UCRL-CR--105455

DE91 005435

FINAL DRAFT

MIXED WASTE STUDY
LAWRENCE LIVERMORE NATIONAL LABORATORY
HAZARDOUS WASTE MANAGEMENT
FACILITIES

Prepared for:

Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94550

Prepared by:

Science Applications International Corporation
4900 Hopyard Road, Suite 310
Pleasanton, California 94588

November 1990

88464/MWC/toc

EXECUTIVE SUMMARY

The storage and management of mixed waste at Lawrence Livermore National Laboratory (LLNL) and the Hazardous Waste Management (HWM) Division is the focus of this report. An analysis and estimate is provided for the period of time remaining until mixed waste storage at HWM facilities reaches maximum operational capacity. The analysis is based on regulations governing mixed waste storage, quantity and type of mixed waste currently in HWM facilities, past and present mixed waste generation rates, and future projections.

This mixed waste study documents, analyzes, and summarizes information drawn from several document and database sources. Documentation includes current Department of Energy (DOE) and Environmental Protection Agency (EPA) regulations, a detailed inventory of currently stored mixed waste from the HWM computerized database of non-transuranic radioactive waste, historical HWM file data and correspondence related to mixed waste, and a review of Resource Conservation and Recovery Act (RCRA) permitted storage facilities at LLNL. The evolving EPA regulations and DOE Orders as they pertain to mixed waste are also presented.

From the HWM database report, currently stored low-level mixed waste volume at HWM is calculated as 464 yd^3, based on container volumes for solids and reported gallon quantities for liquids. As of October 17, 1990, mixed waste may be located in eleven storage units operated by HWM in accordance with interim status standards. Mixed waste stored in Area 612-1 comprises approximately 50% of the total currently stored. Additionally, significant amounts of mixed waste are stored in Areas 612-5 and 514-2.

EPA characteristic wastes and spent solvents represent 84% by volume of low-level mixed waste currently stored at HWM. Accumulation of mixed waste in storage had steadily increased to approximately 377 yd^3 by the end of 1989. The 1990 year-to-date (October 17, 1990) total already exceeds the 1989 yearly total by 30%. Based on the HWM mixed waste storage capacity and amounts now stored and being generated, it is estimated that operating capacity will be reached in 2.2 years for solid mixed waste and in 2.6 years for liquid mixed waste (before any liquid treatments). Approximately

25% of solid mixed waste capacity and 43% of liquid mixed waste capacity are available. This estimate is subject to change depending on actual realized storage capacity, effectiveness of LLNL's waste minimization program, future program changes that affect generation rates, and improvements in waste treatment capabilities. This remaining capacity also includes space that is available for low-level waste (LLW). Therefore, any increase in LLW storage amounts will decrease the remaining capacity available for mixed waste.

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1.0 INTRODUCTION

This document addresses the generation and storage of mixed waste at Lawrence Livermore National Laboratory (LLNL) from 1984 to 1990. Additionally, an estimate of remaining storage capacity based on the current inventory of low-level mixed waste and an approximation of current generation rates is provided.

Section 2 of this study presents a narrative description of Environmental Protection Agency (EPA) and Department of Energy (DOE) requirements as they apply to mixed waste in storage at LLNL's Hazardous Waste Management (HWM) facilities. These requirements were promulgated by the Resource Conservation and Recovery Act (RCRA), Hazardous and Solid Waste Amendments (HSWA), DOE Orders 5820.2A (DOE, 1988) and 5400.3 (DOE, 1989) and NVO-325 (DOE/NV, 1988), as well as several EPA Notices published in the *Federal Register.*

Based on information collected from the HWM non-TRU radioactive waste database, Section 3 presents a data consolidation -- by year of storage, location, LLNL generator, EPA code, and DHS code -- of the quantities of low-level mixed waste in storage. Related figures provide the distribution of mixed waste according to each of these variables.

A historical review follows in Section 4. The trends in type and quantity of mixed waste managed by HWM during the past five years are delineated and graphically illustrated.

Section 5 provides an estimate of remaining low-level mixed waste storage capacity at HWM. The estimate of remaining mixed waste storage capacity is based on operational storage capacity of HWM facilities and the volume of all waste currently in storage. An estimate of the time remaining to reach maximum storage capacity is based on waste generation rates inferred from the HWM database and recent HWM documents.

A current listing of mixed waste from the HWM database supplements this report as Appendix A. Appendix B consists of five reference volumes of historical mixed waste data and related correspondence.

