and paper, as well as organics (yard and food wastes).

ReCommunity Philadelphia Single-stream Recycling Characterization Study (2015 - 2018): Mr. Vetrano is currently managing field data collection activities for ongoing periodic sampling and sorting of inbound loads of single stream recycling at the ReCommunity MRF in Philadelphia, Pennsylvania. The goal of this study is to improve understanding of the composition of single stream materials as delivered to the MRF, and also to monitor changes to single stream composition from outside factors, such as modifications to the product packaging mix and/or seasonal consumption patterns.

City of Philadelphia, PA Waste Characterization Study (2017): Mr. Vetrano recently served as the field data collection manager of this two-season study, which will provide important input to the City's Solid Waste Master Plan. Citywide representative sample collection occurred at a permitted solid waste transfer station, and a single stream recyclable sorting facility, both located within the city.

Marriott Waste Characterization Study (2016): Mr. Vetrano served as the Lead Field Supervisor on this multi-site study. The objective of this project was to provide key information in the development of a robust waste management program for a multitude of different-sized Marriott hotels. The waste characterization focused upon hotel recycling and waste collection from guest rooms, public areas, restaurant, and kitchen (food preparation areas), and office spaces. The study included thorough tour of each hotel's waste and recycling generation points, interview of key staff in each department, as well as a review of food waste preparation, diversion, and disposal techniques. Existing food waste reduction processes, alternatives, and opportunities were discussed and recommended. Marriott is in the process of implementing these recommendations and conducting pilot studies where feasible.

Louisville Metro Government (LMG) Jefferson County (KY), 2016 Waste Characterization Study (2016): Mr. Vetrano served as the field data collection manager of this two-season study, which provided important input to LMG's Comprehensive Solid Waste Master Plan. Sample collection occurred at three permitted solid waste facilities within the County, and single stream recyclables sorting occurred at one MRF. This study notably involved LMG-designated Central Business District areas, which included sample collection and analysis of food waste from participating commercial establishments.

Maryland Statewide Waste Characterization Study (2016): Mr. Vetrano managed the field data collection for this important inaugural study for the Maryland Department of the Environment (MDE). The study established a baseline snapshot of the disposed waste stream with the intent on reducing landfill disposal and increasing diversion. The 2016 Study was carried out over the course of two seasons at eight selected disposal facilities (landfills and transfer stations).

MassDEP/Wheelabrator and Covanta (MA), WTE Facility Waste Characterization Studies (2016): Mr. Vetrano managed the field data collection for waste characterization studies at six Massachusetts waste-to-energy (WTE) facilities over two seasonal data collection events.



Experience Summary

- ✓ 12 years in the waste management and recycling industry.

Education/Certifications

- ✓ BS, Biology, Mount Saint Mary's University, Emmitsburg, MD
- ✓ M.S. Environmental Studies, San Jose State University, San Jose, CA (continuing education)

Key Skills

- ✓ Project Management
- ✓ Program implementation and evaluation
- ✓ Business Development/Marketing
- ✓ Report Writing
- ✓ Data Analysis
- ✓ Office Management

Natalee has been in the industry for twelve years, specializing in recycling and diversion program development and implementation; solid waste and zero waste planning; waste characterization analyses; and stormwater management. Having previously worked on the West Coast for both municipal government and private consulting firms, Natalee now works out of the Philadelphia area on behalf of MSW Consultants. She has worked with MSW Consultants for over five years as an accomplished analyst, working on a large variety of projects related to planning, operational, and financial analysis. Natalee works on projects for both private and public sector clients while specializing in leading the firm's waste characterization studies across the U.S. Many of her projects have been commissioned by clients looking to achieve sustainability goals involving zero waste, enhanced recycling and organics programs, responsible purchasing, and resource conservation.

Project Experience

Pennsylvania Statewide Waste Characterization (PA) (Ongoing): Project manager for Pennsylvania's upcoming residential and commercial/institutional statewide study.

Confidential Client – Restaurant Sustainability Waste Audits (MA, MN, MD, FL), (2019): Project manager, field supervisor, data analysis, and presentation development for national restaurant corporation.

Howard County Waste Characterization Study (MD), (2019-2020): Field supervisor/sort crew chief and data analysis for residential recycling study.

CalRecycle Statewide Waste Composition Study (CA), (2018-2019): Project manager, field supervisor/sort crew chief and data analysis for subcontract to audit disposal facilities and MRFs throughout CA.

Confidential Client – Facility Waste Audit and Sustainability Study (CA), (2019): Project manager, field supervisor and data analysis for a national retail electronics company's distribution center.

City of San Jose MRF Residual Composition Study (CA), (2019): Project manager, field supervisor and data analysis.

The Recycling Partnership (TRP) and City of Newark Residential Recycling Contamination Study (NJ), (2019): Field Supervisor/Sort Crew Chief and data analysis for a pre- and post-implementation study of the City's recycling outreach program.

The Recycling Partnership (TRP) and SWACO Capture Rate Study (OH), (2019): Field Supervisor/Sort Crew Chief, data analysis.

Solid Waste Authority of Central Ohio (SWACO) Waste Characterization Study (OH), (2018-2019): Field Supervisor/Sort Crew Chief, data analysis.

Confidential Client - Facility Waste Audits and Sustainability Study (PA, OH) (2018): Project organizer, field supervisor, data analysis and lead report writer for an international shipping company's offices and distribution centers.

University of Kentucky Waste Composition Study (KY), (2018-2019): Project manager, sort crew chief, data analysis and lead report writer for the University's comprehensive study of all campus buildings including the football stadium, medical complexes, laboratories, dormitories, offices, and classrooms.

Temple University Waste Composition Study (Philadelphia, PA), (2018): Field supervisor and data analysis for a subcontract to perform the University's waste composition study.

MANNION (continued)

University of Pennsylvania and Local Business Audit (Philadelphia, PA), (2018): Field supervisor and data analysis for a subcontract to perform a waste composition of a UPenn building and surrounding retail and restaurant establishments.

Confidential Client - Waste Characterization and Feedstock Study (Philadelphia, Miami, Portland, Vancouver, BC), (Ongoing): Fieldwork, data analysis, and report writing for study of feedstock for energy and building products.

Confidential Client Waste Composition and Capture Rate Study (NE), (2018): Field supervisor during study to analyze pre- and post-implementation impacts of a local film recycling program on MRF inputs and outputs.

New York City Transit Authority Waste Composition Study (NY), (2018): Sort Crew Chief.

EPA Office of Resource Conservation and Recovery: Recycling Contamination, Yields and Littering Study (Federal) (2018): Lead Researcher for National Litter Rate and Characterization task.

Carbon County Municipal Solid Waste Plan Update (PA) (2018): Research Assistant, Plan writing.

ReCommunity Recycling Waste Characterization Study (Philadelphia, PA), (2015-2018): Sort Crew Chief, data analysis, and report writing.

New York City Department of Sanitation Residential Waste Composition (NY), (2017): Sort Crew Chief, data analysis and report writing.

Philadelphia (PA), Citywide Residential Waste Composition (2017): Sort Crew Chief, data analysis and report writing.

Pennsylvania Statewide (PA), Recycling Technical Assistance (Ongoing): Providing recycling technical assistance, including grant support, for Pennsylvania municipalities.

Maryland Department of the Environment, Statewide Waste Characterization (MD) (2017): Sort Crew Chief, site logistics coordination, data analysis and report writing.

Confidential Client Commercial Waste Composition Study (Brooklyn, NY) (2017): Sort Crew Chief, data analysis and report writing.

Southeastern Pennsylvania Transportation Authority (SEPTA) Facility Recycling Composition Analysis (PA) (2017): Sort Crew Chief

NYSDEC Plastics to Oil Feasibility Study (NY) (2016-2017): Research Assistant.

Confidential Client (OH), Facility Waste Audits (OH) (2017): Project organizer, site supervisor for data collection, and report lead writer.

Confidential Client (International), Northeast Disposal Market Research (2017): Research New England, Pennsylvania, and New Jersey landfill and waste to energy facility markets and contract opportunities.

Marriott Hotels-Penn State University Waste Characterization (2016): Field supervisor for sample collection, data analysis and report writing.

Kravco (Confidential Mall Owner), Waste Generation Audit and Tennant Rate Model (2016): Site supervisor for data collection; data modeling and research to allocate appropriate tenant rates for waste and recycling services, and supply recommendations for an improved recycling program.

Progressive Waste (FL), City of Miramar (2016): Sort Crew Chief, data analysis and report writing.

Progressive Waste (FL), City of Miami (2016): Sort Crew Chief, data analysis and report writing.

Hennepin County (MN), Residential Waste Characterization Study (2016): Sort Crew Chief, data analysis and report writing.

Connecticut Department of Energy and Environmental Protection (CT-DEEP), Statewide Waste Characterization Study (2015): Sort Crew Chief

Multiple Clients (CA, WA, NY), Waste Characterization (2009-2016): Sort Crew Chief, Field Staff Planning, Writer



GREG LENAZ

Data Analyst



Education/Certifications

- ✓ BA, Statistics, University of Central Florida (Orlando, FL)
 - Minor in Computer Science

Key Skills

- ✓ Data Management
- ✓ Database Design
- ✓ Web Design
- ✓ Proficient in SAS, R, C, Java, Python, Javascript, PHP, SQL, HTML5, CSS, VBA
- ✓ Web Scraping
- ✓ Technical Training and Support
- ✓ Microsoft Office/Adobe Products
- ✓ Market Research and Surveying
- ✓ Statistical Methods
- ✓ Client Relations
- ✓ Customer Support
- ✓ Project Management

Greg Lenaz joined MSW Consultants in 2017 to assist in expediting the development of the firm's WasteInsight™ platform, MSW Consultants' proprietary waste market database. Responsibilities include the development of new features for the online platform and ensuring statistical validity of the automated calculations. Additionally, Mr. Lenaz performs data analytics and market research for a variety of consulting projects.

Waste Industry Experience

WasteInsight (Ongoing): Mr. Lenaz has extensive experience in the acquisition of data for use in the WasteInsight platform – a cloud-based database that provides comprehensive benchmarking information on government and institutional waste management programs, facilities, waste characterization studies, and solid waste management plans nationwide. Mr. Lenaz developed an application to automate the gathering of data from waste characterization studies resulting in a collection exceeding 300 studies.

Mr. Lenaz is a key developer in creating WasteInsight's Grading and Purity (GAP) System. The GAP System is a data collection method for determining contamination rates for waste streams or bales of recycled materials. To meet customer

needs, Mr. Lenaz rapidly developed visual inspection software to allow users to photograph and document the material managed as part of the GAP System. In partnership with a third-party commodity pricing index, Mr. Lenaz created a program to integrate real-time pricing with the GAP System.

City of Philadelphia (PA), Solid Waste System & Collections Optimization Analysis (Ongoing): Mr. Lenaz is the lead analyst for modeling the City's collection system in order to gauge current productivity and evaluate alternative collection scenarios.

Pennsylvania Department of Environmental Protection (PA), Food Waste to Energy Assessment (Ongoing): Mr. Lenaz is the project manager of a statewide assessment of food waste generation and processing capacity via anaerobic digestion and composting. This study requires identifying and combining the most current and up-to-date data sources with direct surveying of food waste processing facilities. Additionally, this study utilizes the U.S. EPA's Waste Reduction Model (WARM) to estimate the reduction in GHG emissions from diverting food waste, as well as the U.S. EPA's Co-digestion Economic Analysis Tool (Co-EAT) to evaluate potential co-digestion opportunities at existing anaerobic digestors.

Orange County (FL), Recycling Cart Monitoring (Ongoing): In an effort to educate residents and reduce residential contamination rates, the County contracted MSW Consultants to implement a cart inspection and tagging program. Mr. Lenaz serves as the project's data analyst and is responsible for developing the statistics and figures necessary to assess the effectiveness of the program.

Coalfield Development (WV), Appalachian ReUse Corridor Strategic Plan (2021): Mr. Lenaz serves as the data analyst to developing strategic plan for the WV-OH-KY tristate area (known as the ReUse Corridor). This strategic plan is the first step in redefining the ReUse Corridor's materials management practices in order to move towards a circular economy. Mr. Lenaz is responsible for organizing and analyzing data from stakeholders, creating the survey instruments used to engage stakeholders, and providing industry knowledge on collection operations, transportation logistics, and materials processing.

LENAZ (continued)

City of Apopka (FL), Recycling Cart Monitoring (2021): In an effort to educate residents and reduce residential contamination rates, the City contracted MSW Consultants to implement a cart inspection and tagging program. Mr. Lenaz serves as the project's data analyst and is responsible for developing the statistics and figures necessary to assess the effectiveness of the program.

Boston Mountain Solid Waste District (AR), Waste Reduction & Recycling Master Plan (Ongoing): Mr. Lenaz was responsible for developing the population, waste generation, and waste composition estimates for use in the Boston Mountain Master Plan update.

