CD-404143

MIDDLE GRADES

Using STEM to Investigate Issues in MANAGING WASTE

Integrated activities that cultivate an interest in **science**, **technology**, **engineering**, and **mathematics** and encourage students to explore careers in these fields

SUPPORTS NCTM STANDARDS

State, National, & Provincial CORRELATED Standards

SUPPORTS NSE STANDARDS

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Topic: Issues in waste management

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Concepts:
Solid wastes
Waste management
Recycling, reducing, reusing materials
Getting rid of solid wastes
Impact of solid wastes on the environment
Making decisions about what to do with solid wastes
Pollution
Environmental impact of waste

Objectives:
Students will be able to…

- Examine their own beliefs and values to make decisions related to getting rid of solid wastes.
- Debate the issues, respecting the rights of others to maintain different rights and values.
- Evaluate possible solutions to waste management problems.
- Explain what needs to be considered when making decisions about managing solid wastes.

Activity – Waste Management Issue Discussion Sheets (p. 6–13)

Materials:
Issue Discussion Sheets

TEACHER NOTE: The major purpose of this activity is to help students learn about the issues involved in waste management. Prior to starting, the teacher should discuss the rules for discussion (i.e., all students have the right to their own opinions, they will listen and respect each other's ideas, etc.) Reproduce the number of sets of sheets needed for groups of four students. Each group should have a set.

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Content Background:

In 2008, residents and businesses in the United States produced 250 million tons of municipal solid waste, or 4.5 pounds of waste per person per day. The Environmental Protection Agency (EPA) states that of the 250 million tons of waste, 31% is paper; 13.2% is yard wastes; 12.7% is food; 12% is plastic; 8.4 % is metal; 7.9% is rubber, leather, and textiles; 6.6% is wood; 4.9% is glass; and 3.3% is other materials.

There are four large categories for solid wastes: general waste, metal waste, paper waste, and plastic waste. General wastes include municipal solid waste, aseptic boxes, food wastes, glass containers, lead-acid batteries, scrap tires, and yard wastes. Aluminum packing and steel cars are some metal wastes. Paper wastes include corrugated boxes, magazines, newspapers, and office paper. There are also many kinds of plastic wastes including high-density polyethylene (HDPE), plastic film, and polyethylene terephthalate (PET).

Examples of municipal solid waste are product packaging, grass clippings, furniture, clothing, bottles, food, newspapers, appliances, paint, and batteries. When these items wear out or are replaced by something else, they become a part of the waste stream. A **waste stream** is the general flow of waste from the time it is thrown away until it is destroyed or buried.

Some items are actually designed to wear out or fail after a certain time. This is called **planned obsolescence**. An example of planned obsolescence is car tires that must be replaced after a certain number of miles.

Waste management practices include recycling, composting, source reduction, landfills, and incineration. The EPA ranks the most environmentally sound solutions for solid waste. The most preferred method is source reduction, then recycling and composting, and lastly, disposal by incineration and landfills. In the United States, 33.2% of

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the waste is recovered and recycled or composted, 12.6% is incinerated, and 54% is put into landfills.

There are five R's in waste management. **Reduce** the amount of waste you produce. **Reuse** the objects for new purposes. **Recycle** wastes into new materials. **Rethink** your values and your lifestyle. **Re-buy** recycled products. People may have to examine their values and decide what they are willing to give up in order to help improve the quality of the environment.

Recycling turns materials that would be waste into resources. Recycling protects manufacturing jobs, reduces the need for landfills and incineration, prevents pollution caused by the manufacturing of new products, saves energy, decreases emissions of greenhouse gases, conserves natural resources, and helps sustain the environment. Recycling removes glass, plastic, paper, and metals from the waste stream. The recycled materials are processed and manufactured into new products, and then they are sold. There are three steps to recycling a product: collecting and processing, manufacturing, and purchasing recycled products.

Organic materials, such as yard trimmings, food scraps, wood waste, and paper, are the largest component of our solid wastes. They make up about two-thirds of the solid waste. Composting organic materials will help to reduce this waste. **Composting** decomposes **organic** (was once living or carbon based) waste using microorganisms—mainly bacteria and fungi—to break down the material into a usable form. The organic materials decompose to produce humus that can be used for fertilizer.

In the woods, gardens, and grass, natural composting happens when vegetation and animals die and fall to the ground. As this organic matter decays, it provides minerals and nutrients needed for plants, animals, and microorganisms. Some people are now composting their plant wastes to use as fertilizer on home gardens.

