

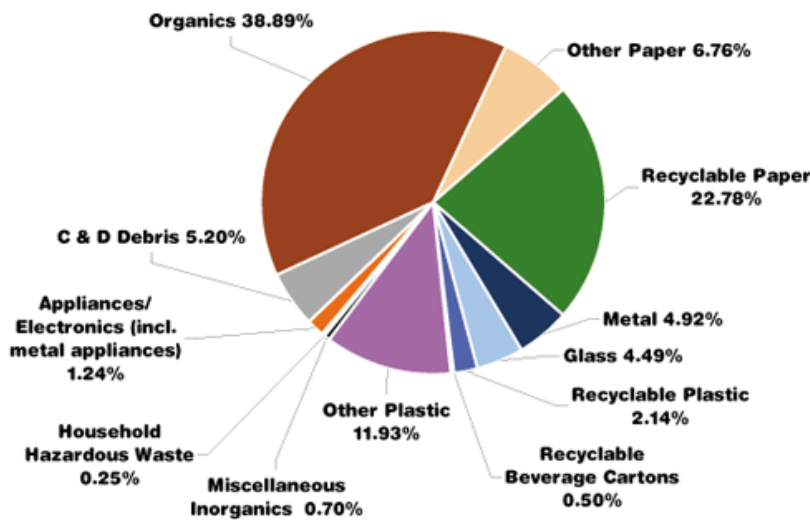


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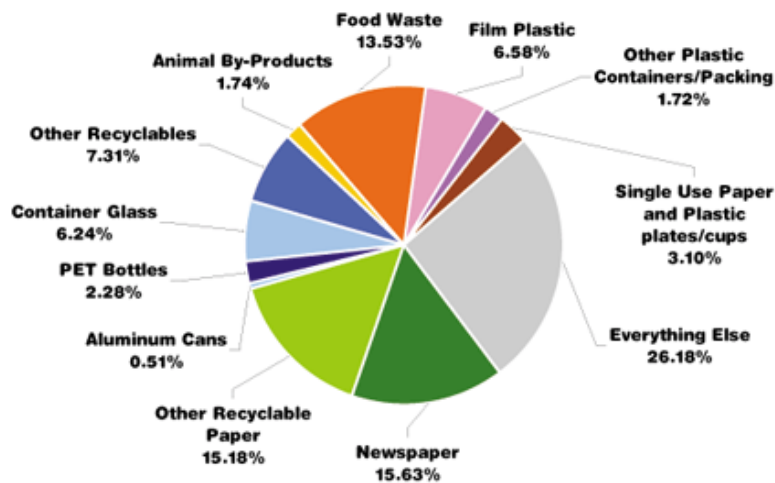
Waste in New York City

New York City disposes of one million tons of organic waste per year. Imagine: That is as much waste as 10,000 blue whales produce, the largest animals on the planet. Over 47% of waste collected from New York City’s street-side baskets consists of materials that could have been recycled.

**NYC Waste Characterization Study
2004/05 Waste Composition
Annualized Results**



**NYC Waste Characterization Study
2004/05 Street Basket Composition
Annualized Results**



Source: NYC Department of Sanitation: http://www.nyc.gov/html/nycwasteless/html/recycling/wcs_charts.shtml

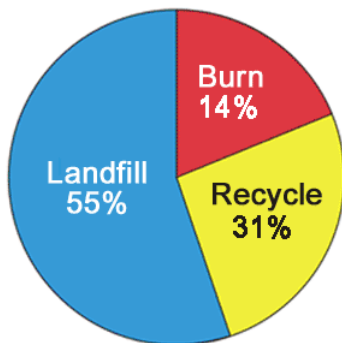


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Waste in New York City

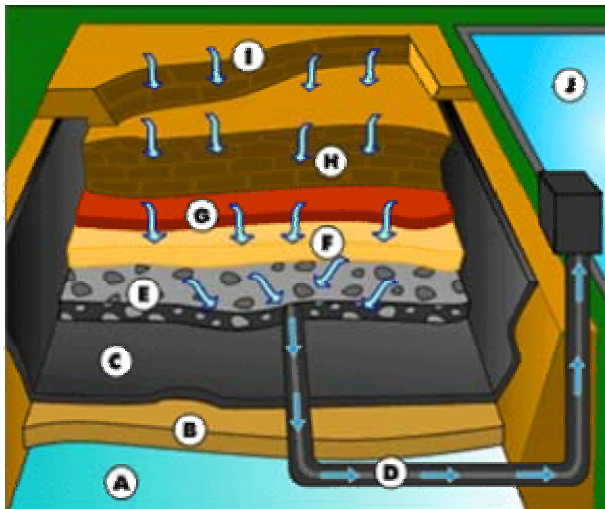
Dumping in landfills is the most common waste disposal method. Decomposition happens very slowly inside a landfill because the waste is not exposed to air. In the absence of oxygen, decomposition produces methane gas which, when contained underground, can explode. Water that travels through landfills can become toxic leachate, posing a threat to groundwater, lakes and streams.

