SOLID WASTE MANAGEMENT

Post Collections

NEW DIRECTOR'S GUIDE

This guide was prepared by APWA's Solid Waste Management Committee. For more information on the committee click here to visit the committee's webpage.

APWA 2023

CONTENTS

INTRODUCTION

The Solid Waste Management New Director's Guide, Collections and Post Collections, was created by the APWA Solid Waste Management Committee to provide a foundation for new directors who may not have a firm knowledge base for solid waste collections and post collections. The Guide is a reference document with real-life examples from committee members and public agencies. The Guide is not a definitive source for the operations and maintenance of a public solid waste management agency.

PLANNING AND FUNDING

Before deciding how to manage your waste after it is collected, developing an integrated waste management plan and estimating the cost of managing your waste is highly recommended.

Solid Waste Management Planning

Planning is critical to developing a solid waste management system that best serves your community. Planning should provide a roadmap for how waste will be collected, processed, and disposed of. The following are some key steps in solid waste management planning.

- Understand the existing solid waste management system and projected needs. The first step in creating a solid waste management plan is to inventory the existing solid waste management programs and infrastructure in your community and region. In addition, staff should seek to project the system's future needs, including increased tonnages, and changes in regulations. Understanding the existing system and projected community needs will assist in identifying opportunities to improve it.
- Develop and implement a public outreach plan. It is important to engage the public throughout the planning process. Public engagement can be obtained via various methods such as public meetings, focus groups, and surveys. Citizens, businesses, community leaders, solid waste service providers, and other community members can provide firsthand input on successes and areas needing improvement in the system.
- Define solid waste management system goals. A solid waste management plan can set forth various goals for the system. The goals of a solid waste management system vary from community to community. For example, a solid waste management plan may improve the recycling program by increasing diversion, decreasing contamination, and increasing participation. A community could also set the goal to increase customer service or decrease the cost of the system. Goals should be measurable and have a targeted schedule.
- Define a preferred solid waste management system and develop a detailed implementation plan. Based on the understanding of the system, input from the public, and established goals, staff should identify system alternatives. Staff should define criteria for evaluation (technical, environmental, and economic) for prioritizing alternatives. Once alternatives have been selected, staff should develop a detailed implementation plan with a description of the activity to be taken, a timeline for implementation, and a funding mechanism.
- Conduct ongoing public education and outreach. Public education and outreach are key to the success of a solid waste management system. Staff should budget and perform ongoing public education and outreach to improve the performance of the community's solid waste and recycling programs.

Planning is an ongoing process. Staff should periodically evaluate solid waste management systems and alternatives. A key evaluation component should include collaboration with the finance department to ensure proper funding for short and long-term needs.

PLANNING AND FUNDING

Funding

Revenues and Expenditures

Most solid waste transfer stations, landfills, waste-to-energy facilities (WtE), and some recycling and compost facilities charge tipping fees (sometimes called gate charges). The tipping fees are assessed when a truck "tips" its load for disposal or recycling. The fee is paid by the individual bringing in the load of trash/recyclables and is generally based upon a given quantity or weight of material received. Tipping fees generally are used to recover the costs of operating the facility. Both publicly and privately owned facilities charge tipping fees; in some cases, these fees are used to offset other solid waste system expenditures. For example, the tipping fees charged at a recycling facility may also cover the costs of collecting at the recycling facility.

Many local agencies receive revenue through the sale of recyclable materials collected from residential and commercial customers. The amount of revenue varies depending upon the value and markets for the recycled materials. As with most goods, the amount they are worth usually depends on how much demand there is for them. The level of demand can vary based on many things, including the time of year, new technology, and the economy's health as a whole.

If the agency provides the collection services, it receives the revenue directly when it sells the recyclable materials. If the agency has a contract or franchise agreement with a private service provider, it can receive the revenue from its service provider or directly from the processor/material recovery facility where the materials are processed. In some cases, the contract specifies that the revenue received by the service provider from the sale of recyclable materials be used to reduce the fees charged to residential and business customers.

Other ways local agencies pay for their recycling programs include the agency's general fund, parcel taxes, voter-approved ballot measures, and state agency grants and loans. The funding sources may include:

- ***General fund.*** The municipality pays for all or part of recycling and solid waste collection services through their general funds.

PLANNING AND FUNDING

- ***Parcel/excise tax/fee.*** A few local agencies pay for recycling and solid waste collection services through an excise tax imposed as a "special tax," which requires voter approval. An excise tax, such as a parcel tax, is an annual tax based upon either a flat per-parcel rate or a rate that varies depending on the size, use, and number of units on a parcel. This can cover just the cost of operating the landfill/processing facility (similar to a gate fee) or the cost of collection services.
- ***State agency grants and funds.*** Many local agencies receive grants or funds from state agencies for recycling programs and facilities. These include grants to purchase waste and recycling bins for public places (like parks, community centers, or downtown plazas), conduct outreach to residents and businesses, or support collection events and programs.
- ***Voter-approved surcharge.*** Some local agencies have additional fees or surcharges imposed through the voter initiative process. For instance, an additional charge per ton could be added to all waste disposed of at a county's landfills to fund recycling programs within the county.

There are pros and cons to weigh for each financing method. Taxes are often difficult to raise, and tipping fees help to offset costs to communities that don't own the disposal facility. On the other hand, user fees attached to recycling, composting, and hazardous or special waste collection programs might discourage people from participating, even though the entire community will share the environmental benefits of these programs.

Franchise Agreements

A funding mechanism becoming more popular for collection is franchise agreements, which can include provisions to fund post-collection facilities and activities. There are primarily two types of franchise service arrangements for municipal solid waste (MSW) collection service: non-exclusive and exclusive. Under a non-exclusive franchise agreement, multiple haulers compete to provide service to individual customers. Customers decide which hauler they will hire, and prices for services are negotiated between the hauler and the customer.

Under exclusive service arrangements, a city typically awards an exclusive franchise agreement to a single hauler. This can be for the entire city or certain collection zones. Customers are required to subscribe to the service from the franchised hauler. Exclusive franchise agreements frequently include standard rates set by a city. The standard rates are charged uniformly to all customers, based on the size and number of bins, and frequency of weekly pickups. In both types of franchise systems, it is common for cities to assess a franchise fee, and the revenue from this fee can be used to offset other expenses incurred by a municipality.

PLANNING AND FUNDING

Debt

Developing a new landfill or waste-to-energy plant requires millions of dollars in capital. In these instances, a municipality may need to finance the construction of the solid waste facility. Three types of debt can be issued by local government:

- ***General obligation (GO) debt*** is secured by the full faith and credit of the local government issuing the debt. The municipality unconditionally pledges its tax revenues to pay the debt's interest and principal as it matures. If the debt is in the form of a bond, the bond owners have a legal claim on the general income of the jurisdiction if a default occurs. See chapter 39.36 RCW and General Obligation Debt Limits for more information on GO debt.
- ***Revenue debt*** is different from GO debt in its method of repayment. Unlike GO debt, which relies on taxation, revenue debt is guaranteed by the specific revenues generated by the issuer. For example, solid waste districts can issue revenue debt with the revenues from customer waste bills guaranteeing debt repayment.
- ***Special assessment debt*** is debt repaid from assessments against those who directly benefit from the project the funds have been used to finance. For example, if a special assessment bond is issued to pay for a transfer station that benefits a specific subset of the population, the local government will develop an assessment roll for those properties benefitting from the improvement to repay the bond.

A good place to begin the borrowing process is by having a discussion with the city attorney and a recognized bond attorney. City borrowings are not automatically tax-exempt, so bond counsel should be consulted. The attorneys will advise the types of borrowing available and the procedures involved, prepare the necessary documentation, and give necessary legal opinions.

PLANNING AND FUNDING

Enterprise Funds

Some solid waste divisions operate as an enterprise fund, which separates and accounts for revenues and expenses of a given operating entity, removing the account from the general fund. Establishing an enterprise fund involves modifying accounting methods to track revenues and expenditures for certain activities separately from other local government activities. One key to establishing an enterprise fund is consolidating all the costs and revenues associated with a specific service, known as full-cost accounting. The key advantage of establishing an enterprise fund is a better understanding and identifying the full costs and revenues associated with providing a service to citizens.

Other enterprise fund benefits include the ability to:

- Charge users of the system fair and equitable rates that represent the true cost of providing the service and the ability to compare such rates with those that private operators propose if privatization is considered;
- Fund long-range MSW management programs, allowing a local government to improve or develop a more efficient and cost-effective MSW system;
- Provide for programs and activities that are not presently offered; and
- Provide a stable source of funding to deal with critical environmental issues.

