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EPA Office of Compliance Sector Notebook Project

Profile of the Healthcare Industry

Chapters I., II and III.

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Healthcare Industry - Including Hospitals, Physicians Offices, Dental Offices, Nursing Homes, etc. (NAICS 62)

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ACRONYMS

ADA	American Dental Association
AFS	Air Facility Subsystem
AHA	American Hospital Association
AHCA	American Health Care Association
AHERA	Asbestos Hazard Emergency Response Act
AIRS	Air Facility Indexing and Retrieval System
AMA	American Medical Association
ANA	American Nurses Association
ANSI	American National Standards Institute
ASHE	American Society for Healthcare Engineers
ASHES	American Society for Healthcare Environmental Services
AST	Aboveground Storage Tanks
AVMA	American Veterinary Medical Association
BBP	Blood Borne Pathogens
BIF	Boilers and Industrial Furnaces
BOD	Biochemical Oxygen Demand
BRS	Biennial Reporting System
C&D	Construction and Demolition
CAA	Clean Air Act
CAM	Compliance Assurance Monitoring
CAP	College of American Pathologists
Cd	Cadmium
CDC	Centers for Disease Control
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act
CERCLIS	Comprehensive Environmental and Liability Information System
CESQG	Conditionally Exempt Small Quantity Generator
CFC	Chlorofluorocarbon
CFR	Code of Federal Register
CMS	Centers for Medicare and Medicaid Services
CSRD	Central Sterile Reprocessing and Distribution
CWA	Clean Water Act
DMR	Discharge Monitoring Reports
DOT	Department of Transportation
e-CFR	Electronic Code of Federal Regulations
ECHO	Enforcement and Compliance History Online
ECOS	Environmental Council of the States
EEG	Electroencephalograph
EMS	Environmental Management System
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPP	Environmentally Preferable Purchasing
EtO	Ethylene Oxide
FDA	Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act

FQPA	Food Quality Protection Act
FRN	Federal Register Notice
FRS	Facility Registry Systems
GDP	Gross Domestic Product
H2E	Hospitals for a Healthy Environment
Hal	Hydrochloric Acid
HAP	Hazardous Air Pollutants
HAZWOPER	Hazardous Waste Operations and Emergency Response
HBN	Healthy Building Network
HCWH	Health Care Without Harm
Hg	Mercury
HHS	Health and Human Services
HMIWI	Hospital/Medical/Infectious Waste Incinerators
HVAC	Heating Ventilation and Air Conditioning
ICIS	Integrated Compliance Information System
IDEA	Integrated Data for Enforcement Analysis
IS	Information Services
ISO	International Organization for Standardization
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
LDR	Land Disposal Restrictions
LEPC	Local Emergency Planning Committees
LQG	Large Quantity Generators
MACT	Maximum Achievable Control Technology
MCL	Maximum Containment Levels
MCLG	Maximum Containment Level Goals
MMS	Minerals Management Service
MOU	Memorandum of Understanding
MRI	Magnetic Resonance Imaging
MS4	Municipal Separate Storm Sewer Systems
MSDS	Material Safety Data Sheet
MSW	Municipal Solid Waste
MWTA	Medical Waste Tracking Act
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System
NCDB	National Compliance Database
NEETF	National Environmental Education & Training Foundation
NESHAP	National Emission Standards for Hazardous Air Pollutants
NET	National Emission Trends
NIHE	National Institute for Health and the Environment
NLIC	National Lead Information Center
NOVs	Notices of Violation
NO_x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
NPIC	National Pesticide Information Center
NRC	Nuclear Regulatory Commission
NSPS	New Source Performance Standards

NSR	New Source Review
NTI	National Toxics Inventory
OAR	Office of Air and Radiation
OB/GYN	Obstetrics and Gynecology
OECA	Office of Enforcement and Compliance Assurance
OSHA	Occupational Health and Safety Administration
OSWER	Office of Solid Waste and Emergency Response
P2	Pollution Prevention
P2OSH	Pollution Prevention and Occupational Safety and Health
Pb	Lead
PCB	Polychlorinated Biphenyls
PCS	Permit Compliance System
PEER	Public Entity Environmental Resource Center
POTW	Publicly Owned Treatment Works
PSD	Prevention of Significant Deterioration
PVC	Polyvinyl Chloride
RCC	Resource Conservation Challenge
RCRA	Resource Conservation and Recovery Act
RCRAInfo	Resource Conservation and Recovery Act Information System
RMW	Regulated Medical Waste
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SERC	State Emergency Response Commissions
SHP	Sustainable Hospitals Project
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SPCC	Spill Prevention Control & Countermeasure
SQG	Small Quantity Generators
SWDA	Solid Waste Disposal Act
TCLP	Toxicity Characteristic Leaching Procedure
TIP	Tribal Implementation Plans
TRI	Toxic Release Inventory
TRIS	Toxic Release Inventory System
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
UIC	Underground Injection Control
USDW	Underground Sources of Drinking Water
USPS	United States Postal Service
UST	Underground Storage Tanks
VOC	Volatile Organic Compounds

I. INTRODUCTION TO THE SECTOR NOTEBOOK PROJECT

I.A. Summary of the Sector Notebook Project

Environmental policies based upon comprehensive analysis of air, water, and land pollution (such as economic factors and community-based approaches) are becoming an important supplement to traditional single-media approaches to environmental protection. Environmental regulatory agencies are beginning to embrace comprehensive, multi-statute solutions to facility permitting, compliance assurance, education/outreach, research, and regulatory development issues. The central concepts driving this policy are that pollutant releases to each environmental medium (air, water, and land) affect each other, and that environmental strategies must actively identify and address these interrelationships by designing policies for the whole facility. One way to achieve a whole-facility focus is to design environmental policies for similar industrial facilities. By doing so, environmental concerns that are common to the manufacturing of similar products can be addressed in a comprehensive manner. Recognition of the need to develop the industrial sector-based approach within EPA's Office of Compliance led to the creation of this document.

The Sector Notebook Project was initiated by the Office of Compliance within the Office of Enforcement and Compliance Assurance (OECA) to provide its staff and managers with summary information for specific industrial sectors. As other EPA offices, states, the regulated community, environmental groups, and the public became interested in this project, the scope of the original project was expanded. The ability to design comprehensive, common-sense environmental protection measures for specific industries is dependent on knowledge of several interrelated topics. The key topics examined for this project are: general industry information (economic and geographic); a description of activities; pollution outputs; pollution prevention opportunities; federal statutory and regulatory framework; compliance history; and a description of partnerships that have been formed between regulatory agencies, the regulated community, and the public.

For any given industry, each topic listed above could alone be the subject of a lengthy volume. However, in order to produce a manageable document, this project focuses on providing summary information for each topic. This format provides the reader with a synopsis of each issue, and references where more in-depth information is available. Text within each profile was researched from a variety of sources, and was usually condensed from more detailed sources pertaining to specific topics. This approach allows for a wide coverage of activities that you can further explore using references listed at the end of this profile. As a check on the information included, each Notebook went through an external document review process. The Office of Compliance appreciates the efforts of all those who participated in this process and enabled us to develop more complete, accurate, and up-to-date summaries. Many of those who reviewed this Notebook are listed as contacts in Section IX and may be sources of additional information. The individuals and groups on this list do not necessarily concur with all statements within this Notebook.

I.B. Additional Information

Providing Comments

OECA's Office of Compliance plans to periodically review and update the Notebooks and will make these updates available both in hard copy and electronically. If you have any comments on the existing Notebooks, or if you would like to provide additional information, please send them to: EPA Office of Compliance, Sector Notebook Project (2224-A), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Comments can also be sent electronically via the Sector Notebooks web page at: *www.epa.gov/compliance/sectornotebooks.html*. If you are interested in assisting in the development of new Notebooks, or if you have recommendations on which sectors should have a Notebook, please contact the Office of Compliance at (202) 564-2310.

Adapting Notebooks to Particular Needs

This Sector Notebook is meant to generally describe the healthcare industry on a national basis. In many instances, facilities within specific geographic regions or states may have unique characteristics that are not fully captured in these profiles. The Office of Compliance encourages state, tribal, and local environmental agencies and other groups to supplement or repackage the information included in this Notebook to include more specific industrial and regulatory information that may be available. Additionally, interested states and tribal governments may want to supplement the "Summary of Applicable Federal Statutes and Regulations" section with state, tribal, and local requirements. Compliance or technical assistance providers may also want to develop the "Pollution Prevention" section in more detail.

Updated Web Site Links

An updated list of all of the web links contained in this Notebook can be found at *www.hercenter.org/links*.

II. INTRODUCTION TO THE HEALTHCARE INDUSTRY

This section provides background information on the size, geographic distribution, employment, and economic condition of the healthcare industry. Facilities described within the document are also described in terms of their North American Industry Classification System (NAICS) codes. The NAICS, which was developed jointly by the United States, Canada, and Mexico to provide new comparability in statistics about business activity across North America, has replaced the U.S. Standard Industrial Classification (SIC) system, under which Health Services is designated 80. Facilities in the healthcare industry are identified under NAICS code 62.

Note that, while there are benefits to the NAICS codes for organizing categories of business, there are disadvantages in the case of the healthcare sector. For the most part, healthcare organizations, whether large or small, in-patient or outpatient, have some level of complexity to their operations and functions. Even small multi-service hospitals have complex service offerings, and generate a large variety of waste. Therefore, the NAICS code information presented below is supplemented with a more robust picture of the rapidly changing healthcare universe.

II.A. Introduction, Background, and Scope of the Notebook

The healthcare and social assistance industry (NAICS code 62) comprises many subsectors including ambulatory healthcare services, hospitals, nursing and residential care facilities, and social assistance. This Notebook focuses primarily on the activities performed at hospitals. However, many of these activities can be performed by others in the healthcare industry, and as such, this notebook applies to those providers as well.

The specific subsectors covered in this industry document are:

- **NAICS 621. Ambulatory Healthcare Services**. The following types of facilities are covered under this NAICS code:
  - Physicians' offices,
  - Dentists' offices,
  - Other health practitioners' offices,
  - Outpatient care centers,
  - Medical and diagnostic laboratories,
  - Home healthcare services, and
  - Other ambulatory healthcare services.

  These entities may be free standing and perhaps privately owned or may be part of a hospital or health system. Currently, most hospitals (NAICS 622) also offer ambulatory healthcare services. For some facilities, these services represent as much as 60-70 percent of hospital business. Much of this change has been driven by adjustments in healthcare finance and reimbursement, advances in technology, and new and effective

pharmaceuticals, that eliminate the need for inpatient and invasive care services.

Also of note is the growing emergence of complementary healthcare services that are also ambulatory in nature. These include chiropractic care, massage, acupuncture, and acupressure.

- **NAICS 622. Hospitals**. The following types of facilities are covered under this NAICS code:
  - General medical and surgical hospitals,
  - Psychiatric and substance abuse hospitals, and
  - Specialty (except psychiatric and substance abuse) hospitals.

  This category potentially includes many types of hospitals such as academic medical center/university-based/teaching hospitals, community hospitals, speciality hospitals (i.e., orthopedic or pediatric), and tertiary care facilities that are qualified to handle major trauma cases (i.e., burns and catastrophic accidents). There are also distinctions between public and private hospitals, hospitals that are part of a healthcare system (i.e., organizations such as Kaiser Permanente), Veterans Administration hospitals, and other types of facilities.

  Hospitals and healthcare systems are continually changing their service offerings, and responding to various internal and external forces including reimbursement issues, advances in technology, and shifts in the populations they serve.

- **NAICS 623. Nursing and Residential Care Facilities**. The following types of facilities are covered under this NAICS code:
  - Nursing care and assisted living facilities,
  - Residential mental retardation/health and substance abuse facilities,
  - Community care facilities for the elderly, and
  - Other residential care facilities.

  Nursing care and residential care facilities offer nonacute care to individuals, either those suffering from a chronic condition (e.g., dementia, developmental delay, multiple sclerosis, Parkinson's disease, autism), aging, or mental health problems.

  As population demographics in the United States shift and demand for care services and facilities increases, more and more facilities offering some component of the above services will arise.

The veterinary services industry (NAICS 541940) also performs many activities similar to the healthcare industry. Veterinary facilities may find some of the information in this Notebook relevant and useful.

- **NAICS 541940. Veterinary Services**. This industry includes establishments of licensed veterinary practitioners primarily in the practice of veterinary medicine, dentistry, or surgery for animals, and establishments providing testing services for licensed veterinary practitioners.

II.B. Characterization of the Healthcare Industry

II.B.1. Service Characterization

The healthcare industry provides a variety of services to support the healthcare needs of a community or individuals. Many of the activities in healthcare result in waste outputs and air or water pollution. In order to understand which activities generate polluting waste outputs, it is necessary to look at various functions within healthcare, and understand the products and supplies used and the resulting wastes. Much of the waste in healthcare is solid waste consisting of paper, cardboard, glass, plastic, and metals. A subcomponent of healthcare waste is biohazardous, or infectious waste. Another component is Resource Conservation and Recovery Act (RCRA) hazardous waste.

Healthcare is vastly different from the many industries that have a defined 'product line,' a finite number of input materials and defined and consistent 'waste outputs.' There are thousands of procedures, tests, processes, and activities, which encompass as many materials. The hazardous component in healthcare waste tends to be made up of small amounts of many different wastes, emanating from many different departments. Due to the decentralized nature of service delivery in healthcare, there can be various departments with different functions all generating various amounts of hazardous waste.

Hospitals are most often described by speciality or service areas. Some of these areas include, but are not limited to: cardiology, critical care, emergency services, family practice, facility engineering, general surgery, gynecology, infectious disease, internal medicine, laboratory and analysis, medical monitoring/computer services, morgue, neurology, neurosurgery, obstetrics, oncology, pathology, pharmacy, radiology, residential care, and urology.