2.0 SUMMARY OF EPA REGULATIONS AND DOE ORDERS REGARDING MIXED WASTE

This section provides a brief discussion with definitions of key components of mixed waste and a summary of current DOE and EPA regulations. The bulk of information in Section 2.1 regarding the dual regulation of mixed waste is drawn from the EPA's "Mixed Waste Training Course Supplemental Information" (EPA, 1990). Section 2.2 summarizes Nevada Test Site (NTS) waste acceptance criteria and certification and transfer requirements (DOE/NV, 1988). Sections 2.3 through 2.5 summarize specific regulations that govern storage and disposal of mixed waste.

2.1 REGULATORY AUTHORITIES FOR MIXED WASTES

Mixed waste is defined as waste that contains both radioactive and hazardous components. The radioactive components of mixed waste are defined by and regulated under the Atomic Energy Act (AEA), as amended, which is administered by the U.S. Nuclear Regulatory Commission (NRC); DOE facilities must also comply with DOE regulations promulgated under this Act. The hazardous components of mixed waste are defined and regulated under RCRA, which is administered by the EPA. LLNL also handles California-listed hazardous materials not regulated under RCRA. Currently, RCRA does not regulate the radioactive component of mixed waste. Under Section 1006 of RCRA, precedence is given to AEA requirements if the regulations are inconsistent.

In states that do not have the authority to administer and enforce a hazardous waste management program under Subtitle C of RCRA, mixed waste is regulated by EPA. In EPA authorized states, a Memorandum of Understanding (MOU) defines the roles of state agencies regulating hazardous and radioactive wastes.

Source, special nuclear, and by-product materials are radioactive materials regulated by the DOE under the AEA; RCRA specifically excludes these materials from regulation. However, when waste containing source, special nuclear, or by-product

materials also contains hazardous waste, the mixed waste becomes subject to regulation under both RCRA and the AEA.

2.1.1 Definitions of Nuclear Material and Waste Types

Radioactive material as defined by the AEA (and reflected in DOE Order 5400.3) includes source material, special nuclear material, and by-product material. These are defined as follows:

- **Source material** is defined as uranium, thorium, or any other material that under the provisions of the AEA is determined to be source material. Furthermore, ores containing one or more of the above materials in such concentrations as determined under the AEA are also classified as source material.

- **Special nuclear material** is defined as plutonium, ^{233}U, or ^{235}U, and any other material that is determined under the AEA to be special nuclear material but which does not include source material. Secondly, any material that is artificially enriched by any of the above, but which does not include source material, is also special nuclear material.

- **By-product material** is defined as any radioactive material (except special nuclear material) yielded in, or made radioactive by exposure to, the radiation incident to the process of producing or utilizing special nuclear material (Definitive Paragraph 11(e)1, AEA, 1954); or the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content (Definitive Paragraph 11(e)2, AEA, 1954). By-product material includes industrial and medical radionuclides and uranium and thorium mill tailings.

Radioactive waste is categorized according to its content and/or to the process that generated it. These categories include the following:

- **Transuranic (TRU) waste** is defined as waste which is contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/gram at the time of assay, without regard to source or form.

- **High-level radioactive waste** is defined as the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid, that contains a combination of TRU waste and fission products in concentrations requiring permanent isolation.

- **Spent nuclear fuel** is that material which is withdrawn from a nuclear reactor following irradiation, but has not been reprocessed to remove its constituent elements.

- **Low-level radioactive waste** (LLW) is defined as waste that contains radioactivity and (1) can be classified as: a low specific activity (LSA) waste as defined in 49 CFR 173.403 with the exception that there is no lower concentration limit, a limited quantity of radioactive material as defined in 49 CFR 173.403, a radioactive Type A quantity as defined in 49 CFR 173.431, or a radioactive quantity transported in accordance with Type B packaging requirements as defined in 49 CFR 173.403; and (2) is not classified as high-level waste, TRU waste, uranium or thorium mill tailings, mixed waste, or spent nuclear fuel. Test specimens of fissionable material irradiated for research and development only, and not for the production of power for plutonium, may be classified as LLW, provided the activity concentration of transuranic nuclides is less than 100 nCi/g. This definition encompasses DOE, Department of Transportation (DOT), NRC, and DOE/Nevada Operations Office (DOE/NV) NVO-325 definitions as applicable to LLNL waste streams. Low-level mixed waste is defined in this document as waste that is low-level and contains a hazardous component as defined by 40 CFR 261 or 22 CCR, Chapter 30, Articles 9 and 11.

