CHAPTER 1
INTRODUCTION

PURPOSE

State and federal agencies are concerned about lead, cadmium and mercury in solid waste due to their toxicity and concentrations. States are interested in reducing these metals in incinerator emissions and ash and landfill leachate. This report examines the contribution of products containing these metals from hospital solid waste to the municipal solid waste (MSW) stream.

Hospitals are an important industry in the Northeast. They provide essential services for the health and welfare of communities. They also produce a variety of waste streams because of the range of their services. Reducing and managing waste is a challenge for hospitals and state environmental agencies. State officials suspect that hospital and other institutional and commercial sources may contribute to the presence of toxic metals in incinerator emissions and ash and MSW landfills. However, environmental agencies have not studied these sources extensively. Therefore, this project was designed to be a scoping study of potential sources of lead, cadmium and mercury (the target metals) in hospital solid waste (HSW).

REPORT ORGANIZATION

This report is presented in five chapters as follows:

Chapter 1 describes health concerns regarding lead, cadmium, and mercury and their fate in the environment to provide the reader with a brief summary of some of the literature. The chapter also provides a description of the regulatory classification of wastes.

Chapter 2 identifies and quantifies sources of lead, cadmium and mercury in municipal solid waste from households and identifies some potential sources in HSW. The researchers use data on sources of the target metals from households as a starting point since data regarding metals in HSW are not available.

Chapter 3 identifies and estimates some sources of lead, cadmium and mercury in hospital solid waste. To identify these sources of the target metals, the researchers conducted a case study of a Boston-area hospital. This chapter also suggests source reduction and recycling practices available to hospitals.

Chapter 4 provides a survey of U.S. federal and state legislation and regulations that affect HSW, including those concerning hazardous waste, air quality and source reduction initiatives. This examination also includes a description of some regulatory initiatives undertaken by European countries and Japan.
Chapter 5 presents options for the reduction and proper management of the target metals in HSW.

The report ends with a bibliography and list of contacts.

POTENTIAL HEALTH EFFECTS

The impetus for this project was concern about potential adverse health effects resulting from human exposure to the target metals in HSW. The following sections briefly describe the potential health effects associated with the target metals and possible exposure pathways.

HEALTH EFFECTS

Heavy metals can exert a broad range of toxic effects. The most well documented are the non-carcinogenic effects to the neurological, hepatic, renal, and hematopoietic systems (Denison, 1988). Due to their stability, the target metals can accumulate in the environment and bioaccumulate in the body. Therefore, human exposure even at low levels over an extended period of time can have adverse impacts.

Low level lead exposure can result in neurological damage, particularly in young children. Exposure to high levels of lead can lead to abdominal cramps, headaches, loss of appetite, anemia, and motor-nerve paralysis. Children exposed to high levels of lead may experience encephalopathy and repressed neurodevelopment (Clayton, 1981).

Acute exposure to cadmium can occur through inhalation or ingestion. When inhaled at high levels, cadmium can cause severe pulmonary irritation, and when ingested at high levels the metal can irritate the gastrointestinal tract. Cadmium may accumulate in the body resulting in chronic exposure and possible damage to the kidneys (Waalkes, 1991).

Mercury exposure can be associated with neurological, kidney and immune system damage. Most of these effects can result from chronic occupational exposures. Death can result from acute exposures to high concentrations of inorganic mercury (ATSDR, December 1989). Fetal exposure to even low concentrations of mercury can be associated with delayed development (Murdock, 1990).

EXPOSURE PATHWAYS

Hospitals currently manage such metal containing wastes as spent batteries and electronic equipment by landfilling and incineration. This section briefly explores
possible routes of exposure during these waste management practices. In general products used by hospital are not recycled.

**Incineration**

Approximately 70 percent of the U.S. biomedical waste stream is incinerated on-site and another roughly 15 percent is incinerated at regional facilities. This represents roughly ten percent on a mass basis of the solid waste incinerated in the U.S. (Glasser et al. 1991).