II.B.2. Industry Size and Geographic Distribution

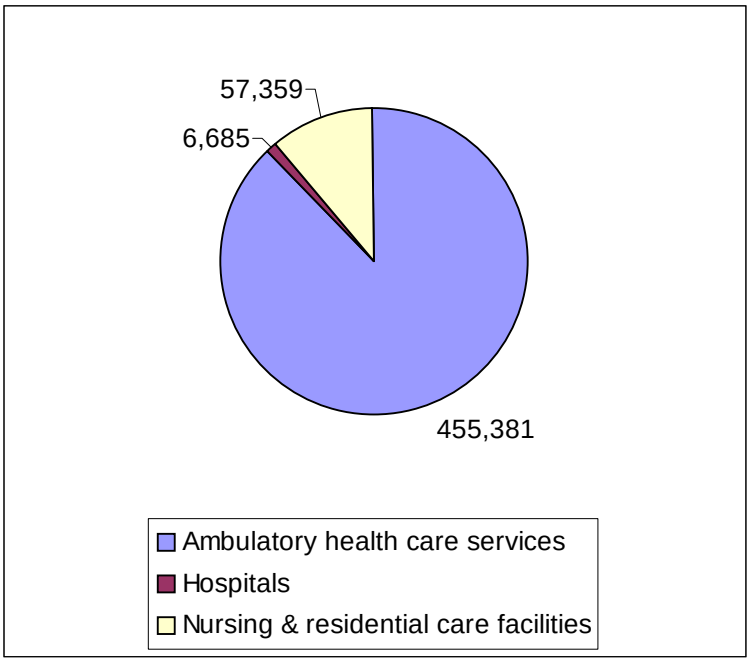
The healthcare industry impacts the lives of nearly every person in the United States. According to the 1997 Census of the Healthcare Industry (NAICS codes 621, 622, and 623), there are more than 500,000 healthcare facilities throughout the country, employing almost

12 million people, with an annual payroll of more than $353 billion. In 2002, the 5,794 registered[1] hospitals included 975,962 staffed beds and admitted 36,325,693 patients.

Hospitals alone contribute more than $1.3 trillion to the nation's economy, according to a TrendWatch report by the Lewin Group released at the 2004 AHA Annual Meeting in Washington. Hospitals employ nearly five million people, rank second as a source of private sector jobs, and directly or indirectly support one of every nine jobs in the United States.

Figure II-1 demonstrates how the healthcare industry is divided among ambulatory healthcare facilities, hospitals, and nursing and residential care facilities. The majority of the facilities, 88 percent, are ambulatory healthcare facilities. The remainder of the industry is divided between nursing and residential care facilities (11 percent) and hospitals (1 percent).

Figure II-1: Number of Establishments in the Healthcare Industry

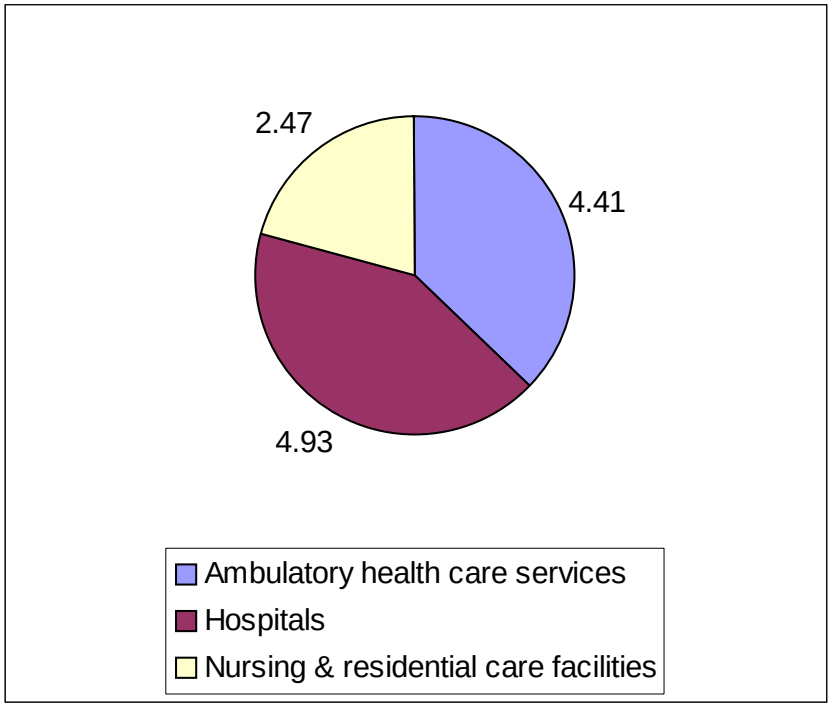


Source: The 1997 Economic Census of the Healthcare and Social Assistance Industry.

Although ambulatory healthcare facilities make up 88 percent of the healthcare facilities, hospitals have the most employees, totaling more than 42 percent of the industry. Ambulatory healthcare facilities have 37 percent of the healthcare staff, while nursing and residential care facilities have only 21 percent. Figure II-2 shows the number of employees by type of healthcare facility.

[1] Registered hospitals are those hospitals that meet the American Hospital Association's (AHA) criteria for registration as a hospital facility. Registered hospitals include AHA member hospitals as well as nonmember hospitals. For a complete list of the criteria used for registration, please see *http://www.hospitalconnect.com/aha/resource_center/*

Figure II-2: Number of Paid Employees (millions) by Type of Healthcare Facility

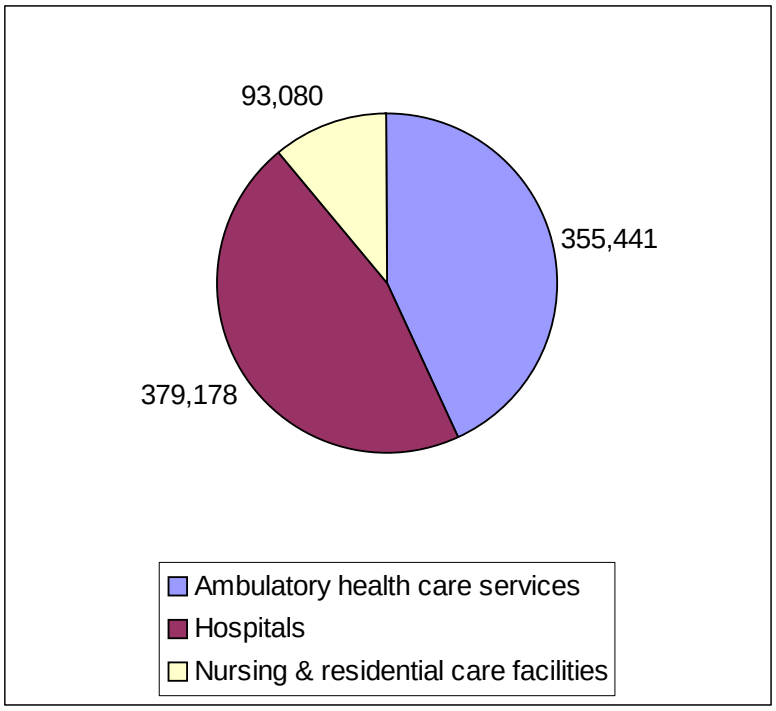


Source: The 1997 Economic Census of the Healthcare and Social Assistance Industry.

The revenue for healthcare facilities is divided unevenly across the number of ambulatory healthcare, hospitals, and nursing and residential care facilities. As shown in Figure II-3, the majority of the revenues, 46 percent, are from hospitals. It is important to once again note, however, that a large part of a hospital's service offerings are ambulatory healthcare offerings. There are also many hospitals/health systems that have affiliated nursing homes, residential care facilities and other healthcare sector entities that deliver service, which may not be reflected in the value of claims and revenues. The remainder is divided between ambulatory healthcare facilities (43 percent) and nursing and residential care facilities (11 percent). In the healthcare industry, these revenues come from:

- Patient care services (which includes laboratory services, diagnostic testing, and direct patient care);
- Home healthcare services, including sales of blood, blood products, organs and tissues, and ambulance services;
- Rental and leasing of goods and equipment, including both medical and "other"; and
- Other services and medical equipment related to prescription and nonprescription drugs, vision care services, orthopedic services, and other related needs.

Figure II-3: Value of Revenue in the Healthcare Industry (millions)



Source: The 1997 Economic Census of the Healthcare and Social Assistance Industry.

Healthcare establishments are concentrated in areas with high population density. California has the highest number of facilities, followed by New York, Texas, Florida, and Pennsylvania. California has more than 67,000 ambulatory healthcare, hospital, and nursing and residential facilities, which employ over one million people per year. Table II-1 presents the number of healthcare establishments, the number of healthcare employees, and the total healthcare receipts in each of the 50 states and the District of Columbia. The information is ordered by number of establishments.

Table II-1: Number of Healthcare Establishments, Number of Healthcare Employees, and Total Healthcare Receipts, by State

State	Establishments	Paid Employees	Receipts ($1,000)
California	67,049	1,084,719	93,742,883
New York	37,640	968,004	68,576,184
Texas	35,543	790,629	53,894,354
Florida	33,863	664,362	49,513,538
Pennsylvania	25,826	626,842	42,445,050
Illinois	21,107	519,598	36,820,144
Ohio	20,872	535,457	34,537,846
Michigan	19,135	431,813	29,168,412
New Jersey	18,508	354,546	27,056,992
Georgia	12,802	290,674	22,242,191
Massachusetts	12,799	389,529	25,146,242
North Carolina	11,669	319,631	21,908,538
Virginia	11,273	247,869	17,692,485
Washington	11,157	222,782	15,460,294
Maryland	10,709	225,103	15,968,224
Indiana	10,076	263,591	16,950,896
Missouri	9,813	274,628	17,365,887
Tennessee	9,756	257,050	18,489,619
Wisconsin	9,173	245,975	15,368,388
Arizona	8,800	159,723	11,947,321
Colorado	8,334	151,265	10,772,791
Minnesota	8,081	157,894	9,864,404
Louisiana	8,026	214,367	13,843,010
Connecticut	7,444	93,899	6,241,205
Oregon	7,212	127,530	8,518,910
Alabama	6,706	180,407	12,688,762
Kentucky	6,647	171,005	11,345,390
Oklahoma	6,601	147,287	8,832,649
South Carolina	5,783	136,320	9,597,946
Iowa	5,355	98,979	5,129,312
Kansas	4,868	66,756	3,667,767
Arkansas	4,471	108,101	6,870,149
Mississippi	3,828	112,359	7,577,714
Utah	3,658	71,790	4,795,081

Table II-1: Number of Healthcare Establishments, Number of Healthcare Employees, and Total Healthcare Receipts, by State (Continued)

State	Establishments	Paid Employees	Receipts ($1,000)
West Virginia	3,461	83,485	5,526,231
Nevada	3,010	49,295	4,434,559
New Mexico	2,933	64,709	4,134,335
Nebraska	2,847	48,392	2,865,939
Maine	2,777	37,388	2,272,419
Hawaii	2,430	22,932	2,090,765
Idaho	2,351	43,029	2,678,189
New Hampshire	2,256	55,401	3,618,105
Rhode Island	2,143	31,298	2,197,746
Montana	1,967	23,902	1,294,100
District of Columbia	1,496	47,742	4,194,304
South Dakota	1,363	41,507	2,371,023
Delaware	1,356	19,353	1,367,588
Vermont	1,274	27,330	1,589,182
Alaska	1,141	20,740	1,787,722
North Dakota	1,064	27,686	1,339,141
Wyoming	972	17,728	1,076,409

Source: The 1997 Economic Census of the Healthcare and Social Assistance Industry.

The 1997 Census information did not separate Veterinary Services (NAICS 541940) from the other industries within the 5419 code category. However, according to the American Veterinary Medical Association, as of September 2002, there are 61,477 veterinarians employed in about 21,044 veterinary practices located across the United States. These practices have a mean gross practice revenue of $677,823 per practice per year. This information includes both private clinical practices and public and corporate employment.

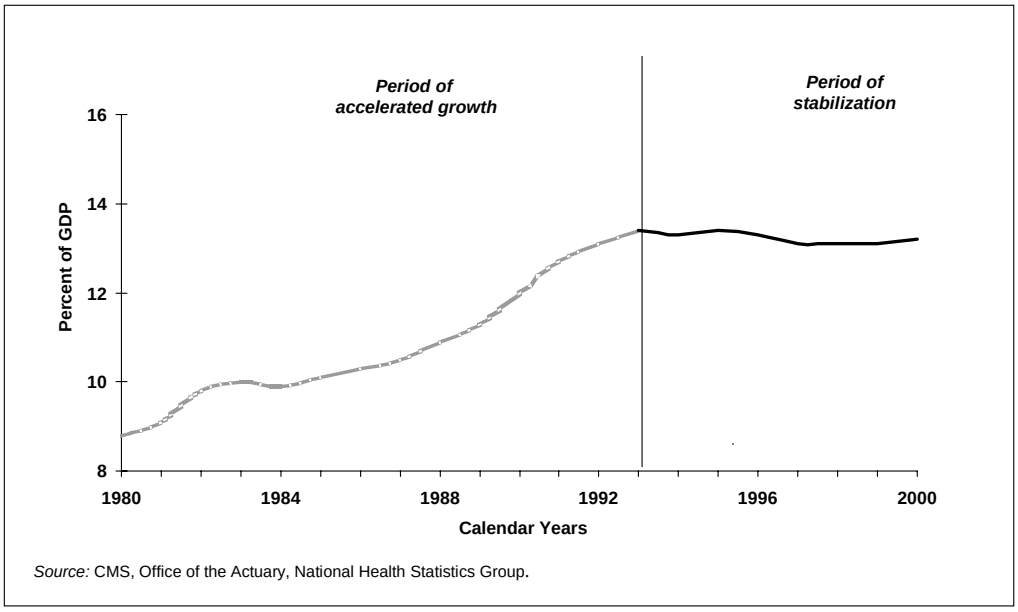
II.B.3. Economic Trends

Healthcare Expenditures as a Share of the Gross Domestic Product

According to the Centers for Medicare and Medicaid Services (CMS), the healthcare industry currently accounts for about 13 percent of the Gross Domestic Product (GDP) of the United States. By the year 2010, healthcare expenditures are expected to increase to 17 percent of the GDP. As shown in Figure II-4, the growth of spending has stabilized since 1993 because medical prices averaged only a 2.9 percent annual growth between 1993 and 1999. This growth is relatively minimal compared to the 11.2-percent average annual growth between 1980 and 1982, and the 6-percent average annual growth between 1982 and 1993. Another

factor to consider in this stabilization is the growth in the complementary care industry (i.e., nonallopathic healthcare services), which was reported to be about 42 billion dollars in the mid-1990s.

