ENVIRONMENTAL ISSUES COMMON TO MULTIPLE SOLID WASTE MANAGEMENT METHODS

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ABSTRACT

Cross-media environmental issues and regulatory aspects of various solid waste disposal methods are presented. The air quality, water quality, and land disposal environmental effects of solid waste combustion, composting, recycling, and landfilling solid waste management options will be discussed relative to the range of contaminants involved in each option. The environmental regulations which may affect each option are discussed in terms of the main facets of each option which are or may be regulated.

NOMENCLATURE

PSD = Prevention of Significant Deterioration
RCRA = Resource Conservation Recovery Act
ppm = parts per millon
MSW = Municipal Solid Waste
BACT = Best Available Control Technology
EPA = United States Environmental Protection Agency
NAAQS = National Ambient Air Quality Standards

INTRODUCTION

This paper will address the potential environmental impacts and the associated regulatory requirements of each solid waste disposal option. The potential pollutants of each type of solid waste disposal option and the regulations pertaining to them will be presented. Since regulatory requirements can be imposed by federal, state or local governments and these requirements are continuing to evolve at all levels, it is not feasible to provide a complete inventory of all such requirements currently existing or being developed. This paper will discuss some of the major areas of environmental regulatory activity and summarize some of the types of issues which may be encountered. No attempt is made to evaluate the relative worth of any of the solid waste disposal options. The purpose of this paper is to present the impacts and regulatory requirements of each option.

Until the mid-to-late 1970s, the most accepted solid waste management practice was land disposal; first in open dumps, and later in sanitary landfills. The national solid waste crisis first became apparent in the densely populated areas of the Northeast, where existing land disposal facilities were filling up and the lack of land available to construct new facilities were the focus of the problem. The human health and environmental risks posed by land disposal have resulted in stringent regulations that have had the effect of further reducing the sites available for landfills. The amount of waste generated continues to increase, while processing and disposal capacity available to handle mixed solid waste decreases. To close this gap, and to increase the ability to properly manage mixed municipal solid waste, EPA has identified waste reduction and recycling as preferred activities with incineration and land disposal as the other parts of an integrated waste management system. EPA acknowledges that the bulk of waste will be managed through combustion and landfills, while emphasizing a significant shift to source reduction and recycling with a goal of diverting 25% of the nation's solid waste from landfills and combustors by 1992 [1].

The four types of solid waste disposal options discussed will be: recycling, composting, incineration, and landfilling. Recycling is defined as the reuse of materials such as aluminum cans, automobile tires, glass bottles, lead-acid batteries, newspapers, magazines, etc. in their original form or using them as a raw material or feedstock in manufacturing products. Composting is the controlled biological modification or microbial degradation of organic waste to yield a humus-like product. Both recycling and composting require sorting and separation of the solid waste stream, and composting can be thought of as a type of recycling involving the organic portion of solid waste. Incineration is the combustion of either raw or processed solid waste, often with the subsequent production of energy in the form of steam or electricity. Land disposal is the disposition of solid waste on the land in the form of sanitary landfills.

RECYCLING

The public generally thinks of recycling as the separation of different portions of the waste stream (glass, aluminum, newspaper, etc.) by the householder for curbside pickup, or for transport by the householder to a centralized processing facility. These activities have virtually no environmental impact and should be known as source separation. The processing of waste to remove recyclables and processing of the materials for reuse does, however, produce emissions and/or effluents that have environmental impacts. This section deals with the environmental and regulatory aspects of the processing procedures when materials are to be reused or remanufactured.

Recycling has been designated by EPA as a preferred option because it prevents potentially useful material from being combusted or landfilled, thus preserving waste disposal capacity. It also saves energy and natural resources, and can be accomplished without the relatively large capital outlays required by incineration and land disposal. At this time there are no environmental or health requirements that apply specifically to recycling. However, the proliferation and evolution of environmental requirements and human health effects associated with combustion and land disposal indicate that solid waste contains a wide variety of materials and substances with potential adverse effects. Recycling should not be considered immune from these issues. As this option for waste management develops, it can be anticipated that environmental and health requirements will develop also [2].