What We Do with Our Trash



Source: Energy Information Administration:
<http://www.eia.doe.gov/kids/energyfacts/saving/recycling/solidwaste/landfiller.html>

Structure of a Landfill



Source:http://www.ecokids.ca/pub/eco_info/topics/waste/itsnotwaste/theproblem/how_deal.cfm

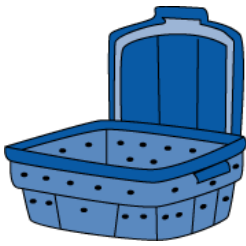
- | | |
|-----------------------------|----------------------|
| A: Ground Water | F: Drainage Layer |
| B: Clay | G: Soil Layer |
| C: Plastic Liner | H: Old Garbage Cells |
| D: Leachate Collection Pipe | I: New Garbage Cells |
| E: Gravel | J: Leachate Pond |



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Worm Bin Basics

The process of keeping a worm bin is called vermicomposting. Simply stated, this involves feeding organic waste materials such as kitchen scraps and newspapers to worms, and then harvesting the resulting worm excrement (poop) to use as nutrient-filled plant fertilizer. Keeping a worm bin reduces waste as well as the time, cost and energy otherwise used for disposal or recycling. When used as a plant fertilizer, vermicomposting returns nutrients, such as carbon, nitrogen, oxygen and hydrogen, to the energy cycle.



Container

The ideal worm bin should be no more than 12 inches to 18 inches deep. This is because worms feed from underneath. So, the more surface available, the more feeding can take place. Also, in deep containers, vermicompost tends to get packed down, reducing levels of oxygen. It is necessary to put many small holes in the sides and bottom of the container so that air can circulate through the bin.

Image Source: <http://www.resourcefulschools.org/2004/learnwithworm.html>

Bedding

The simplest and most accessible material that can be used for worm bin bedding is shredded newspaper. Paper printed with black ink is safer for the worms than paper printed with colored ink. Moisten the bedding: it should be thoroughly and consistently wet but not dripping. Then, fill the bin approximately three-quarters full of moistened bedding.



Red worms or Red Wigglers (*Eisenia fetida* or *Lumbricus rubellus*)

These worms are not soil dwellers and prefer to live in layers of decaying matter. They feed and convert the most energy at temperatures between 59 and 77 degrees Fahrenheit. Therefore, worm bins should be kept in an environment that stays within this temperature range. When adding worms to a new bin, dump them all on top of the bedding. Leave the lid off so that the worms will be exposed to the light. This should force them to tunnel their way down into the bedding.

Image Source: <http://www.mygreencorner.com/wormtea.php>



Potting Soil

Add a few handfuls of potting soil to a new bin to help the worms digest their food. Worms ingest small particles of soil, which helps with grinding up food inside the worm's digestive system.

Image Source: <http://www.nitrate.com/agnk3.htm>



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Worm Bin Basics continued

Organic waste

Feed worms unused parts of vegetables and fruits, plate scrapings and old leftovers that do not contain meat or minimal animal products, such as oils and dairy. Coffee grounds and filters, tea bags and eggshells can also be fed to the worms. Be careful not to feed them large amounts of citrus as this can become toxic for the worms. Also, do not feed the worms pet feces or non-biodegradables, such as metal, rubber bands or plastic. See the New York Compost Project website at www.nyccompost.org for a full list of foods that are acceptable for worm bins. Worms eat approximately half their weight in a day, so the quantity of worms in a bin determines how much they should be fed. Generally, two pounds of worms process a pound of waste per day.

Image Source: <http://www.nyccompost.org/how/materials.html>



Harvesting

After several months, harvest the bin, in order to separate the worm castings, or poop, from the worms. There are several ways to do this. One method is to create small, cone-shaped piles with the contents of the worm bin, and leave the piles out in the sun or under a bright light. After an hour, the worms will have moved to the center of the piles as they try to position themselves as far from the bright light as possible. The worm castings can then be easily removed from the outer edges of the piles and the worms returned to the bin with new bedding to start the cycle again. Most likely, pieces of un-decomposed materials will be left. These can be sifted out with a large sized sieve and added back to the bin with the worms and the fresh bedding..