District of Columbia, Desktop Waste Characterization (2020): Mr. Lenaz was the project manager for the District's first desktop waste characterization study. A desktop waste characterization study differs from a traditional waste characterization study in that compositions are estimated based on existing sort data from comparable jurisdictions. In addition to deriving the composition estimates, Mr. Lenaz compiled District generation and demographic data to estimate the District's waste generation and diversion rates.

City of Poughkeepsie (NY), DPW Sanitation Restructuring & Consolidation Study (2020): Mr. Lenaz was responsible for modeling the City's current collection program and alternative scenarios. The result of this exercise allowed the City to compare potential collection costs, GHG emissions, and routing metrics associated with the alternative scenarios if the City were to alter their system.

City of Grand Rapids (MN), Evaluation of Solid Waste Collection System (2020): Mr. Lenaz was responsible for modeling the City's current collection program and alternative scenarios. The result of this exercise allowed the City to compare potential collection costs, GHG emissions, and routing metrics associated with the alternative scenarios if the City were to alter their system.

Minnesota Pollution Control Agency (MN), Construction and Demolition Waste Generation and Composition Study and Analysis (2020): Mr. Lenaz assisted in creating the field data entry forms used to visually characterize C&D waste. Additionally, Mr. Lenaz created the survey to receive responses from contractors, trade associations, and retailers related to C&D, and subsequently summarized the responses into easily understood figures.

Guam Solid Waste Authority, Consultant Services (2020): Mr. Lenaz assisted in compiling labor and equipment costs for use in modeling the territory's collection system.

City of Oviedo (FL), General Solid Waste Consulting Services (2020): Mr. Lenaz was responsible for modeling the City's current collection program and alternative scenarios. The result of this exercise allowed the City to compare potential collection costs, GHG emissions, and routing metrics associated with the alternative scenarios if the County were to alter their system.

City of Philadelphia (PA), Municipal Waste Management Plan Update (2020): Mr. Lenaz was responsible for managing and analyzing the data required to update the Plan, including historical tonnages, demographic information, and survey responses. Because some recent data was not available, Mr. Lenaz was also responsible for formulating a methodology to estimate recycled quantities of recent years.

Cameron County (PA), Municipal Waste Management Plan Update (2020): Mr. Lenaz was responsible for managing and analyzing the data required to update the Plan, including historical tonnages, demographic information, and survey responses. Additionally, Mr. Lenaz assisted in designing the survey administered to solid waste directors for the purpose of gathering information on their municipality's solid waste activities.

Clinton County (PA), Municipal Waste Management Plan Update (2020): Mr. Lenaz was responsible for managing and analyzing the data required to update the Plan, including historical tonnages, demographic information, and survey responses. Additionally, Mr. Lenaz assisted in designing the survey administered to solid waste directors for the purpose of gathering information on their municipality's solid waste activities.

Onondaga County Resource Recovery Agency (NY), Waste Characterization Study (2019): Mr. Lenaz prepared detailed waste characterization results using statistical weighting. Mr. Lenaz then created numerous figures to easily convey the information.



Education/Certifications

- ✓ BA, Interdisciplinary Studies, **University of Central Florida**, Orlando, FL
 - Minor in Marketing

Key Skills

- ✓ Market Research
- ✓ Data Analysis
- ✓ Product Development
- ✓ Microsoft Office
- ✓ Adobe Creative Suite

Memberships

- ✓ Young Professionals Group, Solid Waste Association of North America (SWANA)

Carl Muth joined MSW Consultants as a research intern for WasteInsight™, MSW Consultants' proprietary waste market database. After completing his degree, with academic backgrounds in Social Sciences, Communications, and Marketing, Mr. Muth has grown to take on more roles in the firm, planning and executing customized operational research initiatives, as well as managing field data collection teams through MSW's various waste and recycling characterization studies. Mr. Muth has also been instrumental in field testing the firm's recycling cart monitoring protocols, data management tools, and health and safety practices.

Recent Projects

Orange County (FL) Recycling Quality Improvement Program (Ongoing): Mr. Muth serves as field supervisor for the ongoing recycling cart monitoring project. As part of this role, Mr. Muth conducted interviews of prospective cart monitors, conducted classroom and in-field training, and oversees the daily operations of the field teams. Mr. Muth is responsible for logistics, supplies purchases, monitor tracking, and regular reporting to the client. Mr. Muth also acts as field supervisor for recycling audits, where he oversees representative sampling collection and sorting activities.

WasteInsight™ Portal (Ongoing): Mr. Muth serves as a senior market analyst. Mr. Muth's responsibilities include the acquisition, research, and analysis of data for the population of the database,

as well as the auditing of existing information. Mr. Muth also specializes in the training and development of new talent on the *WasteInsight™* team. In addition, Mr. Muth is also responsible for the development of the data for commercial purposes.

Orange County (FL) Accepted Recycling Composition Audit (2021): Mr. Muth coordinated with Orange County staff to develop a study design and sampling methodology for an audit of inbound recycling loads deemed to fit within acceptable contamination parameters. Mr. Muth also acted as Field Supervisor over the course of the one-week study, also performing QAQC and analysis of collected data. Mr. Muth also developed the final deliverable for the County.

Polk County (FL) Recycling Composition Audit (2020): Mr. Muth acted as Field Supervisor and Crew Chief for this audit of recyclables for Polk County. Additionally, Mr. Muth conducted data QAQC and analysis, as well as worked to complete the final deliverable.

North Port (FL) Recycling Audit (2020): Mr. Muth worked with the project's prime to train staff on the use of the GAP System, MSW Consultants' proprietary data management software designed for material characterization studies. Mr. Muth also supervised sorting activity for the first day of the project and provided QAQC on the gathered data.

Ada County (ID) Waste Composition Study (2020): Mr. Muth supervised the training of prime contractor personnel to fill the crew chief roll for future projects. Mr. Muth, by example, instructed the best methods for capturing data in the field in waste sort activities, and how to properly train and manage field teams in this effort. Mr. Muth also managed data organization.

Hamilton County (OH) Recycling Audit (2019): Mr. Muth acted as crew chief for this project, managing local labor and acting as the primary data collection specialist on the project.

University of Massachusetts (MA) Waste Audit (2019): Mr. Muth served as the project's crew chief, overseeing data collection from the campus' solid waste, recycling, and organics material streams across seven identified material generation types throughout the university's campus. Mr. Muth also handled the data analysis and developed the technical memorandum for the project.

Muth (continued)

Onondaga County (NY) Waste Characterization Study (2019): Mr. Muth acted as the crew chief, managing field labor and data acquisition for the solid waste and recyclables portion of the study.

Summit County (UT) Waste Composition Study (2019): Mr. Muth served as the project manager and field supervisor for Summit County's Waste Composition Study, working closely with the host facility to ensure a representative sampling of solid waste and recyclable material from across the county. Mr. Muth also managed the project's data organization and analysis efforts.

Boulder County (CO) Waste Composition Study (2019): Mr. Muth acted as the project manager and crew chief for this project, training local labor, collecting data, and coordinating with facility staff to ensure project success. Mr. Muth also managed data organization and analysis.

SWACO (OH) Waste Composition Study (2019): Mr. Muth acted as the sampling manager for this project, communicating with SWACO staff, truck drivers, loader operators, and prime contractor staff to collect material composition data from three separate facilities across the Central Ohio area. Mr. Muth acted as the primary field contact for SWACO and the project's prime contractor.

California Statewide Waste Composition Study (2018): Mr. Muth conducted a series of gate-side surveys throughout the State of California, working in close coordination with scale house and operations management staff in Transfer Stations and Landfills as far North as Grass Valley and as far South as Chula Vista. Upon completion of these surveys, Mr. Muth continued to work as a crew chief, training the local labor and collecting data. Additionally, Mr. Muth acted as multifamily residential collection field coordinator, interacting with contacts at various apartment complexes to collect samples from these off-site locations.

Buffalo (NY) Waste Composition Study (2018): Mr. Muth acted as the project's crew chief, managing field labor and data acquisition.

Recycling Partnership Bellevue (NE), Capture Rate Study (2018): Mr. Muth acted as crew chief, managing field labor and data acquisition in this multi-season project, also managed the data organization portion of the project.

Lexington Fayette Urban County Government (KY), Organics Processing Feasibility Analysis (Ongoing): Mr. Muth worked in concert with LFUCG to conduct a survey of businesses and organizations within Fayette County to gauge interest and potential effectiveness of an organic waste program in the area. This data was part of a larger project to determine the feasibility of an organics processing program in the county.

New York City Transit Authority (NY), Waste Characterization Study (2018): Mr. Muth acted as a crew chief for the waste characterization portion of the project. Mr. Muth led a team of sorting personnel in the accurate cataloguing and recording of materials found in the NYCTA waste stream.

Gilbert (AZ), Solid Waste Rate Study (2018): Mr. Muth conducted a comprehensive benchmarking study for a publicly operated solid waste system, facilitating the creation of a detailed rate analysis.

Logan (UT), Solid Waste Cost of Service Study (2018): Mr. Muth conducted a comprehensive benchmarking study for a publicly operated solid waste system, facilitating the creation of a detailed rate analysis.

Continuus Energy (FL), Waste Composition Study (2018): Mr. Muth served as a crew chief for the in-field collection, sorting, and recording of materials found in the Miami area waste stream, directing and managing a team of cataloguing personnel in order to determine whether the location's waste stream met the conditions for the client. The data collected was then compiled into a comprehensive report for the client's review.

Environmental Protection Agency (2018): Mr. Muth assisted in the procurement of waste composition studies nationwide for materials recovery, combustion energy recovery, and mixed waste processing.

New York City (NY), Citywide Waste Composition Study (2017): Mr. Muth operated the recyclable materials table responsible for collecting, sorting and recording recoverable materials collected from truck routes around the five boroughs of the City.



FRANCESCO CANEPA

Financial Analyst

Education/Certifications

- ✓ BS, Economics, **University of Central Florida**, Orlando, FL
 - Minor in Digital Media

Key Skills

- ✓ Financial Analysis and Rate Development
- ✓ Data Analysis
- ✓ Project Management
- ✓ Market Research
- ✓ Process Documentation
- ✓ Microsoft Office
- ✓ Adobe Creative Suite

Memberships

- ✓ Young Professionals Group, Solid Waste Association of North America (SWANA)

Mr. Canepa is an experienced member of MSW Consultants with an academic background in economics and a passion for creating a positive impact on the environment. He is the firm's lead financial analyst and has completed solid waste utility cost-of-service models for numerous municipal clients. Mr. Canepa also developed MSW Consultants' long haul transportation model for use in cost and operations modeling. In addition to supporting the firm's consulting projects, Mr. Canepa continues to lead the *WasteInsight*TM research team where he specializes in analyzing collection and disposal markets and contracts.

Recent Projects

Sevier Solid Waste, Inc. (TN), Solid Waste Consulting and Evaluation Services (Ongoing): Mr. Canepa is conducting comprehensive cost-of-service studies for three municipalities, one county, and one solid waste management authority which include multiple collection systems, landfills, transfer stations, convenience centers, and a composting facility. In addition, Mr. Canepa has provided ad-hoc analyses of ticket and tonnage data.

Philadelphia (PA), Collection System Optimization (Ongoing): Mr. Canepa is conducting a comprehensive cost-of-service study for a publicly operated solid waste system which includes convenience centers and a transfer station.

Orange County (FL), Transportation and Disposal Evaluation and Procurement Assistance (2021): Mr. Canepa conducted comprehensive transportation cost modeling for multiple scenarios

with various combinations of origin points, disposal facilities, and transportation providers. The resulting outputs compared costs per mile, costs per ton, capital costs, and estimated air emissions.

Orange County (FL), Accepted Loads Recyclables Audit (2021): Mr. Canepa served as a crew chief for the recyclables audit and assisted in the subsequent data analysis.

Orange County (FL), Pre-Monitoring Recyclables Audit (2020): Mr. Canepa served as a crew chief for the recyclables audit and assisted in the subsequent data analysis.

Georgia Tech (GA), Materials Management Conservation Plan (2020): Mr. Canepa assisted in the development of cost and waste generation estimates for multiple solid waste services provided by university staff.

Liberty County (GA), Solid Waste Cost of Service Study (2020): Mr. Canepa conducted a comprehensive cost-of-service and rate study for a rapidly expanding, publicly operated solid waste system which included multiple levels of collection and disposal options for various customer classes.

Charleston (WV), Recycling Program Feasibility Study (2020): Mr. Canepa assisted in the development of cost estimates and collection system metrics for existing solid waste management programs. The results of this exercise allowed the city to compare collection costs, estimated emissions, and routing metrics among current and possible program alternatives.

Confidential Facility Developer (NY), Feasibility Analysis (2020): Mr. Canepa assisted in the planning-level feasibility analyses for gas and electric power plants.