Figure II-4: National Healthcare Expenditures as a Share of the GDP



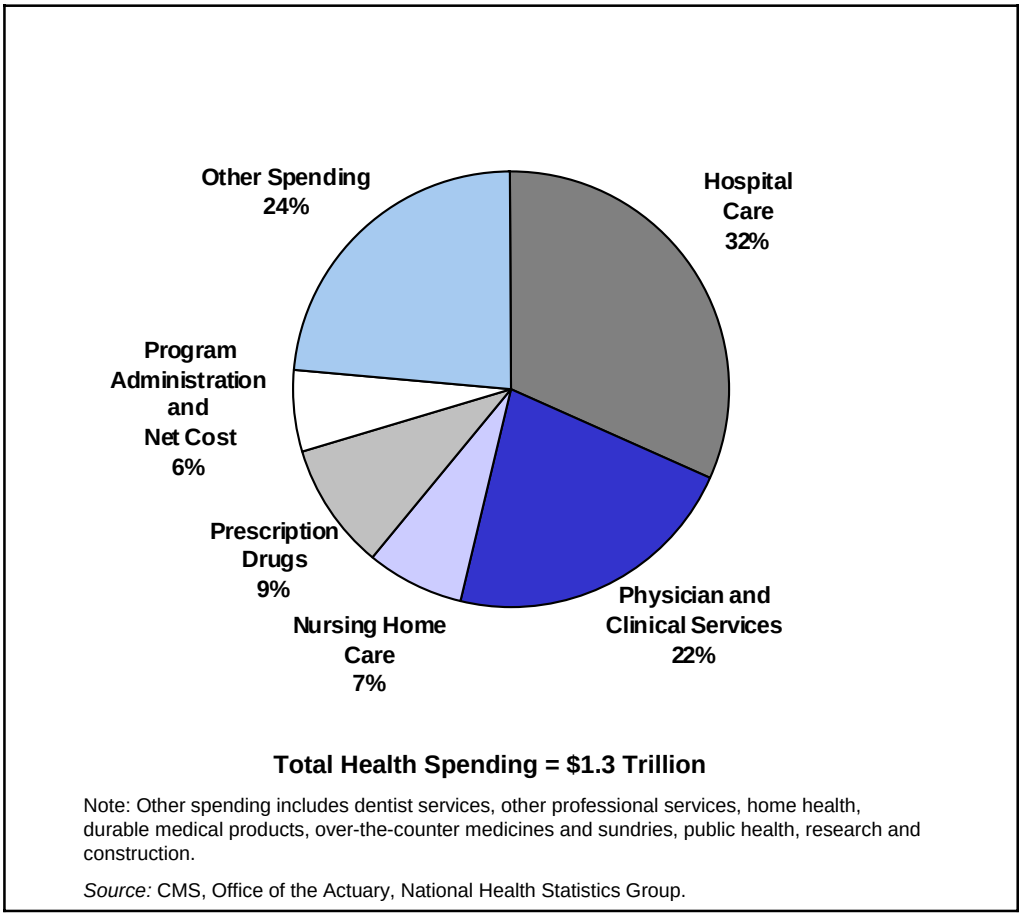
Source: June 2002 Centers for Medicare and Medicaid Services Report.

Healthcare Spending

In calendar year 2000, the United States spent $1.3 trillion on healthcare (NAICS code 62). Most of this money was split between hospital care (32 percent) and physician and clinical services (22 percent).

As shown in Figure II-5, prescription drugs accounted for 9 percent of the total healthcare spending in 2000. According to the CMS, between 1990 and 2000, prescription drug spending increased by more than 3 percent while the amount of money spent at hospitals decreased by 4.8 percent.

Figure II-5: The Nation's Health Dollar, CY 2000

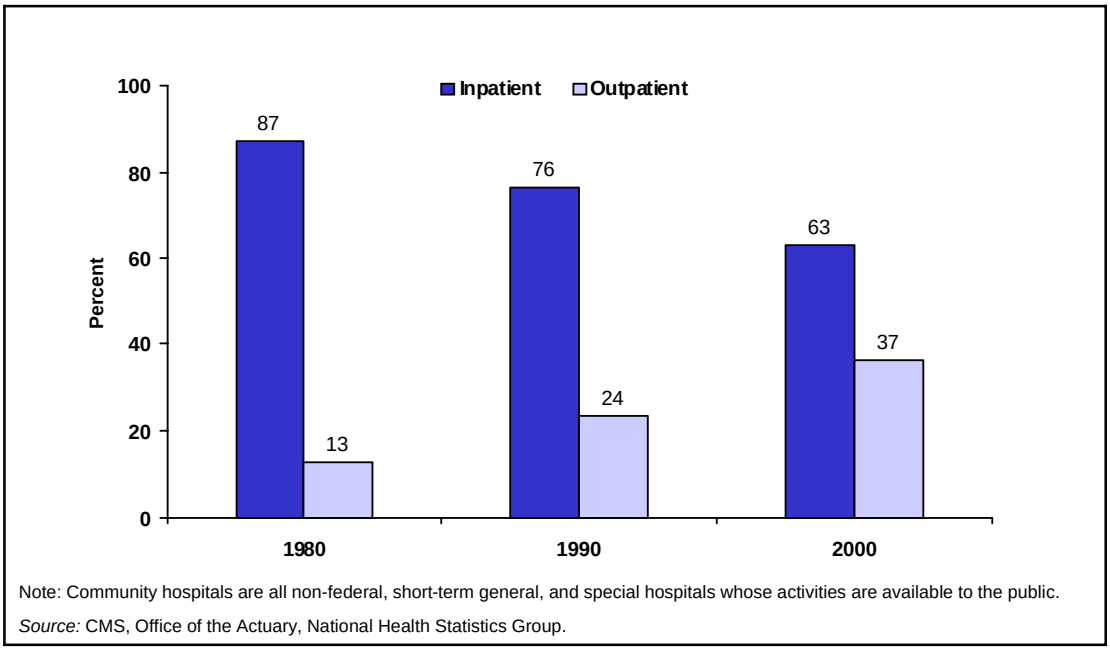


Source: June 2002 Centers for Medicare and Medicaid Services Report.

Inpatient Care Versus Outpatient Care

The implementation of Medicare prospective payment systems and the increased enrollment into various managed care programs have contributed to the decreased length of patient hospital stays since 1980. According to the CMS, in 1980, the average length of a hospital stay was between 7 and 8 days. In 1999, it was about 2 to 3 days. These factors, along with advances in technology and pharmaceuticals available to treat diseases, have also led to a decline in the number of inpatient hospital procedures. As shown in Figure II-6, inpatient care accounted for 87 percent of hospital procedures in 1980. In 2000, that number was down to 63 percent.

Figure II-6: Community Hospital Expenditures: Inpatient and Outpatient Shares for All Payers



Note: Community hospitals are all non-federal, short-term general, and special hospitals whose activities are available to the public.

Source: CMS, Office of the Actuary, National Health Statistics Group.

Source: June 2002 Centers for Medicare and Medicaid Services Report.

III. ACTIVITY DESCRIPTIONS

As discussed in Section II.B.1 of this Notebook, the healthcare industry is most often described by speciality or service area. This section describes key functions within the healthcare industry that create wastes that must be carefully managed to mitigate environmental pollution.

Healthcare is a very dynamic field. Institutions are changing at a rapid rate, adding new activities and shedding others. To understand what wastes might be generated in any given facility, it is important to have a clear understanding of the activities that are housed in the facility. This section describes selected key activities and the wastes these activities create, and discusses issues related to proper handling and disposal. In some cases, it is the disposal decisions that are responsible for the pollution created, as in the case of waste incineration (i.e., dioxins and mercury air emissions) or mislabeled red bag waste. In other cases, it is the actual materials necessary to be used in healthcare processes that create the pollution (e.g., ethylene oxide used in sterilizing critical healthcare devices).

III.A. Healthcare Activities

Thousands of activities take place daily within the healthcare sector. While the desired outcome of delivering healthcare services is improved health for patients and the community, many of the activities of the healthcare sector are not directly related to patient care. Maintaining physical facilities, substantial amounts of diagnostic and testing activities, key administrative services, and research activities are not direct forms of patient care. In fact, the majority of wastes produced in a hospital (more than 50 percent of waste can be cardboard and office paper) never comes in direct contact with patients.

In some healthcare facilities, activity areas may be separately owned and operated, or run by contractors. It would not be unusual to find laboratory services at a hospital owned and run by a private firm, housekeeping run by a contract cleaning service, food service operated by another vendor or series of vendors, and dialysis run by another private service. As a result, knowledge of and control over environmental issues and wastes can be decentralized and scattered.

Producing an exhaustive list of every healthcare activity would be extremely cumbersome and ultimately would not focus on those functions within healthcare that create problem wastes and pollution. Nor would it equip the reader with information and strategies for identifying and mitigating the waste. Instead, this Notebook identifies 17 key functions and major activities that are the major sources of waste and pollution within health sector institutions. These activities, and the wastes produced and environmental impacts that may be associated with them, are described below.

Administrative Activities and Services

All healthcare settings include administrative functions, which can include offices, billing services, medical records, public relations/marketing, nursing care documentation, human resources, security services, social services/care management, retail services, shipping and receiving, and printing/copying.

From this standpoint, healthcare institutions can be viewed similarly to office settings. From an environmental management perspective, the majority of waste from these functional areas is paper. Specific activity locations within this category that deserve closer scrutiny include:

- **Shipping and Receiving** - The majority of "product" coming into any facility will pass through a central receiving area, where it is inventoried, temporarily warehoused, and then distributed to various departments. A number of hazardous materials used in any facility pass through this point, and some are stored here. It is important to note that some individual departments in some facilities may have direct ordering, bypassing shipping and receiving. These may include areas such as the lab, facilities management, food service, or housekeeping.

- **Retail Services** - Increasingly, hospitals are changing to respond to patient demands and to seek alternative revenue streams. To accomplish these goals, some facilities are bringing banking, childcare centers, shopping, and food services onto the hospital campus through a lease or other arrangements to provide patients with the ability to access their daily needs without running to different locations.

- **Printing and Copying Services** - These services range from individual printers and copiers found throughout the facility to centralized copy shops or even professional print shops.

Support Services

Both large and small facilities have a wide range of support services. These support services can include information services, food services, laundry services, pharmacy, central sterile reprocessing, and biomedical engineering. In some cases, the support services are contracted services. Wastes from support services vary greatly by support area.

- **Information Services (IS)** - The reliance on computers and electronic technologies for all levels of function is growing at a rapid pace. IS might be responsible for managing portable electronic devices and repairing or disposing of dysfunctional or older equipment including computers and monitors.

- **Purchasing** - All of the products that are handled by shipping and receiving are bought through the purchasing department. Wastes in this department consist mostly of paper and paper products but can also include pallets, shrink wrap, and cardboard.

- **Food Services** - Facilities use a large number and amount of products, from meats and vegetables, to canned goods, cleansers, disinfectants, and pesticides which generate solid and organic wastes. The food service at a large healthcare facility can be the largest restaurant in the community, and should be examined in that light from a compliance standpoint. These facilities store and use numerous chemical cleaners, and if "pest" control is not contracted out, a number of pest control devices and chemicals can be present. Additionally, chlorofluorocarbons might be present in freezer and refrigeration units. Special wastes, such as kitchen grease from fryalators need separate collection and disposal to avoid drain disposal or disposal as a "solid" waste. Drain disposal of wastewater from dishwashing and food preparation must also be monitored to avoid excess grease, harsh chemicals, or an excessive amount of organic substances (increased BOD) from being discharged to the sanitary sewer.

- **Laundry Services** - Although many healthcare facilities have contracted out to commercial laundries, some laundry services still exist within hospitals. Water use, boilers for hot water, detergents and disinfectants are all environmental areas of concern. Hospital laundries may process large quantities of linens contaminated by blood and body fluids. This is seldom of concern to a publicly owned treatment works (POTW) directly, but is the reason for the use of industrial detergents and disinfectants.

- **Pharmacy Services** - This is an essential service that includes the compounding and dispensing of pharmaceuticals. As they are received and prepared, large quantities of paper and plastic waste from product packaging and inserts are generated. Administering pharmaceuticals to patients and the resulting residual waste can take place in any number of clinical areas within a healthcare setting, including patient care floors, surgical suites, and free-standing clinic settings. Pharmaceuticals can also be packaged for administration in home-care settings. There are a number of common pharmaceuticals that are listed as RCRA P- or U- listed waste and many others that meet the criteria for RCRA characteristic waste. The pharmacy function may take place in one central location, may be off site, or may have a number of satellite sites throughout a facility. Of particular importance is the management of the large amounts of expired, unused, or partially used pharmaceuticals, the control of chemotherapeutic agents, and management of contaminated materials and containers, as well as residual or bulk amounts of chemotherapy product. Drug classes to be concerned about include: antineoplastic (toxic, mutagenic, persistent, accumulative), steroids (persistent, reproductive effects), antibiotics

(persistent, bacterial resistance), antifungal (toxic, mutagenic, target organs, endocrine effects), antiviral (toxic, mutagenic, chronic effects), vaccines with thimerosal (contains mercury), and contrast reagents (with barium). Of less concern are recombinant proteins, analgesics, antihistamines, antiemetics, and electrolytes.

- **Central Sterile Reprocessing and Distribution (CSRD)** - This service function provides support for surgical services and other departments requiring sterile products. Typically a CSRD unit includes a 'dirty' or decontamination area that receives and cleans used equipment, and a 'clean' area that manages sterilized and cleaned products for redistribution throughout the facility. CSRD units usually work very closely with surgical services units, endoscopy units and other care units requiring a ready supply of key materials routinely cleaned and distributed from within the organization. Often these areas house ethylene oxide sterilizers, steam sterilizers (autoclaves) and chemical treatment (steris, sterrad) units. Solid and biohazardous wastes are regularly generated in these areas. Select hazardous chemical wastes may be generated depending upon the types of processes used at a given site. Water discharges from chemical processes and autoclaves should be monitored. Air discharges should be monitored if ethylene oxide (EtO) is usedd.

