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2002

Date: February 26, 2002
Refer to: E/ES:02-005

Honorable Peter Maggiore, Secretary of the New Mexico Environment Department
Harold Reynolds Building
1190 Saint Francis
P. O. Box 26110
Santa Fe, New Mexico 87502

Dear ~~Secretary~~ Maggiore: Pete,

SUBJECT: 2001 ENVIRONMENTAL STEWARDSHIP ROADMAP, LOS ALAMOS NATIONAL LABORATORY

Enclosed is the Laboratory's 2000 Environmental Stewardship Roadmap. This is the fourth annual roadmap. It summarizes a systems description of Laboratory processes that could impact the environment. It also describes measures that greatly reduce the possibility of impacting the environment. Many of these measures are now being implemented.

This roadmap, in conjunction with the Site Pollution Prevention Plan (published in 1997) and the Environmental Restoration Waste Minimization Plan satisfies the waste minimization program requirement of RCRA/HWA SECTION 40CFR264.73(b)(9) (RCRA).

Please contact me (505-667-6639 or tps@lanl.gov) if you would like further information.

Sincerely,

Tom

Thomas P. Starke, Program Manager
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13606

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LOS ALAMOS NATIONAL LABORATORY
2001 POLLUTION PREVENTION ROADMAP

by

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Environmental Stewardship Office
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This roadmap and the FY00 plan for meeting the Department of Energy Secretarial Pollution Prevention/Energy Efficiency goals are certified to satisfy the requirements of 40CFR264.73(b)(9) [Resource Conservation and Recovery Act (RCRA)].

Thomas P. Starke

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ACRONYM AND ABBREVIATION LIST

A/E	Architect/Engineer
AF	Acre Feet
AFV	Alternate Fuel Vehicle
AFY	Acre Feet per Year
AHF	Advanced Hydrotest Facility
APT	Accelerator Production of Tritium (Division)
B	Bioscience (Division)
BRC	Below Regulatory Concern
BUS	Business Operations (Division)
C	Chemistry (Division)
C-ACS	The Analytical Chemistry Sciences Group
CCF	Central Computing Facility
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
C-INC	Isotope and Nuclear Chemistry Group in the Chemistry Division
CMIP	Capability Maintenance and Improvement Project
CMR	Chemistry and Metallurgy Research (Facility)
CNMIP	Colorado/New Mexico Intertie Project
COD	Chemical Oxygen Demand
County	Los Alamos County
County Landfill	The DOE-Owned, Los-Alamos-County-Operated Landfill
CRT	Cathode Ray Tube
CTWC	Cooling Tower Water Conservation
CY	Calendar Year
D&D	Decontamination and Decommissioning
DAHRT	Dual Axis Hydrodynamic Test
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DOE/DP	Department of Energy/Defense Programs
DOE/EH	DOE Office of Environment, Safety, and Health
DOE/EM	Department of Energy/Environmental Management
DOT	Department of Transportation
DP	Defense Programs
DSSI	Diversified Scientific Services, Inc.
DU	Depleted Uranium
DVRS	Decontamination and Volume Reduction System
DX	Dynamic Experimentation (Division)
E	Environmental Science and Waste Technology (Division)
E-ET	Environmental Technologies Group of the Environmental Science and Waste Technologies Division
EM	Environmental Management
EMS	Environmental Management System
EO	Executive Order
EPA	Environmental Protection Agency

ACRONYM AND ABBREVIATION LIST (cont)

ER	Environmental Restoration
ER/D&D	Environmental Restoration/Decontamination and Decommissioning
ESA	Engineering Sciences and Applications (Division)
ESH	Environment, Safety, and Health (Division)
ESO	Environmental Stewardship Office
FFCO/STP	Federal Facility Compliance Order/Site Treatment Plan
FWO	Facility and Waste Operations (Division)
FWO/UI	Facility and Waste Operations Utilities and Infrastructure Group
FY	Fiscal Year
GDMS	Gas Discharge Mass Spectrometer
GET	General Employee Training
GIC	Green Is Clean
GPMS	Glove Procurement Management System
GPP	General Plant Project
GSA	General Services Administration
GSAF	Generator Set-Aside Fee
GW	Ground Water
GWCP	Generator Waste Certification Program
HE	High Explosives
HEPA	High-Efficiency Particulate Air Filter
HLW	High-Level Waste
ICP	Inductively Coupled Plasma
IM	Information Management (Division)
INEEL	Idaho National Energy and Environmental Laboratory
ISM	Integrated Safety Management
ISM-E	Environmental Component of ISM
ISO	International Standards Organization
JCNNM	Johnson Controls Northern New Mexico
JIT	Just In Time
Laboratory	Los Alamos National Laboratory
Landfill	The DOE-Owned, Los-Alamos-County-Operated Landfill
LANL	Los Alamos National Laboratory or the Laboratory
LANSCE	Los Alamos Neutron Science Center Experiment, or Los Alamos Neutron Science Center (Division)
LAPP	Los Alamos Power Pool
LDCC	Laboratory Data Communications Center
LEDA	Low-Energy Demonstration Accelerator
LEED™	Leadership in Energy and Environmental Design
LINAC	Linear Accelerator
LIR	Laboratory Implementation Requirement
LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level (Radioactive) Waste
LPR	Laboratory Performance Requirement
LRS	Laramie River Station

ACRONYM AND ABBREVIATION LIST (cont)

MBA	Material Balance Area
MDA	Materials Disposition Area
MEO	Mediated Electrochemical Oxidation
MLLW	Mixed Low-Level Waste
MRF	Material Recycle Facility
MST	Materials Science and Technology
MT	Metric Ton
MTRU	Mixed Transuranic
MW	Megawatt
NARS	NITRIC ACID RECOVERY SYSTEM
NDA	NONDESTRUCTIVE ASSAY
NIS	NONPROLIFERATION AND INTERNATIONAL SECURITY (DIVISION)
NMED	NEW MEXICO ENVIRONMENT DEPARTMENT
NMSWMR	New Mexico Solid Waste Management Regulations
NMT	Nuclear Materials Technology (Division)
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
ODS	Ozone-Depleting Substances
P2/E2	Pollution Prevention and Energy Efficiency
PCB	Polychlorinated Biphenyl
PEP	Project Execution Plan
PM	Project Management (Division)
PNM	Public Service Company of New Mexico
PNMGS	Public Service Company of New Mexico Gas Services
PNNL	Pacific Northwest National Laboratory
PPE	Personnel Protective Equipment
PTLA	Protection Technologies Los Alamos
PVA	Polyvinyl Alcohol
PVC	Polyvinyl Chloride
R&D	Research and Development
RANT	Radioassay and Nondestructive Testing
RCA	Radiological Control Area
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal
RLWTF	Radioactive Liquid Waste Treatment Facility
SAR	Safety and Analysis Report
SCC	Strategic Computing Complex
SD	Sustainable Design
SNM	Special Nuclear Material
SPP	Storage Photostimulable Phosphor
STL	Safeguards Termination Limit
STP	Site Treatment Plan
SWB	Standard Waste Box
SWEIS	Sitewide Environmental Impact Statement

ACRONYM AND ABBREVIATION LIST (cont)

SWO	Solid Waste Operation
SWS	Sanitary Wastewater System
SWSC	Sanitary Wastewater Systems Consolidation
TA	Technical Area
TBD	To Be Determined
TCE	Trichloroethylene
TCLP	Toxic Characteristic Leaching Procedure
TFCH	Treated Formerly Characteristic Hazardous (Waste)
TRI	Toxic Release Inventory
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
UC	University of California
VOC	Volatile Organic Carbon
WAC	Waste Acceptance Criteria
WAPA	Western Area Power Administration
WCRRF	Waste Compaction, Reduction, and Repackaging Facility
WFM	Waste Facilities Management
WIPP	Waste Isolation Pilot Plant
WM	Waste Management
WMC	Waste Management Coordinators

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EXECUTIVE SUMMARY

Los Alamos National Laboratory's (the Laboratory's) goal is to experience zero environmental incidents. The Environmental Stewardship Office (ESO), which manages the Laboratory's Pollution Prevention Program, coordinates efforts to eliminate the sources of environmental incidents. The ESO assists the Laboratory in eliminating these sources through waste minimization, pollution prevention, and conservation improvements. In fact, good environmental practices move the Laboratory beyond compliance-based goals toward zero waste produced, zero pollutants released, zero natural resources wasted, and zero natural resources damaged. These practices and policies help the Laboratory operate in such a way that future employees will have equal or better natural resources and quality of environment as do current employees.

Pollution prevention and environmental stewardship not only protect the environment; they also pay for themselves by reducing costs and creating a safer workplace. Furthermore, they minimize both waste- and pollution-related work tasks, enabling staff to devote more time to mission activities. In effect, they increase productivity. Environmental awareness, good environmental practices, and reducing the sources of environmental incidents are the responsibility of every person working at the site.

This roadmap documents the Laboratory's Pollution Prevention Program and the process used to define and implement environmental improvements. It describes current operations, improvements that will eliminate the sources of environmental incidents, and the end state that is the Laboratory's goal. Over the next 18 months, the Laboratory will move from an environmental management approach that emphasizes compliance requirements to an Environmental Management System that embodies the concepts of ISO 14001. The Laboratory currently has implemented environmental protection as part of Integrated Safety Management (ISM) implementation. The initial implementation focuses on ensuring that Laboratory operations comply with applicable laws and regulations. The ISM Program requires continuous improvement of the ISM System. An ISM environmental upgrade is now being planned.

This 2001 version of the roadmap is responsive to the pollution prevention and environmental efficiency goals issued by the Secretary of Energy on November 12, 1999, and it is also certified to satisfy the waste minimization program documentation requirements of 40 CFR 264.73(b)(9) (Resource Conservation and Recovery Act).

LOS ALAMOS NATIONAL LABORATORY
2001 POLLUTION PREVENTION ROADMAP OVERVIEW

1.0. INTRODUCTION

1.1. Site Description

Los Alamos National Laboratory (the Laboratory) occupies 43 square miles of land in northern New Mexico and is located within the county of Los Alamos, ~35 miles northwest of Santa Fe. The Laboratory is divided into 50 technical areas (TAs), with locations and spacing that reflect historical development patterns, topography, and functional relationships. Owned by the Department of Energy (DOE), the Laboratory has been managed by the University of California (UC) since 1943.

Los Alamos is located in a temperate mountain climate at an elevation of ~7400 ft. In July, the warmest month of the year, the temperature ranges from an average daily high of 27.2°C (81°F) to an average daily low of 12.8°C (55°F). In January, the coldest month, the temperature ranges from an average daily high of 4.4°C (40°F) to a low of -8.3°C (17°F). The large range in daily temperatures results from the relatively dry, clear atmosphere, which allows strong solar heating during the day and rapid radiative cooling at night. The average annual precipitation (rainfall plus the water equivalent of frozen precipitation) is 18.7 in.

Topographically, the Laboratory is situated on a series of mesas separated by canyons. Most of the natural water and aqueous discharges from Laboratory operations flow into and along the canyon floors.

1.2. Laboratory Mission

The central mission of the Laboratory is to enhance the security of nuclear weapons and nuclear materials worldwide. Its statutory responsibility is the stewardship and management of the nuclear stockpile. This requires a solid foundation in science and state-of-the-art technology. The Laboratory has approximately 7400 UC employees plus approximately 3000 contractor personnel. Partnering with universities and industry is critical to the Laboratory's success. Carefully selected civilian research and development programs complement the Laboratory's mission.

As in any other activity, waste and pollution are generated in executing the Laboratory's mission. Environmental management at the Laboratory provides for the reduction and elimination of this waste and pollution and for remediation of sites impacted by previous operations. Figure 1-1 shows the Laboratory process map, which is an environmental systems view of the Laboratory from the local environmental perspective. Not shown, but also important, is the regional environmental impact related to Laboratory operations.

The Laboratory receives funding and mission assignments from the DOE. Through the DOE, it also performs work for other government sponsors and private industry. To accomplish these assignments, the Laboratory procures services, materials, equipment,

new facilities, and commodities (electricity and natural gas). The Laboratory also takes in water from the regional aquifer and air from the surrounding atmosphere. Figure 1-1 also shows the substance and energy inflows to the Laboratory. The inflows are used in the six types of operations provided in the figure and in the following list.

1. Office operations use the most UC and subcontractor person-hours.

2. Experimental operation includes bench-scale research, experiments at the Los Alamos Neutron Science Center (LANSCE), criticality experiments at TA-18, explosive tests at Dynamic Experimentation (DX) Division firing sites, and fabrication of the experimental hardware used in experiments.

3. Production operations include Nuclear Materials Technology (NMT) Division plutonium processing and production operations. They also include NMT analytic chemistry operations at the Chemistry and Metallurgy Research (CMR) Facility.

4. Maintenance and infrastructure operations include all Johnson Controls Northern New Mexico (JCNNM) maintenance activities, Facility Management Unit maintenance activities, and sitewide infrastructure systems such as the solid waste operation (SWO) (TA-54), Radioactive Liquid Waste Treatment Facility (RLWTF) (TA-50) power plant, Sanitary Wastewater Systems Consolidation (SWSC) wastewater plant, water influent system, and highway system.

5. Construction includes both smaller construction projects performed by JCNNM and major construction projects conducted by competitively selected contractors.

6. Environmental Restoration (ER) includes all DOE/Environmental Management (EM)-funded facility Decontamination and Decommissioning (D&D) and contaminated-site remediation.

Because the Laboratory's products are mostly information-oriented, most material inflows become byproduct or waste outflows. Consequently, both consumption and waste generation reflect the Laboratory's inefficiency. Outflows are divided into transuranic (TRU) waste, mixed low-level (radioactive) waste (MLLW), low-level (radioactive) waste (LLW), hazardous waste, and solid sanitary waste. These outflows are well defined and are discussed in detail later in this document. Excess property includes all items processed through the Business Operations Division (BUS)-6/JCNNM salvage system. Effluents include all of the wastewater released from the site into the canyons. Two-thirds of the water brought on-site is discharged through outfalls; the remainder is evaporated. Emissions include greenhouse gases, criteria gases, and process offgases.

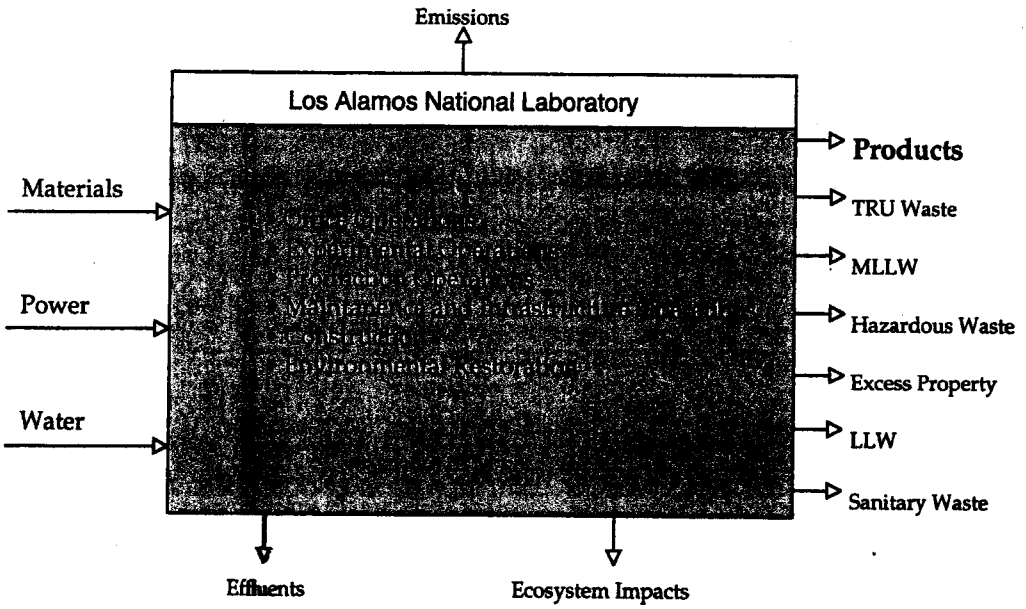

Fig. 1-1. Laboratory process map.

1.3. Pollution Prevention in Integrated Safety Management

The Laboratory's primary environmental-excellence goal is zero environmental incidents. The strategy for achieving this goal has two primary elements:

1. The Laboratory will comply with all applicable environmental laws, regulations, DOE orders, and consensus standards identified through the Laboratory's Integrated Safety Management (ISM) Work Smart Standards process and listed in the UC contract. Compliance is managed through the ISM System. The Environment, Safety, and Health (ESH) Division assists Laboratory divisions in planning and maintaining compliant operations.

2. The Laboratory will continue to execute a prevention-based program that seeks to eliminate the potential for environmental incidents. Both compliance and pollution prevention are accomplished through the ISM system.

The control and reduction of waste generated by the Laboratory must take place within certain constraints. Pollution-prevention and waste-minimization activities must not compromise safety or increase worker exposure to radioactive or hazardous materials. For that reason, pollution prevention is an integral part of ISM. To help accomplish pollution prevention, the Laboratory evaluates environmental hazards.

The environmental component of ISM (ISM-E) identifies all of the Laboratory's activities, products, and services that can interact with the environment; evaluates each with regard to its magnitude and severity; and prioritizes them accordingly. Options and business cases can be developed to mitigate the highest priority aspects. In this way, the environmental aspects of Laboratory operation can be managed efficiently and cost effectively to protect the environment. Currently, the environmental aspects have

not been broken down to the level of specific pollution-prevention strategies in the ISM; however, that work largely will be accomplished in the next fiscal year (FY). Pollution prevention and waste management also should not compromise either productivity or product quality. Indeed, successful implementation of good pollution-prevention practices should increase both productivity and quality because waste is a manifestation of inefficiency.

Executive Order (EO) 13148 requires each DOE site to have developed an Environmental Management System (EMS) by FY05. The requirements for the EMS are specified in the EO and in subsequent documents. When pollution-prevention strategies are fully developed and incorporated into the ISM, the resulting system will satisfy the requirements for an EMS as defined in EO 13148.

1.4. Pollution Prevention Goals

On November 12, 1999, the Secretary of Energy issued challenging pollution prevention and energy efficiency (P2/E2) leadership goals to achieve his environmental mission at DOE sites. On February 8, 2001, the Laboratory submitted a plan to meet the secretarial P2/E2 leadership goals and described the resource requirements necessary to accomplish that plan. In that plan, the Laboratory proposed to adopt goals that were responsive to the secretarial goals but that differed from specific secretarial goals in some cases because of local circumstances. This section describes the rationale for the proposed goals and the metric the Laboratory has adopted for measuring progress toward the goals.

The Laboratory is unable to address the goals related to the purchase of clean energy and the increase in use of alternate fuel vehicles (AFVs) because those activities are controlled by government agencies and not by the Laboratory. In addition, the goal to increase the rate of purchase of AFVs has been negotiated to a less-stringent goal because of the unavailability of such vehicles for purchase and lack of local and regional infrastructure for AFVs.

The Laboratory's response to the secretarial goals is captured in the waste-minimization performance measures for FY02 as incorporated in Appendix F of the UC contract. The performance measures are in two parts: one for TRU waste and one for other waste types. The measures and associated metrics for all waste types are presented in Table 1-1. The weights listed in this table, with the exception of toxic release inventory (TRI) chemical weights, are in units of metric tons (MT or tonnes). The tonne is the standard unit used by the DOE and is used throughout this document to express weight. Laboratory performance toward the goals will be measured through an index that combines performance toward individual goals into a single index number expressed as a percentage. A 0 index corresponds to baseline year performance; a 100 corresponds to achieving the 2005 goal. The performance metrics are based on the weighted average of the index based on the nine individual goals in this measure. All nine goals are weighted equally.

The DOE 2005 pollution-prevention goals require that the DOE complex reduce routine TRU/mixed transuranic (MTRU) waste generation 80% by 2005 as compared with a calendar year (CY)93 baseline. The goal for the FY02 TRU waste-minimization

performance measure is to measure progress against the DOE 2005 pollution-prevention goal. However, from a facility-specific perspective, the baseline for determining the reduction goal will be based on TRU waste generation for FY96 through FY99. This period represents the years that NMT operations were fully operational for the entire year. The baseline is determined by taking the average TRU waste generation for FY96 through FY99, which is computed to be 100 m^3. The Laboratory is committed to achieving a 50% reduction in TRU/MTRU waste generation over the next 4 years, depending on the assumptions stated in Appendix F. FY02 will be the initial year for implementing the Laboratory plan for meeting this goal. For FY02, the Laboratory is committed to achieving a 10% reduction of TRU waste volume to 90 m^3.

TABLE 1-1
WASTE MINIMIZATION GOALS AND INDEX WEIGHTED PERFORMANCE METRICS

#	Goal Title	FY05 Goal % Reduction	Baseline (Year)	FY00	FY05 Goal	Index
1a	Hazardous waste reduction	90	307 MT (1993)	22 MT	31 MT	100
1b	LLW reduction	80	1987 m^3 (1993)	401 m^3	397 m^3	100
1c	MLLW reduction	80	12.3 m^3 (1993)	5 m^3	2.5 m^3	74
1d	TRU waste reduction	50	100 m^3 (1996-1999)	63.2 m^3	50 m^3	74
2	TRI chemical use reduction	90	88,293 lb (1993)	26,057 lb	8,829 lb	78
3	Sanitary waste reduction	50	2780 MT (1993)	2353 MT	1337 MT	31
4	Sanitary material recycling	45	N/A	9%	45%	20
5	Cleanup/stabilization waste reduction	10	N/A	25%	10%	100
6	Purchase of EPA*-designated items	100	N/A	93%	100%	93
9	Replace ODS** Class-I chillers, >150 T	100	3000 T (2000)	3000 T	0	0

*Environmental Protection Agency.
** Ozone-depleting substances.

Performance	Yearly Weighted Average of Index Values			
	2002	2003	2004	2005
Unsatisfactory	<72	<77	<82	<88
Marginal	>72	>77	>82	>88
Good	>77	>83	>88	>94
Excellent	>82	>88	>95	>100
Outstanding	>88	>94	>100	>110*

The performance metrics for TRU waste are shown in Table 1-2.

1.5. Roadmap Methodology

The approach that the Environmental Stewardship Office (ESO) has taken to prevent pollution and minimize waste relies on an understanding of the systems that produce waste. A system is defined as an aggregation of related processes that have a common product or purpose and can be regarded as the highest-level process. Thus, the Laboratory is viewed as a system comprising the various processes depicted in Fig. 1-1. That figure is a typical system or top-level process map. Each of the high-level processes identified in the map can, in turn, be deconstructed to describe individual processes that produce waste. Normally, several distinct waste streams are identified with each process or activity. The waste stream then can be quantified with respect to size. In most cases, the largest waste streams are the best candidates for minimization. Sometimes regulatory, policy, or cost requirements make smaller streams the better candidates for minimization. Pareto analysis is the tool most often used to evaluate the relative importance of waste streams. When the streams have been identified, quantified, and evaluated, specific actions can be defined to reduce the waste in the most important streams. Process mapping is the technique used to define specific actions. These individual actions are integrated into action plans for each waste type.

Process maps are constructed by specifying a set of inputs or influxes of materials; a description of activities required to produce the desired product; and a set of outputs, one of which is waste. In a typical process map, the input to the system, all the processes involved in producing the product, and all the pathways to the final output are described graphically. By closely examining and quantifying each process step and, if necessary, generating lower level process maps, it is possible to see the details of waste production. When the inputs, activities, costs, and outputs are understood and quantified, the root causes of waste generation can be assessed for that process, and points in the process where opportunities to reduce waste may exist can be identified. After those points are identified, waste-reduction strategies can be developed for each process. The result is an action plan for waste minimization. This process is used by the ESO to develop programs and projects to reduce waste in the Laboratory's major waste streams.

TABLE 1-2
TRU WASTE PERFORMANCE METRICS

Performance	Annual Production of TRU Waste (m^3)			
	FY02	FY03	FY04	FY05
Unsatisfactory	>96	>92	>80	>60
Marginal	96	86	73	56–60
Good	92–95	82–85	69–72	51–55
Excellent	90–91	80–81	65–68	21–50
Outstanding	<90	<80	<65	20

1.6. Roadmap Structure

This current roadmap document describes the Laboratory's principal waste streams; the source, volume, and root cause of the waste; and programs and projects designed to avoid or minimize the waste. The roadmap contains eight chapters; one chapter is an introduction, five chapters (Chapters 2 through 6) are devoted to the major individual waste streams, and two chapters (Chapters 7 and 8) describe conservation programs at the Laboratory.

The chapter for each waste type contains a definition of that waste type, the regulatory drivers associated with that waste type, an analysis of the waste streams that make up the waste type, and a description of the programs and projects (both current and proposed) that are intended to avoid or minimize the waste.

The analysis section in each chapter contains a systems-based process analysis of the data reported for that waste type. That analysis is frequently supplemented by results of other analysis techniques, such as the Green Zia analysis.

Each waste-type chapter contains a section at the end that details performance metrics for that waste type. The metric is based on progress toward implementing the projects identified as important to reducing the large waste streams within that waste type. Full implementation earns three points; partial implementation earns fewer points. In some cases, implementation is not the project goal, in which case the goal is detailed in the comments section. These metrics will be used to manage progress against objectives during the year.

The roadmap serves several purposes. Its primary purposes are to report pollution-prevention and waste-minimization performance, update analyses of waste streams, and periodically revisit and evaluate the programs and projects intended to reduce the environmental impact of Laboratory operation. The roadmap also serves to satisfy the requirements of 40CFR264.73(b)(9) in the Resource Conservation and Recovery Act (RCRA). In addition, the roadmap serves as the DOE-mandated description of the Laboratory's sitewide pollution prevention plan. The roadmap also contains supplemental information in two appendices. Additional information regarding the Laboratory's environmental impact can be found in the following documents.

General Data on the Environmental Impact of Laboratory Operations

- United States Department of Energy, "Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory," United States Department of Energy document DOE/EIS-0238 (January 1999).
- United States Department of Energy, "Mitigation Action Plan for the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory," United States Department of Energy document DOE/EIS-0238 (September 1999).

- "Environmental Surveillance at Los Alamos During 1999," Los Alamos National Laboratory document LA-13775 (December 2000).

The roadmap does not contain any information regarding effluents or outfalls except those associated with water conservation projects. There is no information on air or TRI emissions. There are no data regarding sediments, groundwater, or site ecology. The roadmap contains no Laboratory fleet transportation efficiency data. These data may be found in the following documents.

Air Emissions, Sediments, Surface Water, Groundwater, and Site Ecology

- "Environmental Surveillance at Los Alamos during 1999," Los Alamos National Laboratory document LA-13775 (December 2000).
- "New Mexico 2.73 Emissions Inventory, Los Alamos National Laboratory document LA-13850-SR (August 2000).
- "US Department of Energy Report 2000 LANL Radionuclide Air Emissions," Los Alamos National Laboratory document LA-13839-ENV (August 2001).
- Water-quality database: http:/wqdbworld.lanl.gov.

NPDES Permitted Outfalls

- NPDES Permit Number NM0028355 Fact Sheet (December 1999) http://www.esh.lanl.gov/~esh18/.

Toxic Chemical Release Inventory

- "Toxic Chemical Release Inventory for the Emergency Planning and Community Right-to-Know Act," Los Alamos National Laboratory document, LA-13764-PR (December 2000).

2.0. TRANSURANIC WASTE

2.1. Introduction

Transuranic (TRU) waste is waste containing more than 100 nCi of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years (atomic number greater than 92), except for (1) high-level waste (HLW); (2) waste that the Department of Energy (DOE) has determined, with the concurrence of the Administrator of the Environmental Protection Agency (EPA), does not need the degree of isolation required by 40 Code of Federal Regulations (CFR) 191; or (3) waste that the United States Nuclear Regulatory Commission (NRC) has approved for disposal on a case-by-case basis in accordance with 10 CFR 61. TRU waste is generated during research, development, nuclear weapons production, and spent nuclear fuel reprocessing.

TRU waste has radioactive elements such as plutonium, with lesser amounts of neptunium, americium, curium, and californium. These radionuclides generally decay by emitting alpha particles. TRU waste also contains radionuclides that emit gamma radiation, requiring it to be managed as either contact handled or remote handled. Approximately half of the TRU waste analyzed is mixed TRU (MTRU) waste, containing both radioactive elements and hazardous chemicals regulated under the Resource Conservation and Recovery Act (RCRA).

The DOE has ~68,000 m^3 of stored TRU waste that can be retrieved and expects to generate ~64,000 m^3 over the next 20 years (excluding TRU waste that could be generated as a result of environmental restoration activities), for a total of ~132,000 m^3. TRU waste is disposed of at a geologic repository called the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico.

TRU waste at Los Alamos National Laboratory (the Laboratory) can be classified as either legacy waste or newly generated waste. Legacy waste is that waste generated before September 30, 1998. DOE Environmental Management (DOE/EM) is responsible for disposing of this waste at WIPP and for all associated costs. Newly generated waste is defined as waste generated after September 30, 1998; DOE/Defense Programs (DOE/DP) is responsible for disposing of this waste at WIPP. This roadmap focuses only on the newly generated wastes. Within this broad category, newly generated wastes are subdivided further into solid and liquid wastes, as well as routine and nonroutine wastes. Solid wastes include cemented residues, combustible materials, noncombustible materials, and nonactinide metals. Liquid wastes comprise effluent solutions associated with the nitric acid and hydrochloric acid plutonium-processing streams. Because of the final pH of these streams, they are also referred to, and are reported as, the acid and caustic waste streams, respectively. Routine waste is defined as waste produced from any type of production operation, analytical and/or research and development (R&D) laboratory operations; treatment, storage, and disposition facility operations; "work for others"; or any other periodic and recurring work that is considered ongoing in nature.

Nonroutine waste is defined as one-time operations waste: wastes produced from environmental restoration program activities, including primary and secondary wastes associated with retrieval and remediation operations; legacy wastes; and

decontamination and decommissioning (D&D)/transition operations. TRU and MTRU wastes are reported separately because of the differing characterization requirements applied to them. These requirements are detailed in the RCRA and the Federal Facilities Compliance Order/Site Treatment Plan (FFCO/STP). The top-level process map for TRU waste is shown in Fig. 2-1.

The majority of the TRU wastes generated at the Laboratory are associated with the Stockpile Stewardship and Management Program, the MilliWatt Heat Source Program, and nuclear materials R&D. Nuclear Materials Technology (NMT) Division is the principal waste generator responsible for these programs, which are conducted at the Plutonium Facility (TA-55, Building PF4) and the Chemistry and Metallurgy Research (CMR) Facility (TA-3, Building SM-29). The MilliWatt Heat Source Program is the sole producer of ^{238}Pu-contaminated TRU waste. A small quantity of TRU waste is produced from waste characterization activities required for waste disposal at WIPP. The Environmental Technologies (ET) group of the Environmental Science and Waste Technologies (E) Division (called E-ET) performs these characterization activities.

Figure 2-2 shows total routine and nonroutine TRU and MTRU waste-generating organizations by the relative volume of waste generated. All of the E-ET TRU waste is nonroutine, and the Facility and Waste Operations Division (FWO) waste is solid waste generated from the treatment at the Radioactive Liquid Waste Treatment Facility (RLWTF) of NMT Division's acid and caustic waste streams. Fiscal-year (FY)00 data are used because the FY01 data are not representative of a typical year because of limited operations in the plutonium processing facility and may be misleading.

The total volume of TRU waste generated by the Laboratory is shown in Fig. 2-3 and identified as routine, nonroutine, and environmental remediation waste. The Environmental Remediation (ER)/D&D Program has produced TRU waste intermittently, related directly to the area or facility being remediated, or decommissioned. In FY97, significant quantities were generated because of the D&D of TA-21, the old uranium- and plutonium-processing site. On March 16, 2000, a radiological release of ^{238}Pu occurred near a glovebox in Los Alamos National Laboratory's (the Laboratory's) Plutonium Processing and Handling Facility (TA-55). As a result of the subsequent Type-A accident investigation and the response to that investigation, work within TA-55 was curtailed for the remainder of FY00 and a portion of FY01. The curtailment of operations resulted in artificially low TRU waste generation rates for FY00 and FY01.

2.2. TRU Waste Minimization Performance

The DOE 2005 pollution-prevention goals require that the DOE complex reduce "routine" TRU/MTRU waste generation by 80%, to <141 m^3, by 2005. The Laboratory's allocation of that 141 m^3 has not been determined, but only the Laboratory and the Savannah River Site have ongoing missions related to the use of plutonium. However, the Laboratory must reduce its present generation rate if the DOE is to achieve that goal. Between 1993 and 1998, the amount of TRU waste generated by the Laboratory increased from 76.7 to 121.7 m^3 (58%). The volume of routine TRU waste produced by the Laboratory decreased in FY00 and FY01 as a result of unplanned shutdowns of the

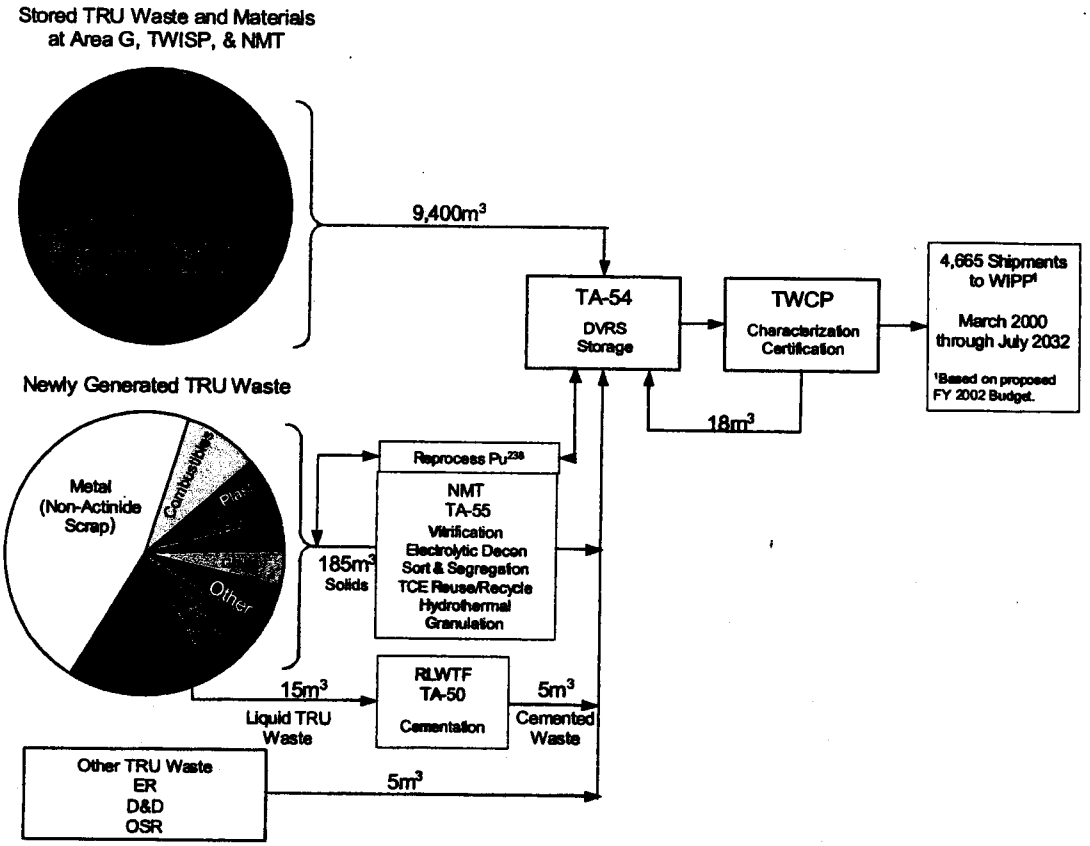

Fig. 2-1. Top-level TRU waste process map and waste streams.

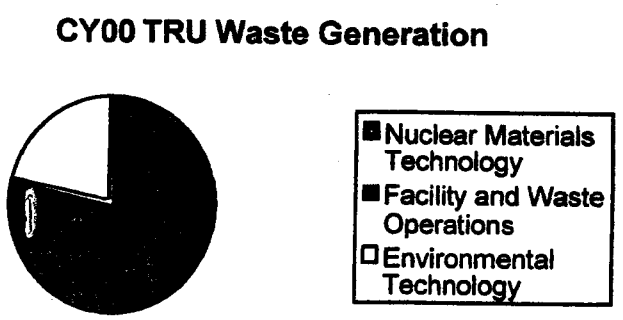

Fig. 2-2. TRU and MTRU waste-generating organizations.