Image Source: <http://www.nyccompost.org/how/vermicompost.htm>

After the worms have been separated, the worm castings can be mixed with other materials such as peat moss, sand, garden soil, perlite or vermiculite to make customized potting soil that meets the drainage needs of specific plants. Soil tests can also be conducted to measure the pH levels and the nutrient levels of these soils. It is exciting to observe how the results vary, and consider how the variations might correlate with the type of food wastes that was fed to the worm bin. The resulting worm castings can also be sprinkled directly on the soil surface of potted plants every 45 – 60 days, or they can be added to seed rows.



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Inhabitants of the Worm Bin

A worm bin is an ecosystem that is home to many different organisms. Decomposers in this ecosystem process matter, transforming its nutrients so they are available to plants. Decomposers also secrete moisture that helps soil to clump together. Decomposers fall into two main categories: chemical decomposers and physical decomposers. Chemical decomposers are typically microscopic organisms. They include bacteria, fungi and protozoa. The most numerous in the worm bin are bacteria, and they play the greatest role in the chemical decomposition process. Physical decomposers include worms, mites, nematodes, springtails, sow bugs, beetles, centipedes and millipedes, to name a few. Worms play the greatest role in the physical decomposition process.



Mites



Nematodes



Springtails



Sow Bugs



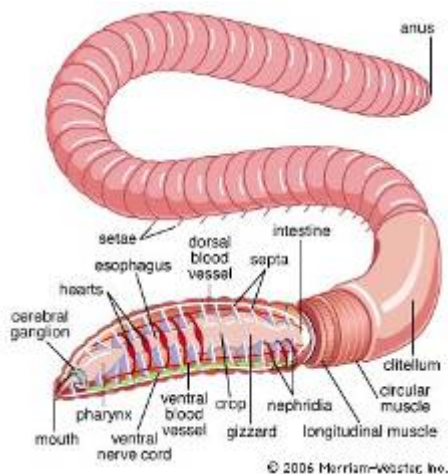
Bacteria



Fungi

Red worms live in leaf litter and other piles of decaying matter. They come up to the surface of a pile at night and pull down leaves and twigs to use to line their burrows. Red worms also secrete chemical moisture that softens the leaves and makes it easier for the worms to later tear or suck off pieces. Worms need moisture on their skin in order to breathe. In the soil and leaf litter, there is usually sufficient moisture for worms to survive. Too much exposure to the drying effect of the sunlight can paralyze worms. That is why they surface at night. In the summer, worms stay closer to the earth's surface. In the colder weather, they find their way further into the soil, where many curl up together in a ball at the bottom of a burrow.

Worms, like many other underground dwellers, do not have eyes. They sense predators by feeling their vibrations. Worms move by stretching their bodies long and then scrunching them up to fill a narrow space. In an enclosed space, they use tiny bristles called setae to anchor themselves to the sides of the space and then pull the rest of their bodies along.



Worms have both male and female reproductive parts, but they need a mate in order to reproduce. After mating, cocoons start to form over the parent worm's body at the site of the clitellum. When they are ready, the cocoons slide off. The ends of the cocoon then seal up, the eggs are fertilized and baby worms begin to grow inside. Eventually, the babies will hatch out of one end of the cocoon.

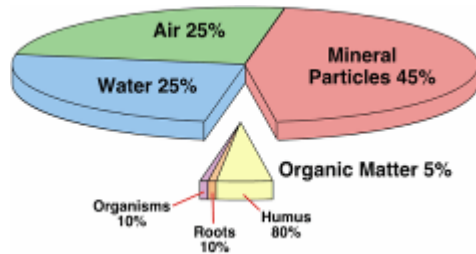
Worms ingest food through their mouths, where it is softened by moisture or bacteria. The food then travels to the gizzard, where it is mixed with other hard objects that have been ingested, such as small pieces of soil. The gizzard contracts and the harder objects inside help grind up the food. The food then travels to the intestine to be further digested by enzymes. Nutrients in the food are absorbed through the intestinal wall, and the remaining materials are excreted through the worm's anus.



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What is Soil?

