Waste Landfills

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Caterpillar® Equipment Selection and Application Guide

CATERPILLAR®

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Waste Landfills

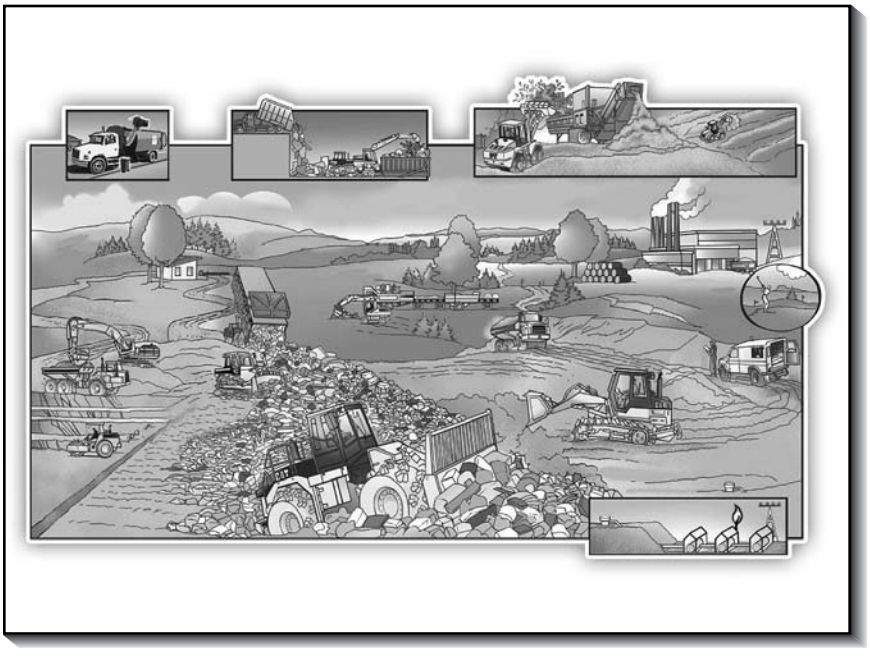
About This Selection Guide

It takes a variety of equipment to run a landfill. It also takes a lot of planning to select the right equipment for the job. Initial cost is only one factor in the purchase decision. Machine and parts availability and equipment life-cycle costs are other factors you should consider. This selection guide provides a process for choosing the right equipment from Caterpillar's complete line of purpose-built machines and work tools. Of course the final selection must be based on the unique circumstances of your landfill. Your local Cat® dealer is an excellent resource. Dealer representatives know operating and maintenance costs and can help you select the best equipment for your operation.

It's important to understand the life cycle of a landfill. From **land acquisition** to the closing of the site, each stage of the cycle is vital to a successful operation. It begins with picking the right site and following up with **required approvals**. **Developing** an environmentally friendly site using professional engineers creates a solid foundation for your business. To maximize value you will have to monitor **daily operations** and utilize nearby **transfer stations and recycling centers**. **Incineration** is a process that changes the physical, chemical and biological composition of waste to render it harmless or reduce its volume. **Electricity generated** from landfill gas can provide an additional revenue source and benefit the environment. The **final use** of the land should be part of the initial landfill planning. Closed-out sites can be converted to golf courses, baseball diamonds, soccer fields and parks. If the landfill has been properly designed and operated, its final use is virtually unlimited.

Scope

The scope of this guide is global. The philosophy, design and techniques used in solid waste processing tend to be regional. The broad equipment principles explained here apply anywhere. You may adapt them to site-specific circumstances. If you want to expand your existing landfill operation, these principles will guide you through the process of increasing operational efficiencies. This guide also shows you how to be flexible in the design phase to achieve optimum results.



How to Get the Most Out of This Selection Guide

This guide is organized by sections. Each section helps the user through the process of selecting the right equipment for specific landfill operations by building on information provided in the previous section. Various types of landfills are described in the **About Waste Landfills** section. Also included are factors to consider when planning a landfill site. In the **Landfill Methods and Operations** section, topics include how to efficiently and safely manage a landfill, control of gas and leachate and tips for successful compaction. The **Machine Profiles** section covers the primary and support equipment most appropriate for various landfill applications. The **Systems Section** helps you match machines to specific landfill applications and type of waste. It is critical to select a machine or machine combination that will increase the production and efficiency of your landfill. In the **Machine Operating Efficiencies Section** factors such as traction, push power and operator ability are reviewed. The **Worksheet Section** contains worksheets that can be photocopied and used as templates to assure all information—application data, machine specifications and site requirements—are taken into consideration in the machine selection process. Everyone, even those experienced in the solid waste industry, is encouraged to read the selection guide from front to back. It may give you a fresh look at the machine-buying process or lead you to consider new possibilities.

We hope this guide, along with advice from your local Cat dealer, helps you make an easier, more informed decision.

Waste Information

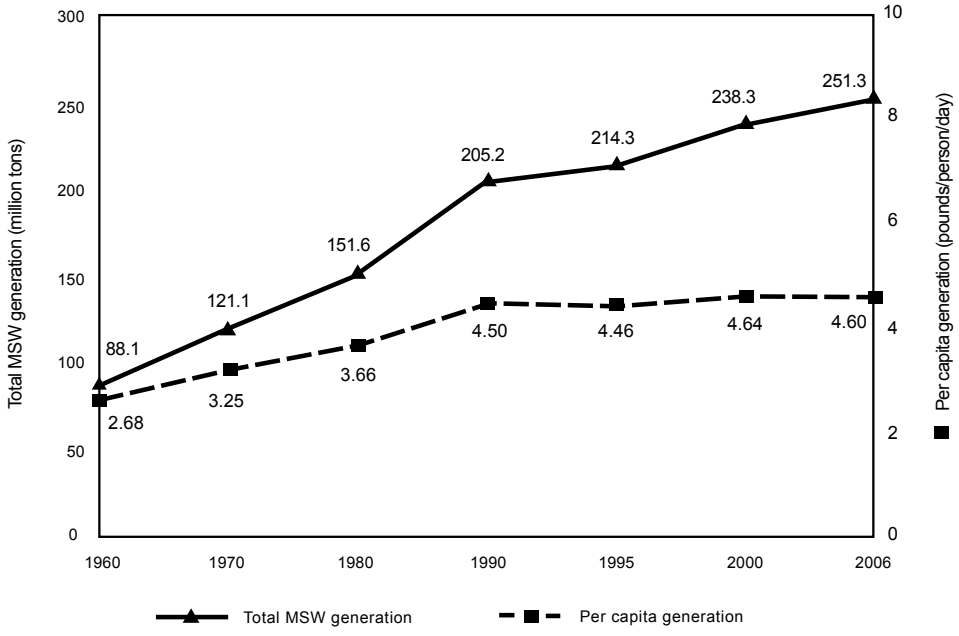
Everybody creates waste that must be disposed of properly. The amount of waste created steadily rose from 1960 until 1990, but has since leveled (see chart). According to 2003 Environmental Protection Agency (EPA) data, in the United States, one person generates an average of four and a half pounds of municipal solid waste (MSW) each day. That adds up to more than 236 million tons (214 million metric tons) of MSW per year. Only 31 percent of that waste is either recycled or composted. The other 69% is discarded in landfills. Approximately 1,767 landfills receive more than half of all U.S. solid waste. While city and county governments own 65% of these landfills, the balance is privately owned. The need for more landfills grows with the amount of generated waste – and not just in the U.S. As more countries become industrialized, we can expect to see more waste being generated.

Landfill Types

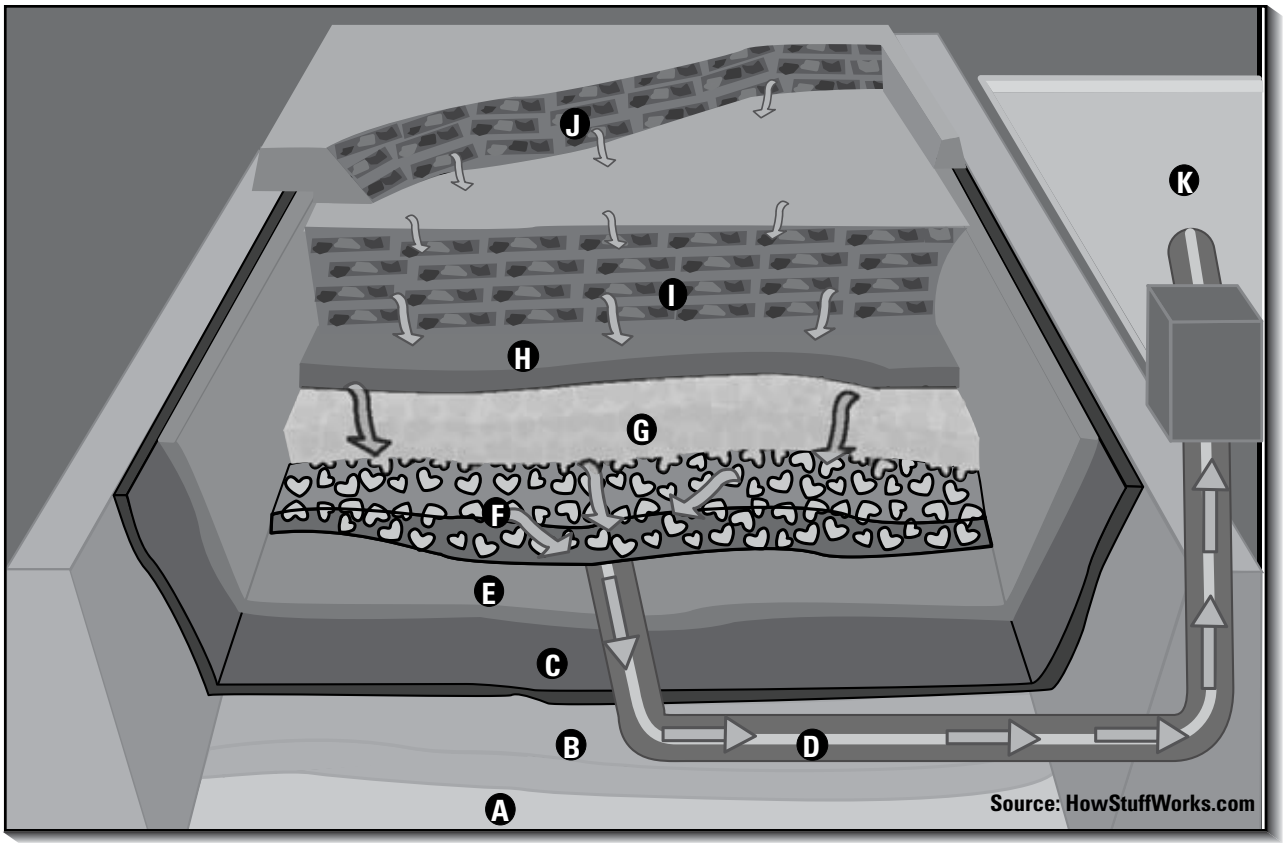
To determine which machines and work tools best suit your needs will depend on your type of operation. There are four general types of landfills.

- **Municipal Solid Waste Landfills** are the type typically seen in U.S. communities. They receive and process waste materials like paper, wood, plastic, glass, rubber, textiles, organic waste, yard waste and other miscellaneous items. The typical MSW landfill is a combination of systems that hold waste in sections or cells. Cells are separated from the surrounding environment by clay and impermeable membrane liners. Collected waste in MSW landfills is compacted. In other words, weight is applied to the waste in a controlled systematic method, increasing the density of material. The denser the material in a landfill, the more waste a landfill can accommodate.
- **Construction and Demolition Landfills** consist of waste like concrete, construction lumber, trees, roofing materials, industrial soils or sludge, iron, steel, aluminum, metals and other miscellaneous items. Just as in MSW landfills, construction and demolition, or C & D waste is placed in sections or cells in the landfill. Cells are separated from the surrounding environment by both clay and an impermeable membrane liner. The already dense construction and demolition waste in these landfills is shredded and compacted further so it will fill the least amount of airspace possible. Construction and demolition landfills are often harsher environments than typical MSW landfills.
- **Bioreactor Landfills** are similar to MSW landfills. The main difference is the acceleration of the decomposition process, accomplished by adding liquids to the waste mass to reach optimal moisture content. Accelerated decomposition provides more useful space and increases the life of the landfill. Waste stabilization is also sped up in bioreactor landfills. As the landfills become stable, the land can be converted to other uses much sooner than MSW landfills. Other benefits of bioreactor landfills include more rapid generation of methane and the recirculation of leachate. Methane gas can be used to power projects while decreasing greenhouse gas emissions over the life of a landfill. The recirculation of leachate reduces treatment and hauling costs.
- **Hazardous Waste Landfills** are governed by stricter guidelines than any other landfill. Waste is placed in sections or cells that are separated from the surrounding environment by clay and impermeable liners. Hazardous waste is usually neutralized for content, acidity and alkalinity. Because of its extreme density, compaction of hazardous waste isn't routine. But at many landfills, tracked vehicles and compactors are still used to achieve as much density and maximum airspace as possible.