If the separation of the recyclable materials is not or can not be accomplished at the original source of the waste, some degree of handpicking of materials from conveyors in the processing facility to remove recyclable or undesirable materials must be done. Workers are potentially exposed to the variety of contaminants which may be present in the waste both by physical contact and inhalation of dust or vapors. These exposures may be regulated by either occupational safety and health standards or indoor air pollution standards. For example, the Occupational Health and Safety Administration (OSHA) has proposed regulations limiting contaminant levels in confined spaces [3]. This example shows the type of regulations that may be developed for protection from these types of impacts. Enviromental impacts from recycling processes are presently controlled by air quality, water quality, or land disposal regulations. These regulatory systems have not developed very extensive requirements for the waste processing aspect of recycling or may not be applied to some recycling processes and processing facilities because the size of the facility may not be large enough to warrant regulation under these systems. The remanufacturing of materials into new products is regulated under existing requirements for the particular type of industry involved (i.e., paper pulping, metal melting, glass furnaces). The toxics or other trace pollutants generated from these processes may not be easily quantifiable. However, the concentrations and nature of the chemicals in recycling and remanufacturing processes have similar potential to cause water or air pollution as landfilling or combustion, but they have not been studied as intensively. An example of this is the reprocessing of paper in the deinking and bleaching reprocessing steps in the manufacture of recycled paper. Even modern lead-free ink contains small amounts of lead. Chlorine is used in the bleaching process. These substances will be found in the wastewater stream from recycled paper manufacturing facilities. When insulated copper or aluminum wire or aluminum cans are smelted at recycling plants, lead, cadmium, and other heavy metals that are in the original paint or insulation will be in ash and stack emissions [4].

In general, there are at least three sources of contaminants in recycling processes: chemicals in the refuse, chemicals added to waste materials to facilitate reprocessing procedures, and secondary chemical compounds inadvertently created during the recycling process by chemical or thermal action. Other than yard wastes, which will be addressed under composting, the principal materials recycled are metals (ferrous metals, aluminum and copper), paper, and glass.

Most metals recovery processes are thermally based, resulting in pollutant emissions to the air. In secondary aluminum smelting a variety of substances, many of which are chlorine based, are added to separate other metals from the melted aluminum, to protect the aluminum from exposure to air and to drive off contaminants. The major pollutants from such processing are metallic chlorides and oxides, acid gases in the form of hydrogen chloride and hydrogen fluoride, and chloride gas. As with other thermal processes involving chlorine-based compounds, the potential for the formation of trace chlorinated hydrocarbon compounds (dioxins, furans, toluene, choloroform, etc.) exists [5]. Acid gas emissions from other secondary metals processing of lead have been quantified [6].

Water quality impacts from recycling activities can be illustrated by describing the paper recycling process. Paper is often de-inked during the recycling process. Although most newspaper ink is classified as nonlead base ink, lead is often a trace contaminant in these inks in concentrations up to 600 ppm [7]. Modern inks used in many printing processes use a variety of hydrocarbon compounds including acrylics, plastics, and numerous resins, pigments, varnishes, defoamers, and alcohols. Paper itself contains a number of chemicals added during manufacture as preservatives, brighteners, and strength enhancers [8]. Paper can also contain small quantities of dioxin which can be produced during pulp bleaching operations [9]. During the paper recycling processes, many of the chemicals are released into the wastewater stream.