- **Biomedical Engineering** - This service function provides support to the many types of equipment and devices used in providing direct patient care and support services. Biomedical engineering can be an in-house function or a contracted service and would include calibrating blood pressure monitoring devices (both mercury and nonmercury). Often, a mercury sphygmomanometer and/or barometer is used to aid in calibration. Biomedical engineering often handles the increasingly large quantity of batteries (including NiCD, NiHydride, Lead acid, Lithium, dry cell) that have to be tested and changed out in many different types of equipment.

Facilities Management, Maintenance, and Plant Operations

The maintenance of a hospital or healthcare facility includes housekeeping, maintenance shops (paint, electric, plumbing), heating ventilation and air conditioning (HVAC) systems, water treatment, waste treatment, aboveground tanks, underground tanks, fleet management, groundskeeping, and pest management. It is similar in many ways to the maintenance of a large commercial or light manufacturing facility. It has many of the same functions and generates many of the same environmental concerns involving waste, air, and water issues.

- **Housekeeping or Environmental Services** - Cleaning complex facilities with many varying needs for cleanliness, ranging from "clean" to "sterile," requires the use of chemical agents, technologies, and water. Maintaining surfaces (e.g., floors, walls, counters, sinks, toilets, furniture,

and equipment) requires the use of a large range of cleaners, disinfectants, and treatments. Cleaning floors can involve the use of strippers and waxes, as well as cleansers. Housekeepers are also often charged with collecting, transporting, and overseeing the storage of all the wastes generated, including solid waste, biohazardous waste, and hazardous chemical wastes. In addition, housekeepers often operate equipment that uses hydraulic fluids (compacters and balers).

- **Engineering and Maintenance** - These functions and the scope of this service is defined differently in different settings. Often, there is overlap between the housekeeping staff, maintenance staff, and engineering staff duties. Maintenance functions, including painting, electrical work, plumbing, and carpentry, are sometimes internal functions with full shop areas in place to provide these services. Solvents, degreasers, cleaners, oil paints, and a number of toxic and often flammable products are regularly used, stored, and disposed of. Large amounts of chemicals are required in maintaining the HVAC and water treatment systems, boilers, and coolers. Monitoring systems for air emissions and water discharges must be maintained. Staff serving in these functions also are often responsible for changing out lighting fixtures and bulbs, generating waste fluorescent bulbs and lighting ballasts. Mercury management is often a primary concern in this service, as mercury is often found in devices throughout the facility in thermostats, mercuric oxide batteries, switches and relays in alarms and other electrical equipment, gauges and switches on boilers, as well as in additives to paints, cleaners, and other chemicals.

- **Waste Treatment** - Technologies might be on site and in operation to treat the facility wastes. These technologies could range from wastewater pre-treatment, an incinerator (solid and biohazardous waste), to an autoclave (biohazardous waste) to distillation units for solvents, alcohols, and formalin (usually located in conjunction with the lab), to bulb crushers (fluorescent bulbs). Emissions (primarily air) are of concern with all of these, as are residual wastes. Additionally, the treatment and disposal process may convert some materials that are nonhazardous into hazardous waste. Incineration of PVC plastics, products, and packaging (which comprise a portion of plastic wastes in healthcare) can create dioxins when incinerated. Many facilities collect biohazardous waste in red bags and red sharps containers and certain chemotherapy wastes in yellow bags. The colors in these containers can be from cadmium-based pigments, although the use of cadmium has been phased out in recent years. Cadmium, a hazardous air pollutant, can be released if these containers are combusted as part of the treatment process.

- **Fleet Management** - Vehicles of various kinds can be owned, leased, or used through a contracted service. Facilities that maintain a fleet (this can range from golf carts, to cars, trucks and vans, to ambulances, to

helicopters) must determine how to address maintenance and cleaning of the vehicles, as well as fuel storage. Wastes to be addressed include waste oil, solvents, tires, batteries, and coolants/CFCs.

- **Groundskeeping** - Landscaping, mowing, snow removal, and pest management increasingly are services that are contracted out. Use of fertilizers, herbicides, pesticides, and deicing substances needs to be carefully monitored for releases and run-off. Similarly, pest control is often a contracted service.

Laboratory Services

Thousands of medical and diagnostic tests and services are performed on a daily basis, even in small labs serving healthcare facilities. These services can include hematology, microbiology, chemistry, blood bank, surgical pathology, and histology. The functions of laboratory testing are highly varied, and involve a number of separate processes. Labs use large volumes of a few chemicals (e.g., xylene, alcohol, formalin) and small quantities of a large number of other substances. Labs tend to expend many of the chemicals used in testing through evaporation or dilution and disposal to the sanitary sewer. Both air and water emissions are of concern. Larger quantities of some chemicals may be collected for disposal, or in some cases may be reprocessed for reuse within the lab. More information is available at: *Environmental Management Guide for Small Laboratories*, EPA 233-B-00-001, May 2000, Office of the Administrator (2131), *http://www.epa.gov/sbo/smalllabguide_500.pdf*.

Labs can be free-standing entities or part of a larger facility. If they are within a larger facility, they still may be privately owned and operated, or operated under contract. Consequently, responsibility for managing hazardous materials and wastes can be complicated.

Disinfecting equipment and materials is important to the accuracy of lab functions, so a range of disinfecting solutions is often found in labs. Autoclaves are often used to sterilize equipment that has been cleaned for reuse, and they may be available in labs to pretreat some wastes (e.g., culture plates) prior to disposal.

Many labs have automated chemical analyzer systems. These systems contain many reagent reservoirs and reagents with preservatives. It is often necessary to contact the manufacturer to identify all potential chemical waste locations within the system.

A range of mercury-containing devices in labs is still not uncommon, sometimes due to the age of equipment or interpretation of laboratory accreditation standards that require mercury calibration equipment.

Wastes that are commingled (biological samples and chemicals) are also common, especially in surgical pathology where tissue samples in formalin have to be processed and in many cases stored for extended periods.

Diagnostic Services

An increasingly diverse and large number of diagnostic services are now available. These can include, but are not limited to endoscopy, cardiac catheterization, radiology (CT, MRI, digital imaging), nuclear medicine, sleep studies labs, and electroencephalograph studies (EEG). Diagnostic services are often found in association with medical centers but in some cases can be free-standing facilities.

- **Endoscopy and Cardiac Catheterization** - New techniques in these areas have resulted in less biohazardous waste generation but an increased use of high-level disinfectants (e.g., glutaraldehyde) or sterilants (e.g., ethylene oxide (EtO) gas), both of which represent significant hazards as releases to water or air.

- **Radiology** - These functions have traditionally involved the use of film and film-developing chemicals. Radiology activities can occur within a hospital center, urgent care setting, outpatient clinic, dental offices, or other care areas that require X-rays to help evaluate healthcare conditions. Although many healthcare organizations are transitioning away from wet processing and silver-containing films to digital imaging and PAX-it brand systems, heavy metals waste is generated through a number of activities in Radiology. In particular, lead shields are used to shield patients from exposure. These shields wear out over time, and should be managed as a hazardous waste or sent back to the supplier for remanufacture into a smaller shield device. Additionally, contrast reagents are not always fully consumed by the patient and will result in hazardous waste if discarded unused.

- **Nuclear Medicine** - This branch of diagnostic testing primarily offers diagnostic imaging and radioisotope treatment. Radionuclides are used in various tests and procedures and require careful management, storage, and monitoring until they are safe for disposal. Radioactive waste may also be RCRA hazardous waste, which should be separated from the nonhazardous waste prior to decay storage.

Surgical Services

Surgical services include anesthesia, preoperative services, ambulatory outpatient services, surgery, and post-anesthesia care. Advances in surgery have vastly reduced the invasive nature of different procedures and correspondingly reduced the amount of biohazardous wastes (e.g., blood and body-fluid-contaminated wastes) generated. However, surgery functions still represent one of the highest waste-generating areas. Many of the new surgical devices represent environmental challenges, such as batteries with heavy metals that must be managed, or devices that require special chemical disinfection or sterilization.

In most areas, the majority of surgery is performed as ambulatory, or "day" surgery. These procedures do not require that patients stay overnight. As a result, what was previously a highly centralized function is now very decentralized, with many of the specialized wastes being generated outside of large institutions.

Special wastes can be found in anesthesia services and surgical pathology units. Anesthesiologists and nurse anesthetists administer to patients during surgical procedures and provide pain management services. Waste anesthetic gases from care delivery must be managed to prevent releases. Careful management of compressed gas cylinders (e.g., oxygen, nitrogen, and argon) is also a safety concern. Surgical pathology units can present a host of hazardous chemicals to monitor, as tissue samples are taken and preserved in formaldehyde, or a dilute version, formalin (e.g., biopsies and surgical excisions).

Inpatient Care Services

The need for inpatient care services has declined in the last decade, with an increasing number of services being offered on an out-patient basis (e.g., stay at the facility is less than 24 hours). Specialized treatment for many acute and chronic conditions or more serious illness or injury still requires overnight and longer terms stays in hospitals and other types of healthcare institutions. The primary concerns in waste are usually limited to the management of biohazardous wastes (mostly sharps), the use of cleaners and disinfectants, and, as in all patient care areas, the possible presence of mercury-containing devices (e.g., fever thermometers, sphygmomanometers, and a variety of pharmaceutical products). Some services, such as dialysis and oncology (discussed below), can be delivered in these areas. Inpatient care services include medical surgical care, orthopedic care, neurology care, urology care, cardiac care, psychiatric/behavioral health, geriatric care, palliative care, cancer care, maternal child care (labor and delivery/birthing, postpartum care, nursery, pediatrics), pediatric care, and rehabilitative care.

Critical Care Services

Critical care inpatient services such as surgical intensive care, medical intensive care, pediatric intensive care, cardiac intensive care, burn care, and neonatal intensive care are conducted in hospital facilities. Many critical care waste concerns are the same as in other inpatient service areas (discussed above). In addition, specialized monitoring equipment and an array of pharmaceuticals are used in these areas. Two common drugs used in critical care areas that become hazardous when disposed of are epinephrine and warfarin (Coumarin).

Emergency Care Services

Emergency care services are offered in different types of settings, both in very large and small hospitals, as well as in free-standing units. While care offered in these types of service units is meant to be limited in time and scope, they are often designed to provide a wide range of services, as their goal is to respond to "emergencies." These services entail a large degree of response to unpredictable situations, including emergency response to industrial accidents and bioterrorism incidents. Additionally, as the ranks of uninsured Americans grows,

it is common for individuals to seek routine care in emergency department settings, rather than at physicians' offices.

Emergency service areas are also responsible for disaster response management, and many institutions have set up decontamination rooms in association with emergency services. Such rooms are designed to allow individuals who have been exposed to chemicals or biological agents to be safely decontaminated before entering the emergency service area. Decontamination can involve using chemicals and copious amounts of water. Facilities should have a system of trapping the wastewater so that they can test and then properly manage the wastes.

Many emergency service waste concerns are the same as in other patient care service areas (see above) and include biohazardous wastes, chemicals for cleaning and high-level disinfection or sterilants, the possible presence of mercury-containing devices, and the possibility of pharmaceutical wastes.

Other activities that may also be present as part of emergency services include storing formalin for preserving specimens, operating X-ray technology, and managing photographic chemicals, wastewater, silver recovery, and films. Given the range of instruments used, there may also be disinfectant chemicals, such as glutaraldehyde, or other high-level disinfectants present.

Respiratory Care Services

A variety of wastes are generated through respiratory care functions, which include pulmonary function testing and oxygen therapies. Reprocessing some equipment may involve using high-level disinfectants. As in other patient care areas, mercury devices and batteries could be used. Special management concerns include pressurized tanks such as oxygen.

Dialysis

Dialysis can be conducted in a wide variety of settings, from homes to specialty clinics to large hospital facilities. There are different types of dialysis. Hemodialysis involves external technologies that filter the blood using a mechanical dialyzer. Peritoneal dialysis involves pumping dialyser fluids into the patient's abdominal cavity and using the peritoneum liner as a natural filter. Areas conducting hemodialysis can generate larger amounts of biohazardous wastes due to the nature of the process. The waste often contains large amounts of liquid and is heavy.

Hemodialysis equipment requires water treatment and the use of high-level disinfectants. In the past, formaldehyde was commonly used to clean machinery. Today, less toxic disinfectants are primarily used.

Physical Therapy/Occupational Therapy

Generally, these areas generate little waste of concern. As in other patient care areas, mercury devices could be used. Biohazardous waste, such as sharps, forceps, blades, or lancets may be generated, especially if wounds/burns are debrided and treated in these areas. If prosthetic devices are made on site, chemicals related to leather working (tanning chemicals, adhesives) and plastics molding may be used.

Outpatient Services (Nonsurgical)

Outpatient services include womens' health/gynecology, general medicine, family practice, specialty clinics (e.g., orthopedics, urology, pulmonology, allergy), pediatrics, and rehabilitative services.

Generally, these areas generate little waste of concern. As in other patient care areas, mercury devices could be used. In some cases, formalin may be used to preserve tissue samples (biopsy). Sharps management is the biohazardous waste management concern. As in many patient care functions, a variety of pharmaceutical products may be present. For example, trichloroacetic acid and potassium hydroxide, both characteristic (corrosive) wastes are usually used in OB/GYN practices.

Oncology/Cancer Care Services

Oncology care includes administering chemotherapy medications to cancer patients. In radiation oncology, treatment can involve intravenously administering radioactive isotopes and applying radiation externally to cancer patients. These treatment activities are sometimes grouped together but are often found separately. They may take place in either outpatient or inpatient settings. In some cases, chemotherapy is administered through home-based treatment programs.

Antineoplastic, or cytotoxic, agents that are used to produce chemotherapy solutions are generally procured through a central purchasing area or directly from the pharmacy. Chemotherapy medications may either be prepared in a special area within the hospital pharmacy or prepared in a special area in the oncology unit (in-patient or outpatient type of unit). The amount and type of chemotherapy found in any institution depends on the amount of care/ number of procedures provided and physician preferences for ordering pharmaceuticals. In the preparation area, work is conducted in a safety cabinet equipped with the appropriate filters. Facilities must maintain the filters and determine if they require special disposal, which is often done under a maintenance contract. Residuals from preparation include any contaminated materials including vials, bottles, IV bags, packaging, and personal protective equipment. Proper segregation containers need to be available for materials determined to be RCRA waste, or as nonhazardous materials (often personal protective equipment and packaging) that can be collected separately. Chemotherapy wastes that are not classified as RCRA waste must be properly labeled as chemotherapy-containing materials (e.g., collected in yellow bags) but they can be sent out for incineration (or other technologies as they become available) with the institution's biohazardous waste. Note that if an unregulated chemotherapy waste is

contaminated with a RCRA hazardous waste, RCRA regulations apply. Radiation therapy areas will contain radioactive materials that must be properly handled and monitored.