Figure 1. MSW Generation Rates, 1960-2006



Source: U.S. EPA
(EPA-530-F-07-030, November 2007)



This cross-section drawing shows the structure of a municipal solid waste landfill. The arrows indicate the flow of leachate.

- Ⓐ Ground Water
- Ⓑ Compacted Clay
- Ⓒ Plastic Liner
- Ⓓ Leachate Collection Pipe
- Ⓔ Geotextile Mat
- Ⓕ Gravel
- Ⓖ Drainage Layer
- Ⓗ Soil Layer
- Ⓘ Old Cells
- Ⓙ New Cells
- Ⓚ Leachate Pond

Landfill Operations

There are several factors to consider in the efficient operation of a landfill. You will need to build main access roads for all weather conditions; secondary roads must be suitable for operating in wet weather. The spreading of gravel, cinders, crushed rock or small-size demolition rubble on the haul roads works well and provides good base material.

Certain types of waste are difficult to compact and can damage your equipment. Be prepared to handle materials such as wire, construction and demolition, tires and other damaging materials.

Windblown litter is a persistent operating nuisance. Methods of controlling it include keeping the size of the working face as small as possible and using litter fences near unloading and spreading areas.

Settlement rate is another factor to consider in operating your landfill. The rate and extent of settlement will depend on the type of waste, fill depth, decomposition, compaction density, liquid incorporation and ratio of cover material. Once settling occurs – usually during the first three to five years after refuse is buried – closure depressions must be filled and drainage problems corrected until the land is completely stabilized.

Control Gas and Leachate

Installing both gas and leachate control systems are essential in landfill operations. Methane gas is a by-product of waste decomposition and can cause fires and asphyxiation. One method of controlling gasses is to install a gas collection system to keep possibly dangerous levels of methane from diffusing underground. Gas collection systems either flare off the gas or convert it to energy through generation of electricity or heat.

Electricity generated from landfill gas *can* provide an additional revenue source and benefit the environment. Despite the benefits, it's still essential to control gasses with proper landfill engineering and operating techniques.

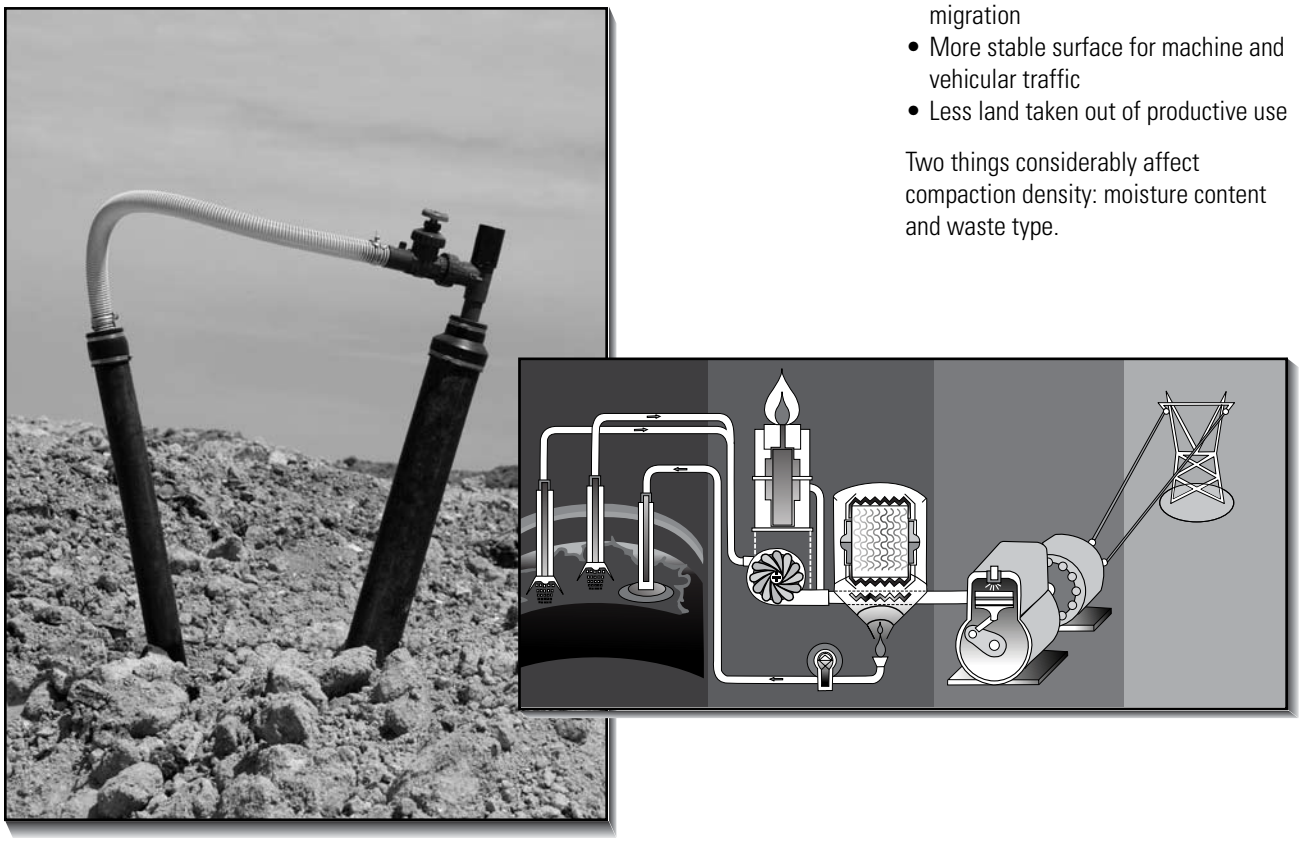
Leachate forms when rain, snow, surface or groundwater seeps through waste, picking up chemicals and biological contaminants. Leachate can poison drinking water and kill aquatic life if it gets in streams or lakes. To limit the amount of leachate produced, you must first limit the amount of liquid coming into the landfill. Liquid can be reduced by compacting waste properly, spreading cover to the right depth and building and maintaining proper surface drains around the site. And once you've installed a leachate control system, it must be regularly maintained and monitored.

Compaction and Landfill Life

The most valuable commodity in a landfill is airspace. Once your airspace is gone, so is your business. Ideally you should utilize every available cubic yard. You can do that through compaction – packing more waste in less space. The benefits of successfully compacting waste include:

- Extended landfill life
- Decrease in settlement
- Reduced voids
- Reduction in windblown litter
- Fewer insects and rodents
- Less waste washed away by rain
- Reduced daily cover requirements
- Reduced leachate and methane migration
- More stable surface for machine and vehicular traffic
- Less land taken out of productive use

Two things considerably affect compaction density: moisture content and waste type.



Guidelines to Achieving Compaction

How do you utilize every inch of airspace? Through proper placement, blending and compaction techniques. Waste placement aids such as surveys and electronic systems like Caterpillar's Computer-Aided Earthmoving System (CAES) are valuable tools that can help extend the life of your landfill. It's also critical to train operators to properly handle various types of waste (MSW, construction and hazardous) to achieve maximum density. Training should include machine operators use of appropriate pass, pushing and blending techniques. Operators must consistently run over the waste in a set pattern and apply cover material to reach proper lift requirements.

Techniques for Proper Compaction

Passes and Patterns

Perform three to five passes over each layer of waste, depending on waste composition and density. Some waste requires more passes and takes longer to compact. Use a set pattern and stick to it. Running patterns means compacting all un-compacted waste before adding more. Run over or compact the entire area and remember to compact out and back in the same tracks. It's also important to compact the full length of the layered material—until the wheels run off the layer. Limit turning on top of the compacted waste. Always remember to compact in first gear. You'll achieve better and more efficient compaction, use less fuel and decrease heat load. In addition, blend wetter material with drier material. You may often have to set aside some materials until others arrive before blending in order to achieve higher densities.

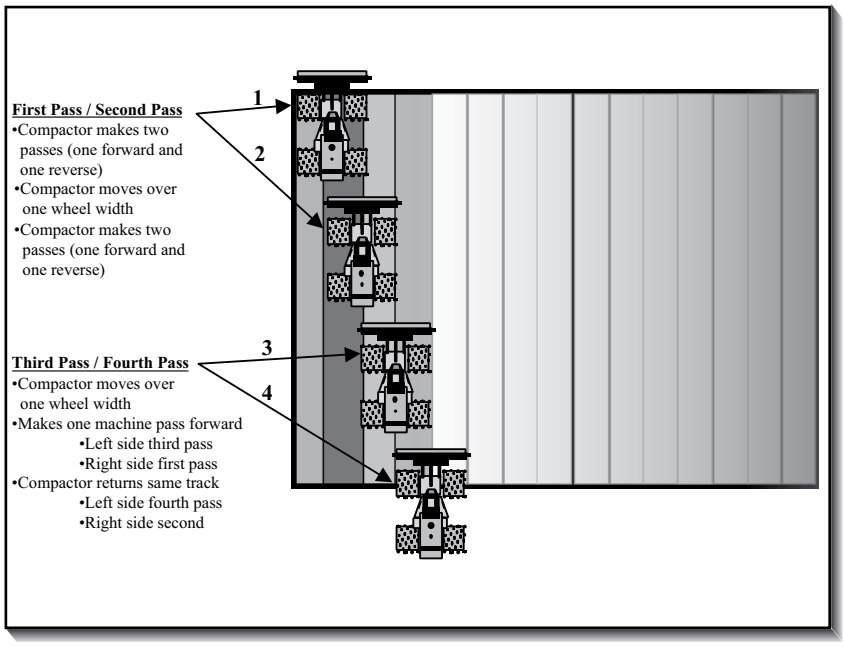
Compaction passes are defined as one trip over the waste in one direction. For Cat compactors to achieve four-pass coverage, operators must make one pass forward then a second pass in reverse over the same tracks. Then, move over one wheel width (approximately half the blade width) and perform the same pattern. Because the space between the wheels is approximately the width of wheels on Cat machines, this pattern achieves a full machine pass.

Once the compactor moves over one more wheel width and the operator begins the next pattern run, the right wheel performs two passes because it is running over uncompacted waste. The left wheel is running over previously compacted waste and is therefore performing a third pass when moving forward and a fourth pass when in reverse over the same tracks.

However many passes you perform or patterns you run, the best tip to remember during peak periods is to keep moving and compacting. To help compaction, material must be pushed and layered properly.

Pushing

In landfills, you'll be pushing material uphill, downhill or on flat terrain. There are advantages and disadvantages of each. It's easier to carry and spread waste uphill. Material layering is more even and material receives slightly more shredding. Blending material uphill is easier and it's simple to return in the same tracks. But pushing material uphill often results in thinner layers at the bottom and thicker layers towards the top. Working in this direction often increases machine heat load, fuel consumption and cycle times.



You can layer, spread and compact waste quicker when pushing material downhill, which often shortens cycle times. Visibility is better downhill, too. Disadvantages of pushing material downhill include uneven waste layering, less material shredding, thicker layers at the top of the hill and thinner layers at the bottom. Uneven layering can cause operators to spin a machine's tracks or wheels.

Pushing material on a flat surface is the best-case scenario. It makes for the fastest cycle times. You can cover more area, spread and layer waste easier and burn less fuel on flat terrain. Heat load on your machine is decreased. Visibility is optimal. And it's easier to stay in the same track during passes. Pushing on a flat surface requires more planning and teamwork. One drawback – it can result in less shredding of the material.

Layering

Proper layer heights are key to decreasing cycle and compaction times and increasing production and efficiency. When layering, remember to keep layers thin. Compacting layers of two feet or less decreases fuel consumption, heat load and machine damage. Machines will "walk out" of the waste quicker, resulting in more area covered per hour. Thick layers are spongy and compact only on the top. Compacting thick layers increases rolling resistance and machine resistance while decreasing your productivity.

Cover Material

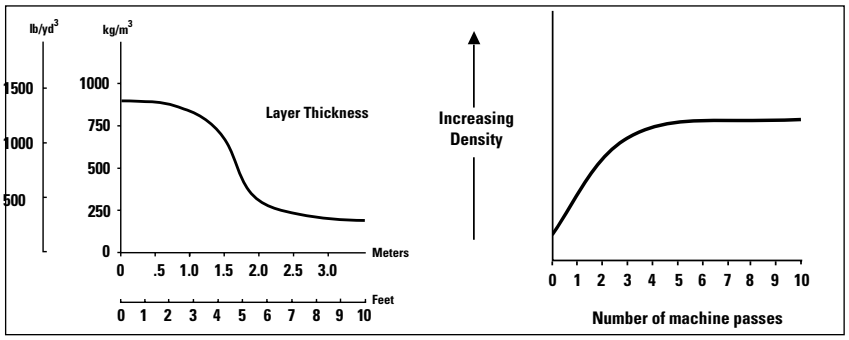
Selecting the right cover material – and properly handling it – will help control health and environmental problems in your landfill operation. A Track-Type Tractor is ideal for spreading cover material thinly with little to no waste flagging – material that protrudes from cover material. Daily cover layer depth depends on governmental, local and regional regulations. Normal regulations for daily cover layer depth are:

- Daily: 6 – 8 inches (0.15 – 0.20 meters)
- Intermediate: 12 – 15 inches (0.3 – 0.4 meters)
- Final: 3 feet (0.9 – 1 meter)

Waste to soil ratios for normal cover range from 4:1 to 8:1, depending on the landfill. A good tip: the less soil the better. Cover should be spread at regulation depth the first time to decrease possible waste flagging. Spreading layers too thin results in more cover usage.