Oviedo (FL), Solid Waste Franchise Technical Assistance (2020): Mr. Canepa conducted an economic analysis to determine the total cost of the received proposals to create a total cost ranking of the responses.

Grand Rapids (MI), Department of Public Works Operational Assessment (2020): Mr. Canepa conducted a comprehensive cost-of-service study for a publicly operated pay-as-you-throw solid waste system largely funded by municipal tax revenue.

CANEPA (continued)

Poughkeepsie (NY), Department of Public Works Restructuring and Consolidation Study (2020): Mr. Canepa conducted a comprehensive cost-of-service study for the publicly operated solid waste system along with modeling rate impacts of various collection configuration scenarios.

Guam Public Utilities Commission, Management Audit (2020): Mr. Canepa conducted a comprehensive rate sufficiency analysis of the Guam Solid Waste Authority's rates on behalf of the PUC.

Orange County (FL), Recycling Cart Monitoring (Ongoing): Mr. Canepa helped develop the initial requirements for equipment and logistics for the county-wide monitoring of recycling carts covering over 30,000 households. He was also involved in the training of the initial group of cart monitors.

University of Massachusetts at Amherst (MA), Waste Management System Review (2020): Mr. Canepa compiled existing waste audit data and tonnage information to assist in the decision on whether to conduct a more comprehensive waste audit. He then assisted in the development of the waste audit methodology, procedures, and sampling targets.

The Recycling Partnership/SWACO (OH), Capture Rate Study (2020): Mr. Canepa provided analytical support for the project's data findings and report tables.

Cockey's Enterprises (MD), Transfer Station Feasibility Study (2019): Mr. Canepa developed MSW's long-haul transportation model to compare the costs of transportation to a variety of facilities in the mid-Atlantic area. In addition, Mr. Canepa developed cost comparisons for different transfer station scenarios involving facility size, materials processed, and disposal destination.

Boulder County (CO), Waste Characterization Study (2019): Mr. Canepa spearheaded the data analysis for the County's waste characterization project which covered multiple cities and county areas.

Circular Matters/Mount Dora (FL), Recycling Audit (2019): Mr. Canepa served as the project manager and field supervisor for a curbside recycling audit analyzing the capture rate of specific paper materials and containers.

University City (MO), Solid Waste Rate Study (2019): Mr. Canepa conducted a comprehensive cost-of-service study for a publicly operated solid waste system which included a transfer station.

CalRecycle (CA), Statewide Waste Characterization Study (2018): Mr. Canepa served as the project manager for the gate survey component of California's statewide waste characterization study. He was tasked with developing the survey methodology, scheduling site visits for more than 20 landfills and material recovery facilities, and then performing the gate surveys.

Ørsted A/S (CA), Biogas White Paper (2018): Mr. Canepa researched the current California waste stream to determine the available feedstock for a Renaissance™ facility and to create feedstock projections in consideration of state reduction goals and regulatory changes.

Fayetteville (AR), Solid Waste Rate Study (2018): Mr. Canepa conducted a comprehensive cost-of-service study for a publicly operated solid waste system which included a transfer station, compost facility, recycling center, and two new pilot programs for glass and food waste. He then provided financial analysis on revenues and expenses to determine cash flow, reserve requirements, and proper rates for a ten-year period.

New York City Transit Authority (NY), Waste Characterization Study (2018): Mr. Canepa acted as a crew chief for the waste characterization portion of the project.

Logan (UT), Solid Waste Cost of Service Study (2018): Mr. Canepa conducted a comprehensive cost-of-service study for a publicly operated solid waste system and developed full cost rates for collection and disposal services. He then provided financial analysis to determine cash flows and revenue sufficiency for a ten-year period.

Gilbert (AZ), Solid Waste Rate Study (2018): Mr. Canepa conducted a comprehensive solid waste rate study and developed full cost rates for the commercial and residential sectors.

Philadelphia (PA), Organics Feasibility Study (2018): Mr. Canepa conducted organic and food waste collection and disposal benchmarking research in Seattle, WA and San Jose, CA for use in a comparative analysis for the city of Philadelphia.

APPENDIX B

PROPOSAL MATRIX

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Solid Waste Generation and Composition Study Matrix

Proposer: MSW Consultants

Requested Information	Proposer's Response
<p>Names and brief description on background of individuals working on the project. Please include their role on the project and attach resume.</p>	<p>John Culbertson, Vice President Role on Project: Technical Advisor and QA/QC Officer Mr. Culbertson is a Principal of MSW Consultants with a background in solid waste management and recycling planning, financial analysis, procurement, and program optimization. Mr. Culbertson has 20 years of experience providing waste management consulting services to federal, state, county, and city organizations across the nation. He specializes in helping municipalities implement integrated waste management strategies that align policy, education, revenue mechanisms, service contracts, and programs for effective diversion and environmentally sound waste management. Mr. Culbertson has developed sampling plans and performed detailed statistical analysis for numerous large-scale, complex waste characterization studies for states (Wisconsin, Iowa, Pennsylvania, Georgia), cities (Boston, San Jose, Philadelphia, New York City) and counties (Montgomery County, MD; Boulder County, CO; Lexington County, KY), and is regarded as an expert in the field.</p> <p>Phil Bresee, Senior Consultant Role on Project: Manager/Client Liaison Phil Bresee joined MSW Consultants in late 2018 after more than 25 years developing and leading recycling and solid waste management programs at the city and county levels and serving in leadership roles in state recycling organizations. He specializes in recycling and solid waste planning, program benchmarking and research, recyclables processing contracts, technical writing, and state and local government policies. Just prior to joining MSW Consultants, Phil was division chief for Arlington County, VA's Solid Waste Bureau where he managed solid waste, recyclables and organics collections and processing contracts, public education and outreach, solid waste planning, and the county's commercial and multi-family recycling system. Just prior to his stint in Arlington, Phil was the recycling director for the City of Philadelphia (2012 to 2016).</p> <p>From 2004 until 2012, Phil was the recycling program manager for Broward County where he directed programs and initiatives on behalf of the county its 26 partner cities, and the Broward public schools' system. He was the architect of the \$20 million grants project which used solid waste system reserves to help cities improve their residential recycling programs and led the county's innovative project that studied the feasibility of using recycled glass for beach erosion control. Phil served on the Board of Recycle Florida Today (RFT) from 2005 until 2011, including as its chair from 2007 until 2009, as well as the City of Pembroke Pines' Green City Commission in 2008 and 2009.</p> <p>Cynthia Mormile, Senior Project Manager Role on Project: Operation Specialist Cynthia Mormile joined MSW Consultants after spending over 20 years working in the solid waste industry for public sector and non-profit organizations. She most recently served as the Solid Waste Utility Manager for the City of Columbia (Missouri), where she managed the operational and financial aspects of residential and commercial trash and recoverables collection, a Class I bioreactor landfill, a compost facility and material recovery facility (MRF). Her expertise encompasses all aspects of a full-service collection, disposal, and recovery solid waste utility, including planning and budgeting; personnel management; procurement/contracts; capital projects; rolling fleet and routing; heavy equipment; subtitle D and bioreactor landfill; waste analysis, minimization, and sustainability programs; facility operation and regulatory compliance. A former resident of Middletown, Connecticut (2017), she has served on multiple industry</p>

association boards, presented at numerous state and national conferences and is currently an active member of SWANA and MORA, having served on the board and committees for all three during her career.

Joe Vetrano, LEED AP, Project Manager

Role on Project: Project Field Supervisor

Joe Vetrano is an environmental professional with a diverse skill set that encompasses project management, strategic planning, recycling, zero waste systems design, environmental permitting, and contingency planning. He has conducted sustainability assessments, environmental compliance audits, property condition surveys, waste stream analyses, and environmental due diligence. Mr. Vetrano has served on the MSW Consultants waste characterization field operations management team since joining the firm in 2012, and has performed large-scale studies for New York City, Philadelphia (PA), Lexington-Fayette County (KY), Phoenix (AZ), and statewide studies for Rhode Island, California, and Massachusetts, as well as waste audits for schools, transit authorities, hotels, and a variety of retail and office properties.

Natalee Mannion, Project Analyst

Role on Project: Field Supervisor/Crew Chief

Natalee has been in the industry for twelve years, specializing in recycling and diversion program development and implementation; solid waste and zero waste planning; waste characterization analyses; and stormwater management. Having previously worked on the West Coast for both municipal government and private consulting firms, Natalee now works out of the Philadelphia area on behalf of MSW Consultants. She has worked with MSW Consultants for over five years as an accomplished analyst, working on a large variety of projects related to planning, operational, and financial analysis while specializing in leading the firm's waste characterization studies across the U.S.

Carl Muth, Project Analyst

Role on Project Field Supervisor/Crew Chief

Carl Muth is a results-oriented professional specializing in field data collection and analysis for the company's material characterization and capture rate studies. Carl is a graduate of the University of Central Florida where he studied Social Science and Marketing. Carl has extensive experience developing study designs and training materials for use with the WasteInsight™ GAP System, MSW's proprietary data management platform. Additionally, Carl conducts benchmarking efforts to support a wide variety of MSW projects and acts as field supervisor for MSW's recycling cart monitoring program for clients throughout the US.

Greg Lenaz, Project Manager

Role on Project: Project Data Analyst

Greg is an expert in combining client-provided data with industry knowledge. Greg is a graduate of the University of Central Florida where he studied Statistics and Computer Science. Since joining the firm in 2017, Greg has worked on the development of Solid Waste Management Plans for Carbon County (PA), Wayne County (PA), and the City of Buffalo (NY). In each of these projects, Greg has forecasted waste and recycling generation over a ten-year period, as well as modeled the effects of potential diversion programs. Greg was also the project manager for the Massachusetts Materials Management Capacity Study, conducted for the Massachusetts Department of Environmental Protection, where he compiled and analyzed local and state data that spanned 9 states, 1,160 facilities, and 27 million tons of MSW. Greg is proficient in Excel, SAS, SQL, and numerous programming languages.

Frank Canepa, Financial Analyst

Role on Project: Project Data Analyst

Frank is an experienced member of MSW Consultants with an academic background in economics and a passion for creating positive impacts on the environment. Frank is the firm's

lead financial analyst and has created the firm's cost-of-service and rate model used on projects for multiple public sector clients. He has also developed MSW Consultants' transportation cost model, conducted financial feasibility studies, and performed field work for various projects across the United States. He previously spent nine months working as a research intern for *WasteInsight*TM, MSW Consultants' proprietary waste market database.

References of the most recent waste generation and composition studies performed by your firm (Provide at least 3 references and use additional sheets to provide more):

Reference 1	<p>Municipality or District Name: Onondaga County Resource Recovery Agency (OCRRA), NY Type of Study: County-wide Waste Characterization Study When Completed: 2020 Population or Amount of Waste Disposal by Entity: 460,000 residents; overall MSW stream of 818,000 tons Contact Information of Individuals familiar with the project: Andrew Radin, Director of Recycling and Waste Reduction; (315) 453-2866; aradin@ocrra.org</p>
Reference 2	<p>Municipality or District Name: New York City Department of Sanitation, NY Type of Study: Residential Waste and Recycling Characterization Study When Completed: 2018 Population or Amount of Waste Disposal by Entity: 8.25 million residents; residential MSW stream of 3 million tons. Contact Information of Individuals familiar with the project: Bridget Anderson, Deputy Commissioner, (212) 437-4672, banderson@dny.nyc.gov</p>
Reference 3	<p>Municipality or District Name: Orange County, FL Type of Study: Single Stream Recycling Audits When Completed: 2020 Population or Amount of Waste Disposal by Entity: 1.4 million residents (217,000 households in unincorporated areas); overall MSW stream of 3.3 million tons Contact Information of Individuals familiar with the project: David Gregory, Section Manager/Orange County Utilities Department, (407) 254-9622, David.Gregory@ocfl.net</p>

Describe your firm's approach to completing the study:

Task 1	<p><u>Project Planning and Preparation</u></p> <p>MSW Consultants proposes to perform the following subtasks as part of the overall Project Planning and Preparation Task:</p> <p>Subtask 1.1 – Information Request: Within five days of receipt of a notice to proceed from the County, MSW Consultants will submit a request for information needed to inform the study design plan and data management. This request may include, but not be limited to the following:</p> <ul style="list-style-type: none"> ◆ Reported solid waste tonnage data by solid waste facility located in Broward County from the past three years, as well as facilities who reported receiving solid waste generated in Broward County. Assuming confidentiality concerns can be addressed, this would include reports issued to SWRS from the Florida Department of Environmental Protection (FDEP), as well as reports maintained by the County's Environmental Protection Department (EPD) and shared with SWRS. ◆ A description of solid waste and recyclables tonnages as well as summaries of collection services by municipality, including service provider, service type, whether the municipality has an exclusive franchise, etc. ◆ County and city demographic data, including population estimates for the County and municipalities (2019 U.S. Census data is acceptable); household counts by municipality, including delineation between single-family households and multi-family households to the extent available
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Subtask 1.2 – Participate in a Kick-off Meeting: MSW Consultants will propose to schedule and lead a kick-off meeting with County staff and SWWG representatives to initiate the project. The purposes of this meeting will be to confirm points of contact, communication, and correspondence protocols, discuss data and informational requests, project milestones, deliverables and ensure overall understanding. The kick-off meeting will also allow the County to further articulate program and project goals and concerns to MSW Consultants.