However, programs are funded, best management practices include tracking all the costs of solid waste services. This should include asset management or replacement cost funding to set aside funding for future growth, equipment purchases, and post-closure care (if applicable).

Attachment A (see pages 40 and 41) provides a model of how one community estimated its landfill tipping fees.

MATERIAL SUPPLY

Material supply is crucial in developing and operating many solid waste management facilities since the economics are based on having reliable feedstock. Compost facilities, material recovery facilities, and resource recovery facilities all depend on material supply. Larger volumes can provide economies of scale benefits. They can positively impact the financing of capital costs, the cost of day-to-day operations, and the more efficient use of personnel and equipment.

The conventional means to secure material deliveries are long-term agreements between public entities and contracts with put-or-pay provisions.

Long-term Agreements	An agreement between two or more public authorities or organizations can improve the capacity and effectiveness of the facility to provide public solid waste services.
	Generally, the participants of the agreement have common values and objectives.
	The benefits of scale and shared resources can deliver higher public efficiencies and lower participant costs.
Contracts	Put-or-pay provision assures that a base tonnage of material will be delivered to the facility or that potential revenue from that tonnage is paid.
	Customer is securing throughput processing capacity that the facility could otherwise market to another customer.
	The facility may set an upper limit to the throughput processing capacity available to the customer since it may not guarantee that significant increases in tonnage can be processed.

The quality of the material supplied is also important. Contaminants increase processing costs and make the finished product difficult to market. Because of this, it is common in contracts to set limits on the percent contamination that the facility is expected to process. The contract should define this limit and who is responsible for the cost of dealing with the resulting residue.

ACCEPTABLE VERSUS UNACCEPTABLE WASTES AT POST-COLLECTION FACILITIES

Public works directors have many departments reporting to them, and the information they are expected to receive, process, and act on encompass a wide area. Similarly, post-collection facilities have a constant flow of waste material daily from many sources and industries that must be received, processed, and disposed of. The material is physical in nature, and the potential to cause harm to human health and the environment is real. As a public works director, you will be subject to federal, state, and local regulations regarding what materials can be processed at your post-collection facilities. These regulations are in place to ensure that your facilities do not accept materials that are hazardous and deemed unacceptable.

ACCEPTABLE VERSUS UNACCEPTABLE WASTES AT POST-COLLECTION FACILITIES

Material Sources and Acceptable Waste

Your post-collection facilities will receive waste from various sources, and it is important that you only accept wastes that are permitted for your facility. The type of post-collection facility you oversee (transfer station, landfill, compost, waste-to-energy, etc.) will determine the wastes you will be permitted to accept.

The table below shows sources and the acceptable wastes they typically generate.

Source	Typical waste generators	Types of solid wastes
Residential	Single and multifamily dwellings	Food waste, paper, cardboard, plastics, textiles, leather, yard waste, wood, glass, metals, ashes, bulky items, consumer electronics, white goods, batteries, oil, tires, and household hazardous wastes
Industrial	Light and heavy manufacturing, fabrication, power and chemical plants, refineries, mineral extraction, and processing	Ashes, industrial process waste, scrap materials, off-specification products, tailings
Commercial and institutional	Stores, hotels, restaurants, markets, office buildings, schools, hospitals, prisons, government centers	Paper, cardboard, plastics, wood, food waste, glass, metals, housekeeping wastes
Construction and demolition	New construction sites, road repair, renovation sites, building demolitions	Wood, steel, concrete, clean soil
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational areas, sludge
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms	Spoiled food waste, agricultural waste

Source: *What A Waste: Solid Waste Management in Asia*. Hoornweg, Daniel with Laura Thomas. 1999. Working Paper Series Nr. 1. Urban Development Sector Unit. East Asia and Pacific Region. Page 5.

ACCEPTABLE VERSUS UNACCEPTABLE WASTES AT POST-COLLECTION FACILITIES

Unacceptable Waste

Your facilities will be restricted on what they can and cannot accept. If unacceptable and hazardous materials are allowed to pass through your facility undetected, then you are putting human health and the environment at risk. The following are materials that the majority of post-collection facilities cannot accept:

- Characteristic wastes. Solid wastes that are ignitable, corrosive, reactive, or toxic.
- Mixed waste. Hazardous waste that has the additional property of being radioactive.
- Polychlorinated biphenyls (PCBs). This dangerous organic compound was very useful in manufacturing electrical equipment and heat transfer systems. PCBs were used extensively between 1930 and 1979. The innocuous appearance of this waxy or oily substance can easily be misidentified during post-collection screenings.
- Asbestos is a natural mineral with a wide range of uses as a construction material (insulation and fire retardant) and in manufactured goods (roof shingles, ceiling and floor tiles, automobile parts). Friable asbestos is hazardous because the material can easily become airborne and inhaled. When inhaled, asbestos fibers become lodged in the lungs and can cause numerous conditions, including lung cancer, mesothelioma, and asbestosis. Note that stable, non-airborne asbestos is not hazardous.

ACCEPTABLE VERSUS UNACCEPTABLE WASTES AT POST-COLLECTION FACILITIES

The following table contains common hazardous wastes generated by industry. It is important that your post-collection facilities are aware of the sources of the material they are handling to ensure unpermitted and dangerous wastes are stopped at your facility.

Waste Generators	Waste Type
Chemical manufacturers	Strong acids and bases Reactive wastes Ignitable wastes Discarded commercial chemical products
Vehicle maintenance shops	Paint wastes Ignitable wastes Spent solvents Acids and bases
Printing industry	Photography waste with heavy metals Heavy metal solutions Waste inks Spent solvents
Paper industry	Ignitable wastes Corrosive wastes Ink wastes, including solvents and metals
Construction industry	Ignitable wastes Paint wastes Spent solvents Strong acids and bases
Cleaning agents and cosmetic manufacturing	Heavy metal dust and sludges Ignitable wastes Solvents Strong acids and bases
Furniture and wood manufacturing and refinishing	Ignitable wastes Spent solvents Paint wastes
Metal manufacturing	Paint wastes containing heavy metals Strong acids and bases Cyanide wastes Sludges containing heavy metals

Source: United States Environmental Protection Agency. (1997). *RCRA: Reducing Risk from Waste.* EPA. Retrieved from https://archive.epa.gov/epawaste/inforesources/web/pdf/risk-1.pdf

ACCEPTABLE VERSUS UNACCEPTABLE WASTES AT POST-COLLECTION FACILITIES

Waste Screening Controls

Whether your post-collection facility will be receiving material from residential, commercial, institutional, or industrial sources, it is vital they are not accepting and disposing of items that have the potential to inflict significant harm to human health and the environment. The best way to mitigate this potential is to use control systems, which can be either engineered or operational.

Engineered control systems are included in the design phase of your site (in addition to the structural, civil, and other engineering concerns); in other words, engineered controls are included "from the ground up." On the other hand, operational controls are integral to your site's daily operations and are typically addressed in your solid waste facility plan during the permitting phase.

The following are common controls for detecting and excluding unacceptable materials at your post-collection facilities.

Engineered controls:

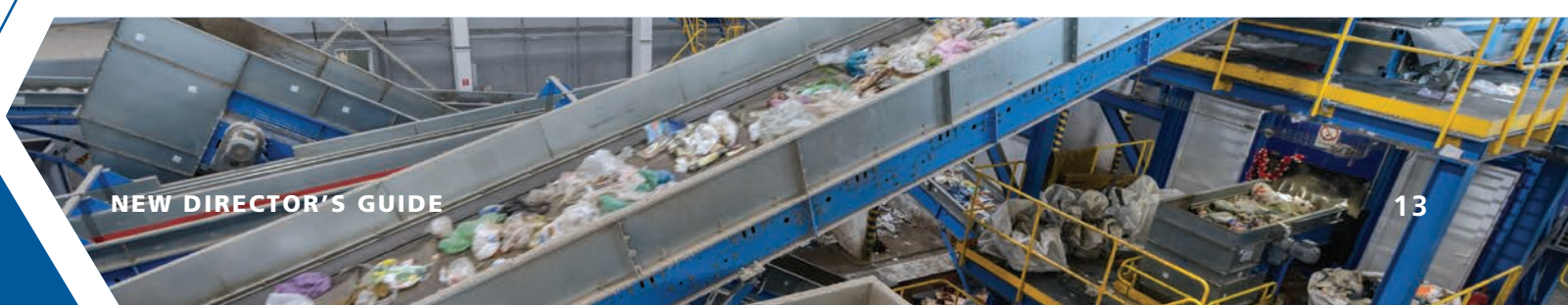
- Site security, including fencing, gates, and guards
- Video security systems
- Sensors for detecting radioactive materials
- Overhead cameras or walkways for load screening

Operational controls:

- Employees trained to identify and manage suspected hazardous materials
- Visual inspections at the first point of contact to identify unacceptable wastes
- Observation of waste unloading and inspections of suspected hazardous materials
- Safely providing temporary storage of hazardous materials until safe disposal is possible
- Materials testing such as the Paint Filter Test (EPA 9095B) for material acceptability

Conclusion

Your post-collection facilities will need to exclude unacceptable wastes safely. To accomplish this, you will need to be familiar with the wastes your facilities are permitted to accept and the associated regulations that come with those wastes. Waste screening control systems that are adequate to capture hazardous waste at your sites need to be included in the design phase, and personnel training and education should be integral to your facilities' operations. Protection of human health and the environment depends on identifying and excluding hazardous waste that arrives at your facilities.