Waste should be ready for immediate cover during and at the end of the day. Save the best waste for final compaction. You'll use less cover material. Tracking in the material with a Track-Type Tractor or Track Loader results in less cover as does cross compacting the waste at 45 to 90 degrees.

Keep alternative daily cover materials in mind, but be sure to check local regulations before using them. It's also important to understand how alternative materials react with the type of waste and weather conditions at your landfill. Alternative materials include green waste, compost, mulch, plastic films, concrete/paper mix, foams, tarps or canvas. They're handled similar to dirt cover. Using alternative materials properly is another way to save airspace.



These practices – using less or alternative daily cover material combined with the right ratio of waste to soil – result in water runoff, which means less leachate is produced. Properly handled cover material can also help seal in odors, prevent fires, control litter, prevent the breeding of insects and provide a dense, stable fill that can serve as a good road base. Additionally, to help ensure optimal use of landfill airspace, consider using electronic systems such as laser leveling and Global Positioning Systems (GPS). These systems allow for more accurate control of grade and cover layer depth.

Keep Track

Keeping accurate statistics on incoming waste amounts is the only way to determine current and future landfill needs. Weigh incoming materials to help operators determine the volume of waste cells and the amounts of cover required. The use of statistical tracking analysis methods to record landfill airspace used, incoming material volume and cover material quantities. Properly archiving the statistics is just as important as gathering the information.

Teamwork

The most important point to remember in any landfill application is to communicate with your team – before, during and after shifts. Have a plan in place to work with different material types and densities, but be prepared to be flexible with the plan if conditions change. Teamwork helps you handle peak periods, unforeseen circumstances and bad weather with more ease and less stress on everyone involved.

Landfill Costs

The cost of running a landfill falls into two categories: capital costs and daily operational and maintenance costs.

Capital costs include:

- Land acquisition
- Building construction
- Major equipment
- Closeout costs (final cover, grading, drainage and landscaping)

Daily operational and maintenance costs include:

- Administration and personnel
- Equipment operation (fuel, maintenance and depreciation)
- Cover material

Landfill Safety

Landfills are busy, harsh environments where the stress of deadlines combines with an unpredictable number of machines and pedestrians. To reduce the risk of accident and injury on your landfill site, separate public and commercial areas. Also provide special safe dump areas intended only for public access. Don't allow scavenging. Secure the entrance when the site is not in operation.

Waste is one of the harshest environments in which machinery operates. To maintain equipment, operators must perform walk-around inspections of machines before, after and anytime they're off the equipment. Pull debris from the machine and clean all windows and mirrors in order to maintain optimal visibility. Make first aid supplies available. Make sure all safety equipment is available and in working order. Telephones or radio equipment on all machines allow operators to report an accident quickly.

Fires are a very real threat in landfills. They're often caused by outside sources. You can help control the risk by prohibiting smoking on or near the working face; post signs and enforce the rule. Divert smoking or burning waste to a safe area. Finally, always install fire extinguishers and other suppression devices on all landfill equipment.

If there's a landfill fire or machine fire, follow your company rules for fighting the fire. Most of the time machine fires can be contained with fire extinguishers, fire suppression systems or both. To contain the landfill fire, use a machine to push burning material away from the active working face and onto cover material or a dirt-based platform. Cover the fire with cover material for surface fires. When appropriate, use high pressure water from water trucks or water wagons on larger landfill fires. For underground fires incorporate nitrogen gas. Also, prevent the spread of fire by creating proper cover layers between the layers of compacted waste.

Machine Matrix

Before you can choose a machine or work tool, you have to know the job. What type of material will the machine be handling? How much material? How often does the job need performed? The answers will determine the machine characteristics you will consider: size, lifting and pushing capacity and the range of work tools it can use.

No matter the selection, it's important to train machine operators to be aware of surrounding materials to prolong machine life and minimize maintenance and downtime.

The Machine Matrix below can help you quickly identify the machines typically considered for a particular landfill task. The far left hand column lists different-sized machines within a machine family.

The top horizontal row lists the most common machine functions. Functions marked with a "P" are the machine's primary function. If you need a machine to perform a certain function most, be sure it's marked "P." Functions marked with "A" are auxiliary functions that the machine is capable of performing.

Caterpillar® Landfill Equipment

	Waste Handler		Pushing	Densification	Stockpiling	Cover Matl.	Utility Work	Cell Construction	Remediation	Gas Systems	Composting
Compactor											
816F2	X		P	P							
826H	X		P	P							
836H	X		P	P							
Track-Type Tractor											
D6K			P	A	P	P	P	P	A		A
D6N XL	X		P	A	P	P	P	A	A		A
D6T III	X		P	A	P	P	P	P	A		A
D7R 2	X		P	A	P	P	P	P	A		A
D8T	X		P	A	P	P	A	P	A		A
D9T	X		P	A	P	P	A	P	A		A
D10T	X		P	A	P	P	A	P	A		A
Track Loader											
953D	X		P	P	P	P	P	A			A
963D	X		P	P	P	P	P	A			A
973C	X		P	P	P	P	P	A			A
Wheel Loader											
924H Std. H.O.	X				P	A		A		P	P
924Hz Std. P.O.	X				P	A		A		P	P
928Hz Std. P.O.	X				P	A		A		P	P
930H Std. H.O.	X				P	A		A		P	P
938H	X				P	A		A		P	P
950H	X				P	A		A		P	P
962H	X				P	A		A		P	P
966H	X				P	A		A		P	P
972H	X				P	A		A		P	P
980H	X				P	A		A		P	P

P Primary Application **A** Auxiliary Application

Note: Consult your local Caterpillar® dealer for Waste Handler packages and options available for the application and machine you are considering.

Caterpillar® Landfill Equipment

	Waste Handler	Pushing	Densification	Stockpiling	Cover Matl.	Utility Work	Cell Construction	Remediation	Gas Systems	Composting
Integrated Tool Carrier										
IT38H					P	A	P		P	P	P
IT62H					P	A	P		P	P	P
Hydraulic Excavator										
315DL					P		P			P	P
318CL					P		P			P	P
320DL					P		P			P	P
324DL					P		P			P	P
325DL					P		P			P	P
330D	X				P		P			P	P
330DL					P		P			P	P
345C					P		P			P	P
365CL					P		P			P	P
Wheel Excavator										
M313D					P		P			P	P
M315D					P		P			P	P
M316D					P		P			P	P
M318D					P		P			P	P
M322D					P		P			P	P
Wheel Tractor-Scraper										
613G						P		P			
623G						P		P			
627G						P		P			
637G						P		P			
657G						P		P			
Articulated Truck										
725						P		P			
730						P		P			
730 Ejector						P		P			
735						P		P			
740						P		P			
740 Ejector						P		P			
Motor Grader										
120M							P	P			
12M							P	P			
140M							P	P			
160M							P	P			
14M							P	P			

P Primary Application **A** Auxiliary Application

Note: Consult your local Caterpillar® dealer for Waste Handler packages and options available for the application and machine you are considering.

Machine Matrix (continued)

Caterpillar® Landfill Equipment

	Waste Handler	Pushing	Densification	Stockpiling	Cover Matl.	Utility Work	Cell Construction	Remediation	Gas Systems	Composting
Vibratory Soil Compactor										
CS-433E							P			
CP-433E							P			
CS-56							P			
CP-56							P			
CS-64							P			
CP-64							P			
Soil Stabilizer										
RM-300							P			
RM-500							P			
Skid Steer and Multi Terrain Loader										
216B2						P	P			P
226B2						P	P			P
232B2						P	P			P
236B2						P	P			P
242B2						P	P			P
246C						P	P			P
252B2						P	P			P
256C						P	P			P
262C						P	P			P
272C						P	P			P
247B2						P	P			P
257B2						P	P			P
277C						P	P			P
287C						P	P			P
297C						P	P			P
Backhoe Loader										
416E						P	P	P	P	P
420E						P	P	P	P	P
420E IT						P	P	P	P	P
430E						P	P	P	P	P
430E IT						P	P	P	P	P
450E						P	P	P	P	P

P Primary Application **A** Auxiliary Application

Note: Consult your local Caterpillar® dealer for Waste Handler packages and options available for the application .and machine you are considering.

Compactor

Primary Landfill Equipment

Landfill Compactor

The first machine designed specifically for landfill work is a Cat® Landfill Compactor. Its primary purpose is compaction, but you can also use the machine to spread and cover large volumes of inbound landfill waste. The Landfill Compactor is more aggressive on the working face and achieves greater compaction density than a tracked machine. The larger the model, the higher compaction densities you'll achieve.

Do not use Compactors to excavate cover material. You may, however, use them to move cover material a short distance to the working face before spreading it to the required depth.

Caterpillar® machines are designed for durability. This machine's rugged construction ensures availability and minimal service time. A quick visual check is usually all the daily maintenance that's required.

Applications

1. *Compacting*

   To maximize compaction density, operate on **level ground**. This allows the compactor to apply the greatest weight to the waste. In turn, you'll run quicker cycles and handle more waste each hour. Operating the machine on slopes steeper than four to one decreases compaction efficiency.

   Maintain **even passes** in both forward and reverse gears. Develop a **pattern** to help cover and compact all layered material. Also, compact **thin layers** to quicken cycle times and decrease fuel consumption, heat load and machine damage.

2. *Pushing*

   There are four steps when pushing material with a Landfill Compactor: acquire the load, slightly raise the blade, slide the load and spread the load on a required area. While pushing with a compactor is similar to pushing with a Track-Type Tractor, it's important to remember Landfill Compactors are *not* Track-Type Tractors and shouldn't be operated as if they were. Machine balance, traction and blade usage are different. Use a compactor to push loads with forward momentum while minimizing wheel spin. To **control wheel spin**, use speed control or the Impeller Clutch Torque Converter (ICTC) pedal – a feature only on the 836H. **Limiting the load size** will also help eliminate wheel spin (varies with load content and density of material). Use **blade control** to help efficiently move and spread the load without slip. To **minimize friction**, slide material with the blade-cutting edge slightly elevated. And in any application, always **look in reverse** *before* moving in reverse. Looking first is especially important when reversing uphill or maneuvering around vehicles, when visibility is limited.

3. *Spreading*

   The key in this application is spreading material in **thin layers**. Thin layers result in maximum compaction and faster cycles as well as a decrease in fuel consumption and heat load. Layer height is determined by type of waste, but layers should be no more than 24 inches (0.6 meters), depending on the weight of the compactor. To achieve proper height, roll the waste with the blade, allowing flow below the blade. Also, for best compaction, **blend materials**. Apply dry waste to wet areas or wet waste to dry areas. Mixing waste helps bind materials together to create optimum densities.

Model	816F2	826H	836H
Engine Model	C9 ACERT	C15 ACERT	C18 ACERT
Flywheel Power	240 hp 179 kW	340 hp 253 kW	480 hp 358 kW
Operating Weight	52,793 lb 23 946 kg	81,498 lb 36 967 kg	118,348 lb 53 682 kg
Drum Width	3'4" 1.02 m	3'11" 1.2 m	4'7" 1.4 m
Width of Two Pass Coverage	14'9" 4.5 m	15'8" 4.78 m	18'7" 6.67 m

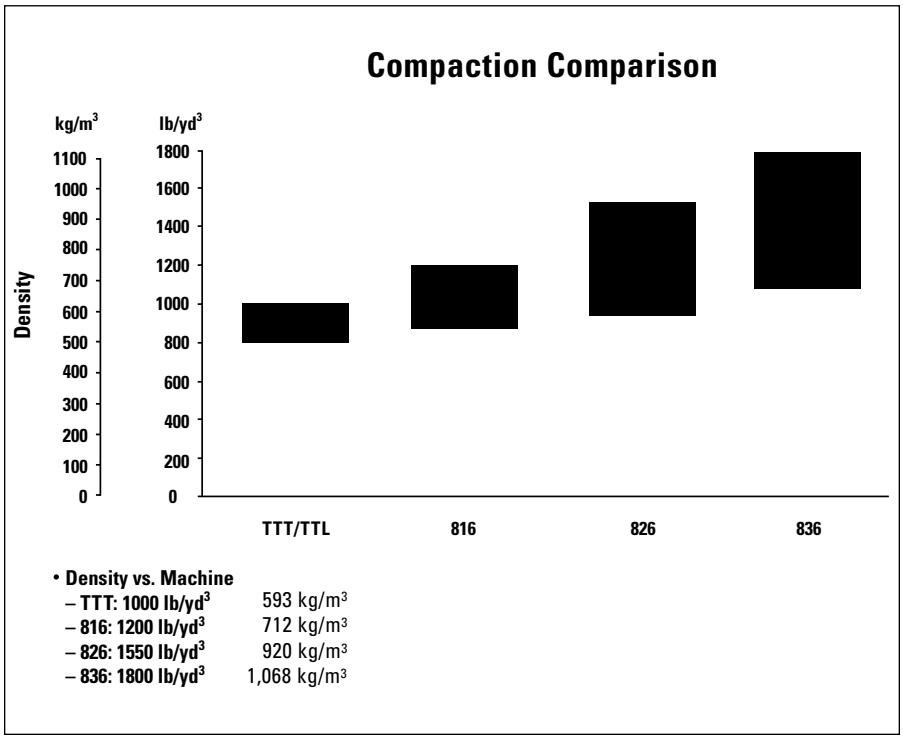
Note: Consult your Local Caterpillar® Dealer for the packages and options available for the machine and application you are considering.