- **Mixed waste** is defined as waste containing both a radioactive component (low-level or TRU) as defined by the AEA and a hazardous component as defined by either RCRA or 22 CCR, Chapter 30, Articles 9 and 11.

Of the radioactive waste categories presented above, only TRU waste and LLW are presently generated at LLNL in combination with a hazardous constituent to form mixed wastes.

2.1.2 Dual Regulation of Mixed Waste

Congress intentionally created a framework of dual regulation for mixed waste. Consequently, EPA (or authorized states) and NRC/DOE jointly regulate the same

waste. DOE is primarily responsible for exercising AEA authority over DOE government-owned and contractor-operated facilities.

2.1.2.1 Onset of RCRA Regulation. There have been three *Federal Register* clarifications establishing dual regulation of mixed waste. The first, on July 3, 1986 (51 FR 24504), clarified RCRA applicability to mixed waste by providing EPA's legal interpretation of the source, special nuclear, and by-product material exclusion and required states to obtain authorization for mixed waste regulation. The second, on May 1, 1987 (52 FR 15937), provided DOE's clarification of the definition of by-product material for the purposes of determining the applicability of RCRA. This clarification applies only to 11(e)1 by-product material (see Section 2.1.1). Significantly, only the actual radionuclides, and not the entire amalgamation of radioactive material, are considered to be by-product material. Therefore, RCRA has the authority to regulate any hazardous portion of the waste material. The third clarification, on September 23, 1988 (53 FR 37045), stated that hazardous waste treatment, storage, and disposal facilities (TSDFs) that manage mixed waste must obtain RCRA interim status. TSDFs may continue to operate under interim status until a final permit is issued or denied.

EPA extended the interim status qualification deadline for TSDFs that handle mixed waste. This extension thereby allowed newly regulated mixed waste facilities to continue to operate legally under RCRA provided that completed notification and Part A permit applications were submitted to EPA for those facilities in accordance with specified deadlines. In California, and other non-authorized states, this deadline for TSDFs handling mixed waste was extended to March 23, 1989.

2.1.2.2 DOE Orders and Operations. Orders, such as DOE Order 5400.3, "Hazardous and Radioactive Mixed Waste Program" (DOE, 1989), are the internal policies for compliance with environmental requirements at DOE facilities. DOE Orders set forth requirements for the management of radioactive waste, including both TRU mixed waste and low-level mixed waste, in accordance with the AEA. The Orders also stipulate management methods for the hazardous portions of mixed waste as stated in RCRA.

TRU mixed wastes at LLNL are managed on-site for eventual disposal at the as yet unopened Waste Isolation Pilot Plant (WIPP) facility near Carlsbad, New Mexico. WIPP is to be dually regulated by DOE and EPA. WIPP has recently been granted an exemption from the RCRA land disposal restrictions (LDRs) through a no-migration petition. Such an exemption may be granted by EPA if it is demonstrated that there will be no migration of hazardous constituents from the disposal unit for as long as the wastes remain hazardous. EPA previously issued (April 6, 1990) a notice of proposed decision to grant WIPP a conditional variance for testing and experimentation.

In contrast to TRU mixed waste, low-level mixed waste must be disposed of on-site or at a DOE disposal site (i.e., NTS). LLNL has no plans to dispose of any mixed waste on-site. Low-level mixed and TRU mixed waste are currently being stored and awaiting proper treatment on-site until the NTS and WIPP disposal options become available. Currently, NTS cannot accept low-level mixed waste from any DOE facility, as further discussed in Section 2.2.

2.1.3 California Department of Health Services, State of California

The California Department of Health Services (DHS) has issued a MOU between the Environmental Health Division and the Toxic Substances Control Program, dated July 20, 1990, stating that the Environmental Health Division will take lead agency status regarding the management of mixed waste in California. The DHS Toxic Substances Control Program, which regulates hazardous waste in California, has been requested in the MOU to lend assistance with the storage, treatment, and disposal of mixed waste. However, to date, no regulations have been written governing the management of mixed waste in the state. Currently, the State of California does not have authority to regulate mixed waste at LLNL.

Radioactive waste that contains a non-RCRA hazardous component that *is* regulated as hazardous by California is termed a "California-only mixed waste." This mixed waste study includes California-only mixed waste that is stored at HWM facilities, i.e., waste that does not have an EPA Code but does have an assigned California DHS Code.