FACILITY OPERATIONS

The following provides an overview of transfer stations, material recovery facilities, organics processing facilities, waste thermal waste conversion technologies, and municipal solid waste (MSW) landfills.

Transfer Stations

Solid waste transfer stations are facilities where solid waste, mainly MSW, is unloaded from collection vehicles or containers for reloading into larger, long-distance vehicles for transport to landfills or other permitted solid waste facilities for final disposal. Facilities that move solid waste from one mode of transportation to another, such as rail to road, can also be considered transfer stations. At many transfer stations, workers screen incoming waste to recover recyclables or materials inappropriate for disposal at a solid waste landfill, such as large appliances, tires, automobile batteries, and similar items.

Waste transfer stations are a critical part of the waste management process. They provide a variety of benefits to the community, including:

- Fuel savings, reduction in road wear, and less air pollution due to fewer vehicles being on the road
- Trash, green waste, and recyclable material drop-off location for residents
- Reduced traffic congestion in the community by consolidating loads onto larger vehicles
- Reduced total truck traffic and improved safety at the landfill or waste-to-energy facility

FACILITY OPERATIONS

Material Recovery Facilities

A materials recovery facility (MRF), sometimes called a materials reclamation facility or materials recycling facility,

is a plant that separates and prepares single-stream recycling materials to be sold to end buyers. An MRF is an essential component of any city's residential and commercial single-stream recycling program as more cities and municipalities across the United States have moved to single-stream recycling.

MRFs can vary in some respects in terms of the technology employed; however, a typical process would involve the following steps:

- MRFs have customer vehicle scales and a yard that can accommodate a queue of trucks. Incoming haulers arrive at the MRF and dump the commingled material onto the tipping floor. A front-end loader or other bulk material handler then drops it into a large steel bin at the start of the processing line. This bin is known as the drum feeder. Inside the drum feeder, a fast-moving drum meters out the commingled material onto the conveyor at a steady rate. It simultaneously regulates the material density on the conveyor so that it is not packed together too tightly.
- From there, the material goes to a pre-sort station where workers or automated equipment remove trash, plastic bags, or other inappropriately placed materials and separate them for disposition. Large pieces of plastic or steel, including pipes and other large items, can damage the system or expose workers to a risk of injury.
- Larger pieces of cardboard are removed from the mixed material stream and pushed to the top by large sorting disks turning on axles, while heavier material stays beneath. Smaller sets of sorting disks may then remove smaller pieces of paper. As materials are separated, they are diverted to separate conveyors for accumulation and baling.
- Powerful magnets separate steel and tin containers, while an eddy current separator is used to draw aluminum cans and other non-ferrous metals from the remaining commingled material. Glass containers can be separated from plastic containers by a density blower, then hammered into the crushed glass known as cullet.
- Any remaining plastic containers may be sorted manually by workers on the conveyor line, or optical sorters may be used to identify different materials and colors. Air classification may be used to separate key plastics such as HDPE and PET.
- Separated materials, other than glass cullet, are typically baled. The finished bales' weight varies greatly according to the material in question and the capacity of the baling equipment; finished bales can weigh anywhere from 25 to 1,500 pounds.

FACILITY OPERATIONS

There are two primary types of materials recovery facilities: source-separated and mixed stream. A source-separated MRF only processes residential or commercial single-stream recycling, that is, recyclable materials that are placed in a curbside recycling bin that is picked up every week or so. The recovery rate at a source-separated MRF (the percentage of materials that enter a source-separated MRF that end up being recycled) is thought to be higher than at a mixed-stream MRF. With that said, MRF recovery rates can be hard to unravel and significantly impacted by the technology used and conditions for marketing recyclables.

A mixed-stream MRF processes residential or commercial trash to capture recyclable materials that have been thrown out as trash. Mixed-stream MRFs may allow for greater overall recovery of recyclable materials and not require separate trucks to collect recyclables. The downside is they typically cost more to run, requiring significantly more manual labor or equipment to remove trash, and any soluble recyclables, such as mixed paper and old corrugated cardboard (OCC), tend to get contaminated.

Organics

Compost Facilities

In general, four technologies are used to create compost:

- ***Windrow composting.*** Windrow composting entails organic waste formed into rows of long piles called "windrows." The windrow is frequently turned by either manual or mechanical means. The ideal pile height, which is between 4 and 8 feet, allows for a pile large enough to generate sufficient heat and maintain temperatures yet small enough to allow oxygen to flow to the windrow's core. The ideal pile width is between 14 and 16 feet.
- ***Aerated static pile composting.*** Materials are mixed in one large pile instead of rows. The piles are placed over a network of pipes that deliver air into or draw air out, activated by a timer or a temperature sensor.
- ***Fabric cover.*** This composting method uses a specialized fabric to cover compost windrows. The entire system involves much more than just covering windrows. It includes fabric covers, in-floor aeration, aeration blowers, oxygen and temperature sensors, controllers, computers, software, cover handling systems, installation, training, and engineering support.
- ***In-vessel system.*** This composting method involves placing all the raw materials into an enclosed vessel, adding moisture and oxygen to the vessel as needed, and turning or rotating the vessel to mix the material as the decomposition proceeds. In-vessel systems control odors by retaining them. The composting process can be greatly accelerated by vessels, as the material can be manipulated as much as desired to add air, mix, and moisture.

More advanced technologies, such as in-vessel systems, can produce compost more quickly. However, they are more expensive to develop. Thus, understanding the markets for the final product should be carefully considered before determining the types of organics to accept at the composting facility and the technology used to process them.

FACILITY OPERATIONS

Biological Conversion

Biological conversion technologies use naturally occurring processes to capture energy content in solid waste resulting in biogas production to generate energy.

- ***Landfill gas-to-energy.*** Landfill gas (LFG) is produced from the biological decomposition of organic waste in landfills. The amount and quality of gas produced depend on the landfill's size, age, and waste composition.
- ***Anaerobic digestion (AD).*** AD is a biochemical process that breaks down organic waste without oxygen and produces biogas and digestate. Biogas produced is approximately 50-60% methane and can be used to generate energy.

After capturing LFG and biogas, they can produce heat and electricity for engines, microturbines, and fuel cells. LFG and biogas can also be upgraded into renewable natural gas (RNG). RNG can be used in place of fossil natural gas, as pipeline-quality gas, compressed natural gas (CNG), or liquefied natural gas (LNG), and injected into natural gas pipelines or used as a vehicle fuel.

AD also creates digestate, defined as the remaining undigested solids and liquid fraction of the input feedstock material after the anaerobic digestion process. Digestate can be land applied or composted to produce a high-quality soil amendment.

Thermal Waste Conversion

Thermal combustion, also known as controlled combustion or thermal WtE, is one of the most widely adopted conversion technologies, with hundreds of active installations worldwide. Thermal WtE usually involves the combustion of solid waste and converts the combustible fraction of the solid waste stream into fuel for energy production. Steam can be used to generate thermal energy or electricity. Bottom ash and fly ash are additional byproducts of the thermal WtE process that may require landfill disposal. Depending on local regulations, bottom ash and fly ash can sometimes be used in construction applications; however, in other instances, fly ash may be classified as hazardous waste and must be disposed of accordingly.

- ***Advanced thermal conversion*** processes convert the carbon content of solid waste into a synthetic gas (syngas), which can then be used to create energy products such as liquid fuels, chemicals, or fertilizers or to generate electricity.