Stay Safe

Safety comes first. To stay safe in any landfill operation, **teamwork, communication** and **training** are critical. People, machines and waste create busy, hazard-filled environments. Navigating around each and every one of them takes a plan and constant communication. Everyone should know the daily working plan, but also be prepared to adjust the plan if conditions change. To communicate with the team, maintain eye contact and use physical or verbal communication with other machines, vehicles and ground-based spotters. All communication requires acknowledgement or a response. Training operators semi-annually or annually is a great way to maintain proper techniques or skills. Monitor operators' progress to determine areas for improvement.

Compactor Production Guidelines			
Model	**816F2**	**826H**	**836H**
Tons Per Day U.S.	500	800	1,000
Tons Per Day Metric	508	813	1016
Tons Per Hour U.S.	62.5	100	125
Tons Per Hour Metric	63.5	102	127

All models are pushing refuse 61 m (200 ft) spreading and making 3 to 4 passes to compact. A pass is defined as a machine traveling over refuse one time in one direction. Totals are based on an eight hour day.



Note: The above graph my be used as a rule of thumb for the compactive ranges of various types of equal weight landfill machines if proper operating technique is employed. The density achieved will vary with the type of waste being handled. The densities listed are maximum.

Track-Type Tractor

Track-Type Tractor

Because of its versatility, the Track-Type Tractor is the most popular machine on a landfill and often the first machine selected. The Track-Type Tractor is primarily used to push and spread material during site preparation, build access and haul roads, rip ground cover and spread and compact waste and cover material. Cat® Track-Type Tractors can achieve compaction densities of 800 to 1,000 lb/yd^3 (475 to 593 kg/m^3) and have no difficulty working in and on the waste material. These tractors can also move material economically at distances up to 300 feet (91 meters).

Check with you local dealer on the wide variety of waste-handling modifications, including individual modifications, available for Track-Type Tractors. Complete waste-handling packages are available. They include extensive guards and accessories designed to extend the life of the machine in the waste environment.

Applications

1. *Pushing*
   There are four steps when pushing material: acquire the load, slightly raise the blade, slide the load and spread the load on a required area. To **minimize track slip**, use the decelerator pedal to maintain control of track slip on waste material. **Limiting the load size** will also help eliminate track slip (varies with load content and density of material). Use **blade control** to help efficiently move and spread the load without slip. Slide material with the blade-cutting edge slightly elevated to **minimize friction**. And in any application, always **look in reverse** *before* moving in reverse. It's simple yet important, especially when reversing uphill or maneuvering around vehicles, when visibility is limited.

2. *Spreading*
   The key in this application is spreading material in **thin layers**. Thin layers result in maximum compaction and faster cycles as well as a decrease in fuel consumption and heat load. Layer height is determined by type of waste, but layers should be no more than 24 inches (0.6 meters), depending on the weight of the compactor. To achieve proper height, roll the waste with the blade, allowing flow below the blade. Also, for best compaction, **blend materials**. Apply dry waste to wet areas or wet waste to dry areas. Mixing waste helps bind materials together to create optimum densities.

3. *Handling cover material*
   Prior to applying cover material, use the Track-Type Tractor to **track over the waste**. This flattens the waste and binds the top surface, which ultimately results in the use of **less cover material**. When it's time to spread cover, have the material **readily available** and staged for quick access. Spread cover to **maximum allowed layer depths**. If layers are too thinly spread, you'll end up using more cover material. In addition, do not leave flagging (material that protrudes from cover layers).

Stay Safe

When operating Track-Type Tractors or any other machine in the landfill, safety comes first. To stay safe, **teamwork, communication** and **training** are critical. People, machines and waste create busy, hazard-filled environments. Navigating around each and every one of them takes a plan and constant communication. Everyone should know the daily working plan, but also be prepared to adjust the plan if conditions change. To communicate with the team, always maintain eye contact and physical or verbal communication with other machines, vehicles and ground-based spotters. All communication requires acknowledgement or a response. Training operators semi-annually or annually is a great way to maintain proper techniques or skills. Watch operators' progress to determine areas for improvement.

Model	D6K XL WH	D6N XL WH	D6T III WH	D7R 2 WH	D8T WH	D9T WH	D10T WH
Flywheel Power	125 hp 93 kW	150 hp 112 kW	200 hp 149 kW	240 hp 179 kW	310 hp 231 kW	410 hp 306 kW	580 hp 433 kW
Operating Weight	28,409 lb 12 886 kg	38,224 lb 17 338 kg	56,620 lb 25 736 kg	61,500 lb 27 920 kg	85,150 lb 38 660 kg	109,180 lb 49 567 kg	144,968 lb 65 764 kg
Engine Model	C6.6 ACERT	C6.6 ACERT	C9 ACERT	3176C	C15 ACERT	C18 ACERT	C27 ACERT
Width of Std. WHA Shoe	22 in 560 mm	24 in 610 mm	22 in 560 mm	22 in 560 mm	22 in 560 mm	24 in 610 mm	24 in 610 mm
Ground Clearance	14.2 in 361 mm	15.5 in 394 mm	15.1 in 383 mm	16.4 in 416 mm	23.4 in 618 mm	23.5 in 596 mm	24 in 615 mm
U-Blade Capacity	N/A	N/A	N/A	22.0 yd^3 16.8 m^3	32.4 yd^3 24.8 m^3	43.8 yd^3 33.5 m^3	63.9 yd^3 48.9 m^3
Semi-U Blade	N/A	7.8 yd^3 6.0 m^3	11.4 yd^3 8.7 m^3	18.4 yd^3 14.0 m^3	26.1 yd^3 19.9 m^3	37.6 yd^3 28.8 m^3	N/A
VPAT Blade	3.5 yd^3 2.7 m^3	4.13 yd^3 3.16 m^3	* 5.65 yd^3 4.32 m^3	N/A	N/A	N/A	N/A

Note: The D6R III has seven different WH machine configurations available.

Note: Not all Track-Type Tractors have "full" waste packages available. Check with your local Caterpillar® Dealer for the WH package that best fits your machine and application.

Note: * Denotes LGP Capacities

Track Loader

Track Loader

Cat® Track Loaders are used in both large and small landfills. Either alone or as support to compliment other on-site machines, this all-purpose machine can perform a wide variety of jobs. Although the primary purpose is to push and spread material, the Track Loader has the ability to carry, stockpile, load, sort, shred, cover, doze, excavate, grade and compact. The double grouser shoe, an all-purpose shoe with good ride and traction characteristics, is the standard type of track shoe on Track Loaders. The single grouser track is more aggressive, giving better traction and chopping action. The chopper track shoe is excellent for landfills that accept construction and demolition materials. It allows Track Loaders to reduce materials effectively through shredding and chopping.

Features like hydrostatic drive, special guarding packages and a rear-mounted engine make the Track Loader perfect for harsh landfill applications. The track undercarriage is durable and can easily work in the waste environment. Hydrostatic drive allows for power turns and the ability to counter-rotate the track, essentially turning in place for tight spaces. A rear-mounted engine gives the operator outstanding visibility to the primary working tool.

The Track Loader becomes even more versatile with options and attachments like multi-purpose buckets, rippers and scarifiers. A properly equipped Track Loader can move from task to task, backing up prime machines during peak periods or even handling multiple jobs alone.

Model	953D WH	963D WH	973C WH
Refuse Bucket	3.5 yd^3 2.7 m^3	5.5 yd^3 4.2 m^3	7.25 yd^3 5.58 m^3
Flywheel Power	148 hp 110 kW	189 hp 141 kW	242 hp 178 kW
Operating Weight	36,730 lb 16 656 kg	46,790 lb 21 224 kg	61,900 lb 28 140 kg
Engine Model	C6.6 ACERT	C6.6 ACERT	C-9
Width of Std. Track Shoe	18.9 in 480 mm	21.6 in 550 mm	19.7 in 500 mm
Length of Track on Ground	91.4 in 2.3 m	101 in 2.57 m	115 in 2.9 m
Ground Contact Area	3,565 in^3 2.3 m^3	4,340 in^3 2.8 m^3	4,542 in^3 2.93 m^3
Track Gauge	71 in 1.80 m	72.8 in 1.85 m	82 in 2.08 m

*Note: Depending on the type of waste and application, Track Loaders have different WHA packages available. Check with your local Caterpillar® Dealer for the WHA package that best fits your machine and application.

Applications

1. *Pushing*
   The four basic steps of pushing also apply when using a Track Loader: acquire the load, slightly raise the bucket, slide the load and spread the load on a required area. To **minimize track slip**, use the speed control. **Limiting the load size** will also help eliminate track slip (varies with load content and density of material). Efficiently move and spread the load without track slip by using **bucket control**. Slide material with the bucket-cutting edge slightly elevated to **minimize friction**. And in any application, always **look in reverse** *before* moving in reverse. It's a simple tip, but especially important when reversing uphill or maneuvering around vehicles, when visibility is limited.

2. *Spreading*
   The key in this application is spreading material in **thin layers**. Thin layers result in maximum compaction and faster cycles as well as a decrease in fuel consumption and heat load. Layer height is determined by type of waste, but layers should be no more than 24 inches (0.6 meters), depending on the weight of the compactor. To achieve proper height, roll the waste with the bucket, allowing flow below the bucket. Also, for best compaction, **blend materials**. Apply dry waste to wet areas or wet waste to dry areas. Mixing waste helps bind materials together to create optimum densities.

3. *Compacting*
   Proper passes and patterns are important in compaction. Maintain even passes in both forward and reverse gears. Develop a pattern to help compact all the material in thin layers. To compact using the Track Loader, load the bucket with cover material, then run the required patterns back and forth over the waste. Be sure to cover all of the waste for maximum compaction.

4. *Handling cover material*
   Prior to applying cover material, use the Track Loader to **track over the waste**. This flattens the waste and binds the top surface, which ultimately results in the use of **less cover material**. When it's time to spread cover, have the material **readily available** and staged for quick access. Spread cover to **maximum** allowed layer depths. If layers are too thinly spread, you'll end up using more cover material.

Stay Safe

While operating any machine in a landfill, safety comes first. To stay safe, **teamwork, communication** and **training** are critical. People, machines and waste create busy, hazard-filled environments. Navigating around each and every one of them takes a plan and constant communication. Everyone should know the daily working plan, but also be prepared to adjust the plan if conditions change. To communicate with the team, always **maintain** eye contact and physical or verbal communication with other machines, vehicles and ground-based spotters. All communication requires acknowledgement or a response. Training operators semi-annually or annually is a great way to maintain proper techniques or skills. Watch operators' progress to determine areas for improvement.

Wheel Loader

Support Landfill Equipment

Wheel Loader

A Cat® Wheel Loader is a valuable waste-handling tool, but is not recommended for compacting. The machine's primary purposes are cover material acquisition and support work. A Wheel Loader is adept at loading cover material into trucks, handling recyclables, carrying waste and performing general clean-up duty. When equipped with a general-purpose bucket, a wheel loader can economically transport cover material over distances of up to 600 feet (183 meters). Because of its mobility, the Wheel Loader is a popular choice when landfills must share a machine.

The machine's articulated frame gives it a tight turning radius and excellent mobility. The wheelbase helps maintain a long foundation and weight distribution for greater stability when lifting. Options and accessories are available for a variety of waste-handling applications. One such waste-handling arrangement features complete guarding of components to prevent damage and reduce downtime. There are a wide range of buckets and attachments available to enhance the versatility of your machine.