COMPOSTING

As previously stated, composting may be thought of as recycling of the nonhazardous, biodegradable portion of the waste stream. Composting can be applied to various portions of the waste stream including yard waste, kitchen waste, paper, cardboard, etc. It can also be applied to sewage sludge either with simultaneous composting of both the solid waste stream and the sewage sludge or to sewage sludge alone. The application of composting to sewage sludge and MSW simultaneously is referred to as co-composting. There are few composting facilities presently in operation in the United States. However, the costs of composting have become competitive when compared to the costs of other solid waste disposal options in recent years [10]. It has been estimated that composting can manage 40–65% of the solid waste stream [11]. Composting has become a technology of great interest. EPA designated composting as a preferred option along with waste reduction and recycling in areas that lack markets for energy from waste to energy facilities and have a small population base.

Composting and recycling are similar in that each requires some degree of sorting of the waste stream. Composting of leaves and yard wastes can significantly reduce the waste stream. Composting is the ideal method of managing leaves and yard waste and it does not pose a problem for other methods of waste management. Yard waste is not desirable for incineration because of its moisture content and the fact that it is a significant contributor to the formation of nitrogen oxides. Yard waste causes settling and water aggregation problems in landfills. Yard waste can enhance the quality of MSW compost, but may be more salable when composted alone, as it is less likely to contain undesirable contaminants. Finally, yard waste is easily separated from other household wastes.

Compost derived from MSW will have environmental impacts from the processing of the waste stream (sorting, size reduction, etc.), and the composting process itself. Dust emissions result from waste stream processing. These must be controlled by proper ventilation and control of the exhaust by a filter mechanism to prevent air contaminant emissions. The air quality impacts of composting consist of odors, entrained particulate and hydrocarbon from the biodegradation/aeration process. A well operated compost facility will avoid the production of odors by not allowing anaerobic conditions to occur. Entrained particulate from the aeration process is controlled by a filter mechanism. However, any hydrocarbons evolved or driven off are not typically controlled at present.

Because composting is in the development stages for MSW management, there is a scarcity of information on its operational or environmental impacts. A list of typical contaminants in finished MSW compost appears in Table 1. A potential concern is the possible leaching of metals or other contaminants from the compost piles or from land application of compost which may eventually end up in groundwater or sur-

TABLE 1 TYPICAL CONTAMINANT LEVELS IN MSW COMPOST (ppm)

Element or Constituent	Concentration
Cadmium	3.3
Lead	547
Zinc	1,274
Chromium	64
Nickel	41
Copper	321
Nitrogen	1,400
Phosphorus	500
Potassium	600
Iron	11,500
Manganese	800
Molybdenum	10

Sources Shumaker, N., "Chemical Composition of Solid Waste Components Co-Components, presented December 1988, Anaheim, California.
Suess, M.J., "Solid Waste Management Topics, Composting," World Health Organization, Copenhagen, Denmark, 1985, p. 71.

face water. There is also a concern that the compost process may not destroy disease vectors or pathogens if compost parameters are not maintained within necessary ranges. The potential exists that these pathogens could be spread by small animals or insects invading the process area or by distribution of nonsterile compost.

Compost utilization can require substantial tracts of land. Only a portion of the waste is suitable for forming compost; the remaining waste must be incinerated or landfilled. Processing assists in reducing the levels of trace elements, volatile organics, metals, glass, and plastics in the original waste. Soil can be contaminated by the leaching of heavy metals, chlorinated organic substances, pathogens, and toxic organics which may remain in the compost. Waste processing is mechanical. It does not have the capability to remove or alter chemical composition of MSW.

Regulation of exposures to pollutants generated by composting operations or in the compost product can be controlled by occupational safety and health regulations or by air/water/land quality regulations. Some states have implemented or are developing environmental regulations specifically to control the impacts of composting operations or the quality and uses of compost. Typical regulations concerning composting have to do with the type of material to be composted (yard waste, MSW, sewage sludge, MSW/ sewage sludge), with limiting the contaminant levels in the finished compost product, and with restrictions on the use of the finished compost product.

