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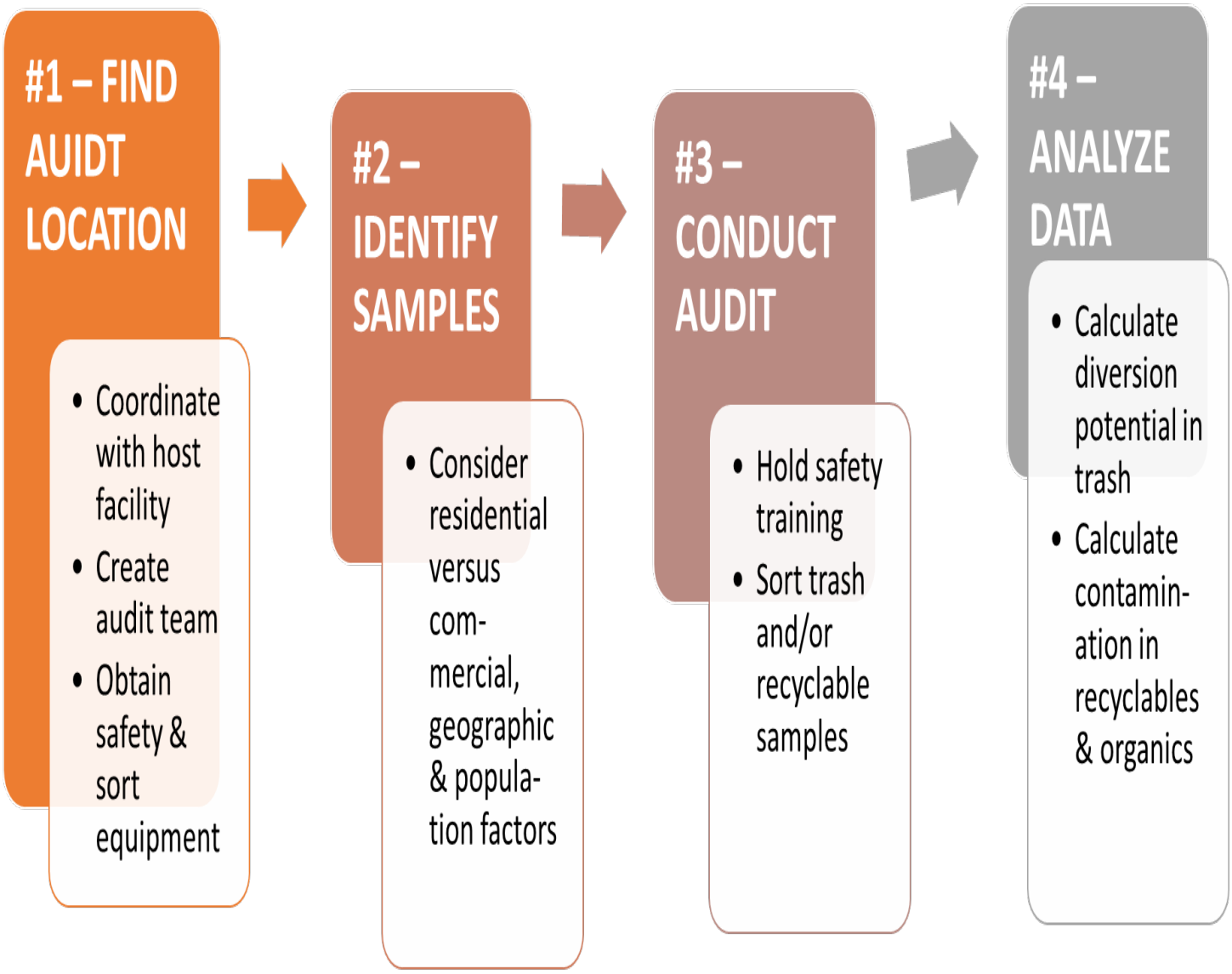
APPENDICES

WASTE AUDIT: THE BASICS

Municipal solid waste (MSW) audits are physical measurements of small MSW samples taken to estimate the composition of the overall MSW stream generated by residents, businesses and institutions in a given project area. Audit results are key to identifying feasible and effective best practices, public messaging and waste diversion successes. The basic components of a MSW audit are illustrated below.



GETTING STARTED

The Municipal Solid Waste Audit Protocol is a guidance document for conducting MSW audits. It has been modified from nationally-established waste composition procedures[i] for the "short" audits typical of Recycling Resource Economic Opportunity (RREO) grant and other small projects. It is intended to provide a standardized, state-wide approach with a sound yet nimble methodology, and results that are comparable across Colorado. This protocol may be used for:

- Trash stream composition – to determine the potential for waste reduction and diversion through both existing and future policies, programs and infrastructure
- Recyclables stream composition – to determine the types of recyclables collected in commingled streams and the potential for addressing contamination

Audits may target one or more of these streams. The protocol will also support an organics stream audit, although these are infrequently required for small Colorado projects.

How to Use this Protocol

The protocol is intended to provide enough information for any grant recipient or project manager to complete an audit. Audit requirements may vary due to sort location constraints, the size of the region and generator idiosyncrasies in urban, mountain and rural areas of Colorado; some adjustments may be needed. Other project and external resources may be available to assist in determining protocol modifications, as well as completion of one or more parts of the audits[ii].

Definitions

Baseline Quantity Data	Annual MSW quantity data (typically expressed in tons/year) generated within the region being audited & including trash & all other streams (e.g.., recyclables, organics, special wastes, etc.) – this data will typically be collected separately from the waste audit (used to estimate diversion potentials & recovery rate)
Density	Relative weight of unit of waste volume (typically expressed in pounds per cubic yard)
Drop Site	Centralized collection facility for recyclables or trash (less common) – can be a collection site only, or a collection site in tandem with a transfer or processing facility
Hauler	Either a public or private MSW hauler who collects MSW curbside from residential, business and/or institutional) generators – haulers "tip" their loads at transfer, disposal or processing facilities
MSW Generator	Residents, businesses and/or institutions that creates MSW for disposal or diversion (generated trash is typically collected curbside by public or private haulers while generated recyclables can be collected curbside or self-hauled to a drop site)
Municipal Solid Waste	That portion of the solid waste stream created by residents and/or commercial entities (the later typically includes businesses, institutions and government buildings but in some rural areas may also agricultural waste collected in mixed loads) – MSW includes trash, recyclables, organics & other materials
Samples	Randomly selected one-cubic yard portions of targeted recyclable and/or trash loads sorted to estimate the overall MSW stream composition – because of different material densities 1 CY of trash will weigh roughly 150-250 pounds, 1-CY recyclables about 100-200 pounds (at least 5 individual samples of either/both material streams should be sorted)
Recovery Rate	Ratio of realized recycling potential (recyclables actually diverted) to the sum or untapped (recyclables placed in trash) & realized recycling potential (expressed as percent by weight)
Recycling Potential	This potential (typically expressed in tons/year) can measure untapped potential, realized potential & total (sum or untapped & realized recycling potential (can also apply to organics)
Targeted MSW Loads	Those recyclable and/or trash loads identified for sorting to provide reasonable representation of the overall MSW stream (can be loads collected by haulers or from drop-site containers)
Tare	Empty weight of a container, truck or vehicle typically subtracted from containerized sample measurements (or gross weight) to obtain true sample weight

Abbreviations

CY	Cubic yard
MSW	Municipal solid waste
OP	Office paper
OTD	Old telephone directories
PET	Polyethylene terephthalate
PPE	Personal protective equipment
RREO	Recycling Resources Economic Opportunity
TPY	Tons per year

Limitations of "Short" Audits

Given the resources available to most small projects, "short" audits that take a snap-shot-in-time of the trash or recycling stream are typically conducted. These short audits necessarily sample only a small number of loads relative to the overall MSW managed in the project area. They also fail to take seasonality into consideration. While "short" audit results are invaluable for informing improved operation or preliminary design parameters for new programming, they should not be construed as being definitively representative of the regional waste stream. Sorting of a larger number of samples over multiple, consecutive seasons would be required to obtain statistically representative composition results: All audit findings should reference this limitation and be used judiciously.

SORT LOGISTICS

Most audits include an evaluation of trash composition, while some include an evaluation of both trash and recyclable streams.

Location

Audits should be conducted at a location(s) that is both safe for audit staff and has access to samples that adequately represent the region. Where MSW from different parts of the region are tipped at different facilities, it may be necessary to conduct multiple audits throughout the region to ensure adequate sample representation.

Trash stream audits should occur at a landfill or transfer station – As trash samples will likely be pulled from different generators throughout the region, sorting should occur at a host facility where mixed MSW loads are tipped by haulers for disposal or transfer. Where multiple potential host facilities are available in the region, selection of the largest facility will facilitate the sampling of more representative loads.

Recycling stream audits may also be sorted at a landfill/transfer station or at drop sites, processing facilities or other recycling collection points – The choice of a recycling host facility will depend on how recyclables are collected in the project area.

Steps for Securing Audit Location:

1. ***Identify potential host facilities – begin with the facility that receives the most MSW waste but include those facilities necessary to sample at least 65% of the project region based on population or MSW tons managed (depending on available data)***

2. ***Visit the host facility(ies) - to verify adequate space, access for sample collection & worker safety (some locations may allow indoor sorting, which can improve sample integrity and staff comfort)***

3. ***Investigate whether the facility can help with sample collection by providing a loader/operator – audit staff can pull samples directly from tipped loads, but this is less safe and may yield less representative samples (especially for trash samples)***