We propose that MSW Consultants’ Principal-in-Charge and Project Manager/Client Liaison attend the kick-off meeting in person, with other MSW staff participating via conference call. This subtask will include preparation of the kick-off meeting agenda, and preparation of notes/minutes that summarize discussions and action items.

Subtask 1.3 – Facility Confirmation and Selection: The 2018 Solid Waste and Recycling Issues Study identified 30 facilities in Broward County that receive MSW from Broward County generators. The facilities by type are detailed in the table below:

Broward County-Based MSW Facilities

Facility Type	Number
C&D/Bulky/Yard Trash	9
MRF	3
Paper Processors	3
Organics	
Processors/Transfer	7
MSW Transfer	5
WTE	1
Landfill	2
Total:	30

MSW Consultants will attempt to confirm which facilities receive MSW from which municipality using data requested in Subtask 1.1. MSW Consultants will utilize these results to identify the appropriate facilities to host the various components of field data collection. We understand that this subtask may require some recruitment of host facilities. If that is indeed necessary, MSW Consultants will request support from the County.

Upon confirmation of the host facilities, MSW Consultants will submit an information request to the management of each of the facilities to collect data necessary to develop the sampling plan. Examples of the types of data in the information request may include:

- ◆ Average daily tonnages delivered, and daily fluctuations in deliveries at each facility
- ◆ Information on vehicle traffic (by time of day) including delivery patterns, and numbers of vehicles arriving, by vehicle type and/or by waste subsector.
- ◆ Information on haulers including origin and type of waste collected by the haulers.
- ◆ For MRFs, information about the mix of inbound materials, the commodities sorted, and the various ejection points where residuals are generated (typically the pre-sort stations and one or more end-of-line residue ejection points).
- ◆ Information about available space for sampling and sort crews and the availability of operational resources, such as a bucket loaders and roll-off containers for sample disposal.
- ◆ Required insurance and waiver of liability that may be needed by the facility owner.

Following the data requests, MSW’s Project Manager or Designated Field Supervisor will schedule site visits at each facility. SWRS staff and SWWG members are invited to attend if interested. These proposed site visits will serve the following crucial functions:

- ◆ Introducing the Project Manager or Field Supervisor to participating facility personnel.
- ◆ Clarifying information provided in response to the information request.
- ◆ Finalizing locations for setting up the work area, taking samples, queuing samples, discarding sorted samples, and other in-process activities.
- ◆ Confirming availability of facility operations staff and equipment (bucket loaders) for sample acquisition and discard.
- ◆ Confirming procedures requiring coordination between host facility personnel and the Project Team.
- ◆ Reviewing facility-specific health and safety procedures and emergency contact numbers.
- ◆ Answering any questions or addressing concerns of the Facility Managers.

MSW Consultants maintains a customized Safety and Health Plan, included in this proposal, which will be provided to host facilities as a precursor to performing any sorting.

Subtask 1.4 – Validate/Refine Material Categories: MSW Consultants accepts the materials categories as identified in Exhibit B of the RFP document. We understand the importance of balancing two key objectives: (1) maintaining the ability to track waste and recyclables composition over time, and (2) adapting the categories to provide the most useful data for use by recycling and solid waste planners. However, we will propose that the materials categories be expanded to conform with standard waste characterization study best practices. Proposed updates may include:

- ◆ Expansion of categories that can be composted or processed via anaerobic digestion,
- ◆ Separation of plastic films into two or more subcategories,
- ◆ Addition of several categories of rigid plastic,
- ◆ Inclusion of several special categories for recyclables, including “bagged materials” and “tangles.”

A ~60 item materials category list from a recent assignment is shown in the table below although MSW Consultants understands the final list of material categories will be determined with input from the County. Note that examples of potential material categories for C&D and recyclables characterization are shown in project Tasks 4 and 5, respectively, but will be developed under this subtask.

Potential Refuse Materials Categories

Paper	Recoverability Class	Organics	Recoverability Class
Corrugated Cardboard/Kraft Paper	Targeted Fibers	Food Waste-Edible Packaged	Contaminant
Newspaper	Targeted Fibers	Food Waste-Edible Non-packaged	Recoverable Organics
Newspaper in Sleeves	Contaminant	Food Waste-Inedible	Recoverable Organics
Office/High Grade Paper	Targeted Fibers	Yard Waste—Grass	Recoverable Organics
Magazine & Catalogs	Targeted Fibers	Yard Waste—Other	Recoverable Organics
Aseptic Boxes & Gable Top Cartons	Targeted Fibers	Wood—Unpainted	Contaminant
Mixed Recyclable Paper (Low Grade)	Targeted Fibers	Wood—Painted	Contaminant
Compostable Paper	Contaminant	Textiles & Leather Products	Recoverable - Drop-off
Non-recyclable Paper	Contaminant	Diapers & Sanitary Products	Contaminant
		Animal By-Products	Contaminant
		Other Organics	Contaminant
Glass	Recoverability Class	Inorganics & Other	Recoverability Class
Glass Bottles and Jars	Targeted Containers	Electronics - Covered Devices	Recoverable - Drop-off
Non-Recyclable Glass	Contaminant	Other Electronics	Recoverable - Drop-off
Plastics	Recoverability Class	Carpet & Carpet Padding	Contaminant
#1 PET Bottles & Jars	Targeted Containers	Drywall/Gypsum Board	Contaminant
#1 PET Non-Bottles & Containers	Targeted Containers	Concrete, Rock, Brick	Contaminant
#2 HDPE Natural Bottles	Targeted Containers	Asphalt Roofing	Contaminant
#2 HDPE Colored Bottles	Targeted Containers	Asphalt Paving	Contaminant
#3 - #7 Bottles	Targeted Containers	Other C&D	Contaminant
#2-#7 Non-Bottle Rigid Containers	Targeted Containers	Medically-Related Waste	Contaminant
Expanded Polystyrene	Contaminant	Lithium Batteries	Recoverable - Drop-off
Clean Retail Plastic Bags	Contaminant	Automotive Batteries	Recoverable - Drop-off
Industrial Film	Contaminant	Other Batteries	Recoverable - Drop-off
All Other Film	Contaminant	Other HHW	Recoverable - Drop-off
Durable/Bulky Rigid Plastics	Targeted Containers	Bulky Materials	Contaminant
Remainder/Composite Plastic	Contaminant	Furniture	Contaminant
Metals	Recoverability Class	Other Inorganics	Contaminant
Steel Cans	Targeted Containers	Fines-1/2" minus	Contaminant
Aluminum Cans	Targeted Containers	Fines-2" minus	Contaminant
Other Aluminum	Contaminant	Tanglers	Contaminant
Other Ferrous Metals	Contaminant	Bagged Recyclables	Contaminant
Other Non-Ferrous Metals	Contaminant	PPE	Contaminant

Subtask 1.5 – Finalize Study Design: The following bullets present our preliminary study design:

- ◆ **Generator Sectors:** Consistent with the annual tonnage reporting classification specified by FDEP, MSW Consultants proposes to sample and differentiate solid wastes by:
 - ◆ **Single Family Residential:** Municipal or commercially collected and self-hauled wastes generated in single family residential households, which may include parcels with up to four housing units.
 - ◆ **Multi-family Residential:** Municipal or commercially collected wastes generated in apartments condominiums, and possibly some trailer parks, that have more than four housing units per parcel.
 - ◆ **Industrial/Commercial/Institutional (ICI):** Municipal or commercially collected and self-hauled waste generated in commercial, industrial, and institutional establishments.
 - ◆ **Construction and Demolition (C&D) Waste:** Commercially collected or self-haul waste from construction, demolition, and remodeling activities, whether performed at residential or commercial structures.
- ◆ **Sampling Targets:** According to the 2020 report to FDEP, Broward County's MSW generation by sector is shown in the table below:

MSW Generation by Sector 2020

Generator Sector	2020 Tons	By %
Single-Family Residential	708,963	17.3%
Multi-Family Residential	232,012	5.7%
Commercial/Institutional	1,376,003	33.6%
C&D	1,783,869	43.5%
Total	4,100,847	100.0%

- ◆ **Sample Allocation - Single-Family Residential, Multi-Family and Commercial:** Based on Broward County's population, the number of cities, and the County's desire to achieve statistically valid and representative samples, MSW Consultants' preliminary sampling plan includes obtaining a total of 372 samples during a two-season study. The preliminary sampling plan for these sectors is shown in the table below:

Preliminary Sampling Plan – Residential and Commercial MSW

Name	Population	Proportion	Samples – Proportional Allocation	Sampling Plan
Broward Co Unincorporated	15,375	0.8%	2.4	3
Coconut Creek	58,803	3.0%	9.1	9
Cooper City	34,006	1.8%	5.3	5
Coral Springs *	129,263	6.7%	20.1	30
Dania Beach	32,215	1.7%	5.0	5
Davie *	105,050	5.4%	16.3	30
Deerfield Beach	80,178	4.1%	12.4	12
Fort Lauderdale *	189,321	9.8%	29.4	30
Hallandale Beach	39,945	2.1%	6.2	6
Hillsboro Beach	1,937	0.1%	0.3	1
Hollywood *	151,818	7.9%	23.6	30
Lauderdale-by-the-Sea	6,305	0.3%	1.0	1
Lauderdale Lakes	36,527	1.9%	5.7	6
Lauderhill	72,507	3.8%	11.3	11
Lazy Lake	28	0.0%	0.0	0
Lighthouse Point	10,536	0.5%	1.6	2
Margate	59,351	3.1%	9.2	9
Miramar *	138,873	7.2%	21.6	30
North Lauderdale	45,549	2.4%	7.1	7
Oakland Park	45,709	2.4%	7.1	7
Parkland	35,438	1.8%	5.5	6
Pembroke Park	6,373	0.3%	1.0	1
Pembroke Pines *	168,949	8.7%	26.2	30
Plantation	90,802	4.7%	14.1	14
Pompano Beach *	112,941	5.8%	17.5	30
Sea Ranch Lakes	682	0.0%	0.1	1
Southwest Ranches	7,786	0.4%	1.2	1
Sunrise *	94,333	4.9%	14.6	30
Tamarac	66,089	3.4%	10.3	10
Weston	67,438	3.5%	10.5	11
West Park	15,228	0.8%	2.4	2
Wilton Manors	12,857	0.7%	2.0	2

Totals: 1,932,212 100.0% 300 372

* Larger cities have upwardly adjusted sampling targets to achieve customized composition estimate.

- ◆ **Sample Allocation – C&D Waste:** MSW Consultants proposes to perform a total of 600 visual samples taken at up to five facilities as depicted in the table below:

Preliminary Sampling Plan - C&D

Facility	Sampling Targets
Facility 1	120
Facility 2	120
Facility 3	120
Facility 4	120
Facility 5	120
Total:	600

- ◆ **Sample Allocation – Recyclables:** MSW Consultants is aware that the cities of Coral Springs, Coconut Creek, Davie, Deerfield Beach and Sunrise have suspended curbside recycling due to contract pricing challenges. Accordingly, our proposed sampling plan for curbside recyclables will be limited to the larger cities and a blending of other cities and Unincorporated Broward County.

Preliminary Sampling Plan - Recyclables

Name	Sampling Plan
Fort Lauderdale	30
Hollywood	30
Pembroke Pines	30
All Other Cities & Unincorporated Broward	30
Total	120

Subtask 1.6 – Issue Project Study Design: At the conclusion of Task 1, MSW Consultants will deliver a Study Design document summarizing the sampling plan, field methods, field forms, and other procedures to be followed for this study. We will incorporate comments from the County prior to finalizing this document.

Task 2

Quantifying Solid Waste and Recyclables Generation

MSW Consultants’ proposed approach to Task 2 is detailed below:

Subtask 2.1 – Compile and Review FDEP Reports: MSW Consultants will compile, and review FDEP county overview reports as published on the department’s website for the past 10 years (2010-2020). Key data and metrics to be reviewed and analyzed will include:

- ◆ County population,
- ◆ Disposition of MSW in tons and by percent including:
 - ◆ Tons recycled
 - ◆ Tons combusted
 - ◆ Tons landfilled

- ◆ MSW generation levels in lbs. per capita,
- ◆ Quantification of County's traditional recycling rates and renewable energy credits, and
- ◆ Quantification and analysis of participation in recycling among single-family, multi-family and C/I sector

Subtask 2.2 – Examine Impacts of COVID-19 on MSW Generation: The stay-at-home orders and decreased commercial activity associated with the COVID-19 pandemic have impacted solid waste generation around the U.S. MSW Consultants has performed research on these impacts on behalf of other clients, and will apply this knowledge and experience, and generate some high-level analysis and assumptions on the impacts felt in Broward County. The following table shows examples from research performed on behalf of a municipal client.