INCINERATION

There are several types of incineration processes for solid waste. The two principle solid waste incineration processes are mass-burn and refuse-derived fuel (RDF). Mass-burn systems combusts MSW with little or no sorting and separation of reusable materials. Therefore, mass-burn systems have a relatively variable fuel in terms of energy value, ash and moisture content. RDF subjects the MSW to mechanical processes that separate many of the reusable materials. RDF fuel is composed mainly of paper, fiber, and plastics and is fairly uniform in terms of energy value, ash and moisture but it still contains contaminants such as heavy metals, glass and plastics. RDF may be burned in a modified existing boiler, or in a boiler specifically designed for RDF. Since the late 1970s, incineration of MSW has been combined with energy production as a response to the energy crisis and to recover capital or operating costs by the sale of steam or electricity. This technology has come to be known as waste-to-energy. Waste-to-energy has two distinct advantages: the volume of the waste is reduced by 90–95%, and it has the capability to manage a large portion of the waste stream. Some components of the waste stream are not combustible. Noncombustibles, such as glass and metals, and low heating value materials such as yard waste are better managed through other waste management methods. Removal of these components of the waste stream increase the energy content of the incineration fuel and reduce the quantity of incineration ash residue.

Air quality issues associated with combustion technologies involve the emission and control of pollutants for which an ambient air quality standard has been set, as well as many pollutants for which no ambient standards exist. Pollutants subject to ambient standards are: particulate matter (both TSP and PM_{10}), sulfur dioxide, nitrogen dioxide, carbon monoxide, volatile organic compounds (for ozone), and lead. Other pollutants that are analyzed and controlled are heavy metals, fluorides, hydrogen chloride, dioxins, and furans. Mass-burn systems have metal emissions due to the presence of metals in common products such as household batteries (cadmium, zinc, mercury, silver, or lead), printing inks, used oil, and soldered cans (lead) in the waste burned. RDF also contains a significant amount of metals contained in plastics, magazine paper, and printing inks among many others. Both fuel types have the potential to emit dioxins and furans.

Emissions from waste-to-energy facilities have been studied extensively. Overall emissions are best controlled by good combustion practices followed by appropriate post-combustion emissions control systems. These types of controls are typically referred to as the "best available control technology" (BACT). Good combustion practices are achieved by maintaining a minimum of one to two seconds residence time in the combustion chamber at temperatures from 1600–1800°F. Appropriate post-combustion technologies are currently defined as a dry scrubber followed by either a fabric filter or an electrostatic precipitator.

There are both state and federal air quality regulations, and sometimes local regulations also, that control air quality impacts from waste-to-energy facilities. If a facility combusts 250 TPD or more of MSW, or if it emits 250 TPY or more of any regulated pollutant, it is subject to the federal program known as the Prevention of Significant Deterioration (PSD) regulations. PSD permit applications require detailed ambient air quality analyses for compliance with ambient air quality standards, increment consumption, significant impacts, and de minimis monitoring levels, as well as for BACT and additional analyses for impacts on visibility, growth, soils and vegetation. PSD regulations apply in areas that are attaining the National Ambient Air Quality Standards (NAAQS). A facility with emissions of a nonattainment pollutant in excess of 100 TPY, or that will have predicted significant concentrations in an area that is not attaining the NAAQS for any pollutant will have to acquire offsetting emissions reductions from other sources that are 20% greater than the facilities emissions for such pollutant and will have to install control equipment that achieves the Lowest Achievable Emission Rate (LAER). A facility that locates in an area that has attainment status for all pollutants but will not process 250 TPD or emit 250 TPY of any regulated pollutant is only subject to state or local permit requirements at this time.