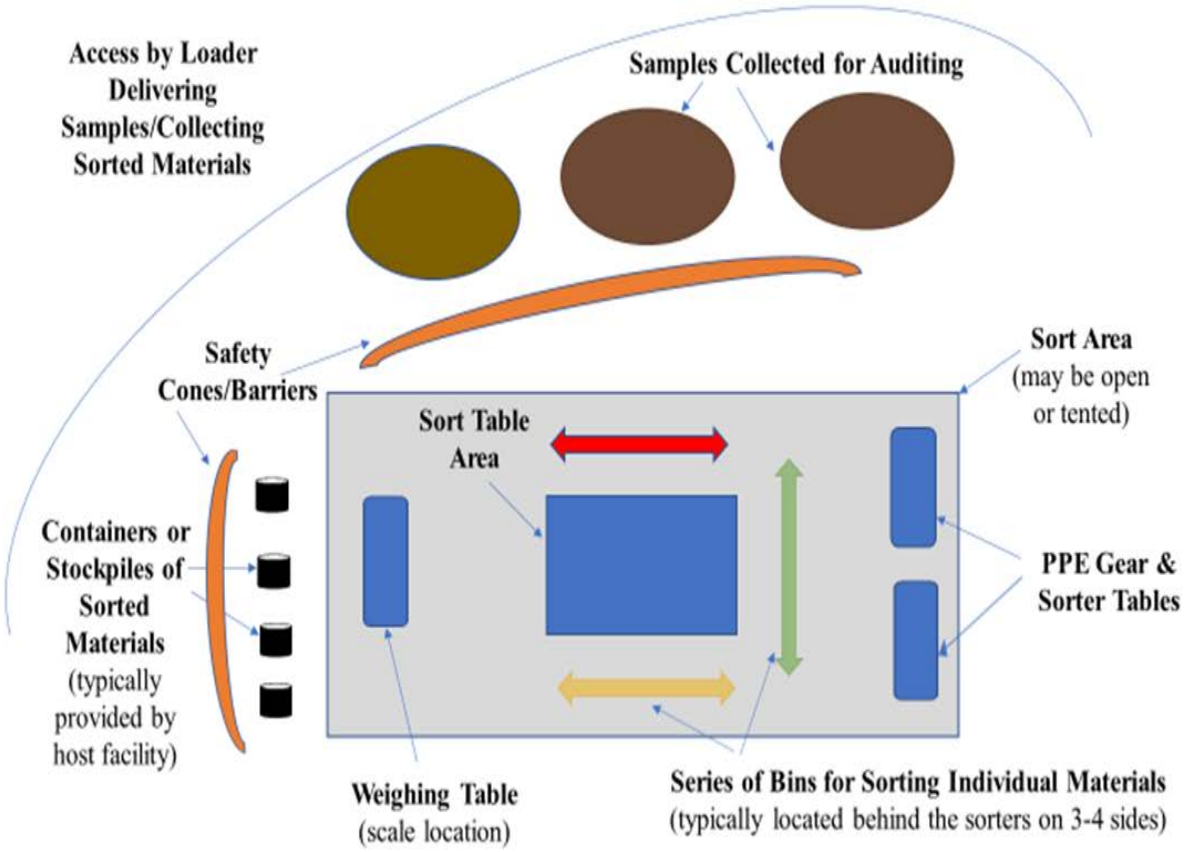
4. ***Coordinate with host facility and haulers – to ensure adequate sample collection***

For some reasons, multiple audit locations may be necessary. An example is the Southwest Colorado Council of Government audit, which conducted separate trash audits at five facilities throughout the region to obtain waste stream sample access from cities

and towns where approximately 70% of the five-county population lived. Conversely, the San Luis Valley Ecosystem Council conducted an entire audit for its six-county project area at the regional landfill, which captures over 90% of the regional MSW.

Sorting Area

The figure below illustrates a typical audit configuration. Photos on the next page show actual layouts of an outdoor and indoor sort. An overall space of about 40' by 40' is ideal and will provide enough room for sample storage, tables, bins, staff access and safe movement of heavy equipment conveying samples in and out of the sort area. Smaller areas may be workable where heavy equipment is not required, and safety zones are not as large.



The sort area should include a large sorting surface that accommodates at least 5-6 sorters. Typically, this will be 2 to 3 banquet tables placed adjacent to one-another by their long sides, covered with a plastic tarp and secured with bungee cords. Another table should be covered and secured for a dedicated data weighing and recording area. One to two tables can also be provided for gear and supplies. Areas adjacent to the sorting area should be assigned for storing samples on the tarped ground prior to sorting and collecting materials after sorting. The photos on the next page show an outdoor (left) and indoor (right) audit layout.

Audit Staff

Some audits will use volunteers or a mix of sorters from different communities and organizations (larger audits may also use temporary labor). In most cases, sorters will have no experience sorting waste and will need initial training and on-going oversight. It will be important for staff to be committed to the entire audit if possible.

All audit staff should:

- ***Be in good physical condition***
- ***Not be sensitive to odors or dust***
- ***Be able to read warning signs or labels***
- ***Be able to take direction***
- ***Have a current tetanus booster & Hepatitis B shot (optional but recommended)***

Each audit should have a supervisor who is familiar with the audit protocol, understands the sort categories and is able to direct other staff - Where available, up to two supervisors can divide duties. Other experienced personnel or consultants familiar with MSW audits can also be utilized.

Ideally there will be a team of 4 to 5 sorters in addition to the supervisor – To complete a five-sample trash audit in a two-day period, there should be 4- to 5-person sort team. If larger audits or simultaneous trash and recyclable audits are conducted, additional teams or a longer audit may be required (see the Sample Selection section for more information). When consecutive audits are conducted for the same project, the ability to retain the same supervisor and soring staff will minimize retraining and provide greater consistency.

Schedule & Duration

Each audit is expected to last the equivalent of two days and will include set up/break down, training and sorting. Most host facilities will prefer that the audits occur between Tuesday and Thursday to avoid busy start- and end-of-week schedules.

Schedule considerations should include:

- Need for high-season samples (with more tourist-related waste) versus low- or shoulder-season samples (with waste primarily from the permanent population) – these apply more to resort areas where a multi-season sort is needed to address seasonal variability
- Holidays – can skew results and should be avoided unless the project is specifically targeting holiday waste (this may include several days before and after the holiday, especially for Christmas)
- Winter audits – while sorts during every season can provide valuable results, sample contamination from rain/snow and sorter discomfort for outdoor audits makes this period less favorable
- Inclement weather – high wind, snow or rain sort days may require postponement of outdoor sorts

In some instances, sort set up and initial sample collection may be necessary the day before the audit begins to access to targeted sample loads – For example, some host facilities do not receive hauler loads before late morning, which could delay the sorts. Samples pulled from targeted MSW loads must be well documented, labelled and secured overnight under tarps to minimize impacts from animals, wind and precipitation.

Equipment

The audit equipment list (next page) includes the equipment and supplies needed for each audit. Most items in Table 1 can be purchased at local hardware or box stores (e.g., Ace Hardware, Target, Home Depot, Harbor Freight, etc.). In some cases, equipment can be borrowed from audits previously conducted by others (contact CDPHE for suggestions – see the References & Resources section).

The equipment tabulated on the previous page typically doesn't require long lead times to obtain. Exceptions include:

Table, chair and tent rental should be coordinated in advance – Local rental companies can be scarce;

- Tents are optional – but recommended for outdoor audits to protect samples and sorters (these can add significant expense)
- Typical tent dimensions are 20' by 20' – side flaps may be used but add cost and can be problematic in high winds
- Flies/tarps can be used to cover discrete areas – see staff tent example (see the picture at left following the equipment list)

Equipment List

(based on 5-6 total workers)[a]

Item	Number for Trash Audit	Number for Recyclables Audit	Description	Comments
20’ by 20’ Tent Canopy	1	1	Rental (optional)	
6’ by 30” Tables	5-6	5-6	Rental or borrowed	
Chairs	5-6	5-6	Rental	
Large Sample Barrels	2	1	Large heavy barrels (~ 44-gal)	For moving sample portions to tables (“Brutes” from Home Depot or similar)
Medium Sort Bins	50	30	Light to medium (~18-gal)	Can be mix of solid & perforated (i.e., laundry basket) - at least 20 must be solid
Small Sort Bins	20	5	5-gal pails	For low-quantity materials
Materials Signs	1 set	1 set	Sealed in plastic	To label sample containers
Loader & Driver	1	Optional	Ideally 1-CY bucket or grapple	Larger bucker makes sampling difficult
Plastic Tarps	15-20	6-8	10’ x 12’ or larger with grommets & zip ties	To protect samples & cover sort tables (few tarps for recyclables as minimal organics)
Bungee Cords	8 4’ long cords			To secure tarps to sort tables
Hand Sorting Tools	Plastic or metal garden tongs (2/sorter) & hand rakes (1/sorter)			
Platform Scale	1	1	150-lb/0.05 increment	Portable, digital display, rechargeable
Back-Up Scale &	1	1	Optional	Simple bathroom scale
Magnets	1	1		For sorting, ferrous metals
1-Inch Minus Screen (optional)	1	1	Optional for screening residue	May need to be fabricated from wire mesh & wood frame materials
Small Cones & Markers	5-6	5-6	6” height	For labelling samples – can be reused
Large Cones	8-10	8-10	Should be available from landfill/transfer station	To cordon off safe working area & anchor samples in high wind
Gloves & Liners	Puncture resistant gloves & Latex liners			At least 1 pair of gloves/sorter-day
Tyvek Coveralls	Varying sizes (these run small)			At least 1/sorter-day
Face Masks	2-3/sorter-day			
Hats, Vests, Glasses. Ear Plugs	1 each/sorter – may wear their own eyeglasses/sunglasses instead of safety glasses			
First Aid & Sanitizers	1 first aid kit & 2-3 hand sanitizers			
Fire Extinguisher	1	1		For liquid & electrical fire control
Eye Wash Solution	2 bottles	2 bottles	Saline	To supplement facility’s emergency eyewash/shower
Portable Eyewash	1	1	Minimum 16-gallon, meets ANSI Z358.1-2009	For spills in face, eyes, body
Rakes & Shovels	2-3 each		Bow rakes & wide pan shovels	To maintain & clean site
Miscellaneous	Laptop computer, sealed gallon jug of water, small hand brush, duct tape, black Sharpie markers, scissors or plastic cutters, paper towels, camera, water for flushing injuries, beverage & snacks			

[a] Assumes separate trash and recyclables sorts with no overlapping equipment – if both audits are conducted for the same project, some equipment can be used for both (e.g., bins if cleaned between uses, hand tools, scale, magnet, cones, fire extinguisher, rakes/shovels)

Scales can be challenging to obtain and maintain functionality – They must be tested regularly (see example weighing station/scale in the photo above, right);

- Should be recalibrated as needed (see manufacturer's instructions)
- Should be checked during the audit with an unopened one-gallon jug of water (which should weigh 8.34 pounds)
- Batteries should be charged overnight before each audit day

Emergency Eyewash/Shower – These units are rarely needed but critical safety gear that may/may not be provided by the host facility. Table 1 includes saline that can be used for spills in the face or eyes (see safety supplies in the photo below). For larger spills, most host facilities have a gravity-fed eyewash and/or shower unit. If not the case, a portable eye wash unit can be purchased on-line[iii] and filled with potable water prior to use.

SORT SAFETY

Prior to beginning of any sort day with new staff, the supervisor should lead the audit sorters through a training session to ensure that all sorters are properly prepared and informed. The training agenda should include a thorough explanation of the safety equipment and location, safety and sorting procedures.

All audit staff should review this section prior to participating in the audit – This review will facilitate on-site training and reduce the risk from typical waste sort hazards.

Potential Sorting Hazards

Waste audits pose potential health and safety hazards. Sorters may encounter hazardous materials such as pesticides, herbicides, solvents, paints, explosives, hypodermic needles and broken glass. While the quantity of hazardous material that sorters may encounter during waste studies is relatively small, the potential health and safety risks associated with some types of waste can be significant.

All hazards should immediately be brought to the attention of the supervisor. If the potential exists for worker injury, the supervisor should clear the area and notify local response agencies as appropriate. Such occurrences include, but are not limited to, any spill that is large, emits an odor, foams or otherwise appears unstable; fires; bombs; or personal injuries requiring medical attention.