Sample of COVID-19 Impacts Research

City	Increase (in %)	Notes:
A	17.40%	Tonnage change through October; includes recyclables disposed of with trash during program suspensions.
B	6.60%	Tonnage change through October; city reported initial increase of 25%. Total includes trash only.
C	9.60%	Tonnage change through October; reported increase of 15% during first month of stay-at-home order. Total includes trash only.
D	15 - 20%	City also services commercial accounts which have seen decreases in tonnage generation.
E	10.90%	Change over 2019; 2020 pre-COVID vs. post-COVID increase is 19.3%. Total includes trash only.
F	14.20%	Tonnage change through 1st quarter of FY 2021 & includes all MSW; trash increase of 24.4%
G	8%	Tonnage change reported in April.

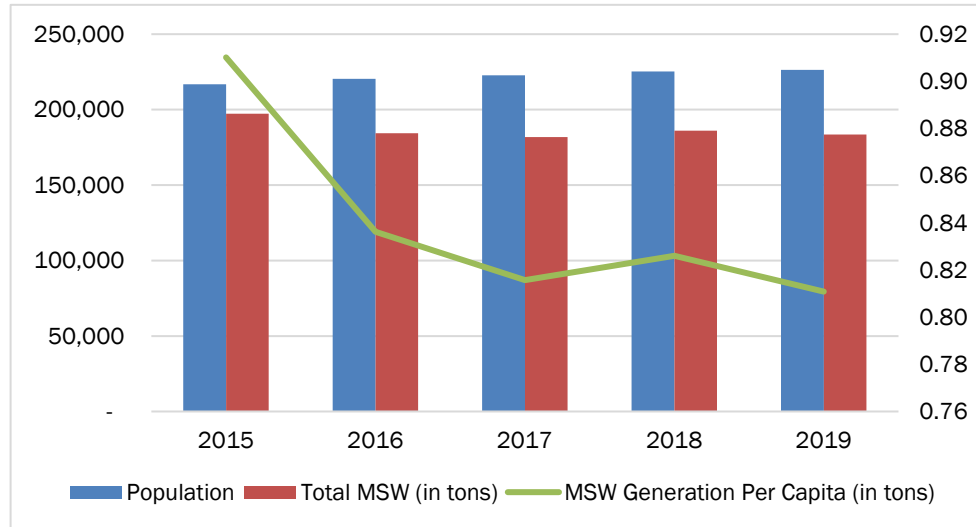
Subtask 2.3 – Technical Memorandum: At the conclusion of Task 2, MSW Consultants will issue a Technical Memorandum that presents data collected, MSW Consultants' methodology, and provides analysis. The technical memorandum will be organized in both a narrative and tabular/graphic format. Examples from similar client deliverables are shown below:

Sample MSW Generation Table

Year	Population	Residential Waste Generation (tons)	Per-Capita Rate (tons/person/year)
2010	1,526,006	619,268	0.41
2011	1,534,293	636,027	0.41
2012	1,542,581	642,680	0.42
2013	1,550,868	624,287	0.40

2014	1,559,156	623,474	0.40
2015	1,567,443	575,883	0.37
2016	1,576,390	601,938	0.37
2017	1,580,221	570,521	0.36
2018	1,584,138	618,513	0.39

Sample MSW Generation Trends Chart



Task 3 Quantifying Solid Waste by Generator Type

MSW Consultants is aware of the challenges associated with adequately measuring MSW generation by sector or generator type. In the RRS era, tonnages collected from municipalities were not distinguished by residential or commercial classifications. MSW Consultants will apply its understanding of solid waste generation to this project task, including:

Task 3.1 – Review and Analyze Generator Data from FDEP Reports: MSW Consultants will review and analyze the already retrieved FDEP reports to quantify solid waste and recyclables by the following generator types:

- ◆ **Single Family Residential:** Municipal or commercially collected and self-hauled wastes generated in single family residential households.
- ◆ **Multi-family Residential:** Municipal or commercially collected wastes generated in apartments condominiums, and possibly some trailer parks.
- ◆ **Industrial/Commercial/Institutional (ICI):** Municipal or commercially collected and self-hauled waste generated in commercial, industrial, and institutional establishments.
- ◆ **Construction and Demolition (C&D) Waste:** Commercially collected or self-haul waste from construction, demolition, and remodeling activities, whether performed at residential or commercial structures.

MSW Consultants will review and analyze this data over a 10-year period, reporting on generation trends in tons and percentage, households, and commercial establishments eligible for service, and generation rates (such as per-capita).

Subtask 3.2 – Perform High-Level Comparative Analysis: MSW Consultants will examine solid waste and recyclables generation levels among Broward County’s residential single-family,

residential multi-family, and commercial generators and compare those with generation levels among other jurisdictions. A truncated example of a similar analysis performed on behalf of another client is shown below:

Sample Benchmarking Table

Jurisdiction	Type	State	Population (2017 U.S.)		Reporting Period	Total Residential MSW Generation	MSW Generation Per Household	MSW Generation Per Capita
			Census Estimates	Est. Households Served				
New York	City	NY	8,622,698	3,100,000	FY 2018	3,067,636	1,979	0.36
Chicago	City	IL	2,716,450	600,000	CY 2017	913,712	3,046	0.34
Philadelphia	Consolidated City-County	PA	1,560,297	522,000	FY 2018	603,987	2,314	0.39
Austin	City	TX	950,715	199,448	FY 2018	219,795	2,204	0.23
Washington	City	DC	702,445	105,282	FY 2018	129,263	2,456	0.18
Boston	City	MA	685,094	351,000	CY 2017	239,338	1,364	0.35
Baltimore	City	MD	611,648	210,000	FY 2017	188,520	1,795	0.31

Subtask 3.3 – Technical Memorandum: At the conclusion of Task 2 MSW Consultants will issue a Technical Memorandum that presents data collected, MSW Consultants’ methodology, and provides analysis.

Task 4 Waste Material Composition and Generation Stream (as listed in Exhibit B to the Letter)

MSW Consultants’ proposed Task 4 will include two components, including the actual waste composition study and the visual sampling of the C&D stream.

Refuse Composition Study Approach

Subtask 4.1 – Project Mobilization: It will be critical to make appropriate arrangements for the personnel and equipment needed to execute the field data collection portion of this project. MSW Consultants will arrange for the experienced staff and provide all sorting equipment (table, bins, carry cans, scale, small tools, and personal protective equipment) needed for the project.

MSW Consultants’ approach to staffing the project is further detailed below:

- ◆ **Staffing and Training:** MSW Consultants proposes to use a two-person professional staff to manage and supervise all sampling and sorting activities, supported by local light industrial laborers to conduct actual sorting. For this approach to be effective, it is important to configure the work area, label material containers, and have appropriate roles and consistent procedures in place. The MSW Consultants field data collection team will include the following individuals:
 - ◆ **Field Supervisor:** MSW Consultants will provide a dedicated Field Supervisor who will have lead responsibility for planning each sampling and sorting event, and for interacting with the facility personnel whose cooperation will be needed throughout the field data collection. The Field Supervisor will generally lead the sampling selection process and will oversee the physical taking of samples. The Field Supervisor is ultimately responsible for the successful completion of the project, and we commit to providing an experienced Field Supervisor for the duration of the study.

- ◆ **Crew Chief:** MSW Consultants will supply a dedicated Crew Chief for each host facility. The Crew Chief will be the second professional staff person. The Crew Chief is responsible for managing the manual sorting area, including crew management, sorting productivity and accuracy, data recording, work site health and safety, and cleaning up at the end of the day. We commit to providing an experienced Crew Chief for the duration of the study.
- ◆ **Sorting Labor:** MSW Consultants holds a national contract with People Ready for sorting labor. If not available locally, we will team with a local staffing firm to supply the labor for this engagement.
- ◆ **Training:** MSW Consultants is proposing that training take place the morning of the first sort day of each seasonal event. Our professional supervisory staff have proven success in training and managing temporary employee sorters to follow a clear and consistent methodology. With built-in quality control practices, we have found that the use of temporary laborers for sorting is extremely successful for week-long sorting events like those included in this project.

The training session for all sorting personnel will include:

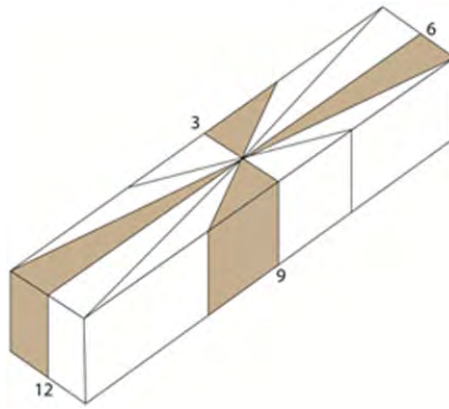
- ◆ An overview of the work area and site rules
- ◆ A thorough review of the Site-Specific Health and Safety Plan
- ◆ Detailed descriptions of categories, with physical examples
- ◆ Weigh out of sorted materials and field data recording.

We welcome County, municipal and host facility personnel to attend any training session and to participate in any phase of the project side-by-side with MSW Consultants.

Subtask 4.2 – Sample Acquisition and Material Sorting: Accurate characterization of solid waste is a complex and demanding undertaking, which requires precise coordination and planning among team members and rigorous adherence to standards of quality. **For refuse and recyclables, MSW Consultants uses a “grab sampling”, or “back of truck” methodology,** which is explained below:

- ◆ **Sample Selection:** Upon targeted truck arrivals at the designated sorting area, MSW’s Field Supervisor will interview incoming drivers for basic information which is noted to identify and verify the load origin. Information from the weight ticket for each vehicle will be obtained for every incoming truck either from the driver, or through communication with the scale house.
- ◆ **Sorting Area:** MSW Consultants typically requires a work area measuring at least 20’x20’ and in close enough proximity to the load discharge area in order to conduct sampling, sorting, and material discard procedures in a safe and efficient manner. This will include room for a screened sorting platform, sorting bins and barrels, the portable scale, and data recordation device, as well as an area for materials discharge once the containers are weighed out.
- ◆ **Taking Samples from Selected Loads:** MSW Consultants understands that a bucket loader and operator will be available to assist with sample acquisition and moving materials from each selected load. Samples of organic materials will be selected based on systematic “grabs” from the perimeter of the load. For example, if the tipped pile is viewed from the top as a clock face with 12:00 being the part of the load closest to the front of the truck, the first samples will be taken from 3 o’clock, 6 o’clock, 9 o’clock, 12 o’clock, and then from 1, 4, 7, and 10 o’clock, and so-on. This concept of systematically rotating around subsequent loads is shown in the figure below.

Systematic Sampling Guide for Tipped Loads



The figure below shows a typical tipping and sample acquisition process.

Sampling of Inbound MSW



Once the section of the load designated for sampling is identified, MSW Consultants' Field Supervisor will label it with a placard and digitally photograph it prior to obtaining the sample. At that point, MSW Consultants' Field Supervisor will request that facility staff collect the sample using its bucket loader for loading into 30-to 35-gallon barrels, which are weighed, and then brought closer to the sorting platform for sorting. The remainder of the load can then be removed for regular materials processing.

- ◆ **Average Sample Size:** MSW Consultants will target samples of MSW materials between 200 to 250 pounds, weights that are consistent with industry standard methodologies, including ASTM D 5231-92 (Reapproved 2016), "Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste."
- ◆ **Materials Sorting:** MSW Consultants will provide the sorting equipment, which includes a sorting platform, labeled bins, and labeled barrels for the most prevalent materials. Sorters are typically instructed to specialize in certain material groups so they can become more knowledgeable in a short period of time as to the definitions of individual material categories. The Field supervisor will monitor the bins as each sample is sorted, rejecting materials that may be improperly classified. Open bins allow the field supervisor to see the material at all times. A picture of a typical sorting platform and bins is shown below.

Sorting Platform and Bins



The Field Supervisor or the Crew Chief will also verify the purity of each component during the weigh-out (discussed below). The materials will be sorted to particle size of 2-inches or less by hand, until no more than a small amount of homogeneous fine material (“mixed residue”) remains. This layer of mixed 2-inch-minus material will be allocated to the appropriate categories based on the best judgment of the Crew Chief—most often a combination of Other Paper, Other Organics, Food Waste, or Miscellaneous. The overall goal is to sort each sample directly into component categories in order to reduce the amount of indistinguishable fines or miscellaneous categories.