Dentistry

Dentistry services, including oral surgery, periodontics, and oral healthcare, are provided in a wide range of settings from individual private practices to dental surgery centers that are free standing or located within large teaching and research hospitals. It is estimated that dental facilities in the United States used 40 metric tons of mercury in 1997, which may be placed in teeth, recycled, discharged into wastewater, or disposed of as waste.[2] About 50 percent of dental amalgam is mercury. A study by the Association of Metropolitan Sewerage Agencies found that dental offices are the largest source of mercury to POTWs, contributing more than 35 percent of mercury influent to the POTWs studied.[3] Other studies have estimated the contributions to be as high as 80 percent.[4]

Mercury in dental amalgam can enter the environment in a variety of ways. Dental amalgam waste that is generated (for instance, excess amalgam that is not placed in a tooth, or amalgam that is captured by traps and filters in the dental office) can release mercury into the environment if it is not managed properly. When amalgam restorations are placed in or removed from teeth during dental work, amalgam can enter dental wastewater; when it reaches a wastewater treatment plant, a small percentage of the mercury in the amalgam will be discharged by the plant.

While amalgam has very low solubility in water, a small percentage can be released in a bioavailable form and be converted to methylmercury, the form that accumulates in the food chain, presenting potential health risks to humans and wildlife who consume contaminated fish. Most of the mercury that reaches sewage treatment plants (in excess of 90 percent) is likely to be captured by the treatment plant and enter the sewage sludge, or biosolids.[5] These biosolids may be land-applied, landfilled, or incinerated. Incineration will likely volatilize mercury back into the environment.

Other wastes from dentistry include X-ray wastes (developer chemicals, silver discharges, lead shields), high-level disinfectants, chemical sterilizers, nitrous oxide, and biohazardous wastes, especially sharps. A simple guide to waste management specific to dentistry practices and wastewaters can be found at the following web sites:

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[2] Stone, Mark E., DDS, 2004. "The Effect of Amalgam Separators on Mercury Loadings to Wastewater Treatment Plants," *CDA Journal*, Vol. 32, No.7, July 2004.

[3] Association of Metropolitan Sewerage Agencies (2002). *Mercury Source Control & Pollution Prevention Program Evaluation: Final Report*. March 2002 (Amended July 2002).

[4] Stone, 2004.

[5] Options for Dental Mercury Reduction Programs: Information for State/Provincial and Local Governments, A Report of the Binational Toxics Strategy, Mercury Workgroup Co-chairs
Alexis Cain, U.S. Environmental Protection Agency, Robert Krauel, Environment Canada,
http://www.epa.gov/region5/air/mercury/dentaloptions3.pdf, December 16, 2003, Revised August 4, 2004.

- A Guide for Dentists: How to Manage Waste From Your Dental Practice University of Wisconsin—Extension *http://www.uwex.edu/shwec/Pubs/pdf/guidefordentists.pdf*

- Guidelines for New Mexico Dental Facilities Waste-Management, Education and Research Consortium *http://www.cabq.gov/p2/pdfs/dentalbooklet.pdf*

- Characteristics and Treatment of the Dental Wastewater Stream University of Illinois, Chicago *http://www.wmrc.uiuc.edu/main_sections/info_services/library_docs/rr/RR-97.pdf*

- Options for Dental Mercury Reduction Programs: Information for State/Provincial and Local Governments, U.S. EPA and Environment Canada *http://www.epa.gov/region5/air/mercury/dentaloptions3.pdf*

- Northeast Waste Management Officials' Association (NEWMOA) has both a Dental Mercury Topic Hub *http://www.newmoa.org/Newmoa/htdocs/prevention/topichub/toc.cfm?hub=103&subsec=7&nav=7* and a list of links to articles , fact sheets, and case studies *http://www.newmoa.org/Newmoa/htdocs/prevention/topichub/bibliography.cfm?hub=103&subsec=7&nav=100*

- The Environmentally Responsible Dental Office: A Guide to Proper Waste Management http://www.delta-institute.org/pollprev/mercury/linkfiles/VTdentalguide.pdf

Animal Research and Testing

This testing represents a wide rage of activities that can occur at free-standing research laboratories or in association with healthcare facilities. The research is usually independently funded, varied, and conducted out of the usual system of procurement at the facility. The activities and wastes of concern can encompass all of those usually encountered in labs, with the addition of animal care and housing. Animal care facilities may have antibiotics and pharmaceuticals in the animal's drinking water. Also, the facility may wash the animal cages with corrosive reagents. The waste can also include chemicals and materials not usually associated with the general delivery of healthcare services. Any facility sponsoring animal research and testing should maintain an inventory of materials currently in use and stored at the facility.

Clinical Research

Like animal research and testing, clinical research represents a wide rage of activities that can take place at free-standing research laboratories or in association with healthcare facilities. The research is usually independently funded, varied, and conducted out of the usual system of procurement at the facility. The activities and wastes of concern can

encompass all of those usually encountered in labs and under many patient care and treatment activities. It can also include chemicals and materials not usually associated with the general delivery of healthcare services. Any facility sponsoring clinical research should maintain an inventory of materials currently in use and stored at the facility.

Construction and Renovation

Construction and renovation are constant activities in healthcare settings. The largest portion of wastes is that common in any construction and demolition (C&D) waste stream, mainly solid waste. However, there may be some special concerns, including stormwater control, asbestos and lighting ballasts, as well as less obvious ones like mercury. While mercury would be commonly associated with thermostats and other switches or gauges, a number of healthcare facilities undergoing renovation projects have found residual mercury in drains and traps.

III.B. Waste Streams Generated by the Healthcare Industry

There are many variables affecting healthcare waste generation, including:

- The type of products and materials purchased for use;
- The type of waste segregation systems in place;
- The degree to which problem wastes are identified and mitigation strategies are implemented; and
- The location of care delivery (in a hospital, clinic, or home).

This subsection presents a brief overview of the major waste streams in healthcare. Chapter IV of this Notebook will provide a broader profile of the major wastes and waste streams. Note that states and local regulating bodies may impose more stringent definitions of waste and more stringent waste requirements than those established by EPA and other federal agencies.

In response to the Medical Waste Tracking Act (MWTA) of 1988, the Society for Hospital Epidemiology produced a position paper entitled *Medical Waste*[6]. Its focus was on the majority of wastes that are produced by healthcare activities and are generally classified as solid waste or biohazardous wastes. It did not address the chemical or radioactive wastes from the sector. This paper provided the most authoritative and comprehensive definition, characterization, profiling, and analysis of risks from healthcare wastes to date.

[6] (Rutala WA, Mayhall CG, "The Society for Hospital Epidemiology of American (SHEA) Position Paper: Medical Waste." *Infection Control Hospital Epidemiology*. 1992; 13:38-48).

Healthcare wastes can be categorized as follows:

- Municipal solid waste;
- Biohazardous waste (regulated medical waste);
- Hazardous waste:
  - Listed and characteristic waste,
  - Commingled waste,
  - Pressurized containers and ignitable compressed gas, and
  - Universal waste; and
- Waste by media category:
  - Wastewater,
  - Stormwater, and
  - Air emissions.

Each of these areas is described in detail below.

III.B.1. Municipal Solid Waste

The majority of healthcare wastes are produced under circumstances identical to restaurants and food industry facilities, hotels, and office complexes. The industry generates large volumes of solid wastes (much of what could be subcategorized as recyclable wastes). Studies indicate that 1 percent of all solid waste produced in the United States is generated by healthcare facilities. There have been numerous studies of these wastes, including ways to manage them to minimize waste and environmental impacts. In 1993, the American Hospital Association (AHA) published a manual for its members, *An Ounce of Prevention: Waste Reduction Strategies for Health Care Facilities* (Bisson, McRae and Shaner). Since then, state hospital associations, state solid waste agencies, and a number of private organizations have produced additional manuals. A cooperative program between the EPA and the American Hospital Association, Hospitals for a Health Environment (H2E) is compiling recent materials; this compilation can be found at: *http://www.h2e-online.org/*.

A special subcategory of municipal solid waste to be considered is construction and demolition (C&D) debris. During remodeling, C&D debris can fall into several categories of waste. Healthcare facilities must identify which materials are RCRA Subtitle C hazardous waste (discussed in Section VI of this document), including lead shielding, lead paint, and demolished equipment containing lead, mercury, silver and/or cadmium (especially batteries, fluorescent light bulbs, and computer monitors). Facilities may identify some construction and demolition debris that is recyclable, which can reduce disposal cost. Also, some C&D debris is municipal solid waste, but is generated at a large enough volume to warrant separate disposal in a construction and debris landfill.

III.B.2. Biohazardous Waste (Regulated Medical Waste)

The concern with and need for better management of healthcare waste that triggered the Medical Waste Tracking Act largely relates to those wastes in healthcare that can potentially harbor and transmit infectious diseases. This includes a wide range of materials that are considered contaminated or pose special risks (e.g., sharps). This category of wastes is defined by regulation at the state, tribal, or local level.

There is general agreement on certain characteristics and components of this waste as noted in the list below, but the specific definitions of this waste are defined on a state-by-state basis, and there are sometimes significant differences in those definitions between states. Further, what and how much waste falls into this category can vary widely depending on the interpretation of these regulations by the generator on a facility-by-facility basis, even within states.

Terminology used to describe this waste category is often confusing and used interchangeably. Words such as "*biohazardous waste*," "*infectious waste*," "*infectious medical waste*," "*potentially infectious material*," "*contaminated trash*," and "*regulated medical waste*," are examples of the terms used in describing this segment of healthcare wastes.

Wastes usually considered in this category include[7]:

- Cultures and stocks of infectious agents and associated biologicals, including: cultures from medical and pathological laboratories; cultures and stocks of infectious agents from research and industrial laboratories; wastes from the production of biologicals; discarded live and attenuated vaccines; and culture dishes and devices used to transfer, inoculate, and mix cultures.

- Human pathological waste, including tissues, organs, and body parts and body fluids that are removed during surgery or autopsy, or other medical procedures, and specimens of body fluids and their containers.

- Human blood and blood products including: (i) liquid waste human blood; (ii) products of blood; (iii) items saturated and or dripping with human blood; or (iv) items that were saturated and or dripping with human blood that are now caked with dried human blood, including serum, plasma, and other blood components, and their containers, which were used or intended for use in either patient care, testing and laboratory analysis or the development of pharmaceuticals. Intravenous bags are also included in this category.

[7] Definition taken from the Federal Plan Requirements for Hospital/Medical/Infectious Waste Incinerators Constructed On or Before June 20, 1996.

- Sharps that have been used in animal or human patient care or treatment or in medical, research, or industrial laboratories, including hypodermic needles, syringes (with or without the attached needle), Pasteur pipettes, scalpel blades, blood vials, needles with attached tubing, and culture dishes (regardless of presence of infectious agents). Also included are other types of broken or unbroken glassware that were in contact with infectious agents, such as used slides and cover slips.

- Animal waste including contaminated animal carcasses, body parts, and bedding of animals that were known to have been exposed to infectious agents during research (including research in veterinary hospitals), production of biologicals, or testing of pharmaceuticals.

- Isolation wastes including biological waste and discarded materials contaminated with blood, excretions, exudates, or secretions from humans who are isolated to protect others from certain highly communicable diseases, or isolated animals known to be infected with highly communicable diseases.

- Unused sharps including unused, discarded hypodermic needles, suture needles, syringes, and scalpel blades.

III.B.3. Hazardous Waste

There are some special waste streams that fall most logically under the heading of "hazardous" but because of their unique nature and the risks inherent in each of them, they are discussed separately below as Mixed Waste, Pharmaceutical Waste, Pressurized Containers and Ignitable Compressed Gas, and Universal Waste. The RCRA standard is cited below. States must at least accept these standards but have the right to impose stricter standards and list additional wastes.

To be considered hazardous waste under RCRA, waste must either be listed or characteristic. Listed wastes are specifically named in 40 CFR Section 261. Characteristic wastes are either ignitable, reactive, corrosive, or toxic. This subsection gives a quick overview of listed and characteristic hazardous wastes, and lists the most common healthcare hazardous wastes. The following EPA web site provides a flowchart that outlines the major steps in the hazardous waste identification process: *www.fedcenter.gov/resources/facilitytour/hazardous/whatis/flowchart/*

RCRA Listed and Characteristic Wastes

- **Listed Waste** - The four types of RCRA listed waste are F, K, P, or U, with a three-digit identifier (e.g., F005, P039, U135). EPA listed these wastes as hazardous because they are known to be harmful to human health and the environment when not managed properly, regardless of their concentrations. Some states may list more wastes as hazardous than

EPA. Visit *www.hercenter.org* to locate state-listed wastes. The lists include the following four types of waste:

— F-listed wastes. These non-specific-source wastes are material-specific, such as solvents, generated by several different industries. Waste codes range from F001 to F039. Examples of healthcare facility wastes that fit this category are solvents often used in research laboratories, pharmacies, and morgues (e.g., methanol, acetone, and methylene chloride).

— K-listed wastes. These source-specific wastes are from specifically identified industries and range from K001 to K161. Healthcare facilities typically do not produce K-listed wastes.

— U-listed wastes. These discarded commercial chemical products include off-specification products, container residuals, spill residue runoff (pure or mixed with non-active ingredients such as colorants, flavoring agents, emulsifiers, fragrances, water, etc.), technical grades (e.g., 95% pure Acetone), off-specification species, or active ingredients that have spilled or are unused and that have been, or are intended to be, discarded. Waste codes range from U001 to U411. Examples of healthcare facility wastes that fit into this category are ethylene oxide (U115), some waste pharmaceuticals such as lindane (U129) and selenium sulfide (U205), and some waste chemotherapy drugs such as chloroambucil (U035).