TA-55 Plutonium Processing Facility. To help achieve the DOE complex-wide goal, the Laboratory set an FY05 performance goal that includes decreasing routine TRU waste generation by 50% from a baseline of 100 m³. The 100-m³ baseline quantity represents the average TRU waste production for FY96 through FY99. This period is typical of normal operation at the TA-55 Plutonium Processing Facility.

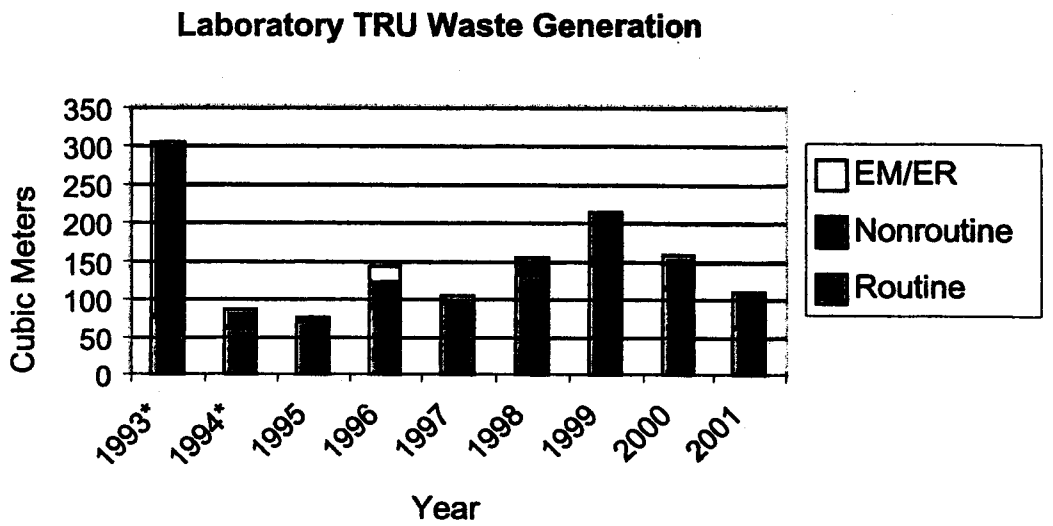

Fig. 2-3. Generation rates for TRU waste at the Laboratory.*

*All data are for FYs except 1993 and 1994. 1993 to 1995 data obtained from EM/ES: 96-350 letter of baseline corrections submitted to the DOE in December 1996. The 1996 to 1999 data were obtained from previous reports to the DOE on waste generation and are stored in the "twilight.saic" database. The 2000 to 2001 data were obtained from the solid-waste operation (SWO) database "swoon".

The recent trend in TRU/MTRU waste generation is shown in Fig. 2-4. The DOE goal shown is the 80% reduction from the calendar year (CY)93 baseline. It is clear that the Laboratory will have to continue its aggressive waste avoidance and minimization measures to help the DOE meet that goal.

2.3. Waste Stream Analysis

TRU wastes are generated within radiological control areas (RCAs). These areas also are material balance areas (MBAs) for security and safeguards purposes to prevent the potential diversion of special nuclear material (SNM). TRU and MTRU wastes are reported separately because of the different characterization requirements for the wastes. These requirements are detailed in the RCRA and by the FFCO/STP—New Mexico Environment Department (NMED), which stipulates treatment requirements for MTRU wastes. In CY99, WIPP received a "No Mitigation Variance," which allows it to accept MTRU waste for disposal without treatment. However, the characterization requirements for MTRU waste remain. MTRU waste can be shipped to WIPP without treatment, except as needed to meet storage and transportation requirements. In the following sections, TRU/MTRU wastes will be discussed as one waste type because the waste minimization strategy for both waste types is the same. As shown in Fig. 2-5, the MTRU waste stream is ~24% of the routine TRU waste and 53% of the nonroutine TRU waste. The use of acceptable knowledge for characterization of newly generated TRU waste at the TA-55 Plutonium Processing Facility may increase the percentage of MTRU.

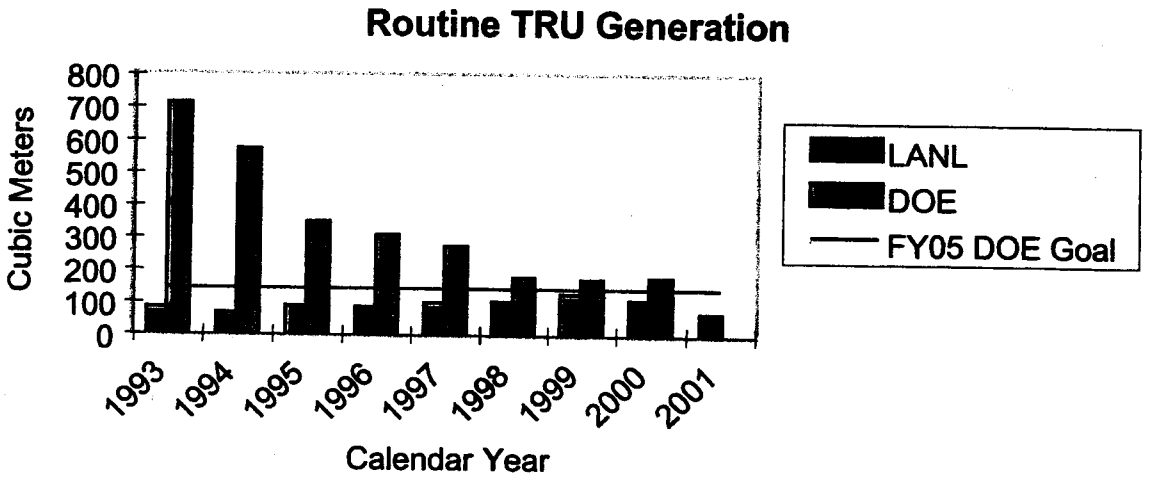

Fig. 2-4. TRU waste generation by CY.*
*The DOE 2001 total volume is not yet available.

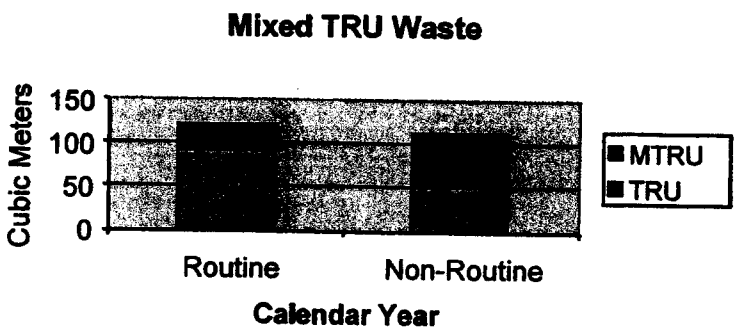

Fig. 2-5. The proportion of Laboratory-generated MTRU waste.

The TA-55 Plutonium Processing Facility processes ^{239}Pu from residues generated throughout the defense complex into pure plutonium feedstock. The manufacturing and research operations performed at TA-55 in the processing and purification of plutonium result in the production of plutonium-contaminated scrap and residues. These residues are processed to recover as much plutonium as is practical. These recovery operations, associated maintenance operations, and TA-55 plutonium research are the sources of TRU waste generated at TA-55.

TRU waste materials, process chemicals, equipment, supplies, and some RCRA materials are introduced into the RCAs to support the programmatic mission. All SNM introduced into Building PF-4, TA-55 is stored in the vault in the PF-4 basement until needed for processing. Because of the hazards inherent in the handling, processing, and manufacturing of plutonium materials, all process activities involving plutonium are

conducted in gloveboxes. High levels of plutonium contamination can build up on the inside surfaces of gloveboxes and process equipment as a result of the process or because of leaking process equipment. All materials being removed from the gloveboxes must be multiple-packaged to prevent the spread of contamination outside the glovebox. Currently, all material removed from gloveboxes is considered to be TRU waste. Large quantities of waste, primarily solid combustible materials such as plastic bags, cheese cloth, and protective clothing, are generated as a result of contamination avoidance measures taken to protect workers, the facility, and the environment.

Process residues [with plutonium contamination less than the Safeguards Termination Limits (STLs)] and cemented evaporator bottoms are other solid TRU wastes generated during operations. Process residues exceeding the STL values are returned to the vault for storage and future reprocessing. From FY98 through FY00, ~59,087 kg of solid TRU waste was generated by NMT Division. The percentage breakdown of that waste is shown in Fig. 2-6.

The TRU waste stream is the result of Laboratory missions focused on the Stockpile Stewardship and Management Program, the MilliWatt Heat Source Program, and nuclear materials R&D. NMT Division is the predominant generator of TRU wastes. In FY01, NMT Division prepared an integrated TRU Waste Minimization Management Plan that included project descriptions, required technologies, cost, cost savings, waste reduction estimates, and implementation issues for a comprehensive set of waste avoidance/minimization activities specific to NMT Division operations. The NMT Division philosophy and expectations for environmentally conscious plutonium processing are presented in the NMT Division Waste Management Program Plan. The goals of this plan are to reduce liquid waste by 90% and essentially to eliminate the combustible waste stream by CY03. Both plans made assumptions regarding annual funding levels and programmatic priorities and thus must be updated periodically.

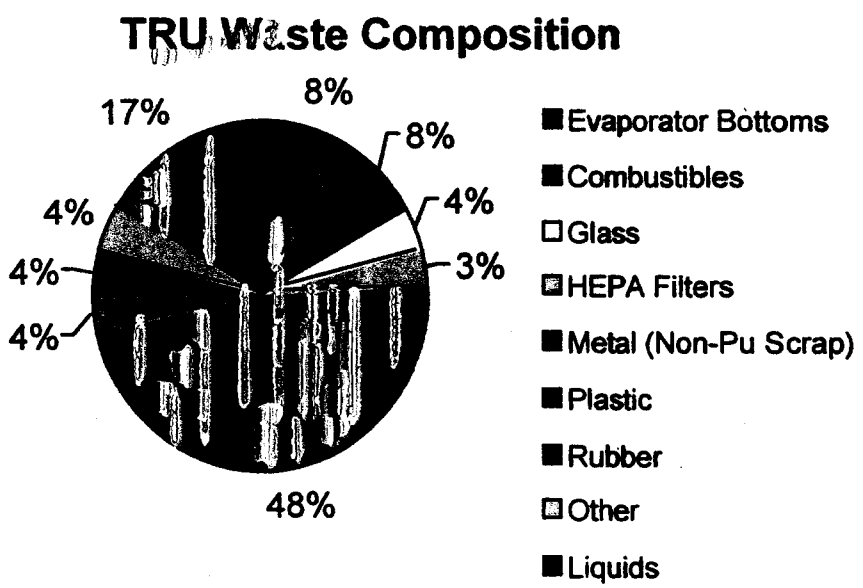

Fig. 2-6. Composition of TRU waste from NMT Division, FY98 through FY00.

NMT Division, E-ET, and the FWO Waste Facilities Management (WFM) Group all generate TRU waste. Effective waste minimization must begin at TA-55 because the TRU waste produced at the TA-50 RLWTF is a direct result of (1) treating TA-55 caustic and acid waste streams and (2) characterizing and certifying NMT-Division-produced waste (both legacy and newly generated) from the E-ET TRU waste results. The volumes included in the following waste descriptions are based on the base-case generation rate of 100 m^3 of routine waste. These values were derived from the average of quantities produced in FY96 through FY99.

Combustible Wastes (10 m^3). Combustible wastes comprise ~10% of the TRU waste generated at the Laboratory. For the MilliWatt Heat Source Program, combustible solids account for almost 90% of the TRU wastes contaminated with ^{238}Pu, for which there is currently no disposal pathway. In all instances, combustible waste comprises mostly plastic bags, plastic reagent bottles, plastic-sheet goods used for contamination barriers, cheese cloth, gloves, protective clothing worn by workers, and a small volume of organic chemicals and oils.

Noncombustible TRU Waste (22 m^3). Noncombustible TRU waste includes glass; high-efficiency, particulate-air-filter (HEPA) graphite; plastic; rubber; or other materials.

Nonactinide Metals (55 m^3). Nonactinide metals are any metallic waste constituents that may be contaminated with, but are not fabricated out of, actinide metals. Metallic wastes typically include tools, process equipment, glovebox structures, facility piping, and ventilation ducting. Significant volumes of metallic waste are generated under the following conditions: (1) when gloveboxes have reached the end of their useful life, (2) when processes within the facility and glovebox are changed, (3) when routine and nonroutine maintenance activities are completed, and (4) as facility construction projects are implemented to meet new programmatic missions.

Cemented Wastes (4 m^3). Cemented wastes are those acidic and caustic processing sludges and oxalate precipitation residues that contain levels of plutonium exceeding the STLs but containing less than the values required for reprocessing. Before being discarded, the residues must be immobilized to minimize their potential attractiveness for diversion. Cementation meets this immobilization requirement. The high concentrations of actinides in this sludge frequently exceed the thermal wattage limit for WIPP disposal and require dilution by as much as a factor of five to meet certification requirements. Implementation of vitrification for this waste stream will reduce the final volume by a factor of four.

Caustic and Acidic Liquid Waste (9 m^3). Caustic liquid waste results from the final hydroxide precipitation step in the aqueous chloride process. Feedstocks for this process typically are anode heels, chloride salt residues, and other materials having a relatively high chloride content. Efforts are underway to upgrade the throughput capabilities of the aqueous chloride process to handle the increased quantities of chloride residues that will result from workoff under the 94-1 Residue Stabilization Program. Over the next 3 to 5 years, throughput quantities are expected to double. Caustic process liquids will be transferred to the TA-50 RLWTF for final processing via the caustic waste line. Acidic liquid waste is derived from processing plutonium feedstock with nitric acid for matrix dissolution. Following oxalate precipitation, the

effluent is sent to the evaporator, where the evaporator overheads are removed and sent to the acid waste line for further processing. Evaporator bottom sludge is cemented into 55-gallon drums for disposal.

The waste streams are shown as a per cent of total TRU waste in Fig. 2-7.

TRU solid wastes are accumulated, initially assayed, and characterized at the generation site. TRU solid waste is packaged for disposal in metal 55-gallon drums, 4-x-4-x-6-ft standard waste boxes (SWBs), and oversized containers. Security and safeguards assay measurements are conducted on the containers for accountability before they are removed from PF-4. The 55-gallon drums are stored in an auxiliary building at TA-55. The SWBs and oversized containers are staged on an asphalt pad behind PF-4 to await shipment to the waste characterization areas at TA-54 or TA-50. Detailed characterization of TRU wastes occurs at TA-54, Building 34, the Radioassay and Nondestructive Testing (RANT) facility; and at TA-50, Building 69, the Waste Compaction, Reduction, and Repackaging Facility (WCRRF). Samples from drums are sent to the CMR building for characterization in some cases. TRU waste is stored at TA-54, Area G, until it is shipped to WIPP for final disposal. Certification of the waste for transport to and disposal at WIPP is the responsibility of the E-ET Group of E Division. TRU waste shipments to WIPP began on March 25, 1999, and are expected to continue through 2032.

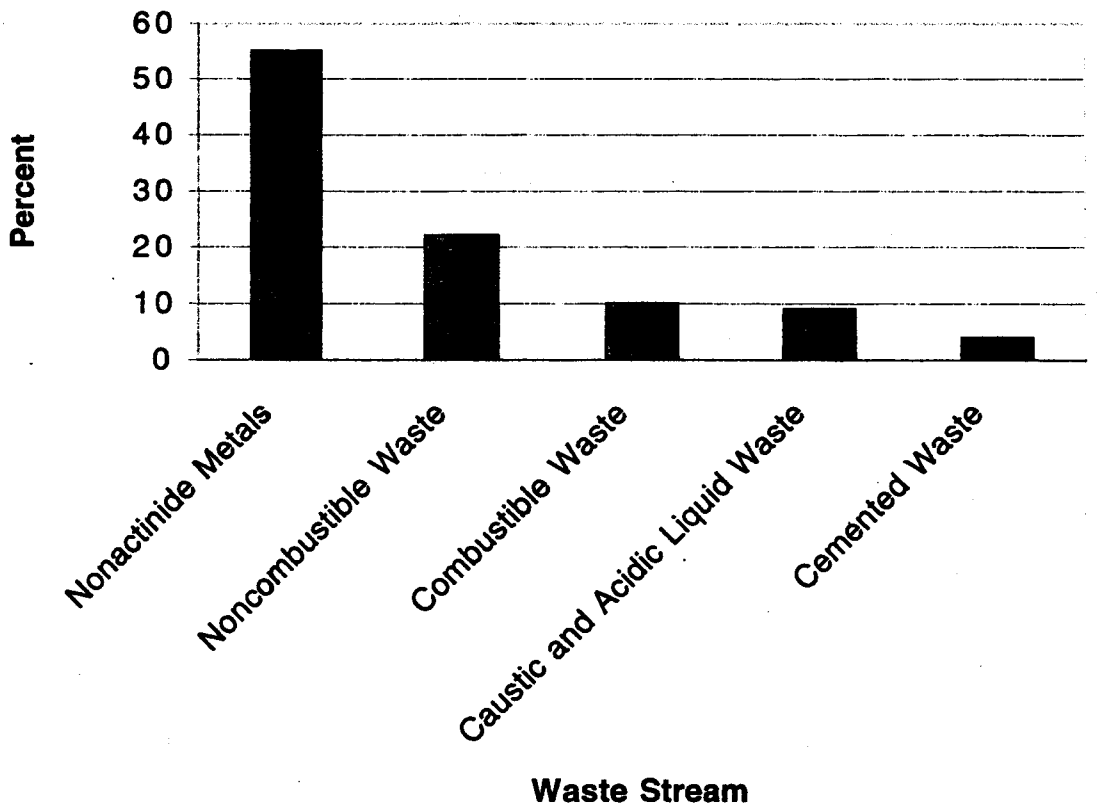

Fig. 2-7. TRU waste streams.

Liquid TRU wastes from the nitric-acid (acidic) and hydrochloric-acid (caustic) aqueous processes are transferred from TA-55 to the TA-50 RLWTF via separate, doubly encased transfer lines for processing and further removal of plutonium by flocculent precipitation. The precipitate is cemented into 55-gallon drums and transported to TA-54 for storage and ultimate disposal at WIPP as TRU solid waste. In FY00, ~11,660 liters of liquid TRU waste was processed at the TA-50 RLWTF. Of this volume, 76% came from the acid waste stream and the remaining 24% came from the caustic waste stream. Implementation of the Nitric Acid Recovery System in FY01 is reducing the volume of the acidic waste stream.

The cost for handling, storage, and disposal of TRU waste was estimated at approximately $58,000/m^3 in FY01. However, that cost did not include the fixed cost of the storage facility at TA-54 or the cost to open and operate WIPP (fixed disposal cost).

2.4. Improvement Projects

Many process improvements have been identified for implementation within TA-55 and in the processing of TRU waste after it is produced. Priorities for new waste-minimization projects and activities within TA-55 are detailed in the integrated TRU Waste Minimization Management Plan that was prepared by NMT Division in FY01. These projects are divided into three categories: (1) projects completed in the last year, (2) projects currently funded and ongoing, and (3) unfunded proposed projects. Projects are characterized further by type: source reduction (SR), sort and segregate (SS), reuse/recycle (RR), and treatment (T) or disposal (D).

2.4.1. Completed TRU Waste Minimization Projects

The following projects have been completed and/or implemented in the last year. Most of the projects completed in previous years (not listed below) continue to avoid or minimize TRU waste.

Electrolytic Decontamination (RR). The Plutonium Processing Facility at the Laboratory, TA-55, PF-4, contains hundreds of gloveboxes that are used to provide containment for process equipment and as work areas. When taken out of service, gloveboxes are large-volume waste items, and because they are categorized typically as TRU/MTRU waste, they are packaged in oversized containers. These oversize containers require costly size reduction and repackaging to meet certification requirements before disposal at WIPP. A technique was developed and implemented that allows decontamination of certain gloveboxes. Decontaminated gloveboxes are either reused at the Laboratory or disposed as low-level waste (LLW) vs TRU/MTRU waste.

Nitric Acid Recovery System (RR). Nitric acid liquid waste is derived from processing plutonium feedstock with nitric acid for matrix dissolution. Following oxalate precipitation, the effluent is sent to the evaporator, where the overheads are removed and sent to the acid waste line for further processing. A process has been implemented that allows the processed nitric acid to be reused. This process will reduce the annual purchase of nitric acid below reportable limits for toxic release inventory (TRI) chemicals.

Sort and Segregation of "Zero Gram" Waste Items (SS). Historically, all TA-55 process waste was considered TRU waste because the equipment in TA-55, PF-4,cannot achieve sufficient detection sensitivity for TRU waste determination. A segregation program to separate items that assay below detection limits ("zero count item") has been instituted. Reassay of zero-count items using better measurement techniques in a low-background environment is required to validate the initial waste determination. Reassay of 64 low-mass drums determined that24 of the drums were LLW. It is estimated that segregating LLW from TRU will avoid 15% of the low-mass TRU, or ~2m^3 annually.

2.4.2. Ongoing TRU Waste Minimization Projects

These projects have been funded and currently are being executed. These ongoing TRU waste-minimization and avoidance projects are funded by the ESO Base and Generator Set-Aside Fee (GSAF) programs and by operating funds.

Vitrification System (T). The ESO Pollution Prevention Base Program is funding the fabrication, testing, and installation of a vitrification process for that TRU waste currently solidified with cement. The project provides the fabrication and installation of gloveboxes to house the vitrification equipment, the fabrication and operational testing of the vitrification system, and installation of the equipment within the gloveboxes at TA-55, PF-4. The Vitrification System will produce waste drums certifiable to WIPP waste acceptance criteria (WAC) and is expected to reduce the generation of TRU/MTRU-cemented waste at a rate of 20 to 30 drums per year.

Gas Discharge Mass Spectrometer (GDMS) (SR). An inline GDMS is currently under development, with funding provided through the GSAF program. This analytical instrument allows real-time analyses of metal feeds and castings. It not only enhances the process efficiency in the plutonium foundry but also reduces the amount of samples sent off-site for analyses, the waste generated, and the reprocessing cost. The use of an inline GDMS will reduce operational costs and drastically reduce the TRU waste that would be produced in the wet chemistry analysis of these samples.

Plutonium Oxidation State Diagnostic for Chloride Line (SR). This project is funded through the GSAF program and will implement a real-time, inline capability to rapidly determine the plutonium oxidation state while a batch is in process by monitoring the visible light absorption spectrum of plutonium in solution. This diagnostic will use off-the-shelf, compact, reliable spectrometers. By providing a continuous knowledge of the plutonium oxidation state, this diagnostic will enable operators to adjust process conditions immediately if the oxidation state drifts. This process will eliminate most of the unacceptable batches, reducing operation costs and process waste generation by 5% to 10%. It also will reduce the consumption of reagents for oxidation state adjustment, which commonly are overused to compensate for uncertainty about the oxidation state. The primary waste stream that will be affected consists of 15,000 liters/year of neutralized TRU liquid waste (4.3-mCi/liter average) that normally is piped to TA-50 for precipitation and solid waste disposal as TRU waste. A 5% reduction in the number of batches would eliminate ~750 liters (3.2 Ci) of this stream per year.

PF-4 Trichloroethylene (TCE) Upgrade (RR). The processes for cleaning plutonium parts at TA-55 are undergoing a series of upgrades designed to reduce the amount of waste generated, reduce the exposure levels of the operator to both radiation and

solvent, and aid in removing any inconsistencies in the level of cleaning. Central to these upgrades is replacing the ultrasonic bath currently in use with a mechanical spray washer developed by NMT-5. A second development designed to reduce the amount of waste generated further is that of installing a distillation recycle unit in conjunction with a fluorometer and pH meter to monitor the organic contaminant loading and trichloroethylene (TCE) breakdown. Combined, these process modifications will reduce the annual volume of TCE waste by >95%. This project is funded through the GSAF program.

Hydrothermal Processing of Organic Chemicals (T). This project is completing the upgrade and installation of a Hydrothermal Processing System used to destroy organic chemicals. Use of the Hydrothermal Processing System will reduce the generation of TRU/MTRU waste organic compounds by ~0.4 m^3/year.

Decontamination and Volume Reduction System (DVRS) (T). The DVRS is designed for the decontamination and size reduction of oversized TRU waste items, including gloveboxes and process equipment. It consists of (1) an outer building that provides secondary containment, storage, and preparation space; and (2) an inner building that houses a shear-bailer volume reduction machine and provides segmented space for removal of packaging and decontamination of the waste materials. The DVRS will be able to process only the TRU waste that is less than the Category 3 radiological limits (8.4 g ^{239}Pu equivalent) until the Safety and Analysis Report (SAR) is approved in ~2 years. At that time the DVRS will become a Nuclear Category 3 facility and will be able to process waste with an inventory up to 900 g ^{239}Pu equivalent. Waste reduction is expected to be at least 12 m^3/year.

Small-Item Volume Reduction (T). The plutonium processing facility at the Laboratory, TA-55, Building PF-4 generates metal tools, parts, and equipment. The DVRS was developed to process the large metal items such as gloveboxes. This project will demonstrate the volume reduction of waste containers filled with small metal tools, parts, and equipment at the DVRS.

Ion Beam Etching and Polishing of Plutonium Alloys (SR). Plutonium-based alloys must be mounted and polished by conventional metallographic procedures, including diamond polishing, until the surface of the specimen displays a mirror finish. After a final polish is achieved, the specimen surface is chemically treated or electrochemically etched to reveal surface features of interest. The ion etching system will replace much, if not all, of the diamond polishing and yield a finished, treated surface, with no additional processing. This will eliminate the chemical or electrochemical etching steps after polishing and the waste these steps produce.

2.4.3. Project Development and Unfunded Projects

These projects have either been proposed or are under development to help reduce mixed (M) LLW. Proposed projects that currently are unfunded and projects under development are designated as such.

Glove Improvement Project (SR). Glovebox gloves protect workers from radiological contamination while they are working with nuclear materials. At the Laboratory, about 50 gloves fail and about 490 are replaced each year. The typical failure results in facility

contamination, worker exposure/contamination, waste generation, and work stoppage. This project will result in a 50% reduction in glove failures. As part of this project, a common glove procurement specification and glove-testing protocol will be developed and implemented. A lead-free glove and a self-monitoring glove will be procured, tested, and implemented. A second glove source or vendor and a vendor quality assistance program will be established.

Radiolytically Induced Recombination of Hydrogen and Oxygen (SR, RR). Weapons-related activities at TA-55 produce TRU wastes that contain ^{238}Pu, ^{239}Pu, and ^{241}Am. High-wattage cemented TRU waste is more likely to generate hydrogen gas in concentrations that exceed the 5% lower-flammability limit for hydrogen imposed by the Department of Transportation (DOT) and the NRC. Drums are only partially filled so as not to exceed the prescribed wattage limit; this results in the shipment of a greater number of waste drums. This proposal will establish a feasible means of maintaining a low percentage of hydrogen in the headspace of TRU waste drums by effective use of the alpha-particle radioactivity in the waste. By selecting the proper geometric dimensions of a waste container, it may be possible to eliminate the hydrogen generation hazard. Successful use of the proposed packaging scheme for enhancing recombination of hydrogen and oxygen will reduce the number of drums loaded for shipment to WIPP significantly. This project will fabricate three reaction chambers that will contain plutonium/americium-cemented waste forms or configurations to determine the effectiveness of recombination with and without headspace.

Hot-Water Extraction for Characterization of Hazardous Compounds (SR). The established methods for extraction and characterization of organic compounds were developed for nonradioactive wastes. When applied to TRU waste, those same methods were environmentally unfriendly, yielded poor analytical results, were expensive, exposed the analyst to radiological hazards, and produced an MTRU waste that currently has no path to disposal. The processes involving RCRA solvents will generate ~800 liters of MTRU waste per year. This project will purchase off-the-shelf instrumentation to demonstrate the effectiveness of hot-water extraction (250°F water at a pressure of 1000 psi) for characterization of hazardous compounds. Successful implementation of this project will (1) eliminate a source of MTRU waste, (2) reduce characterization time and improve quality, (3) greatly enhance worker safety, and (4) reduce operational costs.

Dissolution Chemistry (SR). The TA-55 Plutonium Facility processes ^{239}Pu from residues generated throughout the defense complex into pure plutonium feedstock. The manufacturing and research operations performed at TA-55 in the processing and purification of plutonium result in the production of plutonium-contaminated scrap and residues. The residues are processed to recover as much plutonium as practical, and the process step with the highest nuclear material loss is dissolution. Although the materials that are not completely dissolved are not lost, they are effectively trapped in a residue matrix that cannot be recovered or discarded and thus must be stored indefinitely. Dissolution chemistry has been considered in the past without identifying successful or new technologies that would integrate successfully into the nitrate-based process. This project would develop techniques to dissolve contaminated materials effectively to enhance the recovery of plutonium.

Solid-Surface Leaching Testing (SR). This project would develop and implement sonication-aided surface leaching for decontamination of plutonium-contaminated materials. In addition to obtaining a better general understanding of dissolution chemistry, better solid-surface leaching is needed, whether electrolytic (surface electrolytic decontamination or in baths) or sonic (sonication-aided leaching using proprietary surface penetration and wetting agents). This project includes conducting proof-of-principle experiments with a sonication system and the procurement and installation of sonication system equipment if the proof-of-principle activities are successful.

Polymer Filtration Equipment (SR, T). This project would engineer and implement polymer filtration on the caustic waste stream from TA-55. Although the effluent and filtrate losses in the caustic and acid waste streams are generally of low concentration, the large volumes involved result in a significant loss. Demonstrated technologies are available but still require engineering development to be deployed successfully. Polymer filtration for the caustic stream is one such technology. Reducing the concentration and volume of the caustic liquid waste stream will reduce the processing required at the RLWTF and the amount of TRU waste produced by the RLWTF.

Development of Extraction Chromatography (SR, T). This project would develop extraction chromatography for the nitric acid waste stream from TA-55. Although the effluent and filtrate losses in the caustic and acid waste streams generally are of low concentration, the large volumes involved result in a significant loss of nuclear material. Demonstrated technologies are available but still require engineering and development to deploy successfully. One such technology is the use of extraction chromatography for acid solutions. Reducing the concentration and volume of the caustic and acid waste streams reduces the processing required at the RLWTF and the amount of TRU waste produced by the RLWTF.

Development and Certification of Destructive Chemical Analysis (SR). This project would implement advances in analytical chemistry and nondestructive assay (NDA) to improve process control and material accountability. To maintain good process control, a significant and integrated level of analytical chemistry is required. Because of the lack of radiation signature from some of the materials, NMT Division must rely on destructive chemical analysis using estimates of the isotopic composition for routine process control and material accountability. Advances in analytical chemistry and NDA make elemental destructive assay available (no reliance on isotopic input), as well as possible nondestructive solution assay advances that would be applicable to the material's isotopic makeup. Improvements in process controls will reduce the radioactive waste streams by reducing the amount of material requiring disposal and reducing the concentration of radionuclides within the waste.

Pyrolysis of Plastics (SR, T). This project will develop and demonstrate the pyrolysis of contaminated plastic materials to aid in the recovery of plutonium. For the most recent recovery campaigns, the host matrix containing the most material was plastic. Surface leaching techniques have not been successful, and sonication-aided leaching may not be amenable. Pyrolysis (high-temperature decomposition in the absence of oxygen) would be developed, demonstrated, and deployed to create an ash from the plastic that then would be processed by more aggressive dissolution techniques. Although pyrolysis has

been developed and deployed for cellulose, it has not been modified for treating the wide variety of plastics generated in glovebox operations.

Casting Improvements (SR). This project would develop and implement improved casting technologies to reduce the amount of feed material required. Improved efficiencies in the casting and manufacturing areas also could be important in reducing losses from those processing areas. In particular, near-net-shape casting would reduce the amount for feed material required for an experiment, and the development and deployment of a reusable casting mold would reduce waste and minimize the amount of residues requiring processing for material recovery. Reducing the amount of feed material required for an experiment will reduce the volume of LLW and TRU waste generated.

CMR Assay and Compaction (T). This project would implement an assay-and-compaction process for glovebox waste at the CMR. That improvement would reduce the generation of TRU/MTRU waste solids by up to 3 m^3/year.

State-of-the-Art NDA Instrumentation (SR). This project would purchase and install state-of-the-art NDA instrumentation for the characterization of radioactive waste at TA-55. NDA is used to determine the radiological characteristics of TRU waste as part of the characterization process. Because of background radiation levels, the current instrumentation is not sensitive enough to distinguish clearly between LLW and TRU waste concentrations. This lack of sensitivity requires that the LLW be categorized as TRU waste until further characterization is performed at another facility. Those low-level radioactive wastes that previously were categorized as TRU waste are separated and removed from the TRU waste stream at this point in the characterization process. Proper characterization and separation of TRU waste materials from LLW will reduce the amount of TRU waste generated and resolve issues related to differences in data generated during the characterization of the waste and that data generated during the safeguards and security assay at TA-55.

Lauderable Personal Protective Equipment (PPE) Pilot (SR). This project would pilot the use of launderable PPE and plastic sheet goods used for contamination control. If successful, the launderable materials would replace their disposable counterparts. Use of launderable PPE will reduce the volume of radioactive waste produced.

Nonhalogenated Plastic Materials (SR). This project would pilot the replacement of polyvinyl chloride (PVC)-based plastic goods with nonhalogenated plastics and polyvinyl alcohol (PVA) counterparts to reduce the corrosive off-gas produced during thermal decomposition. Use of PVA will allow the exploration of dissolution of the PVA PPE using commercially available technology at a throughput rate large enough to decompose much of the low-level combustible waste stream, in addition to the TRU/MTRU waste volumes. If successful, replacement of the PVC materials will reduce the generation of combustible LLW, TRU, and MTRU waste.

NDA (SR). To maintain good process control, a significant and integrated level of analytical chemistry is required. Because of the lack of radiation signature from some material, the Laboratory must rely on destructive chemical analysis using estimates of the isotopic composition for routine process control and material accountability.

Advances in analytical chemistry and NDA have made elemental destructive assay available (with no reliance on providing isotopic input), as well as possible nondestructive solution assay advances that would be applicable to this unique material's isotopic makeup. This project will implement advances in NDA to improve process control and material accountability and includes equipment procurement and fabrication and software modification. Better process control will reduce the amount of material that must be processed as radioactive waste.

Sphere Size Reduction (T). This project applies to the Laboratory-generated testing spheres that must be managed as TRU waste. This project will develop/demonstrate methods of cleaning and decontaminating the containers. Methods developed/demonstrated could include sphere cutting, cleaning with a magnetic robotic crawler, and chemical or plasma decontamination.

Implementation of the projects described in the above section will have an important impact on the TRU waste stream. The following chart indicates the magnitude of the routine waste reduction expected in the outyears relative to the baseline quantity, assuming implementation of all funded but currently unimplemented projects. Additional waste reduction will accrue from implementation of projects that currently are unfunded.

Figure 2-8 shows the expected savings if the planned projects are implemented.