2.2 NEVADA TEST SITE DEFENSE WASTE ACCEPTANCE CRITERIA, CERTIFICATION, AND TRANSFER REQUIREMENTS (NVO-325)

NVO-325 establishes DOE/NV defense radioactive waste acceptance criteria and requirements for waste certification and transfer (DOE/NV, 1988). The policy of DOE/NV is to receive, store, and dispose of radioactive waste generated by DOE defense programs in a manner consistent with DOE Order 5820.2A, "Radioactive Waste Management" (DOE, 1988).

All mixed waste generated by LLNL is considered to be defense-related radioactive waste and must be disposed of at a DOE disposal facility. Currently, NTS is the only DOE disposal facility available. Although one of the functions of NTS includes low-level mixed waste disposal, it cannot accept any radioactive waste from LLNL until LLNL demonstrates compliance with NVO-325.

NTS cannot currently accept low-level mixed waste from any DOE facility until agreement on variances from RCRA-Permit Application Requirements can be resolved with the State of Nevada and the EPA. NVO-325, however, defines requirements and criteria for acceptance should shipments be allowed to resume in the future. Specific requirements in NVO-325 for acceptance of low-level mixed waste include requirements for waste characterization, certification, packaging, marking, and labeling. Section 2.2 of NVO-325 describes the general waste form criteria for NTS acceptance of LLW and also specifies "Additional Criteria for Mixed Waste." These additional criteria require the following:

- Required treatment must be performed prior to shipment to NTS.
- LDR waste will not be accepted unless treated as specified in 40 CFR 268.
- Reactive or ignitable waste that has not been treated according to 40 CFR 264.312 must be reviewed for acceptance (or denial thereof).
- Mixed waste must not contain free liquids.
- PCB-contaminated waste will not be accepted except in certain low concentrations.

NVO-325 states that the mixed waste generator is responsible for identifying each mixed waste stream and for providing proper waste characterization information. Furthermore, when sampling mixed waste, the generator must sample in accordance with EPA requirements and methods. In addition, the hazardous characteristics and constituents of each mixed waste must be identified on a Waste Stream Characterization Data Sheet.

2.3 RADIOACTIVE WASTE MANAGEMENT, DOE ORDER 5820.2A

DOE Order 5820.2A (DOE, 1988) establishes policies, guidelines, and minimum requirements for managing radioactive wastes, mixed wastes, and contaminated facilities. Requirements for LLW management include those for waste generation reduction, waste characterization, waste treatment, waste shipment, waste storage, environmental monitoring, and recordkeeping. The Order states that DOE low-level mixed waste shall conform to the stated LLW requirements and shall also be regulated under RCRA. Furthermore, the preparation of an annual Waste Management Plan that describes both radioactive and mixed waste management operations is required.

2.4 HAZARDOUS AND RADIOACTIVE MIXED WASTE PROGRAM, DOE ORDER 5400.3

The regulations stated in DOE Order 5400.3 (DOE, 1989) stipulate DOE policies and requirements for the management of hazardous and radioactive mixed wastes, including compliance with the requirements of RCRA and the AEA. RCRA is applied to the extent that it is consistent with the AEA. DOE Order 5400.3 reiterates the dual regulation of mixed waste by the DOE (radioactive component) and EPA (hazardous component).

2.5 RESOURCE CONSERVATION AND RECOVERY ACT (EPA, 1976)

RCRA established the framework for the regulation of solid wastes, including those which are designated as hazardous. It also established the regulation of waste management facilities via a permitting program, including required approvals of, for example, treatment processes, monitoring systems, closure plans, siting, and design.

EPA regulates the management of hazardous waste under the Solid Waste Disposal Act, as amended by RCRA and additional implementing regulations. These implementing regulations govern hazardous waste generation (40 CFR 262); transportation (40 CFR 263); and treatment, storage, and disposal (40 CFR 264, 265, and 270). Under RCRA, hazardous waste includes EPA-listed waste or waste that exhibits one or more of the following characteristics: ignitability, corrosivity, reactivity, or characteristic toxicity (40 CFR 261). Additionally, RCRA stipulates that it does not apply to any substance that is subject solely to the AEA -- specifically source, special nuclear, and by-product material.