There have been several bills proposed in Congress affecting emissions controls and limitations for solid waste combustion facilities. Senate bill S:196 and house bill HR4902 proposed in 1988 are summarized in Table 2. These bills require that specific emissions and operational requirements be developed by EPA and set maximum limits for some pollutants or limits which are triggered if EPA fails to promulgate timely regulations. These bills require EPA to consider many more pollutants than those included in Table 2. These pollutants are nitrogen oxides, heavy metals, volatile organic compounds, complex organics and other trace elements. The specific limits as shown in Table 2 require a combination of wet or dry flue gas scrubbing, electrostatic precipitators or baghouses, and furnace combustion control systems. Additional controls such as for nitrogen dioxide are left to EPA to decide but there appears to be a definite trend towards such controls in current permit actions.

TABLE 2 LEGISLATIVE PROPOSALS FOR MUNICIPAL SOLID WASTE EMISSION CONTROL, NEW UNITS

Parameter	Senate File [1] 196	House File [2] 4902
Particulates	.015 grains/dscf corrected to 7% O_2.	.015 grains/dscf corrected to 7% O_2.
Carbon Monoxide	50 ppm on a 4-hour avg., 100 ppm for RDF units with dry scrubbers and fabric filters.	100 ppm on a 24-hour avg.
Sulfur Dioxide	40 ppm 7% O_2 on a 8-hour avg. or 70% reduction from uncontrolled emissions is achieved.	50 ppm on a 24-hour avg. unless 70% reduction from uncontrolled emissions is achieved.
Hydrogen Chloride	30 ppm 7% O_2 on a 8-hour avg. unless 90% reduction in uncontrolled emissions is achieved.	50 ppm on a 24-hour avg. unless 90% reduction in uncontrolled emissions is achieved.
Combustion Controls	Furnace temperature not less than 1800°F and residence time not less than 1 second at fully mixed height.	Furnace temperature not less than 1800°F and residence time not less than 1 second at fully mixed height.

[1] 1989 draft--limits are levels which EPA cannot be less stringent than.

[2] June, 1988 draft--limits are imposed if EPA fails to promulgate emission limits in a timely manner.

Water quality impacts result principally from energy production: boiler blowdown in which dissolved solids are removed from the process water in the boiler drum, equipment and facility washdown, pretreatment filter backwash water, neutralized demineralizer regenerate, and others depending on the technology used. Other water quality impacts are from site drainage and sanitary wastewater. In a combustion facility, some of the wastewater sources are often used in the ash quenching system or other systems which can reutilize such wastewater. Some pretreatment is usually necessary before discharge to a local sewer system. Other water quality impacts result from the leaching of contaminants from ash in landfills (Table 3).

Impacts on land result from the necessity to dispose of the bottom ash and fly ash generated when MSW is incinerated. Bottom ash is the material left on the grates of the facility. Fly ash is the material carried over past the boilers into the air pollution control equipment. The individual or combined ash stream may contain certain residual trace toxic metals inherent in materials or trace organics as a result of combustion. The ash generated by MSW incineration must be disposed in a landfill unless recycled in some manner such as paving or construction uses. Most facilities presently combine bottom and fly ash for disposal. EPA currently but unofficially recommends that if fly ash is managed separately, it should be disposed in a monofill with a double liner and a leachate collection system. EPA further recommends that fly ash should not be landfilled in combination with MSW. Bottom ash or

TABLE 3 RANGES OF CONSTITUENTS IN FIELD LEACHATES FROM MONOFILLED COMBINED ASH (Courtesy of Versar, Inc.)

Constituent	Field Leachate (mg/l)
Arsenic	0.005-0.218
Cadmium	0.0025-0.044
Chromium	0.0025-0.914
Copper	0.045-2.57
Iron	0.758-121
Lead	0.025-2.92
Manganese	0.103-4.57
Mercury	0.0001-0.008
Nickel	0.0075-0.037
Selenium	0.0025-0.037
Zinc	0.048-3.3
Dioxin (Total)	0.06-543 ng/l
Furan (Total)	0.04-280 ng/l

Source: Versar, 1987

combined ash is recommended to be disposed in a composite lined landfill with leachate collection. Each state, however, has discretion to regulate the testing and disposal of ash and there are federal legislative and regulatory proposals affecting these areas.