Incinerators do not destroy heavy metals. Incineration can volatilize heavy metals which condense onto the surface of fly ash or are emitted from the stack. For example, the Agency for Toxic Substances and Disease Registry (ATSDR) reports that incinerator stacks may emit cadmium if proper pollution control devices are not in place (ATSDR, March 1989). Although fly ash can be efficiently removed from modern MSW incinerators, most hospital incinerators do not have air pollution control equipment (Brunner, 1988). Biomedical waste incinerators using current incineration technologies may not meet the performance criteria for metals emissions that several states have proposed (Lee, 1991).

The particles from incineration are usually under ten microns in diameter, and they can easily be ingested or inhaled (Denison, 1988). Exposure may occur through ingestion after the airborne metals have deposited onto crops, soils, and surface waters. Some studies have shown that this deposition route may be many times higher than exposure to airborne metals (Denison, 1988).

Incinerators concentrate lead and cadmium in bottom ash (Denison, 1988) (Lee, 1991). Bottom and fly ash is ultimately disposed in a landfill, where it can continue to pose a threat to the environment and human health. Contaminated leachate can form from landfilled incinerator ash and can enter groundwater and surface water. Exposure can occur through ingestion of the water, contact during agricultural irrigation, consumption of irrigated food or recreational activities. Exposure during recreational activities can occur through eating contaminated fish and other aquatic organisms caught in the contaminated water, direct ingestion of the water, or dermal contact (Clark, 1989).

A recent analysis of air emissions from biomedical waste incinerators found elevated levels of the target metals. This study reported that these incinerators are often located in heavily populated areas and have comparably higher target metals emissions per unit volume of waste than other incinerators. The study concluded that the risks from emissions from biomedical waste incinerators are at least comparable to hazardous or municipal waste incinerators (Glasser et al. 1991).

Under the Clean Air Act Amendments of 1990, EPA will be proposing New Source Performance Standards (NSPS) for emissions from new medical waste combusters
and emissions guidelines for existing ones. Lead, cadmium and mercury and other toxic pollutants are among those that the Agency plans to regulate. The NSPS should reflect the maximum achievable control technology (MACT) while the guidelines may be equal to or less than the NSPS.

**Landfilling**

The metal leaching capability of hospital wastes disposed in MSW landfills has not been assessed; however, researchers are investigating this subject (Rathje, 1991). There is evidence of lead and cadmium in leachate from MSW landfills exceeding drinking water standards (MIT, 1990). There is no source data available to correlate this leachate with any particular components of solid waste.

Plants grown in soil that is contaminated either through ash deposition or leachate may take the metals into their root system (Desmarais, 1990). Contaminated crops may be ingested directly by humans or indirectly through animals used for meat and milk production who ingest the crops. Lead is more able to translocate into cow's milk than cadmium and mercury (Stevens, 1991).

Workers in close contact with solid waste and incinerator ash can be exposed to the target metals during their handling, treatment, and transportation. This may be a route of exposure that can be readily controlled by the use of personal protective equipment or through such other interventions as substitution and/or removal from the waste stream.

**CATEGORIES OF WASTE**

This study focuses on solid waste generated by hospitals. Hospital solid waste is considered to be a component of commercial solid waste. Commercial solid waste (CSW) combined with household solid waste make up municipal solid waste. The United States produced approximately 160 million tons of MSW in 1988 (EPA, February 1989). EPA and states may differ in their regulatory definitions of these various types of waste. However, this report uses such terms as hospital, commercial and municipal solid waste as they are commonly understood.

For the purposes of this study, CSW is defined as solid waste generated by establishments that are commercial in nature (DEP, 1990). Commercial establishments include wholesalers and retailers of merchandise, financial services firms, hotels, personal and business services firms, amusement and recreational facilities, medical and health services organizations and non-profit organizations. Hospital solid waste is a component of commercial solid waste. Hospitals in Massachusetts account for approximately three percent of the total CSW generated. A study of CSW in Kentucky found that medical and health services accounted for approximately four percent of their commercial solid waste.