Applications

1. *Loading*
   When loading haul vehicles with a wheel loader, remember simple safety tips – they're often the best. **Look** in reverse *before* moving in reverse and **maintain constant visibility** with the haul vehicle's driver or operator and ground crew. When it's time to load, the load area should be **clean**. Position the load or stockpile close to the load-out area when possible. Load in **first gear** for tight cycles in order to match the ground speed with hydraulics. The proper gear also reduces wheel spin. Load in **straight lines**. **Plan** the load sequence. Use **V-pattern loading**, which is loading the vehicle at a 45-degree angle to the load area. Tight V-patterns with less than one and a half wheel revolutions take less steering and result in faster cycles. When loading heavier material like medium-sized rocks or stumps, cushion the bottom of the haul unit with a thin layer of material. Distribute materials evenly across the vehicle and visually check the load, looking for **equal distribution**. During non-peak times, work the material for loading, clean the area and separate unwanted material.

2. *Pushing and Spreading*
   When wheel loaders are used in utility work, the same safety tips apply. **Look** in reverse *before* moving in reverse and **maintain constant visibility** with haul vehicle operators and ground crew. To maintain visibility to the front work area, keep the bucket low while spreading, loading or carrying. Push in **straight lines** and **don't spin the wheels**. To sweep material, keep light bucket contact with the ground. Following these guidelines while pushing or spreading will shorten cycle times, making you **more efficient**. Remember, *think time and distance by minimizing cycle times for optimum efficiency.*

Model	938H	950H	962H	966H	972H	980H
Engine	C6.6 ACERT	C7 ACERT	C7 ACERT	C11 ACERT	C13 ACERT	C15 ACERT
Max Net Power Per ISO 9249	179.9 hp 134.2 kW	197 hp 147 kW	211 hp 158 kW	262 hp 195 kW	287 hp 214 kW	318 hp 237 kW
Operating Weight	32,216 lb 15 071 kg	40,435 lb 18 338 kg	42,100 lb 19 365 kg	52,254 lb 23 698 kg	55,451 lb 25 148 kg	67,294 lb 30 519kg

Std. HO Model	924H Std. PO	924Hz Std. PO	928Hz Std. HO	930H Std. PO
Engine	C6.6 ACERT	C6.6 ACERT	C6.6 ACERT	C6.6 ACERT
Max Net Power	130 hp 97 kW	130 hp 97 kW	150 hp 112 kW	150 hp 112kW
Operating Weight	25,644 lb 11 632 kg	24,180 lb 10 968 kg	27,699 lb 12 564 kg	28,725 lb 13 029 kg

Note: Depending on the application that the machine will be used in, check with your local Caterpillar® Dealer for WH packages or optional packages that will provide you with the best operational efficiency.

(Std. HO) = Standard Hook-On
(Std. PO) = Standard Pin-On

Integrated Toolcarrier

Integrated Toolcarrier

A versatile utility machine, the Integrated Toolcarrier is ideal for various recycling and waste-handling applications. The built in quick coupler allows for quick tool changes; in most cases it takes less than 60 seconds. And with more than 100 work tools available, an Integrated Toolcarrier becomes versatile enough to replace more than one machine on the landfill site.

Specially designed linkage provides parallel lift from the ground to full height, with minimal tilt correction required by the operator. In other words, operators can keep a load level as it's raised. Longer lift arms provide extra height, lift and dump clearance.

Model	IT38H	IT62H
Engine	C6.6 ACERT	C7 ACERT
Max Net Power	179.9 hp 134.2 kW	211 hp 158 kW
Operating Weight Empty With Waste Bucket	35,516 lb 16 114 kg	42, 770 lb 19 397 kg

* Max Net Power based on ISO 9249

Note: Depending on the application that the machine will be used in, check with your local Caterpillar® Dealer for WH packages or optional packages that will provide you with the best operational efficiency.

Hydraulic Excavator

Hydraulic Excavator

Hydraulic Excavators are utilized in a wide variety of applications on landfills. Applications include excavating cover material, assisting in gas line maintenance and remediation. Work with your local dealer to choose the right landfill arrangement for your particular application.

When used with Articulated Trucks, Hydraulic Excavators are becoming increasingly popular for excavating and soil-hauling applications. This machine combination is often more versatile than using a scraper alone for handling saturated soil and loose shot rock.

It is capable of exceptional reach, and with a grapple or clamp it can efficiently sort material or load vehicles from a distance. Excavators are primarily used for cover material acquisition and support work. They're also often used for trench excavation, trash separation or to lay drainage pipe. In addition, the machine can handle specialty applications like toxic waste handling and disposal. Equipped with a special long stick, the Hydraulic Excavator can perform deep excavation that usually requires two machines.

Applications

1. *Loading*

Being aware of the excavator's **tail swing** is critical when operating this machine. It's best to minimize the swing range, using **short swing angles** – no more than 90 degrees if possible. While loading haul vehicles, always **maintain constant visibility** with the other operator. **Fully load the bucket** with material. **Load over idlers** of the machine and never over the drive motors or sprockets. Working in the **"sweet spot"** of the machine is ideal. That spot is approximately 15 degrees on either side of the perpendicular stick position. Position the haul vehicle to match the swing pattern of the excavator. When loading heavier material like medium-sized rocks or stumps, cushion the bottom of the haul unit with a thin layer of material. Distribute materials evenly across the vehicle and visually check the load, looking for **equal distribution**. During non peak times, work the load area, prepare the next load and sort and separate unwanted materials. Using proper **bench and load methods** improve load times and visibility. Working in a **clean area** and **planning ahead** for the next move will also make you more productive.

2. *Trenching*

Just as with loading, it's equally as important to be aware of the excavator's **tail swing** while trenching. Minimize the swing range, using **short swing angles** – no more than 90 degrees if possible. **Be alert** of your depth at all times as well as nearby gas and leachate lines. Use crew members as extra pairs of eyes to prevent machine damage and accidents. When loading trenched material, **load over idlers** of the machine and never over the drive motors or sprockets. Working in the **"sweet spot"** of the machine is ideal. Use application-specific **work modes and ranges**.

Model	315DL (1)	318CL (2)	320DL WH (3)	324DL (4)	325DL (5)	330D WH (6)	330DL (7)	345C WH (8)	365CL (9)
Flywheel Power	115hp 86kW	125hp 93kW	148hp 110kW	188hp 140kW	201hp 152 kW	247hp 184kW	268hp 200 kW	345hp 257kW	404hp 301kW
Operating Weight	38,100 lb 17 280 kg	43,320 lb 19 650 kg	47,400 lb 21 500 kg	54,660 lb 24 790 kg	64,460 lb 29 240 kg	83,980 lb 38 093 kg	79,700 lb 36 151kg	99,150 lb 44 973 kg	155,177 lb 70 348 kg
Maximum Reach at Ground Level	28'8" 8.75 m	29'11" 9.15 m	35'0" 10.68 m	34'7" 10.55 m	36'7" 11.15 m	31'0" 9.45 m	38'5" 11.71 m	42'6" 12.96 m	46'2" 14.07 m
Maximum Loading Height	20'8" 6.31 m	21'3" 6.46 m	23'0" 7.02 m	23'1" 7.04 m	23'4" 7.10 m	29'2" 8.9 m	24'9" 7.54 m	26'0" 7.93 m	30'3" 9.21 m
Maximum Digging Depth	19'1" 6.07 m	20'10" 6.37 m	24'10" 7.58 m	24'1" 7.33 m	25'8" 7.83 m	21"1" 6.4 m	26'10" 8.19 m	29'3" 8.92 m	31'0" 9.45 m

Note: Depending on the application that the machine will be operated in, check with your Caterpillar® Dealer for WH packages or optional packages that will provide you with the best operational efficiency.

Configurations with Reach Booms

(1) – 8'6" Stick
(2) – 8'10" Stick
(3) – 12'10" Stick
(4) – 11'10" Stick
(5) – 12'4" Stick
(6) – 12'10" Stick
(7) – 12'10" Stick
(8) – 14'1" Stick
(9) – 15'4" Stick

Wheel Excavator

Wheel Excavator

Wheel Excavators are used for many of the same applications as Hydraulic Excavators. Applications include excavating trenches, ditching, separating trash, laying drainage pipe, acquiring cover material, support work and special tasks like handling and disposing toxic waste.

While operating the machine on haul or access roads, there are several safety tips to keep in mind. Maintain a safe and reasonable travel speed. Wipe windows and mirrors clean for optimum visibility. Keep the boom, stick and bucket in a safe-carry position to avoid low hanging wires or other hazards, but don't rest the work tool or bucket on the undercarriage. And the front axle of the Wheel Excavator should be unlocked for most roading applications.

Applications

1. *Support Work*

Before beginning any work, clear the work area. When you're ready, remember to maintain eye contact with drivers, ground crew members and anyone else working in your area. Use application-specific work modes, tools and attachments. And properly stabilize the machine for the task at hand.

2. *Ditching*

To ditch, **lock the front axle** of the excavator. Always be aware of **side stability**, using stabilizers as needed. If you're ditching on two-lane roads, be aware of the machine's tail swing as it may enter the opposite lane of traffic. Also, during roadwork use **proper traffic control** and never work on public roads when visibility is low.

3. *Loading*

As with Hydraulic Excavators, be aware of the Wheeled Excavator's **tail swing**. It's best to minimize the swing range, using **short swing angles** – no more than 90 degrees if possible. While loading haul vehicles, always **maintain constant visibility** with the other operator. **Fully load the bucket** with material. Working in the **"sweet spot"** of the machine is ideal. That spot is approximately 15 degrees on either side of the perpendicular stick position. Position the haul vehicle to match the swing pattern of the excavator – making sure to hit that 15-degree range when loading through the tailgate. When loading heavier material like medium-sized rocks or stumps, cushion the bottom of the haul unit with a thin layer of material. Distribute materials evenly across the vehicle and visually check the load, looking for **equal distribution**. During downtime, separate and sort unwanted material. Working in a **clean area** and **planning ahead** for the next move will also make you more productive.

4. *Trenching*

Just as with loading, it's equally as important to be aware of the excavator's **tail swing** while trenching. Minimize the swing range, using **short swing angles** – no more than 90 degrees if possible. **Be alert** to your depth at all times as well as nearby gas and leachate lines. Use crew members as extra pairs of eyes to prevent machine damage and accidents. Working in the **"sweet spot"** of the machine is ideal.

Model	M313D	M315D	M316D	M318D	M322D
Net Power ISO 9249	127 hp 95 kW	135 hp 101kW	158 hp 118 kW	166 hp 124 kW	165 hp 123kW
Operating Weight	37, 715 lb 16 200 kg	40,345 lb 18 300 kg	43,651 lb 19 800 kg	44,313 lb 20 100kg	48,502 lb 22 000 kg
Maximum Reach at Ground Level*	29'8" 9.04 m	31'5" 9.58 m	31'5" 9.58 m	31'6" 9.60 m	33'7" 10.24 m
Maximum Digging Depth*	18'3" 5.56 m	19'4" 5.89 m	19'4" 5.89 m	20'4" 6.20 m	21'5" 6.53 m

* With VA Boom

Wheel Tractor-Scraper

Wheel Tractor-Scraper

Wheel Tractor-Scrapers are popular in landfill applications for two reasons: it's an elevated self-loading scraper – it doesn't require another machine for loading and they are designed to excavate and haul cover material economically at distances of more than 600 feet (103 meters). With these machines, you can quickly and efficiently load, move and dump large amounts of cover material.

Three models of the Cat self-loading scraper are widely used in landfill applications. Each has the ability to load in as little as nine-tenths of a minute and dump in just seven-tenths of a minute. The other two models are tandem-powered and may or may not be push-loaded, depending on conditions.

Model	613G	623G	627G	637G	657G
Flywheel Power Tractor	175 hp 131 kW	365 hp 272 kW	365 hp 272 kW	500 hp 373 kW	600 hp 447 kW
Flywheel Power Scraper	N/A	N/A	266 hp 198 kW	283 hp 211 kW	451 hp 337 kW
Scraper Capacity Heaped	11 yd^3 8.4 m^3	23 yd^3 18 m^3	22 yd^3 17 m^3	34 yd^3 26 m^3	44 yd^3 34 m^3
Top Speed Loaded	22 Mph 35 Km/h	32 Mph 51 Km/h	32 Mph 51 Km/h	33 Mph 53 Km/h	33Mph 53 Km/h

Note: Depending on types of material and conditions, the "Auger" option adds an efficient method to self-loading, material processing, and ability to layer "cover" material in required depths. Check with your local Caterpillar® Dealer regarding the many options available in the Wheel Tractor-Scraper product line.

Articulated Truck

Articulated Truck

When you need to haul large volumes of landfill cover material for either short or long haul distances, the Articulated Truck is up to the task. This truck is a versatile, all-weather hauler that easily maneuvers in tight places and in poor underfoot conditions. The truck's 45-degree articulation makes it extremely effective in tight borrow and working face areas.