— P-listed wastes. Like U-listed wastes, these discarded commercial chemical products include off-specification products, container residuals, spill residue runoff spill residue runoff (pure or mixed with non-active ingredients such as colorants, flavoring agents, emulsifiers, fragrances, water, etc.), technical grades (e.g., 95% pure Acetone), off-specification species, or active ingredients that have spilled or are unused and that have been, or are intended to be, discarded. Waste codes range from P001 to P205. These wastes are considered acutely hazardous waste and as little as 2.2 lbs of these wastes generated in a given calendar month, or one quart of these wastes stored in a satellite accumulation area designates a facility as a large quantity generator. An example of a healthcare facility waste in this category is epinephrine (P-042).

Table III-1 below lists some specific examples of RCRA hazardous waste from healthcare facilities.

Table III-1: Examples of RCRA Listed Hazardous Waste Found in Healthcare Facilities

Chemical or Device Containing Chemical	RCRA Listing
Note: This list is not exhaustive but provides some common healthcare hazardous wastes.	
Solvents used in the laboratory such as xylene, ethanol, toluene, and methanol. Solvents are also used in inks for forms and menus.	Xylene, U239 Methanol, U154 Several ethanol compounds are U-listed
2-Chloroethyl Vinyl Ether	U042
3-Methylchloranthrene	U157
Acetone	U002
Acetyl Chloride	U006
Acrylonitrile	U009
Aniline	U012
Bromoform	U225
Cacodylic Acid	U136
Carbon Tetrachloride	U211
Chloral Hydrate	U034
Chlorambucil	U035
Chloroform	U044
Creosote	U051
Cresols	U052
Cyclophosphamide	U058
Daunomycin	U059
Dichlorobenzenes	U070, U071, U072
Ethyl Acetate	U112
Ethyl Carbamate	U238
Ethyl Ether	U117
Ethylene Oxide	U115
Formaldehyde	U122
Formic Acid	U123
Hexachloroethane	U131
Hexachlorophene	U132
Lindane	U129
Maleic Anhydride	U147
Melphalan	U150
Mercury	U151
Methanol/Methyl alcohol	U154
Mitomycin C	U010

Table III-1: Examples of RCRA Listed Hazardous Waste From Healthcare Facilities (Continued)

Chemical or Device Containing Chemical	RCRA Listing
Naphthalene	U165
N-butyl Alcohol	U031
Paraldehyde	U182
p-Chloro-m-Cresol	U039
Phenol	U188
Reserpine	U200
Resorcinol	U201
Saccharin	U202
Selenium Sulfide	U205
Streptozotocin	U206
Tetrachloroethylene	U210
Thiram	U244
Trichloroethylene	U228
Uracil Mustard	U237
Warfarin (Coumarin) < 0.3%	U248
Waste codes range from P001 to P205 and should be noted as acutely hazardous waste, as 2.2 lbs of these wastes generated in a given calendar month designates a facility as a large quantity generator.	
3-Benzyl Chloride	P028
Arsenic	P012
Arsenic Trioxide	P012
Chloropropionitrile	P027
Cyanide Salts	P030
Epinephrine	P042
Nicotine	P075
Nitroglycerin (unless the state adopted the federal exclusion for healthcare facilities)	P081
Osmium Tetroxide	P087
Phentermine	P046
Phenylmercuric Acetate	P092
Physotigmine	P204
Physotigmine Salicylate	P188
Potassium Silver Cyanide	P099

Table III-1: Examples of RCRA Listed Hazardous Waste From Healthcare Facilities (Continued)

Chemical or Device Containing Chemical	RCRA Listing
Sodium Azide Sodium azide is often used as a preservative in a variety of laboratory reagents usually at concentrations of less than 0.1%. It is not the sole active ingredient in these cases and would not be a P-listed waste.	P105
Warfarin (Coumarin) > 0.3%	P001
Mercury compounds such as thimerosal, amalgam, and mercury-containing fixatives. Mercury-containing equipment such as thermometers, sphygmomanometers (blood pressure measuring device), thermostats, weighted feeding tubes and fluorescent bulbs. If the state adopted the Universal Waste Rule, then fluorescent bulbs are considered universal waste.	Mercury is listed as U151, but several other mercury compounds are also listed. The RCRA toxicity characteristic (discussed below) also lists mercury (D009) and requires a limit of 0.2 mg/L.
Lead-containing equipment such as lead aprons, bitewings, lead pigs, lead shielding removed during construction or renovation, batteries, and computer monitors. If the state adopted the Universal Waste Rule, then batteries are considered universal waste.	The RCRA toxicity characteristic (discussed below) lists lead (D008) and requires a limit of 5.0 mg/L.
Silver from X-rays. Silver can come from fixer/developer solutions or from film or from devices employed to harvest silver.	The RCRA toxicity characteristic (discussed below) lists silver (D011) and requires a limit of 5.0 mg/L.

Sources: EPA Region 2 presentation dated February 2004, entitled "Identification and Management of Regulated Hazardous Waste, A Workshop Geared Toward Healthcare Facilities" and H2E's web page, at *http://www.h2e-online.org/pubs/chemmin/master.pdf*.

Note that some chemicals used in healthcare are toxic and harmful to the environment, but RCRA does not list them as hazardous waste. These include glutaraldehyde and many chemotherapy drugs (other than the nine that are listed). A best management practice is to handle such materials as if they were hazardous waste, to protect workers, patients, and the environment. For an explanation of RCRA requirements, see Section VI of this Notebook.

- **Characteristic Waste** - Even if waste does not appear on one of the hazardous waste lists, it still might be regulated as hazardous waste if it exhibits one or more of the following characteristics:

  — Ignitability. (40 CFR § 261.21) Ignitable wastes create fires under certain conditions, are spontaneously combustible, and have a flash point of less than 60°C (140°F), are ignitable compressed gas, or are an oxidizer (such as a chlorate or peroxide). The waste code for these materials is D001. They are liquids, other than aqueous solutions containing less than 24 percent alcohol by volume and with a flash point less than 60 ˚C (140 ˚F).

  — Corrosivity. (40 CFR § 261.22) Corrosive wastes are acids or bases that are aqueous and have a pH less than or equal to 2 or greater than or equal to 12.5; or are liquid capable of corroding

metal containers, such as storage tanks, drums, and barrels. A liquid is considered corrosive if it can corrode steel at a rate of at least 0.25 inches per year at 55° C (130° F). Wastes are aqueous if they contain 20 percent water, measured quantitatively or separated from the waste by pressure or vacuum filtration as described in EPA Method 1311. Note, waste that is not aqueous and contains no liquid falls outside the definition of EPA corrosivity. Examples include pharmaceutical compounding chemicals such as sodium hydroxide solution. The waste code for these materials is D002.

— Reactivity. (40 CFR § 261.23) Reactive wastes are unstable under normal conditions. They can cause explosions, toxic fumes, gases, or vapors when mixed with water. They can be a cyanide or sulfide-bearing waste that can generate fumes in a quantity sufficient to present a danger to human health when mixed with an acid or base. They may be capable of detonation or a forbidden explosive, or a Class A or Class B explosive, as defined in Department of Transportation regulations in 49 CFR Part 173. Examples include picric acid and lithium-sulfur batteries (such as those used in electronic thermometers). The waste code for these materials is D003.

— Toxicity Characteristic. (40 CFR § 261.24) Toxicity characteristic wastes are harmful or fatal when ingested or absorbed. When toxicity characteristic wastes are disposed of on land, contaminated rain or liquid may drain (leach) from the waste and pollute ground water. Toxicity is defined through a laboratory procedure called the Toxicity Characteristic Leaching Procedure (TCLP). Toxicity characteristic healthcare wastes include those exceeding regulatory values for chloroform, lindane, m-cresol, mercury and mercury compounds (thimerosal), and certain metals (such as arsenic). A number of other pesticides and solvents are also regulated under the TCLP rule. The waste codes for these materials range from D004 to D043. Research chemicals (TSCA exempt) do not always have toxicity data established for them. Most of the time these chemicals are incinerated as hazardous waste because not enough information is available. For mixed reagents, the toxic effects should be considered additive.

Highlighted below are eight hazardous waste types that are commonly used in healthcare facilities: mercury, chemotherapy and antineoplastic chemicals, formaldehyde, photographic chemicals, radionuclides, solvents, anesthetic gases, and toxic, corrosive, and miscellaneous chemicals.

- **Mercury** - The primary sources of mercury waste at most hospitals include:

  — Broken or obsolete medical equipment – sphygmomanometers, thermometers, tilt switches (e.g. in electric wheel chairs), intraocular pressure reducers (little bags of mercury used in past for eye surgery), esophageal dilators, cantor tubes, and miller abbott tubes.

  — Broken or obsolete components of facility equipment or capital medical equipment and or calibration or process monitoring devices – manometers, barometers, oven and refrigerator thermometers, thermostats, mercury switches (tilt switches, reed switches, float switches), flow meters, flame sensors, boiler gauge controls, and fluorescent light bulbs. These can be found in pulmonary and blood gas labs, HVAC and facilities areas, laundry, kitchen, and laboratories as well as general areas.

  — Laboratory reagents and chemicals – as a preservative (e.g., thimerosol) or contaminant.

  — Plumbing – pipes and fittings, especially drain traps, can be contaminated with mercury because of spills that occurred in the past.

  Mercury wastes are decreasing in quantity due to the substitution of solid state electronic sensing instruments (thermometers, blood pressure gauges, etc.), and greater awareness of the hazards of mercury in the workplace. Mercury is also found as a preservative in many pharmaceuticals (thimerosal or phenylmercuric acetate); however, this is less common as awareness of the health and environmental hazards has increased. Finally, mercury has been identified as a "tramp" contaminant in a number of other common products including bleach. In these cases, the mercury is not intentionally added to the product.

- **Chemotherapy and Antineoplastic Chemicals** - Nine of the chemotherapy and antineoplastic drugs of concern from a waste perspective are on either the P or the U list of RCRA hazardous wastes, which was created in the 1970s. These are: Chlorambucil (Leukeran) (U035), Cyclophosphamide (Cytoxan, CTX, Neosar, Procytox) (U058), Daunomycin (Daunorubicin, Cerubidine, DaunoXome, Rubidomycin, Liposomal Daunorubicin) (U059), Diethylstilbestrol (Diethylstilbesterol, DES, Stilbestrol, Honvol, Stilbesterol) (U089), Melphalan (Alkeran, L-PAM) (U150), Mitomycin C (Mitomycin, Mutamycin) (U010), Streptozotocin (Streptozocin, Zanosar) (U206), Uracil Mustard (U237), and Arsenic Trioxide (Trisenox) (P012). Since that time, hundreds of new

formulations have come into the healthcare marketplace due to advances in pharmaceutical research. Some of these substances may have RCRA characteristics, which would place them in the hazardous waste category. It is important to note that not all chemotherapy medications are considered RCRA characteristic or listed wastes. However, because a single drug may have more than a dozen synonym names, determining collection and disposal methods for these drugs can be confusing and time-consuming. Healthcare facilities will need to determine the best collection method (e.g., maintain a list of RCRA characteristic or listed chemotherapy and antineoplastic drugs so that they may be collected and disposed of as RCRA waste or collect all chemotherapy and antineoplastic as RCRA waste) for their facility.

- **Formaldehyde** - Formaldehyde can be a significant source of hazardous waste at many hospitals. Formaldehyde (usually found in a dilute form called formalin) may be used in pathology, autopsy, dialysis, and in some nursing units. Formaldehyde is a U-listed waste that is regulated as an unused chemical product. Formaldehyde use in healthcare applications has diminished in recent years as greater understanding of the occupational risks and hazards has been recognized. In some cases, formalin that had been used to preserve specimens is discharged to the sewer. Healthcare facilities should determine if the spent formalin meets the definition of a characteristic waste (e.g. ignitability). Even if the waste is not hazardous, it is still a best management practice not to dispose of formalin down the drain, even if sanitation authorities allow such disposal. Some facilities that still use formalin in quantity have found that commercially available distillation and filtration technologies are cost-effective ways to reclaim reusable formalin. Additionally, some states may permit the use of formalin recycling units.

- **Photographic Chemicals** - Many healthcare facilities offer X-ray and radiology services. In the past, nearly all X-rays were developed using wet processing and chemicals. The photographic developing solutions used in X-ray departments consisted of two parts, a fixer and a developer. For facilities using the wet processing method for developing, the silver-containing effluent from the fixer solution is passed through a filter or is otherwise treated to recover this precious metal. The remaining aqueous waste, containing about 1.4 percent glutaraldehyde, 0.3 percent hydroquinone, and 0.2 percent potassium hydroxide, is typically discharged to the sewer. Discharges containing potentially regulated chemicals should be evaluated to determine if they contain hazardous waste, and if allowed by the POTW, approved for discharge in writing (See Section VI.A. RCRA Domestic Sewage Exclusion). Some hospitals use X-ray services that also provide silver recovery, through ion exchange or electrostatic techniques, as part of the customer service package.

Much has changed in radiology in the past decade. New films contain less silver and can be developed with dry processing. Digital imaging has taken the place of the standard X-ray. Many facilities are moving away from traditional radiology practice and going to a PAX-it brand system and digital X-rays. Facilities that have made this change have dramatically reduced the pollution outputs of fixer/developer and silver associated with films. New low-silver content films are also available on the market.

- **Radionuclides** - Radioactive wastes are generated in nuclear medicine and clinical testing laboratory departments. At some hospitals, short-lived radioactive materials in nuclear medicine are retained on site until they decay to nonhazardous levels. Depending on what the waste material is, it is then disposed of as solid or hazardous waste. For longer-lived radionuclides, storage times may be more limited and decay might only reduce the radionuclide to levels that can be more easily managed as low-level waste. Note that "mixed wastes" (defined by RCRA as low-level radioactive waste that is also hazardous) must be identified as such and disposed of properly. In cases where 'sharps' waste is associated with the radioactive material, such wastes are stored on site for proper decay, then disposed of as biohazardous waste once they are judged to be indistinguishable from natural background radiation.

- **Solvents** - Solvent wastes are typically generated by various activities throughout a hospital, such as pathology, histology, engineering, morgue, and laboratories. Volumes of solvent wastes generated at many hospitals are small. Specific solvents used in medical settings include halogenated compounds such as methylene chloride, chloroform, freon, trichloroethylene, and 1,1,1-trichloromethane. Other solvents include nonhalogenated compounds such as xylene, acetone, ethanol, isopropanol, methanol, toluene, ethyl acetate, and acetonitrile. Xylene, methanol, and acetone are the most frequently used solvents at many hospitals.