◆ **Sample Weigh-outs and Data Recording:** MSW Consultants believes that the weigh-out and data recording process can be most critical process of the sort. Once each sample has been sorted, the weigh-out will be performed. Each bin containing sorted materials will be weighed with a digital scale provided by MSW Consultants. A rugged tablet computer will be used to record the composition weights. The tablet allows for samples to be tallied in real time so that field data collection can immediately identify and rectify errors associated with light sample weights. The tablet synchronizes with the cloud via cellular signal, providing excellent data security. For Quality Assurance/Quality Control (QA/QC) purposes, each sample will be cross-referenced against the Field Supervisor’s sample sheet to assure accurate tracking of the samples each day. The real-time data entry offers several important advantages:

- ◆ The template contains built-in logic and error checking to prevent erroneous entries.
- ◆ The template sums sample weights in real time so the Field supervisor can confirm achievement of weight targets for each and every sample.
- ◆ Except where host facilities are outside of cell phone range, the data file syncs routinely and can be accessed and checked by MSW Consultants QA/QC staff back at the office. For remote facilities that cannot synchronize during the workday, it is usually possible to sync in the evening upon returning to the hotel.

A screen shot of a typical electronic weigh-out form is shown below.

Weigh-Out Form Screen Shot

Current Date/Time: 3/19/2021 10:36:01 AM

WASTEINSIGHT™
PA DEP Waste Audit (Recycling)

Back

Field ID: INPUT Sample Notes:

Submit Sample

TOTAL PRE-WEIGH (lbs): SORTED (lbs): 0.0

1	Corrugated Cardboard/Kraft Paper (Uncoated)	4.00	<input type="checkbox"/>	0.00
2	Newspaper	4.00	<input type="checkbox"/>	0.00
2R	Newspaper in Steeves	4.00	<input type="checkbox"/>	0.00
3	Office/High Grade Paper	4.00	<input type="checkbox"/>	0.00
4	Magazine & Catalogs	4.00	<input type="checkbox"/>	0.00
5	Aseptic Boxes & Gable Top Cartons	4.00	<input type="checkbox"/>	0.00
6	Mixed Recyclable Paper (Low Grade)	4.00	<input type="checkbox"/>	0.00
7	Compostable Paper	4.00	<input type="checkbox"/>	0.00
8	Non-recyclable Paper	4.00	<input type="checkbox"/>	0.00
9	#1 PET Bottles & Jars	4.00	<input type="checkbox"/>	0.00
10	#1 PET Non-Bottles & Containers	4.00	<input type="checkbox"/>	0.00
11	#2 HDPE Natural Bottles	4.00	<input type="checkbox"/>	0.00
12	#2 HDPE Colored Bottles	4.00	<input type="checkbox"/>	0.00
13	#3 - #7 Bottles	4.00	<input type="checkbox"/>	0.00

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- ◆ **Sample Discard, Site Maintenance and Cleanup:** MSW Consultants will coordinate with the facility hosts for sample discards. This typically is accomplished either by spotting roll-off containers for sample discard, or by facility hosts removal of the material using a front-end loader. To the extent feasible, MSW Consultants will also ensure sampled recovered materials are kept separate from sampled refuse material and managed accordingly.

MSW Consultants will be responsible for clean up around the work area at the end of each workday. This will generally involve the removal of any residual debris from the sorting work, as well as organizing the overnight storage of the sorting table, bins, and other equipment.

These procedures will be discussed and confirmed with the facility hosts during Task 1 (Host Facility Validation).

Subtask 4.3 – Data Analysis: The following statistical measures will be calculated to determine the overall composition of each waste generator sector.

- ◆ **Sample Mean:** The sample mean, or average, composition is considered the “most likely” fraction for each material category in the waste stream.
- ◆ **Standard Deviation:** The standard deviation measures how widely values within the data set are dispersed from the sample mean. A higher standard deviation denotes higher variation in the underlying samples for each material, while a lower standard deviation reflects lower variation among the individual samples.
- ◆ **Confidence Intervals:** A confidence interval is a statistical concept that attempts to indicate the likely range within which the true value lies. The confidence intervals reflect the upper

and lower range within which the population mean can be expected to fall. Confidence intervals are customarily calculated at a 90 percent level of confidence, meaning that we can be 90 percent sure that the mean falls within the upper and lower confidence intervals shown. However, prior studies have used a 95 percent level of confidence. We can discuss the advantages and disadvantages of different confidence levels with the County. In general, the higher the level of confidence chosen, the wider the confidence intervals.

Subtask 4.4 – Technical Memorandum: At the conclusion of these Subtasks, MSW Consultants will prepare a draft technical memorandum that describes the purpose, study methodology, and sampling plan, and that summarizes the essential composition findings for each waste sector. Specifically, the report will include:

- ◆ An executive summary providing key findings
- ◆ Introduction and background for the study, including objectives
- ◆ A description of the methodology used in the study and a summary of the sampling and sorting plan
- ◆ A description of the data collection and analytical techniques used
- ◆ A summary of findings, conclusions, and supporting documentation, including by generator type and by city to extent possible
- ◆ A summary of the numbers of samples characterized
- ◆ Raw data in an approved format; and
- ◆ Photos of samples, clearly labeled with a sample placard, delivered separately.

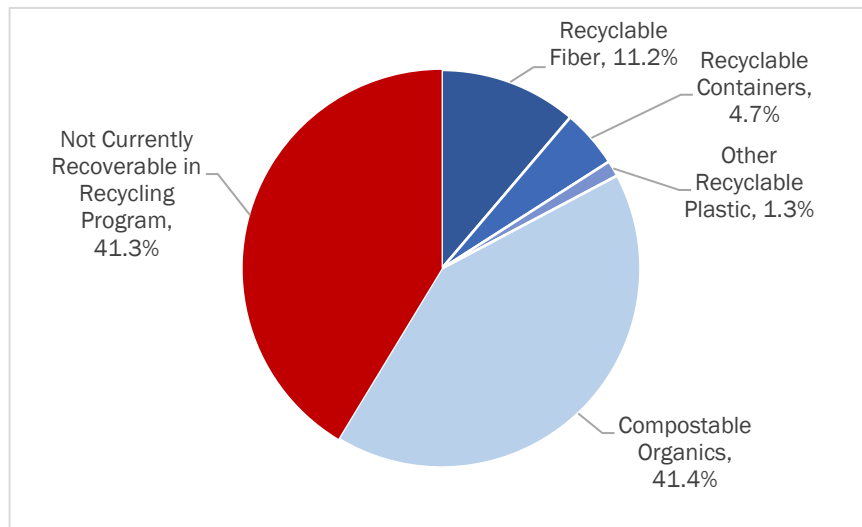
MSW Consultants will provide a draft memorandum for review and comment by SWRS. We have budgeted for one round of reviews by the County and will integrate comments into the final memorandum. MSW Consultants specializes in the tabular and graphical presentation of waste characterization data. Samples of results presented are below.

Sample Waste Composition Tabular Results

Material Category	Est.	Conf.	Tonnage	Material Category	Est.	Conf.	Tonnage
	Percent	Int (+/-)			Percent	Int (+/-)	
Paper	26.0%	1.4%	1,001,551	Plastic	15.3%	2.8%	590,979
OCC/Kraft	8.5%	1.1%	326,094	PET (#1) Bottles/Jars	1.4%	0.1%	54,764
Newsprint	1.5%	0.5%	56,588	PET (#1) Non-Bottle Containers	0.2%	0.1%	8,321
Magazines	0.9%	0.2%	35,327	HDPE (#2) Natural Containers	0.4%	0.0%	15,399
High Grade Office Paper	1.3%	0.3%	51,027	HDPE (#2) Colored Containers	0.5%	0.1%	19,462
Mixed Recyclable Paper	4.0%	0.4%	155,827	Clean Film Bags	0.3%	0.1%	11,948
Compostable Paper	8.1%	0.5%	312,127	Clean Ind'l/Com'l Film	0.7%	0.3%	26,524
Remainder/Composite Paper	1.7%	0.6%	64,562	Contaminated Film/Other Film	5.9%	0.8%	229,256
Glass	2.8%	0.3%	108,996	Plastic Containers #3 thru #7	1.0%	0.1%	38,140
Clear Glass Containers	1.4%	0.2%	53,206	Expanded Polystyrene #6	0.7%	0.1%	27,908
Brown Glass Containers	0.8%	0.2%	32,428	Bulky Durable Plastic Products	1.9%	0.3%	72,746
Green Glass Containers	0.2%	0.0%	8,310	Remainder/Composite Plastic	2.2%	0.4%	86,510
Remainder/Composite Glass	0.4%	0.1%	15,052	Textiles	4.8%	1.2%	186,773
Metal	4.4%	0.5%	168,079	Textiles - Clothing	2.3%	0.4%	87,347
Aluminum Cans & Containers	0.6%	0.1%	24,498	Textiles - Non-Clothing	1.9%	0.3%	73,652
Other Aluminum	0.3%	0.0%	11,985	Shoes/Belts/Leather	0.7%	0.1%	25,775
Tin/Steel Containers	1.0%	0.1%	39,365	Inorganics	12.7%	0.9%	491,013
Other Ferrous	1.8%	0.4%	70,018	Fines	1.7%	0.2%	65,106
Other Non-Ferrous	0.5%	0.2%	20,802	Drywall/Gypsum Board	0.6%	0.3%	23,013
Oil Filters	0.0%	0.0%	1,411	Asphalt, Brick, Concrete & Rocks	0.5%	0.2%	18,639
Organics	32.4%	0.6%	1,248,872	Carpet & Carpet Padding	2.6%	0.7%	100,713
Food Waste	15.0%	1.3%	578,315	Other Construction & Demolition	1.6%	0.5%	60,431
Wood - Clean/Untreated	3.7%	1.2%	141,024	Bulky Items/Furniture	3.1%	0.6%	121,343
Wood - Painted/Stained/Treated	4.5%	1.0%	173,266	Mattresses/Boxsprings	0.7%	0.3%	26,118
Disposable Diapers & Sanitary Prod.	3.1%	0.4%	118,429	Tires	0.8%	0.4%	31,399
Yard Waste	2.6%	0.7%	101,921	Other/Not Classified	1.1%	0.9%	44,249
Remainder/Composite Organic	3.5%	0.6%	135,918	HHW	0.4%	0.1%	15,974
Electronics	1.2%	0.4%	46,216	Household Hazardous Waste	0.4%	0.1%	15,974
Electronic Waste	1.2%	0.4%	46,216				
				Grand Total	100%		3,858,452
				No. of Samples	254		

Confidence intervals calculated at the 90% confidence level. Percentages for materials may not exactly equal category subtotals due to rounding.

Sample Divertibility Assessment



Note: If the County selects the two-season study option, MSW Consultants will provide an interim report at the conclusion of season 1 and a final report at the conclusion of the project.

Subtask 4.5 – C&D Waste Composition Study: MSW Consultants proposes to integrate a C&D characterization effort into Task 4's Waste Materials Composition Study. C&D debris is by nature very different in composition compared to residential and commercial waste collected in compacting vehicles. Where residential and commercial waste loads consist of waste from dozens (commercial) or hundreds (residential) generators, and since most particles are relatively small (less than 12 inches), physical grab sampling and sorting is both practical from an operations standpoint and is also statistically appropriate. However, C&D debris is very different in several important ways:

- ◆ It contains many large and/or heavy particles – such as sheets of plywood, concrete, 2x4s, drywall sections, etc. It may take only two or three unique items in a load of C&D debris to make the 200 to 300-pound sample size that is customary for MSW sorts.
- ◆ The composition of individual loads varies widely – one load may be all dimensional lumber, the next load drywall, and the next roofing shingles, etc. This means the standard deviations of waste constituents are much higher compared to MSW, which in turn implies much larger samples sizes.
- ◆ It is often not possible to obtain a representative sample by extracting only 200, 300, or even a 1,000-pound sample from a load. As such, manually sorting substantial amounts of large loads would result in only a handful of loads analyzed per day and would require extended sampling periods.

The pictures below illustrate the dramatic variance from load to load of C&D debris.

Variation in the Composition of Inbound C&D Debris Loads



As a consequence of these issues, it would require potentially thousands of 200 to 300 pounds of manually sorted samples of C&D to arrive at an estimated composition to the same level of certainty achieved in a typical MSW composition study.

The shortfalls of manual sampling and sorting for C&D debris have been extensively documented by research from the Hinkley Center for Solid Waste Management (see particularly *Generation and Composition of Construction and Demolition Debris in Florida*, Reinhart et.al., December 2002) and by CalRecycle. Both of these organizations have explored visual surveying methods and found such methods to offer a better means of estimating C&D composition. CalRecycle has even published the California state standard methodology for visual characterization of C&D debris (*Method of Visual Characterization of Disposed Waste from Construction and Demolition Activities*, CalRecycle, 2006).

MSW Consultants has first-hand experience comparing and contrasting manual and visual characterization methods for C&D dating to the mid-2000s. In particular, we supported an extensive waste characterization study (working as a subcontractor) for the Delaware Solid Waste Authority. As part of this study, MSW Consultants manually sorted entire loads of C&D debris which were also visually surveyed, so that it was possible to compare the results of both methods. Ultimately the visual survey accuracy was found to be quite high, especially if the C&D load could be spread out somewhat by a loader so that the visual surveyor could see the interior of the tipped load (in effect, making sure to spot the denser items like concrete block and soil that tend to fall to the bottom of the pile).