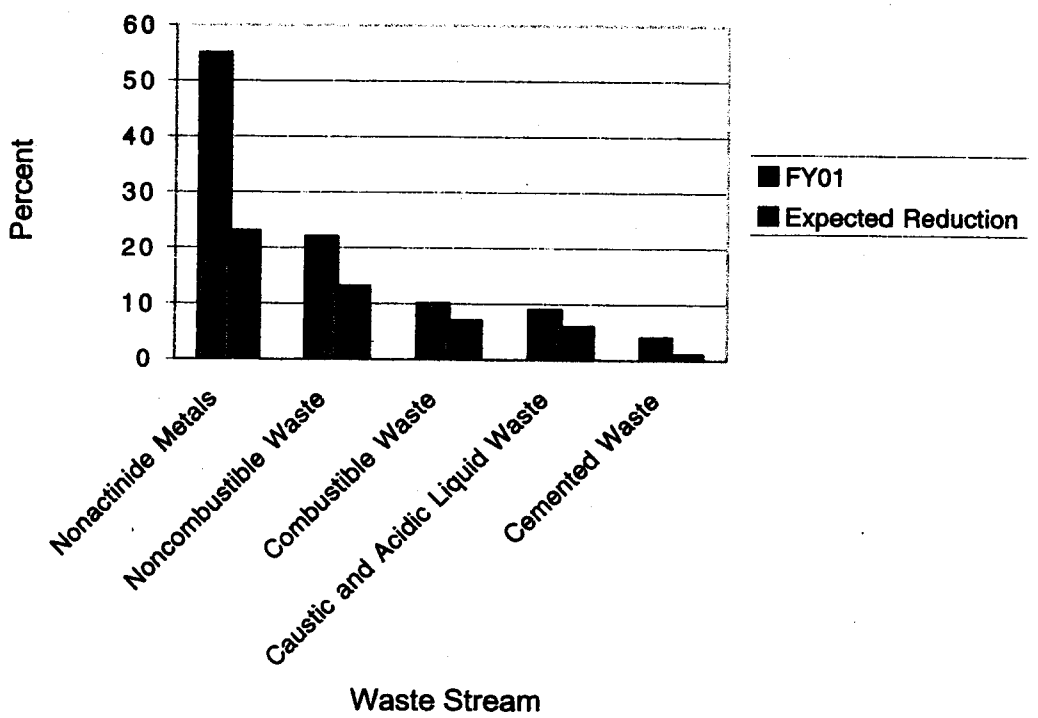

Fig. 2-8. Expected TRU waste reduction.

2.5. FY02 Performance Metrics

ESO has established performance metrics for the waste stream minimization project completion (see Table 2-1). These metrics will be used to measure performance throughout the year to assess progress. A score of 3 has been established for each completed project having a significant impact on a waste stream. Scores of 1 or 2 are assigned to projects with minimum waste stream impact or to the completion of major milestones. The following metrics have been developed for the TRU waste stream.

TABLE 2-1
TRU WASTE PERFORMANCE METRICS

Initiative (Score)	Comments
Small-Item Volume Reduction Conduct Demonstration (1) Develop DVRS WAC (1)	Saves up to 37 m^3 of TRU if all small parts go through the DVRS
DVRS Complete Laboratory Readiness Assessment (1) Begin Hot Operation (2)	
TRU Waste Vitrification Complete Cold Testing (1) Modify TA-55 Permit (1) Install Vitrification System in PF-4 (1)	Currently, 50 liters of evaporator bottoms are placed in each cemented waste drum. Vitrification will avoid 75% of the TA-55 cemented waste stream by allowing 200 liters of evaporator bottoms to be placed in a drum of vitrified waste
TCE Minimization and Reuse Implement TCE Recycle (1)	
Ion Beam Etching and Polishing of Pu Alloys Install in PF-4 (1)	
Plutonium Oxidation State Diagnostic for Chloride Line Install Feedline (1) Collect and Review Operational Data (1)	

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3.0. LOW-LEVEL WASTE

3.1. Introduction

Low-level waste (LLW) is defined as waste that is radioactive and is not classified as high-level waste (HLW), transuranic (TRU) waste, spent nuclear fuel, or by-product materials (e.g., uranium or thorium mill tailings). Test specimens of fissionable material irradiated only for research and development and not for the production of power or plutonium may be classified as LLW, provided that the activity of TRU waste elements is <100 nCi/g of waste.

Disposal of LLW is governed at Los Alamos National Laboratory (the Laboratory) by its waste acceptance criteria (WAC), which also drives LLW reporting requirements. These criteria place limits on the physical, chemical, and radiological characteristics of acceptable LLW and are developed from Department of Energy (DOE) Orders, federal and state laws and requirements, and site characteristics. Laboratory Implementation Requirement (LIR) 404-00-05.1, *Managing Radioactive Waste*, provides guidance specific to LLW; and LIR 404-0002.2, *General Waste Management Requirements*, contains waste minimization requirements.

Figure 3-1 depicts the process map for LLW generation at the Laboratory and a pie chart showing the percent of the total LLW stream comprising each category (combustible waste, noncombustible waste, and scrap metal).

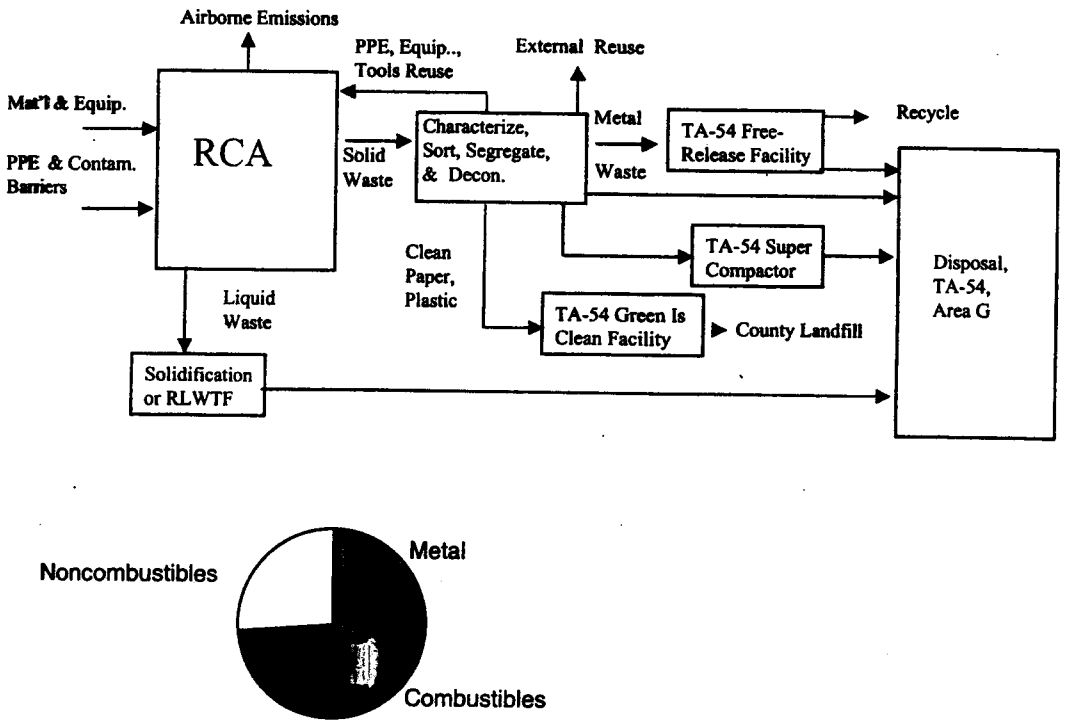

Fig. 3-1. Top-level LLW process map and waste stream chart.

LLW generation by division is depicted in the pie chart in Fig. 3-2. Nuclear Materials Technology (NMT) and Facility and Waste Operations (FWO) divisions were by far the largest LLW generators in fiscal-year (FY)01. These large percentages are consistent with the amount of radiological work performed by these divisions.

Figure 3-3 shows that NMT and FWO divisions are also the largest routine waste generators.

The solid LLW generation values for each division are listed in Table 3-1.

3.2. LLW Performance

The DOE has implemented goals for waste minimization. Its environmental leadership program will go beyond compliance requirements and will be based on continuous and cost-effective improvements. To achieve these goals, the Laboratory will use an Environmental Management System (EMS) to evaluate environmental hazards and define the highest-priority hazards and the most cost-effective solutions to reduce the environmental impacts from these hazards.

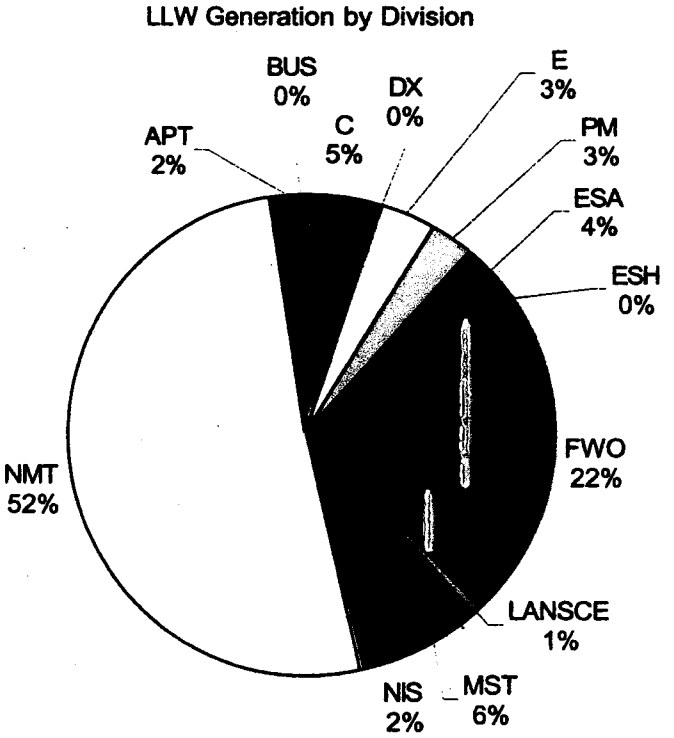

Fig. 3-2. Total LLW generation by division.

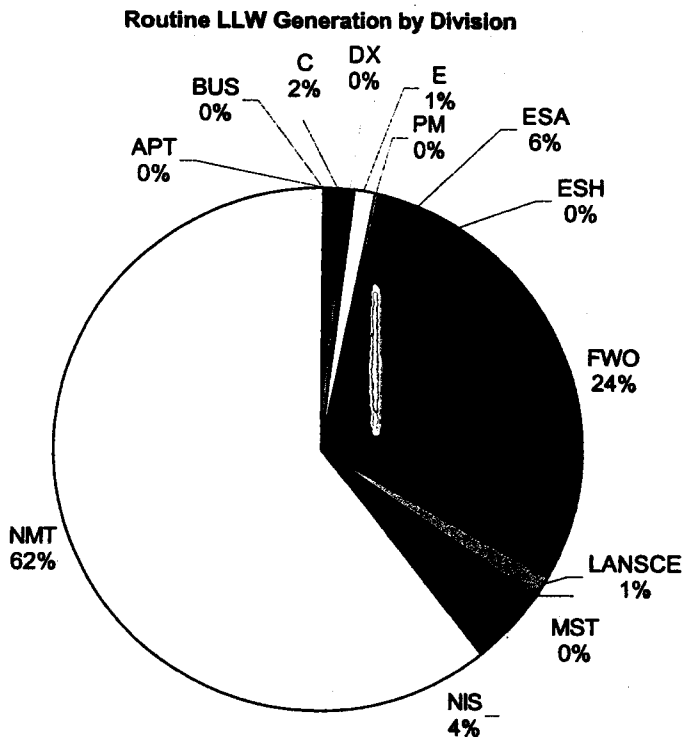

Fig. 3-3. Routine waste generation by division.

The LLW reduction goal for FY05 is to reduce waste from routine operations by 80% by 2005, which will be calculated using calendar year (CY)93 as the baseline, as required by the DOE. Figure 3-4 shows the Laboratory's routine and nonroutine waste generation rates. Figure 3-5 shows the Laboratory's success in achieving this goal and clearly illustrates that the Laboratory has exceeded the 2005 goal. In Figs. 3-4 and 3-5, the FY00 and FY01 values for the volume of routine waste include compaction. In previous years, the values did not include compaction.

The FY02, Appendix F performance measure also requires Laboratory-wide implementation of waste minimization best practices. For MLLW minimization, these practices include

- implementing Green is Clean (GIC) in the Laboratory's radiological controlled areas (RCAs),
- deploying compactor boxes to RCAs, and
- using launderable contamination barriers in RCAs.

TABLE 3-1
LLW GENERATION BY DIVISION

Division	Routine	Nonroutine	TOTAL
C (Chemistry)	6.49	36.36	42.85
DX (Dynamic Experimentation)	0.53	1.14	1.67
E (Environmental Science and Waste Technology)	5.13	24.98	30.11
PM (Project Management)	0	25.66	25.66
ESA (Engineering Sciences and Applications)	21.11	14.04	35.15
ESH (Environment, Safety, and Health)	0.55	0	0.55
FWO (Facility and Waste Operations)	90.08	103.48	193.56
LANSCE (Los Alamos Neutron Science Center)	5.47	0	5.47
MST (Materials Science and Technology)	1.5	51	52.5
NIS (Nonproliferation and International Security)	15.97	1.34	17.31
NMT (Nuclear Materials Technology)	228.9	217.24	446.14
APT (Accelerator Production of Tritium)	0	20.31	20.31
BUS (Business Operations)	0	2.52	2.52
Total	375.73	498.07	873.8

3.3. Waste Stream Analysis

Materials, hardware, equipment, personnel protective equipment (PPE), and contamination barriers (paper and plastic) are used in RCAs. After these items are no longer needed, they leave the RCA after being sorted, segregated, and, if possible, decontaminated. Some PPE, equipment, and tools are reused at the Laboratory, whereas some other equipment is sent off-site for reuse. Compactable waste is sent to the TA-54, Area-G compactor for volume reduction before disposal. Much of the waste leaving

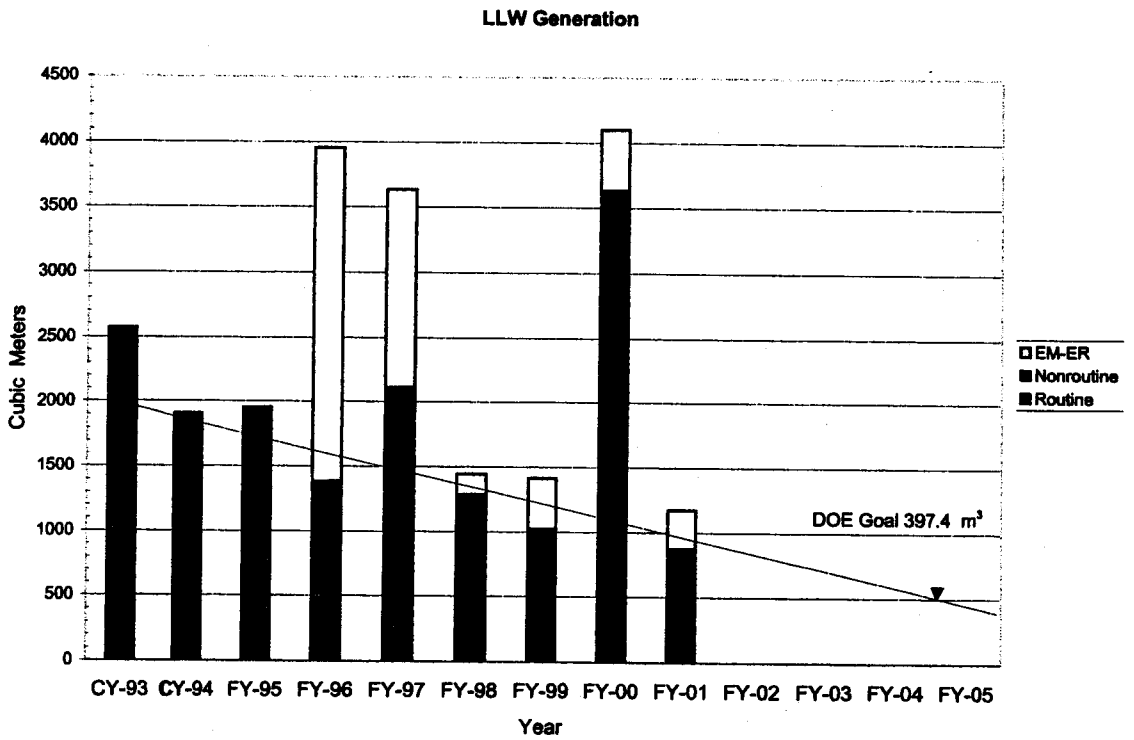

Fig. 3-4. The Laboratory's routine and nonroutine waste generation rates.

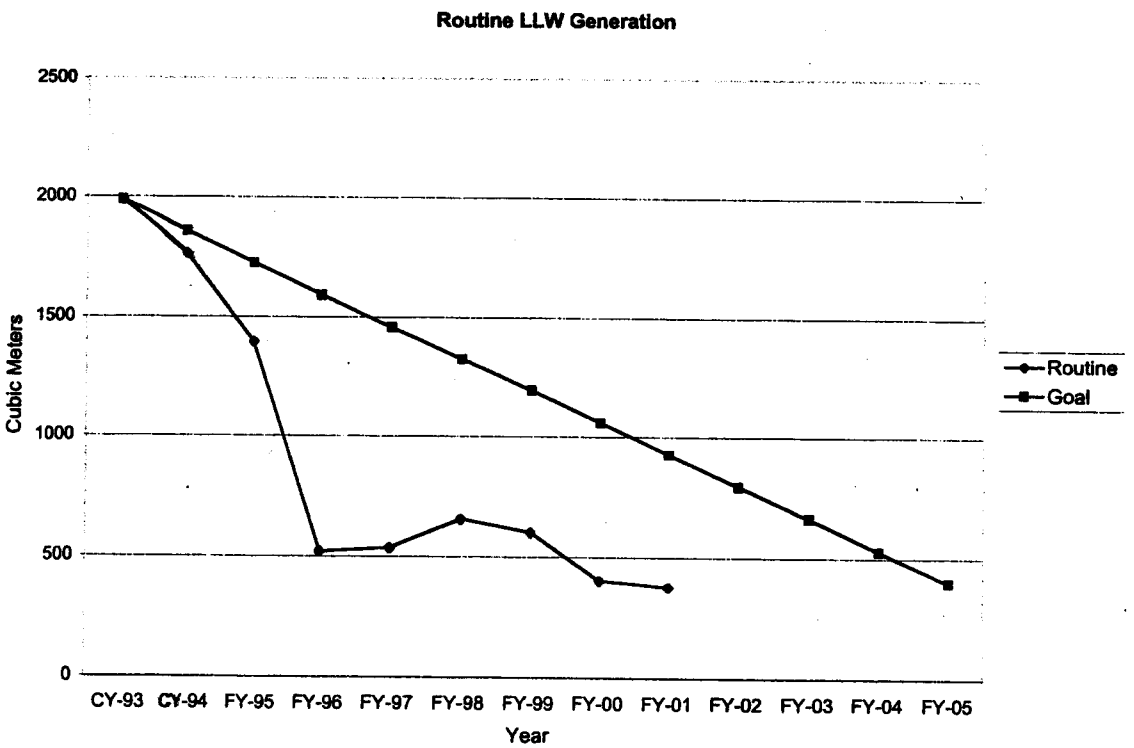

Fig. 3-5. Chart demonstrating that the Laboratory has exceeded the 2005 goal.

RCAs is not radiologically contaminated and can be surveyed to determine if the waste meets the radiological release criteria. If so, it is recycled or disposed of as sanitary waste. Low-density waste is sent to the GIC Facility at TA-54, Area G for verification that it meets the radiological release criteria. It then is sent to the County Landfill for disposal. The LLW streams are broken down by percent in Fig. 3-6.

Solid LLW generated by the Laboratory's operating divisions is characterized and packaged for disposal at the on-site LLW disposal facility at TA-54, Area G. LLW minimization strategies are intended to reduce the environmental impact associated with LLW operations and waste disposal by reducing the amount of LLW generated and/or by minimizing the volume of LLW that will require storage or disposal on-site. LLW minimization is driven by the finite capacity of the on-site disposal facility and by the requirements of DOE Order 435.1 and other federal regulations and DOE Orders.

A 1998 analysis of the LLW landfill at TA-54, Area G indicated that at previously planned rates of disposal, the LLW landfill's disposal capacity would be exhausted in a few years. Reduction in LLW generation has extended this time to ~5 yr; however, potentially large volumes of waste from planned construction upgrades and the Environmental Restoration/Decontamination and Decommissioning (ER/D&D) Program could fill the remaining available landfill rapidly. Because the Sitewide Environmental Impact Statement (SWEIS) (through a DOE Record of Decision in the fourth quarter of 1999) has received regulatory approval, construction of additional disposal sites now is allowed. Additional sites for LLW disposal at Area G would provide on-site disposal for an additional 50 to 100 years. However, cost considerations and public acceptance issues may delay construction of additional disposal sites.

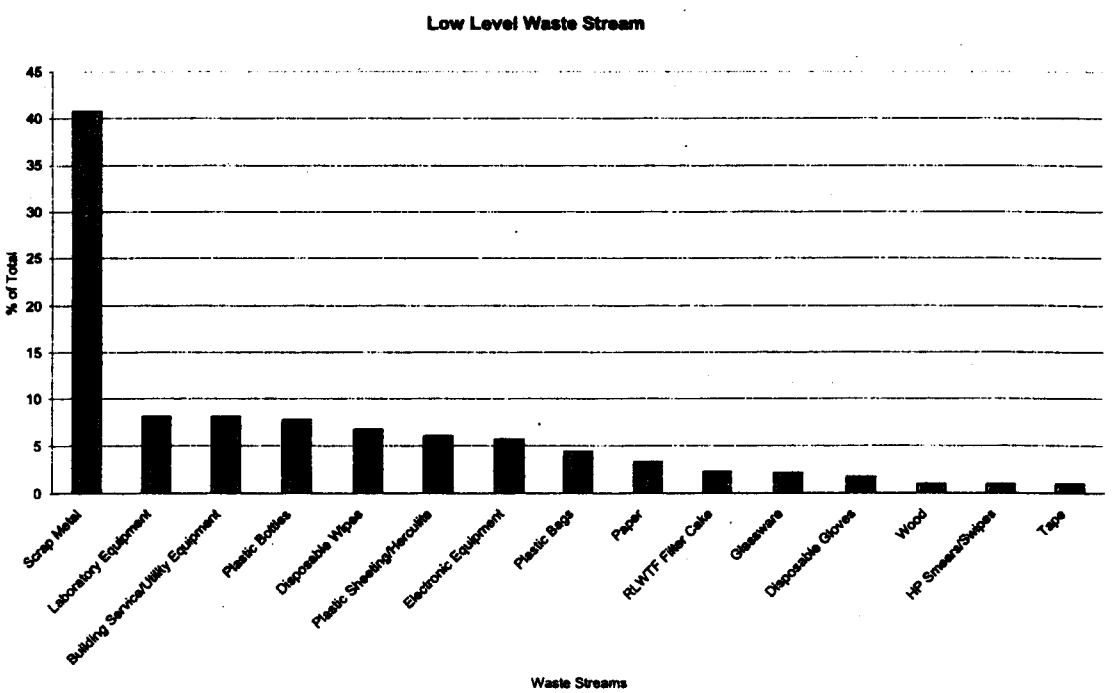

Fig. 3-6. LLW streams.

Liquid LLW typically is generated at the same facilities that generate solid LLW. It is transferred through a system of pipes and by tanker trucks to the Radioactive Liquid Waste Treatment Facility (RLWTF) at TA-50, Building 1. The radioactive components are removed and disposed of as solid LLW. The remaining liquid is discharged to a permitted outfall.

Unlike other waste, waste produced from decommissioning and ER projects will be disposed of either at the Envirocare site in Utah, *in situ*, or at Area G and is not addressed in this LLW section.

Solid LLW comprises various waste streams that are categorized as combustible LLW, noncombustible LLW, and scrap-metal LLW. LLW is generated when materials, equipment, air, and water brought into RCAs to assist in performing work are radiologically contaminated and then removed from the facility in the form of air emissions, solid LLW, or aqueous LLW.

The LLW streams at the Laboratory arise from processes at various Laboratory sites and are interrelated in some cases. For example, significant quantities of Laboratory equipment (e.g., computers) contain circuit boards that must be disposed of as MLLW. The goal for the TRU program is to lower the radiation levels of gloveboxes from TRU to LLW levels through decontamination; the goal for the LLW program is to use all means possible to release the maximum materials for recycle, reuse, or sanitary waste disposal. LLW streams are categorized in the following subsections as combustible, noncombustible, or scrap metal. The categorized waste streams and their definitions follow.

3.3.1. Combustible Waste Streams

Materials from combustible waste streams used to accomplish programmatic work in RCAs are processed as LLW when they are removed. Combustible materials make up ~40% of the total LLW produced at the Laboratory annually. Combustible LLW streams and their definitions follow in descending order by volume.

Plastic Bottles. Plastic bottles are used to contain aqueous samples and move aqueous material from one RCA to another.

Disposable Wipes. Disposable wipes consist of any absorbent product (paper towels, wipes, cheese cloth, etc.) used as a cleaning aid or to absorb aqueous materials. The majority of these wipes either are used as laboratory aids or are contaminated during cleanup activities.

Plastic Sheeting/Herculite. Plastic sheeting is used for contamination barriers. Typically, it is placed on the floor areas or used to build containment structures around equipment to prevent the spread of radioactive contamination and to ease cleanup activities.

Plastic Bags. Plastic bags are used to package waste for disposal and to transport materials from one RCA to another.

Paper. Office paper is used for recording data, working procedures, etc. Other forms of paper, such as brown wrapping paper, are used as temporary contamination barriers to prevent the spread of contamination and to ease cleanup activities.

RLWTF Filter Cake. The RLWTF uses a ferric chloride flocculation agent to precipitate contaminates as part of the treatment process for the radioactive liquid effluent. This waste stream consists of the filter cake resulting from this process.

Disposable Gloves. Disposable gloves are an essential PPE requirement when working in RCAs. Disposable gloves offer a high level of dexterity. If more protection is required, a heavier, more launderable pair of gloves can be worn over the disposable gloves.

Wood. Wood is used as a construction material to erect temporary containment structures. It is introduced into RCAs in the form of wooden pallets, scaffolding planks, and ladders. Wood also is used to support heavy objects being packaged for disposal to ensure that the objects do not shift in their packaging container during transport.

Tape. Tape serves many purposes within RCAs, such as to seal PPE. It is also used to fix plastic and paper contamination barriers in place.

HP Smears/Swipes. This material consists of filter paper and large "masslin" swipes used to monitor removable contamination levels within RCAs.

3.3.2. Noncombustible Waste Streams

Noncombustible materials make up ~28% of the total LLW produced at the Laboratory annually. Noncombustible LLW streams are defined in the following list.

Laboratory Equipment. This waste stream consists of a variety of laboratory equipment that is either outdated, no longer functional, or unusable. This waste stream consists of hot plates, furnaces, centrifuges, computers, and a variety of miscellaneous analytical instrumentation.

Building Service/Utility Equipment and Tools. This waste stream consists of a variety of work tools, as well as equipment used to provide basic facility services, such as pumps, ventilation units, and compressors. This equipment generally is removed during facility maintenance or upgrade activities.

Electronic Equipment. This waste stream consists of a variety of equipment, including computer equipment and miscellaneous laboratory and building services and utilities electronic equipment. This equipment is expensive to dispose of because it is difficult to characterize and because many of the components are classified as hazardous waste; therefore, this equipment must be either disposed of as MLLW or recycled.

Glassware. This waste stream consists of laboratory glassware that no longer can be used because it cannot be cleaned well enough to prevent the cross-contamination of samples.

3.3.3. Scrap Metal Waste Stream

Scrap Metal (380 m^3). This waste stream consists of a large variety of items, including structural steel, piping, sheet metal objects, laboratory furniture, gloveboxes, and other scrap metal items. Typically, the majority of this material is produced during facility upgrade activities.

3.4. Improvement Projects

The following projects were identified as potential corrective measures for the LLW type. These projects are divided into three categories: (1) projects completed in the last year, (2) projects currently funded and ongoing, and (3) unfunded proposed projects. Projects are characterized further by type: source reduction (SR), sort and segregate (SS), reuse/recycle (RR), treatment (T), or disposal (D).

3.4.1. Completed Projects

These projects have been completed and/or implemented in the last year. Many projects completed in previous years, especially sort and segregate and recycle/reuse projects, continue to avoid LLW.

Depleted Uranium (DU) Machining, Turning, and Chip Recycling (RR). The Engineering Sciences and Applications (ESA)-Division machine shops segregate DU machining operations from nonradioactive machining operations. After a DU machining operation is completed, the machining equipment is cleaned before nonradioactive machining operations begin. However, even with these precautions, discreet chips of DU periodically contaminate the clean machining chips and turnings, preventing their recycling as scrap metal. This project consists of constructing specialized survey equipment for monitoring this material and segregating any discreet chips of DU from the chips and turnings so that they can be recycled as scrap metal.

Real-Time Surface Contamination Monitor (SR). Much waste is produced when monitoring for tritium contamination at tritium facilities. Potentially contaminated surfaces are smeared with small, specialized cloth swabs. The swaps then are placed in 25-ml vials with scintillation cocktail for analysis. Thousands of these samples are processed annually. This project developed an instrument that will provide a direct reading of the surface contamination without the need to take samples for processing in the laboratory. Successful implementation of this device essentially will eliminate this waste stream.

RLWTF Influent Minimization Project (SR). It is estimated that at least 20% of the liquid LLW currently being discharged to the RLWTF could be eliminated. This project identified sources of waste that could be eliminated and recommended actions to eliminate these streams. In addition, two of the recommended actions were implemented, thus eliminating 3.5 million liters of influent annually to the RLWTF. This resulted in a 17.5% reduction in influent from an average of 20 million liters annually.

3.4.2. Ongoing Projects

These projects have been funded and are currently being executed. All of the ongoing LLW projects are funded by the Environmental Stewardship Office (ESO) Base and Generator Set-Aside Fee (GSAF) Program.

GIC (SS). It is estimated that 50% of the LLW stream is not contaminated. Through the use of acceptable knowledge and segregation techniques, a large portion of this waste stream can be eliminated. A verification facility with sophisticated counting instrumentation was established at TA-54 to perform verification surveys on waste segregated based on acceptable knowledge before it was disposed of as sanitary waste. In addition, sitewide implementation procedures were developed. The ESO still supports this project as part of its base program activities. Support consists of working with generators to define acceptable knowledge and segregation techniques better. In FY02, a GSAF project to enhance the throughput of the GIC waste verification facility from 50 to 100 m^3 annually. In addition, the ESO will perform a Green Zia tools analysis on this project to greatly enhance the Laboratory-wide implementation.

Metal Recycling (RR). This project consisted of setting up the infrastructure at the Laboratory to enable large-scale surveying and release of scrap metal leaving radiological areas at the Laboratory. Since its implementation, ~600 m^3/yr of scrap metal has been recycled. The ESO still provides technical assistance to generators to encourage and assist in this effort. Because of the metal recycling suspension imposed by the Secretary of Energy, this recycling activity is not currently being performed. However, if the Secretary lifts the suspension, the Laboratory will continue this recycling program in FY02. To prepare for this suspension, in FY02 a GSAF project to implement a sorting and segregation project for scrap metal leaving the LANSCE facility will be funded. This project will implement administrative controls to ensure that nonactivated metals are segregated from activated metals and to install verification equipment.

Launderable Product Substitution (SR). This project increases the use of launderable PPE at the Laboratory to eliminate disposable PPE. The ESO still is supporting this project as part of its base program to encourage the use of launderable wipes, mops, bags, and contamination barriers to eliminate further the use of disposable products. In FY02, a GSAF project to implement the use of launderables to minimize job control waste at TA-55 will be funded.

New Compactor Boxes (T). LLW is placed in 2-ft^3 cardboard boxes or large (96-ft^3 or 48-ft^3) steel waste containers for disposal. Large amounts of job control and other compactable waste are placed in the large steel containers because they are too large to fit in the small cardboard containers. These materials cannot be compacted. Use of the steel compactor boxes is not possible because BUS will not certify these boxes for transportation on a public highway. This project will design new compactor boxes that meet the transportation requirements so that these large materials can be compacted and the volume of the LLW stream reduced. In addition to meeting the transportation requirements, the new boxes will be designed to meet the security requirements (lockable) for TA-55. Once an initial supply of new boxes is purchased, a recharge system will be put in place to purchase additional boxes as needed.

It is estimated that at least an additional 100 m^3 of addition LLW could be compacted annually. This would eliminate ~75 m^3 of LLW disposal volume.

3.4.3. Project Development and Unfunded Projects

These projects either have been proposed or are under development to help reduce LLW. Proposed projects that currently are unfunded and projects under development are designated as such.

Verification of Scrap Metal Release Surveys (RR) (Unfunded). New requirements for performing release surveys for metal being recycled have been proposed by the Secretary of Energy, and a guidance document outlining these requirements has been prepared. The new guidance requires independent verification of the release survey protocol used by the Laboratory. The Laboratory has proposed using Storage Photostimulable Phosphor (SPP) technology to meet the independent verification requirements. SPP devices can be placed on scrap metal, exposed to alpha and beta radiation, and then read with a laser scanning device. A permanent record of the exposed material is maintained as part of the verification record and can be reviewed easily and documented by an independent verification team.

If these projects are implemented, the Laboratory expects to see a significant reduction in LLW next year. Because these projects address the routine LLW stream components, the effects will be seen there. Figure 3-7 illustrates how the routine hazardous waste stream would be affected by implementation of these projects.

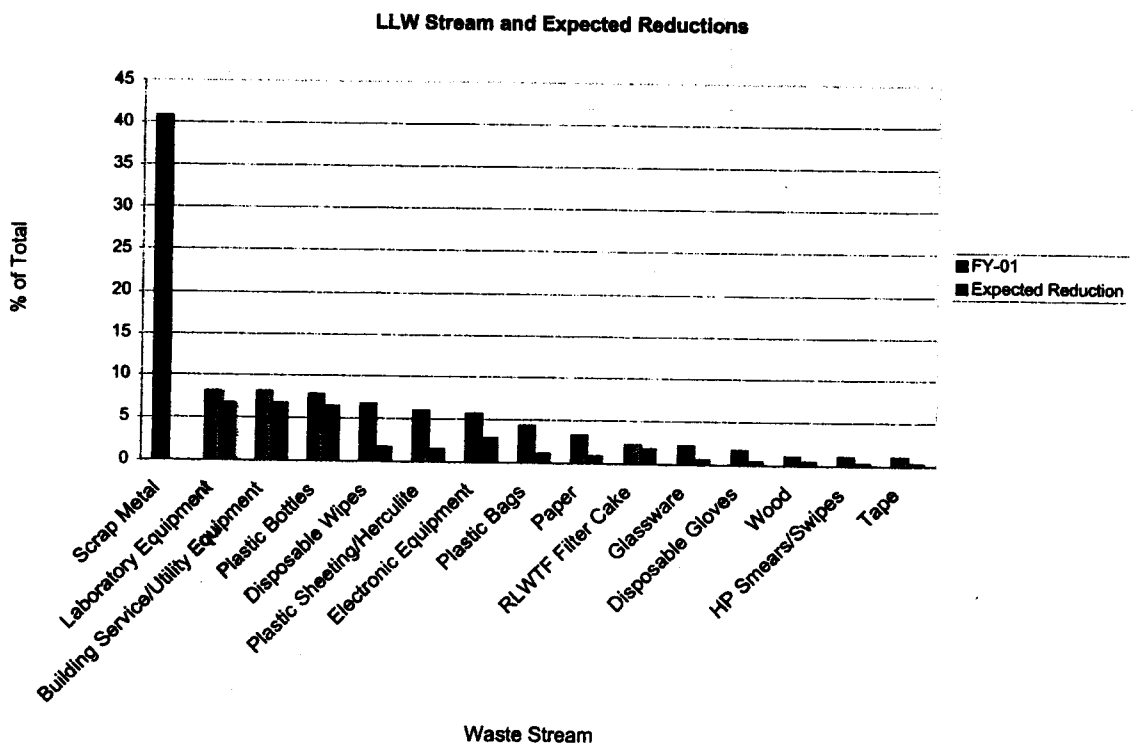

Fig. 3-7. LLW stream and expected reductions.

3.5. FY02 Performance Metrics

To ensure that they continue to exhibit outstanding improvement in meeting the Laboratory's waste minimization goals, the ESO has established performance metrics for the individual waste streams and other aspects of concern. These metrics will be used to measure performance throughout the year to measure success. A score of 3 has been established for each completed project having a significant impact on a waste stream. Scores between 1 and 2 are assigned to projects with minimum waste stream impact or to the completion of major milestones. The metrics in Table 3-2 have been developed for the LLW stream.