In February 1984, DOE entered into a MOU with EPA in which DOE agreed to comply with RCRA requirements. However, applicability of RCRA to DOE mixed waste was not clearly defined. Then, in July 1986, DOE, EPA, and the State of Colorado reached an agreement which gave Colorado the right to enforce RCRA regulations as they applied to mixed waste at DOE's Rocky Flats Plant. Shortly afterward, the EPA announced in the *Federal Register* (51 FR 24504) that the hazardous components of mixed waste are subject to RCRA. In May 1987, DOE published a new rule clarifying the dual regulation of radioactive and hazardous components of mixed waste by DOE and EPA.

The RCRA HSWA (EPA, 1984) greatly expanded EPA's authority to require corrective actions for releases of hazardous waste and also established the framework for the "land ban" or LDR program (40 CFR 268). The land disposal of RCRA hazardous waste is restricted by the requirement that all hazardous waste either be treated to meet a specified treatment standard prior to its land disposal or, failing nationwide availability of treatment to meet the standard, be disposed of in suitable land disposal units (e.g., landfills and surface impoundments meeting minimum technology requirements). HSWA

delegated to the EPA the establishment of LDR restrictions for all listed and characteristic hazardous wastes according to a defined schedule. The schedule provided for the LDR restrictions for listed wastes to be established in groups of roughly one-third of the total on three separate dates. Hence, the wastes in these groups are referred to as the first-third, second-third, and third-third listed wastes. On May 8, 1990, EPA promulgated the last of these restrictions, which now cover virtually all hazardous wastes, and extended their effective date to August 8, 1990. This last group of LDR restrictions includes the decisions for mixed waste.

All of the promulgated treatment standards for listed and characteristic wastes apply to the hazardous portion of mixed waste, unless a separate treatability group has been established for a specific category of mixed waste. For certain mixed waste types, treatment standards are established, each in the form of a specified technology.

Mixed waste in the non-government sector poses a major problem under the LDR restrictions because very few commercial facilities will accept it for treatment or disposal. Of course, LLNL mixed waste can only be sent to DOE treatment and disposal facilities. EPA is in agreement with DOE that there is inadequate nationwide treatment capacity for mixed waste. Therefore, mixed waste in which the hazardous component is a first-, second-, or third-third listed waste has been granted a further extension (to May 8, 1992) of the effective date for complying with the treatment standards for the hazardous portion of the wastes. However, mixed waste for which the hazardous components are spent solvents, dioxins, or California-listed wastes must continue to meet treatment standards that are already effective for these wastes. (The California list of restricted hazardous wastes are RCRA hazardous wastes that are liquids and contain either free cyanide, certain heavy metals, PCBs, or halogenated organic compounds of specific concentrations; or have a pH less than 2.0). Treatment standards for these wastes had already been established by EPA apart from the first-, second-, and third-third listed wastes. Thus, mixed waste with these hazardous components is not subject to the 2-year extension.

3.0 LOW-LEVEL MIXED WASTE TYPES AND QUANTITIES

This section discusses the types and quantities of low-level mixed waste stored at the various HWM facilities. Figures and tables present current quantities and types of mixed waste. Specific information is included regarding major types of mixed waste stored in each HWM facility.

Containerized waste presently received at LLNL HWM facilities for storage and handling is unloaded into storage areas located at the 514 and 612 Complexes. Before waste is accepted into these areas, containers are inspected for leaks, corrosion, bulging, and other signs of structural damage.

A description of the mixed waste types and quantities stored by HWM is provided in Tables 3-1 through 3-4. All quantities were compiled from the HWM computer database of non-TRU radioactive waste as of October 17, 1990. TRU mixed wastes are not included in this database; hence, they are not included in this section. (TRU mixed waste at LLNL is discussed in Section 4.1).

3.1 MIXED WASTE HWM STORAGE LOCATIONS

Mixed waste is presently stored in several HWM storage areas. Principal storage is located at the 514 and 612 Complexes. Mixed waste is also stored in Building 513. Drawings of these storage areas are provided in Figures 3-1 and 3-2, respectively. Figure 3-3 presents of flow diagram depicting the movement of mixed waste within LLNL and HWM. Management of mixed waste in the Building 612 area includes container storage and a drum/container crusher. Areas 612-1A, 612-1B, and 612-5 are covered storage areas used to store solid mixed waste. No liquid waste is stored or handled in these areas. Area 612-4 is used for receiving, segregation, and temporary storage of containerized waste. TRU mixed waste is stored in Building 625 East.

Waste management units located at Building 514 include various treatment operations and storage areas. Building 514 houses the wastewater filtration operations.

The storage capacity for mixed waste in each area is discussed in Section 5.