Source reduction is altering the design, manufacture, or use of products and materials to reduce the amount of toxicity of what is thrown away as waste. Grass-cycling or mulching grass clippings, backyard composting, copying on two sides of paper, and reducing transport packaging in industry are examples of source reduction.

Landfills are areas that have been created to store solid wastes. Sanitary landfills are engineered to protect the environment from contami-

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nants. The landfill siting laws prevent placing landfills in environmentally sensitive areas and require environmental monitoring systems that monitor groundwater contamination. They also require safety systems to be in place.

Landfills also need to be monitored for greenhouse gases. Landfills release methane, nitrous oxide, and carbon dioxide. The total emissions are 2.25% of the U.S. greenhouse gas emissions. To alleviate this problem, waste-to-energy landfills collect methane gas emissions to convert the gas to energy for heat and electricity. Other landfill facilities use oxidation of the methane or burning of the collected gases.

Between 1974 and 1997, increased recycling, composting, waste-to-energy sites, and landfill gas reductions reduced the greenhouse gas emissions by 78%. Landfills store carbon due to incomplete degradation of organic materials as the material degrades slowly. Recycling and composting reduced greenhouse gases by 2.5% in 2005, and 85 million tons of municipal solid wastes were recycled or composted in 2007. This is a great improvement, but more needs to be done.

Another way to control solid waste is incineration. **Incineration** is a controlled high-temperature burning of solid waste materials. This process helps reduce the amount of space needed for a landfill. Recyclable materials can be removed from the wastes before burning. The burning waste can be used to heat water to fuel heating systems or generate electricity.

Pollution controls must be built into the incineration process to control the gases given off during the burning process. Scrubbers and filters are added to the chimneys to remove the gases and ash particles given off. Burning waste at high temperatures destroys chemical compounds and disease-causing bacteria. Ash from the incineration process is monitored to be sure it is non-hazardous so it can be used for daily cover in landfills and road construction.

Commercial and industrial waste is a significant portion of municipal waste. Commercial and industrial waste are usually collected by private waste haulers, and recyclable materials are not always recovered. The EPA has guidelines that will help communities more effectively handle commercial and industrial waste and meet high waste recovery goals. These guidelines can be found at <http://www.epa.gov/epawaste/nonhaz/industrial/index.htm>. Communities need to examine how to safely and effectively manage these wastes.

Non-municipal solid wastes include agricultural wastes. Runoff from agricultural land is also considered solid waste. Agricultural runoff includes herbicides, pesticides, and fertilizers. **Herbicides** are used to control weeds, and **pesticides** are used to

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control or destroy pests, such as insects. **Fertilizers** are used to enrich the soil so the crops grow better. The environmental impact of the use of these chemicals needs to be studied and alternatives to using them need to be found.

Monitoring and controlling how waste is disposed of is also a health issue. In early European countries, wastes and waste products were just thrown in gutters in the streets. The Plague spread rapidly in these areas.

The World Health Organization (WHO) reports that garbage collection services are still very poor in developing nations. Thirty to fifty percent of wastes go uncollected in these nations. Some countries still have open sewers to transport human wastes, which can carry diseases. Most developing countries have open waste dump sites with waste pickers (people who go through the open garbage). The problem is that in the past 20 years, solid wastes in these countries have increased 50–100% with no way of collecting the waste materials.

Proper management of hazardous household waste is also an issue related to waste management. There are four categories of hazardous substances: corrosive, flammable, reactive, and toxic. **Corrosive** materials eat away materials by a chemical reaction. Oven cleaners, toilet bowl cleaners, and battery acid are corrosive materials. **Flammable** materials ignite easily. Lighter fluid, gasoline, paint remover, and varnish are flammable, or ignitable. **Reactive** materials create an explosion or produce deadly vapors when exposed to heat, air, water, shock, or when mixed with other chemicals. Bleach mixed with ammonia-based cleaners is reactive. **Toxic** materials are poisonous when eaten, touched, or inhaled, even in small amounts. Pesticides, cleaning fluids, bleach, and some metals like lead are toxic.

An average home contains numerous products with warning labels on them. Read all labels before disposing or storing materials. None of these materials should be placed in a landfill because they will leach into the ground and water and become hazards to the environment, animals, and people.

This chapter will introduce the issues involved in monitoring and controlling the waste stream.