Most Frequently Encountered Hazards:

- ***Hypodermic needles and other sharp objects***
- ***Sprains and muscle strains from heavy lifting***
- ***Inhalation of, ingestion of, or direct contact with hazardous substances***
- ***Puncture wounds***
- ***Injuries involving moving vehicles***
- ***Noise exposure***
- ***Slips, trips, and falls***
- ***Fires***

Safe Sorting Procedures

The risks associated with waste studies can be minimized by carefully following safety guidelines described below. Critical work practice controls that should be followed by all audit staff are described on the next page.

All waste should be handled as if it were hazardous - Sorters should not allow waste to contact bare skin, inhale waste or handle waste without wearing personal protective equipment and practicing the proper procedures outlined in this plan. The supervisor will be responsible for ensuring that the sorters wear the appropriate equipment and follow safe sorting procedures. A first aid kit and fire extinguisher should be available during the sort.

Proper housekeeping and handling of waste is an on-going requirement – The supervisor should manage any biohazardous or hazardous waste that is encountered or suspected. Biohazardous waste should be placed in a plastic bag, tied, weighed, and recorded as medical waste. The supervisor should notify the host facility that biohazardous or hazardous waste has been received and allow it to manage these materials according to their existing procedures.

Work Practice Controls

Containers or other items weighing more than 25 pounds should be lifted on and off the ground and scale by two sorters
Sorters should step around solid waste when sorting on tarps to avoid slipping and falling
Sorters should not wear contact lenses during sorting activities since, in the event of a chemical spill, chemicals can become trapped behind lenses causing serious eye injuries
Tongs and hand rakes should be used to separate and remove all objects from waste sample
Sort large pieces of glass first, then remove clear glass – never use hands to sort
No capped, closed or sealed waste items should be opened to minimize hazards associated with contents (many loads will include bagged waste, however, which should be opened & sorted unless signs of danger identified above are noted)
No batteries will be removed from any product
Syringes or suspicious materials (including any materials with red staining, red-bagged waste, containers taped together, or an unusual amount of ammonia bottles, cold capsules or similar container; these items may indicate methamphetamine paraphernalia) shall be managed by the supervisor only
Other potentially hazardous and special waste materials should be moved to hazardous/special waste basket using shovel (preferred) or hand tools
Sorters should work from tables instead of ground whenever possible (especially for trash samples)
Sorters shall stay inside the coned areas that indicate a separation from dangerous activity
Sorters should not operate motorized equipment under any condition
A “line-of-sight” buddy system should always be used – the supervisor should pair audit staff during training
Rest and refreshment breaks should be taken as needed to maintain hydration – but no drinking or eating should occur in the immediate vicinity of sort location
No smoking in the sort area – most host facilities will similarly restrict or prohibit
Remove all disposable clothing and gear at the end of each audit day – dispose with other trash materials

Personal Protective Equipment (PPE)

Sorters' clothing should provide maximum protection from the risks associated with hazardous waste. Safety and protective equipment worn during the audits should not be worn off the site to eliminate the possibility of contaminating sorters' automobiles and homes.

PPE includes:

- ***Over-the-ankle boots (hard plastic shanks and steel toes recommended***
- ***Cotton work clothes, including long trousers (not shorts)***
- ***Plastic coveralls (optional)***
- ***Safety glasses or face shields (optional)***
- ***Safety vests – <u>these are required for all audit staff during all audit activities</u>***
- ***Hard hats (optional)***
- ***Filter masks and ear plugs (optional)***
- ***Thick outer gloves***
- ***Inner liner gloves to minimize solid or liquid waste exposure when putting on and removing the outer gloves (optional)***

Guidelines for Avoiding Hazards

To minimize risk of infection through ingestion, inhalation, or direct contact with hazardous or infectious substances, all eating, drinking, applying lip balm/lotion and similar activities are prohibited on site until hands and forearms are thoroughly washed with soap and water or waterless cleansing lotion - The most likely routes of exposure to infectious or hazardous substances are ingestion and inhalation. Exposure by ingestion can be controlled through proper work practices (i.e., no eating or drinking while sorting) and good personal hygiene (i.e., control of hand-to-mouth activity while on site). Exposure by inhalation can be reduced through proper use of filter masks.

Direct skin contact with hazardous substances can be controlled by proper hand washing practices and by consistent use of coveralls, gloves, boots, and other personal protective equipment. If a hazardous substance meets skin, the area should be flushed with water and appropriate medical care should follow (face and eyes should be flushed with saline). The supervisor should direct affected sorter(s) to the host facility's shower area, if available and appropriate.

Eyes are particularly vulnerable to caustic dusts and vapors. Safety glasses or face shields must be worn to reduce the risk of eye injury. Contact lenses should not be worn during sorting activities due to the potential hazards of dust and chemical exposure. Precautions should be taken to ensure that sorters do not generate unnecessarily high levels of dust in the air while sorting. Sorters should not open unidentified containers that may expose their eyes, skin, or lungs to vapors, dusts or mists. If eyes are exposed to a hazardous substance, the eyes should be thoroughly flushed at the sort location before

an additional 15-minute flush using the emergency eyewash/shower equipment with saline. Appropriate medical care should follow.

Waste materials may contain broken bottles, hypodermic needles, medical wastes and other sharp objects that can cause puncture wounds - Gloves, safety shoes with steel shanks and proper handling will reduce the likelihood of puncture wounds. Small cuts must be cleaned immediately with antiseptic and bandaged to reduce the risk of infection.

To reduce the risk of slipping and falling onto sharp objects, sorters should minimize stepping on or over waste samples. To protect hands from puncture wounds, small hand rakes should be used to separate and remove dangerous items from waste samples.

To avoid injuries involving moving vehicles the supervisor will oversee the delivery of waste samples to the sorting area and ensure that all sorters are at least ten feet from the delivery equipment - Host facility vehicle operators are instructed in advance to deliver samples only by the supervisor. Only authorized delivery vehicles should be permitted in the sorting area. All sorters are restricted to the immediate area around the sorting table. The supervisor should secure MSW load data directly from the delivery vehicle drivers.

To avoid back and muscle strains, small portions of each sample should be raised and lowered as few times and for as short a distance as possible - Each trash sample will weigh 150 to 250 pounds (recycling samples will be slightly less), and sorting activities involve manually moving the material several times before it is finally discarded. Bags, barrels, and other objects weighing more than 25 pounds should be lifted by two or more sorters or divided into smaller loads, if possible.

When lifting, the following guidelines should be followed:

- Maintain the natural curves of the spine by keeping the head and chest high, the chin tucked in and the back arched
- Bend the hips and knees
- Stand diagonally (one foot ahead, one foot behind) for a wide, balanced base of support
- Keep the abdominal muscles tight when lifting to help take pressure off the spine
- Consciously lift with the legs - straighten knees and hips at the same time while keeping stomach muscles tight so that the strongest muscles of the legs do the work
- Move smoothly in a well-planned, deliberate manner - be certain of good foot traction and good grip on the object, do not jerk the load since jerking increases stress on the back
- Avoid twisting when lifting - twisting increases stress on the spine, lift straight and then turn the entire body if a directional change is necessary, pivot on the feet instead of at the waist
- Avoid lifting above the shoulders
- Sort samples on a table to eliminate excess stooping and bending

If working close to heavy equipment, high noise levels may pose a risk - Earplugs should be provided to protect sorters' hearing and should be worn while working in noisy areas. Earplugs are designed to permit spoken communication while filtering out ear-damaging frequencies. Sorters who wear hearing protection will be less tired at the end of the day than those who do not wear ear protection.

The sorting area can become slippery for a variety of reasons - While sorting, sorters should refrain from walking to the other side of the table to place material in a container. Instead, the material should be given to a person who is on the other side of the table so that they can place the material in the appropriate container. This procedure will save time and reduce the risk of accidents.

No smoking is allowed in the sorting area to avoid the chance of fire - Most host facilities will only allow smoking in restricted areas, it at all. In the event of a small fire in sort area, it should be extinguished using the fire extinguisher. In the event of a larger facility fire, all sorters should immediately stop sorting activities and follow the direction of the host facility.

Emergency contacts should be available for any applicable staff, agency, organization or labor company manager – A route map with written directions should be available for the nearest emergency care center.

SAMPLE SELECTION

The objective of the audit sample selection process is to obtain samples from targeted MSW loads that provide the best representation of the overall MSW stream in the project region.

How to Target MSW Samples

1. ***Identify which haulers tip trash/recyclables at the audit location and;***
   - ***What geographic areas loads will be collected from***
   - ***If routes will be residential, commercial or mixed (for any commercial identify if retail, grocery, restaurant, lodging, office, school, health facility, etc.)***
   - ***Recyclables sorts may be collected from drop-site containers or tipped loads at processing/transfer facilities***
   - ***Appendix A includes a Pre-Sort Hauler Survey Form to compile data (this is an optional tool)***

2. ***Also consider using existing information on cities/towns/ unincorporated county areas to target the approximate number of samples from each geographical area;***
   - ***See example on the next page***
   - ***Annual landfill quantities can also be used (available from CDPHE at https://www.colorado.gov/pacific/cdphe/swreports***

3. ***Determine which loads to target for sampling;***
   - ***This will require strategic selection to obtain samples that provide the best representation across the project area***
   - ***For recyclables sorted at drop sites, targeting may be limited to random drop-site containers or even in-coming carloads***

4. ***Determine baseline quantity data for MSW streams;***
   - ***Baseline quantity data will usually be collected separately from the audit but will provide important information for interpreting audit results***
   - ***Quantities will ideally be determined for the previous full calendar year and broken into trash & diverted streams (including but not limited to commingled & source-separated reused/recycled materials and donated/composted organics)***

Example Sampling Plan
(Upper Arkansas Area Council of Governments sort)

County	Population	Audit Location	Primary MSW Haulers	Number of Samples	Key Generators
Chaffee Salida Unincorporated	18,600 5,400 9,500	Chaffee County Landfill	Waste Management	3 to 4	Salida, Buena Vista, Buena Vista Correct-ional Facility, Unincorporated
Custer Westcliffe Unincorporated	4,500 600 3,200	Oak Disposal Facility	Oak Disposal	2	Westcliffe, Unincorporated
Fremont Canon City Florence Unincorporated	46,600 16,200 3,800 24,500	Fawn Hollow Transfer Station	Howard Disposal, City of Florence, USP Florence Admax Prison	Fawn Hollow – 4 to 5; CCI – 1 to 2	Canon City, City of Florence, Unincorporated; Dept of Corrections/CCI
Lake Leadville Unincorporated	7,500 2,600 4,700	Lake County Landfill	Waste Management	2 to 3	Leadville, Unincorporated
Total				12 to 16	

Number & Weight of Samples

A minimum of five trash and five recyclable (if a recyclables audit is conducted) samples should be sorted for each audit. The table below summarizes the expected volume and weight metrics associated with these samples. These values are based on approximate ranges published by the USEPA[iv] and can vary greatly as a function of actual stream content; they are provided here are a general guideline only.