Further, as described in our enclosed experience and qualifications, **MSW Consultants has developed the nation's only visual survey app that helps the enumerator by converting visual, volumetric composition estimates into weight-based estimates derived from density factors and calibrated with actual scale weights of the C&D load. We used this method for a statewide study in Missouri and recently for the Boulder County, Colorado study and were able to realize a significant reduction in the variance between actual and estimated load weight. We believe our system provides unmatched accuracy for weight-based C&D and other bulky waste characterization studies.**

Based on our professional experience and on widely vetted industry literature, we are therefore offering a **weight-calibrated visual surveying approach** for this project. This method can be performed at much lower cost, will obtain far more samples, and will provide more representative characterization estimates.

C&D characterization project planning and preparation will be completed in conjunction with the Waste Material Composition and Generation Stream Task (Task 4). The following bullets summarize the critical elements that will be undertaken for completion of the C&D study.

- ◆ **Location(s):** TBD at up to five facilities based on outcomes of Task 1.
- ◆ **Staffing:** MSW Consultants professional management staff will conduct the field data collection.
- ◆ **Material Categories:** Potential material categories are in the table below. These will be presented and confirmed with SWRS in Task 1.

Potential C&D Materials Categories

C&D	Paper	Plastic
Rock/Gravel	Untreated OCC-Recyclable	HDPE Buckets
Concrete	Other Paper	Tyvek Building Wrap
Brick	Wood	Film Plastic
Asphalt	Untreated Dimen. Lumber	Plastic Siding/Decking
Gypsum Wallboard - Clean	Untreated Engineered Wood	Plastic Furniture
Gypsum Wallboard - Painted	Painted/Stained Wood	Durable Plastic Items
Roofing Shingles	Treated Wood	Plastic Piping
Carpet	Wood Pallets/Crates/Spools	R/C and Other Plastic
Carpet Padding	Wood Furniture	
Acoustic Tiling	Organics	Glass
Ceramics/Porcelain Fixture	Yard Waste	Flat Glass
HVAC Ducting	Dirt/Sand	R/C and Other Glass
Tires	Metals	Other Wastes
Appliances	Ferrous Scrap	E-Waste
Other C&D	Non-Ferrous Scrap	Asbestos
Insulation	Composite Metal (wires)	Bulky Items
Rubber Products		Mixed MSW

- ◆ **Sample Surveying:** Our assigned staff will coordinate with the scale house, tip area spotter, and inbound deliveries to select loads for surveying. It is understood a loader and operator will be available to assist in spreading the loads from time to time if they are not spread during the offload so we can see the interior of the loads. On most occasions, the driver is able to spread the load out as he tips.
- ◆ **Number of Samples:** MSW Consultants anticipates visually characterizing roughly 25 samples per day per facility over a six-day season (300 samples per season).
- ◆ **Distribution of Samples:** MSW Consultants will request historical scale or tonnage information from facility hosts and allocate samples in proportion to the waste generating sectors and truck types delivering to the facilities.
- ◆ **Sample Selection:** We will select the Nth vehicle based on estimated daily arrivals of C&D debris loads.
- ◆ **Data Collection:** The following methodology is used with our accurate visual surveying protocol:
 - ◆ Measure and record the dimensions of the incoming load prior to tipping and (if possible) estimate the percent full of the vehicle/container.
 - ◆ Tip the load. If it is a large load of non-homogeneous materials, have a loader spread out the material so that it is possible to discern dense materials such as block, brick, and dirt that tend to sink to the bottom of the pile.
 - ◆ Make a first pass around the load marking the major material categories that are present in the load—Wood Waste, Organics, Fiber, etc. Estimate the percentage of the load made up of these major materials.
 - ◆ Make a second pass around the load, noting the secondary material categories contained in the load—Wooden Pallets, Sawn Lumber, OCC, etc. Estimate the percentage of the load made up of these materials.
 - ◆ Validate that the estimated percentages sum to 100 percent, and that the sum of estimated weight is within acceptable range and realistic given the overall truck dimensions and volume.
 - ◆ Compare the calculated weight of the load to the actual scale weight of the load, identify possible sources of discrepancy, and make adjustments to volumetric

estimates and/or density factors to reduce the degree of difference. This last step is critical to the accuracy of the data.

For the Visual Surveying activity for the C&D material stream, a proprietary field form has been developed to provide real-time balancing based on vehicle/container size, consumed capacity and material densities to allow immediate data quality control. An example of a typical data entry screen for our waste characterization studies is shown in the exhibit below.

Example of Visual Survey Entry Tablet Screen

Sample ID: Add Samples

Sample Notes:

Load Weight (tons):

Facility: Generic C&D Facility

Generator: select one

Material: select one

Hauler: Other (write-in):

Truck Type: select one

Truck Number:

Ticket Number:

Total Truck Volume (CY): 0.0
L (ft) W (ft) H (ft) Area (CY) (%)

Total Trailer Volume (CY): 0.0
L (ft) W (ft) H (ft) Area (CY) (%)

Sum of Groups (%): --

Total Volume (CY): 0.0

Actual Weight (tons): 0.00

Actual Sum of Lbs.: 0

Sum of Estimated Lbs.: 0

Variance (%): --

	Paper (%)	Plastic (%)	Glass (%)	Metal (%)	Organics (%)	Wood (%)	C&D (%)	Other Wastes (%)
1. Uncoated OCC - Recyclable	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
2. Other Paper	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
3. HDPE Buckets	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
4. Tyvek Building wrap	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
5. Film Plastic (commercial/industrial)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
6. Plastic furniture	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
7. Durable plastic items	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
8. Composite/Other Plastic (flooring, knobs, etc.)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

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◆ **Data Recording:** The data files are synced routinely while in the field if good cell service is available. In the least, the data is synced each evening and can be accessed and checked by MSW Consultants QA/QC staff back at the office.

Data for each load is input on the field tablet as the Field Supervisor visually characterizes the load as described above. Data is later uploaded to the company portal for quality checking and analysis. Statistical analysis will be completed similar to the process for the MSW and recycling study as described in Task 4 above.

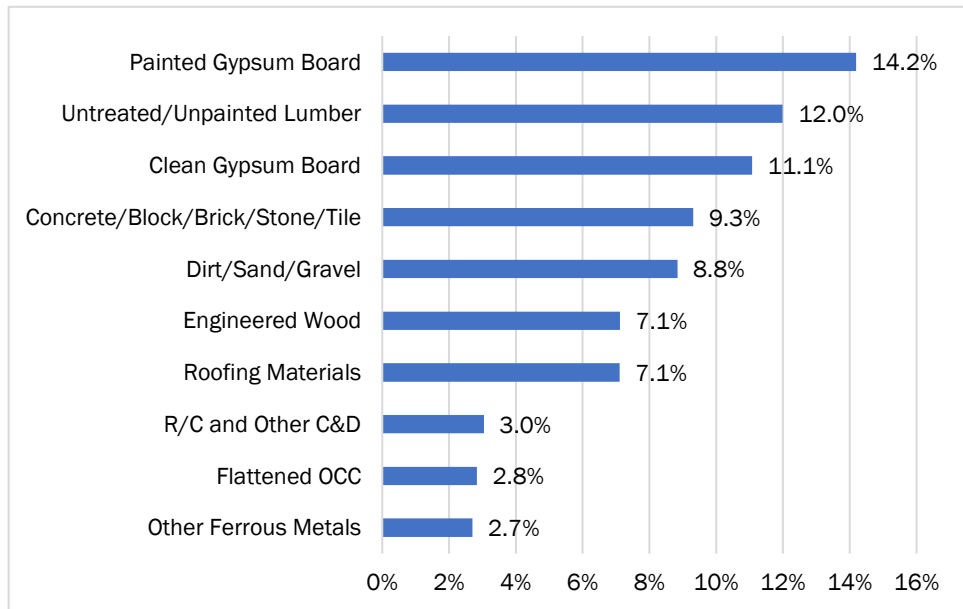
Subtask 4.6 – Technical Memorandum: The results of the C&D material characterization will be issued in a format similar to that described for the Waste Material Composition and Generation Stream memorandum. Samples of tabular and graphical presentation of the C&D waste characterization data are provided below.

Sample Detailed C&D Waste Composition

Material Category	Est. Percent	Conf. Int (+/-)	Est. Tonnage	Material Category	Est. Percent	Conf. Int (+/-)	Est. Tonnage
MSW/Other Waste	7.3%	3.9%	26,108	Roofing Materials	8.0%	2.5%	28,687
Flattened OCC	0.7%	0.2%	2,533	Roofing Materials	8.0%	2.5%	28,687
Unflattened OCC	0.1%	0.0%	514	Dirt/Sand/Gravel	4.7%	3.0%	16,884
R/C and Other Paper	0.2%	0.2%	888	Dirt/Sand/Gravel	4.7%	3.0%	16,884
All Glass	0.5%	0.2%	1,668	Other C&D	5.2%	1.6%	18,644
Electronics	0.9%	0.2%	3,194	Carpet	2.5%	0.5%	8,951
Items with CRTs	0.3%	0.1%	1,025	Carpet Padding	0.3%	0.1%	959
Tree Trunks		<i>Not Found</i>		Asphalt Paving	0.6%	0.3%	2,144
Fines/Mixed Residue	2.4%	1.1%	8,659	Ceiling Tiles	0.3%	0.1%	930
Mixed MSW	2.1%	0.3%	7,626	Insulation	0.8%	0.2%	2,892
Agricultural Waste		<i>Not Found</i>		R/C and Other C&D	0.8%	0.3%	2,768
Plastic	5.6%	5.6%	20,252	Special Wastes	14.4%	5.5%	51,759
Plastic Bottles (Recyclable)		<i>Not Found</i>		Bulky Wastes/Furniture	14.3%	2.3%	51,526
HDPE Buckets (stacked)		<i>Not Found</i>		Tires - Cut	0.0%	0.0%	135
HDPE Buckets (unstacked)	0.0%	0.0%	62	Tires - Whole	0.0%	0.0%	30
Clean Recoverable Film	0.0%	0.0%	139	All HHW	0.0%	0.0%	68
R/C and Other Plastic	5.6%	2.5%	20,051	Contaminated Soil		<i>Not Found</i>	
Metal	3.7%	1.7%	13,243	Wood	19.7%	6.8%	70,935
Appliances	0.1%	0.1%	314	Pallets - Standard	1.0%	0.3%	3,449
Other Ferrous Metals	3.1%	0.8%	11,306	Pallets/Crates/Heavy	0.0%	0.0%	92
Other Non-ferrous Metal	0.3%	0.1%	951	Untreated/Unpainted Lumber	3.4%	0.9%	12,134
HVAC Ducting	0.2%	0.1%	672	Treated/Painted/Processed Wood	6.8%	1.4%	24,490
Organics	2.5%	5.8%	9,041	Engineered Wood	3.0%	0.7%	10,783
Leaves/Grass/Mixed Yard Waste	0.3%	0.1%	1,110	Wood Furniture	3.2%	0.9%	11,586
Branches/Limbs	0.1%	0.1%	302	Other Wood	2.3%	1.4%	8,401
R/C and Other Organics	2.1%	3.3%	7,629	Concrete/Brick/Rock	17.7%	4.5%	63,781
Gypsum Board	11.3%	3.3%	40,738	Concrete/Block/Brick/Stone/Tile	17.7%	4.5%	63,781
Clean Gypsum Board	1.8%	0.8%	6,358				
Painted Gypsum Board	9.5%	2.2%	34,380	Grand Total	100.0%		360,073
				<i>No. of Samples</i>		109	

Confidence intervals calculated at the 90% confidence level. Percentages for materials may not exactly equal category subtotals due to rounding.

Sample Top 10 Most Prevalent Materials in C&D Waste



Note: If the County selects the two-season study option, MSW Consultants will provide an interim report at the conclusion of season 1 and a final report at the conclusion of the project.

Task 5 Source-Separated Recyclable Material Composition (as listed in Exhibit B to the Letter)

With many of Broward County's largest cities electing to suspend curbside recycling programs due to poor market values and purported high-contamination levels, MSW Consultants understands the importance of this task.

From a task execution standpoint, with some considerations, the Subtasks associated with Task 4 will generally apply to sampling of source separated recyclables. Key considerations and subtasks follow:

- ◆ **Materials Categories:** The recyclables materials categories should parallel the refuse material categories to allow for recyclables capture rate analyses. However, the contaminants fraction can be consolidated in order to arrive at a more manageable and practical list of recyclables categories. A potential ~40 item recyclables material category list is shown in the table below although it will be presented and validated with SWRS as part of Subtask 1.3.