TABLE 3-2
LLW PERFORMANCE METRICS

Initiative (Score)	Comments
Perform a Green Zia Analysis of the GIC Project to Enhance Sitewide Implementation (1)	
Fully Implement GIC Sitewide (3)	80% implementation rate is considered sitewide
Implement the Use of Launderable Contamination Barriers Sitewide (3)	80% implementation rate is considered sitewide
Deploy Compactor Boxes to RCAs (3)	
Restart Metal Recycling Project (3)	Requires lifting of the suspension by the Secretary of Energy and implementation of new survey protocols

4.0. MIXED LOW-LEVEL WASTE

4.1. Introduction

For waste to be considered mixed (M) low-level waste (LLW), it must contain Resource Conservation and Recovery Act (RCRA) materials and meet the definition of radioactive LLW. LLW is defined as waste that is radioactive and is not classified as high-level waste (HLW), transuranic (TRU) waste, spent nuclear fuel, or by-product materials (e.g., uranium or thorium mill tailings). Test specimens of fissionable material irradiated only for research and development (R&D)and not for the production of power or plutonium may be classified as LLW, provided that the activity of TRU waste elements is <100 nCi/g of waste. Because MLLW contains radioactive components, it is regulated by Department of Energy (DOE) Order 435.1. Because it contains RCRA waste components, MLLW also is regulated by the State of New Mexico through Los Alamos National Laboratory's (the Laboratory's) operating permit, the Federal Facility Compliance Order/Site Treatment Plan (FFCO/STP) provided by the New Mexico Environment Department (NMED), and the Environmental Protection Agency (EPA). Materials in use that will be RCRA waste upon disposal are defined as hazardous materials.

Most of the Laboratory's routine MLLW results from stockpile stewardship and management and from R&D programs. Most of the nonroutine waste is generated by off-normal events such as spills in legacy-contaminated areas. Environmental restoration and waste management legacy operations, which also produce MLLW, are not included for the purposes of this roadmap. Typical MLLW items include contaminated lead-shielding bricks, R&D chemicals, spent solution from analytic chemistry operations, mercury cleanup-kit waste from broken fluorescent bulbs and mercury thermometers, circuit boards from electronic equipment removed from a TRU waste radiation area, discarded lead-lined gloveboxes, and some contaminated water removed from sumps.

Figure 4-1 shows the process map for MLLW generation at the Laboratory.

Total MLLW generation by division is shown in the pie chart in Fig. 4-2.

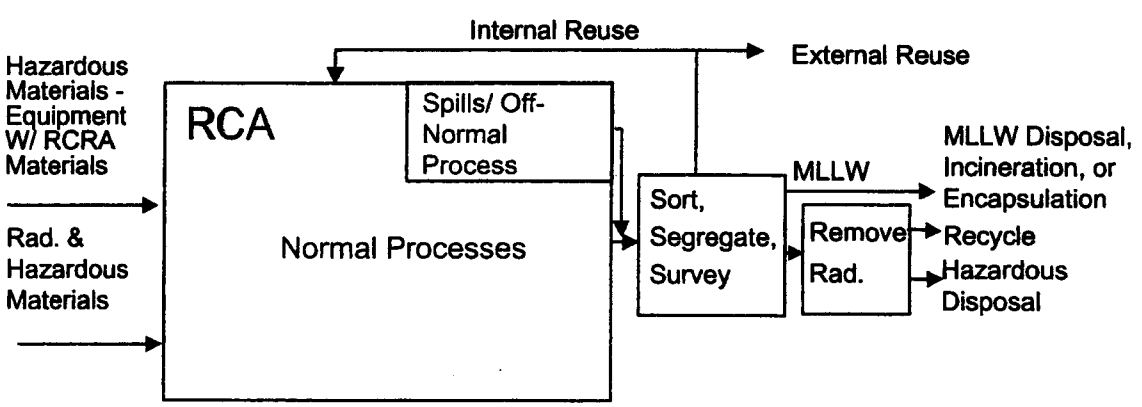

Fig. 4-1. Top-level MLLW process map.

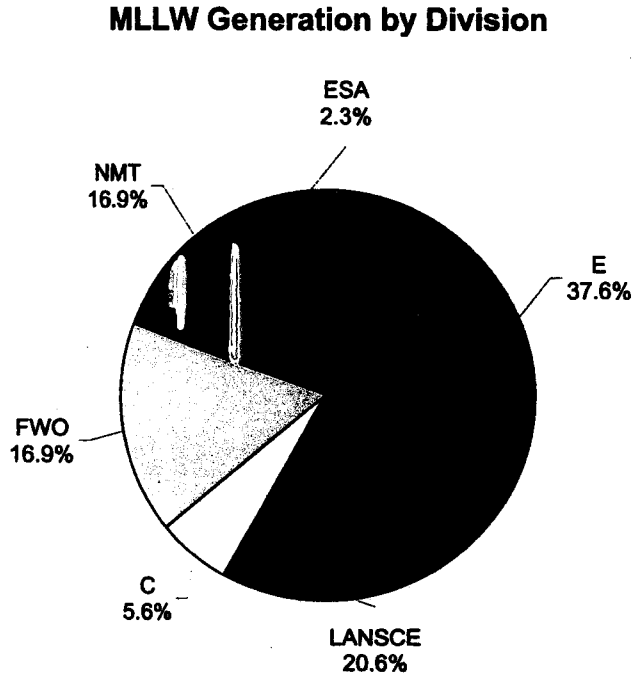

Fig. 4-2. Total MLLW generation by division.

Environmental Science and Waste Technology (E), Nuclear Materials Technology (NMT), Los Alamos Neutron Science Center (LANSCE), and Facility and Waste Operations (FWO) Divisions were the largest MLLW producers in fiscal year (FY) 01. The biggest contributor to E Division's waste volume was electronics from their sort-and-segregation activities [performed by the Environmental Technologies Group of the Environmental Science and Waste Technologies Division (E-ET)]. This sort-and-segregation activity is performed primarily for NMT and Chemistry (C) Divisions; the waste from this operation actually belongs to those divisions. The largest contributor to FWO waste volumes was nitric-acid bioassay waste left over from the nitrate destruction project at the Radioactive Liquid Waste Treatment Facility (RLWTF). This waste belonged to C Division before it was transferred to FWO Division. Mercury-contaminated debris from the drain system was the largest contributor to LANSCE-Division-generated volumes.

Routine MLLW generation by division is shown in the pie chart in Fig. 4-3.

E, NMT, C, and FWO Divisions were the largest routine MLLW producers in FY01. The largest contributor to E Division's waste volume was lead that could not be decontaminated. This lead was being decontaminated for other divisions. The largest contributor for NMT Division was lead solder in the copper joints and combustible debris from DOE Portsmouth. The major contributor for C Division was chemical and solvent waste, and the largest contributor for FWO Division was again nitric-acid waste from C-Division operations.

Routine and nonroutine MLLW generation is shown by year in Fig. 4-4.

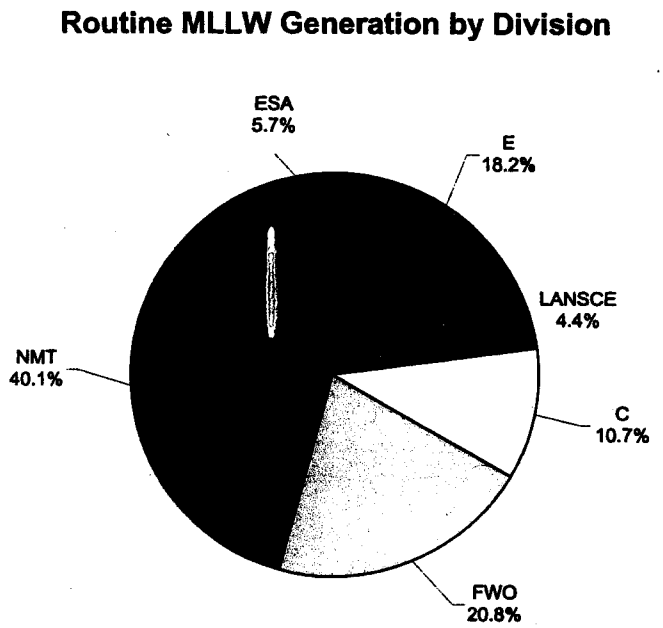

Fig. 4-3. Routine MLLW generation by division.

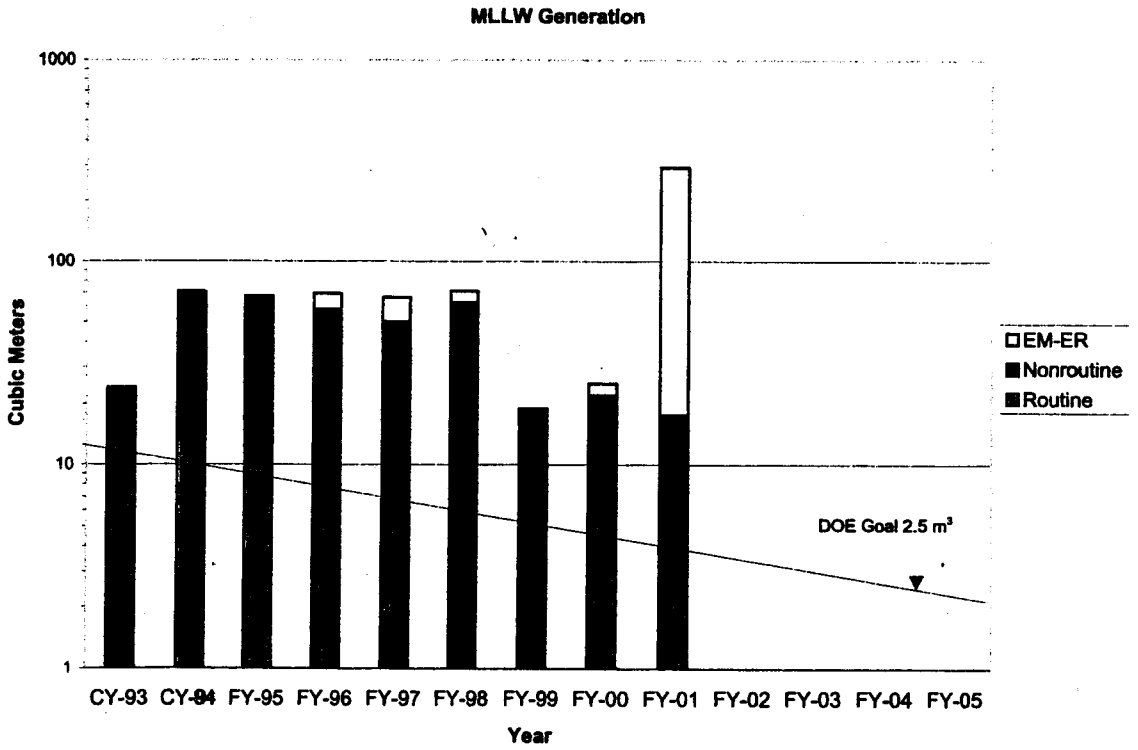

Fig. 4-4. Routine and nonroutine waste generation.

From FY94 to FY98, nonroutine MLLW has dominated the waste stream.

4.2. MLLW Minimization Performance

The DOE has implemented goals for waste minimization. The DOE-proposed MLLW goal is to reduce MLLW from routine operations by 80% by 2005 using calendar-year (CY)93 as the baseline. Because the MLLW generation in the baseline year was a low 12.3 m^3, the proposed DOE FY05 goal would be a very low 2.5 m^3. MLLW generation at the Laboratory is currently only ~5 m^3/yr. The Laboratory has proposed MLLW reduction projects that could reduce MLLW generation over the next 4 years. These projects include elimination of RCRA hazardous paint stripper, solidification of MLLW hydraulic oils, and improvements in chemical analysis processes. The Laboratory will continue to make every effort to reduce the MLLW generation to the lowest possible level consistent with funding and operational constraints.

Figure 4-5 shows the Laboratory's progress toward achieving this goal. For the past 3 years, the Laboratory has averaged ~5.75 m^3 of MLLW. The spike in waste generation of 7.45 m^3 that occurred in FY01 was caused by FY99 and FY00 waste that was placed in the Site Treatment Plan (STP) but not yet received at the disposal site at TA-54, Area G. All of this waste was added to the FY01 generation rate to avoid further complication of the waste accounting system. The actual FY01 generation was 4.39 m^3.

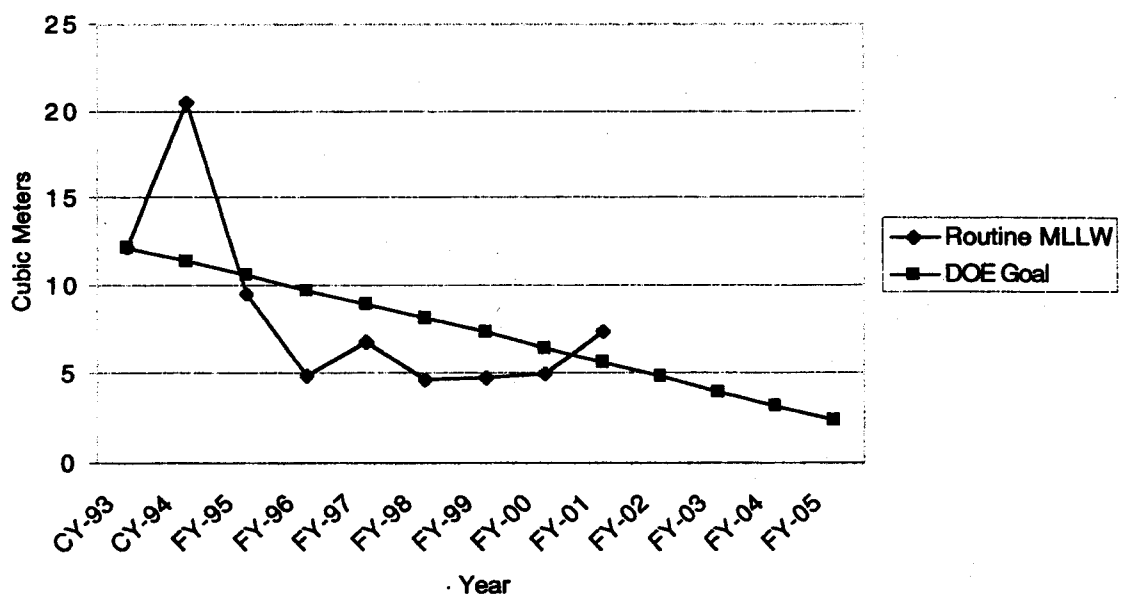

Fig. 4-5. Routine MLLW generation vs the DOE goal.

The FY02 Appendix F performance measure also requires Laboratory-wide implementation of waste minimization best practices. For MLLW minimization, these practices include

- implementing Green is Clean (GIC) in Laboratory radiological controlled areas (RCAs),
- neutralizing acids and bases where such action will make the waste non-RCRA, and
- replacing mercury thermometers and manometers in RCAs with mercury-free devices.

4.3. Waste Stream Analysis

MLLW is generated in RCAs. Hazardous materials and equipment containing RCRA materials, as well as MLLW materials, are introduced into the RCA as needed to accomplish specific activities. In the course of operations, hazardous materials become contaminated with LLW or become activated, becoming MLLW when the item is designated as waste.

Typically, MLLW is transferred to a satellite storage area after it is generated. Whenever possible, MLLW materials are surveyed to confirm the radiological contamination levels, and if decontamination will eliminate either the radiological or the hazardous component, materials are decontaminated and removed from the MLLW category.

Waste classified as MLLW is managed in accordance with appropriate waste management and Department of Transportation (DOT) requirements and shipped to TA-54.

From TA-54, MLLW is sent to commercial and DOE treatment and disposal facilities. The waste is treated/disposed of by various processes (e.g., segregation of hazardous components and macroencapsulation or incineration).

In some cases, the Laboratory procures spent MLLW materials from other DOE/commercial sites to avoid creating new MLLW. For example, LANSCE is designing several new beam stops and shutters from lead. Rather than fabricating these from uncontaminated lead, LANSCE can receive these parts at no expense from GTS Duratek (formerly SEG), a company that processes contaminated lead from naval nuclear reactor shielding. Duratek fabricates parts at no cost to the Laboratory because their fabrication costs are much less than those of MLLW lead disposal.

The largest waste streams are generated from one-time equipment removal operations, electronic components, and mercury-contaminated debris. These waste streams constitute ~50% of the MLLW waste type and are the primary targets for elimination. The waste streams were determined from the generation data for FY99 through FY01. The individual waste streams are listed in the following.

Electronic Equipment (5.83 m^3). This waste stream comprises circuit boards and other materials removed from electronic equipment containing lead.

Lead and Lead-Contaminated Debris (2.33 m^3). This waste stream comprises activated or surface-contaminated lead shielding, contaminated lead paint, and lead components. Lead normally is sent to Envirocare, Inc., for encapsulation and land disposal. Lead debris is contaminated copper pipe with lead solder joints, contaminated plastic sheets, duct tape, hoses, and used pump housings.

Mercury and Mercury-Contaminated Debris (1.75 m^3). This waste stream consists of elemental mercury and paper and plastic debris that has been contaminated with mercury.

Nitrate Waste (1.32 m^3). This waste stream consists of nitric acid used in Laboratory processes that is neutralized and disposed of. Previously, this waste stream was disposed of at the RLWTF. To meet new nitrate regulatory limits, the nitrate waste is being collected in carboys for off-site disposal.

Paint and Painting Debris (1.25 m^3).

Samples (1.10 m^3). MLLW samples are taken and analyzed routinely to determine radioactivity and hazardous constituent levels. This waste stream consists of the unused samples left over after the analytical procedures and treatability studies have been completed.

Copper-Pipe Solder Joints (0.87 m^3). This waste stream consists of copper piping and tubing with copper-pipe fitting joints soldered with lead-based solder. The Laboratory quit using lead-based solder some time ago. However, there is a legacy of this material present in the older facilities at the Laboratory.

Oil (0.75 m^3). This waste stream consists of oil removed from laboratory and facility machinery. Typically, the oil is contaminated with heavy metals from the bearings and other materials in the equipment. Laboratory vacuum pump oil also is typically contaminated with various laboratory solvents. This waste stream averages ~1 m^3 annually, although there are annual variances, depending on the month of generation.

Miscellaneous (0.40 m^3). This consists of contaminated water, decontamination fluids, unused commercial products, and other miscellaneous materials.

Asphalt (0.21 m^3).

Sump Cleanout (0.19 m^3).

The relative size of the various waste streams, expressed in per cent of total MLLW volume, is shown in Fig. 4-6.

The majority of waste produced from the electronics, lead/lead debris, mercury and mercury debris, copper-pipe solder joints, and fluorescent-light waste streams are legacy waste. Efforts to substitute alternatives and to improve sorting and segregation of these waste streams should reduce these volumes dramatically in the coming years. Nitrate waste, paint/paint debris waste, and oil wastes are ongoing waste streams for

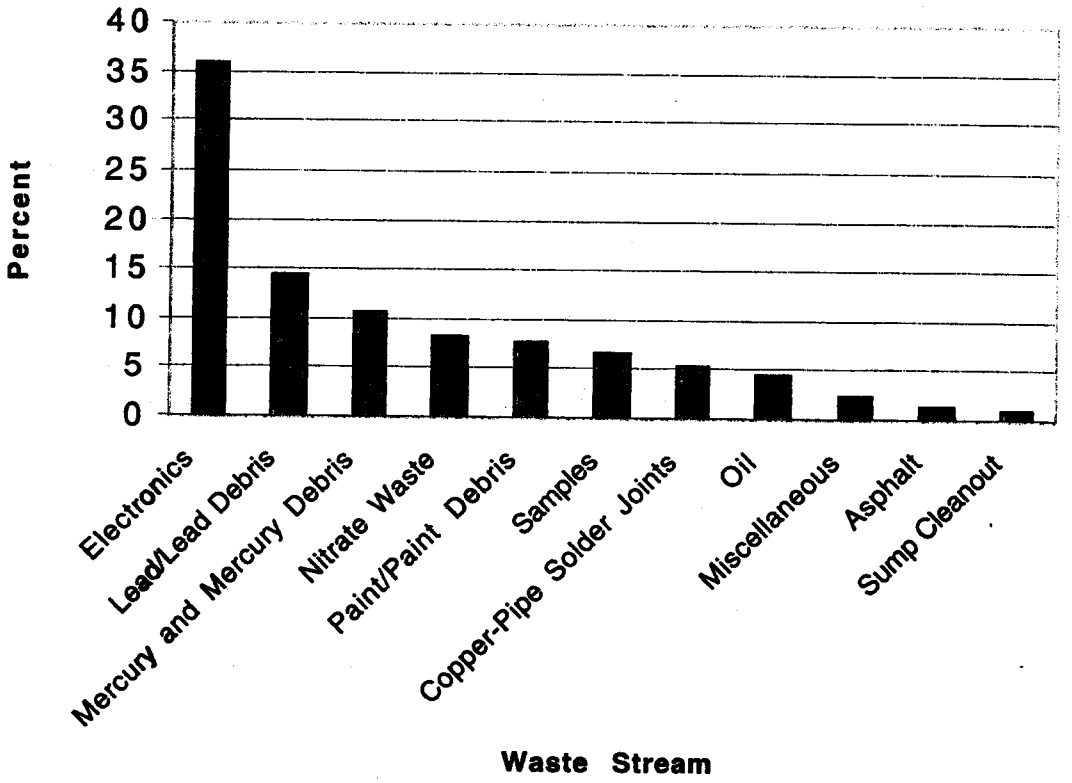

Fig. 4-6. Waste stream constituents.

which substantial improvement is possible. Improvement projects have been proposed that will lead to a reduction in MLLW. In the following sections, these projects are discussed.

MLLW cost an average of $36.85/kg to characterize, treat, and dispose of in FY01. Table 4-1 summarizes the Laboratory's typical unit costs for MLLW disposal. Waste is disposed of either by incineration or by macroencapsulation and land disposal. Macroencapsulation involves potting the waste (typically solid parts) in a suitable plastic and creating a barrier around the waste.

A small fraction of the MLLW generated has no disposal path. Typically, this waste is radiation-contaminated mercury or mercury compounds.

4.4. Improvement Projects

The following projects were identified as potential corrective measures for the MLLW type. These projects are divided into three categories: (1) projects completed in the last year, (2) projects currently funded and ongoing, and (3) unfunded proposed projects. Projects are characterized further by type: source reduction (SR), sort and segregate (SS), reuse/recycle (RR), treatment (T) or disposal (D).

TABLE 4-1
APPROXIMATE COSTS FOR MLLW STREAMS[4-1]

Waste Type	Treatment Method	Treatment and Disposal Cost	Transportation Cost
Activated or inseparable lead	Macroencapsulation	$15,000/m^3	$5000 per shipment
Surface-contaminated lead (for off-site recycling)	Standard decontamination methods (bead blasting, acid dip, etc.), followed by recycling	$8000/m^3	$5000 per shipment
RCRA waste-regulated solvents with radioactive components	Fuel recycling in Diversified Scientific Services, Inc. (DSSI)-permitted boiler	$19,815 to 52,840/m^3. Actual costs depend on levels of radionuclides, metal content, per cent water, and halogen content	$5000 per shipment
Activated RCRA waste components	Macroencapsulation	$15,000/m^3	$5000 per shipment
Fluorescent tubes with mercury	Amalgamation followed by landfill disposal	$105,900/m^3	$5000 per shipment
Printed circuit boards	Macroencapsulation	$15,000/m^3	$5000 per shipment

4.4.1. Completed Projects

These are projects that have been completed and/or implemented in the last year. Many projects completed in previous years, especially sort and segregate and recycle/resuse projects, continue to avoid MLLW.

Reduction of MLLW with Imaging Scanner (SR). Ion exchange and liquid scintillation are used to determine the ^{99}Tc chemical species in solution. These techniques have been replaced with paper chromatography using an imaging scanner to determine the distribution of ^{99}Tc on the paper chromatography strips, essentially eliminating this waste stream. This project has eliminated the generation of 0.05 m^3 of MLLW annually.

Mercury-Contaminated Radiation Waste Reduction (SS). This project evaluated the potential for segregation of mercury-contaminated debris during spill cleanup and other activities. The potential for segregation was determined by segregating and analyzing several actual mercury waste streams. This work was performed on actual waste during the performance of a mercury treatability study. The information clearly showed that personal protective equipment (PPE) and other paper and plastic wastes generated during cleanup activities were not contaminated and would pass toxicity-

characteristic-leaching-procedure (TCLP) testing. Based on these results, new sorting and segregation techniques will be deployed in FY02.

4.4.2. Ongoing Projects

These projects have been funded and currently are being executed. All of the ongoing MLLW projects are funded by the Environmental Stewardship Office (ESO) Base and Generator Set-Aside Fee (GSAF) Program.

Upgrade of Mercury Shutters (SR). The mercury beam shutters at the LANSCE facility are the major source of mercury-contaminated waste at the Laboratory. This project will redesign these shutters to eliminate this source of contamination.

LANSCE MLLW Reduction Project (SS). This project will implement the sorting and segregation techniques learned during the mercury-contaminated radiation waste reduction project performed during FY01.

Reduction of Perchlorate (SR). This project will evaluate the current aqueous waste streams discharging to the RLWTF to determine the best approach for reducing the quantity of perchlorates currently being discharged. It is unclear if the majority of perchlorates currently being discharged is the result of ongoing activities or is generated from the holdup of perchlorates in the effluent systems to the RLWTF.

Validation of New Chemical Oxygen Demand (COD) Test (SR). This project eliminates a no-path-forward mercury waste. Currently, a mercury reagent is used to perform COD analytical tests. This project will replace the mercury with manganese. After the EPA accepts the revised analytical method, the new method will eliminate the generation of 0.003 m^3/yr of MLLW.

Flat-Screen Monitors in RCAs (SR). Standard cathode ray tube (CRT) displays contain hazardous materials that, when contaminated in RCAs, become MLLW. About 100 CRT displays are removed from RCAs each year, and about 10% of these constitute ~3 m^3 of suspect MLLW. The balance is LLW. Flat-screen displays do not contain as much hazardous material (such as lead) as do CRTs. This replacement would eliminate one of the largest sources of contaminated electronics in the MLLW stream. In addition, the volume of a flat-screen monitor is about one-quarter of the volume of a CRT; thus, the volume of non-MLLW generated will be reduced. Waste avoidance after full deployment is estimated to be >1 m^3 of MLLW.

Oil-Free Vacuum Pumps (SR). This project is piloting the replacement of oil-filled vacuum pumps used in RCAs. Oil-free replacement pumps are being purchased. The use of these pumps will eliminate a significant amount of the MLLW oil produced at the Laboratory. Following this successful pilot, the use of oil-free vaccuum pumps in RCAs will be made a requirement. It is expected that when implemented sitewide, this project could eliminate up to 1 m^3 of MLLW annually.

Lead Reuse (RR). This project enables owners of unneeded, contaminated lead to identify, contact, and transfer that lead to projects that need it. In many cases, this avoids the need to either decontaminate or dispose of the lead.

Lead Removal from Gloveboxes (RR). Gloveboxes decontaminated to LLW levels are classified as MLLW because of the lead shielding present. This project funded the development of techniques to remove the lead and recycle the lead shielding. The lead from several gloveboxes was recycled as part of this project. This project will be incorporated into the Decontamination and Volume Reduction System (DVRS) in the future.

Sorting, Segregation, Recycle, and Reuse of Electronic Equipment (SS). Miscellaneous electronic equipment leaving RCAs is disassembled, and the individual components are surveyed. Those components that are nonradioactive are recycled. It is estimated that this project avoids up to 10 m^3 annually of MLLW generation.

Sorting, Segregation, Recycle, and Reuse of Miscellaneous Equipment from RCAs (SS). Equipment or materials (copper pipe with lead solder joints) are disassembled and surveyed. Materials that can be determined as nonradioactive are recycled. The ESO continues to support this project as part of its Base program activities.

Nitrate Bioassay Diversion Projects (SS). Nitric-acid waste currently generated by the bioassay laboratories must be disposed of as MLLW. This project allows this waste to be neutralized and, because of its extremely low level of radioactivity, diverted to the sanitary wastewater treatment facility.

Oil Solidification (T). Contamination of oils with radioisotopes is a common problem in RCAs. These oils become MLLW and must be disposed of as such. Recent tests, using the NoChar solidification media developed at Mound Laboratory, indicate that if the oil is solidified with this product, the oil would pass TCLP testing and could be buried as LLW, saving substantial waste disposal costs. This project is providing the data necessary to adopt and use this technology for routine management of contaminated oil wastes. When implemented, it is estimated that this process will eliminate up to 0.75 m^3 of MLLW generation annually.

4.4.3. Project Development and Unfunded Projects

These projects either have been proposed or are under development to help reduce MLLW. Proposed projects that are currently unfunded and projects under development are designated as such.

Improved Plutonium and Americium Analytical Methods for Environmental Matrices (SR) (Unfunded). Current methods for radioisotopic analyses of plutonium and americium in soil and water samples by alpha spectrometry performed by the Isotope and Nuclear Chemistry Group in the Chemistry Division (C-INC) were largely developed 15 or more years ago. Several modifications to the digestion, separation, electroplating, and counting steps of these methods, which should significantly improve the overall analyses, have been proposed. For soils, the aliquot size will be reduced from 10 to 5 g, and count length will be increased from 22 to 50 hours to maintain the current level of sensitivity of 0.002 pCi/g soil. For water samples, the current sample size will be maintained but the count length will be increased to 50 hours, resulting in improved sensitivity. Operational benefits include a reduction in both liquid waste discharges and airborne emissions, improvements in operational efficiency, reductions in the cost and time required to complete the analyses, reduced

exposure to hazardous chemicals to workers, and simplification of operations. These benefits will extend to future years.

Reduction of Total Nitrate-Containing Waste in Sample Coprecipitation Methods (SR) (Unfunded). This project proposes a modification of current methods to reduce the production of total nitrate waste in the urine bioassay for uranium and americium. Modifications in the precipitation and ion exchange steps may result in the elimination of ~70% of the total nitrates produced by the current process. New ion exchange technology has yielded a class of resins that requires much smaller volumes and a lower concentration of acids. Precision or accuracy of the data produced by these new technologies is unchanged. Changes in coprecipitation and the use of these new resins could reduce the total nitrates produced in this preliminary step. Added benefits include a reduction in both liquid waste discharges and airborne emissions, improvements in operational efficiency, reductions in cost and time required to complete the analyses, reduced exposure of hazardous chemicals to workers, and simplification of operations.

Reduction of Perchlorate Use in Environmental Radioanalytical Methods (SR) (Unfunded). The Analytical Chemistry Sciences Group (C-ACS) provides radioanalytical support for a wide variety of programs throughout the Laboratory. Of all the analytical methods currently in use, only one remaining program still utilizes concentrated (67% to 71%) perchloric acid as part of the analytical process. Using the acid has the following two functions: (1) in conjunction with concentrated HNO_3, the mixture is used to destroy and oxidize any remaining organic substances within the samples and (2) the addition of perchloric acid allows for the modification of the oxidation state that is needed to prepare the sample. With the new anion exchange resins commercially available today, along with the use of alternative methods for the destruction of residual organic materials, we believe that alternative methods can be developed that would remove the use of perchloric acid from the analytical process. On an average year, the Laboratory processes approximately 300 to 350 samples that require the use of this particular method. If an alternative method could be developed that would process the samples without the use of perchloric acid, the reduction would equate to (at 350 samples/year) ~3.50 liters. Modifying the method also would eliminate using a variety of other organic solvents (e.g., HDEHP and Dodecane) that are currently part of the liquid/liquid extraction methodology, thus removing a mixed waste component.

Lifetime Monitoring of Suspect Clean Materials (SS) (Unfunded). Much of the equipment that is used in RCAs is uncontaminated but must be surveyed before it can be declared nonradioactive under DOE Order 5400.5. The survey usually requires dismantling the equipment. This project will develop techniques for *in situ*, lifetime monitoring of equipment in RCAs. Many options exist for accomplishing this, but a protocol will be required to certify the accuracy of the monitoring techniques. The project will focus initially on the use of adhesives to collect radioactive materials. Other approaches are possible. A qualification program will be needed to verify that the selected rapid survey technique accurately represents the degree of contamination over time.

MLLW Aqueous Waste Stream Dose Assessment (SS) (Unfunded). A standard does not exist to release aqueous waste streams from radiological areas. Drinking-water limits exist for aqueous discharges to the environment, but no similar limits exist for hazardous aqueous waste streams being shipped to an MLLW treatment facility. If such a limit existed, many of our current MLLW streams could be classified as hazardous waste and the cost of treatment could be substantially reduced. This project will supply the funds necessary to perform a dose assessment to define release limits for this waste stream. The dose assessment will be prepared and submitted to the DOE Office of Environment, Safety, and Health (DOE-EH) for approval.

Improved Alpha Contamination Monitoring (SS) (Development). Many of the items in the MLLW stream are present because an accurate means of monitoring the alpha contamination levels is not available. This is especially true for circuit boards and copper-pipe solder joints having areas that are inaccessible to standard survey instrumentation. It is estimated that a more effective survey method could reduce the MLLW stream by as much as 1 m^3 annually.

Mercury Amalgamation (T) (Development). The Laboratory does not use the treatment standard for disposal of elemental mercury, i.e., amalgamation. The Laboratory adds elemental mercury to the debris collected during spill cleanup activities, although it is much more cost effective to amalgamate the elemental mercury so that it can be handled as a non-RCRA waste. Mercury spills generated in radiological areas generate MLLW, which frequently has no path to disposal; disposal also is very expensive when it is an available option. This project would develop suitable methods to collect and amalgamate elemental mercury during spill cleanup activities and avoid the generation of this MLLW stream.

If these projects are implemented, the Laboratory expects to see a significant reduction in MLLW next year. Because these projects address the routine MLLW stream components, the effects will be seen there. Figure 4-7 illustrates how the routine MLLW waste stream would be affected by implementation of these projects.

4.5. FY02 Performance Metrics

To ensure that the Laboratory continues to exhibit outstanding improvement in meeting the Laboratory's waste minimization goals, the ESO has established performance metrics for the individual waste streams and other aspects of concern. These metrics will be used to measure performance throughout the year to measure success. A score of 3 has been established for each completed project having a significant impact on a waste stream. Scores between 1 and 2 are assigned to projects with minimum waste stream impact or to the completion of major milestones. The metrics in Table 4-2 have been developed for the MLLW stream.

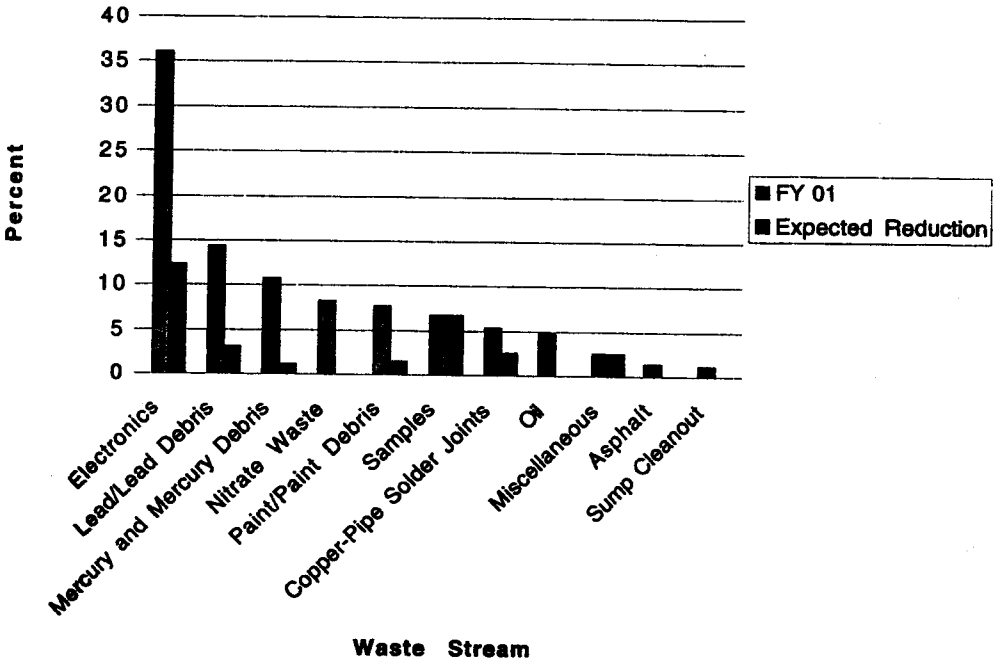

Fig. 4-7. MLLW stream and expected reductions.