Ash from MSW incinerators is not classified as hazardous waste by EPA provided that the MSW incinerator is recovering energy and that: *(a)* the facility burns only household and solid waste from sources that contain no hazardous waste; and *(b)* that precautionary measures for screening hazardous wastes from commercial or industrial generators are adopted [12]. A state may require ash testing consisting of the EPA Extraction Procedure (EP) toxicity test. This test is intended to simulate the leaching a waste will undergo in a landfill. If the levels of the substances tested for are below established thresholds, the ash is allowed to be disposed in appropriate sanitary landfills. Once disposed in a landfill, ash will not generate methane or other gaseous air pollutants that MSW landfill disposal does because it is inert and will not decompose.

LAND DISPOSAL

There are two types of landfills, uncontrolled and controlled. The vast majority of the nation's 9000 active and inactive landfills are uncontrolled. Uncontrolled landfills are those that do not have leachate and air emissions systems. Controlled landfills are equipped with modern gas control equipment for collecting and flaring fugitive gas emissions and leachate collection systems [13]. The concept of "sanitary landfilling" was introduced by EPA in 1972 [14]. A sanitary landfill is designed to spread layers of solid waste in a confined area, or "cell," compact the waste in the smallest practical volume, and cover it with soil on a daily basis. Such a landfill has a leachate control and collection system, groundwater monitoring, and gas monitoring and venting. There are also strict controls on types of waste accepted.

Air quality impacts are generated by the decomposition of solid waste in the landfill. A number of gases are commonly produced, primarily methane and carbon dioxide. Other gases emitted are nitrogen, oxygen, hydrocarbons, trace volatile organics (VOC), hydrogen sulfide, benzene, and vinyl chloride. The presence of toxic organic compounds in landfill gas have several possible explanations: illegal dumping of toxic compounds, inadvertent disposal of small quantities as a normal part of household and commercial waste, and as a consequence of waste decomposition. Landfill gas can migrate upward or laterally to escape to the ambient air, or can collect beneath the surface to form gas pockets that are potentially explosive. Control of landfill gas is achieved by venting the gas through pipes driven into the landfill and around its perimeter, and by subsurface perimeter barriers. The gas may be allowed to escape to the atmosphere, or may be ignited by installing flare equipment on the vents. Flaring controls potential odorous compounds and destroys much of the volatile gases which are present. The gas may also be captured to use as a fuel source. However, it is not reasonable to assume that some gas does not escape to the ambient air even with these systems in place [15]. EPA has started development of proposed regulations limiting emissions from new and modified municipal landfills under Section 111(b) of the Clean Air Act. These regulations

TABLE 4 CONTAMINANT CONCENTRATION RANGES IN LEACHATE REPORTED IN THE LITERATURE
(Courtesy of the Wisconsin Department of Natural Resources)