Caterpillar offers Articulated Truck models with capacities ranging from 26 to 43.5 tons (23.6 to 39.5 metric tons). Never worry about rain, mud, or slippery slopes. All Cat® Articulated Trucks are six wheel drive and the differential locks can be engaged or released on-the-go. Sound suppressed pressurized cabs provide excellent visibility. Cat Articulated Trucks also feature high-strength bodies with low loading height and large, low-pressure tires for high flotation.

Dumping loads in an Articulated Truck is easy with either the standard or Ejector body. The Ejector body allows faster cycles by dumping in either the static mode or "on the go." It can even eject cover material in reverse to keep the tires off the waste. Another big benefit of ejector trucks is the reduced chance of tipping the body over. When dumping loads on spongy underfoot, the ejector truck is not only quicker but the safety aspect is also an important consideration. Cat Articulated Trucks are also available in both container handler and refuse body configurations.

Model	725	730	730 Ejector	735	740	740 Ejector
Engine	C11 ACERT	C11 ACERT	C11 ACERT	C15 ACERT	C15 ACERT	C15 ACERT
Net Power (ISO 9249)	304 hp 227 kW	321 hp 239 kW	321 hp 239 kW	424 hp 319 kW	458 hp 342 kW	458 hp 342 kW
Operating Weight	49,075 lb 22 260 kg	50,376 lb 22 850 kg	56,330 lb 25 550 kg	69,206 lb 31,391 kg	72,973 lb 33,100 kg	78,505 lb 35,610 kg
Rated Payload	26 tons 23.6 tonnes	31 tons 28.1 tonnes	31 tons 28.1 tonnes	36 tons 32.7 tonnes	43.5 tons 39.5 tonnes	42 tons 38 tonnes

Motor Grader

Motor Grader

Primarily used for maintenance of both haul and access roads in a landfill, the Motor Grader is also used in a variety of other applications. Constructing cells and settling ponds, shaping drainage ditches, applying smooth final grade and preparing seed bed for a closed-out site are all jobs the Motor Grader can easily handle. In landfill cell construction, this machine grades cell floors, drain fields and side slopes. By working the Motor Grader for what it's designed to do – maintain haul and access roads – you can save valuable time and maintenance costs on both commercial haulers and the rest of the machines in your fleet.

Model	120M	12M	140M	160M	140M
Net Power	138 hp 103 kW	158 hp 118 kW	183 hp 136 kW	213 hp 159 kW	259 hp 193 kW
Operating Weight	31,069 lb 14 093 kg	32,016 lb 14 522 kg	33,356 lb 15 130 kg	35,060 lb 15 903 kg	47,133 lb 21 379 kg

Vibratory Soil Compactor/ Soil Stabilizer

Vibratory Soil Compactor

The machine's ability to climb steep slopes and work on clay soils makes the Vibratory Soil Compactor perfect for landfill construction and closure. Both jobs have strict density and permeability requirements. The Vibratory Soil Compactor's dual-pump propel system gives it remarkable hill climbing ability. In the dual-pump system, the wheel drive and drum drive propel systems are independent. If one begins to slip, the other is unaffected and the machine continues to move forward.

Model	CS-433E	CP-433E	CS-56	CP-56	CS-64	CP-64
Model	Smooth	Padded	Smooth	Padded	Smooth	Padded
Drum Width	66 in 1676 mm	66 in 1676 mm	84 in 2134 mm	84 in 2134 mm	84 in 2134 mm	84 in 2134 mm
Power	100 hp 75 kW	100 hp 75 kW	156 hp 116 kW	156 hp 116 kW	156 hp 116 kW	156 hp 116 kW
Operating Weight	14,875 lb 6745 kg	15,750 lb 7145 kg	25,885 lb 11 741 kg	25,765 lb 11 687 kg	31,901 lb 14 470 kg	32,062 lb 14 543 kg

Model	RM-300	RM-500
Power	350 hp 261 kW	540 hp 403 kW
Mixing Width	96 in 2438 mm	96 in 2438 mm
Mixing Depth	20 in 508 mm	20 in 508 mm
Operating Weight	43,280 lb 19 630 kg	62,589 lb 28 385 kg

Soil Stabilizer

Often times, native soils must be modified for use in a landfill. That's where the Soil Stabilizer can help. Whether the soil must be mixed to create a uniform material or blended with other materials, the Soil Stabilizer can handle the job quickly and accurately.

Skid Steer and Multi Terrain Loader

Skid Steer and Multi Terrain Loader

They're small in size, but big on versatility. The Skid Steer Loader is an essential machine for solid waste work sites. With a wide range of machine-matched Cat® work tools, the Skid Steer Loader can handle a variety of tasks at the landfill. Work tools include forks for handling bailed material, grapples for separating waste, a broom for road cleanup and multi-purpose buckets for both loading and cleanup needs.

Model	216B2	226B2	232B2	236B2	242B2	246C	252B2	256C
Net Power ISO 9249	49 hp 37 kW	57 hp 42 kW	57 hp 42 kW	70 hp 52 kW	57 hp 42 kW	73 hp 54 kW	70 hp 52 kW	82 hp 61 kW
Operating Weight	5,814 lb 2637 kg	5,885 lb 2669 kg	6,812 lb 3090 kg	7,118 lb 3228 kg	6,988 lb 3170 kg	7,383 lb 3349 kg	7,945 lb 3603 kg	7,571 lb 3434 kg

Model	262C	272C	247B2*	257B2*	277C*	287C*	297C*
Net Power ISO 9249	82 hp 61 kW	90 hp 67 kW	57 hp 42 kW	57 hp 42 kW	82 hp 61 kW	82 hp 61 kW	90 hp 67 kW
Operating Weight	7,978 lb 3619 kg	8,331 lb 3779 kg	6,987 lb 3169 kg	7,991 lb 3624 kg	9,451 lb 4287 kg	9,954 lb 4516 kg	10,035 lb 4552 kg

*Note: Multi Terrain Loaders are an optional consideration if you desire versatility as well as low ground pressure characteristics. The MTL is capable of working with a wide range of machine matched Cat work tools and can handle a variety of tasks at the landfill.

Backhoe Loader

Backhoe Loader

Exceptional power for its size, excellent stability and maneuverability and load-sensing hydraulics make the Cat® Backhoe Loader a very productive utility machine in landfills. The excavator-style backhoe can dig and load trucks while the loader can push or lift material. When equipped with an IT boom, the IT Backhoe Loader becomes a highly versatile machine with the capability of using multiple attachments.

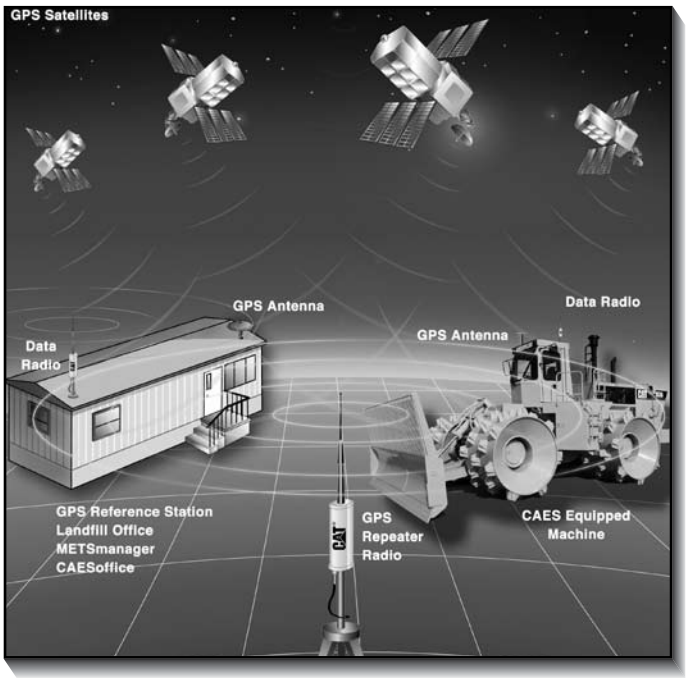
Model	416E	420E/420E IT	430E/430E IT	450E
Engine Model	3054C DINA	3054C DIT	3054C DIT	C4.4 ACERT
Net Power ISO 9249	75 hp 56 kW	90 hp 67 kW	98 hp 73 kW	12.5 hp 93 kW
Nominal Operating Weight	14,960 lb 6792 kg	15,474 lb 7025 kg	16,066 lb 7294 kg.	24,141 lb 10 980 kg

Computer Aided Earthmoving System for Landfills (CAES)

Computer Aided Earthmoving System for Landfills

Advanced GPS technologies for earthmoving equipment improve machine efficiency, maximize air space utilization, and extend landfill life.

The Computer Aided Earthmoving System (CAES) is a high technology earthmoving tool that allows machine operators to achieve maximum landfill compaction, desired grade/slope, and conserve and ensure even distribution of valuable cover soil with increased accuracy without the use of traditional survey stakes and crews. Using global positioning system (GPS) technology, machine-mounted components, a radio network, and office management software, this state-of-the-art machine control system delivers real-time elevation, compaction and grade control information to machine operators on an in-cab display. By monitoring grade and compaction progress, operators have the information they need to maximize the efficiency of the machine, resulting in proper drainage and optimum airspace utilization.CAES uses GPS technology, a wireless radio communications network, and office software to map landfills, create site plans, locate a machine's position, and track compaction and earthmoving progress with complete accuracy and history.



The receiver uses signals from GPS satellites to determine precise machine positioning. Two receivers are used to capture and collect satellite data – one located at a stationary spot on the landfill site, and another located on the machine. Signals from the ground-based reference station and on-board computer are used to remove errors in satellite measurements for centimeter accuracy.

CAES gives the operator the ability to control grade by monitoring progress on the in-cab display, which shows a graphical representation of lift thickness and compaction density. Cut/fill numbers are displayed in real-time as the machine moves across the site, which allows the operator to know precise elevation, material spread, compaction passes, and required cut or fill at any point on the job.

Selection Criteria

One of the most significant decisions that will affect production, operational costs and efficiency at your landfill is made right at the front end: choosing the equipment that is best suited to accomplish the task. No matter how carefully you plan, you won't be effective if you have the wrong equipment. Because landfills are busy, harsh environments, the key to selecting landfill equipment is 100 percent machine availability. Back-up machines are a luxury few landfills can afford. That's why it's important to know and understand performance capabilities of machines as well as the wide variety of options available.

Equipment versatility is one of the first criteria to consider in equipment selection. In other words, the more jobs a machine can do, the better. Tonnage – the amount of waste handled – also determines the choice and size of equipment. Keep in mind how those amounts may change in the event of future growth. Other factors to consider in the equipment-selection process:

- Type of waste
- Type of cover material
- Weather
- Landfill methods
- Compaction
- Peak periods (tonnage and vehicles)

By definition a system is an orderly, interconnected, complex arrangement of parts. A multiple machine system is no different. It's hard to know which machines will work best all the time. The key is to select equipment that allows you to meet your daily requirements with enough spare capacity to cover your peak periods and unforeseen glitches – and to do it for the least cost per ton and least stress on you.

Machine Combinations

When you match two machines that compliment each other to accomplish a specific landfill application, you increase production and efficiency. Select machines based on factors like peak tons handled per hour, peak tons handled per day, amount of surface area covered per day waste type, waste density and special requirements.

In some instances, one machine can handle the job. For example, in a mid-size landfill, a compactor might be the only machine used to push, spread and compact the waste. But considering a system or multi-machine approach is often the best way to take advantage of a machine's true potential. For example, if you use compactors to push and spread waste instead of compacting it, you may be wasting time and airspace. The time spent pushing and spreading could be spent on covering more area or making more passes over the waste for higher compaction densities. A Compactor and Track-Type Tractor or Track Loader combination is more expensive, but the benefits may be worth it. There's less wear and tear on the main compaction machine and the machine can perform the main function for which it was designed. With two machines you can more quickly handle and layer waste, getting it ready for compaction. Unlike landfill compactors, track-type tractors and track loaders are designed to push and spread material – using less fuel and creating less heat. When you use a compactor only to compact, you can quickly cover more area with less fuel, machine damage and heat load. And at the end of the workday, the compactor can finish final compaction while the Track-Type Tractor or track loader can spread and work daily cover to the proper layering depths.

Work with your local dealer to decide what's best for your specific landfill application. Use the production worksheets in this guide along with the information you obtain to determine which machine or machine system is right for you. Your dealer can also do a Waste Fleet Analysis study to help you understand your landfill needs.

The following examples and data are based on several jobsite studies. The information below is based on these studies. Each site and day are different. Keep in mind your site, waste and application might produce different results.

These are guidelines for a machine selection process. Take all aspects of your landfill and its needs into consideration. Work with your local dealer to make the best decision based on your landfill needs.

Landfill Compactor vs. Landfill Compactor And Track Type Tractor System

It should be noted that the use of a system (Landfill Compactor And Track Type Tractor) is more effective in getting the job done in terms of speed and efficiency. With increased efficiency, you are able to work the area faster, and make more passes over the waste in the same amount of time. The Caterpillar® Landfill Compactor is purpose built to handle your waste stream, however it may not always be used alone in performing this function. Caterpillar has taken the industry lead in performing field studies to aid you in the selection of the best combinations of machines for your application.