TABLE 4-2
MLLW PERFORMANCE METRICS

Initiative (Score)	Comments
Complete Nitrate Bioassay Diversion Project (3)	This project will eliminate 1.32 m^3 of MLLW generated annually.
Complete Oil Solidification Project (3)	Although not present in this year's data, this stream averages 0.75 m^3 annually. This project will eliminate this waste stream.
Complete new Mercury Shutter Design (1)	
Obtain funding for FY03 Mercury Shutter Project (1)	$150K needed.
Complete LANSCE MLLW Reduction Project (3)	
Complete development and obtain funding for mercury amalgamation in <90-day-storage areas (1)	Legacy issues will continue to produce elemental mercury waste streams. These nonroutine waste streams average ~1 m^3 annually. If successful, this project will eliminate the majority of this waste.
Complete validation of new COD test (1)	This project will eliminate the generation of 0.003 m^3 of no-path-forward MLLW.
Complete development and obtain funding for improved alpha-contamination-monitoring instrumentation (1)	This project is technically difficult, and the potential for success is unknown at this time. However, if successful, it is estimated that improved monitoring could eliminate 1 m^3 of MLLW annually.

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4-1. John Kelly, Los Alamos National Laboratory, personal communication, November 2, 2000.

5.0. HAZARDOUS WASTE

5.1. Introduction

Hazardous waste is divided into three waste types: Resource Conservation and Recovery Act (RCRA) waste, Toxic Substances Control Act (TSCA) waste, and State special solid waste. For purposes of reporting the waste minimization University of California (UC) Contract (Appendix F, performance measure), Los Alamos National Laboratory (the Laboratory) distinguishes between routine and nonroutine waste generation. Routine generation results from production, analytical, and/or other research and development (R&D) laboratory operations; treatment, storage, and disposal operations; and "work for others" or any other periodic and recurring work that is considered ongoing. Nonroutine waste is cleanup stabilization waste and relates mostly to the legacy from previous site operations.

The RCRA and 40 Code of Federal Regulations (CFR) 261.3, as adopted by the New Mexico Environment Department (NMED), define hazardous waste as any solid waste that

- is generally hazardous if not specifically excluded from regulation as a hazardous waste;
- is listed in the regulations as a hazardous waste;
- exhibits any of the defined characteristics of hazardous waste (i.e., ignitability, corrosivity, reactivity, or toxicity); or
- is a mixture of solid and hazardous waste.

Hazardous waste also includes substances regulated under the TSCA, such as polychlorinated biphenyls (PCBs) and asbestos.

Finally, a material is hazardous if it is regulated as a special waste by the State of New Mexico as required by the New Mexico Solid Waste Act of 1990 (State of New Mexico) and defined by the most recent New Mexico Solid Waste Management Regulations, 20NMAC 9.1 (NMED) or current revisions. This determination includes the following types of solid wastes that have unique handling, transportation, or disposal requirements to ensure protection of the environment and the public health, welfare, and safety:

- treated formerly characteristic hazardous (TFCH) wastes;
- packing house and killing plant offal;
- asbestos waste;
- ash;
- infectious waste;
- sludge (except compost, which meets the provisions of 40 CFR 503);
- industrial solid waste;
- spill of a chemical substance or commercial product;

- dry chemicals that, when wetted, become characteristically hazardous; and
- petroleum-contaminated soils.

Hazardous waste commonly generated at the Laboratory includes many types of laboratory research chemicals, solvents, acids, bases, carcinogens, compressed gases, metals, and other solid waste contaminated with hazardous waste. This waste may include equipment, containers, structures, and other items that are intended for disposal and are contaminated with hazardous waste (e.g., compressed gas cylinders). Also included are asbestos waste from the abatement program, wastes from removal of PCB components, contaminated soils, and contaminated waste waters that cannot be sent to the sanitary wastewater system (SWS)s consolidation (SWSC) or high-explosives (HE) wastewater treatment plants.

Most hazardous wastes are disposed of through Duratek Federal Services, a Laboratory subcontractor. This company sends waste to permitted treatment, storage, or treatment storage disposal facilities (TSDFs), recyclers, energy recovery facilities for fuel blending or burning for British-thermal-unit recovery, or other licensed vendors (as in the case of mercury recovery). The treatment and disposal fees are charged back to the Laboratory at commercial rates specific to the treatment and disposal circumstance. The actual cost varies with the circumstances; however, the average cost for onsite waste handling by solid waste operation (SWO) and offsite disposal is $5.92/kg.

Figure 5-1 shows the process map for hazardous waste generation at the Laboratory.

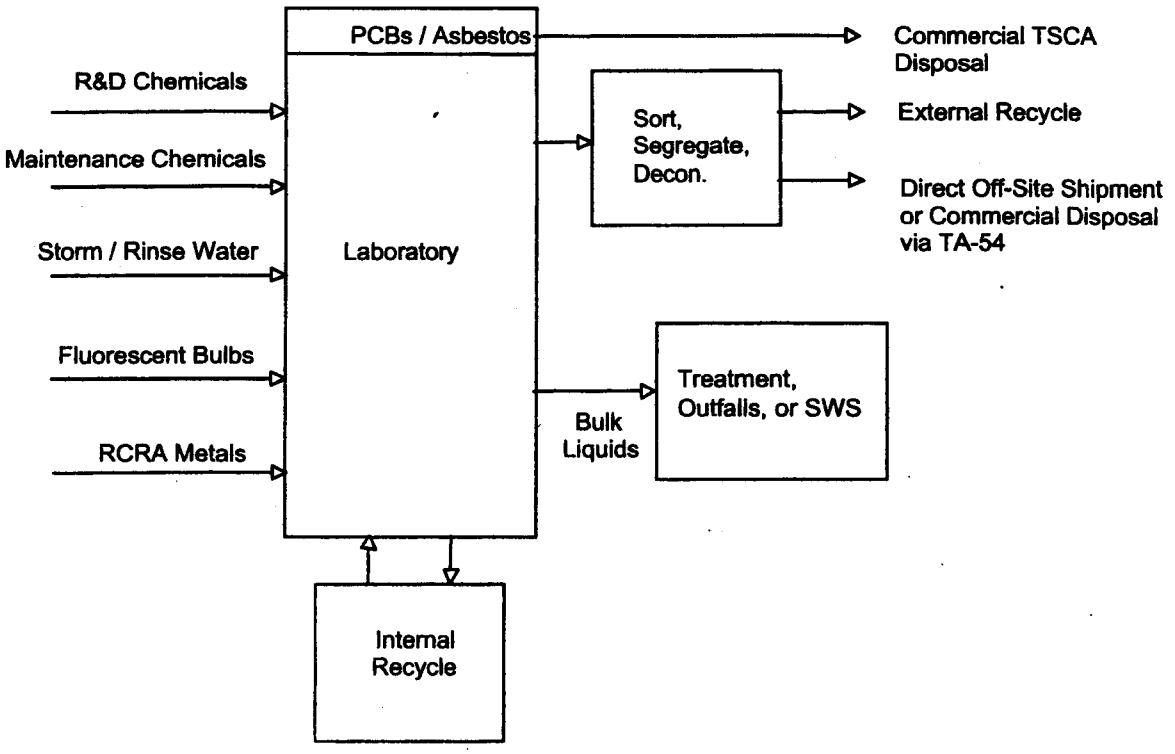

Fig. 5-1. Hazardous waste process map.

The total quantity of hazardous waste generated at the Laboratory during the past 5 fiscal years (FYs) is shown in Fig. 5-2. The waste quantities shown include routine, nonroutine, and environmental-restoration (ER)-generated waste.

The large volumes of environmental management (EM)-ER-generated hazardous waste in FY00 and 01 resulted from remediation activities. Nearly all of the EM-ER hazardous waste derives from projects in which large amounts of potentially contaminated soil and sod were removed. Routine hazardous waste decreased abruptly from FY99 to FY00 because the Laboratory began excluding recycled hazardous waste from the hazardous waste total. Routine hazardous waste generation unexpectedly increased in FY01 for several reasons, all of which are discussed in Section 5.2 (Hazardous Waste Minimization Performance).

As previously discussed, the Laboratory produces three types of hazardous waste: RCRA waste, TSCA waste, and New Mexico Special waste. The quantity of each type of waste, along with the quantity of recycled waste, is shown in Fig. 5-3. The waste shown in the figure excludes EM-ER-generated waste.

The total (routine and nonroutine) hazardous waste generation by division, excluding EM-ER, is shown in the pie chart in Fig. 5-4.

Johnson Controls Northern New Mexico (JCNNM), the Laboratory's crafts support contractor, generated the most hazardous waste, followed by the Facility and Waste Operations (FWO) Division and the Environment, Safety, and Health (ESH) Division. JCNNM waste results primarily from support of Laboratory operating divisions and special cleanups (e.g., the Cerro Grande Fire recovery effort).

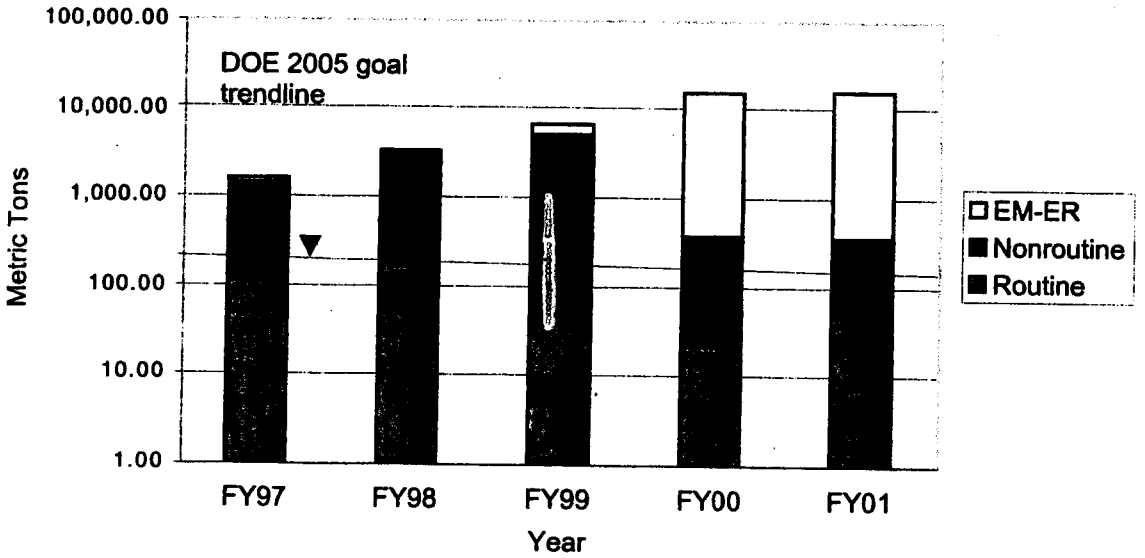

Fig. 5-2. Hazardous waste generation for FY97 through FY01.

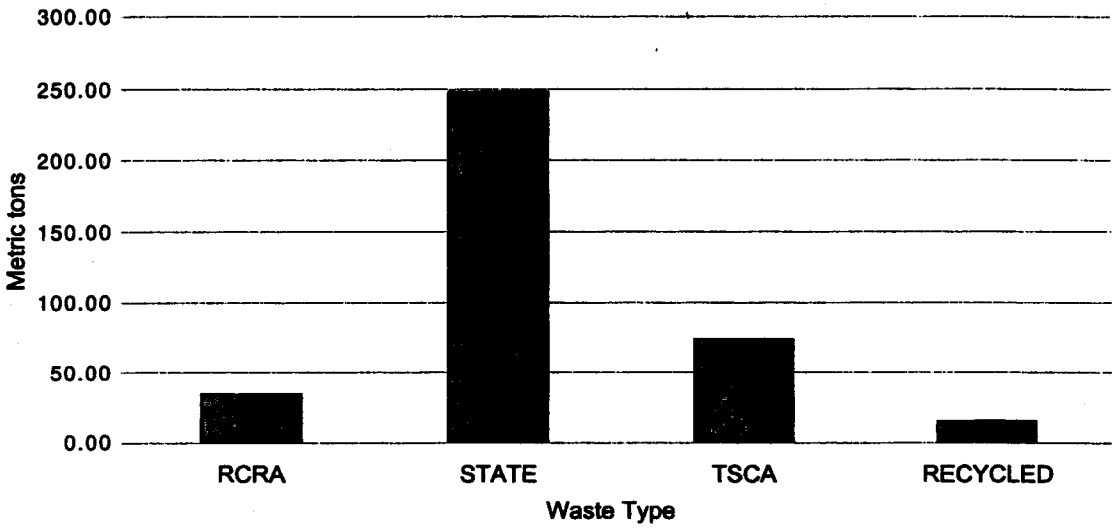

Fig. 5-3. FY01 hazardous waste by type.

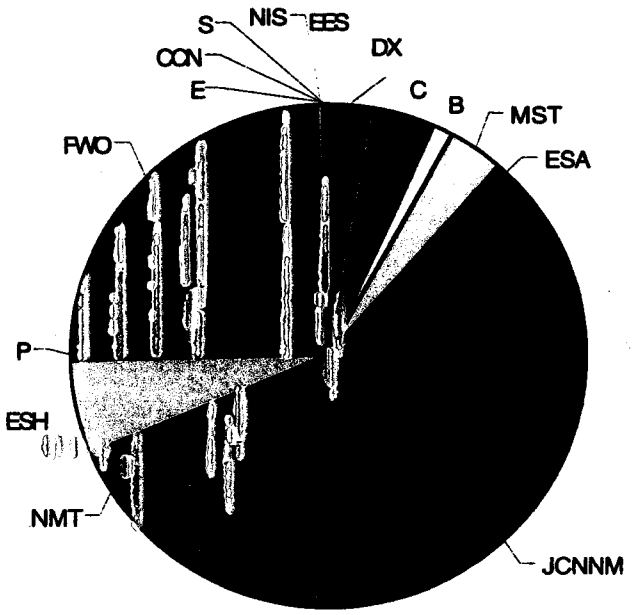

Fig. 5-4. The total hazardous waste by division, which excludes EM-ER waste.

The organizations that produced the most routine hazardous waste in FY01 were the Dynamic Experimentation (DX), Chemistry (C), and Bioscience (B) Divisions. The routine hazardous waste generation by division is shown in Fig. 5-5.

Additional information on hazardous waste, Laboratory procedures for managing hazardous waste, and historical waste generation can be found in Refs. 5-1 through 5-5.

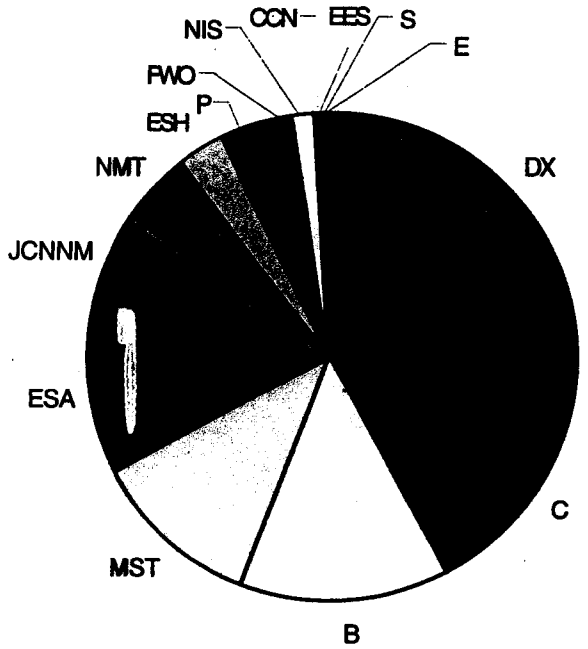

Fig. 5-5. Routine hazardous waste by division, which excludes EM-ER waste.

5.2. Hazardous Waste Minimization Performance

In a November 12, 1999, memorandum, the Secretary of Energy established a 2005 goal to reduce hazardous waste from routine operations by 90%, using a calendar year (CY) 1993 baseline. The Laboratory's CY93 baseline quantity was 307,000 kg; therefore, the FY05 target becomes 31,000 kg.

The FY01 performance measure in the UC contract, Appendix F for hazardous waste was more restrictive than the DOE 2005 goal because it required the Laboratory to generate no more than the FY00 quantity of hazardous waste, or 22,183 kg.

Although the trend over the last several years has been very good, the Laboratory is projected to dispose of 48,652 kg (48.6 tonnes) of hazardous waste in FY01 and is now above the FY05 goal. In addition, the Laboratory failed to stay below the FY00 hazardous waste generation rate as required by the FY01, Appendix F performance measure. The Laboratory's performance in hazardous waste generation is shown in Fig. 5-6.

A major factor in increased hazardous waste generation was the disposal of hazardous wastes in FY01 that have been recycled in the past. Approximately 10,250 kg of hazardous waste that could have been recycled was instead sent off-site for disposal. This action resulted from a conflict between the Laboratory's Appendix F performance measure for hazardous waste minimization and the waste management performance measure to process waste as quickly and cost effectively as possible. The cost to recycle

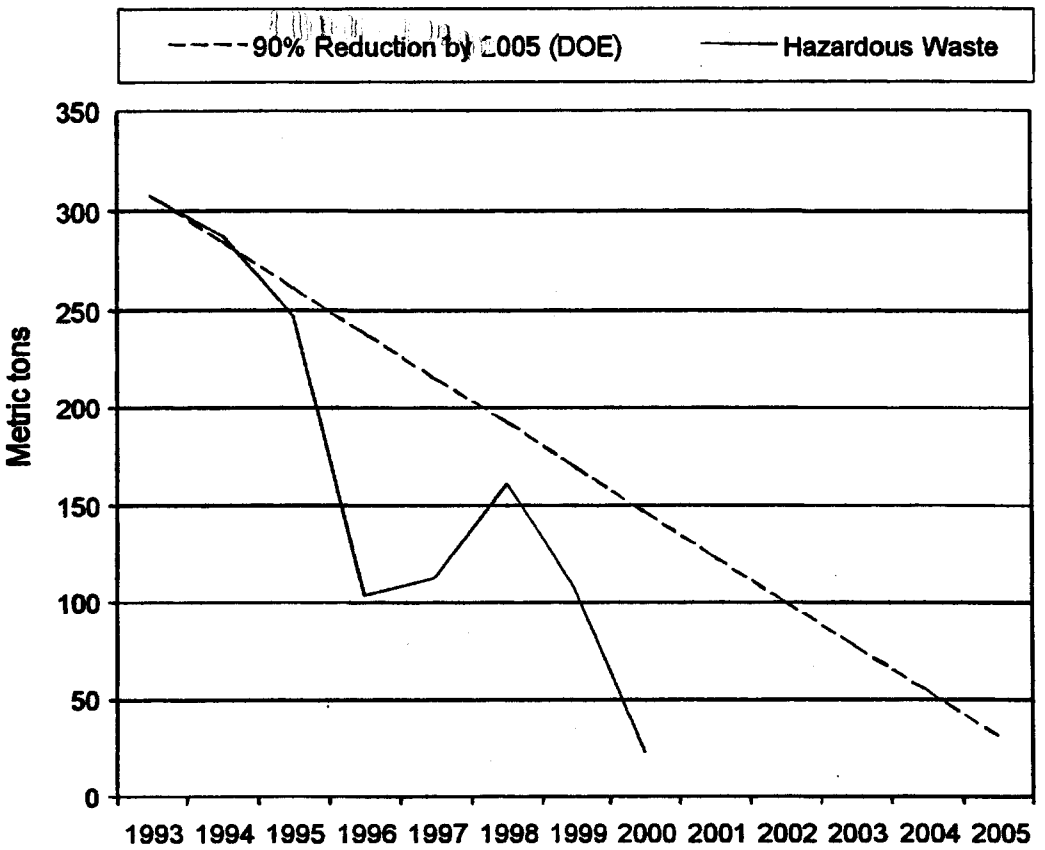

Fig. 5-6. Routine hazardous waste generation compared with the DOE's FY05 goal.

waste is currently higher than the cost to dispose of it. In addition, spent materials to be recycled frequently must be accumulated until there is a full truckload. Thus, disposal was chosen over recycling. This issue has been resolved, and wastes that can be recycked will be recycled in the future.

It is estimated that 15,000 kg of unused, unspent chemicals will be disposed of in FY01, as compared with 8000 kg in FY00. This increase is attributed to a continuing emphasis on reducing chemical inventories and to NMED interest in chemical stores during a recent RCRA audit. Also, a Green Zia tools analysis of chemical practices at TA-48, RC-1 stimulated over 3000 kg of additional unused/unspent chemical disposal.

5.3. Waste Stream Analysis

Hazardous waste is derived from hazardous materials/chemicals purchased, used, and disposed of; hazardous materials already resident at the Laboratory that are disposed of as part of equipment replacement, facility replacement, or facility decommissioning; and water contaminated with hazardous materials. After it is declared waste, hazardous waste is described (assayed if necessary), labeled, and collected at less-than-90-day storage areas. This waste then is either directly shipped to off-site TSDFs or transshipped to Area L, TA-54, from which it will be subsequently shipped to an off-site TSD. ER project waste typically is shipped directly from ER sites to commercial TSDFs.

Spent research and production chemicals make up the largest number of hazardous waste items; however, they account for only a small fraction of total hazardous waste volume. The ER project is the largest hazardous waste generator on-site, accounting for over 95% of all hazardous waste. The Laboratory spent a total of $6,500,000 managing newly generated hazardous waste in FY01.

The largest waste streams in the hazardous waste category for FY01 are described in the following list. These wastes are treated/disposed of off-site. This list includes both routine and nonroutine wastes but excludes EM-ER wastes. The Laboratory also has high explosives (HEs) and HE water wastes that are treated on site; these are not included below.

Sludge from the Sanitary Waste Plant (137,601 kg). In CY95, the Laboratory's grit screenings contained one sample that exceeded the regulatory limit for PCBs. Since then, sanitary sewage sludge has been disposed of as TSCA waste. The largest single constituent of the TSCA hazardous waste type is the PCB-contaminated sanitary sludge. In FY00, the Laboratory cleaned the PCB-contaminated drains and, because the Laboratory has not had another high-PCB event in the sanitary sludge, it received Environmental Protection Agency (EPA) approval to no longer treat the sludge as a TSCA waste. The EPA and NMED require that this waste be disposed of at an industrial landfill and that it not be allowed to be used as a soil amendment.

Cerro Grande Fire Debris (54,432 kg). This waste is contaminated debris from the Cerro Grande fire.

Oil, Petroleum, and Petroleum Contaminated Materials (42,762 kg). This waste stream is composed of both routine and nonroutine oil- or petroleum-contaminated materials. Approximately 91% of this waste stream is nonroutine legacy materials.

Asbestos (26,463 kg). All of the asbestos waste stream is TSCA waste and as such is nonroutine. The asbestos is almost exclusively in friable form.

Various Liquids (10,607 kg). This nonroutine waste stream is composed of contaminated rainwater and various unspecified contaminated liquids derived from EM-ER sites.

Unused/ Unspent Chemicals (14,850 kg). This waste stream is by far the largest routine waste stream for FY01 and constitutes more than 30% of the total routine hazardous waste disposed. It consists primarily of unopened or unused research and production chemicals, many in their original containers.

Ferric Chloride (4034 kg). This waste stream is composed of ferric chloride etchant used largely in production operations.

Corrosives (2905 kg). Large quantities of unneutralized acids and bases are disposed of each year at the Laboratory. These are primarily spent chemicals and consist mostly of sodium hydroxide and nitric acid.

Photochemicals (2233 kg). The Laboratory still operates several wet photographic processes. These processes generate waste in the form of spent fixers, developers, and silver-contaminated fluids or other items. Normally, these are recycled.

Commercial Products (1818 kg). The Laboratory routinely disposes of both used and unused industrial products, such as cleaners, strippers, rust inhibitors, and detergents.

Other (1784 kg). This waste stream consists primarily of laboratory trash, used glassware, other used containers, and spent equipment and components contaminated with hazardous materials, such as high-efficiency particulate air filter (HEPA) filters.

Ash (1739 kg). A persistent component of the hazardous waste stream is ash collected from the various Laboratory burn grounds.

Solvents (1170 kg). Solvents are widely used at the Laboratory in research, maintenance, and production operations. They constitute the single largest number of items sent for disposal each year and are persistent year-to-year.

Acetonitrile (1100 kg). This hazardous substance is used in the synthesis of nucleo-peptides. Because of program growth, the Laboratory expects to double the amount of waste generated next year.

Electoplating Fluids (888 kg). Electroplating is required, both for production and research operations. Most electroplating chemicals are continuously recycled; this waste constitutes the small residue that is disposed of.

Biomedical Waste (273 kg). This waste stream consists primarily of blood, blood-contaminated items, and used sharps.

Mercury (132 kg). Mercury waste is generated primarily from breakage of mercury-containing laboratory instruments and mercury spills. The 13 largest waste streams in the routine hazardous waste category for FY01 are shown in Fig. 5-7.

The waste streams are shown as a percent of total hazardous waste in Fig. 5-7. This chart excludes EM-ER waste and sanitary sludge with legacy contamination. Such wastes also were excluded from the calculation of percentages.

5.4. Improvement Projects

The following projects were identified as potential corrective measures for the hazardous waste type. These projects are divided into three categories: (1) projects completed in the last year, (2) projects currently funded and ongoing, and (3) proposed projects that are unfunded. Projects are characterized further by type: source reduction (SR), sort and segregate (SS), reuse/recycle (RR), treatment (T), or disposal (D).

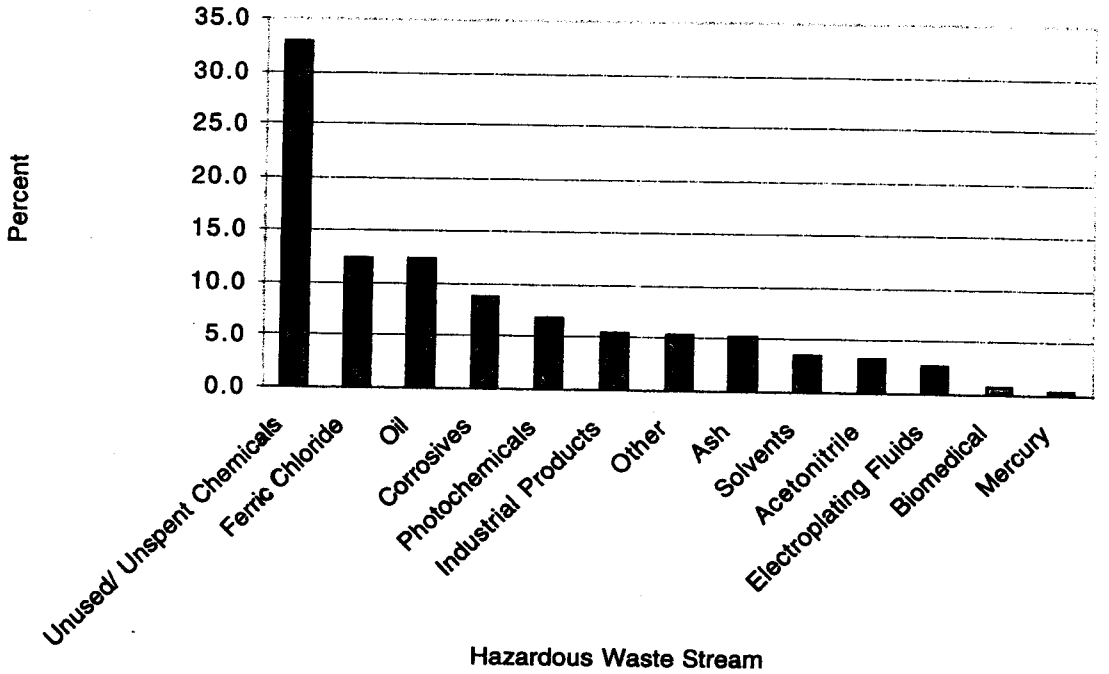

Fig. 5-7. FY01 routine hazardous waste streams.

5.4.1. Completed Projects

These projects have been completed and/or implemented in the last year.

Phosphor Scanner (SR). DX-3 has procured and is installing a large-format phosphor scanner that enables two large phosphor screens to replace photographic film in explosive hydrotest radiographs. By switching to the phosphor screens, DX-3 saves over $50,000 annually from reduced waste disposal, lower equipment costs, and labor. Approximately 450 gallons of spent photochemicals per year is no longer generated, and the administrative activities associated with storing, characterizing, documenting, and disposing of this waste have been eliminated. The film development area is being remodeled for other use.

Nonoperational Wastewater Sumps Eliminated (SR). Eight sumps at TA-9 (DX-1) have been capped and protected so that they no longer fill with rainwater that must be treated at the HE wastewater treatment plant. This process will avoid 40,000 gallons of HE wastewater. It also avoids the risk of sump overflow and release of contaminated water to the environment. This work was conducted by the IT Corporation under the direction of DX-1 and the ER Project.

Neutralize Radioactive Liquid Waste. Printed circuit fabrication at the detonator production facility generates 2000 kg of caustic hazardous waste annually. The Radioactive Liquid Waste Treatment Facility (RLWTF) will neutralize its acidic influent with the caustic stripper solution.

Sanitary Sewage Grit Screenings (SR). PCB-contaminated drains in the Sigma facility were cleaned to regulatorily prescribed levels as a corrective action for PCB contamination found in the SWSC plant screening grit.

Machine Coolant Recycle (RR). The MST-6 and ESA main machine shops have installed coolant filtration and management systems that achieve a tenfold-to-one-hundred-fold increase in coolant lifetime.

HE Waste Water Reduction (SR). DX-2 replaced handwashing of glassware with industrial dishwashers that use less water.

Nonhazardous Ink Plotter (SR). JCNNM replaced a plotter using hazardous inks with a dry-ink model.

Biowaste Autoclaving (T). B Division routinely autoclaves all biomedical waste so that it can be disposed of at the sanitary landfill.

5.4.2. Ongoing Projects

These projects have been funded and are currently being executed. In some cases, the remedies are administrative actions that have been taken to resolve conflicting goals. Hazardous waste reduction projects are funded by the Defense Programs (DP)-funded Pollution Prevention Program, Generator Set-Aside Fee (GSAF) Program, and mission programs.

Recycle vs Disposal (RR). As discussed in Section 5.2, Waste Minimization Performance, the major contributor to poor performance on the hazardous waste goal in FY01, arose out of the conflict between the waste minimization performance measure and the FWO-Division performance measure. This problem has now been rectified, and in the future, all recyclable waste will be recycled. The Laboratory will keep a record of increased costs resulting from recycling and report this to the DOE in the future. No additional action is required. This action will reduce hazardous waste disposal by ~10,000 kg.

Hydraulic Systems Improvements (SR). JCNNM is redesigning hydraulic couplings on backhoes and other machinery to reduce the likelihood of coupling failure and the resulting oil spills. Oil spill cleanup generates New Mexico State special waste. JCNNM is replacing the oldest Pakmaster (trash compacting truck), which has had frequent hydraulic line failures. (These improvements are based on a Green Zia Tools assessment conducted by JCNNM in FY00.)

Bio-Based Hydraulic Oil (SR). JCNNM is converting Laboratory heavy equipment to use bio-based hydraulic oils. These are not regulated as hazardous waste; consequently, oil spills and spill cleanup will become sanitary waste.

Non-RCRA Wastewater Pretreatment (T). The JCNNM-managed sanitary wastewater system (SWS) has configured a wastewater pretreatment trailer to process wastewaters that do not meet the SWS-plant waste acceptance criteria (WAC). These screenings are now disposed of as State special solid waste. Once treated, they can be sent to the SWS plant. Floor stripper (for removing wax) and mop water from some floor-cleaning

operations are examples of this kind of waste. Hazardous waste will be reduced by ~900 kg.

Ferric Chloride Recycle/Disposition (RR). Ferric chloride suppliers will pick up spent ferric chloride solution for recycle. This action will reduce hazardous waste by ~4000 kg.

5.4.3. Proposed Projects

These projects or actions have been proposed to (1) allow further reduction in the routine hazardous waste stream; (2) improve operational efficiency; and, in the case of fixing finely divided powders, (3) increase safety. Many projects currently are unfunded. If implemented, they will provide an additional margin against unexpected and unplanned increases in waste generation. The projects are presented in the order of the waste streams they are intended to reduce, with the largest streams first.

Distributed Chemical Pharmacy (SR). The Laboratory is in the process of procuring a new chemical management software system, which will create the opportunity for much more effective management of chemicals, both maintenance/production chemicals and research chemicals. This project will develop and implement site-wide procedures for (1) sharing and exchanging chemicals, (2) minimizing the amount of chemicals purchased, and (3) implementing an external chemical exchange system. The external exchange system will enable the Laboratory to share excess chemicals with other institutions. This will be a distributed system in that chemicals will not be stored or dispensed from a central facility. This project should have an impact on the unused chemical and the solvent waste streams, which are large and persistent.

Oil Waste Reduction (SR). The continuing expansion of ongoing programs is expected to reduce this waste stream significantly over the next 2 to 3 years.

Digital Photography Implementation (SR). The photochemical waste stream is one of the large components of FY01 hazardous waste. The Laboratory has been gradually making the transition from film and wet chemistry photodevelopment to digital photography. This project will complete that transition, including development of Laboratory photographic and x-ray photographic standards that would preclude future purchase of film photography and wet film development equipment, except where it is the only possible option. The project involves replacing wet chemistry systems (cameras, development, and printing) at low-volume activities, followed by a changeover in the Laboratory's production photographic services. This project, combined with recycle of photochemical waste, should virtually eliminate this waste stream.

Sitewide Process Neutralization (T). Currently, spent acidic or basic chemicals are disposed of as waste. Because of their corrosive nature, they are RCRA hazardous waste. By implementing a simple neutralization step at the end of the processing cycle, many kilograms of hazardous waste (in the form of corrosives) could be converted to less-hazardous New Mexico State special waste. Neutralized waste should be easier to recycle than the original corrosives.

Acetonitrile (RR). The Laboratory produces ~1 tonne of this waste material per year. The chemical is used in the production of nucleopeptides. The Laboratory expects programmatic growth, which would effectively double yearly production starting in FY02. The Laboratory has initiated an investigation of recycling options for this material, including both on- and off-site recycle. After evaluating these options, the Laboratory will pursue the selected option.

Fixing Finely Divided Powders (T). Many waste products that are not inherently hazardous are classified as hazardous waste because they are in the physical form of fine, respirable powders. By potting, melting, or otherwise immobilizing these powders, they can be removed from the hazardous waste stream.

Nonhazardous Fluorescent Light Bulbs (SR). Several Laboratory groups have switched to low-mercury (nonhazardous) fluorescent light bulbs that can be managed as salvage rather than as hazardous waste at the end of their useful life. These are cost competitive with high-mercury light bulbs and are available through the Laboratory's Just-in-Time (JIT) procurement system. Low-mercury bulbs are now available for almost all Laboratory light fixtures. Procurement group BUS-5 and Summit Electric (the Laboratory's fluorescent-bulb supplier) are working to update JIT to direct purchasers to the low-mercury bulbs. A Laboratory-wide conversion to low-mercury bulbs will simplify broken-bulb cleanup (which no longer must be treated as hazardous waste spills), eliminate the cost of managing bulbs as hazardous waste, and eliminate the risk of compliance failure from improper bulb management. This improvement does not reduce waste generation because high-mercury bulbs are already being recycled.

Paint Shop Waste Minimization (SR or RR). The JCNNM paint shop generates considerable hazardous waste. During FY02, JCNNM will be conducting a Green Zia tools analysis of lacquer and thinner waste streams to identify waste minimization options.

Heat-Exchanger-Cleaner Spent Solution (SR or RR). Chemical cleaning of cooling-tower heat exchangers leads to significant volumes of hazardous waste. The Laboratory is now completing a Green Zia tools analysis of this waste stream that identifies several waste minimization strategies that will be pursued in the coming year.

Mercury Elimination (SR). The use of mercury-containing devices (thermometers) is a frequent source of hazardous waste. When these break, they generate significant hazardous waste. The Laboratory's pollution prevention program has funded replacement of mercury thermometers with alcohol and electronic ones.

Recover and Recycle Silver from Photochemical Fluids (RR). A vendor will be identified and a contract will be placed to recover silver from photochemical fluids. This will allow recycling of the silver.

Initiate Puncture and Recycle of Aerosol Cans (RR). Aerosol propellants are normally hazardous substances. Aerosol cans cannot be recycled if they contain residual propellant. By puncturing the cans and recovering the propellant, the cans can be recycled.