Material	Density Assumption	Volume	Weight	Total Sample Size Weight	Number of Sorters for Two-Day Sort
Trash	150-250 pounds/CY	1 CY	150-250 pounds	Approx 1,000 pounds (minimum = 5 samples)	Approx. 5-6
Recyclables	200-300 pounds/CY	1 CY	100-200 pounds	Approx 750 pounds (minimum =5 samples)	Approx. 2-3
Organics (optional)	300-500 pounds/CY	1 CY	300-500 pounds	Approx 1,000-1,500 pounds (minimum = 3 samples)	6 or more

Where the suggested total sample size weight is not met with the minimum number of five samples, additional samples should be sorted. Additional samples should also be sorted if there are adequate resources or if the initial sample integrity/number is in doubt (more information is provided in the Sort Protocol section).

Sample Description

Comprehensive information verifying the source and mix of each targeted MSW load is critical to the integrity and interpretation of audit results. The supervisor should

document the following at the top of each Sample Field Log (see Appendix B); an example log for a recyclables audit is shown below. Sample description data (shown in the circled area) should include:

- Recorder – who observed the sample selection and logged audit results
- Hauler company, driver name & vehicle number – in case post-audit follow-up is needed (this and the following information may require a short driver interview)
- Sample collection locations – the facility/area where the audit is conducted
- Waste origin - such as residential, commercial or mixed waste sources (with as much description on regional areas/neighborhoods, businesses/schools, etc. as possible)
- Other comments that may impact the sample or audit results – such as weather, difficulty collecting the sample or unusual observations

RECORDER: lbs	DATE/TIME: 3/26 4 pm	HAULER & DRIVER: WM - James	VEHICLE NUMBER: WM # 312		SAMPLE NO. #1
COLLECTION LOCATIONS: Washington St. Transfer Station					
RESIDENTIA Mostly	COMMERCIAL? Some	MIXED?	OTHER (describe): Mostly residential carts but one dumpster from strip mall on 7th (book store, gas station & deli)		

MATERIALS	TYPE OF CON-TAINER	TARE	GROSS WEIGHTS (from multiple bin measurements within the same sample)								NET WEIGHT CALCULATIONS (these columns are locked for automatic calculations)								TOTAL NET WEIGHT	% BY WEIGHT
			1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8		
Glass Conta	Medium	3.0	8.0	23.0	15.0	11.0					5.0	20.0	12.0	8.0	0.0	0.0	0.0	0.0	45.0	**20.4%**
Aluminum	Medium	3.0	4.0	6.0							1.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	**1.8%**
Steel/Tin	Medium	3.0	4.0	5.0							1.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	**1.4%**
#1 Bottles	Medium	3.0	4.0	3.0	4.0	3.0					1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	2.0	**0.9%**
#2 Bottles	Medium	3.0	5.0	4.0	4.0	3.0					2.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	4.0	**1.8%**
Non-Bottle	Medium	3.0	6.0	8.0							3.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	**3.6%**
Bulky Rigids	Medium	3.0	11.0								8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	**3.6%**
Styrofoam	Medium	3.0	5.0	3.0							2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	**0.9%**
Cardboard/	Medium	3.0	9.0	10.0	12.0	23.0	17.0				6.0	7.0	9.0	20.0	14.0	0.0	0.0	0.0	56.0	**25.3%**
Newspaper	Medium	3.0	6.0								3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	**1.4%**
Office Pape	Medium	3.0	8.0	4.0							5.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	**2.7%**
Chip/Paper	Medium	3.0	4.0	5.0	4.0	6.0					1.0	2.0	1.0	3.0	0.0	0.0	0.0	0.0	7.0	**3.2%**
Junk Mail/A	Medium	3.0	10.0	7.0	12.0	6.0					7.0	4.0	9.0	3.0	0.0	0.0	0.0	0.0	23.0	**10.4%**
Magazines	Medium	3.0	26.0	8.0							23.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	28.0	**12.7%**
Contamina	Medium	3.0	8.0	6.0	11.0	9.0					5.0	3.0	8.0	6.0	0.0	0.0	0.0	0.0	22.0	**10.0%**
TOTALS											73.0	53.0	41.0	40.0	14.0	0.0	0.0	0.0	**221.0**	100.0%

NOTES:	
	Bulky rigids = mostly plant pots
	Heaviest cardboard weights had wet cardboard (some with food contamination)
	Junk mail = had a few telephone directories (new phone books just out)
	Contamination = some dirty paper towels (looks like commercial waste, possibly from gas station rest room)
	(see photographs of contaminated bins taken before weighing)

One log must be completed for each sample and will allow compilation of all the bin measurements for that sample. As there will be five or more samples for each audit, there will be five of more field logs. The logs will subsequently be used to record sorted material weights. Two blank field logs are provided with this protocol and can be copied to meet the needs of each audit.

MATERIALS TO BE SORTED

The recommended material sort lists for trash and recyclables are provided on the following pages. These lists may be adjusted to accommodate information needs in the project area, although these core materials are recommended to support composition results and comparable waste composition data state-wide (additions or deletions may require revisions to the field logs and analytical models). Slight adjustments can be made in the field by the supervisor, if needed, to ensure that the same materials are sorted from all samples during each audit and for any audits within the same project area.

Key Sort Considerations

Supervisor should be familiar with the materials sort lists, train sorters & maintain sort consistency throughout audit – these responsibilities may be assisted by other experts or consultants as needed	In addition to reviewing the tables, it is recommended that the supervisor practice sorting household trash or other small samples prior to the audit
Supervisor shall oversee sorting	Supervisor should make all final sorting decisions when questions arise
Sort bagged waste – many sample items will be bagged (often in grocery & trash bags)	Bags should be emptied to allow sorting of contents – all plastic bags should be sorted as plastic film, bags & wrap unless there are signs of hazards (see the Safety Plan section)
Sort composite items that include a mix of materials (& are not specifically described in the material sort lists) as that material with the apparent greatest weight	For example - metal picture frames may be sorted as metal (despite glass & paperboard backing); toys sorted as other plastics (despite metal components); cleaning products as miscellaneous hazardous/special waste (despite plastic containerization)
Sort the contaminated materials in any recyclables (or organics) samples to identify the top three or four contaminants	This should be based on materials in the Trash Material list – for example ♦ Recyclables contaminates may primarily be Styrofoam & other plastic ♦ Organic contaminants may be paper towels & compostable service ware
Adequately describe any materials sorted into "other" trash (all other glass, all other metal, all other plastic, all other paper, all other organics, miscellaneous hazardous/special waste, residue) & recyclable contaminants	There should be a written description & photos of any "other" materials
Supervisor shall determine when sample is fully sampled & how to measure remaining residue ♦ Will include mix of small materials – generally <1-inch that are indistinguishable ♦ Should include less than 10% of the sample	♦ Typically, residue should be collected & measured as a separate category – visual observations concerning content will be made ♦ Some audits may include sorting of residue with a 1-inch minus screen (see General Sorting Protocol section)

Trash Material Categories & Description

Materials	Description	Sort Bin (see Equip-ment List)
GLASS		
Glass Food & Beverage Containers	All colors of food & beverage bottles, jars & containers – NO LIDS	Medium
All Other Glass	Glass-only materials that don't fit above including mirrors, window/auto glass, ceramic, porcelain, glass cookware, drinking glasses, light bulbs COMPACT FLUORESCENT BULBS sorted as MISCELLANEOUS HAZARDOUS/SPECIAL WASTE	Small & Solid
METAL		
Aluminum Food & Beverage Containers, Foil & Pie Tins	Aluminum, tin, steel & bi-metal beverage & food cans, soft drink & beer cans, foil, food trays and pie tins – NO LIDS	Medium
Steel/Tin Food & Beverage Cans & Containers	Tin, steel & bi-metal beverage & food cans, also empty aerosol cans (nozzles are ok but no lids) EMPTY METAL PAINT CANS sorted as OTHER METAL AEROSOL CANS CONTAINING PRODUCT sorted as MISCELLANEOUS HAZARDOUS/SPECIAL WASTE	Medium
All Other Metal	Metal-only materials that don't fit above - coat hangers, cook pots, non-food containers, copper tubing, brass fittings, piping, metal appliances, all scrap metal & items that are primarily metal including metal container lids/caps	Small
PLASTICS		
PET Plastic Bottles #1	Clear or white #1 bottles – NO LIDS OR CAPS	Medium
HDPE Plastic Bottles #2	Colored or natural #2 bottles - NO LIDS OR CAPS	Medium
Non-Bottle Plastic Containers #1-#7	Resin #1-#7 plastic jugs, jars, tubs, cups, trays, non-Styrofoam clamshells & other containers labelled with triangulated resin code #1 & #2 BOTTLES sorted as PET #1 or HDPE #2	Medium
Bulky Rigid Plastics	Non-container toys, furniture, laundry baskets, buckets, pails, flower pots, etc. – NO ELECTRONIC TOYS	
Plastic Film, Bags & Wrap	Non-rigid plastic grocery & trash bags, plastic sheeting, tarps, etc. BUBBLE WRAP sorted as OTHER PLASTIC	Medium & Solid
Styrofoam	Styrofoam (extruded polystyrene foam) packaging, clamshells, food containers, foam cups, coolers, foam egg cartons, etc.	Large
All Other Plastic	Plastic-only materials that don't fit above including foil-lined chip bags, plastic caps/lids, straws, CD/VHS tapes, plastic cutlery/plates, hoses, toys and plastics lacking triangulated resin code	Medium
PAPER		
Cardboard & Brown Paper Bags	Corrugated (waffled, multi-layer) cardboard, Kraft paper/bags, pizza bags with minimal food/grease – WAXY COATED IN OTHER PAPER	Medium
Newspaper	Newspaper with all inserts and glossies MAGNETS sorted as OTHER METAL SAMPLE PACKETS as OTHER PLASTIC	Small
Office Paper	"High" grade paper including whole or shredded printer paper, typing paper, copy paper, colored paper, computer paper, sticky notes, envelopes with windows, wrapping paper, brochures, file folders PAPER WITH WAXY LINERS sorted as OTHER PAPER BUBBLE TYEK ENVELOPES sorted as OTHER PAPER	Medium & Solid
Chipboard/Paperboard	Non-corrugated (single layer) cereal, cracker boxes, paper egg cartons, gift & shoe boxes, paper/toilet paper rolls, etc. WAXY COATED sorted as OTHER PAPER	Medium
Junk Mail, Aseptic Containers & Other	"Low" grade paper including junk mail, telephone books, paperback books Multi-layered waxy milk/drink cartons, gable-top juice/soup boxes, tofu/ice	Medium & Solid