	George (1972)	Chian DeWalle (1977)	Metry Cross (1977)	Cameron (1978)
pH	3.7-8.5	3.7-8.5	3.7-8.5	3.7-8.5
Alkalinity	0.20850	0-20850	310-9500	0-20900
Acidity				0-9590
Total Solids		0-59200		
TDS	0-42276	584-44900	100-51000	0-42300
Total Susp. Solids	6-2685	10-700	13-26500	
Specific Conductance		2810-16800	100-1200	
BOD	9-54610	81-33360	2200-720000	9-55000
COD	0-89520	40-89520	800-750000	0-9000
TOC		256-28000		
Bicarbonate			3260-5730	
Hardness	0-22800	0-22800	35-8700	0-22800
Chlorides	34-2800	4.7-2467	47-2350	34-2800
Fluorides				0-2.13
Sulfates	1-1826	1-558	20-1370	0-1826
Sulfide				0-0.13
Total-K-Nitrogen	0-1416			
NH3-Nitrogen	0-1106	0-1106	0.2-845	0-1106
Organic Nitrogen			2.4-550	
NO3-Nitrogen	0-1300	0.2-10.29	4.5-18	
Total Phosphorus	1-154	0-130		
Ortho-Phosphorus		6.5-85	0.3-136	0-154
Aluminum				0-122
Arsenic				0-11.6
Barium				0-5.4
Beryillium				0-0.3
Boron				0.3-73
Cadmium				0-0.19
Calcium	5-4080	60-7200	240-2570	5-4000
Total Chromium				0-33.4
Copper	0-9.9	0-9.9		0-10
Cyanide				0-0.11
Iron	0.2-5500	0-2820	0.12-1700	0.2-5500
Lead	0-5.0	0.10-2.0		0-5.0
Magnesium	16.5-15600	17-15600	64-547	16.5-15600
Manganese	0.60-1400	0.09-125	13	0.06-1400
Mercury				0-0.064
Molybendum				0-0.52
Nickel				0.01-0.8
Potassium	2.8-3770	28-3770	28-3800	2.8-3770
Sodium	0.7700	0-7700	85-3800	0-7700
Titanium				0-5.0
Vanadium				0-1.4
Zinc	0-1000	0-370	0.03-135	0-1000

All concentrations in mg/l except pH (std. units) and Sp. Cond. (umhos/cm).

Source: McGinley, P.M., and Kmet, P. "Formation Characteristics, Treatment, and Disposal of Leachate from Municipal Solid Waste Landfills," Wisconsin Department of Natural Resources Special Report, August 1984.

are currently scheduled to be proposed in February 1990 and promulgated in May 1991.

The principal environmental concern with landfill disposal is the formation and migration of leachate into surface or groundwater. The contaminants in leachate of greatest concern are heavy metals and toxic organics. Table 4 shows a range of leachate contaminants found in the literature [16]. The severity of water resources impacts tends to depend on site specific conditions of geology, soils, water table, slope location, and others.

Protection of water resources is achieved through use of landfill liners, leachate collection systems, and daily, intermediate, and final cover operations. Landfill liners are barriers designed to prevent both leachate migration into underlying formations and infiltration into the landfill from above. Liners are built with low permeability and synthetic liner materials. Leachate collection is done by a system of perforated drainage pipes laid above the liner. The collected leachate is treated at water treatment facility before ultimate discharge. Daily, intermediate, and final cover operations limit water infiltration by prompting runoff through the use of slope designs and low permeability materials. Final cover utilizes slope design and vegetation to prevent erosion and promote evapotranspiration via plant growth, thus reducing the quantity of leachate produced.

Impacts of landfills on land may include reducing the options for ultimate land use, decreased land values for the site and the surrounding area, and restrictions on the types of vegetation grown on the site [17]. These impacts are caused by the production of gas and waste settling. An additional potential impact involves the attraction of rodents, insects, and birds which can be potential carriers of disease. These impacts can be controlled by proper daily, intermediate, and final cover operations. Ashfills do not provide habitat for potential disease carriers because of the lack of usable food items in ash [18].

SUMMARY AND CONCLUSIONS

The environmental issues and regulatory aspects of the four principal methods of managing solid wastes—recycling, composting incineration, and landfilling—have been presented. The public perception of the four MSW management methods seems to be that incinerators and landfills are viewed negatively, while recycling and composting are environmently benign. However, closer examination of the processes involved show that regardless of the waste management option used, pollutants will be emitted from any facility that processes MSW or utilizes materials derived from MSW.

EPA has a stated goal of implementing integrated solid waste management systems using all four waste management methods. The environmental and health risks of each method differ in the extent each medium (air, water, and land) is impacted, and in total impact. Some of the management methods may have emissions and/or effluents that are unique. Each option will also impact differing sizes of geographic area from regional to very small localized areas. However, when viewed objectively no aspect of solid waste management is free of enviromental issues and concerns.

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