If these projects are implemented, the Laboratory should see a significant reduction in hazardous waste. Because these projects address the routine hazardous waste stream components, the effects will be seen there. Figure 5-8 illustrates how the routine hazardous waste stream would be affected by implementation of these projects over the next few years.

Successful implementation of these projects will reduce the hazardous waste stream to a total value below the FY05 goal of 31 tonnes.

5.5. FY02 Performance Metrics

The Environmental Stewardship Office (ESO) has established performance metrics for the waste stream minimization project completion. These metrics will be used to measure performance throughout the year to assess progress. A score of 3 has been established for each completed project having a significant impact on a waste stream. Scores of 1 or 2 are assigned to projects with minimum waste stream impact or to the completion of major milestones. The metrics in Table 5-1 have been developed for the hazardous waste stream.

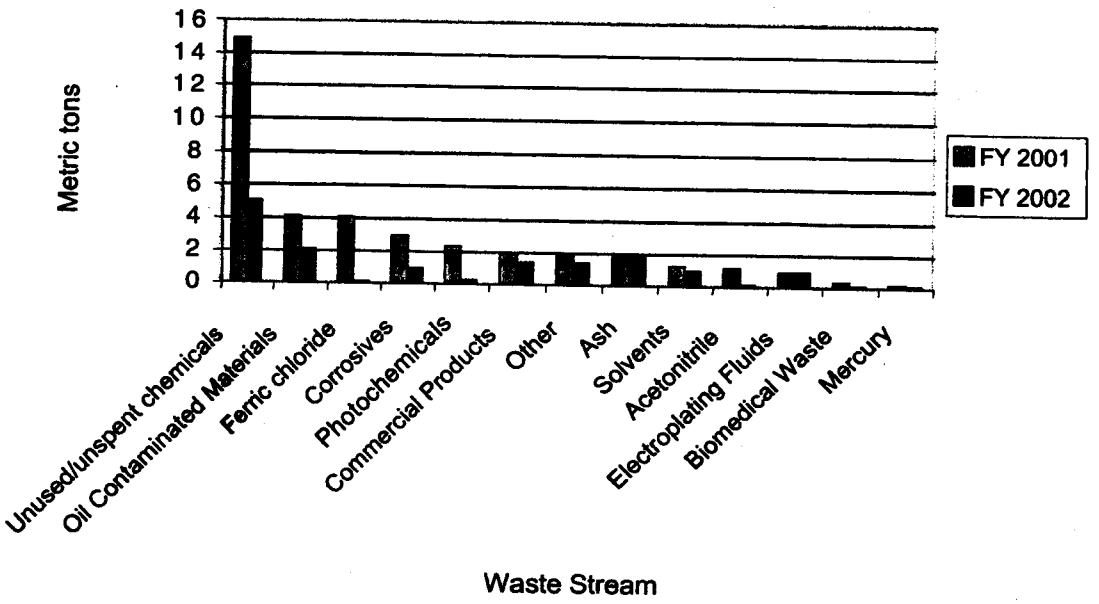

Fig. 5-8. Projected routine hazardous waste in FY02.

TABLE 5-1
HAZARDOUS WASTE METRICS

Initiative (Score)	Comments
Develop distributed chemical pharmacy protocol (1) Implement distributed chemical pharmacy (2)	This project will reduce the unused/unspent chemical waste stream significantly.
Implement digital photography (80% of Laboratory) (2)	
Perform sitewide conversion to bio-based hydraulic oils (2)	
Develop sitewide process neutralization protocol (1) Implement in 80% of possible processes (2)	
Identify and implement recycling options for acetonitrile (3)	This project will counter the expected growth of this waste stream and could eliminate all such waste being disposed of.
Recover and recycle silver from photochemicals (1)	
Initiate puncture of aerosol cans (1)	
Implement other proposed projects (2 each)	

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5-1. United States Department of Energy, "Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory," United States Department of Energy document DOE/EIS-0238 (January 1999).

5-2. United States Department of Energy, "Mitigation Action Plan for the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory," United States Department of Energy document DOE/EIS-0238 (September 1999).

5-3. "General Waste Management Laboratory Implementing Requirement (LIR)," Laboratory Implementation Requirement LIR404-00-02.2 (Issue Date: November 1, 1998, Revised Date: October 6, 1999).

5-4. "Hazardous Waste Management LIR—Laboratory Implementation Requirements," LIR404-00-03.0 (Effective Date: December 16, 1996).

5-5. Los Alamos National Laboratory Hazardous Waste Permit NM0890010515-1 (1989).

6.0. SOLID SANITARY WASTE

6.1. Introduction

Most material brought into Los Alamos National Laboratory (the Laboratory) will leave as solid sanitary waste if it cannot be sold for reuse, salvage, or recycle. Sanitary waste is excess material that is neither radioactive nor hazardous and that can be disposed of in the Department-of-Energy (DOE)-owned, Los-Alamos-County-operated landfill (County landfill, or landfill) according to the waste acceptance criteria (WAC) of that landfill and the State of New Mexico Solid Waste Act and regulations. Solid sanitary waste includes paper, cardboard, office supplies and furniture, food waste, wood, brush, and construction/demolition waste. Figure 6-1 is the process map for sanitary waste generation at the Laboratory.

Materials come into the Laboratory as required by Laboratory operations. Mail includes both internally and externally generated mail. Many items, such as copiers, computers, office supplies, experimental apparatus, and furniture, are procured as part of the Laboratory operation. Food is brought into the Laboratory as part of the cafeteria operations and from homes and restaurants. Materials and substances, such as building materials and chemicals, are needed in construction, maintenance, research, and infrastructure operations.

After items either have reached the end of their useful life or are no longer needed, they are discarded. Many are salvaged or placed in recycle bins. Salvaged items can be recycled either internally or externally. Some items are discarded and end up in dumpsters, which go to the Materials Recovery Facility (MRF). At the MRF, items that can be recycled are segregated from the dumpster waste and sent to recycle. Items that cannot be recycled are sent to the landfill. Some items, such as firing-site glass and nonrecyclable construction waste, go directly to the landfill. Thus, virtually every nonradioactive, nonhazardous item brought to the Laboratory eventually is either recycled or buried at the landfill. Reducing the volume of sanitary waste being buried at the landfill requires either reducing the quantity of materials flowing into the Laboratory (source reduction) or increasing the quantity of materials recycled.

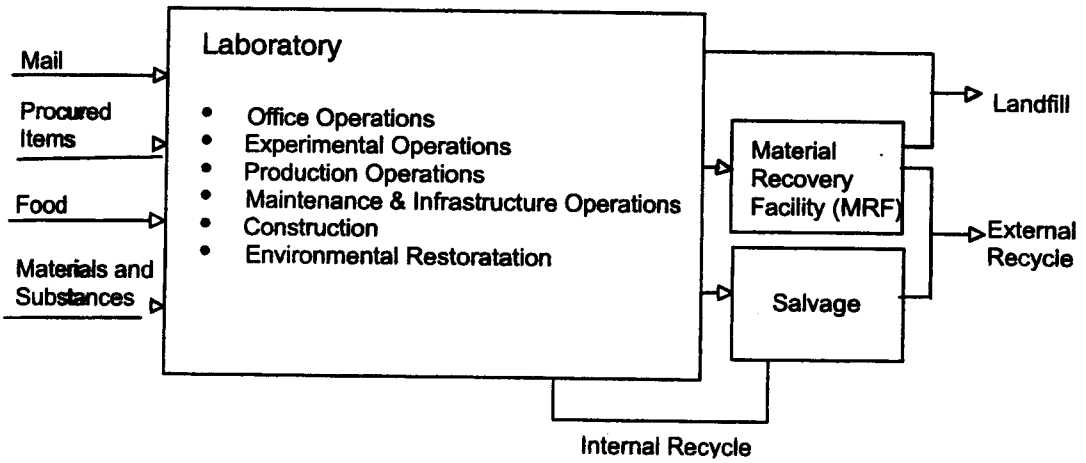

Fig. 6-1. Top-level sanitary waste process map.

The Laboratory generated ~5066 tonnes of sanitary waste in fiscal-year (FY)01. Of this total, 3072 tonnes was nonroutine sanitary waste largely composed of construction debris, and 1994 tonnes of material was routine sanitary waste, the vast majority of which came from Laboratory dumpsters. In FY01, 3814 tonnes of sanitary waste was recycled.

Figure 6-2 displays the relative volumes of construction, routine, and recycle materials in the sanitary waste stream.

The routine sanitary waste has three components: dumpster waste, waste diverted from the hazardous waste stream by the Solid Waste Operation (SWO) at TA-54, and other waste. The dumpster waste is composed of anything that is discarded in desk-side trash cans, trash recepticals, or dumpsters. The SWO waste is nonhazardous solid waste that is generated as a result of hazardous waste handling and disposal operations at TA-54. Other waste is mixed waste that is co-mingled in white-paper recycle bins. The relative magnitudes of these components are shown in Fig. 6-3.

Dumpster waste is the largest component of routine sanitary waste and includes virtually all discarded items that are not initially recycled. The major constituents of the dumpster waste stream are cardboard, paper, food waste, wood, plastic, Styrofoam, glass, and metals. Figure 6-4 shows the relative weights of the components of the dumpster waste stream.

6.2. Sanitary Waste Minimization Performance

The DOE has implemented goals for waste minimization. The DOE proposes that solid sanitary waste generated from routine operations be reduced by 75% by 2005 and by 80% by 2010, using calendar-year (CY)93 as the baseline. Routine waste is defined as waste generated by any type of production, analytical, and/or research and development (R&D) laboratory operations; work for others; and any periodic and recurring or ongoing work. The Laboratory's performance toward this goal is shown in

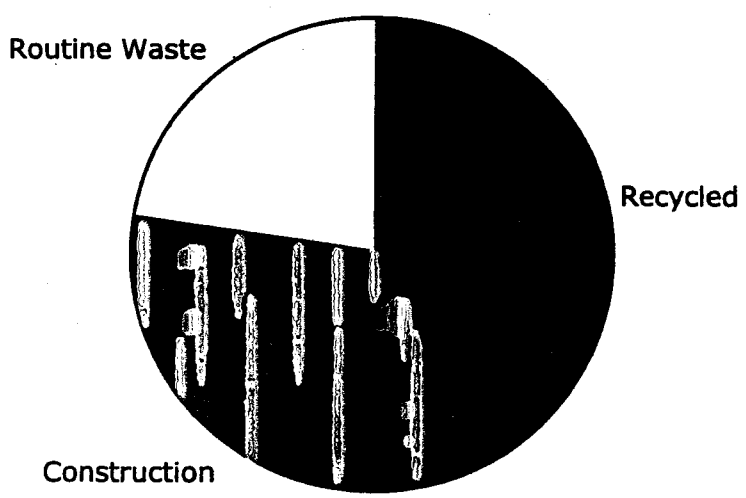

Fig. 6-2. Sanitary waste disposal and recycling.

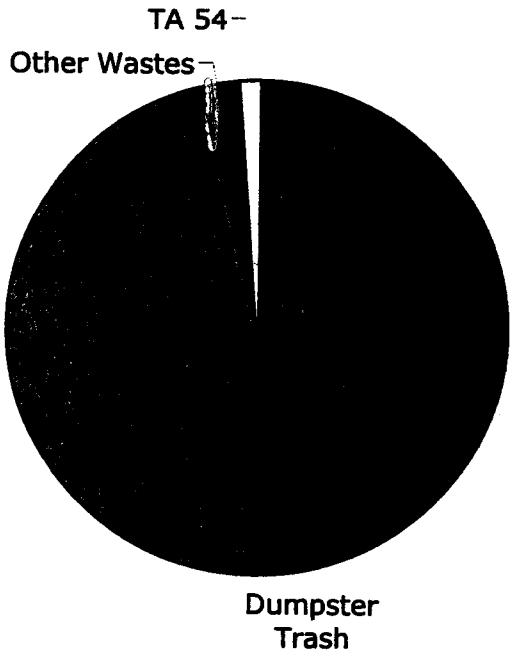

Fig. 6-3. Sanitary waste sources.

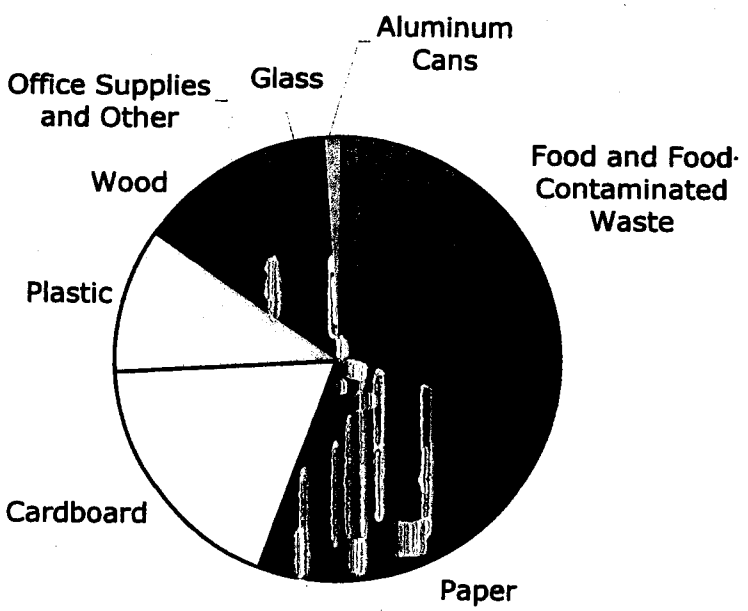

Fig. 6-4. Routine sanitary waste by type.

Fig. 6-5. (Total yearly waste generation is calculated as the sum of disposed waste and recycled volumes—only the yearly amount disposed of is represented in the graph.)

The Laboratory is working with the DOE to develop a modified sanitary waste reduction goal of 50% rather than 75% by 2005. The Laboratory has made good progress

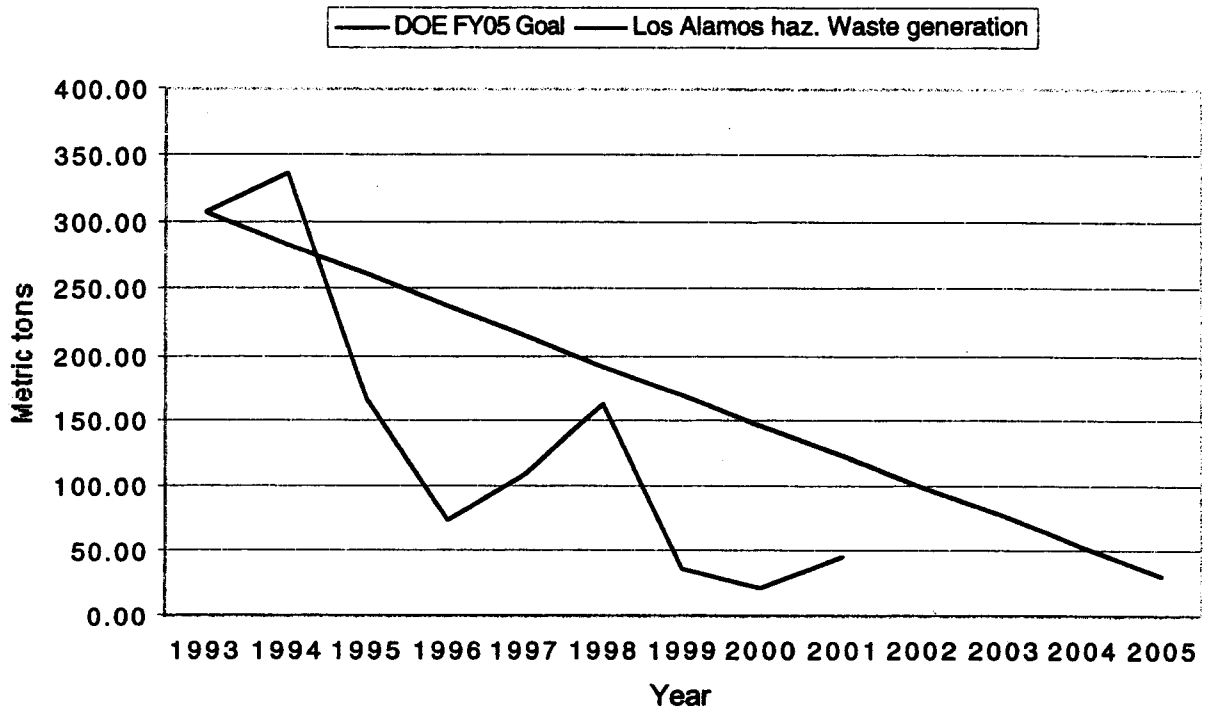

Fig. 6-5. Routine sanitary waste sent to the County landfill.

to date in avoiding and diverting sanitary waste since the baseline year of 1993. The Laboratory's budget has almost doubled since 1993, and the total number of Laboratory employees has increased by approximately 1422 since 1995. Expected sanitary waste generation rates, based on budget and growth in Laboratory employment, would have risen between 13% (based on staffing increases) and 46% (based on budget increases). In spite of budget and staff increases, sanitary waste generation has decreased 28% from the 1993 base year through Laboratory source reduction and recycling programs. The Laboratory can meet the 50% sanitary waste reduction goal by 2005 through expanded recycling and source reduction efforts. A 75% sanitary waste reduction goal would require the Laboratory to employ waste management technologies rather than source reduction and recycling programs. These technologies include waste-to-fuel conversion technology, which is not a proven technology, and digester technologies that may cost several million dollars to install and operate.

Sanitary waste generation has decreased by ~800 tonnes since 1993. The general trend in waste generation has been between 2000 and 25,000 tonnes of waste generation.

The DOE also requires that 45% of the sanitary waste from all operations (both routine and nonroutine) be recycled by 2005 and that 50% of the waste be recycled by 2010. The recycling rate is calculated as

$$\frac{\text{amount recycled}}{(\text{amount recycled}) + (\text{amount disposed of})} = \text{overall recycling rate.}$$

The Laboratory's performance toward this goal for sanitary waste is shown in Fig. 6-6. The recycle of total (routine + nonroutine) sanitary waste currently stands at 46%.

6.3. Waste Stream Analysis

Practically every item that enters the Laboratory (other than radioactive material, hazardous material, and materials that become radioactive) leaves the Laboratory in the sanitary waste stream at the end of its useful life. At that point, it is recycled, reused (salvaged), or buried in the landfill. Materials disposed of include construction waste, food and food-contaminated wastes, paper products, glass, and Styrofoam.

The waste stream analysis addresses wastes that were not recycled during FY01. Expanded recycling and source reduction initiatives are being instituted to reduce these waste streams further.

6.3.1. Nonroutine Waste Streams

Construction/Demolition Waste (3072 tonnes). The largest sanitary waste stream at the Laboratory is the construction/demolition waste stream. Construction/demolition waste is generated during the Laboratory's projects to build new facilities, upgrade existing facilities, or demolish facilities that are no longer needed. Construction/demolition projects require that raw materials and equipment be brought onto the site, along with utilities (especially water). The waste generated by these projects is varied and consists primarily of dirt, concrete, asphalt, some wood items, and various metal objects; the three largest components of this waste are used asphalt, concrete rubble, and dirt. This waste stream is growing and will continue to do so as planned new construction and renovation projects begin. Before May 1998, these materials were reused as fill to construct a land bridge between two areas of the Laboratory; however, that activity was halted because of environmental and regulatory

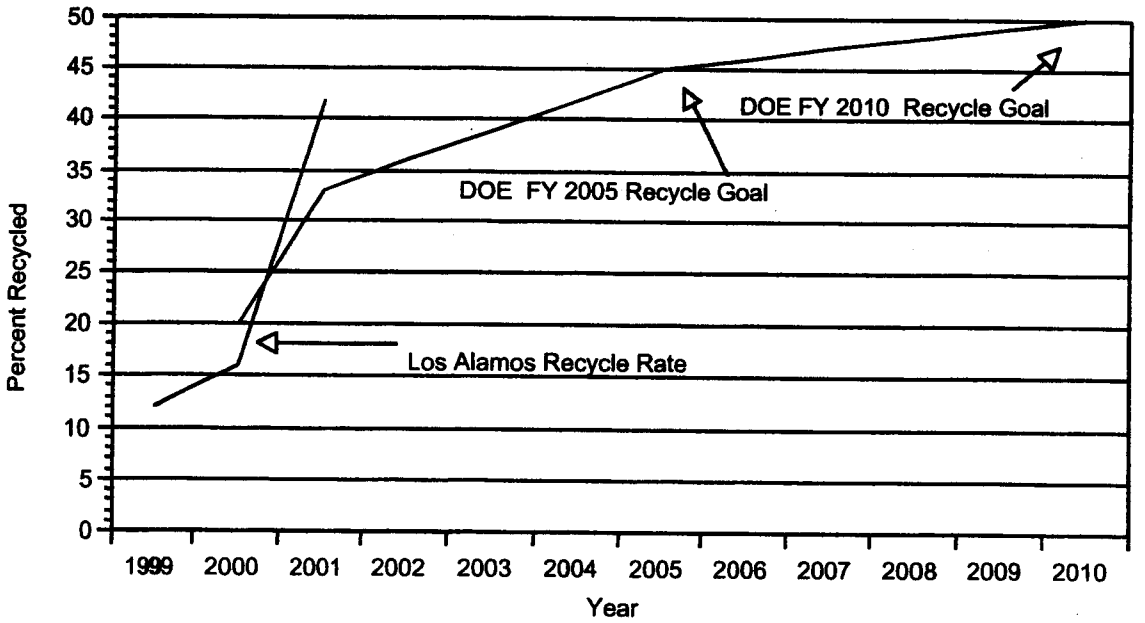

Fig. 6-6. Laboratory routine sanitary waste recycling rate.

issues. Recycling programs were established for concrete, asphalt, dirt, and brush in FY01; these programs diverted ~1980 tonnes of construction waste. These recycling programs will be deployed fully in FY02 and will divert ~3500 tonnes of construction waste, with only ~500 tonnes of unrecoverable construction waste sent for disposal.

6.3.2. Routine Waste Streams

Cardboard (250 tonnes). Cardboard enters the Laboratory in one of two ways: as packaging materials or as newly purchased moving boxes. Some of the cardboard, particularly cardboard moving boxes, is recycled for reuse routinely. Other cardboard is discarded to either the dedicated cardboard collection roll-offs or the trash dumpsters. Dumpster trash is taken to the MRF and sorted, and recyclable cardboard is recovered. Wet or food-contaminated cardboard is sent to the landfill for disposal.

Paper Products (560 tonnes). The Laboratory purchases ~550 tonnes of paper products each year. These products are used in a variety of ways, but mostly in offices for printing, copying, faxing, and other office support uses. Paper is used to produce unclassified, classified, and sensitive documents, and each type has a different path to disposal. Unclassified paper products normally are disposed of in either green desk-side bins, which are taken directly to recycle, or in trash bins. Approximately 45 tonnes of unclassified materials is sent to storage or to archiving. This material is held in storage for varying periods before it is disposed of. Some unclassified material may be distributed to radiological control areas (RCAs), where it is subject to radioactive contamination and disposal as low-level waste (LLW). Uncontaminated paper from RCAs may be disposed of in Green Is Clean (GIC) bins and sent to be characterized and recycled. Every year, the Laboratory receives and distributes over 700 tonnes of mail. This mail includes junk and business mail, catalogs, phone directories, and various documents. The Laboratory distributes mail, including internally generated mail. Most of this material can be recycled after use. Publications such as catalogs and directories that are bound with glue must have the bindings sheared off before the paper is recycled; the bindings then are sent to the landfill for disposal. The paper-recycling program diverted 217 tonnes of white paper and 428 tonnes of mixed office paper in FY01. Classified material may not be disposed of unless it has been security (cross-cut) shredded. Strip-shredded material can be recycled, but cross-cut shredded material currently goes to the landfill. A pilot program to compost shredded paper and food waste will be conducted in FY02.

Food and Food-Contaminated Materials (650 tonnes). Food products enter the Laboratory waste streams either through food service from one of the four cafeterias or from food brought into the Laboratory from off-site. The total waste stream is estimated to exceed 650 tonnes per year and equates to more than 25% of the routine sanitary waste stream. All of the food and food-contaminated wastes generated at the Laboratory currently are sent to the landfill. Approximately 300 tonnes of food waste is generated at the cafeterias; a pilot program to compost shredded paper and food waste from the cafeterias will be conducted in FY02. Food waste from desk-side and kitchen areas around the Laboratory is particularly intractable because it cannot be collected easily and contaminates other recyclable materials with which it comes into contact as a result of compaction during collection.

Plastics (210 tonnes). Plastics and foam are used for many purposes at the Laboratory and constitute the third largest component of dumpster waste. The waste stream consists primarily of food/beverage containers, shrink-wrap, plastic bags, and packaging materials. A plastics recovery/recycle program that will capture a variety of mixed plastics was initiated recently at the Laboratory. Packaging material, e.g., Styrofoam, will continue to be disposed of at the landfill.

Office Supplies and Other Wastes (90 tonnes). Office supplies are used throughout the Laboratory. This includes items such as small equipment that comprises mixed materials such as plastic and metal that are not recyclable or salvageable, small metal items that cannot be safely removed from the waste stream at the MRF, and other various items.

Wood (100 tonnes). The Laboratory produces waste wood through the discarding of wooden pallets and clearing areas of vegetation. The wood contained in dumpsters also includes a significant quantity of construction wood waste that has been improperly disposed of. Construction wood waste is considered nonroutine and should be segregated from the routine waste in dumpsters. Eliminating the disposal of construction waste in dumpsters would reduce this waste stream. To the extent possible, brush and wood waste are recycled for the Laboratory by Los Alamos County. A pilot program to recycle pallets has been initiated and will divert 50 tonnes of wood waste per year.

Glass (80 tonnes). Glass products enter the Laboratory either as purchased items (e.g., beakers, flasks, and pipettes) or as containers. Although many chemicals are purchased in glass bottles, a significant source of glass is beverage containers, either purchased through the food services on-site or brought in from outside the Laboratory and disposed of on-site. Limited opportunities exist for recycling this waste stream because of a lack of market demand and high transportation costs. Glass currently is disposed of at the landfill. A pilot program to collect and recycle glass will be initiated in FY02.

Aluminum Cans (26 tonnes). An estimated 26 tonnes of used aluminum cans is produced each year at the Laboratory. Some of this waste is placed directly in recycle bins located for that purpose, but much of it is discarded in dumpsters. Efforts to increase aluminum can recycling will be increased in FY02.

TA 54 Routine Sanitary Waste (28 tonnes). The Laboratory generates ~28 tonnes of nonhazardous, nonregulated sanitary waste from Laboratory research processes. These wastes are generated from various processes. The relative size of the sanitary waste streams is shown in Fig. 6-7.

The construction waste stream dominates the sanitary waste type with paper, cardboard, food, and plastics, which make significant contributions to the total.

6.4. Improvement Projects

The projects intended to mitigate the effects of sanitary waste on the environment are shown in the following subsections. The projects are classified as completed, ongoing, and unfunded.

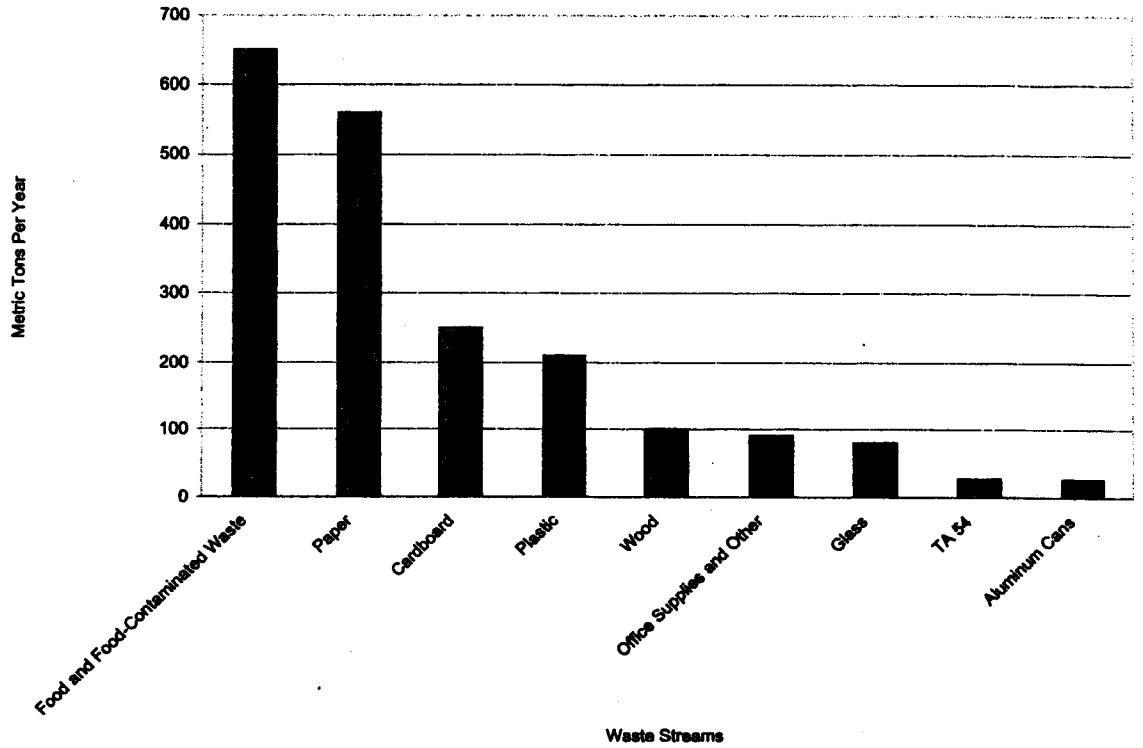

Fig. 6-7. Routine sanitary waste streams.

6.4.1. Completed Projects

The following projects have been completed; however, in some cases, there are follow-on activities.

1. MRF. The Laboratory completed the construction of and began initial operation of an MRF to recover recyclable items from trash dumpsters. Dumpsters are emptied and their contents sorted at the MRF. This operation results in the recovery of ~45.5 tonnes of cardboard, 9 tonnes of metal, 11 tonnes of wood, and 2 tonnes of other recyclables per year. The purchase of a baler has greatly increased the efficiency of the MRF operation.

2. Cardboard Recycle. For several years, the Laboratory has been expanding its cardboard recycle program. Beginning in FY97, the Laboratory began purchasing roll-offs for facilities across the site. This action has greatly increased the volume of cardboard going to recycle. In addition, the Laboratory began recovering cardboard at the MRF and baling it in FY00, which has increased the ease of recycle. The total amount of cardboard recycled in FY01 was 319 tonnes; ~274 tonnes were collected through the cardboard recycle program, and 45 tonnes were recovered through the MRF.

3. Paper and Document Recycle. The Laboratory recycles paper, mail, and publications through three programs.

Green Desk-Side Bin Recycle. Most unclassified white paper can be deposited in green desk-side bins for recycle. Sensitive materials are shredded before being recycled as unclassified waste. Strip-shredded paper can be recycled, but cross-cut shredded material cannot. Approximately 219 tonnes of white paper was recycled in FY01.

MS A1000. Junk mail, books, transparencies, newsprint (newspapers), magazines, flyers, brochures, catalogs, binders, colored paper, and folders are recycled at the Laboratory by sending unwanted materials to MS A1000. Phone books are recycled annually at MS A1000. This program won a White House Closing the Circle Award in FY00. Approximately 397 tonnes of sanitary waste is recycled through the MS A1000 program each year.

MS J568—"Stop Mail." MS A1000 provides a mechanism for recycling unwanted paper or documents, but the "Stop Mail" Program provides a mechanism for stopping unwanted mail from ever entering the mail system. Employees receiving unwanted mail at the Laboratory may send that mail to MS J568 to be removed from mailing lists.

6.4.2. Ongoing Projects

These funded projects currently are active. They are categorized as in the previous section.

Concrete Crushing. The Laboratory conducted a pilot project to establish a concrete crushing and reuse system in FY01. The FY01 pilot program diverted 730 tonnes of concrete and asphalt. The crushing and reuse program will be fully deployed in FY02, and all uncontaminated concrete generated from Laboratory activities and managed by Johnson Controls Northern New Mexico (JCNNM) will be crushed for recycling and reuse.

Construction Debris Inspection/Recycle. A program has been initiated to inspect all construction debris for recyclable content. Sorting and segregation of reusable items occurs at the construction site before the debris is loaded. Trucks containing construction debris then are dispatched to the salvage yard for inspection. If the trucks are found to contain recyclable or reusable items, those items are removed. JCNNM has a performance measure in its contract with the Laboratory to achieve a 45% recycling rate for Laboratory sanitary wastes through the "truck turnaround" and other recycling programs.

Dirt Recycling. All uncontaminated dirt is sent off-site to be used as fill material. Currently, dirt is being sent to the Los Alamos County Golf Course to be used as fill. The dirt reuse program is a partnership among JCNNM, Los Alamos County, and the Laboratory.

Brush Recycling. Brush and branches from construction projects are sent to the Los Alamos County Landfill, where they are chipped and distributed as mulch to County residents.

Salvage and Reuse. Items that have been replaced or are no longer needed but have some useful life left can be reused within the Laboratory through the Laboratory salvage program or sold to individuals, organizations, or vendors off-site for recycling.

Metal Recycle. Metals and scrap wire are recycled through JCNNM. If large amounts of metal or wire are expected to be generated at a site, the site responsible for generating this waste may arrange for a scrap metal collection bin to be placed at its site. All metal must be clean and suitable for public release (i.e., no radioactive or chemical contamination).

Plastic and Aluminum-Can Recycling. Plastic beverage and food containers and aluminum cans are collected and sent for recycling through JCNNM's plastic and aluminum-recycling program. This program will be initiated in early FY02. Other types of plastics from various sources, excluding Styrofoam, also may be recycled upon request for special collection arrangements. It is estimated that ~120 tonnes of plastic and 30 tonnes of aluminum and metal food containers will be diverted through this program.

Paper Use Reduction. An outreach program to encourage the reduction of paper use through double-sided copying and printing will be conducted this year. The pilot will encourage procurement of printers that can print double-sided. Outreach materials and reminders will be distributed to encourage employees to reduce paper use. It is estimated that up to 50 tonnes of paper use will be avoided through this program.

Wood Pallet Recycling. A pilot program to collect and recycle wood pallets off-site was initiated in FY01. It is estimated that ~50 tonnes of wood waste will be diverted through this program. Funding is available to conduct a pilot during FY02; full deployment of this project is not funded.

6.4.3. Unfunded Projects and Pilots

These projects have an environmental aspect but currently are unfunded.

Sitewide Excess Cleanup. The Laboratory has ~10,000 tonnes of mostly unusable excess equipment stored outdoors. Because this material is exposed to rain and snow, it is significantly polluted with stormwater. In addition, some of the material is flammable and represents a fire hazard if stored near structures or other combustible materials such as grass or trees. The excess material also may serve as a shelter for mice, rats, and other small mammals. An effort to reduce or eliminate this material could reduce the pollution potential dramatically, as well as reduce the fire and health risks.

Styrofoam Recycling. The Laboratory generates ~40 tonnes of Styrofoam as part of packaging materials. Styrofoam is not a significant waste stream in terms of weight; however, it is volumetrically a significant waste stream in terms of collection, handling, and baling at the MRF. Currently, noncompacted Styrofoam is not recyclable through existing recycling service providers.

A Styrofoam densifier would compact the Styrofoam materials that could be recycled. This would reduce collection, handling, and baling efforts and could reduce sanitary waste and divert ~40 tonnes of materials from the routine sanitary waste stream.

Composting. A pilot project to collect compostable materials will be conducted in FY02. Compostable materials include cafeteria food waste, shredded paper, and sawdust. This pilot can divert up to 200 tonnes of cafeteria food waste and 225 tonnes of shredded

paper and sawdust. Compostable materials from the cafeterias, sawdust from the JCNNM carpenter shop, and shredded paper will be collected and sent to a commercial composting facility in Albuquerque, New Mexico. Local options for developing composting capacity will be evaluated in FY02 to reduce transportation costs. It is estimated that ~425 tonnes of materials will be diverted through the pilot composting program. Funding is available to conduct a pilot during FY02; full deployment of this project has not yet been funded.

Glass Recycling. A pilot program to collect and crush glass for reuse as aggregate will be conducted in FY02. Beverage and other nonchemical container glass will be collected and sent off-site for crushing and reuse as aggregate. Glass chemical containers will not be recycled through this program because of concerns about chemical residues. It is estimated that up to 30 tonnes of glass will be recycled through this pilot program. Funding is available to conduct a pilot during FY02; full deployment of this project has not yet been funded.