	creams/frozen yogurt cartons	
Magazines/Catalogues	Including all glossies	Medium
Compostable Paper	Paper products contaminated <25% with food waste or moisture including pizza boxes, napkins, paper towels, hot/cold to-go paper cups	Medium
All Other Paper	Microwave trays, any foil-lined paper, waxy cardboard, carbon paper, neon/bright paper, photographs, waxy coffee cups	Medium & Solid
ORGANICS[b]		
Food Waste	All food/beverage waste including bones & rinds, coffee ground, paper products contaminated >25% with food, any food or liquids that can be dumped from other containers without removing lids or caps DO NOT REMOVE ANY LIDS, CAPS OR SEALS OR OPEN CLOSED CONTAINERS	Medium & Solid
Yard Waste	Grass, leaves, weeds, pruning, stumps, shrubs, plants, etc.	Med & Solid
Clean Wood	Unpainted or untreated wood, pallets, dimensional lumber, crates, furniture TREATED WOOD/PLYWOOD/ENGINEERED WOOD sorted as MUNICIPAL C&D	Medium & Solid
All Other Organics	Organic-only materials that don't fit above - carpet & padding, diapers, compostable service ware[a], rubber products, upholstery, animal foods & waste, combustibles including wax, soap, briquettes, ash, etc.	Medium & Solid
OTHER WASTES		
Textiles	Clothing, shoes, rags, towels, leather, blankets, curtains, carpet, carpet padding, upholstery, wallets, purses, rugs other than carpeting, etc.	Medium
Electronics	Electronics with circuit boards including computer monitors, televisions, VCR or DVD players, portable music devices, cell/wireless phones, answering machines, digital cameras, electric razors, newer small household appliances TOASTERS, TOASTER OVENS, OLD/SMALL HOUSEHOLD APPLIANCES sorted as OTHER METAL	Small
Household Batteries	All AA, AAA, C, D and 9-volt batteries LEAD-ACID VEHICLE BATTERIES as MOTOR VEHICLE WASTE DO NOT REMOVE BATTERIES FROM ANY PRODUCT	Small
Paint	Latex and oil paint EMPTY METAL PAINT CANS sorted as OTHER METAL	Small
Motor Vehicle Waste	Automobile/lead-acid batteries, used oil, used filters, tires	Small
C&D Debris	C&D demolition/building debris including painted/treated wood, drywall, fiberglass, insulation, sawdust, etc. & road/bridge debris including rock, concrete, brick, soil, etc. ALL NON-CONTAINER METAL sorted as OTHER METAL PAINT/PAINT SUPPLIES sorted as PAINT	Medium
Miscellaneous Hazardous/Special Waste	Other hazardous materials that don't fit above including compact fluorescent bulbs, other consumer products, furniture, mattresses & box springs, electronics or similar devices without circuit boards (such as headsets), thermostats, smoke detectors Antifreeze, pesticides, herbicides, cleaners, adhesives, glues, explosives, asbestos, aerosols with product, cosmetics, household chemicals, fuels Medicines, medical/biohazard waste Other hazardous materials or materials that require special handling	Small & Solid
RESIDUE	Sand, soil, dirt, inorganic materials not classified elsewhere, mixed MSW fines, recyclables, organics & other materials that are indistinguishable	Medium

[a] Compostable service ware should be designated or easily identified as compostable – see https://ecocycle.org/files/pdfs/Compostable_Food_Serviceware.pdf and similar sources for additional information

[b] An organics audit (if any) should sort for all the organic materials in this category as well as Compostable Paper & Service ware (see the Paper category) – the audit should also measure Contaminants

Recyclable Material Categories & Description

Materials	Description
GLASS	
Glass	All colors of food & beverage bottles, jars & containers – NO LIDS
METAL	
Aluminum Food & Beverage Containers, Foil & Pie Tins	Aluminum, tin, steel & bi-metal beverage & food cans, empty aerosol cans, foil, food trays and pie tins – NO LIDS
Steel/Tin Food & Beverage Cans	Tin, steel & bi-metal beverage & food cans, also empty aerosol cans (nozzles are ok but no lids) - EMPTY METAL PAINT CANS sorted as OTHER METAL - AEROSOL CANS CONTAINING PRODUCT sorted as MISCELLANEOUS HAZARDOUS/SPECIAL
PLASTICS	
PET Plastic Bottles #1	Clear or white #1 bottles – NO LIDS OR CAPS
HDPE Plastic Bottles #2	Colored or natural #2 bottles – NOT LIDS OR CAPS
Non-Bottle Rigid Plastic Containers #1-#7	Resin #1-#7 plastic jugs, jars, tubs, cups, trays, non-Styrofoam clamshells & other containers labelled with triangulated resin code #1 & #2 BOTTLES sorted as PET #1 or HDPE #2
Bulky Rigid Plastics	Non-container toys, buckets, furniture, flower pots, laundry baskets, etc. that are mostly metal – NO ELECTRONIC TOYS
Styrofoam	Styrofoam (extruded polystyrene) packaging, clamshells food containers, foam cups, coolers, foam egg cartons, etc.
PAPER	
Cardboard & Brown Paper Bags	Corrugated (waffled, multi-layer) cardboard, Kraft paper/bags, pizza bags with minimal food/grease – WAXY COATED IN OTHER PAPER
Newspaper	Newspaper with all inserts and glossies - MAGNETS sorted as OTHER METAL SAMPLE PACKETS as OTHER PLASTIC
Office Paper	"High" grade paper including whole or shredded printer paper, typing paper, copy paper, colored paper, computer paper, sticky notes, envelopes with windows, wrapping paper, brochures, file folders - PAPER WITH WAXY LINERS sorted as OTHER PAPER BUBBLE TYEK ENVELOPES sorted as OTHER PAPER
Chipboard/Paperboard	Non-corrugated (single layer) cereal, cracker boxes, paper egg cartons, gift & shoe boxes, paper/toilet paper rolls, etc. WAXY COATED sorted as OTHER PAPER
Junk Mail, Aseptic Containers & Others	"Low" grade paper including junk mail, telephone books, paperback books Multi-layered waxy milk/drink cartons, gable-top juice/soup boxes, tofu/ice creams/frozen yogurt cartons
Magazines/Catalogues	Including all glossies
CONTAMINANTS	All other glass, metals, plastic (including plastic bags/film), paper; all organics; all other waste; and all residue

Recyclables will generally be sorted in medium-sized sort bins
Contaminants should be further assessed – using the Trash Material list – to identify the top 3 or 4 contaminants

SORT PROTOCOL

Load Delivery & Sampling

Where the host facility can provide a loader and operator to assist with the audit, audit samples will be taken from targeted MSW loads tipped at the facility by haulers - As tipped, loads generally form a windrow-shaped pile (see photos of targeted hauler loads tipped at transfer stations below - outdoors at left, indoors at right).

Recyclables may be sorted at drop sites – Recyclables and trash (less commonly) sorted at drop-site locations may be pulled from drop-site containers or incoming cars under the direction of the audit supervisor. These will likely include a mix of bagged and loose recyclables.

Random samples should be selected from targeted MSW loads - The supervisor should provide direction on which sections of each load will be sampled. For example, the load should be visualized in four even quarters and vertical direction (to avoid collecting all heavy materials on the bottom) as shown on the next page. A typical strategy would be to sample every load tipped on the first half-day from the first quarter, from the second quarter on the second half-day and so on. Generally, one sample will be taken from each load. Recyclables audits conducted at drop sites may apply a similar approach to random drop site container sorting.

1 (ground level)	2 (mid-level)
3 (mid-level)	4 (top level)

Samples should be transferred to the sorting area and placed on a tarp to minimize the mixing of soil with loose waste. During wet weather or if stored overnight, the samples should also be covered with a tarp and secured.

Each sample volume should be about one cubic yard and five samples of each audited stream should be sorted – As described in the previous section, these volumes will correlate to different weights depending on the material being audited and external factors such as moisture and wind. To ensure that the minimum total sample size is obtained, total net sample weights should be tracked during the audit. Additional samples may be required if this total is low (which is more often the case than being too high).

Obtaining a 1-CY this volume will be facilitated by use of a bucket loader (see photo below) that is 1-CY in size – a variable that will be determined by the host facility. When smaller or larger buckets are used, the supervisor will need to estimate 1-CY sample size (smaller buckets will require pulling more than one sample from the load while larger buckets will be only partially filled).

Manual Sample Sorting

Materials will be sorted by manual separation and measurement, supported by visual observation.

1. Trash sample material should be transferred in small increments (less than 25 pounds) from the tarps to the sort tables using the large, heavy-duty barrel (see photo below). Once the contents are emptied onto the table, empty garbage bags shall be sorted as plastic film/bags/wrap. If any sample appears excessively large (i.e., greater than 300 pounds of trash or 200 pounds of recyclables by visual observation), the supervisor may limit sorting to only a portion of the sample.

   Lighter bags of recyclable sample material may be lifted directly to the table and in some cases may be effectively sorted on the sample tarps (the supervisor should make this determination based on sample weight and sorter safety). Some trash loads which include a large amount of municipal construction debris, yard waste or other hard-to-manage materials may be partially sorted directly on the tarps to minimize double handling.

2. To avoid confusing results, only one sample will be sorted at a time, regardless of the number of samples pulled for sorting or the number of sorters available. An exception to this rule may occur when separate sort crews and sort stations are established for separate but simultaneous trash and recyclables audits. Regardless of the number of audits being conducted, only one sample should be weighed and documented as one time. Mixing sample data will render the information useless.

3. Prior to sorting, one sort bin of each size must be weighed empty to obtain a tare weight (which will ultimately be subtracted from the total or gross weight of the bin plus sorted material to obtain net weight results). This weight will vary with each type of bin. Only one material will be placed in each bin. Different sized containers may be used for different materials (in the photo below, left shows small/orange and two medium-sized bins/red and green).

4. Sorters shall not scrutinize, read or remove any documentation, correspondence or similar personal or private materials.

5. All sorting should be done with tongs or hand rakes, unless otherwise directed by the supervisor. Closed or sealed waste materials should not be opened even if this means counting a recyclable as an "other" material. Any suspicious, potentially dangerous or hazardous materials should not be touched directly but instead moved to a hazardous/special waste bin with a shovel (preferred) or hand tools for subsequent observations and weighing.

6. The supervisor shall oversee sample weighing and recording. For many samples, multiple sort bins will be filled with the same material and require repeated weights as the sample is sorted. Other materials will only partially fill one bin. At the end of each sample, the supervisor shall weigh and record all bins containing sorted materials (see photo above, right). Any visual observations made by the sorters will be brought to the attention of the supervisor.

   Observations may include:
   - Unusual material such as medical waste
   - Difficult-to-sort material including composites

- Full, capped water bottles
- Half-full food containers

Any sample that includes any "other" materials should include a notation on the field log that describes the sorted materials - Weight and observations shall be recorded on the MSW audit field logs and photographed. Log sheet recordings will ideally be logged electronically (this is more efficient and allows a direct assessment of sample weights).

7. Once weighed, the sorted materials should be emptied into designated containers or areas (see the small roll-off example for trash in photo at bottom, left). Sorted recyclables will be managed by the host facility as either recyclables or trash depending on the availability of recycling containers. Waste materials will typically be transferred by host facility employees to the appropriate disposal and or recycling area.