Table 3-1. Low-Level Mixed Waste Amounts Stored at HWM According to EPA Waste Code (as reported in HWM database on October 17, 1990).

EPA Code	Description	Solids (cu. yd.)	Liquids (cu. yd.)	Total (cu. yd.)
D001	ignitable characteristic waste	2.5	1.4	3.9
D001, D007, F001-F005, F027	above + chromium, HOCs, non-HOCs, tri-chlorophenol	0.4	0.3	0.7
D010-D011, D015, F002	selenium, silver, toxaphene contaminated HOCs	0.5	0.3	0.8
D002	corrosive characteristic waste	1.5	5.1	6.7
D002, D007, F001-F002, F012	corrosive chromium, spent HOCs, sludge w/cyanides	---	0.3	0.3
D002, F001-F005	corrosive spent HOCs and spent non-HOCs	---	0.9	0.9
D003	reactive characteristic waste	48.0	0.1	48.1
D003, F001	reactive spent halogenated solvents	4.2	---	4.2
D004, D011	arsenic and silver contaminants	0.3	---	0.3
D004, D008-D011	arsenic, lead, mercury, selenium, silver	12.0	---	12.0
D006, D008, F002, F005	cadmium, lead, spent HOCs, spent non-HOCs	1.3	---	1.3
D007	chromium contaminants	53.9	7.6	61.5
D007, D009	chromium and mercury contaminants	0.5	---	0.5
D007, F001, F002	chromium and spent halogenated solvents	6.4	---	6.4
D007, F001-F002, F005	chromium, spent HOCs, spent non-HOCs	3.6	---	3.6
D007, F012	chromium, sludge from cyanide processes	0.7	---	0.7
D007, F002, F005	chromium, spent HOCs, spent non-HOCs	10.3	---	10.3
D007, F002	chromium and spent halogenated solvents	3.8	---	3.8
D008, D009	lead and mercury contaminants	2.2	---	2.2
D008, F005	lead, spent non-halogenated solvents	0.3	---	0.3
D009, F012	mercury, sludge from cyanide processes	3.3	5.7	9.0

Table 3-1. Low-Level Mixed Waste Amounts Stored by EPA Code (continued).

EPA Code	Description	Solids (cu. yd.)	Liquids (cu. yd.)	Total (cu. yd.)
F001	spent halogenated solvents from degreasing	133.4	9.8	143.2
F001, F002	spent halogenated solvents	6.7	1.0	7.8
F001, F005	spent halogenated and non-halogenated solvents	---	22.5	22.5
F002	spent halogenated solvents	18.0	13.6	31.5
F002, F003	spent halogenated and non-halogenated solvents	---	0.6	0.6
F002, F005	spent halogenated and non-halogenated solvents	---	1.7	1.7
F020, F027, F028	wastes of tri-, tetra-, or pentachlorophenol	0.9	---	0.9
F003	spent non-halogenated solvents	0.9	1.4	2.3
F003, F005	spent non-halogenated solvents	0.1	0.8	0.9
EPA Code Not Stated (pending analysis)	----	54.3	20.4	74.8
TOTAL*		370.1	93.7	463.7

Some amounts from the HWM computer database were reported in gallons (mostly liquids) while others were reported in pounds (mostly solids). The quantities in the above table are volumes for all mixed waste amounts shown as being stored at HWM facilities in the HWM database of non-TRU radioactive waste.

The volumes for waste listed as dry solids in the database were based upon container volumes, as were the Building 513 liquid wastes stored in 30-gallon drums (depleted uranium, metal chips, and oil), and liquid wastes in the 612-2 and 614 W areas.

For other liquid wastes, it was assumed that density is closely approximated by the density of water, and liquid volume was determined using the following conversion factors:

$1\ yd^3 = 202\ gal$
$= 1684\ lbs$
$1\ gal = 8.34\ lbs$

*Sums of individual amounts may not equal the totals, due to rounding. The total quantity of liquids differs from Tables 3-2 through 3-4 because the above table expressly considers the density of Bldg. 513 drums in the volume calculation.

Table 3-2. Low-Level Mixed Waste in Storage by DHS Code (from HWM database through October 17, 1990).