Waste-to-Fuel Conversion Technology. Waste-to-fuel conversion technology has been developed and currently is being piloted. This technology is designed to convert any sanitary waste with British-thermal-unit value into gas that can be used as fuel. The technology produces fuel and minor wastewater and ash waste streams. There are no air emissions.

Waste-to-fuel technology, if viable, could reduce the sanitary waste stream by ~200 to 250 tonnes per year.

Waste Digester Technology. Digester technology has been deployed at nine sites in the United States. This technology removes organic materials from the sanitary waste stream through a rough digestion process that converts all organic material into compost. The end product is rough compost that can be further cured and used as a soil amendment and as nonorganic materials that are disposed of. The technology would process paper, wood, food, food-contaminated wastes, and cardboard into compost.

The digester technology used alone may reduce the sanitary waste stream by half, or ~1000 tonnes. The digester technology coupled with an active plastic, glass, and metals recycling program can reduce the sanitary waste stream by 90%.

Figure 6-8 shows the expected reduction in waste through 2005 as a result of implementing the ongoing sanitary waste reduction projects and the full deployment of the composting and glass recycling pilot programs. Figure 6-8 does not illustrate nonroutine construction wastes that will be reduced by 3500 tonnes in FY02.

The expected overall reduction across all sanitary waste streams is shown in Fig. 6-9.

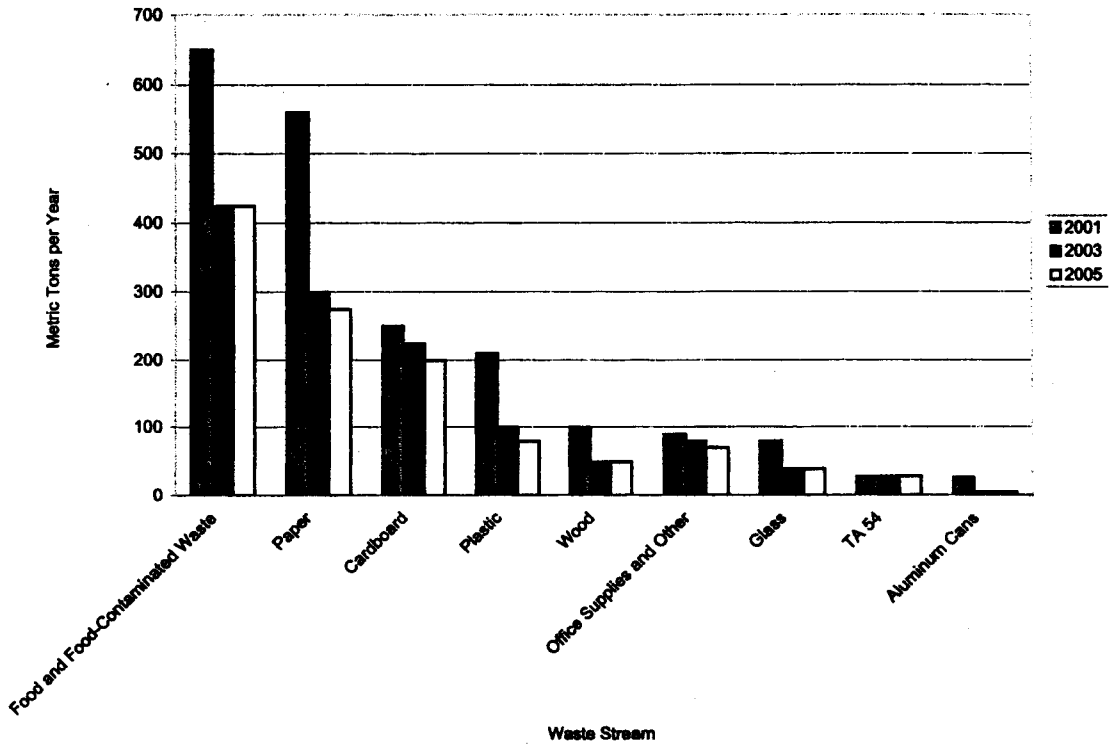

Fig. 6-8. Expected reduction in routine sanitary waste streams by type.

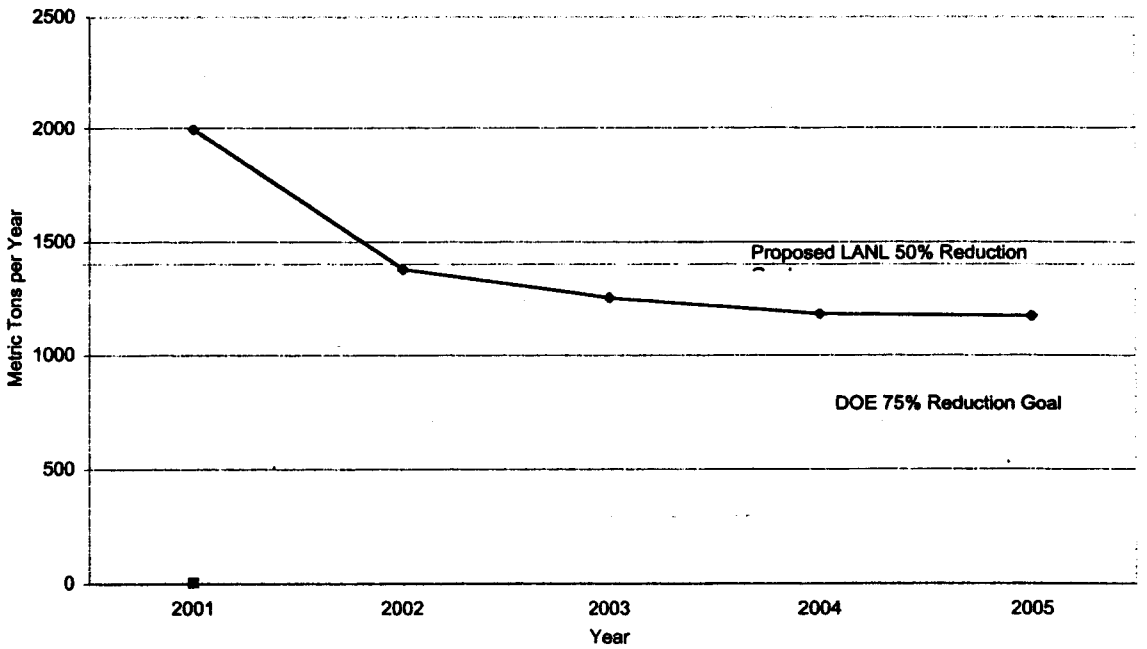

Fig. 6-9. Expected routine sanitary waste reduction.

6.5. FY02 Performance Metrics

To ensure that the Environmental Stewardship Office (ESO) continues to exhibit outstanding continuous improvement in meeting the Laboratory's waste minimization goals, the ESO has established performance metrics for the individual waste streams and other aspects of concern (see Table 6-1). These metrics will be used to measure performance throughout the year to measure success. A score of 3 has been established for each completed project having a significant impact on a waste stream. Scores between 1 and 2 are assigned to projects with minimum waste-stream impact or to the completion of major milestones. The following metrics have been developed for the sanitary waste stream.

TABLE 6-1
SANITARY WASTE METRICS

Initiative (Score)	Comments
Complete the concrete and asphalt recycling program (3).	This project will divert ~3500 tonnes of nonroutine sanitary waste.
Complete glass, plastics, and aluminum-can recycling program (3).	This project will divert ~200 tonnes of routine sanitary waste per year by FY05.
Complete composting pilot (2).	This project will divert ~430 tonnes of cafeteria food waste (200 tonnes), shredded paper (220 tonnes), and sawdust (10 tonnes) per year by FY05.
Complete paper-use-reduction outreach (1).	This project will eliminate the generation of 50 tonnes of paper per year by FY05.
Complete pallet-recycling program (1).	This project will divert 50 tonnes of wood pallets per year by FY05.

7.0. WATER USE AND CONSERVATION

7.1. Introduction

The utility system (water, natural gas, and electricity supply) at Los Alamos National Laboratory (the Laboratory) is driven by the demand for electrical energy and by the increasing Laboratory population. As energy requirements increase, the demand for cooling water and the volume of effluent discharged at outfalls increase. Most of the Laboratory's consumption of electrical energy manifests itself as heat that must be removed and dissipated. In fact, ~60% of the Laboratory's water is used in cooling towers. Although the electrical supply can be increased by implementing one or more options, the critical component of the energy/water cycle (i.e., the availability of water) cannot easily be increased (see Section 7, Water Use and Conservation).

The Department of Energy (DOE) has transferred the management of its local water rights to Los Alamos County. Through this transfer, the Laboratory is targeted to use no more than 30% of the total water rights, or 542 million gallons per year. Water demand at the Laboratory is projecting growth as a result of new mission requirements. With water conservation projects now being implemented, the Laboratory has sufficient water resources to operate current and planned facilities. If the Laboratory significantly increases operation of present facilities or constructs additional ones, its historical water usage could be exceeded. Although Los Alamos County, which supplies water to the Laboratory, has unused water rights, a significant increase in Laboratory or County water use could exceed current water resources. Consequently, it is in the Laboratory's and the County's interest to pursue an aggressive, cost-effective, water-conservation and gray-water-reuse program. It is also in their joint interest to develop additional water resources to accommodate future growth. Water use and planning is the responsibility of the Utilities and Infrastructure group in the Facilities and Waste Operations Division (FWO/UI). This group tracks water use and manages improvements and repairs to the infrastructure that reduce water use at the Laboratory. The newly formed Water Conservation Committee, chaired through FWO Waste Facilities Management (WFM), will represent the Laboratory on all water conservation issues and will have interactions on the Laboratory/University of California (UC) institution, Los Alamos County, DOE, and Regional, State, and National levels. The Water Conservation Committee provides leadership in two areas. The first is in direction, integration, and coordination to promote responsible stewardship in regard to activities potentially affecting regional water resources. Such activities may include, but are not limited to, understanding the legal bases of Los Alamos County and DOE water rights; reviewing water availability issues related to future DOE and Los Alamos County plans; compiling and maintaining an accurate yearly record of actual water use; developing water use forecasts; anticipating and promoting local, State, and Federal water conservation goals and practices; and recommending water conservation technologies. The second area of responsibility is the tracking and participating in regional water planning initiatives outside of Los Alamos County that may affect water availability and/or use.

The Laboratory used ~446 million gallons of water in fiscal year (FY)99, 432 million gallons in FY00, and 348 million gallons in FY01. The source of this water is a series of deep wells that draw water from the Rio Grande aquifer. Approximately 60% of

Laboratory water flows into cooling towers. Without the cooling-tower-water efficiency upgrades, this flow may increase to as much as 70% by 2005 because of new facilities that are being built. Approximately half of this water is evaporated; the remainder is released into the surrounding canyons through National-Pollutant-Discharge-Elimination-System (NPDES)-permitted outfalls and ground-water (GW) permits. Water is consumed at the Laboratory for many purposes, including cooling-tower uses, operations, domestic use, landscaping, and temperature control. The water eventually is discharged in the form of sanitary water effluent, outfalls, evaporation, or leakage losses. The water supply system and water balance for the Laboratory are shown in Fig. 7-1.

The Laboratory's largest water discharge is to the environment. These discharges are regulated through NPDES, GW, and/or storm water permits.

- Water from cooling towers is discharged directly to NPEDS/GW-permitted outfalls or is sent to the Laboratory sanitary system.
- Water used for industrial and domestic purposes is discharged to the Laboratory's sanitary system if it meets the Waste Acceptance Criteria (WAC).
- Treated sanitary wastewater is discharged either directly to NPDES/GW-permitted outfalls or to cooling towers for reuse.
- Water used in construction processes is discharged to the environment and is regulated by a storm water permit.

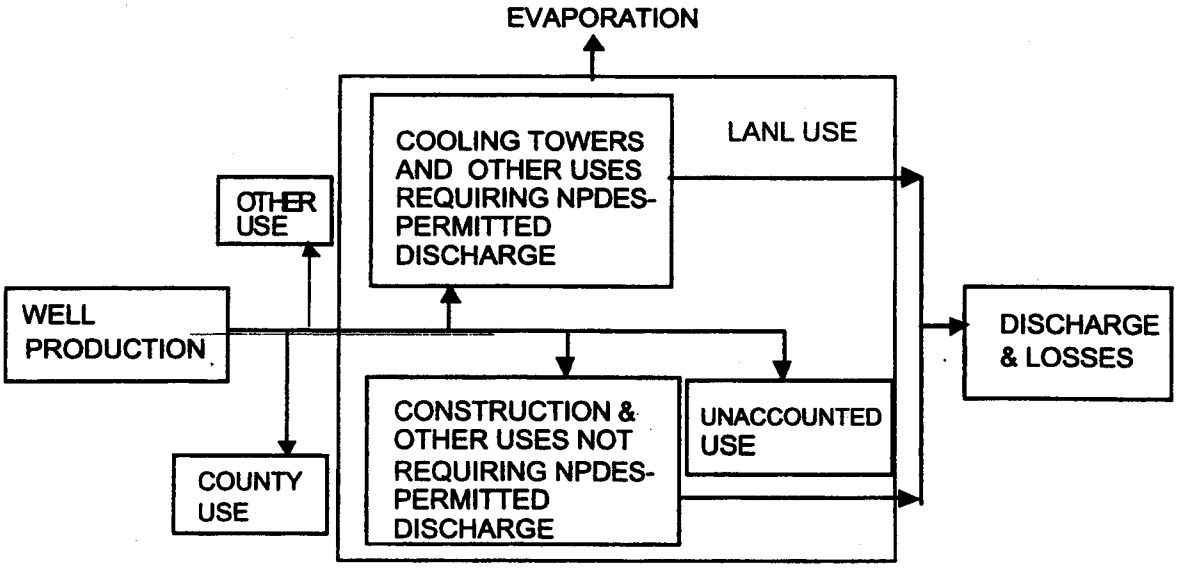

Fig. 7-1. The Laboratory water system.

The only water discharged to the environment that is not regulated is leaks and potable water used for landscaping.

The estimated consumption of water by use type at the Laboratory is shown in Fig. 7-2. This distribution of water use is only approximate and is based on a 1997 estimate. By far, the largest use of water at the Laboratory is for cooling. The various cooling towers that operate at the Laboratory consume 58% of the total water usage. The largest cooling towers, by volume of water consumed, are the Los Alamos Neutron Science Center (LANSCE) towers at TA-53 and the TA-3 towers associated with the large computer facilities [the Central Computing Facility (CCF) and the Laboratory Data Communications Center (LDCC)] and the TA-3 Power Plant. The major constraint on cooling-towers' water efficiency is silica concentrations in the cooling water. The concentration of silica in the local groundwater is ~88 ppm. Because silica will begin to precipitate and foul heat-exchanger surfaces at ~200 ppm, the concentration must be controlled below that level. Currently, the silica concentration is controlled by operating the towers at 1.5 to 2.0 cycles of concentration. However, the Laboratory is addressing this problem and will deploy water treatment technologies that will allow cooling-tower operation at higher cycles of concentration.

The overall consumption of water at the Laboratory in FY99, FY00, and FY01 is shown by month in Fig. 7-3. The trend in water consumption is somewhat seasonal, with the largest volumes being consumed in summer. This is the period of hottest weather and frequently has the highest electrical demand. Water usage at the Laboratory is correlated to electrical demand because water is required to remove waste heat generated by electrical consumption. Because LANSCE is the largest single consumer of electrical energy on site, water use is dependent on the LANSCE run cycle. Over the past few years, LANSCE run cycles have been shortened by comparison to previous

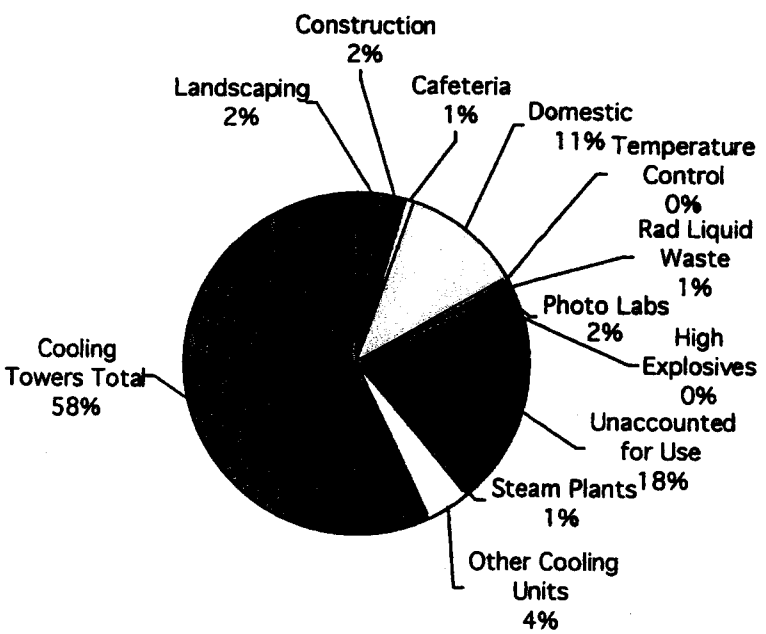

Fig. 7-2. FY97 Laboratory water usage.

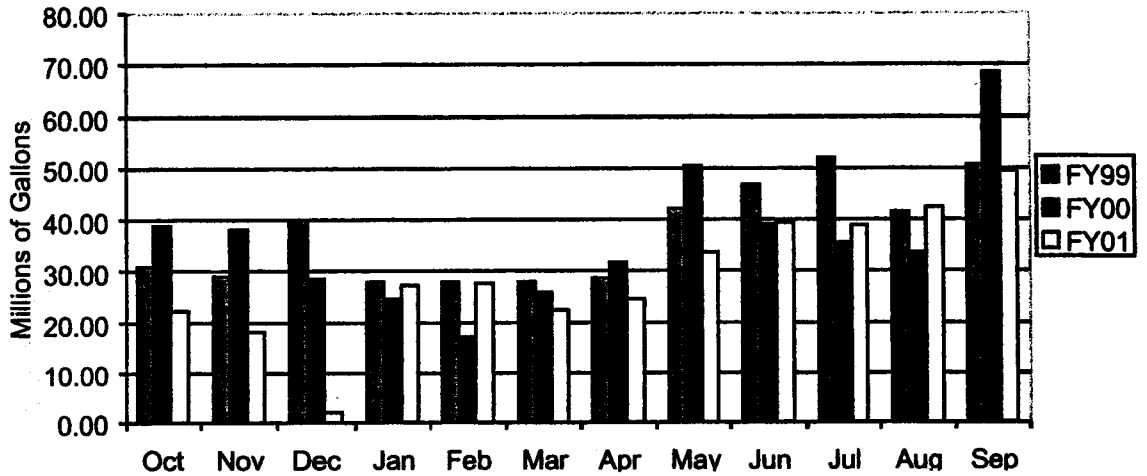

Fig. 7-3. Monthly water consumption.

years so that a strong correlation between LANSCE-run energy consumption and overall water consumption is not immediately evident. However, when LANSCE resumes a full 7- to 9-month operation cycle, the effect on water consumption will be more pronounced.

7.2. Water Conservation Performance

The Laboratory has not established water conservation performance goals. However, Executive Order (EO) 13123, "Greening the Government through Energy Efficiency Management," mandates the development of such water goals. In advance of these goals, the Laboratory has committed to an aggressive water conservation program. The consumption of water at the Laboratory (by year) for recent years is shown in Fig. 7-4.

The data for years before 1999 are approximate because of many factors, including incomplete metering at the Laboratory, unknown system losses, and uncertainty in distribution. There are no reliable data for FY98 because in that year, the operation of the Los Alamos water supply and distribution system was transferred from the DOE to Los Alamos County. The different techniques for measuring and estimating water used at these two entities lead to greater-than-normal uncertainty in the estimate of water use. There is no strong trend in water use at the Laboratory. A pronounced reduction occurred in the mid-1990s, but consumption then rose again. Consumption has decreased over the last 3 years, in part because of an aggressive leak repair program and attention to cooling-tower operations.

7.3. Waste Stream Analysis

Consumptive use of water leads to evaporation or discharge following use. At the Laboratory, NPDES and GW permits control most discharge of wastewater. Of all the water that comes onto the site, approximately half is evaporated. That which is not evaporated is eventually discharged. Of the discharged water, 88% is regulated by NPDES/GW permits. The remaining 12% of discharges are not regulated. Figure 7-5 shows the distribution of water discharge and loss at the Laboratory.

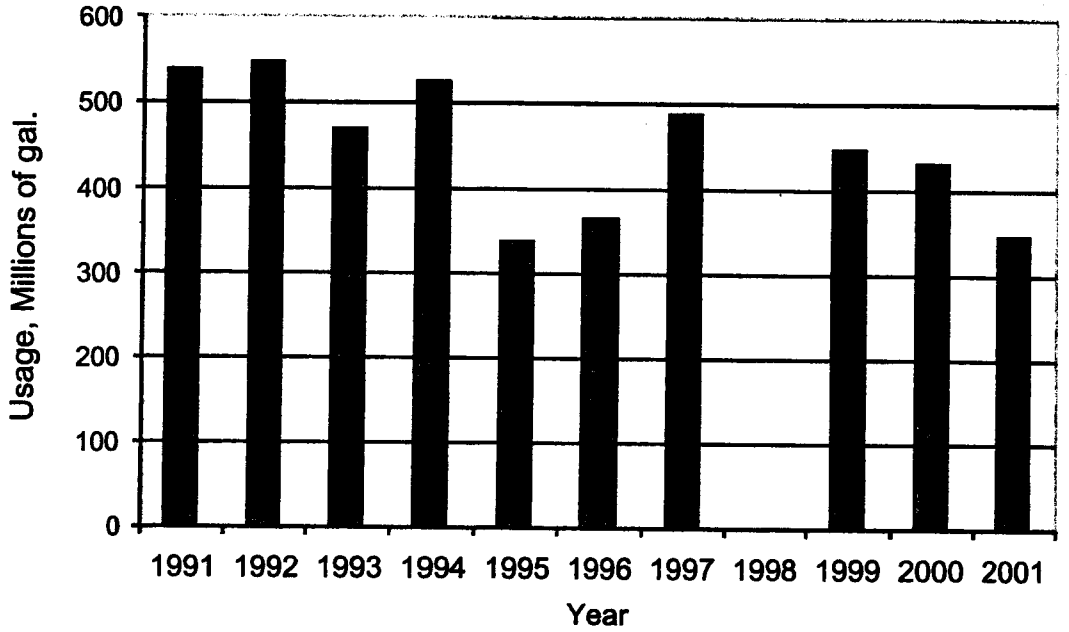

Fig. 7-4. Water usage by year.

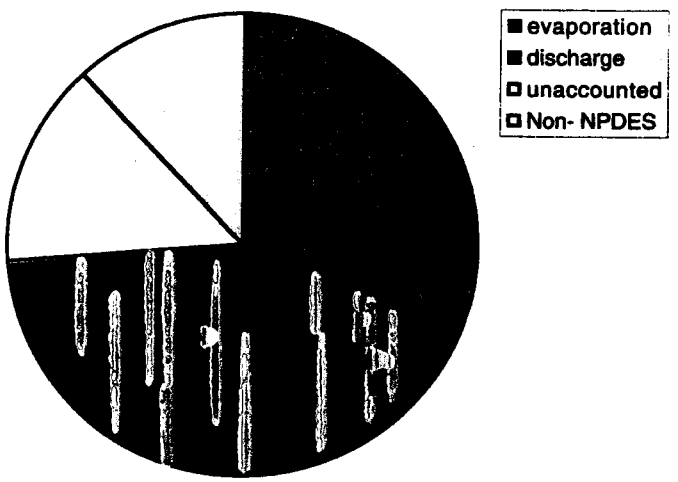

Fig. 7-5. Water discharge and losses.

The following wastewater streams are associated with water use at the Laboratory.

- Evaporation—Many water uses at the Laboratory involve some evaporation. Some uses, such as cooling towers, involve large losses through evaporation.
- NPDES-Regulated Discharges—These are discharges from cooling towers, cafeterias, domestic use, research activities, laboratories, steam plants, etc. Much of this water is treated before discharge, either within the Sanitary

Waste System (SWS) plant or in a specialized treatment plant such as the High Explosives Wastewater Treatment Plant.

- Non-NPDES-Regulated Discharges—These discharges occur through those activities exempted from the NPDES. They include discharges from landscaping and construction.

- Unaccounted Use—This waste stream is water is drawn from the water supply but that either does not enter a Laboratory-consumptive-use process or is not accounted for in that use. The quantity of water drawn from wells is reasonably well known, and the water use at the Laboratory can be estimated. Usually ~10% to 15% of the water drawn from the water supply cannot be accounted for. The sources of this apparent loss could be inaccuracies in the use estimates, leaks in the distribution system, or a combination of these and other uncertainties. With the current metering system, it is not possible to estimate the size of this stream reliably or to find the source of the losses.

7.4. Improvement Projects

Several measures could be implemented to reduce the quantities of water used, improve the life of the aquifer, and reduce the environmental impact from water use. The projects, which are intended to reduce water consumption and increase the efficiency of use, are classified as completed, ongoing, or unfunded.

7.4.1. Completed Projects: Water System Leak Survey and Repair

A survey of leaks in the main water distribution system has been conducted, and repairs have been completed. Based on measurements made at the time of repair, ~46 million gallons of water will be saved annually.

7.4.2. Ongoing and New FY02 Projects

Cooling-Tower Water Conservation (CTWC) Project. The CTWC Project, funded by the Nuclear Weapons/Infrastructure, Facilities, and Construction Program Office, will reduce the total amount of water used in cooling towers even as the new Strategic Computing Complex (SCC) comes on line in 2002. The CTWC Project is a $4 million program that has been initiated to seek the best commercial technologies for improving cooling-tower-water use. The Laboratory issued a Request for Proposal (RFP) to industry to pilot water conservation technologies on large-scale cooling towers with both potable and treated sanitary wastewater. The pilot phase is complete, and the results have been evaluated. The Laboratory will construct a building containing water filtration/treatment process equipment. This equipment will remove particulates from treated sanitary wastewater in the sewage treatment plant at TA-46 for reuse in cooling towers at TA-3. The plant is expected to be on line in FY03. Phase I of the project will supply filtered water to the SCC and (depending on available funding) the LDCC/CCF. Phase I of the project is fully funded. The FY05 Phase II of the project expands the filtration facility to accommodate the expanded need of the SCC. This phase has not been funded, although the Los Alamos Program Office and ESO are evaluating funding options. Tables 7-1 and 7-2 provide the savings in water use that is expected if both phases are funded.

TABLE 7-1
LABORATORY WATER USE WITHOUT THE TREATMENT FACILITY (Mgal.[a]) (ASSUMES TWO CYCLES OF CONCENTRATION)

Cooling Tower	Current	FY02–04	FY05
SCC	0	51	151
LANSCE	111	111	111
LEDA[b]	21	21	21
LDCC/CCF	28	28	28
Power Plant 29-Mgal. Boiler Makeup 53-Mgal. Cooling Tower	82	82	82
General Usage	318	318	318
Total	560	611	711
With SWS Reuse	53	53	53
Total	507	558	658

[a]Mgal. = millions of gallons.
[b]LEDA = Low-Energy Demonstration Accelerator.

TABLE 7-2
LABORATORY WATER USE WITH THE TREATMENT FACILITY (Mgal.) (ASSUMES 10 CYCLES OF CONCENTRATION)

Cooling Tower	Current	FY02–04	FY05
SCC	0	28	83
LANSCE	111	111	111
LEDA	21	21	21
LDCC/CCF	28	15.	15
Power Plant 29-Mgal. Boiler Makeup 53-Mgal. Cooling Tower	82	82 28-Mgal. Boiler Makeup 54-Mgal. Cooling Tower	82
General Usage	318	318	318
Total	560	574	629
With SWS Reuse	53	72	99
Total	507	502	530

A water savings of this magnitude means that water to outfalls will be reduced. The FY03 phase of the Cooling-Tower Water Treatment Project reduces the water to the NPDES/GW-permitted outfalls of less than 20% and will have no impact on the wetlands supported by the outfalls. The wetlands impacts will need to be evaluated before Phase II implementation. Estimates are slightly different than those provided by

the Laboratory SWEIS. They are based on the most recent operating experience, but it should be understood that the estimates provided in the SWEIS are the official projections.

SCC Cooling Towers Use Treated Sanitary Wastewater. The SCC will come online in January 2002. Because of the significant water required to cool the computers in this facility, the SCC has committed to using treated sanitary wastewater in the cooling towers. The SCC will not increase the Laboratory's net water use. After the CTWC Project comes online, the SCC will use filtered treated sanitary wastewater, thus improving the efficiencies of the cooling towers.

Use of Environmentally Beneficial Plantings. Environmentally beneficial and economical landscaping is required, where appropriate, by EO 13123. The Laboratory currently has no plans to replace existing plantings, but the Engineering Manual requires that all new construction projects plant native vegetation landscaping. This project will not reduce current water usage but will limit future growth in water use.

Water Metering Project. The Laboratory has few water meters installed on facilities or systems. To better understand the water use at the Laboratory, the Water Metering Project is underway. This project will meter significant water users, such as large cooling towers. The project is ongoing and will not in itself save water but will allow more efficient management of water resources.

Small-Cooling-Tower Upgrades. Through the pilots for the CTWC Project, the Laboratory learned that towers can achieve three cycles of concentration (when using potable water) without fouling if the towers have high-quality control systems. The Laboratory has approximately 40 small cooling towers running at 1 to 2 cycles of concentration and using ~163 million gallons of water per year. Upgrading these cooling towers with superior control systems will save 49 to 82 million gallons of water per year. The ESO has funded [using Generator Set Aside Funding (GSAF)] facility personnel from TA-35 and TA-48 to install control systems on their high-profile cooling towers in FY02. In addition to reducing the water use at these facilities, the improved control systems will reduce the labor and hazardous waste generated in cleaning heat exchangers. This project will provide an on-site evaluation of different control systems for large (greater than 500 tons) cooling towers and small air washers.

Upgrading Cooling-Tower Operations and Maintenance Manual and Los Alamos National Laboratory Engineering Manual. The evaluation of the small-cooling-tower control systems at TA-35 and TA-48 will help determine which control systems are appropriate for the differently sized towers. ESO and FWO then will distribute this information throughout the Laboratory via the Cooling-Tower Operations and Maintenance Manual and the Los Alamos National Laboratory Engineering Manual. These two manuals will require implementation of cooling-tower upgrades for all new cooling systems and for all large maintenance upgrades.

7.4.3. Unfunded Projects

LANSCE Cooling-Tower Control System Upgrades. LANSCE has three large cooling towers (two supporting LANCE and one supporting LEDA). These towers are operating at 1 to 2 cycles of concentration using ~110 million gallons of potable water

yearly. Because this facility is geographically distant from the CTWC Project, it will not have access to the treated sanitary wastewater to increase the cycles of concentration to 10. This facility is working to increase cycles through better control systems. The facility personnel will install control systems on the three cooling towers in FY02 to achieve three cycles of concentration. This water conservation initiative will save 33 to 50 million gallons of potable water annually.

Import Los Alamos County Waste Water. The TA-46 SWS plant is operating so far below design capacity that the digester microbes are vulnerable to starvation during holidays and to die-off from small quantities of toxic influents. Mildly toxic substances such as wax stripper in mop water and mop-water detergent currently cannot be sent to the SWS plant because of the microbes' vulnerability. Larger volumes of sanitary waste would reduce the vulnerabilities of the SWS plant. The Los Alamos County wastewater treatment plant is running at >80% capacity and is in danger of reaching full capacity in the near future. The transfer of Los Alamos County Western-Area residential wastewater to the Laboratory's wastewater plant would reduce that plant's vulnerability and provide an additional 65 million gallons per year of SWS effluent for reuse in cooling towers. This project benefits both the county and the Laboratory. Two aspects of this project require funding: (1) modifying the Laboratory infrastructure to get the wastewater to the SWS plant and (2) upgrading the CTWC facility and upgrading infrastructure to get the additional treated water to the cooling towers.

Survey and Repair Leaks in the Piping in the Water Drainage System. The Laboratory has conducted camera inspections of the 50 miles of sewer lines and has concluded that as much as 25% of the lines may be subject to leakage. There have been no measurements to date of the losses to leakage from the sewer system.

Small-Cooling-Tower Upgrades Throughout the Site. The ESO has funded cooling-tower control system upgrades for TA-35 and TA-48. Over 30 other small cooling towers at the Laboratory need to be assessed and upgraded to increase water efficiencies. The new requirements in the Cooling-Tower Operation and Maintenance Manual and the Engineering Manual will be a step toward implementing these upgrades. Without funding, these manuals will be able to incorporate only the requirements on new cooling towers and on cooling towers undergoing major upgrades.

The use of water at the Laboratory is projected to grow steadily over the next 5 years as either new capabilities come online or existing capabilities are expanded. Increased electrical usage and the necessity to remove heat generated by the electricity largely will drive increased water consumption. The magnitude of the increased water use is uncertain, but the projects described in this section can act to reduce some water consumption. Figure 7-6 shows the impact of the proposed projects on the Laboratory's entire consumption of water in millions of gallons for FY05. These charts show that the funded initiatives alone have a significant impact on the Laboratory's use, but by including the unfunded initiatives, the Laboratory has water security for unknown mission needs.

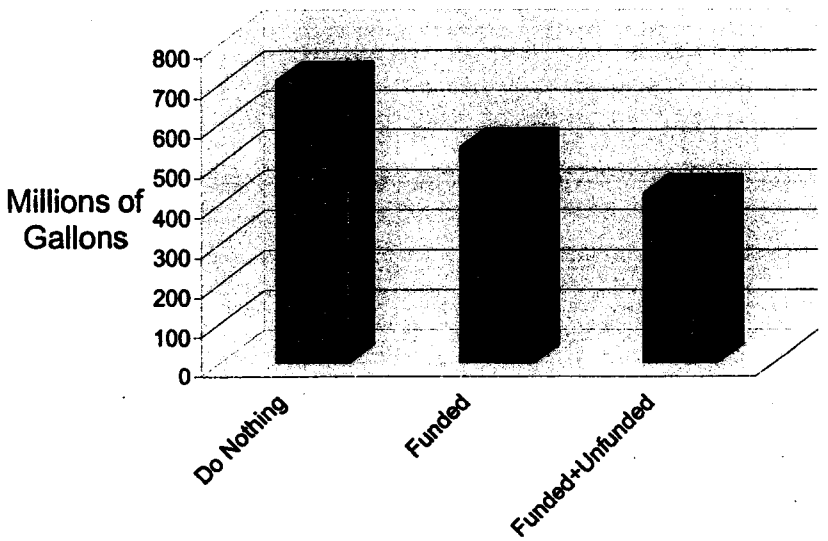

Fig. 7-6. Impacts of proposed projects on Laboratory's water consumption.

7.5. FY02 Performance Metrics

To ensure that the ESO exhibits continuous improvement in meeting the Laboratory's waste minimization goals, the ESO has established performance metrics for the individual waste streams. These metrics will be used to measure performance throughout the year to assess progress. A score of 3 has been established for each completed project having a significant impact on a waste stream. Scores of 1 or 2 are assigned to projects with minimum waste-stream impact or to the completion of major milestones. The metrics presented in Table 7-3 have been developed for the water conservation projects.