8. Once each sample has been fully sorted, the supervisor shall oversee the collection and measurement of any sample residue from sort tables and sample tarps (if any). Residue may include indistinguishable materials that cannot be sorted due to moisture, small size or inability to identify. Alternatively, residue may first be screened to document and remove any 1"-minus material before sorting. Any overs (larger than 1") should be sorted. See screen example at photo above, right.

9. At the end of the audit, the sort area should be returned to its original condition. No waste materials should be left in the sort area unless authorized by the host facility. Any equipment and supplies intended for reuse should be cleaned as appropriate before being stored by the supervisor or shared with other projects.

ANALYSIS OF RESULTS

Data Entry

Following the audit, all field logs (Appendix B) should be reviewed to verify that key data is documented for each sample. The field logs are provided with this protocol; they are Excel-based spreadsheets and will automatically calculate net weights for the materials in each sample if the raw data is appropriately entered[v]. The Selecting Audit Samples section includes an example of a completed field log.

Key Data:

- ***Hauler and load information***
- ***Bin size, tare & gross weight for each bin filled with sorted material***
- ***Total net material weight for each material (gross minus tare)***
- ***Total net sample weight (all materials)***
- ***Notes & photographs to describe sort findings (required for all "other" materials)***

Basic knowledge of Excel is required for this work. The References & Resources include resources that may be available to assist with data analysis.

Key Analyses

All analysis will be conducted on net weights.

1. Net Weights for Each Individual Material in Each Sample – These will be automatically calculated on the field logs (expressed as a percent by weight).

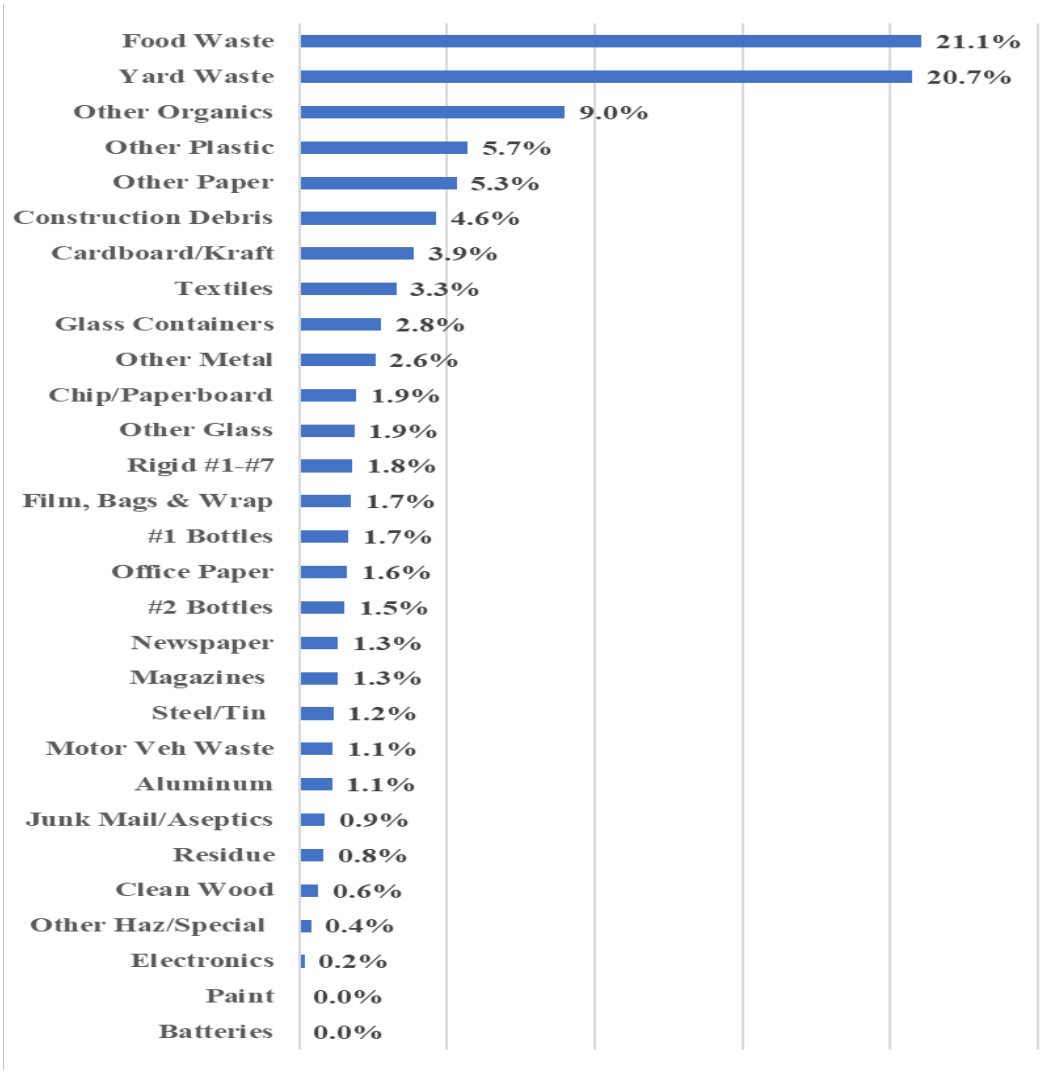
2. Audit Analysis – A Waste Audit Analytical Model has been developed as part of this protocol (see Appendix C). While there will be multiple samples and therefore multiple field logs for each audit, there will only be one trash and/or one recyclables analytical model that analyzes the results for the complete material audit:
   - Percent by weight calculations and sample weight from each field log must be uploaded to this model (see the circled cells in the example model output for a partial recyclables audit on the next page)
   - The models are also Excel-based and will automatically calculate the necessary analytics if data is accurate and appropriately uploaded
   - Results should be manually verified – see the calculations provided in each model

	Percent by Weights & Sample Total Net Weight Uploaded from Individual Field Logs[a]									Weight Average & Confidence Interval Calculations (these columns are locked for automatic calculations)								WEIGHTED AVERAGE[j]	
MATERIALS	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Sample #7	Sample #8	MATERIALS	WEIGHTED AVERAGE[d]	STANDARD DEVIATION[e]	N[f]	T[g]	SQRT N[h]	90% CONFIDENCE INTERVAL[i] Lower	90% CONFIDENCE INTERVAL[i] Upper	Categories Only	
Glass Containers	20.4%	9.5%							Glass Containers	16.1%	7.7%	2	6.314	1.414	-18.2%	50.3%	Glass	16.1%
Aluminum	1.8%	0.8%							Aluminum	1.3%	0.9%	2	6.314	1.414	-2.8%	5.4%	Metals	2.2%
Steel/Tin	1.4%	0.2%							Steel/Tin	0.9%	0.8%	2	6.314	1.414	-2.8%	4.6%		
#1 Bottles	0.9%	0.5%							#1 Bottles	0.7%	0.3%	2	6.314	1.414	-0.5%	2.0%		
#2 Bottles	1.8%	0.5%							#2 Bottles	1.3%	0.9%	2	6.314	1.414	-2.8%	5.4%		
Rigid #1-#7	3.6%	1.5%							Rigid #1-#7	2.8%	1.5%	2	6.314	1.414	-3.9%	9.5%	Plastics	10.5%
Bulky Rigids	3.6%	7.5%							Bulky Rigids	5.2%	2.7%	2	6.314	1.414	-7.1%	17.4%		
Styrofoam	0.9%	0.0%							Styrofoam	0.5%	0.6%	2	6.314	1.414	-2.3%	3.4%		
Cardboard/Kraft	25.3%	30.5%							Cardboard/Kraft	27.4%	3.6%	2	6.314	1.414	11.1%	43.7%		
Newspaper	1.4%	5.0%							Newspaper	2.8%	2.6%	2	6.314	1.414	-8.7%	14.3%		
Office Paper	2.7%	7.5%							Office Paper	4.6%	3.4%	2	6.314	1.414	-10.5%	19.7%	Paper	58.7%
Chip/Paperboard	3.6%	4.8%							Chip/Paperboard	3.8%	1.2%	2	6.314	1.414	-1.3%	9.0%		
Junk Mail/Aseptics	10.4%	7.5%							Junk Mail/Aseptics	9.3%	2.1%	2	6.314	1.414	0.1%	18.4%		
Magazines	12.7%	8.0%							Magazines	10.8%	3.3%	2	6.314	1.414	-3.9%	25.6%		
Contaminants	10.0%	16.5%							Contaminants	12.5%	4.6%	2	6.314	1.414	-8.1%	33.2%	Contaminants	12.5%
Raw Total	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		100.0%	should be 100%								100.0%
Sample Net Weight	221	145							366	total weight of all samples									should be 100
Pro-Ration[c]	0.60	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.0	should be 1.0									

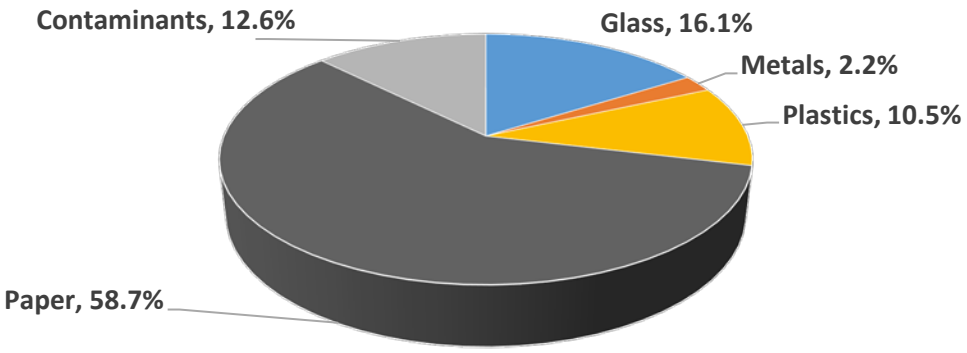
The models will calculate the following:

a. *Sample pro-ration* – to determine the relative importance of each sample within the total audit on the basis of its net weight

b. *Weighted average for material across all samples* - to evaluate each material in each sample based on the sample's pro-ration (this is the basis of overall composition and is expressed as percent by weight);
   - A bar chart depiction of these results is recommended (see the trash audit example on the next page) – this chart (and others shown on subsequent pages) can be generated within the model by selecting the data to be illustrated and applying the appropriate chart
   - In some cases, it may be desirable to also analyze sample results for discrete areas within the region (e.g., to see what opportunities exist in each county or in the residential versus commercial sectors)



c. *Total percent by weight of major categories* – to illustrate composition by major category (i.e., paper, plastic, glass, metals, organics, other wastes and residue categories for trash; paper, plastics, glass, metals and contaminants for recyclables) – see an example recyclables audit pie chart below



d. *Material confidence intervals* (90%) – to indicate the range within which each material weight will fall in the project area's overall MSW 90% of the time;
   - ♦ Confidence intervals should be calculated on each material in all samples and based on standard deviations (which measure how widely each material weight varies around the weighted average of that material)
   - ♦ A high standard of deviation is typical of MSW, which is highly variable
   - ♦ A broader confidence interval is typical in MSW audits as the number of samples is very small and standard deviations are high
   - ♦ The glass analytics in the example model output shown previously exemplifies the magnitude of standard deviations and confidence intervals that can occur with MSW audits

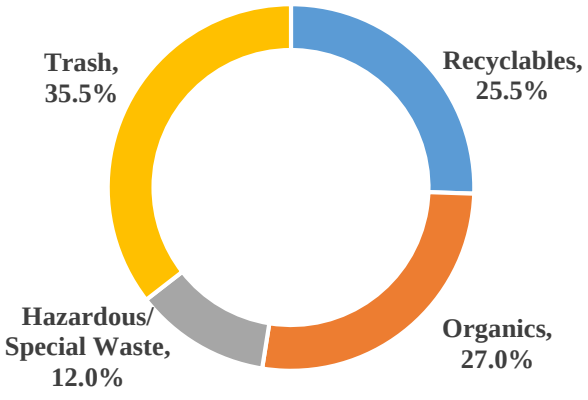
Additional Analyses

Additional analyses will allow the MSW audit results to more effectively inform new or optimized programs. The calculations described below are based on model results but need to be completed manually. They will also require baseline quantity data for the region. Given the limitations of "short" audits and quantity data, results should be appropriately qualified and used judiciously.