FACILITY OPERATIONS

- ***Gasification/pyrolysis.*** Gasification consists of the breakdown of hydrocarbons into syngas by carefully controlling the amount of oxygen present. Pyrolysis consists of thermal degradation of waste in the absence of air to produce char, pyrolysis oil, and syngas. Pyrolysis technologies have also been known to produce liquid fuel from plastics. While the process is essentially the same as pyrolysis processing solid waste, plastics to fuels pyrolysis produces a light liquid fuel that can be used as a substitute for petroleum or diesel fuels.
- ***Plasma arc or plasma gasification.*** Plasma arc uses high electrical energy and high temperatures created by an electrical arc gasifier to convert waste into syngas. Temperatures in the furnace can range between 1,800 and 27,000 degrees Fahrenheit. The resulting syngas can be converted into electricity, thermal energy for direct use, or ethanol as fuel. Slag is a vitreous material used as an aggregate for road construction or processed into slag wool for building insulation.

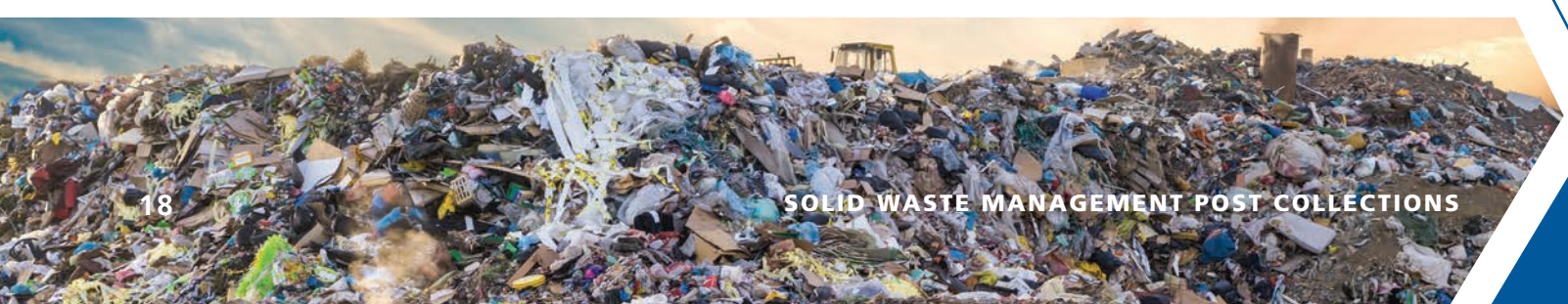
Once a community identifies the collection, recovery, and disposal alternatives for managing MSW, a cost-benefit analysis should be completed to determine the best alternatives. Analysis should also include estimates of elements that can offset costs, including revenues earned from recyclables, compost, and energy generation. Cost analysis should also consider that space saved in landfills now will likely be worth a great deal more in the future. If the community owns and operates the landfill, this is a long-term benefit of materials diversion.

Landfills

Modern landfills are well-engineered and managed facilities for the disposal of solid waste. Landfills are located, designed, operated, and monitored to ensure compliance with federal regulations. They are also designed to protect the environment from contaminants that may be present in the waste stream. Landfills cannot be built in environmentally sensitive areas and are placed using on-site environmental monitoring systems. These monitoring systems check for any sign of groundwater contamination and for landfill gas and provide additional safeguards. Today's landfills must meet stringent design, operation, and closure requirements established under RCRA.

There are multiple types of landfills, such as MSW, construction and demolition debris, and hazardous waste. This document will focus on MSW landfills, which are regulated under Subtitle D of RCRA and has seven primary components:

- ***Location restrictions*** ensure that landfills are built in suitable geological areas away from faults, wetlands, flood plains, or other restricted areas.
- ***Composite liner requirements*** include a flexible membrane (i.e., geo-membrane) overlaying two feet of compacted clay soil lining the bottom and sides of the landfill. They are used to protect groundwater and the underlying soil from leachate releases.
- ***Leachate[1] collection and removal systems*** sit on top of the composite liner and remove leachate from the landfill for treatment and disposal.
- ***Operating practices*** include compacting and covering waste frequently with several inches of soil. These practices help reduce odor, control litter, insects, and rodents, and protect public health.



FACILITY OPERATIONS

- ***Groundwater monitoring*** requires testing groundwater wells to determine whether waste materials have escaped from the landfill.
- ***Closure and post-closure care requirements*** include covering landfills and providing long-term care of closed landfills.
- ***Corrective action provisions*** control and clean up landfill releases and achieve groundwater protection standards.
- ***Financial assurance*** provides funding for environmental protection during and after landfill closure (i.e., closure and post-closure care).

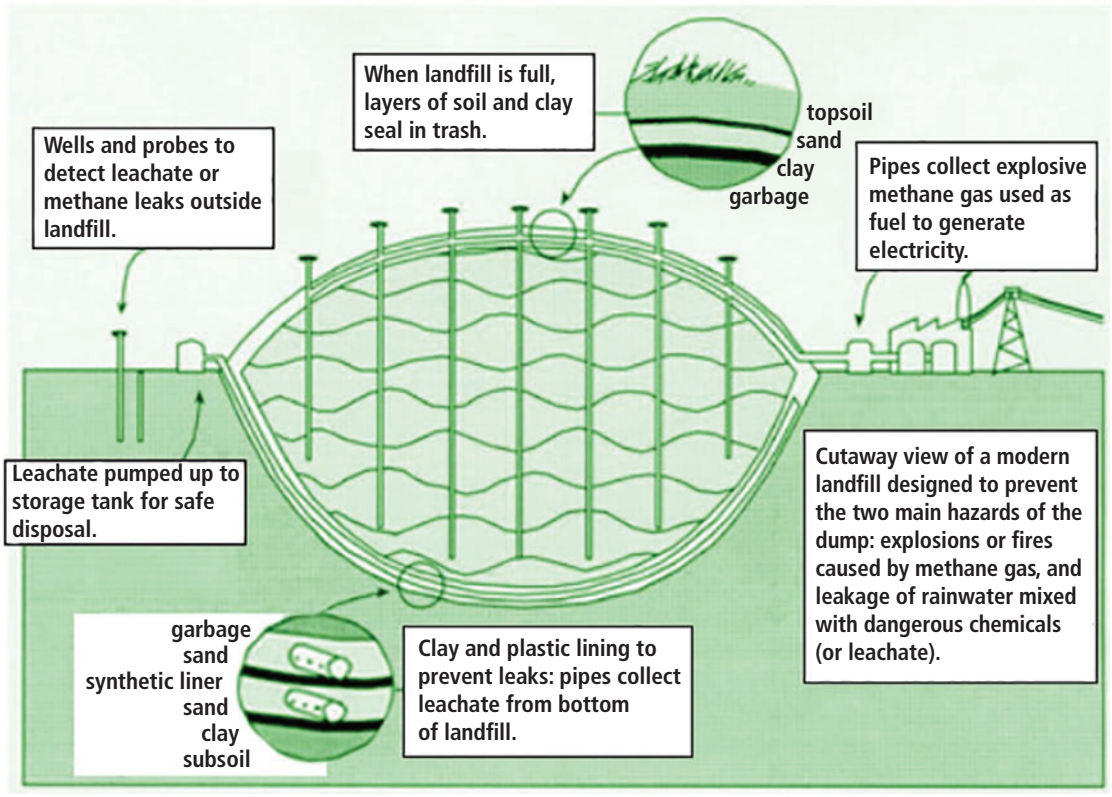


Image courtesy usa.gov

Some materials may be banned from disposal in MSW landfills, including common household items like paints, cleaners/chemicals, motor oil, batteries, and pesticides. Leftover portions of these products are called household hazardous waste. These products, if mishandled, can be dangerous to health and the environment. Many MSW landfills have a household hazardous waste drop-off station for these materials.

The image shows a cross-section of an MSW landfill.

[1]Landfill leachate is the liquid that leaches or drains from a landfill.