DHS Code	Description	Solids (cu. yd.)	Liquids (cu. yd.)	Total (cu. yd.)
121	alkaline solution with metals	---	0.2	0.2
132	aqueous solution with metals	0.4	0.4	0.8
133	aqueous solution with total organic residues 10% or more	---	3.9	3.9
134	aqueous solution with total organic residues less than 10%	---	0.8	0.8
135	unspecified aqueous solution	---	12.8	12.8
141	off-specification,aged, or surplus inorganics	---	0.3	0.3
151	asbestos - containing waste	2.2	---	2.2
171	metal sludge	1.1	---	1.1
172	metal dust and machining waste	1.5	11.2	12.7
181	other inorganic solid waste	186.3	12.2	198.5
211	halogenated solents	8.7	18.3	27.0
212	oxygenated solvents	0.6	1.0	1.6
213	hydrocarbon solvents	0.4	0.3	0.7
214	unspecified solvent mixture	---	0.2	0.2
221	waste oil and mixed oil	4.1	6.1	10.2
222	oil/water separation sludge	---	0.2	0.2
261	polychlorinated biphenyls and material containing PCBs	0.3	---	0.3
322	biological waste other than sewage sludge	0.1	0.7	0.8
341	organic liquids (nonsolvents with halogens)	0.3	---	0.3
343	unspecified organic liquid mixture	5.0	3.1	8.1
351	organic solids with halogens	133.3	---	133.3
352	other organic solids	4.3	---	4.3
491	unspecified sludge waste	---	0.1	0.1
514	unspecified miscellaneous	---	0.1	0.1

Table 3-2. Low-Level Mixed Waste in Storage by DHS Code (continued).

DHS Code	Description	Solids (cu. yd.)	Liquids (cu. yd.)	Total (cu. yd.)
725	liquids with mercury ≥ 20 mg/l	---	2.2	2.2
741	liquids with halogenated organic compounds ≥ 1000 mg/l	0.3	21.5	21.7
751	solids or sludges with halogenated organic compounds ≥ 1000 mg/kg	0.3	---	0.3
791	liquids with pH ≤ 2	---	1.3	1.3
792	liquids with pH ≤ 2 with metals	---	2.9	2.9
801	waste potentially containing dioxins	1.0	- -	1.0
DHS Code Not Stated (pending analysis)	----	19.7	3.1	22.8
TOTAL*		369.7	103.2	472.9

*Totals differ from Tables 3-3 and 3-4 due to rounding. Sums of individual amounts may not equal the totals, due to rounding.

Table 3-3. Low-Level Mixed Waste by Year Placed in Storage (from HWM Database through October 17, 1990).

Calendar Year	Solids (cu. yd.)	Liquids (cu. yd.)	Total (cu. yd.)	Cumulative Total
1983	3.1	---	3.1	3.1
1984	---	4.2	4.2	7.3
1985	74.5	1.5	76.0	83.4
1986	78.5	4.8	83.3	166.6
1987	58.6	13.0	71.5	238.2
1988	53.3	13.7	67.0	305.2
1989	36.2	35.6	71.8	377.0
1990	65.1	28.6	93.7	470.8
No date	0.3	---	0.3	471.1
Total*	369.7	101.4	471.1	

*Totals differ from Tables 3-2 and 3-4 due to rounding. Sums of individuals amounts may not equal the totals, due to rounding.

Table 3-4. Low-Level Mixed Waste in Storage, by LLNL Generator (from HWM Database through October 17, 1990).

LLNL Generator	Solids (cu. yd.)	Liquids (cu. yd.)	Total (cu. yd.)
514[a]	239.6	5.5	245.1
321C	13.3	49.5	62.8
321	25.2	8.9	34.1
419[a]	27.0	5.6	32.5
233	13.6	0.3	13.9
332	4.0	6.6	10.5
491	0.3	10.2	10.5
241	9.3	0.4	9.7
612[a]	8.3	0.1	8.4
513[a]	8.3	—	8.3
377	4.5	0.2	4.8
361	1.7	2.2	4.0
231	0.6	2.7	3.3
222	2.6	0.2	2.8
231V	2.7	—	2.7
331	1.2	1.4	2.6
175	0.1	2.2	2.3
251	2.2	—	2.2
624[a]	—	2.2	2.2
801	2.2	—	2.2
151	0.3	0.7	1.0

Table 3-4. Low-Level Mixed Waste in Storage, by LLNL Generator (continued).

LLNL Generator	Solids (cu. yd.)	Liquids (cu. yd.)	Total (cu. yd.)
253	0.1	0.8	0.9
235	0.8	—	0.9
490	—	0.8	0.8
365	0.3	0.1	0.4
362	0.2	0.1	0.3
366	0.1	0.1	0.2
161	—	0.1	0.1
431	—	0.1	0.1
226	—	0.1	0.1
254	—	0.1	0.1
412	—	0.1	0.1
281	—	0.1	0.1
177	—	0.1	0.1
131	—	0.1	0.1
TOTAL[b]	368.7	101.5	470.2

[a] Wastes from these HWM facilities were originally generated by LLNL generators and subsequently treated and stored at HWM. Wastes do not originate from these facilities.