1. Untapped Diversion Potential – This metric will be assessed from trash audit results to observe those recyclables, organics and other materials sorted from trash samples that could have been diverted instead of disposed. The potential should be based on materials accepted in diversion programs operating in the project area - commonly divertible materials will vary. The example doughnut chart below depicts an example diversion potential, expressed as percent by weight.

Commonly Diverted Materials:

- ♦ ***Recyclables - glass containers, aluminum, steel/tin, plastics #1/#2, OCC, ONP, OP, OMG, chipboard, junk mail***
- ♦ ***Organics – food waste, yard waste, compostable paper***
- ♦ ***Other materials - plastic film, textiles, electronics, paint, motor vehicle waste***



2. Realized Diversion Potential – This metric represents the quantity of diverted materials that are truly recoverable (i.e., recycled quantities minus contaminants), and can be applied to recyclables, organics or all divertibles (expressed as tons/year).

3. Total Diversion Potential – This potential is equal to the sum of untapped and realized diversion potential, and can be used for recycling, organics recovery or all divertibles (expressed as tons/year).

4. Waste Stream Recovery Rate – This metric reflects the ratio of realized diversion potential to the total diversion potential and indicates how much of divertible materials in the total MSW stream was truly diverted from landfill disposal (expressed as percent by weight).

5. Recycling Rate – The recycling rate is the measurement of realized diversion potential to the total MSW stream (expressed as percent by weight).

The following table estimates diversion potential, recovery and recycling rates for an example regional MSW stream. In this example, all diversion and recovery successes are related to recycling (organics recovery could be similarly estimated).

Example Regional Baseline Quantity Data (measured as tons/year):	**Trash = 10,000 tpy** **Recyclables[a] = 1,000 tpy** **Organics = 0 tpy**
Example Audit Results (expressed as percent by weight, see doughnut chart previous page):	**Trash Audit = 47% trash & other; 26% recyclables; 27% organics** **Recyclables Audit = 10% contamination**
Untapped Diversion Potential (recycling):	10,000 tpy X 26% = 2,600 tpy
Realized Diversion Potential[a]:	1,000 tpy X (100% - 10%) = 900 tpy
Total Diversion Potential:	2,600 tpy + 900 tpy = 3,500 tpy
Recycling Recovery Rate:	900 tpy / 3500 tpy = 26%
Recycling Rate	900 tpy / (10,000 tpy + 1,000 tpy) = 8%

[a] The waste audit-measured contamination level will only apply to commingled materials – note that source- separated materials may also be collected (e.g., shredded paper, cardboard, etc.)

In this table, actual regional recycling efforts yielded a diversion rate of 8% with 26% of all potential recyclables diverted. If 3,500 tpy of recyclables had been diverted instead, the recycling rate would be 32% and the recovery rate 100% - the highest that could be achieved in this example (unless organics were also recovered).

6. Comparison to Previously Collected Audit Data – In those project regions where previous MSW audits have been conducted, a comparison will be made to show changes in the trash and recycling stream over time (see an example historical comparison on the next page). It is likely that sort protocols and material sorted will vary; major changes in methodology and material sorted should be identified when conducting the comparison.

Material Type	2008	2016/2017	Difference
Glass	2.3%	5.5%	3.2%
Metals	2.7%	2.5%	-0.2%
Plastic	9.8%	12.8%	3.0%
Paper	14.4%	20.7%	6.3%
Organics	57.2%	47.9%	-9.3%
Hazardous & Special Waste	7.4%	10.6%	4.2%
Residue	6.1%	0%	-6.1%

Reporting

Reporting of waste audit results should include a presentation of calculations, summary charts, comparison against historical results (if any) and a discussion of overall findings including any insight provided by written sort notes and photographs. Example reports can be obtained from the resource list found in the References section.

REFERENCES & RESOURCES

[i] National waste composition study procedures include:

- California Integrated Waste Management Board's Uniform Waste Disposal Characterization Method
- U.S. Green Building Council's LEED Waste Management Policy and Waste Stream Audit Requirements
- American Society for Testing Materials D-5231.

[ii] External sources include:

- CDPHE Pollution Prevention Advisory Board RREO Coordinator, Eric Heyboer – eric.heyboer@state.co.us, 303.335.6932
- LBA Associates, Laurie Batchelder Adams (protocol author & rural/urban audit coordinator) – laurie@lbaassoc.com, 303.733.7943
- Resource Recycling Systems, Juri Freeman (urban audit coordinator) – jfreeman@recycle.com, 303.827.6586
- UAACOG Recycling Program Manager, Beth Lenz (manager for 2017 rural audit) – beth.lenz@uaacog.com, 719.275.1675

[iii] Example emergency eyewash unit – see https://www.globalindustrial.com/g/safety/eyewash-stations-and-showers/portable-emergency-eyewash/guardian-portable-eye-face-wash-stations.

[iv] US EPA Volume-to-Weight Conversion Factors, April 2016 – these published values cover a range of density findings and can vary widely depending on the generator source, weather (wind and moisture) and content (e.g., recyclables with/without glass and organics with/without food waste) - https://www.epa.gov/sites/production/files/2016-04/documents/volume_to_weight_conversion_factors_memorandum_04192016_508fnl.pdf

[v] Field logs and analytical models are password-protected and cells with automatic calculations are locked. The password for all files is lbarreo2018 and is case-sensitive.

APPENDIX A
PRE-SORT HAULER SURVEY FORM

	DATE	TIME	HAULER	COLLECTION LOCATIONS[1]	TYPE OF WASTE[2]
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

[1] Try to get the drivers to be as specific as possible in terms of city/towns or areas of unincorporated counties

[2] Type of waste will likely include:

* Residential = waste generated in homes (haulers may include only that residential waste collected in individual bags, cans or carts)
* Commercial = waste generated from businesses (retailers, grocers, restaurants, hotels, offices, etc.); institutions (schools, hospitals, govt buildings, etc.) *(haulers may include residential waste collected from dumpsters)*
* Mixed Residential & Commercial
* Other

APPENDIX B

TRASH FIELD LOG (Sample #1) - REGIONAL WASTE AUDITS

1	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	AMPLE NO	T	U	V	W	X
2	RECORDER:		DATE/TIME:			HAULER & DRIVER:							VEHICLE NUMBER:					SAMPLE NO: #1					
3	COLLECTION LOCATIONS:																						
4	RESIDENTIAL?		COMMERCIAL?			MIXED?		OTHER (describe):															
5	MATERIALS	TYPE OF CONTAINER	TARE	GROSS WEIGHTS (from multiple bin measurements within the same sample)									NET WEIGHT CALCULATIONS[a] (these columns are locked for automatic calculations)									MATERIAL NET WEIGHT[b]	% BY WEIGHT[c]
6				1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8			
7	Glass Containers												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
8	Other Glass												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
9	Aluminum												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
10	Steel/Tin												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
11	Other Metal												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
12	#1 Bottles												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
13	#2 Bottles												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
14	Non-Bottle #1-#7												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
15	Bulky Rigids												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
16	Film, Bags & Wrap												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
17	Styrofoam												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
18	Other Plastic												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
19	Cardboard/Kraft												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
20	Newspaper												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
21	Office Paper												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
22	Chip/Paperboard												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
23	Junk Mail/Aseptics												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
24	Magazines												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
25	Compostable Paper												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
26	Other Paper												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
27	Food Waste												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
28	Yard Waste												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
29	Clean Wood												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
30	Other Organics												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
31	Textiles												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
32	Electronics												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
33	Batteries												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
34	Paint												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
35	Motor Veh Waste												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
36	C&D												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
37	Misc Haz/Special												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
38	Residue												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
40	TOTALS												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**	#DIV/0! *should be 100%*

NOTES:

[a] Net Weight = Gross Weight - Tare (example cell N7 = E7 - D7)

[b] Material Net Weight = Sum of Net Weights (example cell W7 = N7 + O7 + P7 + Q7 + R7 + S7 + T7 + U7)

Sample Net Weight = cell W40 - *upload to master audit spreadsheet*

[c] Percent by Weight = Material Net Weight / Total Sample Net Weight (example cell X7 = W7 / W40) - *upload ot master audit spreadsheet*

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APPENDIX B

TRASH FIELD LOG (Sample #2) - REGIONAL WASTE AUDITS

RECORDER:		DATE/TIME:		HAULER & DRIVER:		VEHICLE NUMBER:		SAMPLE NO: #2	
COLLECTION LOCATIONS:									
RESIDENTIAL?		COMMERCIAL?		MIXED?		OTHER (describe):			

MATERIALS	TYPE OF CONTAINER	TARE	GROSS WEIGHTS (from multiple bin measurements within the same sample)								NET WEIGHT CALCULATIONS[a] (these columns are locked for automatic calculations)								MATERIAL NET WEIGHT[b]	% BY WEIGHT[c]
			1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8		
Glass Containers											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Other Glass											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Aluminum											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Steel/Tin											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Other Metal											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
#1 Bottles											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
#2 Bottles											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Non-Bottle #1-#7											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Bulky Rigids											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Film, Bags & Wrap											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Styrofoam											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Other Plastic											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Cardboard/Kraft											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Newspaper											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Office Paper											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Chip/Paperboard											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Junk Mail/Aseptics											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Magazines											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Compostable Paper											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Other Paper											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Food Waste											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Yard Waste											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Clean Wood											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Other Organics											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Textiles											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Electronics											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Batteries											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Paint											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Motor Veh Waste											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
C&D											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Misc Haz/Special											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
Residue											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	#DIV/0!
TOTALS											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	#DIV/0! *should be 100%*

NOTES:

[a] Net Weight = Gross Weight - Tare (example cell N7 = E7 - D7)

[b] Material Net Weight = Sum of Net Weights (example cell W7 = N7 + O7 + P7 + Q7 + R7 + S7 + T7 + U7)