TYPES OF EQUIPMENT

Transfer Station

- Scales—to weigh material delivered to the transfer station as well as transported out of the facility
- Drop-off/roll-off containers—for residents or small haulers to deposit materials
- Front-end loaders—to move waste into the transfer trailers
- Transfer trailers—to transport waste from the transfer station to the final management facility

Landfill

- Compactor—compacts waste in landfill, "king of the working face," helps reduce the volume of waste, cleats are specifically designed for waste compaction versus soil compaction
- Dozer—pushes and levels waste in landfill cells, levels daily cover over working face
- Excavator—could be used for excavating cover material, maintaining gas lines, or trenching
- Motor grader—constructs cells, shapes drainage ditches, maintains access roads, grades land

Compost Operation

- Baggers—loads finished product into smaller-sized bags to market and sell
- Screens—removes contaminants or larger-sized material to make a consistent compost product
- Front-end loader—moves material around site, builds windrows, loads product
- Grinders—make incoming material smaller and more manageable throughout composting process
- Turners—drives over windrow to turn pile to mix material and incorporate air

Materials Recovery Facility

- Baler—compacts sorted materials in cubes and secures with wire
- Eddy current separator—repels aluminum off conveyor sorting line
- Glass crusher—grinds glass into pre-determined size
- Optical sorter—sorts plastics using a laser set to a certain frequency
- Screens—sorts objects by shape and size, paper rides along screen over top, 3D objects fall through screens onto conveyor for proper sorting
- Skid steer—moves material from receiving area onto sorting line

TYPES OF EQUIPMENT

Thermal WtE

- Overhead crane—mixes and lifts the delivered waste
- Furnace hoppers—incinerate the waste (at least 180˚F)
- Metal grates—move the waste
- Boiler tubes—absorb heat to produce steam
- Scrubber—where a water mist containing lime is mixed with the gases
- Baghouse—works like a large vacuum cleaner, collecting particles produced in the boiler and scrubber
- Turbine generator—produces electricity to run plant equipment. The remaining electricity, about 85 percent of the total, is sold to be used in homes and businesses.

Replacement Plan

All vehicles and equipment have a life span. When developing a replacement plan, it is important to include the following factors:

- Purchase price
- Resale potential
- Warranty coverage period
- Maintenance cost history and forecast
- Value of driver downtime
- Depreciation factors

The biggest benefit of a replacement plan is budget projections. This will allow organizations to recognize shortfalls during the budget process to ensure equipment is purchased on schedule. Fleet services would be heavily involved in developing a replacement plan.

Innovative Equipment Technology

Drones. From aerial photography to methane monitoring to waste density calculations, drones can serve various roles with less financial investment than traditional methods. Most commonly, drones capture aerial maps of your landfills without the high cost of aircraft or hours spent walking to get a topographic survey. This provides critical information for permitting, environmental monitoring, and landfill management at a fraction of the cost. There are hundreds of different hardware and software choices, such as GPS correction technology, cloud-computing software, and 3D surface modeling. When deciding on the best application of drone technology, be sure to check the Federal Aviation Administration and airspace regulations in your area.

TYPES OF EQUIPMENT

Mobile Inspection Technologies. The key to advancing landfill management for the next generation is improving the quantity and quality of real-time data capture so that leaders and managers can make informed, proactive decisions. One method to take that step is mobile inspection technologies, such as digital smart forms and mobile data capture devices. Field staff can use these mobile platforms to capture information in the field for real-time analysis. Additionally, these tools allow technicians to recall previous information in the field, allowing for smarter and more efficient troubleshooting. Inspection forms, flare station monitoring, load tracking, and MRF bale counts are a few examples of areas where applying mobile inspection technologies can revolutionize landfill management.

Internet of Things (IoT). With the wide integration of cloud-based information storage, the everyday application of IoT has great potential to maximize efficiency in post-collections. IoT is a term used to describe the internet interconnection of computing devices embedded in everyday objects, enabling computers to send and receive information over a wireless network without human intervention. The increased machine-to-machine communication delivers mobile, virtual, and instantaneous conditions at a site or route. For example, compactor equipment at a landfill equipped with an onboard wireless engine monitor might send an alert to the foreperson regarding an issue with high-coolant temperature. This system could simultaneously alert the maintenance team of the vehicles needing maintenance, the level of maintenance, which supplies to order, and schedule the vehicle on their calendars.

EMPLOYEE SAFETY ORIENTATION

Overview

All new or transferred employees should attend a safety orientation relevant to their work area. The supervisor must coordinate this training in conjunction with the safety analyst. Employees should sign and date the orientation sheet acknowledging they have received safety training. Each site's training matrix summary will establish the ongoing training requirements, including employee safety orientation for all department employees. The following is an example of a public work department's safety plan.

Hazards and Controls

Employees must understand and be informed about the hazards inherent in the working procedures and physical environment. Staff must be reminded periodically of these hazards and the appropriate controls to safeguard them. Information on the following subjects (at a minimum) should be provided at the initial safety orientation:

- Access to exposure and medical records
- Accident and injury reporting
- Bloodborne pathogens
- Commercial fleet safety (CDL requirements) or non-commercial fleet safety, as appropriate to position
- Confined space awareness
- Division safety rules
- Electrical awareness
- Emergency procedures
- Hazardous energy control (lockout/tagout)
- Slip, trip, and fall protection
- Fire and explosion
- Hazard communication
- Housekeeping
- Noise and hearing conservation
- Office safety
- Personal protective equipment (PPE)
- Portable ladders
- Portable work platform
- Power tools
- Powered industrial trucks/heavy equipment
- Workplace violence policy
- Work zone traffic safety (if required)

Training

Supervisors/site safety personnel should:

- Explain the importance of doing the task safely and properly, give step-by-step instructions on how to perform the task, and inform employees of the personal protective equipment that must be worn. Failure to follow safety requirements can injure the employee and/or other employees or other individuals. Failure to follow safety procedures can also result in disciplinary action up to and including termination.
- Demonstrate proper procedures and answer any questions the employee may have.
- Let the employee perform the task while observing to correct any incorrect procedure.
- Check back with the employee from time to time to see if the job is being done properly and if there are any questions.

EMPLOYEE SAFETY ORIENTATION

Managers and Supervisors

Department managers and supervisors, both frontline and mid-level, are accountable for administering the department's safety programs within their work units daily. They must comprehensively understand the safety requirements to carry out the duties of the staff assigned to them. In most circumstances, safety-related matters arising in the work unit should be addressed at the supervisory level in the department. Safety responsibilities include:

- Encouraging employees to report all unsafe or hazardous conditions and take corrective action.
- Recognizing and acknowledging excellent safety performance.
- Providing safety orientation before a new employee begins their job activity.
- Coaching, mentoring, and counseling employees on the importance of workplace safety behaviors.
- Seeking to expand their safety knowledge through training, mentoring, self-study, or other continual learning methods.
- Investigating job-related injuries and vehicle accidents.
- Clearly communicating the safety expectations for employees within their work unit, which includes compliance with the business area's safety program and guidelines issued by the county's risk management division or other agencies on safety-related matters, the employees' required attendance at safety-related training, and the use of assigned PPE.
- Resolving safety-related matters promptly, including but not limited to incident prevention, training, hazard assessment, and supervisors' federal, state, local, and county-compliance responsibilities.
- Attending required safety training and authorizing time for direct reports to participate in safety-related training.
- Providing routine safety meetings for communicating safety-related information as it relates specifically to the work unit.
- Ensuring that findings from reviews of the business area's safety program regarding their respective work unit are addressed promptly.
- Investigating and documenting all accidents, injuries, and incidents following the division and risk management policies and guidelines and taking necessary action due to the findings.
- Reporting all unsafe and unhealthy working conditions to the division's safety analyst or other appropriate person.
- Ensuring employees are provided with the required workers' compensation, injury leave, family medical leave, and information and forms when a job-related injury/accident/illness occurs.
- Reporting all job-related accidents, injuries, illnesses, and near misses to the division's safety analyst.
- Stopping work immediately if unsafe working conditions exist and notifying the division's safety analyst immediately.
- Recommending or developing disciplinary action for unsafe behavior or performance to the department area or division manager.
- Coordinating with the business area's safety analyst in providing necessary documentation and information on accidents, injuries, or illnesses, scheduling safety training, conducting hazard assessments, or other safety-related matters.
- Calling 9-1-1 immediately for injuries or illnesses requiring emergency medical attention.

EMPLOYEE SAFETY ORIENTATION

Incident Investigation and Prevention

- Assist supervisors and managers in investigating and reviewing all job-related accidents, incidents, and reported near-misses. Compile, analyze, and interpret incident statistical data and prepare and submit necessary injury forms and reports to directors and other managers.
- Participate in area accident review processes and makes recommendations for safety corrective actions to perform tasks safely and according to established procedures.
- Develop programs and/or review employee training from a safety perspective to eliminate the frequency, severity, and cost of accidents (injury, vehicle, etc.) and occupational illnesses.
- Administer, monitor, and evaluate the incident prevention program and recommend areas for safety and health improvement/enhancement.

Safety Council

Many departments have safety councils responsible for implementing and collaboratively improving department-wide workplace safety and health practices and processes. The council is typically comprised of safety analysts and safety representatives from all departments, in addition to participation from the director's office, human resources, and the risk management division.