Components of an Average Soil Sample



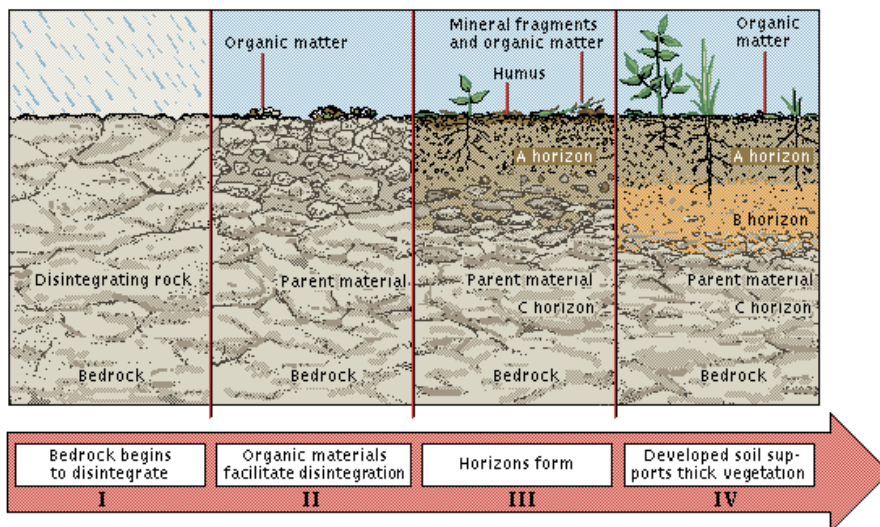
Soil: <http://www.physicalgeography.net/fundamentals/10t.html>

Decomposition produces humus. It is humus that adds the dark color to the top layer of soil. Humus helps soil to retain moisture, provides and keeps nutrients so that they are accessible to plants, and improves soil structure. Humus binds with other mineral and organic soil components to form clumps.

These clumps, also called soil aggregates, make space in the soil for water, air and root growth. The more air in these spaces, the less water, and vice versa. The water in soil is more like a solution, because it also carries small quantities of minerals and nutrients.

Soil serves four functions for plant growth: 1) provides a place for **roots to anchor**, 2) **holds water** for plants, 3) provides **air** for roots to breathe and 4) provides minerals for plant **nutrition**.

Soil Formation



Source: http://encarta.msn.com/media_461530382_761576446_-1_1/Stages_of_Soil_Formation.html



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Kohnke, H. (1962). *Soil Science Simplified*. Lafayette, IN: Balt Publishers.

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<http://www.nyccompost.org/index.html>

Physical Geography.net
<http://www.physicalgeography.net/fundamentals/10t.html>

Resourceful Schools
<http://www.resourcefulschools.org/2004/learnwithworm.html>

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Silverstein, A. & Silverstein, V. (1972). *Life in a Bucket of Soil*. Mineola, NY: Dover Publications, Inc.

Images:

Eco Kids
http://www.ecokids.ca/pub/eco_info/topics/waste/itsnotwaste/theproblem/how_deal.cfm

Encyclopedia Britannica
<http://www.britannica.com/ebc/art-70905/Body-plan-of-an-earthworm>

Energy Information Administration:
<http://www.eia.doe.gov/kids/energyfacts/saving/recycling/solidwaste/landfiller.html>

MSN Encarta
http://encarta.msn.com/media_461530382_761576446_-1_1/Stages_of_Soil_Formation.html

New York City Compost Project
<http://www.nyccompost.org/index.html>

Nitrate Elimination Co., Inc.
<http://www.nitrate.com/agnk3.htm>

NYC Department of Sanitation
http://www.nyc.gov/html/nycwasteless/html/recycling/wcs_charts.shtml

Physical Geography.net
<http://www.physicalgeography.net/fundamentals/10t.html>

Resourceful Schools
<http://www.resourcefulschools.org/2004/learnwithworm.html>



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Resources

BOOKS FOR STUDENTS AND TEACHERS:

(2001). *Dig in!* Arlington, VA: National Science Teachers Association.

Appelhof, M., Fenton, M.F., & Harris, B.L. (1993). *Worms Eat Our Garbage: Classroom Activities for a Better Environment*. Kalamazoo, MI: Flower Press.

Appelhof, M. (1997). *Worms Eat My Garbage: How to Set Up & Maintain a Worm Composting System*. Kalamazoo, MI: Flower Press.

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Silverstein, A. & Silverstein, V. (1972). *Life in a Bucket of Soil*. Mineola, NY: Dover Publications, Inc.

The Earthworks Group. (1990). *50 Simple Things Kids Can Do to Save the Earth*. New York, NY: Scholastic, Inc.

WEB RESOURCES FOR STUDENTS AND TEACHERS:

Eco Kids

http://www.ecokids.ca/pub/eco_info/topics/waste/itsnotwaste/theproblem/how_deal.cfm

Energy Kid's Page from the Energy Information Administration

<http://www.eia.doe.gov/kids/>

Lower East Side Ecology Center

http://www.lesecologycenter.org/les_frames.html

Mansfield Middle School: Where Compost Happens

<http://www.mansfieldct.org/Schools/MMS/compost/overview.htm>

New York City Compost Project

<http://www.nyccompost.org/index.html>

Recycle City

<http://www.epa.gov/recyclecity/mainmap.htm>