Potential Recyclable Materials Categories

Paper	Recoverability Class	Glass	Recoverability Class
Corrugated Cardboard/Kraft Paper	Targeted Fibers	Glass Bottles and Jars	Targeted Containers
Newspaper	Targeted Fibers	Non-Recyclable Glass	Contaminant
Newspaper in Sleeves	Contaminant	Metals	Recoverability Class
Office/High Grade Paper	Targeted Fibers	Steel Cans	Targeted Containers
Magazine & Catalogs	Targeted Fibers	Aluminum Cans	Targeted Containers
Aseptic Boxes & Gable Top Cartons	Targeted Fibers	Other Aluminum	Contaminant
Mixed Recyclable Paper (Low Grade)	Targeted Fibers	Other Ferrous Metals	Contaminant
Compostable Paper	Contaminant	Other Non-Ferrous Metals	Contaminant
Non-recyclable Paper	Contaminant	Contaminants	Recoverability Class
		Food Waste	Contaminant
Plastics	Recoverability Class	Yard Waste	Contaminant
#1 PET Bottles & Jars	Targeted Containers	Electronics	Contaminant
#1 PET Non-Bottles & Containers	Targeted Containers	HHW & Med Waste	Contaminant
#2 HDPE Natural Bottles	Targeted Containers	Lithium Batteries	Contaminant
#2 HDPE Colored Bottles	Targeted Containers	Other Batteries	Contaminant
#3 - #7 Bottles	Targeted Containers	C&D Waste	Contaminant
#2-#7 Non-Bottle Rigid Containers	Targeted Containers	Bulky Metals	Contaminant
Expanded Polystyrene	Contaminant	Tanglers	Contaminant
Clean Retail Plastic Bags	Contaminant	Fines-1/2" minus	Contaminant
Industrial Film	Contaminant	Fines-2" minus	Contaminant
All Other Film	Contaminant	Other Inorganics	Contaminant
Durable/Bulky Rigid Plastics	Targeted Containers	Bagged Recyclables	Contaminant
Remainder/Composite Plastic	Contaminant	PPE	Contaminant

Subtask 5.1 – Project Mobilization: This subtask will follow the same approach described in Subtask 4.1 for the Waste Materials Composition task.

Subtask 5.2 – Sample Acquisition and Material Sorting: This subtask will generally follow the approaches detailed in Subtask 4.2, with the following exceptions:

- ◆ **Taking Samples from Selected Loads:** Grab sampling of inbound single-stream loads will be slightly modified to capture representative material from the dense inner section of the load and the lighter exterior of the tipped load. It is important to note that grab sampling of single stream material requires some additional expertise. This is because the denser recyclables – primarily glass and mixed fibers, tend to sink to the bottom of the tipped load while plastics and corrugated containers tend to get pushed to the sides and top of the tipped load. MSW Consultants’ protocol for sampling single-stream material consequently relies on taking cross-sectional samples to assure a representative and random mix of all tipped recyclables.

For the single stream loads, before the grab sample is obtained, the Field Supervisor will direct a loader or skid steer to cut off a cross section of the tipped load, so that the inner section and outer edges are exposed, prior to taking the grab sample.

It will be important to confirm that host MRFs have suitable equipment to obtain representative grab samples. Specifically, loaders must not have large rubber bumpers, which have the effect of pushing glass rather than capturing glass in the scoop. MSW Consultants will work closely with each host facility and investigate the appropriateness of mobile equipment during the site visit.

- ◆ **Average Sample Size:** MSW Consultants will target recyclables samples between 100 to 125 pounds, weights that are consistent with industry standard methodologies, including ASTM D 5231-92 (Reapproved 2016), “Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste.”

Subtask 5.3 – Data Recording and Analysis: Data will be uploaded to MSW Consultants’ portal for quality checking and analysis. Statistical analysis will be completed similar to the process for the refuse and C&D portions of the study as described in Task 4 above.

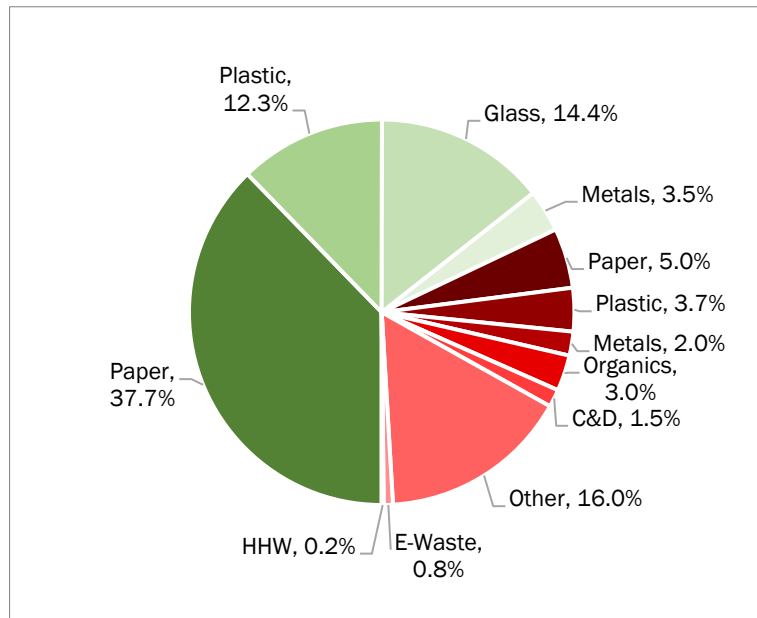
Subtask 5.4 – Technical Memorandum: At the conclusion of these Subtasks, MSW Consultants will prepare a draft technical memorandum that describes the purpose, study methodology, and sampling plan, and that summarizes the essential composition findings as detailed in Subtask 4.4. MSW Consultants will also calculate the recyclables average market value (AMV) based on the composition results.

Table and chart-based examples from other MSW Consultants project deliverables are shown below:

Sample Recyclables Composition Tabular Results

Material	Class	Percent	Confidence Intervals	
			Lower	Upper
Paper		50.0%	45.9%	54.0%
Corrugated Cardboard	Targeted	26.8%	23.6%	30.0%
Residential Mixed Paper	Targeted	17.5%	14.7%	20.3%
Aseptic Packaging and Gable-Top Cartons	Recoverable	0.5%	0.4%	0.7%
Non-Recyclable Paper	Contaminant	5.2%	4.3%	6.0%
Plastics		13.8%	12.3%	15.3%
#1 PET Plastics	Targeted	6.7%	5.7%	7.7%
#2 HDPE Plastics Natural	Targeted	1.1%	0.9%	1.3%
#2 HDPE Plastics Colored	Targeted	1.7%	1.4%	2.0%
#4, #5, #7 Plastics	Targeted	1.0%	0.7%	1.4%
Bulky Rigid Plastics	Targeted	0.7%	0.1%	1.3%
#6 Expanded Polystyrene	Contaminant	0.2%	0.1%	0.2%
#3 PVC	Contaminant	0.0%	0.0%	0.0%
Small Rigid Plastics	Contaminant	1.4%	1.2%	1.7%
Plastic Bags/Film	Contaminant	1.0%	0.8%	1.2%
Glass		23.1%	19.5%	26.8%
Glass Bottles & Jars	Targeted	23.1%	19.5%	26.8%
Metals		5.0%	4.4%	5.6%
Aluminum Beverage Cans & Trays	Targeted	1.8%	1.5%	2.1%
Steel/Aerosol Cans	Targeted	2.8%	2.3%	3.3%
Other Scrap Metal	Contaminant	0.4%	0.3%	0.5%
Other Wastes		8.1%	6.1%	10.1%
Diapers & Sanitary Products	Contaminant	0.0%	0.0%	0.1%
Medical Waste	Contaminant	0.0%	0.0%	0.0%
Bagged Wastes	Contaminant	2.2%	0.9%	3.5%
Loose/Other Wastes	Contaminant	5.8%	4.7%	7.0%
Total		100.0%		
Number of Samples		22		
<i>Targeted Recyclables</i>		<i>83.2%</i>	<i>80.6%</i>	<i>85.9%</i>
<i>Contaminant</i>		<i>16.2%</i>	<i>13.5%</i>	<i>18.9%</i>
<i>Recoverable</i>		<i>0.5%</i>	<i>0.4%</i>	<i>0.7%</i>

Sample Recyclables Composition Chart



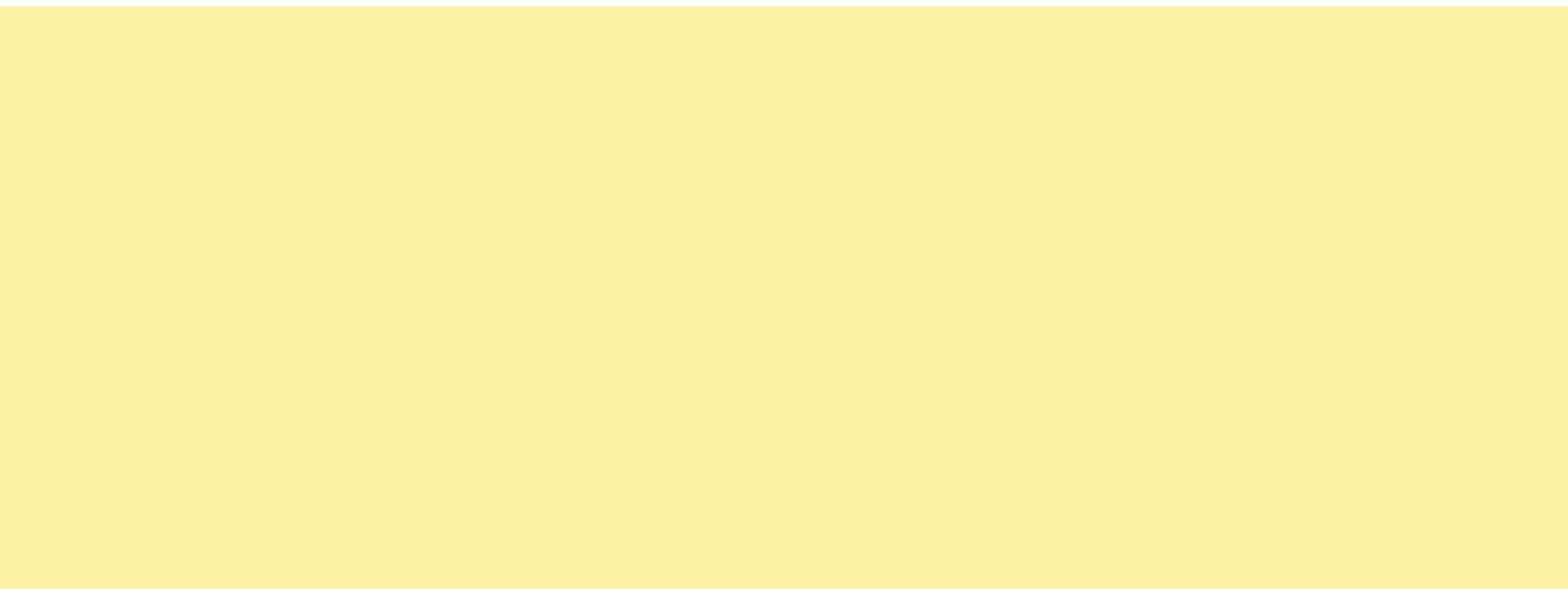
Note: If the County selects the two-season study option, MSW Consultants will provide an interim report at the conclusion of season 1 and a final report at the conclusion of the project.

Time Estimate and Cost Proposal

Task 1	<u>Estimated Time (One-Time):</u> 129 hours	<u>Estimated Time (Seasonal):</u> N/A *
	<u>Cost Proposal (One-Time):</u> \$17,400	<u>Cost Proposal (Seasonal):</u> N/A *
*Task 1 costs are considered one-time expenses		
Task 2	<u>Estimated Time (One-Time):</u> 90 hours	<u>Estimated Time (Seasonal):</u> N/A *
	<u>Cost Proposal (One-Time):</u> \$10,800	<u>Cost Proposal (Seasonal):</u> N/A *
*Task 2 costs are considered one-time expenses		
Task 3	<u>Estimated Time (One-Time):</u> 78 hours	<u>Estimated Time (Seasonal):</u> N/A *
	<u>Cost Proposal (One-Time):</u> \$10,200	<u>Cost Proposal (Seasonal):</u> N/A *
*Task 3 costs are considered one-time expenses		
Task 4	<u>Estimated Time (One-Time):</u> 714 hours	<u>Estimated Time (Seasonal):</u> 1,388 hours

	<u>Cost Proposal (One-Time):</u> \$74,900	<u>Cost Proposal (Seasonal):</u> \$142,800
Task 5	<u>Estimated Time (One-Time):</u> 279 hours <u>Cost Proposal (One-Time):</u> \$26,900	<u>Estimated Time (Seasonal):</u> 532 hours <u>Cost Proposal (Seasonal):</u> \$50,400

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