The council is responsible for developing and managing the safety program, which includes ensuring that the program meets all relevant requirements, remains current, and is revised to address the department's safety needs as appropriate.

Safety council responsibilities include:

- Working to promote safety within the entire department is a critical core value.
- Providing the entire department and its business areas with a resource for safety oversight and initiatives.
- Assisting other safety analysts with internal self-audits of safety programs and procedures.
- Preparing, updating, and implementing the strategic safety plan.
- Developing and implementing department-wide safety training.
- Coordinating department-wide safety and health initiatives with the risk management division.
- Identifying and developing ways to improve inter-business area safety resources.
- Providing recommendations for department-wide safety policies and practices.

EMPLOYEE SAFETY ORIENTATION

Supervisors and managers are accountable for the day-to-day management and execution of their respective safety programs. Business area safety programs shall be kept current and comply with applicable federal, state, and local laws, regulations, codes, and standards.

Committee Structure and Design

The Safety Committee could be chaired by a person chosen by the safety program manager. Committee membership could include at least one representative from each "work area" at the facility and at least one member of management. Meetings may be conducted monthly or at a frequency selected by the committee. Meeting agendas, minutes, and attendance records will be recorded and maintained. The committee will choose the membership term of service. It will include a provision to regularly rotate membership to provide broad staff involvement in this role.

Responsibilities

The responsibilities of a safety committee could include:

- Participate and assist in the organization of safety training programs.
- Determine if safety programs and training are effective.
- Verify that supervisors, managers, and directors conduct safety observations to detect unsafe conditions and acts and that actions are taken to reduce risks and deficiencies.
- Review, implement, and improve safety and health policies and procedures that address safety requirements.
- Make recommendations to eliminate, reduce, or control hazards.
- Assist with occasional safety inspections, identify unsafe work practices or conditions, and recommend corrective measures.
- Collect and provide information regarding safety to management and employees regularly.
- Conduct accident reviews of occupational injuries, vehicular collisions, near misses, and other significant work-related events. Analyze the incident's root cause and determine what corrective action should be taken to prevent a recurrence. Inform employees and management of the findings.

EMPLOYEE SAFETY ORIENTATION

- Encourage feedback from individuals regarding safety and health-related issues, ideas, and solutions.
- Provide support and serve as a resource in the development, implementation, and maintenance of the comprehensive safety program; and
- Serve (along with the safety analyst) as a resource and advisory body to management on safety and health issues.

Secretary

- Ensure meeting minutes are recorded, completed, and distributed.
- Distribute the agenda with minutes to committee members.
- Take and record attendance.
- Distribute any correspondence and/or directives developed by the committee.
- Develop and maintain files of meetings and correspondence.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Overview

Personal protective equipment (PPE) should be provided, used, and maintained when determined that its use will lessen the likelihood of occupational injuries and/or illnesses. Management will ensure the appropriate PPE is available/provided.

Responsibilities

Safety personnel should evaluate all tasks/jobs and determine the appropriate PPE required to be worn by employees and others performing those tasks/jobs. Management and supervisors are responsible for ensuring that employees use all required PPE as specified by the hazard assessment. They must also ensure that employees are trained on the proper use and care of the equipment. Management and supervisors are responsible for monitoring the condition of employees' PPE. They must stress to employees that it is their responsibility to care for their PPE and that they may be disciplined if they destroy it due to careless handling.

Employees must use and maintain their PPE and inform supervisors when replacements are needed. All PPE must be kept clean and properly maintained. Employees shall not alter, abuse or misuse PPE issued to them and shall wear all PPE as designed and intended for use.

Protective Devices

Only equipment that meets the appropriate NIOSH (National Institute of Occupational Safety and Health) or ANSI (American National Standards Institute) standards will be accepted for use. PPE recommendations/requirements are detailed by task or work area in the Hazard Assessment.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Eye and Face Protection

Eye protection is required when there is a potential for injury to the eyes or face from flying particles, chemical hazards, radiation hazards, or a combination. Eyeglasses designed for ordinary wear do not provide the level of protection necessary to protect against workplace hazards. If an individual wears personal prescription glasses, they shall be provided with suitable eye protection to wear over the prescription glasses or may request prescription safety eyewear.

Head Protection

Head protection will be furnished to and used by all employees when there is a potential for a head injury. Hard hats are required when there is a potential for injuries from falling or flying objects (such as when walking below other employees, where materials could fall, or by bumping the head against a fixed object) or where the potential of electrical shock hazards exists. Hard hats are required when working in any construction work area. Additionally, employees working and/or observing crane operations from ground level and within 25 feet of the crane's knuckle boom must wear a hard hat while the boom is in operation.

NOTE: Periodic cleaning and inspection will extend the useful life of protective headgear. A daily inspection of the hard hat shell, suspension system, and other accessories for holes, cracks, tears or other damage that might compromise the protective value of the hat is essential.

Perforation, cracking, or deformity of the brim or shell

Always replace a hard hat if it sustains an impact, even if the damage is not noticeable. Suspension systems are offered as replacement parts and should be replaced when damaged or when excessive wear is noticed.

Foot and Ankle Protection

Employees can be subjected to slipping, uneven terrain, abrasion, puncture hazards, crushing potential, impact hazards, rolling objects, corrosive substances, electrical hazards, and other recognizable hazards. An employee's footwear must be of the design, construction, and material appropriate to these hazards. For example, a boot policy may require that all staff working outside of the office or in otherwise hazardous areas wear safety boots that meet the following criteria:

- Minimum 6-inch-high uppers
- Steel or composite toe protection
- Puncture-resistant soles

High-Visibility Clothing

High-visibility clothing is required for staff on-site at disposal facilities, on collection routes, and other locations where heavy equipment is operating or where other conditions warrant wearing high-visibility clothing. For example, the uniform policy may require that all staff working outside the office or in otherwise hazardous areas always wear Class 3 shirts and/or safety vests.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Hearing Conservation

Exposure to high noise levels can cause hearing impairment and create physical and psychological stress and injury. Certain jobs and tasks may require employees and others to wear hearing protection devices. Any such devices required will be supplied by the site.

Controlled Access Zones

A controlled access zone is a work area designated and marked in which certain types of work may occur without conventional fall protection systems (guardrail, personal arrest, or restraint). Controlled access zones are used to keep out workers other than those authorized to enter work areas for which guardrails or covers are not in place or have been removed. Authorized employees must stay at least 15 feet from the edge of any unguarded fall hazard (e.g., roof edge, skylight, excavation edge). A safety monitor shall be assigned whenever employees work around controlled access zones. The safety monitor must: be able to recognize fall hazards, warn workers of fall hazard dangers, be able to see the worker(s), and be able to communicate with workers orally.

Access zones shall only be permitted with the approval of the site safety analyst and complex manager and with specific written procedures developed for their use. Controlled access zones must be defined by signage, marking, a control line, or other means that restrict access.

Slips, Trips, and Falls

One of the leading causes of workplace injuries is slips, trips, and falls. The primary causes of slips/trips/falls in the workplace include:

- Foreign objects on the walking surface
- Flaws in the walking surface
- Lack of fall protection (such as barricades or guardrails)
- Damaged equipment or improper setup
- Slippery or wet surfaces
- Employee's impaired physical condition
- Distractions

Slip and Trip Prevention

Key elements to control slips, trips, and falls include:

- Provide additional carpets to prevent slip hazards at entrances during inclement weather. Encourage employees to report and/or clean up spills immediately.
- Elevated surfaces can cause fall hazards—standing on chairs, improvised platforms, or climbing on shelves are all unsafe practices that should be prohibited.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Walking on level surfaces can be a tripping hazard when employees are unaware of the surroundings—curbs, items on the floor, and other protrusions should be marked and protected by padding or other suitable guarding.

- Damaged flooring, carpeting, tile, sidewalks, parking lots, and other uneven surfaces or in otherwise poor condition should be reported and repaired by site or building maintenance staff, as appropriate, as quickly as possible.
- Cleaning or reconditioning floors requires appropriate safeguards such as wet floor signage.
- Footwear appropriate for the walking or working surface must be used.
- Ladders should be well constructed and have non-skid bases. Remove damaged equipment from service.
- Work areas should have adequate lighting since lack of visibility can conceal hazards.
- Employees should avoid carrying loads that block vision. Instruct them to obtain help or use mechanical aids.
- When left in walkways, tripping hazards can exist from electrical cords, chairs, papers, wastebaskets, boxes, and other items. Efforts should be made to keep walkways clear and unobstructed.