TABLE 7-3
WATER CONSERVATION METRICS

Initiative (Score)	Comments
CTWC Project Issue Request for Proposal (RFP) (1) Issue contract (2)	This project is expected to be completed in FY03
SCC Cooling Towers Use Treated Sanitary Wastewater Use SWS water (3)	This project will initially save the site 51 million gallons per year. In FY05 it will save the site 151 million gallons per year

TABLE 7-3 (cont)
WATER CONSERVATION METRICS

Initiative (Score)	Comments
Small-Cooling-Tower Upgrades Install control systems at TA-35 (1) Install control systems at TA-35 (1) Analyze and evaluate control system performance (1)	This project will help determine technologies to optimize small-cooling-tower performance
Upgrading Cooling-Tower Operations and Maintenance Manual and Los Alamos Engineering Manual (2)	Upgrading the requirements manuals will cause new and upgraded cooling towers to be as efficient as possible
Use of Environmentally Beneficial Plantings Implement on all new construction projects (1)	Although difficult to quantify, this project will provide ongoing water savings
Water Metering Project Install meters (1)	Installing meters throughout the site will allow the Laboratory to identify unknown large water users and implement conservation measures
LANSCE Cooling-Tower Control System Upgrades Install control systems (2)	This unfunded initiative will save significant water
Import Los Alamos County Waste Water (2)	Taking Los Alamos County sanitary wastewater will allow more efficient SWS operations and save the site 65 million gallons per year
Survey and Repair Leaks in the Piping in the Water Drainage System (1)	Because of the aged infrastructure at the Laboratory, surveying and repairing piping systems will continue to reduce water losses
Small-Cooling-Tower Upgrades Throughout the Site (2)	This unfunded initiative will save the site significant water and allow more efficient operation of cooling towers

REFERENCES

7-1. Thomas P. Starke et al., "Los Alamos National Laboratory 1999 Environmental Stewardship Roadmap," Los Alamos National Laboratory report LA-UR-00-282 (January 7, 2000).

7-2. "The Site Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory," Department of Energy report DOE/EIS-0238 (January 1999).

8.0. ENERGY USE AND CONSERVATION

8.1. Introduction

The continued growth of the Laboratory has required and will continue to require increased energy consumption. The addition of various facilities at the Laboratory, such as the SCC and the Dual Axis Radiographic Hydrodynamic Test (DARHT) second axis, has increased demand significantly. Future projects such as the Advanced Hydrodynamic Facility (AHF) will dramatically increase the demand for electrical energy and for increased load-following capability.[10-1] Access to adequate, reliable power supplies is critical to the continued growth of the Laboratory and particularly to the ability to develop large experimental programs and computing facilities. The consumption of energy at the Laboratory clearly has reached the point where careful planning for the future will be required if growth is to be sustained. The Facility and Waste Operations Utilities and Infrastructure Group (FWO/UI) is responsible for energy planning and managing energy use at the Laboratory. This group also is responsible for the Laboratory's energy conservation program.

Current power demand challenges the existing system capacity so that any future growth of the Laboratory depends on finding practical and cost-efficient solutions to the electrical supply and usage problems. Two avenues for improving the energy supply are conservation and increases in power import or generation capability. Of these two options, conservation is the easiest to implement, will have more immediate results, and will minimize the impact of energy usage on the environment; however, increasing the supply will have a much larger effect on energy availability, as well as on the environment. The Laboratory has been addressing these problems for some time and has taken significant actions, including studying options to increase the power supply and implementation of Laboratory-wide conservation programs. This section investigates the trends in energy usage over time, examines the constraints on such usage, defines problem areas, and explores issues and options for improved performance.

The Laboratory power supply problems are exacerbated by the regional and national situation. Regionally, the northern New Mexico power grid is operating near capacity. If demand increases much beyond current levels, some load shedding may be required across the entire grid. This means that Los Alamos Power Pool (LAPP) could be required to shed its load by curtailing electrical use and shutting down operation in one or more facilities. Nationally, available generating capacity has not kept pace with demand, which, coupled with deregulation, has led to dramatic increases in electrical energy costs. Costs on the open market have risen from about $55/MWh to a capped cost of $250/MWh. If this trend persists, the increase in the cost of electrical energy could alter the strategy for ensuring future energy supplies. At the higher costs, a premium is placed on conservation and on-site generation.

The utility system (water, natural gas, and electricity supply) at the Laboratory is driven by the demand for electrical energy. As energy requirements go up, the demand for cooling water and the volume of effluent discharged at outfalls increases. Most of the Laboratory's consumption of electrical energy manifests itself as heat that must be removed and dissipated. In fact, ~60% of the Laboratory's water is used in cooling

towers. Although the electrical supply can be increased by implementing one or more options, the critical component of the energy/water cycle (i.e., the availability of water) cannot easily be increased (see Section 7, Water Use and Conservation). In fact, the parameter most likely to limit Laboratory growth absolutely is the availability of water. Although the Laboratory currently is far from that limit, additional electrical demand brings the limit closer. Projected increased reliance on the power plant for load following will have a pronounced effect on water use at the Laboratory. The TA-3 power plant most often is used as a power-peaking facility. The facility is aging and is inefficient by modern standards; therefore, its water consumption is large relative to the energy it produces.

The system diagram for the Laboratory consumption of energy and water is shown in Fig. 8-1.

Laboratory operation requires the consumption of water, natural gas, and electricity. Air emissions and effluent discharges result from this consumption. Use of energy and water at the Laboratory is closely coupled. Therefore, the electrical supply system at the Laboratory will be analyzed in this section.

The largest users of electrical energy at the Laboratory are shown in Table 8-1. The top four consumers account for up to 51 MW at coincidental peaks.

The peak electrical demand tends to be seasonal but nearly always is greatest when LANSCE is operating. The peak demand for the last 2 years is shown in Fig. 8-2.

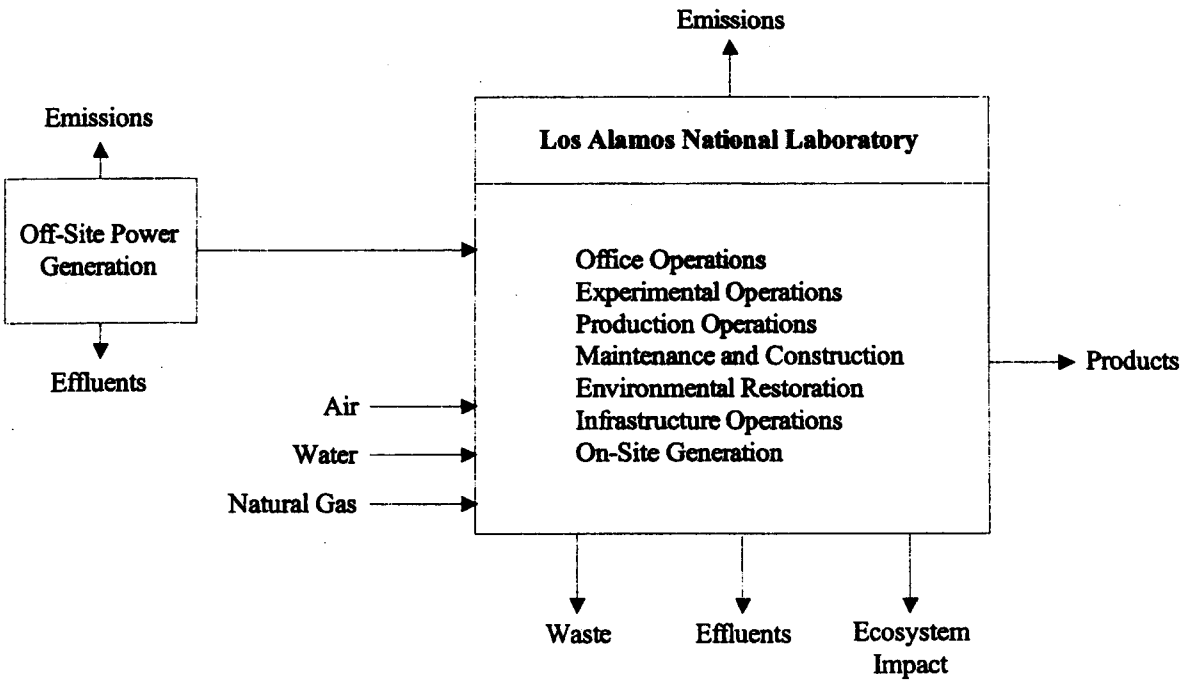

Fig. 8-1. Energy process map for the Laboratory.

TABLE 8-1
ELECTRICAL ENERGY USAGE AT THE LABORATORY

Facility	Electrical Load (MW)	Duration
LANSCE[a]—peak demand	25–32	24 h/d during operation
LANSCE—base load	5–7	24 h/d
Computing (CCF[b] and LDCC[c])	4–5	24 h/d
TA-3[a]	10	5 d/week
TA-55	2–3	24 h/d

[a]Los Alamos Neutron Science Center Experiment.
[b]Central Computing Facility.
[c]Laboratory Data Communications Center.
[d]The above total for Technical Area (TA)-3 **does not** include the 5 MW for the LDCC/CCF. Computing at TA-3 is separate. A 10-MW, Laboratory-wide peak load swing occurs during weekends and holidays.

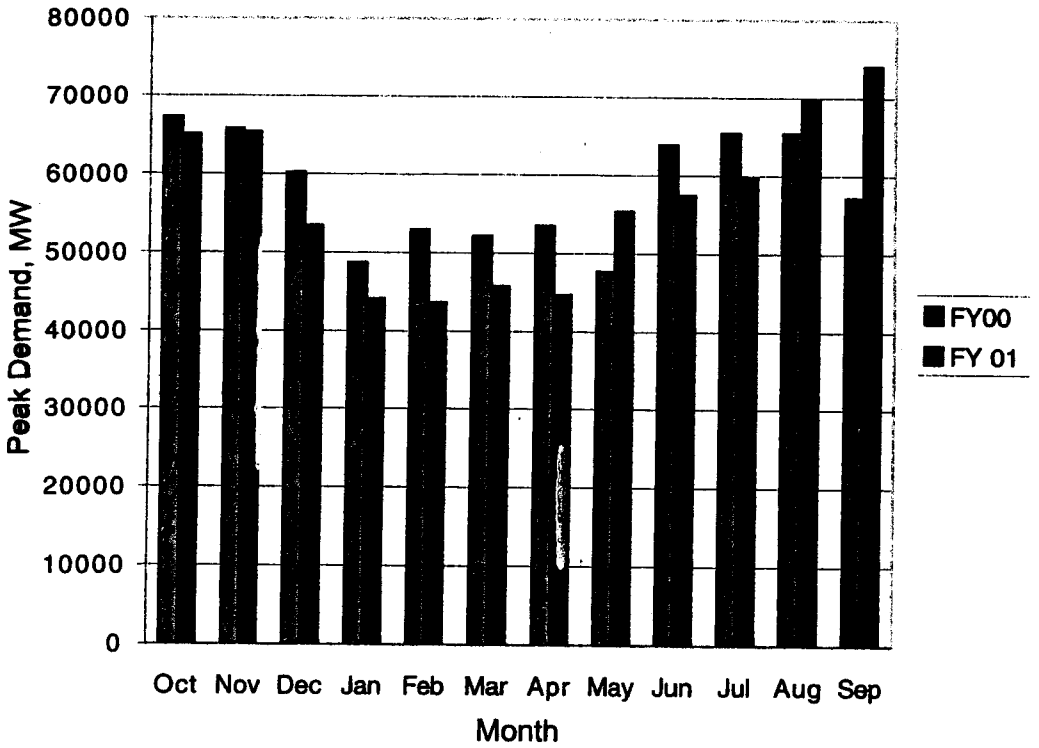

Fig. 8-2. Peak electrical demand.

The peak demand is important in planning for electrical supply because the LAPP has a firm load serving capability that is limited to 82 MW. The portion of the LAPP power supply that relies on regional hydropower is seasonal and during the winter months falls to zero. If the load demand exceeds the load-serving capability, on-site generation is required to make up the deficit. If the LAPP power supply is inadequate for the load demand, LAPP has the option of either buying power on the open market or generating additional power on site. The limitations and options for power supply are critical to the long-term power supply planning process and may also influence the dispatch of power on an hourly basis.

The monthly consumption of electricity at the Laboratory for the past 2 years is shown in Fig. 8-3.

These data in Fig. 8-3 include the LANSCE usage. The Laboratory usage without LANSCE is shown in Fig. 8-4.

8.2. Energy Conservation Performance

Energy usage is not regulated, but the government has established guidelines for government facilities in the *Energy Policy Act of 1992* and in Executive Order (EO) 12902, *Energy Efficiency and Water Conservation at Federal Facilities* (March 8, 1994). EO 12902 mandates a 30% reduction in energy use for agencies by fiscal-year (FY)05 as compared with FY85. The Laboratory has a performance measure in the University of California

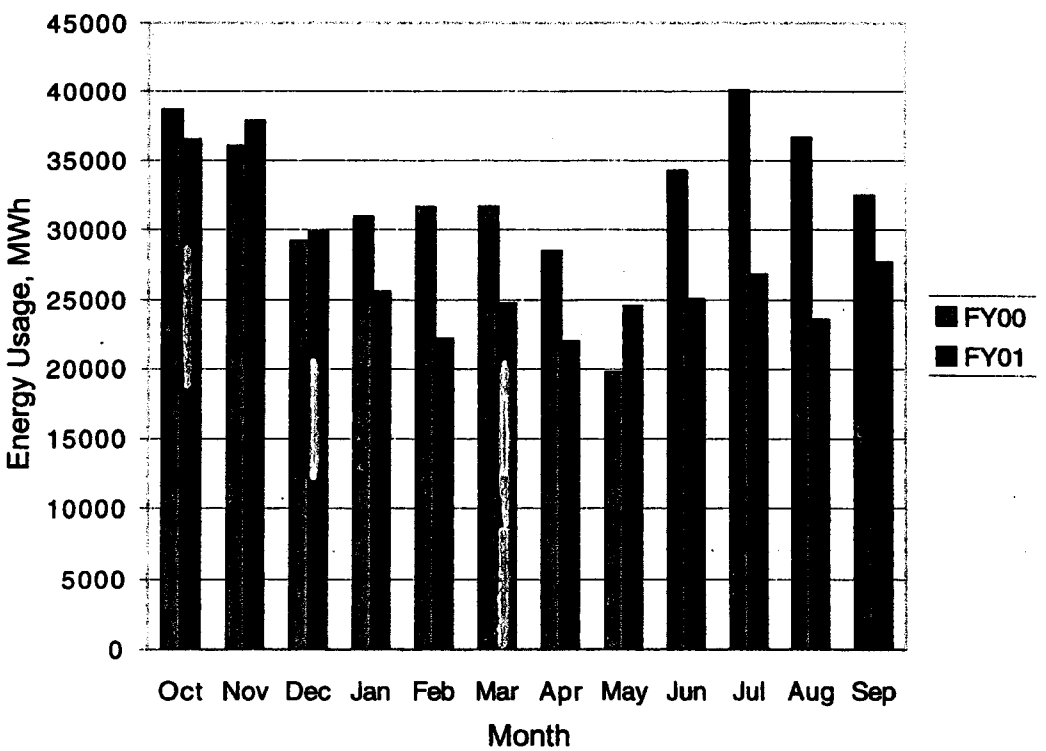

Fig. 8-3. The Laboratory energy usage.

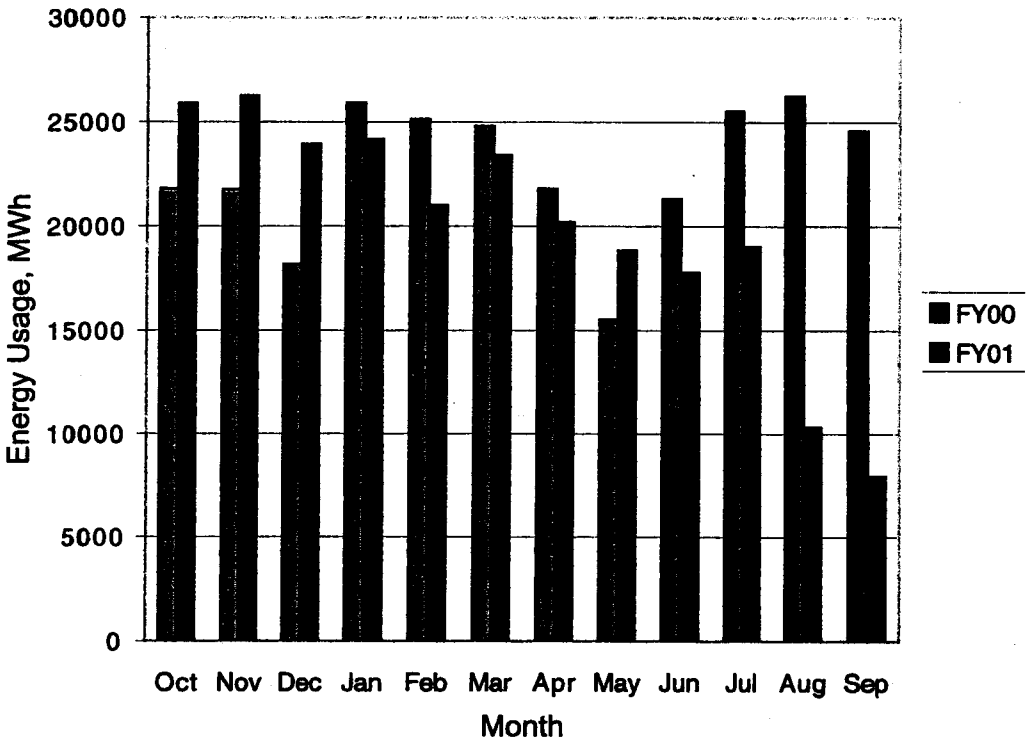

Fig. 8-4. The Laboratory energy usage without LANSCE.

(UC)/Department of Energy (DOE) contract that specifically addresses this reduction. Utility loads associated with the operations of LANSCE (defined as experimental processes) are excluded from this measure. The measure is based on a reduction in energy usage from FY85 levels in British thermal units per gross square feet of building, expressed as a percentage of FY85 energy usage. Total-energy British thermal units includes electricity, natural gas, and liquefied petroleum gas. The performance measure calls for a reduction in FY00 of 25.5% to achieve an outstanding rating. The Laboratory includes electricity, natural gas, and liquefied petroleum gas. The performance measure calls for a reduction in FY00 of 25.5% to achieve an outstanding rating. The Laboratory achieved a 42% reduction from the baseline in total energy in FY99. The available data for energy consumption do not allow the reliable estimation of consumption by division or by user other than the largest users nor does the performance measure require it. Therefore, there is no detailed breakdown of consumption for energy.

The performance data for FY01 were not available at the time this roadmap was prepared but will be reported as part of the annual UC contract appendix performance assessment.

Laboratory electrical consumption is shown by year in Fig. 8-5.

The Laboratory's use of natural gas is limited and tends to be seasonal. The principal use of natural gas is for space heating, although natural gas is burned by the power plant. Natural gas usage is shown for the last two FYs in Fig. 8-6.

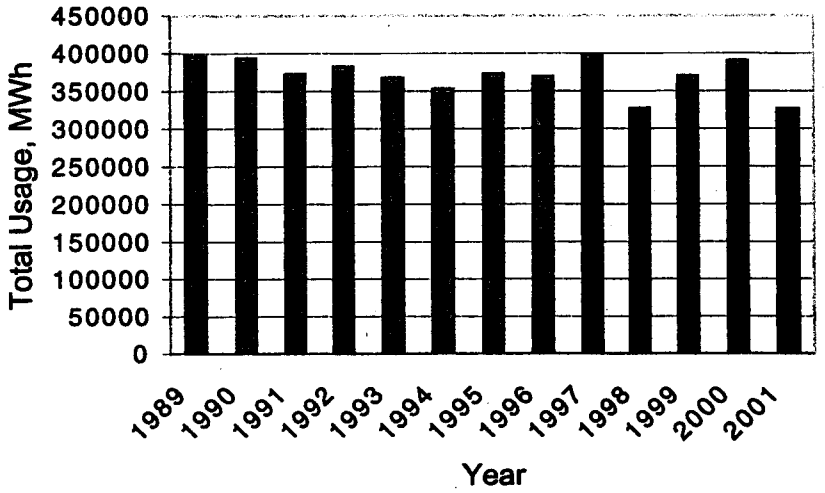

Fig. 8-5. The Laboratory electrical usage.

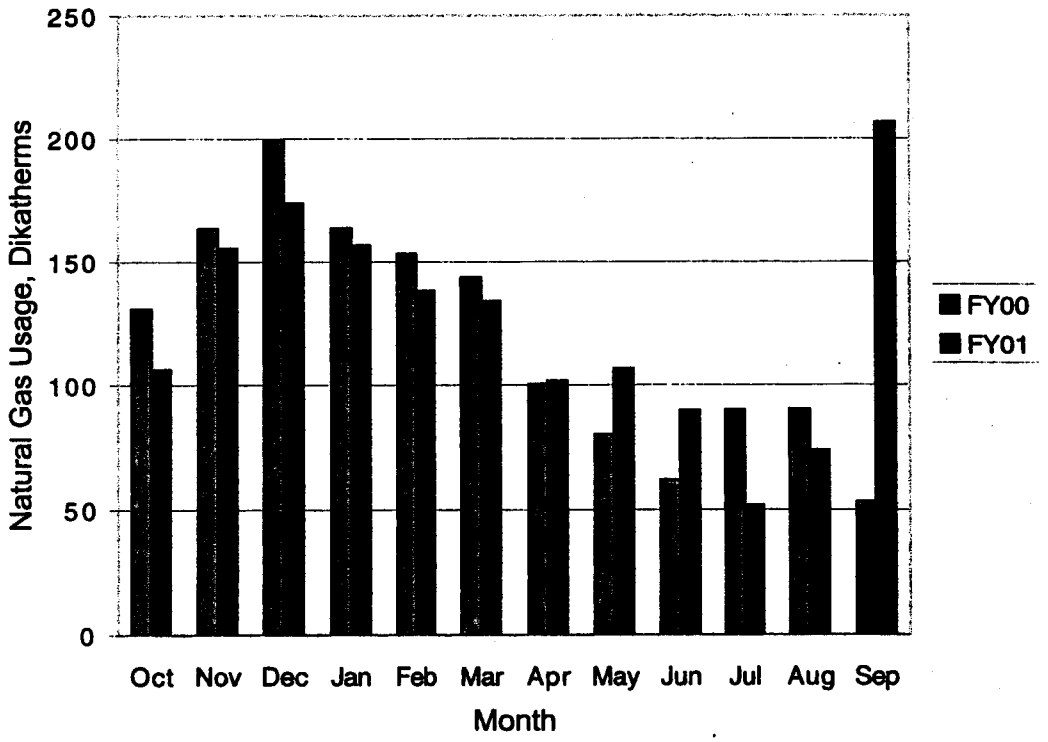

Fig. 8-6. Natural gas consumption at the Laboratory.

8.3. Waste Stream Analysis

The impact of the electricity usage by the Laboratory is at least regional and arguably global. Regional coal and water resources are affected by the necessity to generate power for the Laboratory, and emissions from this generation of power, which although are small in an absolute sense, nevertheless contribute to pollution of the global

atmosphere. The Laboratory cannot function with a significant reduction in electrical usage; in fact, it is probable that the Laboratory will require more electrical power in the future. The increased usage of power directly impacts not only the waste streams associated with power generation, but also water consumption and wastewater discharge. Usage of electricity is a complex system at the Laboratory and is strongly coupled to the consumption of water and emission of pollutants.

Electricity is imported into the Laboratory from off-site sources; however, because peak coincidental demand can exceed the import capacity, it is sometimes necessary to generate power at TA-3 by burning fuel oil or natural gas. Natural gas also is burned to produce steam and hot water for space heating and process support.

The waste streams associated with use of energy at the Laboratory are emissions in the form of industrial gases and wastewater effluent from various cooling towers. Emissions occur on site when the TA-3 power plant is operating and as the result of Laboratory consumption of electricity imported from off site. Emergency power generation and portable generators also produce emissions. The process map element for energy use is shown in Fig. 8-1.

With the exception of water usage in conjunction with on-site generation, the sizes of the waste streams associated with Laboratory electrical usage are not known.

8.4. Improvement Projects

The following projects were identified as potential measures for the improving energy generation, import, conservation, distribution, and reliability at the Laboratory. These projects are divided into three categories: (1) projects completed in the last year, (2) projects currently funded and ongoing, and (3) unfunded proposed projects.

8.4.1. Completed Projects

These are projects that have been completed and/or implemented in the last year.

On-Site Power Generation Study. The laboratory conducted a study to determine the feasibility and cost of replacing or supplementing existing on-site power generating capability. The study established the feasibility of economically supplementing the existing power plant and an RFP has been issued soliciting proposals. The target plant is a 20-MW, simple-cycle-combustion turbine plant.

Turbine #1 Refurbish Project. The laboratory has completed the refurbishment of Power Plant 5-MW turbine #1. The rotor was replaced completely with a modern rotor so that efficiency will be significantly increased.

8.4.2. Ongoing Projects

These projects have been funded and are currently being executed.

WTA Substation Enhancement. A new substation is being put in service at the Western technical area (WTA) site. The transformer will have a maximum capacity of ~56 MW. The new substation will serve to offload the TA-3 substation by providing express feed

to the SCC, S Site, and other facilities now served by the TA-3 substation. The new substation also provides redundancy against loss of the TA-3 substation.

Chiller Replacement. An increase in efficiency will be realized when the older chillers around the Laboratory are replaced with modern and more efficient chillers. Some of the chillers at TA-3 already have been replaced, and the program will continue in the future. A sitewide chiller upgrade will save up to 1.5 MW of power.

Conservation. There is an operational incentive to conserve electricity. As much as 3 to 7 MW of usage could be avoided by implementing simple conservation measures such as "Energy Star" computing. For that reason, the Laboratory has had a conservation program in place for some time.[11-2] Significant savings have been realized as a result of this program. Further savings will be realized, without additional cost, through projects already planned, such as chiller upgrades. The LANSCE 201-MHz upgrade will result in a savings of ~1 MW. Although conservation can never completely solve the peak-demand problem, these measures may be a very effective, short-term remedy. A reduction in demand through conservation will mean that near-term growth will not challenge the firm-load serving capability of off-site import and will reduce the frequency of TA-3 power plant operation. The power plant is a particularly inefficient power producer, and its use has been increasing in response to the growth of peak coincidental demand. It may be possible to save as much as 10 MW through combined conservation efforts.

Combustion Turbine Procurement. The Laboratory has begun the process of procuring a 20-MW, simple-cycle, gas-fired turbine for on-site power generation. The Laboratory has received a proposal as a result of an RFP issued this FY. The project is expected to enter Title Two in FY02, with a turbine in place at TA-3 Bldg. 22 in FY04.

Power Plant Motor Control and Emergency Generator Upgrade. The existing power plant motor control center is being upgraded, and a new 1.1-MW emergency power generator is being installed.

Stack Gas Recirculation System at the Power Plant. A stack gas recirculation system is being added to the power plant. This addition will improve efficiency and reduce the emission of criteria industrial gases.

8.4.3. Proposed Projects

These projects or actions have been proposed to allow further increases in efficiency and reliability. Some currently are unfunded. If implemented, they will provide an additional margin against unexpected and unplanned increases in energy consumption.

Continued Chiller Replacement. Chiller replacement is underway for a significant number of chillers at the Laboratory. However, although many sites are candidates for replacement, no funding is available. Replacement of the chillers at LANSCE would have a significant effect on electrical usage, as would replacement of chillers at TA-48 and the balance of TA-3. Funding has not been identified for these projects. Modern chillers are twice as efficient as the older chillers, and thus, the use of modern chillers represents a significant savings.

Additional Turbine Refurbishment. The Laboratory will perform a study to establish the cost and feasibility of refurbishing another turbine at the power plant. If feasibility and acceptable costs are established, a plan and schedule for the work will be developed.

The existing data and the volatile nature of energy consumption at the Laboratory do not allow reliable comparison of FY05 projected consumption with and without conservation project implementation. However, the implementation of the above projects will reduce peak demand by a minimum of 21 MW.

REFERENCES

8-1. M. Hinrichs and J. Lundberg, "Approaches for Upgrading Electrical Power System Reliability and Import Capability," Los Alamos National Laboratory report LA-UR-96-3882 (August 1997).

8-2. E. Racinez, "Energy Management Plan for Los Alamos National Laboratory, Los Alamos, New Mexico," Rogers and Associates report (December 27, 1996).

APPENDIX A
DEPARTMENT OF ENERGY (DOE) POLLUTION PREVENTION GOALS

On November 12, 1999, the Secretary of Energy issued challenging pollution prevention and energy efficiency (P2/E2) leadership goals to achieve his environmental mission at Department of Energy (DOE) sites. On February 8, 2001, the Laboratory submitted a plan to meet the secretarial P2/E2 leadership goals and described the resource requirements necessary to accomplish that plan. In that plan, the Laboratory proposed to adopt goals that were responsive to the secretarial goals but that in some cases differed from specific secretarial goals because of local circumstances. This section describes the rationale for the proposed goals and the metric the Laboratory has adopted for measuring progress toward the goals.

Goal 1–*Reduce, by 2005, waste from routine operation, using a fiscal-year (FY)93 baseline, for the following waste types:*

- *Hazardous* 90%
- *Low-Level Radioactive* 80%
- *Low-Level Mixed Radioactive* 80%
- *Transuranic (TRU)* 80%

The Laboratory generation of routine hazardous and low-level radioactive waste is at or below the DOE FY05 goal. The Laboratory has committed to maintaining the current level and reducing it where practical. These commitments are documented in the performance measures in Appendix F of the University of California (UC) contract.

Mixed low-level waste (MLLW) generation at Los Alamos National Laboratory (the Laboratory) is very small (only ~5 m^3/yr). Because the generation in the baseline year was low, the DOE FY05 goal is a very low 2.5 m^3.

The DOE 2005 pollution prevention goals require that the DOE complex reduce routine TRU/mixed transuranic (MTRU) waste generation 80% by 2005 compared to a calendar year (CY)93 baseline. The goal of this FY02 TRU waste minimization performance measure is to measure progress against the DOE 2005 pollution prevention goal. However, for the Laboratory, the baseline for determining the reduction goal will be based on TRU waste generation for FY96 through FY99. This period represents the years that Nuclear Materials Technology (NMT) Division operations were fully operational for the entire year. The baseline is determined by taking the average TRU waste generation for FY96–99 which is computed to be 100 m^3. The Laboratory is committed to achieving a 50% reduction in TRU/MTRU waste generation, from 100 to 50 m^3, over the next 4 yr.

Goal 2–*Reduce toxic chemicals subject to toxic release inventory (TRI) reporting by 90% by 2005, using a 1993 baseline.*

The only TRI chemical currently procured or released by the Laboratory is nitric acid. A nitric-acid recycle project is being implemented at TA-55 that should reduce the required procurement of nitric acid below the reportable threshold quantity of 10,000 lb.

Goal 3–*Reduce sanitary waste from routine operations by 75% by 2005 and by 80% by 2010, using a 1993 baseline.*

The difficulty of sanitary waste source reduction combined with the regionally weak market for recycle materials makes achieving the DOE FY05 goal for solid sanitary waste problematic. In addition, many programs that could increase recycle and reduce the volume of waste going to the landfill are not cost effective on a lifecycle cost basis. The Laboratory is working with the DOE to develop a proposed sanitary waste reduction goal of 40% rather than 75%.

Goal 4–*Recycle 45% of sanitary waste from all operations by 2005 and 50% by 2010.*

The recycling of sanitary waste from all sources decreased in FY00, primarily due to the Cerro Grande Fire. The volume of waste generated by the fire was significant and nonrecyclable.

By recycling construction debris it will be possible to achieve the FY05 goal of 45% recycle. The program necessary to achieve this goal will result in no lifecycle savings but will make construction waste such as dirt, rubble, and asphalt available for reuse on-site or locally off-site. This will prevent the material from going to the landfill.

Goal 5–*Reduce waste resulting from cleanup, stabilization, and decommissioning activities by 10% on an annual basis.*

In the last FY, the Laboratory exceeded the 10% reduction in this waste type. Each year a projection of the expected waste is made and a certain volume of that waste is targeted for recycle. The environmental restoration (ER) baseline waste projection is an estimate. Depending on the actual degree of contamination at ER sites, waste generation can vary by significant and unpredictable margins. Although the reduction goal may be met in some years, it will be impossible to meet it in others.

A new program has been proposed that will help increase the recycle rate. This program proposes to recycle some of the dirt generated from materials disposition area (MDA) caps. The volume of soil recycled to MDA caps will vary from year to year, depending on both supplies of soil and demand for MDA capping.

Goal 6–*Increase purchase of Environmental Protection Agency (EPA)-designated items with recycle content to 100%.*

The Laboratory's current rate of affirmative procurement purchases is 93%. A project has been proposed to allow qualification of additional products and to pursue an aggressive education program for Laboratory employees.

Goal 7–*Reduce energy consumption through life-cycle, cost-effective measures by*

- *40% by 2005 and 45% by 2010 per gross square foot of building using a 1985 baseline and*

- *20% by 2005 and 30% by 2010 per gross square foot for laboratories and industrial facilities using a 1990 baseline.*

The Laboratory has proposed unfunded programs that will allow the DOE goals relating to gross building space to be met.

However, many laboratory and industrial spaces are contained in buildings that house other activities, and the energy usage for laboratories is not metered separately. The database for lab spaces is kept as a function of net square footage because of this facility sharing. It is not possible at this time to track energy consumption in laboratory and industrial facilities with any degree of accuracy, and the 1990 baseline data are not available. Therefore, the Laboratory cannot respond to the laboratory and industrial facility goal.

Goal 8–*Increase the purchase of electricity from clean sources.*

The Los Alamos Power Pool (LAPP) exclusively supplies the Laboratory with energy. The LAPP is a partnership of Los Alamos County and the DOE. The Laboratory does not and cannot negotiate for energy supplies independently. Energy supply is the business of the LAPP, not the Laboratory.

Therefore, the Laboratory cannot address this goal.

Goal 9–*Retrofit or replace 100% of chillers with greater than 150 tons of capacity and manufactured before 1984 that use class I refrigerants by 2005.*

The Laboratory has nine chillers qualifying against the 2005 goal. Two are shut down and drained. Funding of $300,000 is required to replace three chillers with new units on hand. An additional $5 million is needed to replace the remaining four.

Goal 10–*Eliminate the use of Class-I ozone-depleting substance (ODS) by 2010 to the extent practical.*

The Laboratory has 32 halon fire protection systems and 14 chillers that qualify against the 2010 goal. No accurate inventory of small chlorofluorocarbon (CFC)-containing equipment exists. Funding is needed to meet the 2010 goal, including finding and replacing all of the small CFC-containing equipment.

Goal 11–*Reduce greenhouse gas emissions from facility energy use by 25% by 2005 and by 30% by 2010 using a 1990 baseline.*

FY 1990 baseline data for greenhouse gas generation do not exist. The earliest year that is practical for baselining data is 1995, and that data will have to be reconstructed from fuel consumption records.

The TA-3 power plant produces approximately two-thirds of all greenhouse gases generated at the Laboratory. The current improvements to that facility will reduce emissions of criteria gases but will not noticeably affect greenhouse gas generation. Reduction of greenhouse gas generation requires burning less fossil fuel, which is most easily accomplished by increasing combustion efficiency. Because efficiency increases at

the TA-3 power plant are not easily accomplished, refitting or replacing the most inefficient boilers at the site provides the best opportunity to reduce greenhouse gas generation. Many boilers and very dirty small generators exist at the Laboratory, which together generate about one-third of the total volume of greenhouse gases. A project has been proposed that would gradually (five boilers per year) replace the most inefficient boilers.

Goal 12–*Reduce vehicle fleet annual petroleum use by 20% by 2005 as compared to 1999.*

Goal 13–*Acquire each year at least 75% of light-duty vehicles as alternative fuel vehicles.*

Goal 14–*Increase the usage rate of alternate fuel vehicles to 80% by 2005 and 90% by 2010.*

The Laboratory fleet probably can reduce its use of petroleum fuels and meet the 2005 goal by purchasing higher-mileage vehicles and by increasing the purchase of bi-fuel or alternate fuel vehicles.

The ability to meet Goal 13, related to alternate fueled vehicles, is impeded by the lack of both local and regional infrastructure for such vehicles. Even with planned improvements in local infrastructure, the ability to make trips off-site is restricted severely by a lack of regional infrastructure. Most alternate fuel vehicles (AFVs) are marginally capable of making a round trip to Santa Fe, New Mexico (~45 road miles from Los Alamos), and many people will not take the risk of running out of fuel. The utility and availability of AFVs in the current environment are severely limited, and a replacement rate of 75% will not be possible. An alternate goal of 62% has been adopted.

The Laboratory no longer believes that this goal should apply to the vehicle fleet. All Laboratory-operated AFVs are owned by the General Services Administration (GSA), which sets the policy for AFV use. AFV fuel consumption is separately tracked and reported by the GSA.

These pollution prevention goals are embodied in the UC contract Appendix F performance measures. Those performance measures for FY02 are contained in Section 1.2.c of Appendix F.