  Solvent waste (e.g., xylene, acetone, and methanol) are normally handled as hazardous waste. Some of these wastes are absorbed in tissue specimens, which are then treated instead as infectious wastes. Solvent wastes are typically stored in 30- or 55-gallon drums and can be recycled on site in solvent distillation units, or transported off site for recycling or for disposal as hazardous waste. Healthcare facilities should check with their state regulations before installing recycling units.

- **Anesthetic Gases** - Nitrous oxide, the halogenated agents halothane (Fluothane), enflurane (Ethrane), isoflurane (Forane), and other substances are used as inhalation anesthetics. Nitrous oxide is supplied as a gas in cartridges or cylinders that are attached directly to the anesthesia equipment. Used containers may be returned to the supplier. The

halogenated anesthetic agents are supplied in liquid form, in glass bottles. Once empty, the bottles and any residual must be properly disposed of.

Waste anesthetic gases are generally removed from the operating room, or the site of application, in one of two ways. At some larger hospitals, a scavenging unit is attached to the anesthesia unit to remove the waste gases. The scavenging unit may have a charcoal filter that absorbs halogenated anesthetic gases but not nitrous oxide. Spent charcoal filters are sent off site as hazardous waste. If there is no scavenging unit, or if the scavenging unit does not have a filter, then vacuum lines are used to collect waste anesthetic gases and vent them to the outside. These waste gases may cause air emission concerns.

- **Toxics, Corrosives, and Miscellaneous Chemicals** - Poisons, oxidizers, and caustics are used throughout most hospitals, generally in small quantities. Waste oils and solvents from maintenance may also be considered hazardous wastes as may some boiler water conditioning chemicals. Major toxic, corrosive, and miscellaneous chemical wastes include:

  — Sterilants (e.g., ethylene oxide),

  — Disinfecting cleaning solutions,

  — Utility wastes: boiler feed water treatment residuals (resin regeneration brine, spent resin), boiler blowdown, boiler cleaning (layup) wastes, cooling tower blowdown, and cooling tower sludges/sediments, and

  — Maintenance wastes: waste lube oils, vacuum pump oils, cleaning solvents, paint stripping wastes, and leftover paints and painting accessories.

Certain Pharmaceutical Waste

Pharmacies store and dispense medications and maintain a small inventory of chemicals for compounding purposes. Healthcare facilities routinely discard partial vials, IVs, and other unused drugs. In cases where medication formularies change, and unused pharmaceuticals accumulate, these items must be properly managed (see the discussion of reverse distribution below). In some cases, the items are RCRA listed or RCRA characteristic wastes. Some preparations of pharmaceuticals may also involve the use of solvents, which also may be RCRA hazardous waste. For these chemicals, disposal should follow the RCRA hazardous waste requirements explained in Section VI. Table III-1 lists more pharmaceutical wastes. For resources and more overview information refer to: *http://www.h2e-online.org/tools/chem-pharm.htm*

Reverse distribution is a product management strategy that allows pharmacies to return unused products to the manufacturer for potential credit, often through a reverse distributor. Pharmacies can remove pharmaceuticals that are not going to be used from their inventory, and quarantine them as a "product for return." The reverse distributor will either return them to the manufacturer for credit and final disposition or properly discard them if they cannot be used. (Note: It is not legal for a reverse distributor to redistribute outdated drugs, which are considered adulterated by FDA.) With this practice, unused/unexpired pharmaceuticals can be returned as product. This includes materials that have gone beyond the manufacturer's expiration date. Healthcare facilities should be careful not to use reverse distribution as a waste management strategy or as a means of avoiding proper disposal of waste (i.e., items that are obviously waste with no potential for reuse.) See the Returns Industry Association web page for more information: *http://www.returnsindustry.com*.

Commingled Waste

There are several examples of commingled wastes that need special consideration. These are wastes that include characteristics of different waste streams, that fall under different regulatory regimes, and pose special management concerns.

- **Commingled "biohazardous" and chemical wastes (e.g., tissue soaked in formalin)** - Many tissue samples are kept by healthcare institutions, labs, and research facilities in containers of formalin or formaldehyde. As a commingled waste, management techniques should be applied to separate the substances, as appropriate, and properly characterize, treat, and dispose of the residuals.

- **Mixed radioactive wastes** - Many healthcare facilities generate low-level radioactive waste as a by-product of administrating radiopharmaceuticals, radioimmunology, and nuclear medicine procedures. Contaminated materials may include solid wastes, biohazardous wastes, and chemical wastes. For healthcare facilities, low-level waste includes clothing, linens, cleaning materials, medical tubes, swabs, injection needles, syringes, and laboratory animal carcasses and tissues that came into contact with radioactivity. To manage low-level radioactive waste, hospitals normally store materials on site, either until the materials are no longer radioactive (and can be handled as municipal solid waste (MSW) or state Regulated Medical Waste (RMW)), or until enough material has accumulated for transfer to a proper disposal facility. If the low-level radioactive waste is mixed with a hazardous waste, it meets the RCRA definition of a "mixed waste" and cannot be disposed of as MSW or RMW. Separating the hazardous and nonhazardous radioactive wastes prior to decay storage will help prevent hazardous waste from entering the solid waste stream during post-decay disposal.

- **Commingled nonhazardous and hazardous wastes** - EPA's "Mixture Rule" states that mixtures of solid waste and listed hazardous waste must

be regulated as hazardous waste. There are two ways to determine if a material is regulated under the mixture rule: (1) if the material is a mixture of a solid waste and a hazardous waste, and the mixture exhibits one or more of the characteristics of hazardous waste; or (2) if the material is a mixture of a solid waste and a listed waste. The mixture rule is intended to discourage generators from mixing wastestreams.

However, the mixture rule does have a number of exemptions for wastewaters that are subject to the Clean Water Act [see 40 CFR 261(a)(2)(iv)]. One exemption is for laboratory wastewater that either (1) does not exceed one percent of the total wastewater flow, or (2) has an average concentration of toxic constituents less than one part per million.

Pressurized Containers and Ignitable Compressed Gas

Pressurized containers sometimes use a flammable propellant (the can is labeled "Flammable"), in which case they are hazardous waste (D001, ignitable). Ignitable compressed gas is also hazardous waste (D001). Healthcare facilities should dispose of these as D001 waste.

Some examples of pressurized containers and ignitable compressed gas include:

- Oxygen gas cylinders;
- Liquid nitrogen cylinders;
- Ethyl chloride (chloroethane); and
- Fluoro-ethyl (25 percent ethyl chloride, 75 percent dichlorotetrafluorethane).

In addition, propellants may contain chlorofluorocarbons (CFCs), which may be F- or U-listed hazardous wastes. CFC-containing wastes should be managed separately from incineration wastes. Finally, large quantities of aerosols should be stored in a secure, fire-safe area to prevent fire hazards.

Universal Waste

Under a special provision of RCRA, universal waste is exempted from Subtitle C requirements and are regulated under the Universal Waste Rule (40 CFR §273). There are four types of universal waste: batteries containing hazardous substances (e.g., lead, acid, nickel, or cadmium), pesticides containing RCRA hazardous components that are recalled or sent to a collection program, mercury-containing thermostats, and spent fluorescent lamps and other hazardous lamps (e.g., with mercury or lead). Note that many states manage their own universal waste programs and many have included electronic wastes in their universal waste programs.

EPA created the Universal Waste Rule (40 CFR §273) in May 1995. Universal waste labeling and storage requirements are less stringent than for hazardous waste. This allows hospitals to more easily recycle batteries, thermostats, and fluorescent lamps. However, hospitals must still comply with special requirements for labeling, storage, and manifesting. More specific information can be found at the EPA web site: *http://www.epa.gov/epaoswer/hazwaste/id/univwast.htm* More information on management of universal wastes at hospitals can be found at: *http://www.h2e-online.org/tools/univwast.htm*

III.B.4. Wastes by Media Category

Hospitals generate several types of media-specific wastes, as described below.

Wastewater

Healthcare facilities wastewater sources include:

- Sinks, floor drains, showers, toilets, dish and laundry washing machines, and tubs;
- Photographic development drains from radiology (X-rays), other imaging, and dentists; and
- Stormwater.

A large healthcare facility contains thousands of drains. Proper drain disposal practices should be in place in each area. Most facilities discharge sink, shower, toilet, and tub wastewater to POTWs, known as indirect discharge. Some facilities may discharge this wastewater directly to surface water, known as direct discharge. All drains that discharge directly should be given special consideration to ensure that no hazardous chemicals are being sent down the drain. Photographic development (X-ray) wastewater is generally filtered to recover silver before it is discharged. Section VI discusses the Clean Water Act (CWA) regulatory requirements for stormwater and direct and indirect discharges from healthcare facilities. Mechanical shop floor drains should drain to a POTW and not simply empty into the soil. Drains that empty to the soil would be considered a Class V Injection Well, which would require a permit under the Underground Injection Control Program of the Safe Drinking Water Act.

EPA conducted a Preliminary Data Summary[8] on hospitals in 1989 and sampled four hospitals. Although five pollutants were detected at levels higher than expected for municipal wastewater (e.g., silver, phenols, barium, acetone, and mercury), the discharge concentrations of these pollutants were determined to be low enough that they would not cause pass-through or interference at POTWs.

[8] EPA, 1989. *Preliminary Data Summary for the Hospital Point Source Category*, EPA-440-1-89-060-n, September 1989.

Healthcare facilities generate stormwater from building and parking lot areas or from aboveground or underground oil or fuel storage tank areas. Hospitals with construction areas of one acre or larger need stormwater permits. Public hospitals in urban areas may discharge to municipal separate storm sewer systems (MS4s) and must also comply with stormwater regulations, as discussed in Section VI of this Notebook.

Healthcare facilities with underground storage tanks (USTs) or aboveground storage tanks (ASTs) need to consider the Oil Pollution Prevention requirements (discussed in Section VI of this Notebook). Facilities with fleet vehicles, such as ambulances, may keep fuel or oil in USTs or ASTs and may also have USTs for on-site diesel generators.

The management of unused prescription drugs may involve oversight by state and local governments and several federal agencies, including the EPA. The Agency does not currently have specific regulations regarding the disposal of expired or waste prescription medications into sanitary sewer systems, nor does EPA's Office of Water have analytical methods to assess the existence of many pharmaceutical compounds in water or wastewater. The Agency, however, is aware of increasing concerns about the potential for pharmaceuticals in water and is reviewing the current state of knowledge and coordinating with other governmental and research agencies.

Air Emissions

At hospitals, air emissions come from air conditioning and refrigeration, boilers, medical waste incinerators (if on site), asbestos, paint booths, ethylene oxide sterilization units, emergency generators, anesthesia, laboratory chemicals, and laboratory fume hoods.

Hospital/medical/infection waste incinerators (HMIWI) are used by hospitals, healthcare facilities, and commercial waste disposal companies to burn hospital waste and or medical/infectious waste. When burned, hospital waste and medical/infectious waste may emit various air pollutants, including hydrochloric acid, dioxin/furan, and the toxic metals lead, cadmium, and mercury (as discussed in Section IV.C of this Notebook).

III.C. Assessment of Wastes Generated by Functional Activity

Table III-2 identifies 18 key functions and major activities that are likely to be found within health sector institutions. The chart can be used to identify the types of EPA regulated wastes likely to be found and the areas in which they would be generated.

Table III-2: Healthcare Facility Wastes

Functional Activities	Wastes Produced
Administrative Activities and Services • Offices • Billing services • Medical records • Public relations/marketing • Nursing care documentation • Human resources • Security • Social services/care management • Retail services • Shipping and receiving • Printing/copying	• Municipal solid waste from all service areas • Batteries from cell phones, special pagers, PDAs, digital cameras, and communication devices • Mercury-containing switches from greeting cards and other 'gifts' in the gift shop • Solvents possibly associated with a print shop • Oils from a printing press • Toner cartridges from copiers and printers • Cleaning chemicals associated with retail establishments • Kitchen grease associated with retail food establishments • Wastewater from retail services
Support Services • Information services • Food services • Laundry services • Pharmacy • Central sterile reprocessing • Biomedical engineering	• Municipal solid waste from all service areas • Biohazardous waste from laundry services and central sterile reprocessing • Electronics/computer wastes (CRTs, hard drives) from information services, and biomedical engineering • Chemicals associated with cleaning, laundry, and food services (decalcifiers, degreasers, chlorine bleach) • Pesticides associated with cleaning services or food services • RCRA listed and RCRA characteristic pharmaceuticals from the pharmacy • EtO from central sterile reprocessing • High-level disinfecting agents associated with central sterile reprocessing • Cleaning chemicals • Peracetic acid from central sterile reprocessing • Batteries (nicad, lithium, mercuric oxide, and others) from biomedical engineering • Kitchen grease from food services • Degreasers, solvents from food services or laundry • Mercury-containing devices such as thermometers in refrigerators, incubators, and heating units • Wastewater from all service areas including food services and laundry services • Air emissions from laundry services, refrigeration, and sterilization • Sharps waste from the pharmacy, central sterile, and from accidental disposal in laundry and food service

Table III-2: Healthcare Facility Wastes (Continued)

Functional Activities	Wastes Produced
Facilities Management, Engineering and Maintenance, and Plant Operations Housekeeping • Maintenance shops (paint, electric, plumbing) • Heating Ventilation and Air Conditioning (HVAC) • Waste treatment • Water treatment • Fleet management • Grounds keeping • Pest management	• Municipal solid waste from all facility areas • Air emissions from boilers • Cleaning chemicals • Chemicals associated with paint shop - turpentine, strippers, solvents, adhesives • Chemicals associated with electric and plumbing shop including oils, adhesives • Chemicals associated with air handling system • Chemicals associated with water treatment systems (decalcifiers, disinfecting solutions) • Radioactive or mixed waste residues in water treatment system, drains and piping • Chemicals associated with elevator care and maintenance (hydraulic fluids) • Chemical associated with groundskeeping and pest management • Mercury-containing switches, manometers, pressure gauges, fluorescent lamps, and thermostats • PCB-containing fluorescent light ballasts and electrical transformers • Asbestos • Pressurized gas canisters/containers from all facility areas • Wastewater from drains, water treatment, and fleet management • Air emissions from HVAC systems and maintenance shops (paint booths)
Laboratory Services • Hematology • Microbiology • Chemistry • Blood Bank • Surgical Pathology • Histology	• Municipal solid waste from all service areas • Biohazardous waste from all service areas • Mixed biohazardous wastes • Chemicals associated with laboratory testing including: alcohols, xylene, toluene, formaldehyde, b5 fixatives, picric acid, other acids and bases chemicals, and cleaning solutions (see chemical inventory in each laboratory area to identify RCRA listed and characteristic wastes) • Mercury-containing devices such as calibration manometer, water bath thermometer, incubator and refrigerator thermometers • Cleaning chemicals • Radioactive or mixed waste residues • Pressurized gas cylinders (blood gas analysis area) • Wastewater from sinks and drains • Air emissions from laboratory chemicals and hoods