Sample Net Weight = cell W40 - *upload to master audit spreadsheet*

[c] Percent by Weight = Material Net Weight / Total Sample Net Weight (example cell X7 = W7 / W40) - *upload to master audit spreadsheet*

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APPENDIX B

RECYCLABLES FIELD LOG (Sample #1) - REGIONAL WASTE AUDITS

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
2	RECORDER:		DATE/TIME:			HAULER & DRIVER:					VEHICLE NUMBER:									SAMPLE NO: #1			
3	COLLECTION LOCATIONS:																						
4	RESIDENTIAL?		COMMERCIAL?			MIXED?		OTHER (describe):															
5	MATERIALS	TYPE OF CONTAINER	TARE	GROSS WEIGHTS (from multiple bin measurements within the same sample)									NET WEIGHT CALCULATIONS (these columns are locked for automatic calculations)									TOTAL NET WEIGHT	% BY WEIGHT
6				1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8			
7	Glass Containers												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
8	Aluminum												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
9	Steel/Tin												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
10	#1 Bottles												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
11	#2 Bottles												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
12	Non-Bottle #1-#7												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
13	Bulky Rigids												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
14	Styrofoam												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
15	Cardboard/Kraft												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
16	Newspaper												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
17	Office Paper												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
18	Chip/Paperboard												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
19	Junk Mail/Aseptics												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
20	Magazines												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
21	Contaminants												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
23	TOTALS												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**	#DIV/0!

should be 100%

	NOTES:
a	Net Weight = Gross Weight - Tare (example cell N7 = E7 - D7)
b	Material Net Weight = Sum of Net Weights (example cell W7 = N7 + O7 + P7 + Q7 + R7 + S7 + T7 + U7)
	Sample Net Weight = cell W23 - *upload to Master Audit Spreadsheet*
c	Percent by Weight = Material Net Weight / Total Sample Net Weight (example cell X7 = W7 / W23) - *upload to Master Audit Spreadsheet*

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APPENDIX B

RECYCLABLES FIELD LOG (Sample #2) - REGIONAL WASTE AUDITS

1	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
2	RECORDER:		DATE/TIME:			HAULER & DRIVER:					VEHICLE NUMBER:									SAMPLE NO: #2			
3	COLLECTION LOCATIONS:																						
4	RESIDENTIAL?		COMMERCIAL?			MIXED?		OTHER (describe):															
5	MATERIALS	TYPE OF CONTAINER	TARE	GROSS WEIGHTS (from multiple bin measurements within the same sample)									NET WEIGHT CALCULATIONS (these columns are locked for automatic calculations)									TOTAL NET WEIGHT	% BY WEIGHT
6				1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8			
7	Glass Containers												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
8	Aluminum												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
9	Steel/Tin												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
10	#1 Bottles												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
11	#2 Bottles												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
12	Non-Bottle #1-#7												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
13	Bulky Rigids												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
14	Styrofoam												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
15	Cardboard/Kraft												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
16	Newspaper												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
17	Office Paper												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
18	Chip/Paperboard												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
19	Junk Mail/Aseptics												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
20	Magazines												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
21	Contaminants												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!
23	TOTALS												0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	#DIV/0!

should be 100%

NOTES:

[a] Net Weight = Gross Weight - Tare (example cell N7 = E7 - D7)

[b] Material Net Weight = Sum of Net Weights (example cell W7 = N7 + O7 + P7 + Q7 + R7 + S7 + T7 + U7)

Sample Net Weight = cell W23 - *upload to Master Audit Spreadsheet*

[c] Percent by Weight = Material Net Weight / Total Sample Net Weight (example cell X7 = W7 / W23) - *upload to Master Audit Spreadsheet*

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APPENDIX C
TRASH ANALYTICAL MODEL - REGIONAL WASTE AUDITS

MATERIALS	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Sample #7	Sample #8
	Percent by Weights & Sample Total Net Weight Uploaded from Individual Field Logs[a]							
Glass Containers								
Other Glass								
Aluminum								
Steel/Tin								
Other Metal								
#1 Bottles								
#2 Bottles								
Rigid #1-#7								
Bulky Rigids								
Film, Bags & Wrap								
Styrofoam								
Other Plastic								
Cardboard/Kraft								
Newspaper								
Office Paper								
Chip/Paperboard								
Junk Mail/Aseptics								
Magazines								
Compostable Paper								
Other Paper								
Food Waste								
Yard Waste								
Clean Wood								
Other Organics								
Textiles								
Electronics								
Batteries								
Paint								
Motor Veh Waste								
C&D								
Other Haz/Special								
Residue								
Raw Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Sample Net Weight[b]								
Pro-Ration[c]	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

MATERIALS	WEIGHTED AVERAGE[d]	STANDARD DEVIATION[e]	N[f]	T[g]	SQRT N[g]	90% CONFIDENCE INTERVAL[i] Lower	Upper
		Weight Average & Confidence Interval Calculations (these columns are locked for automatic calculations)					
Glass Containers	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Other Glass	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Aluminum	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Steel/Tin	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Other Metal	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
#1 Bottles	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
#2 Bottles	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Rigid #1-#7	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Bulky Rigids	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Film, Bags & Wrap	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Styrofoam	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Other Plastic	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Cardboard/Kraft	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Newspaper	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Office Paper	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Chip/Paperboard	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Junk Mail/Aseptics	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Magazines	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Compostable Paper	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Other Paper	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Food Waste	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Yard Waste	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Clean Wood	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Other Organics	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Textiles	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Electronics	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Batteries	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Paint	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Motor Veh Waste	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
C&D	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Other Haz/Special	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
Residue	#DIV/0!	#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
	#DIV/0!	should be 100%					
	0	total weight of all samples					
	#DIV/0!	should be 1.0					

WEIGHTED AVERAGE[j] Categories Only	
Glass	#DIV/0!
Metals	#DIV/0!
Plastics	#DIV/0!
Paper	#DIV/0!
Organics	#DIV/0!
Other Haz & Special Waste	#DIV/0!
Residue	#DIV/0!
	#DIV/0!
	should be 100%

[a] *Manually upload cells X7 through X38 from each Field Log Sheet - copy selected cells, then Paste Special & Paste Link into model to link data between spreadsheets*

[b] *Manually upload cell W40 from each Field Log Sheet - copy selected cells, then Paste Special & Paste Link into model to link data between spreadsheets*

[c] *Pro-rating calculates the relativity of each sample relative to the total weight of samples (automatically calculated in cell L40) - these values are used to calculate weighted averages (automatically calculated in cells M6 through M37) so that the material weights of larger samples have more "importance" than the weights of smaller samples*

[d] Weighted Average = sum of Percent by Weight X Pro-Ration of Sample Weight for each material, example (C6XC41) + (D6XD41) + (E6XE41) + (F6XF41) + (G6XG41) + (H6XH41) + (I6XI41) + (J6XJ41)

[e] Standard Deviation of Net Percent Weights for each material in all samples (shown in cells O6 through O37) - see STDEV under Formulas, More Functions, Statistical

[f] Number of Samples (shown in cells P6 through P37) - sum number of samples

[g] Student T-Test with 10% Probability that Samples Values are the Same (shown in cells Q6 through Q37) - see T.INV.2T under Formulas, More Functions, Statistical

[h] Square Root of Number of Samples (shown in cells R6 through R37) - see under Formulas, Math & Trig

[i] Minus/Plus 90% Confidence Intervals (minus shown in cells S6 though S37, plus in cells T6 through T37) - subtract/add the (T-test X standard deviation) / square root of number of samples

[j] Summation of materials in each category

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APPENDIX C
RECYCLABLES ANALYTICAL MODEL - REGIONAL WASTE AUDITS

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1		Percent by Weights & Sample Total Net Weight												Weight Average & Confidence Interval Calculations					
2		Uploaded from Individual Field Logs[a]												(these columns are locked for automatic calculations)					
3	MATERIALS	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5	Sample #6	Sample #7	Sample #8		MATERIALS	WEIGHTED AVERAGE[d]		STANDARD DEVIATION[e]	N[f]	T[g]	SQRT N[h]	90% CONFIDENCE INTERVAL[i]	
4																			
5																		Lower	Upper
6	Glass Containers										Glass Containers	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
7	Aluminum										Aluminum	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
8	Steel/Tin										Steel/Tin	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
9	#1 Bottles										#1 Bottles	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
10	#2 Bottles										#2 Bottles	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
11	Rigid #1-#7										Rigid #1-#7	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
12	Bulky Rigids										Bulky Rigids	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
13	Styrofoam										Styrofoam	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
14	Cardboard/Kraft										Cardboard/Kraft	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
15	Newspaper										Newspaper	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
16	Office Paper										Office Paper	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
17	Chip/Paperboard										Chip/Paperboard	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
18	Junk Mail/Aseptics										Junk Mail/Aseptics	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
19	Magazines										Magazines	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
20	Contaminants										Contaminants	#DIV/0!		#DIV/0!	0	#NUM!	0.000	#DIV/0!	#DIV/0!
21																			
22	Raw Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			#DIV/0!	*should be 100%*						
23	Sample Net Weight[b]										0	*total weight of all samples*							
24	Pro-Ration[c]	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		#DIV/0!	*should be 1.0*							

[a] *Manually upload cells X7 through X21 from each Field Log Sheet - copy selected cells, then Paste Special & Paste Link into model to link data between spreadsheets*

[b] *Manually upload cell W23 from each Field Log Sheet - copy selected cells, then Paste Special & Paste Link into model to link data between spreadsheets*

[c] *Pro-rating calculates the relativity of each sample relative to the total weight of samples (automatically calculated in cell L23) - these values are used to calculate weighted averages (automatically calculated in cells M6 through M20) so that the material weights of larger samples have more "importance" than the weights of smaller samples*

[d] Weighted Average = sum of Percent by Weight X Pro-Ration of Sample Weight for each material, example (C6XC24) + (D6XD24) + (E6XE24) + (F6XF24) + (G6XG24) + (H6XH24) + (I6XI24) + (J6XJ24)

[e] Standard Deviation of Net Percent Weights for each material in all samples (shown in cells O6 through O20) - see STDEV under Formulas, More Functions, Statistical

[f] Number of Samples (shown in cells P6 through P20) - sum number of samples

[g] Student T-Test with 10% Probability that Samples Values are the Same (shown in cells Q6 through Q20) - see T.INV.2T under Formulas, More Functions, Statistical

[h] Square Root of Number of Samples (shown in cells R6 through R20) - see under Formulas, Math & Trig

[i] Minus/Plus 90% Confidence Intervals (minus shown in cells S6 though S20, plus in cells T6 through T20) - subtract/add the (T-test X standard deviation) / square root of number of samples

[j] Summation of materials in each category

APPENDIX C
RECYCLABLES ANALYTICAL MODEL - REGIONAL WASTE AUDITS

WEIGHTED AVERAGE[j]	
Categories Only	
Glass	#DIV/0!
Metals	#DIV/0!
Plastics	#DIV/0!
Paper	#DIV/0!
Contaminants	#DIV/0!
	#DIV/0!

should be 100%