ENVIRONMENTAL COMPLIANCE

Waste moving from collections to post-collections is routed to various destinations depending on the type of waste. MSW is often delivered to a transfer station, reloaded onto transfer trucks for delivery to an MSW landfill, or hauled directly to the landfill. Similarly, recyclables are brought to a transfer station and routed to a materials recovery facility (MRF) or delivered directly to an MRF. Recyclables are separated and sold at the current market value. Organic material, if collected separately, can be routed to either compost facilities or a waste-to-energy type facility. All these post-collection operations have different environmental compliance considerations.

Throughout the waste management process, several major federal laws frame how we manage, permit, and dispose of waste. These include the:

- ***Clean Air Act,*** which regulates air emissions from stationary and mobile sources, such as a landfill gas flare;
- ***Clean Water Act,*** which regulates discharges of pollutants into US waters, such as stormwater; and
- ***Resource Conversation and Recovery Act (RCRA),*** which regulates the management of hazardous and non-hazardous solid waste.

It is important to familiarize yourself with the requirements and history of these crucial environmental protection acts to ensure waste handling is done in a manner that protects human health and the environment.

As a public works director, protecting human health and the environment should be one of your top priorities. Moving waste through the post-collections stream can inflict significant damage if proper consideration is not given to the role of environmental compliance. These considerations include permitting, environmental control systems, environmental monitoring, and reporting. If these boxes are properly checked, you are doing your part in proper environmental compliance in solid waste post collections.

ENVIRONMENTAL COMPLIANCE

Permitting

Approval of a permit is the regulatory authority permitting you to operate your facility following each agency's rules and regulations. Permits are issued after an application is submitted, reviewed, approved, and a fee paid. Permits may have general conditions that apply to various sites and conditions; permits may also have specific conditions that are site-specific and more stringent than general conditions. The permits you will need to obtain, and maintain, will vary based on your facility's operating conditions and region-specific requirements. Some states may not require a permit for a particular facility, while others may require a slew of permits for a facility of similar function. Contracting with a consultant well-versed in navigating the permits required for your facility is advisable. Please note you will likely require multiple permits from multiple agencies as the permits are typically designed based on the program.

As public works director, you will oversee various facilities and operations that all need their own permits. Permits typically contain recordkeeping, monitoring, and reporting conditions necessary to demonstrate compliance with all applicable requirements. The following is a list of common permits that you may encounter while keeping your sites in compliance:

Solid Waste Facility Permit

A solid waste facility permit is generally obtained at the state level through the Department of Environmental Quality and requires a Solid Waste Facility Plan (describes how site operations will work) and initial and annual fees. Site-specific operations will require specific permits, such as a hazardous waste facility permit if you accept hazardous waste or a waste tire collection permit if you accept waste tires. In most cases, solid waste permitting is managed by the state or local jurisdiction delegated by the federal government. Therefore, the requirements will vary considerably depending upon the state requirements.

Air Quality Permit

Air emissions typically occur from dusty and dry material being dropped off or loaded, vehicle and equipment exhaust, and cleanup operations. The type of air permits you need will depend on the scale and location of your operation. A Non-Title V Air Quality Operating Permit is typical for transfer stations, and requirements include owner information, a site diagram, an operations and maintenance plan, equipment lists, a dust control plan, and estimated emissions. Larger sites with a higher potential to emit pollutants, such as an active landfill, will likely require a Title V air permit. Title V permits contain applicable requirements from local air pollution rules and regulations, state implementation plan requirements, New Source Performance Standards (40 CFR Part 60), and National Emissions Standards for Hazardous Air Pollutants (NESHAP) standards (40 CFR Parts 61 and 63). Many of the permitting requirements are defined in the Clean Air Act, but several states have additional requirements that must be followed.

ENVIRONMENTAL COMPLIANCE

Stormwater Discharge Permit

Rainfall and wash water will flow over the transfer station or landfill surface and can transport pollutants to stormwater systems. The EPA developed stormwater permitting regulations under the National Pollutant Discharge Elimination System (NPDES) to control stormwater contamination by industrial activities. Permitting authorities are typically either the EPA or at the state level. Requirements to obtain a stormwater discharge permit include a written Stormwater Pollution Prevention Plan (SWPPP), implementation of control measures, submittal of a notice of intent (NOI), and fee payment. Stormwater sampling and testing requirements will vary based on site usage and exposure potential. Stormwater permits are typically valid for five years.

Water Quality Permit

These permits are typically obtained if your site has the potential to discharge pollutants into the groundwater, or the water is used as drinking water, and these types of systems are subject to water standards included in your permit. Groundwater quality permits typically include a groundwater monitoring program specific to your site's geology and hydrology. Drinking water permits typically include regular monitoring of water quality. The type of monitoring required and the standards to be met will be included in your permit. Water quality standards (WQS) and their associated permits are provisions of each state, as delegated by the EPA. These WQS are the legal basis for controlling pollutants entering US waters. Landfills may require permits pertaining to the federal WQS to ensure the protection of surface and groundwater. Understanding your state's requirements is an important step in managing your landfill.

404 Permits

If activities at your site occur inside the ordinary high-water mark of US waters, then a Section 404 permit may be required from the US Army Corps of Engineers. The level of permit needed will depend on the activities and amount of land disturbance expected; if impacts are minimal, a General 404 permit may be obtained on a regional or state basis.

Environmental Control Systems

Environmental control systems at your site are designed to mitigate potential negative impacts on your facility's surrounding areas. Issues such as litter, odors, vector breeding, hazardous waste screening, and dust control must be routinely controlled.

- ***Litter:*** Pieces of waste routinely become litter in and around transfer stations, landfills, and recycling centers. Help mitigate litter transport by installing perimeter fencing, frequently removing wind-blown litter from around the site, and regularly cleaning vehicles and equipment.
- ***Odor:*** Waste materials have a high potential for causing odor problems. Help control odors at your site by maintaining a "first in, first out" operation, removing or covering all waste at the end of each workday, and regularly monitoring that good housekeeping procedures are followed.

ENVIRONMENTAL COMPLIANCE

- ***Vector breeding:*** Insects, rodents, and birds can quickly become a nuisance and a public health concern. Waste materials are a prime medium for the breeding of pests. Help control the breeding of these vectors by following good housekeeping procedures and maintaining a contract with a pest control company.
- ***Hazardous waste screening:*** The exclusion of hazardous waste is required by 40 CFR 258.20. The requirements include implementing a program that includes random inspections, recordkeeping, and personnel training.
- ***Dust:*** Generation of airborne dust at your site is typically the result of dry material being loaded or unloaded, driving on dusty surfaces, and cleanup operations. Control dust by following your site-specific dust control plan and applying water to the material being loaded and unloaded.
- ***Stormwater:*** Stormwater control is needed to keep surface water free of runoff contamination from waste, sediment, fuel, and oil. Discharge of stormwater needs a permit and typically requires sampling and testing, determined by the activities at your site and the waters you will discharge to. Help maintain the quality of your local waters by properly controlling and discharging stormwater.

There are two types of control systems typically found at landfills: engineering and operational. Engineering controls are strategies designed to remove or stop environmental nuisances. Some examples are landfill liner systems, which protect groundwater through a physical barrier system; gas control and collection systems, which prevent harmful gas migration; and landfill final cover, which prevents the creation of breeding vectors and fire. Operational controls are processes put in place by your organization to reduce environmental impact, typically managed and executed by people rather than physical infrastructure or systems. Some examples include litter control, odor control, and vector control through people-oriented processes.

Environmental Monitoring

Air and water compliance monitoring is needed to ensure the Clean Air Act and the Clean Water Act and associated laws and regulations are followed. Hazardous waste monitoring is needed to ensure compliance with the Resource Conservation and Recovery Act. The EPA coordinates with federal, state, and tribal regulators to monitor your site for compliance. Your site may be subject to various regulations from federal, state, tribal, and local authorities, but the state and local regulatory programs are most common in public works. Typical regulations may include design and operational standards, closure and financial assurance plans, and siting restrictions.

The type and scale of your facility's operation will determine the level of environmental monitoring you will be required to perform. Monitoring is an integral part of maintaining environmental compliance. Contracting with a knowledgeable consultant to provide these services is recommended. Typical monitoring activities include verification of proper equipment operation, data collection and analysis, site condition monitoring (litter, erosion, etc.), and other monitoring activities required by your site-specific permits.