826GII and TTT System **5-15% More Efficient**

In these field studies, Caterpillar was able to measure the cycle times for the 826G II Landfill Compactor and how it compared when the same machine was worked in tandem with a Track Type Tractor. In these studies, performed using only MSW waste, Caterpillar was able to determine a range of 5-15% increase in speed and efficiency when using the system. This percentage may vary when working in waste in uphill, downhill, or in flat work face conditions, as well as variables in operator experience.

836H and TTT System **3-8% More Efficient**

The 836H Landfill Compactor with ACERT technology was also tested alone and in conjunction with a Track Type Tractor. Again, the results are conclusive that using a system is more effective in the waste. With an increase of 3%-8%, the system is able to make your site a much more efficient landfill.

In conclusion, depending on your waste stream and peak hours, the Landfill Compactor And Track Type Tractor system may be the right machine combination for your site. Contact your local Cat® dealer to determine which machines fit your specific sites requirements.

Machine Operating Efficiencies

Choosing the right machines with the right capabilities for the type of landfill you're operating will prevent machine and production downtime – saving you money in the long run. During the machine selection process you should consider daily tonnage, refuse type, operating distance, weather, working slope and many other variables. The following paragraphs will discuss typical factors that determine machine efficiencies.

**Although the examples used in this section are based on Track-Type Tractors, the same conditions and thought processes apply to compactors and track loaders.

Time and Distance

The main factors that influence site and machine efficiencies are time and distance. Simply put, the greater the distance traveled, the more time it takes, the less efficient you become. When planning the work face, a general guideline is to start from the tip point and keep the distance the machines have to push, spread and compact to a minimum. Shorter travel distances result in quicker cycle times, which result in less maintenance (less wear and tear on the machine) and greater fuel economy. Planning the day in advance is the best technique to achieving gains in cycle times and greater efficiencies.

Traction

Machine traction and push capacity are based on two things: the weight of the machine and the traction available in the material it's working on. Determining machine weight is easy. Check the manufacturer's specifications or contact your local dealer. Traction is based on what the industry refers to as coefficient of traction. Normal coefficient of traction for a tracked machine in good solid earth is 0.9. Waste is estimated to have a coefficient of traction of approx. 0.3-0.5, depending on the compaction that has been applied to it. Most loose, wet, un-compacted waste would have a coefficient of traction of approximately 0.3. Most well-compacted waste or dense waste may have a coefficient of traction of approximately 0.5.

Whether you're using a compactor or a tracked machine, the machine will only be able to push 30 to 50 percent of its weight when working on waste. Here's an example. A D8T is working on loose, un-compacted waste. The D8T weighs approximately 84,320 lbs (38.25 metric tons). Multiply the weight by 0.3, or 30 percent, because of the poor traction on waste. The result is the machine can only push approximately 25,296 lbs (11 474 kg). If the machine is working on well-compacted waste and has good traction, the machine might be able to push approximately 0.5, or 50 percent, of its weight, which is 42,160 lbs (19 123 kg). These numbers are based on level ground. If you're working on a slope, the results will change significantly.

The bottom line is well-compacted material offers better efficiencies. Layering material thinly and taking the time to make the required amount of passes over the material will give you that much desired well-compacted waste.

Push Power

What does push power have to do with efficiency? The machine must be sized correctly (weight and horsepower) to handle the loads quickly and efficiently. Understanding size, tonnage and workflow of the inbound machines is important. Your machines must work around the inbound vehicles and various payloads they bring in. An on-road transfer station vehicle will carry a payload of between 22 and 24 tons (20 and 22 metric tons). You'll need large machines to push these large loads away from the tip floor. Smaller machines can handle smaller rear and side-load trucks.

During the push, the operator must keep aware of many things. Two were mentioned previously: 1) time and distance and 2) traction. Both limit the machine's efficiencies if not handled properly. The types of material you'll be pushing and spreading are also important to understand. For example, normal MSW—although compacted during the pick-up process—will fluff and loosen once it hits the ground. Typically, normal MSW, when loose, will weigh between approximately 350 lb/yd^3 (208 kg/m^3) and 600 lbs/ yd^3 (356 kg/m^3) construction and demolition materials are much more dense and typically weigh approximately 800 lb/yd^3 (475 kg/m^3). (Occasionally, construction and demolition materials weigh 1,200 lbs/yd^3 [712 kg/m^3].)

To estimate how much load is in front of the blade during a push on level ground, calculate your material density weight and multiply it by the blade size. For example:

Material density = 500 lbs/ yd^3 (297 kg/m^3) (loose MSW)
D8T WHA – SU blade = 26.1 yd^3 (20 m^3) (Waste Handling Arrangment)
Total weight in front of the fully loaded blade = 13,050 lbs (5919 kg) of material.

The slope uphill, downhill or flat will determine how much material the machine can push in front of the blade. According to the rules of efficiency, most blades will push two-thirds of the blade capacity when moving earth and rock materials on flat terrain. In waste, due to the types and consistency of materials, machines typically push at least one to two times their blade capacity on level ground.

Model	Loose Waste Minimum Push Power	Compacted Waste Minimum Push Power
D6T – 45,370 lb	0.3 – 13,611 lb	0.5 – 22,685 lb
D7R – 61,500 lb	0.3 – 18,450 lb	0.5 – 30,750 lb
D8T – 84,320 lb	0.3 – 25,296 lb	0.5 – 42,160 lb
D9T – 109,180 lb	0.3 – 32,754 lb	0.5 – 54,590 lb
D10T – 147,161 lb	0.3 – 44,148.3 lb	0.5 – 73,580.5 lb

For example, if material density remains at 500 lb/yd^3 (297 kg/m^3) (average weight) and the D8T still has a 26.1 yd^3 (20 m^3) blade, but now the material in front of the blade is one and a half times the stated load, the machine will push 19,575 lb (8879 kg) on level ground. Increasing the amount of material in front of the blade to two times its blade size results in a machine pushing approximately 26,100 lb (11 839 kg.)

When traction changes, so does push power. If the coefficient of traction is 0.3, or 30 percent, the load in front of the blade would exceed its traction capability and the machine's tracks or wheels would spin. The numbers will change if the machine is working on well-compacted waste, construction and demolition materials or on slopes. No matter what machine you use to push material, once the possible weight for the coefficient of traction is exceeded, track or wheel spin will occur, resulting in **loss of time and efficiency and increased wear**.

Friction also affects the amount of load a machine can push. There are many types of friction or resistance that will rob your machine's capacity to push a full load. **Rolling resistance** is the main friction a machine has to overcome. Rolling resistance is the downward resistance of the track or wheel as it sinks into the material it's on.

Motion resistance is another type of resistance that will rob machine power and efficiency. Motion resistance is the forward resistance of material to the wheel or track. The machine has to overcome this forward resistance created by the sinking of the machine and the layered waste.

Material resistance—the resistance caused by the pushed material sliding over the layer of material beneath—is another source of friction. And **machine resistance**—resistance caused by any contact of the machine against the layer beneath—also causes friction.

It's estimated that rolling and motion resistance together can cause a 25 percent decrease in the push capacity of the machine. Add that to the fact the machine is only able to push a third of its weight because of bad coefficient of traction. The result: push capacity is severely compromised.

There are simple ways to overcome types of resistance or friction. **Thin layers** of waste are key to cutting down on both motion and machine resistance. The operator also needs to **slide the material** across the already layered material. Do that by contacting the material, lifting slightly and keeping the blade from contacting the material layered below. And most importantly, cut down on resistance and friction with **well-compacted layers** of material beneath the machine. By reducing all types of friction, you will achieve faster cycle times as well as reduce heat load and fuel consumption.

Operator ability

An operator's expertise and training are key factors that affect machine efficiencies. It's estimated that an excellent operator can increase the machine's push capacity and efficiency by 40 percent while a bad operator can decrease it by 40 percent. That's an efficiency range of 80 percent. That wide range illustrates why proper operating techniques are critical to a successful landfill operation. How do you make sure you have excellent operators working on your team? It's simple—training. Start operators on a biannual or annual training session and track their progress through observation and evaluation.

In addition to well-trained operators, teamwork and good communication will help everyone become more efficient. When operators, ground crew members and management communicate and work as a team, they'll achieve good compaction, increase machine efficiency, reduce friction and keep up with peak periods of waste and vehicles throughout the day. Airspace usage and maintenance costs will also decrease.

Count on Cat™ for your Equipment Training Solutions

Increased production is just the beginning of the benefit of Caterpillar® Equipment Training Solutions (ETS). No company in the world makes a more complete or purpose-built line of equipment for the solid waste industry. Caterpillar machines perform in virtually any waste application: weather you are loading at a transfer station or recycling center, spreading trash or placing cover on the landfill face. Caterpillar understands the unique needs of these operations and how Cat® machines can contribute to the bottom line.

Trained operators enable you to take full advantage of the productivity and value built into your Cat machines. The benefits of equipment training are increased equipment efficiency and life, reduced maintenance and repair costs, lower incidence of accidents and injuries, and lower warranty costs. All allow a rapid return on your equipment investment.

The Equipment Training Solutions Group can help you maximize your equipment investment by decreasing cycle times, reducing production costs and providing the expertise required to produce highly- skilled operators who will operate your Caterpillar equipment safely and effectively. For more information contact your local Cat Dealer.

Landfill Data Sheet

1. Facility Considerations

- Type of Facility
- Useable Airspace
- Landfill Life Remaining
- Required Density
- Growth Possibilities

2. Facility Information

- Working Face
- How Many
- Size
- Slope
- Flat/Level
- Uphill/Downhill
- Tippers

3. Facility Capacity

- Average Tons/Day (Metric Tons/Day)
- Peak Tons/Day (Metric Tons/Day)
- Peak Tons/Hour (Metric Tons/Hour)
- Days of Operation
- Hours of Operation
- Peak Vehicle Traffic/Day
- Peak Vehicle Traffic/Hour
- Type of Waste
  - Residential
  - Industrial
  - C and D
  - Sludges
  - Specialized
  - Other

4. Machines – Onsite

- Compactors
- Track-Type Tractors
- Track Loaders
- Haul Vehicles
- HEX's
- Motorgraders
- Support

5. Cover Material

- Type
- Dirt/Soil
- Green
- Other
- ADC
- Tarps
- Plastic
- Foam
- Polyshell
- Daily Amount Used/Needed

6. Miscellaneous

Machine Tonnage and Usage Selection Guide

	D6T	D7T	D8T	D9T	D10T	953	963	973	816	826H	836H
0 to 50 Tons Per Day (0 to 45.3 Metric Tons Per Day)											
MSW Landfills	X					X					
MSW/Other Landfills	X					X					
Construction and Demolition Landfills		X						X			
50 to 150 Tons Per Day (45.3 to 136 Metric Tons Per Day)											
MSW Landfills	X					X					
MSW/Other Landfills	X					X			X		
Construction and Demolition Landfills		X						X		X	
150 to 250 Tons Per Day (136 to 227 Metric Tons Per Day)											
MSW Landfills	X					X					
MSW/Other Landfills	X					X			X		
Construction and Demolition Landfills		X	X					X		X	
250 to 350 Tons Per Day (227 to 317.5 Metric Tons Per Day)											
MSW Landfills	X					X	X		X		
MSW/Other Landfills		X				X	X		X		
Construction and Demolition Landfills			X	X				X		X	
350 to 500 Tons Per Day (317.5 to 453.6 Metric Tons Per Day)											
MSW Landfills		X					X		X	X	
MSW/Other Landfills		X					X		X	X	
Construction and Demolition Landfills			X	X				X			X
500 to 750 Tons Per Day (453.6 to 680.4 Metric Tons Per Day)											
MSW Landfills		X					X			X	
MSW/Other Landfills		X	X				X			X	
Construction and Demolition Landfills				X				X	X		X
750 to 1000 Tons Per Day (680.4 to 907.2 Metric Tons Per Day)											
MSW Landfills			X				X				X
MSW/Other Landfills			X				X	X			X
Construction and Demolition Landfills			X	X				X			X
1000 to 3000 Tons Per Day (907.2 to 2721 Metric Tons Per Day)											
MSW Landfills			X					X			X
MSW/Other Landfills			X	X				X			X
Construction and Demolition Landfills			X	X				X			X
3000 PLUS Tons Per Day (2721 Plus Metric Tons Per Day											
MSW Landfills			X	X	X			X			X
MSW/Other Landfills			X	X	X			X			X
Construction and Demolition Landfills			X	X	X			X			X

Compaction Checklist

The following is a "basic" checklist for operators, supervisors, field foremen, etc., to use for achieving proper compaction.
Observed:

Pushing Material

1. Works safely around others – keeps visual contact with everyone ☐
2. Splits load if load is too large ☐
   Utilizes a 'sweep' technique to acquire load
3. Pushes full blade with no material loss ☐
4. Pushes partial blades when necessary ☐
   Steep slopes
   Heavy material
5. Utilizes proper gears ☐
   TTT's – efficient speed/gear with no lugging
   Shifts when machine lugs down
   Compactors – no second gear
6. Slides load ☐
   Acquires load, raises blade/load slightly, and slides load to spread point reducing friction and loss of efficiency
7. NO track/wheel spin ☐
8. Adjusts for 'hard to handle' material ☐
   Adjusts operating procedures to handle sludge, tires, large objects, shingles, wire, etc.
9. Thinks efficiency ☐
   Shortest time and distance for each move
   Plans ahead
   Sets up for the next push

Spreading Material

1. Works safely around others – keeps visual contact with everyone ☐
2. Slides load to spread point and begins to spread efficiently ☐
3. Spreads material evenly ☐
   Layer height is even with little or no high spots or gaps
4. Utilizes proper gears ☐
   TTT's – efficient speed/gear with no lugging
   Shifts when machine lugs down
   Compactors – no second gear
5. Works blade continually to spread material evenly ☐
6. Looks ahead to fill holes and gaps ☐
7. Layers properly for the size of the machine compacting ☐
8. Blends material when possible ☐
   Wet with dry
   Cohesive with non cohesive material

Layer Height – Most important aspect of achieving required densities

1. Layer depth – proper height for the compactor being used depends on content, density and moisture of the material being compacted
   - 50,000 lb (22.7 metric tons) compactor – up to 15" (381 mm)
   - 80,000 lb (36.3 metric tons) compactor – up to 18" (457 mm)
   - 115,000 lb (52 metric tons) compactor – up to 24" (610 mm)

2. No thick layers

3. No cliffing of material

4. Even layers
   - Layer height is even with little or no high spots or gaps

1. Works safely around others – keeps visual contact with everyone

2. Operates in consistent patterns
   - Forward and back in same tracks
   - Covers all the area that is layered before compacting or adding new layer

Compaction Techniques

- Does not stop short on layered material/does not leave soft spots

3. Uses efficient compaction methods
   - Operates in 1st gear
   - Runs efficient patterns
   - Limits steering and turns
   - No wheel spin
   - Covers all the area before starting on new layers
   - Visually keeps check on material compaction

4. Final compaction – prior to daily cover utilizes cross compaction techniques for best density and less cover
   - 45-90 degree of initial compaction runs
   - 1st gear only
   - After a minimum of 2 initial passes

5. Peak periods
   - Communicates on what is needed to obtain best compaction
   - Keeps moving
   - Thick layers
     - If thick layers are necessary to keep up with waste flow then; keep moving, come back and cut layer down during non-peak time, bench material and work the waste again at a later non-peak time, ask for help.

6. Uses blade to knock down high spots and fill gaps/holes

7. Communicates to others what is needed to achieve best compaction

Working Face Dimension	Working Face Area in L 2 W
75 X 100 ft (22.9 X 30.5 m)	7,500 ft^2 (697 m^2)
75 X 125 ft (22.9 X 38.1 m)	9,375 ft^2 (871 m^2)
75 X 150 ft (22.9 X 45.7 m)	11,250 ft^2 (1085 m^2)
75 X 175 ft (22.9 X 53.3 m)	13,125 ft^2 (1219 m^2)
75 X 200 ft (22.9 X 61.0 m)	15,000 ft^2 (1394 m^2)

Tipping Platform Dimension	Tipping Area Area in L 2 W
50 X 100 ft (15.2 X 30.5 m)	5,000 ft^2 (465 m^2)
50 X 125 ft (15.2 X 38.1 m)	6,250 ft^2 (581 m^2)
50 X 150 ft (15.2 X 45.7 m)	7,500 ft^2 (697 m^2)
50 X 175 (15.2 X 53.3 m)	8,750 ft^2 (813 m^2)
50 X 200 ft (15.2 X 61.0 m)	10,000 ft^2 (929 m^2)

Working Face Dimension	Working Face Waste Volume in Cubic Yards			
	12" Layer (305 mm)	15" Layer (381 mm)	18" Layer (457.2 mm)	24" Layer (609.6 mm)
75 X 100 ft (22.9 X 30.5 m)	278 yd^3 (213 m^3)	347 yd^3 (265 m^3)	416 yd^3 (318 m^3)	556 yd^3 (425 m^3)
75 X 125 ft (22.9 X 38.1 m)	347 yd^3 (265 m^3)	434 yd^3 (332 m^3)	520 yd^3 (398 m^3)	694 yd^3 (531 m^3)
75 X 150 ft (22.9 X 45.7 m)	416 yd^3 (318 m^3)	520 yd^3 (398 m^3)	625 yd^3 (478 m^3)	833 yd^3 (637 m^3)
75 X 175 ft (22.9 X 53.3 m)	486 yd^3 (372 m^3)	607 yd^3 (464 m^3)	729 yd^3 (557 m^3)	972 yd^3 (743 m^3)
75 X 200 ft (22.9 X 61.0 m)	556 yd^3 (425 m^3)	694 yd^3 (531 m^3)	833 yd^3 (637 m^3)	1,111 yd^3 (849 m^3)

Incoming Waste Timeline

Time	7:00-8:00	8:00-9:00	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00
Tons/Hr (Metric Tons/Hr) Received										
Peak Tons/Hr (Metric Tons/Hr) Ranking										

Note: After recording the incoming tons per hour, rank the peak periods that waste is received so that equipment can be sized to the most efficiently match machine capability and the tons per hour required to be handled during those peak periods.

Incoming Vehicle Timeline

Time	7:00-8:00	8:00-9:00	9:00-10:00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00
Vehicles/Hr Incoming										
Peak Vehicle Ranking										

Note: After recording the incoming vehicles per hour, rank the peak vehicle traffic periods so that peak traffic can be monitored and adjusted if necessary.

Waste Placement Cycles and Passes Fill in the appropriate values for your landfill				
Working Face Dimension	**Average Cycle Time Place**	**Average Cycle Time Compact**	**Average Passes Compact**	**Average Passes Place**
75 X 100 ft (22.9 X 30.5 m)				
75 X 125 ft (22.9 X 38.1 m)				
75 X 150 ft (22.9 X 45.7 m)				
75 X 175 ft (22.9 X 53.3 m)				
75 X 200 ft (22.9 X 61.0 m)				

Working Face Dimension	**Working Face Cover Volume in Cubic Yards**			
	3" Cover (76 mm)	**6" Cover (152 mm)**	**9" Cover (229 mm)**	**12" Cover (304 mm)**
75 X 100 ft (22.9 X 30.5 m)	69 yd^3 (53 m^3)	138 yd^3 (106 m^3)	207 yd^3 (158 m^3)	276 yd^3 (211 m^3)
75 X 125 ft (22.9 X 38.1 m)	86 yd^3 (66 m^3)	173 yd^3 (132 m^3)	260 yd^3 (199 m^3)	347 yd^3 (265 m^3)
75 X 150 ft (22.9 X 45.7 m)	104 yd^3 (80 m^3)	208 yd^3 (159 m^3)	312 yd^3 (239 m^3)	416 yd^3 (318 m^3)
75 X 175 ft (22.9 X 53.3 m)	121 yd^3 (93 m^3)	243 yd^3 (186 m^3)	364 yd^3 (278 m^3)	486 yd^3 (372 m^3)
75 X 200 ft (22.9 X 61.0 m)	138 yd^3 (106 m^3)	277 yd^3 (212 m^3)	416 yd^3 (318 m^3)	556 yd^3 (425 m^3)

Notes:

Alternative Daily Cover (ADC) – Daily cover other than dirt. Common types include tarps, biodegradable plastics, green waste, crushed glass and spray-on foams. Dirt takes up valuable airspace. ADC helps landfill operators reduce the amount of dirt introduced into the landfill.

Airspace – The projected bank cubic yards (BCY) of the landfill to be filled with waste as determined by survey and/or other engineering techniques.

Aquifer – An underground zone of earth, usually composed of gravel or porous stone, that contains water and frequently serves as a source for well water. An aquifer can become contaminated by leachate through poor waste disposal practices.

Biodegradable – Material that can decompose through the natural activity of microorganisms.

Bio-reactor landfill – A controlled landfill where liquid and gas conditions are actively managed in order to enhance or accelerate the rate at which waste stabilizes.

Borrow Site – An area where material is extracted and removed for use as fill.

Compaction Pass – One time over the waste in one direction.

Compost – Decomposed organic matter, often used for soil enrichment. Composting is a controlled method of decomposing organic matter by the natural activity of microorganisms.

Cross Compaction – Compaction that is either 45 or 90 degrees different than the first two to three passes. Cross compaction is done to knit material closer together and utilize less airspace and cover material.

Energy Recovery – A process in which a portion of the total volume of waste materials is treated to produce liquid, gas or solid fuel. The material may also be burned to produce steam for heat or electricity.

Flagging – Waste protruding or popping up through insufficient cover material.

Groundwater – Water present in aquifer. Groundwater can be "free" to float from one area to another. It is often a source for surface waters like springs or streams. Half the U.S. drinking water originates as groundwater. Groundwater can become polluted through improper waste disposal practices.

Hydrology – Study of the properties distribution of flow water on or within the earth. Hydrology is necessary in any properly designed and operated landfill.

Landfill Cell – Compacted solid waste enclosed by soil or cover material within a landfill. Landfill cells are the basic building block of any landfill.

Layering – The depth of waste being spread by the machine over the compacted layer beneath.

Leachate – Water that has percolated through solid waste or other material and carries matter it has extracted in solution or suspension.

Lift – The total design height for the daily waste. Lift will include several compacted layers.

Methane – A colorless, odorless, combustible gas produced by the decomposition of organic matter. Methane can be used as a fuel source.

Pattern – Machine operation performed in a uniform way so that all material is covered.

Putrescible – Refuse material that may become putrid, rotten and foul smelling.

Pyrolysis – The chemical decomposition of materials by heating in an oxygen-free environment.

Recycling – The process of collecting and turning used products into new products by reprocessing or remanufacturing them instead of throwing them away as waste. Common recyclables are newspapers, cans, scrapped automobiles, corrugated cardboard, bottles and old tires.

Remediation – Reprocessing landfill material in order to gain airspace.

Residue – Waste material, like ash, that remains and must be disposed of after glass, liquids or solids have been extracted through resource or energy-recovery processes.

Resource Recovery – The salvaging of valuable resources from waste material. A resource method includes the recycling of discarded products to provide materials for the manufacturing and conversions of garbage and agricultural wastes to energy.

Runoff – Rain or irrigation water that drains off the surface of the ground.

Sanitary Landfill – An engineered method of solid waste disposal on land by spreading it in layers, compacting it and covering the waste with soil or other approved cover material. Modern landfills are isolated from the environment by an impervious synthetic liner that prevents the leakage of liquids and gases.

Septage – Water waste extracted from septic tanks.

Sewage – Waste that is flushed from toilets into sewers then processed in sewage-treatment plants.

Sludge – A heavy, slimy deposit or sediment such as the substance that is separated out of sewage tank as a solid.

Solid Waste – Discarded material other than liquid waste. Often referred to as "garbage," a solid waste may contain resources that can be recycled, reused or otherwise recovered.

Solid Waste Management – Overseeing the safe and sanitary reuse or disposal of industrial, residential, construction and agricultural wastes. Proper solid waste management includes recycling, resource-reuse and recovery and waste reduction programs, as well as efficient landfill disposal practices.

Source Separation – The breaking apart of various wastes at their point of origin for the purpose of recycling.

Transfer Station – A site where solid wastes are brought by smaller refuse collection vehicles and transferred to larger trucks to be hauled to a disposal site or resource recovery facility.

Vector – A disease carrier and transmitter – usually an insect, rodent or bird.

Waste Reduction – The prevention of waste at the source of generation by redesigning products and packaging. Waste reduction can also be accomplished by changing patterns of production, consumption and waste generation.

Walking the Waste – Usually performed by a tracked vehicle after final compaction, walking the waste helps utilize less cover material at the end of the day.

The development of this guide has been a collaborative effort drawing upon both internal and external resources. Much of the information was obtained from Caterpillar® product and application experts.

Additional information was obtained from:

- U.S. EPA (EPA530-F-05-005, April 2005)
- HowStuffWorks.com

Participants:

City of Arlington, Texas – Neighborhood Services, Solid Waste Division

City of Irving, Texas – Public Health and Environmental Services

Republic Services Inc.

Waste Management Inc.

partnerships

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Our goal is to serve the complete needs of our customers through an effective repair options program that includes standard jobs, guaranteed pricing, guaranteed turnaround, communications, no surprises, warranties, and flexibility. We have established a system to manage our customers' equipment through Equipment Management, repair before failure programs, and planned component replacement.

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