Table III-2: Healthcare Facility Wastes (Continued)

Functional Activities	Wastes Produced
Diagnostic Services • Endoscopy • Cardiac Catherization lab • Radiology (CT, MRI, digital imaging) • Nuclear medicine • Sleep studies (EEG)	• Municipal solid waste from all service areas • Biohazardous waste from all service areas • Mixed waste from tissue samples and chemical, or radioactive and solid, or radioactive and chemical • Glutaraldehyde or other disinfectant/cleaner associated with endoscopy • RCRA listed and RCRA characteristic pharmaceuticals • Formalin for tissue samples obtained from any of the listed diagnostic services • Silver from radiology films, fixer and developer • Radioisotopes from nuclear medicine • Collodion (ether/alcohol) from EEG areas • Cleaning chemicals • Lead shielding from radiology • Wastewater from sinks and drains and photographic developing • Air emissions from sterilization and disinfection
Surgical Services • Ambulatory outpatient services • Surgery • Post-anesthesia care • Preoperative services • Anesthesia	• Municipal solid waste from all service areas • Biohazardous waste from all service areas • Mixed waste from tissue samples • RCRA listed and RCRA characteristic pharmaceuticals • Mercury-containing monitoring equipment (thermometers, sphygmomanometers, and esophageal dilators) • Used batteries (Nicad, lithium, other) • Waste anesthetic gases and compressed gas cylinders • Cleaning solutions; high-level disinfectants • Phenol • Collodion • Formalin • If surgical pathology unit is present in surgical services area, look for xylene, toluene • Wastewater from sinks and drains • Air emissions from anesthetic gases
Inpatient Care Services • Medical surgical care • Orthopedic care • Neurology care • Urology care • Cardiac care • Psychiatric/behavioral health • Geriatric care • Palliative care • Maternal child care (labor and delivery/birthing, postpartum care, nursery, pediatrics) • Pediatric care • Cancer care • Rehabilitative care	• Municipal solid waste from all service areas • Biohazardous waste from most service areas • RCRA listed and RCRA characteristic pharmaceuticals • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • Cleaning solutions; high-level disinfectants • Chemicals related to leatherwork, plastic casting, etc. for rehabilitation/prosthesis device producing settings • Wastewater from sinks and drains • Air emissions from sterilization and disinfection

Table III-2: Healthcare Facility Wastes (Continued)

Functional Activities	Wastes Produced
Critical Care Services • Surgical intensive care • Medical intensive care • Pediatric intensive care • Cardiac intensive care • Burn care • Neonatal intensive care	• Municipal solid waste from all service areas • Biohazardous waste from all service areas • RCRA listed and RCRA characteristic pharmaceuticals • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • Used batteries (Nicad, lithium, other) • Cleaning solutions; high-level disinfectants • Wastewater from sinks and drains • Air emissions from sterilization and disinfection
Emergency Care Services	• Municipal solid waste from all service areas • Biohazardous waste from all service areas • RCRA listed and RCRA characteristic pharmaceuticals • Mercury-containing monitoring equipment (thermometers, sphygmomanometers, and especially hypothermia thermometers) • Chemical or biological agents from decontamination (chemical/biological) area for incoming patients • Waste anesthetic gases and compressed gas cylinders • Cleaning solutions; high-level disinfectants • Formalin • Silver from radiology films, fixer and developer • Lead shielding from radiology • Wastewater from sinks and drains, ensure that decontamination area drains connect to containment tank for potentially hazardous fluids. • Air emissions from sterilization and disinfection, ensure that decontamination area ventilation system connects to filter or separate system for potentially hazardous pollutants
Respiratory Care Services • Pulmonary function testing • Oxygen therapies	• Municipal solid waste from all service areas • RCRA listed and RCRA characteristic pharmaceuticals • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • Compressed gas cylinders (oxygen tank management) • Used batteries • Cleaning solutions; high-level disinfectants • Wastewater from sinks and drains • Air emissions from sterilization and disinfection
Dialysis • Hemodialysis • Peritoneal dialysis	• Municipal solid waste from all service areas • Biohazardous waste from all service areas • RCRA listed and RCRA characteristic pharmaceuticals • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • Formaldehyde, formalin • Cleaning solutions; high-level disinfectants • Wastewater from sinks and drains

Table III-2: Healthcare Facility Wastes (Continued)

Functional Activities	Wastes Produced
Physical Therapy Occupational Therapy	• Municipal solid waste from all service areas • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • Cleaning solutions • Chemicals related to leatherwork, plastic casting, etc. for rehabilitation/prosthesis device producing settings • Wastewater from sinks and drains
Outpatient Services (Nonsurgical) • Womens' health/gynecology • General medicine • Family practice • Specialty clinics (orthopedics, urology, pulmonology, allergy) • Pediatrics • Rehabilitative services	• Municipal solid waste from all service areas • Biohazardous waste (mostly sharps) • RCRA listed and RCRA characteristic pharmaceuticals from sample medications • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • Cleaning solutions; high-level disinfectants • Wastewater from sinks and drains
Oncology/Cancer Care Services • Radiation oncology • Chemotherapy • Lead molds - Cerrobend	• Municipal solid waste from all service areas • Biohazardous waste • RCRA listed and RCRA characteristic pharmaceuticals • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • Chemotherapy waste - RCRA listed and RCRA characteristic • Chemotherapy waste - non-RCRA regulated • Mixed radioactive and hazardous waste • Radioisotopes from nuclear medicine • Cleaning solutions; high-level disinfectants • Wastewater from sinks and drains
Dentistry • Oral surgery • Periodontics • Oral healthcare	• Municipal solid waste from all service areas • RCRA listed and RCRA characteristic pharmaceuticals • Waste anesthetic gases and compressed gas cylinders • Residual mercury amalgam • X-Ray materials; lead shields • Cleaners, disinfectants • Wastewater from sinks and drains • Air emissions from sterilization and disinfection • Biohazardous and sharps waste
Animal Research and Testing	• Municipal solid waste from all service areas including animal care • Biohazardous waste from all service areas • RCRA listed and RCRA characteristic pharmaceuticals • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • Research chemicals • Radioactive or mixed waste residue • Wastewater from sinks and drains • Air emissions from laboratory chemicals and hoods, and from sterilization and disinfection

Table III-2: Healthcare Facility Wastes (Continued)

Functional Activities	Wastes Produced
Clinical Research	• Municipal solid waste from all service areas • Biohazardous waste from all service areas • RCRA listed and RCRA characteristic pharmaceuticals • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • Research chemicals • Wastewater from sinks and drains • Air emissions from laboratory chemicals and hoods, and from sterilization and disinfection
Construction and Renovation	• Municipal solid waste from all service areas • Mercury-containing monitoring equipment (thermometers and sphygmomanometers) • PCB-contaminated light ballasts • Asbestos • Radioactive or mixed waste residue in drains and piping • Stormwater • Lead paint

III.D. Management of Waste Streams

Healthcare facilities may treat, recycle, or dispose of the waste streams that they produce. This subsection presents some examples of management techniques (and example waste types). This is not meant to be a comprehensive list, but an introduction only; refer to the sources at the end of this Notebook for more detail.

EPA ranks options for managing waste in descending order of preference. This ranking encourages reliance on those approaches that minimize the generation of waste and environmental releases. SOURCE REDUCTION is assigned the highest priority because it emphasizes eliminating or reducing wastes at the point of generation. Purchasing a digital thermometer, rather than one containing mercury, for example, reduces the heavy metal content in the waste and reduces the need for recycling, treatment, or disposal. Source reduction is typically less expensive than collecting, treating, and disposing of waste. It also reduces risks for workers, the community, and the broader environment.

REUSE is the next preferred option. Implementing measures to reuse products and packages for their original purpose reduces purchasing costs and packaging wastes as well as wastes from patient care activities. Healthcare facilities find that reusable linens, reusable patient supplies, such as bedpans and emesis basins, as well as reusable dishes and cutlery for food service are generally economically and environmentally preferable to their disposable counterparts, although there are costs incurred in cleaning and sterilizing equipment for reuse.

RECYCLING encourages regenerating materials or reclaiming constituents of the waste stream into usable items. Paper and paper products, such as corrugated cardboard, glass food and beverage containers, metals, and certain plastics may be recyclable. However, facilities

should evaluate the local environmental and economic consequences associated with collecting and recycling materials as well as the associated energy and resource costs.

TREATMENT to reduce the volume or the potentially harmful environmental impacts of the waste is ranked at the lower end of the hierarchy. Medical waste treatment technologies include autoclaving, hydropulping, pyrolysis, microwave, incineration, chemical treatment, and irradiation. Treatment precedes disposal, the least favored option. Ultimately, however, some wastes and medical waste treatment residues require land disposal. The costs of treatment and disposal are significant, and both have inherent environmental impacts, including emissions to air and water.

Reduction/Prevention

The amount of almost all wastes produced through healthcare activities can be reduced. This can be as easy as a manufacturer using less packaging or replacing corrugated shipping containers with reusable totes. It can also mean not using certain materials (e.g., mercury) that become problematic wastes, through a technique called Environmentally Preferable Purchasing (EPP). This technique can be used by the purchasing agency for any healthcare facility. For more information regarding EPP go to *http://www.epa.gov/opptintr/epp/*.

Waste can also be prevented through vendor return programs, which encourage product stewardship. A common program is returning cartridges from printers and copiers. Many healthcare facilities are now signing contracts for computers and peripherals that require the vendor to take back units when new units are purchased. There is also a "returns" industry for pharmaceuticals that takes back unused pharmaceuticals as product, not waste.

Segregation

As wastes are generated, the most important management technique to ensure worker safety, ensure proper treatment and disposal, and minimize environmental risk, is to strictly segregate wastes. The general principle is to segregate wastes so that most of the waste ends up in categories that can be reused, recycled, or that are safer and cheaper to dispose of (e.g., municipal solid waste). The principle of segregation is most commonly used to reduce the generation of biohazardous wastes, to ensure that only those wastes truly contaminated or posing a risk are placed in "red" bags or sharps containers. This principle is also very important when considering separating wastes for recycling and for management of chemical wastes.

Reuse

Common chemicals (xylene, formalin, alcohol) used in some activities can be reprocessed and reused. Newer technologies have made this option safer and more affordable.

A number of common medical devices have now been designed for reprocessing and reuse (e.g., pulse oximeters). Numerous other reusable items can be used in healthcare activities including linens, gowns, drapes, bedpans, dishware, utensils, and cutlery.

Recycling

Much of the municipal solid waste generated from healthcare activities is easily recyclable, when one considers that up to 40-50 percent of the waste from most activities is paper and cardboard. Another large portion consists of other commonly recycled metals, plastics and glass. Aggressive recycling programs can divert a very large portion of waste from healthcare activities.

Pressurized containers, universal wastes, and construction and demolition debris are also commonly recycled materials generated at healthcare institutions.

Composting

Some hospitals have identified options for segregating and disposing of food waste and landscaping discards at authorized composting operations.

Landfill

Waste from healthcare activities that is classified as municipal solid waste is often sent to a landfill for final disposal. In some states or tribal regions, untreated biohazardous wastes may be sent to landfills under special conditions. Proper segregation is important to keep hazardous materials from being disposed of in landfills, many of which have specific bans on such items.

Incineration (Off-site Municipal Plant)

Waste from some healthcare activities classified as municipal solid wastes may be sent to a municipal solid waste incinerator. The waste ash will then have to be disposed of as either municipal solid waste or hazardous ash depending on testing. A key issue in the incineration of healthcare wastes is that the municipal solid waste stream from healthcare tends to be rich in PVC plastics, which when combusted can produce dioxins.

Medical Waste Incinerator (On-site or Off-site)

Depending on state or tribal regulation, at least a small portion of biohazardous waste, including sharps, may have to be incinerated. This will likely include pathological wastes and wastes contaminated with small amounts of chemotherapy substances. The incineration of large amounts of biohazardous wastes has decreased in the United States, due to concerns over emissions and the implementation of the EPA air emission regulations for Hospital/Medical/ Infectious Waste Incinerators (HMIWI). Most treatment has moved to other noncombustion technologies.

Noncombustion Biohazardous Treatment Technologies (e.g., Autoclave/ Microwave Treatment/Chemical Mechanical Treatment) (On-site or Off-site)

The majority of biohazardous wastes is now being treated using noncombustion technologies. More than 40 certified noncombustion treatment technologies are in use or being tested in the United States. These devices use heat and pressure or chemicals to render the wastes generally noninfectious and suitable for disposal in landfills.

Hazardous Waste Treatment Facilities, Incinerators, Landfills

Of the wide variety of hazardous materials generated through healthcare activities, some will have to be packaged and transported for special treatment and disposal at specialized licensed facilities to manage hazardous waste. These range from waste oils to toxic chemicals such as phenol.

Treatment at POTWs

Many wastes, from body fluids, to kitchen food scraps, to a wide mix of chemicals, cleaners and disinfectants are discharged to the wastewater system, and must be managed by a POTW. Stormwater run-off from facilities may also have to be discharged to these treatment plants or to a municipally maintained stormdrain network. Local and state regulations may specifically require pollutant prevention measures, waste segregation, and or treatment of these waste streams prior to discharge.

Treatment/Control On-site

A variety of technologies to pretreat wastewater and various air emissions (e.g., ethylene oxide) have been used at healthcare facilities to reduce direct emissions.