ENVIRONMENTAL COMPLIANCE

Reporting

Reporting is the submittal of required documentation to regulatory authorities. The conditions outlined in your site's permits will determine your specific reporting requirements. Common reports include annual emissions inventory for air quality, discharge monitoring reports for stormwater, and annual tonnage reports for solid waste. The timely and accurate submittal of documentation is required to maintain environmental compliance. There are best management practices (BMP) to ensure compliance and timely reporting that leaders should consider in their programs. Below are some BMP strategies to consider:

- Contracting with a consultant to prepare, review, and finalize reports offers a third-party perspective to your compliance documentation.
- Generating a compliance tracking system in your organization helps leaders and staff stay on track with deadlines and requirements. Consider digital solutions to curate transparency in your team.
- Developing an internal inspection/audit system can help your organization prepare for annual inspections. Use prior inspection reports from your regulators to create the benchmark of comparison with your inspection team.
- Be prepared to organize and document all actions taken, no matter how small they may seem. Having a clear timeline of your compliance tasks and responsibilities will help you during your reporting periods.

MARKETS

Locating markets for recyclables, compost, and renewable energy is essential for closing the recycling loop and getting resources back into use. Before starting a landfill diversion program, markets for products must be secured. This section of the Guide provides basic information on marketing recyclables, compost, and renewable energy.

Types of Buyers

Recyclables

Once recyclables are collected, they must be moved to a business that remanufactures them into a new product. End-users or manufacturers are the businesses that make the new product. Three types of buyers provide intermediate services to collect, process, and ultimately sell recyclables to end markets. They are commonly categorized as collectors or haulers, processors or material recovery facilities (MRF), or brokers, although the exact terms may vary.

- Collectors or haulers are typically businesses that have expanded their garbage operations to collect recyclables from residents and businesses. Haulers most often charge for their collection service; some may pay small amounts for recyclables. Most will accept clean, unprocessed recyclables, either source-separated by the residents or commingled (mixed recyclables in a single bag or bin). These materials are marketed to an intermediate processor or an end-use market.
- Processors (often called material recovery facilities—MRFs) generally accept and process recyclables from residential, business, or industrial sources. Processors typically sort materials by type and grade and then bale, shred, or granulate them to create a marketable intermediate product. These buyers sell to brokers or end-use markets.
- Brokers buy and sell recyclable materials and often arrange to have them shipped from one location to another by haulers or processors. Some brokers provide processing services, while others purchase only processed recyclables. Brokers generally sell to end-use markets and often pay premium prices because they accumulate and sell large quantities of materials. They usually prefer to purchase trailer-load quantities of recyclables.
- End-users, or manufacturers, purchase recyclable materials from several sources and remanufacture those materials into new products. They generally deal only in trailer-load quantities and usually purchase materials from regular suppliers (those able to provide consistent quality and quantity monthly). However, some specialized end-users, such as animal bedding manufacturers, often purchase smaller quantities.

MARKETS

Some general rules of thumb usually apply to these four types of buyers. Preparation and separation requirements are usually most flexible with haulers and become increasingly stringent with processors, brokers, and end-users/manufacturers. Accordingly, prices are generally lowest with haulers and increase with processors, brokers, and end-users/manufacturers. Service fees usually are higher for haulers and lower for manufacturers.

Compost

Compost can be processed for use as a soil amendment, turf top dressing, mulch, or erosion control media. It can be further refined into a soil nutrient or blended to use in various high-end applications. Because of compost's versatility, the best application for a particular product—and thus the end users who can best use it—is determined by its characteristics. The table below shows compatible products and feedstocks.

Compatible Products and Feedstocks

PRODUCT	COMPATIBLE FEEDSTOCKS	NOT-SO-COMPATIBLE FEEDSTOCKS
Mulch/erosion control	Bark, wood, lumber, green organics, brush	Manure, biosolids, mushrooms
Soil amendment—field, turf soil, landscape beds	Green organics, manure, biosolids, food, mushroom	Wood
Top dress—turf and field soils	Manure, grass, leaves, food, screened biosolids, and green organics	Wood, unscreened green organics
Soil amendment—organic agriculture	Manure, green organics without pesticides	Biosolids, grass with pesticides
Land reclamations/landfill	Contaminated green organics, municipal solid waste	Clean and nutrient-rich organics

MARKETS

Waste Conversion

It is typically not the responsibility of public works departments to market the energy or products created by waste conversion technologies. Even if the municipality owns the waste conversion plant, it is usually operated by a private company. This does not mean municipalities should not be concerned with the marketability of waste conversion products.

Most revenue for waste conversion technologies comes from product sales and tipping fees on waste receipts. If product sales fail to meet expectations, the fees plants charge to accept municipal waste will increase. A city may have a contract limiting the tipping fee that is charged. However, they may have nowhere to take their waste if the plant does not generate enough revenue to keep its doors open. Thus, it is imperative to consistently conduct due diligence on a conversion technology's ability to create a marketable product.

Conversion technologies use various temperatures to recover the energy content present in the waste. Technology options and the products they create are classified according to the heat spectrum through which waste conversion is achieved: biological, thermal, and advanced thermal conversion.

ATTACHMENT A

Establishing Tipping Fees

To estimate the tipping fees for a solid waste facility, a public works department needs to identify the costs for developing, operating, and maintaining the facility. Below are the costs associated with the conceptual landfill cost model. This model assumes the landfill will accept waste for 30 years. However, costs will span over 60 years, from upfront costs at the beginning of the project to ongoing construction of the facility to final management after facility closure. The table below shows the total, approximate cost for each phase of the landfill, as well as Year 1 estimated annualized cost.

Phase	Total Cost	Period for Debt/Accrual	Year 1 Annualized Cost
Pre-Development	$2,370,500	NA; Upfront Cost	NA
Site Development; includes first phase of construction	$27,972,100 + $2,672,000	20-year debt	$2,059,800
Construction Cost, every three years	$2,672,000	3-year accrual	$973,300
Operating & Maintenance Cost	$3,741,000	NA; Annual Cost	$3,741,000
Closure Cost	$6,278,400	30-year accrual	$742,300
Post-Closure Cost	$691,900×30	30-year accrual	$1,059,000
Annual Costs (does not include Pre-Development)			$8,575,400

Assumptions for deriving these cost estimates are provided below.

For the financial analysis, the following assumptions were used for a 700 tpd landfill facility:

- Pre-development costs are approximately $2.4 million and include:
  - Site selection and feasibility evaluation
  - Legal and community relations
  - Subsurface investigations, engineering, and surveying
  - Pre-development costs would not be financed; they would be paid out of an initial fund for landfill development
- Site development is approximately $2.1 million. Site development expenses include:
  - 300 acres of land
  - Site development and infrastructure
  - Facility equipment (compactors, excavator, dozers, etc.)
  - Construction of first disposal cell
  - Engineering, surveying, and oversight
  - Site development costs financed through 20-year revenue bonds at a rate of 3%

ATTACHMENT A

- Landfill construction will occur every three years starting in Year 4
  - Construction of a disposal area (called a cell) will be approximately 8.3 acres and will cost approximately $2.7 million in 2018 dollars. However, based on a 3% inflation rate, cell construction will cost approximately $2.9 million.
  - Approximately $973,000 will need to be set aside for the first three years of landfill operation to pay for cell construction in Year 4.
  - A total of 10 cells will be constructed over the 30-year life.
- Operating and maintenance (O&M) costs in Year 1 would be approximately $3.7 million and include:
  - Salaries
  - Equipment maintenance and an equipment replacement reserve fund
  - Leachate management/treatment/disposal
  - Environmental monitoring and compliance
- Landfill closure will occur in two phases: Year 20 and Year 30. Each phase would cost approximately $6.3 million in 2018 dollars. However, based on a 3% inflation rate, the Year 20 closure could cost approximately $11 million, and the Year 30 closure could cost approximately $15 million.
  - Closure includes construction of the final cover system and associated systems, as well as engineering, surveying, and oversight.
  - 41.1 acres will be closed in Year 20; the final 41.1 acres will be closed in Year 30.
  - Approximately $742,000 will be contributed to a closure fund during each year of operation to fully fund the anticipated closure expenses of $11 million in Year 20 and $15 million in Year 30.
- Post-closure care will continue each year for 30 years after final closure (Years 31 through 60). Post-closure care would cost approximately $21 million in 2018 dollars. However, based on a 3% inflation rate, approximately $50 million dollars in post-closure care funds may need to be accrued by Year 31. Post-closure care costs include:
  - Leachate management/treatment/disposal
  - Maintenance and environmental monitoring
  - Approximately $1 million will be appropriated to a post-closure fund during each year of operation to fully fund the post-closure expenses starting in Year 31.