[b] Totals differ from Tables 3-2 and 3-3 due to rounding. Sums of individuals amounts may not equal the totals, due to rounding.

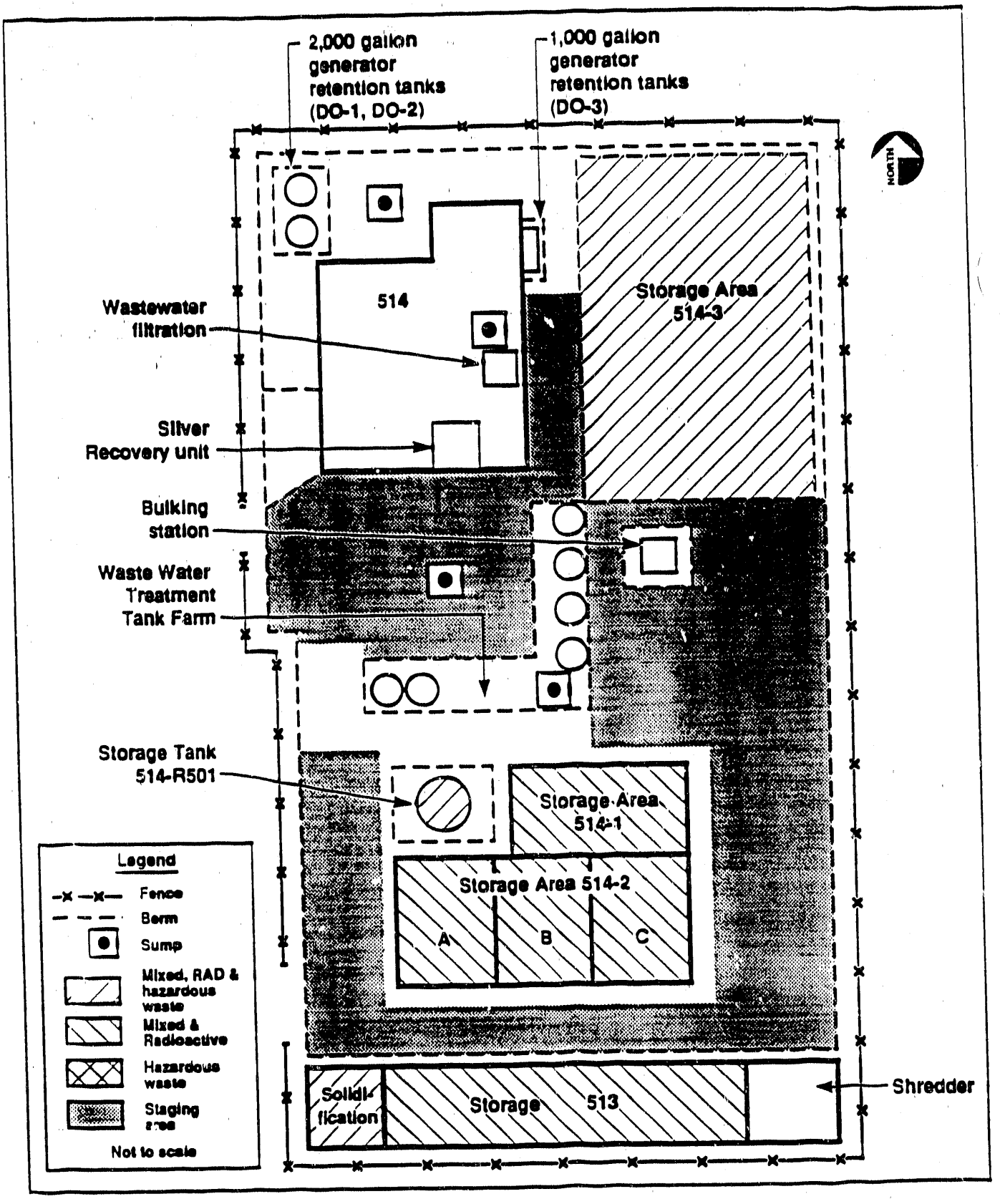


Figure 3-1. Location of 514 Area Waste Management Facilities.

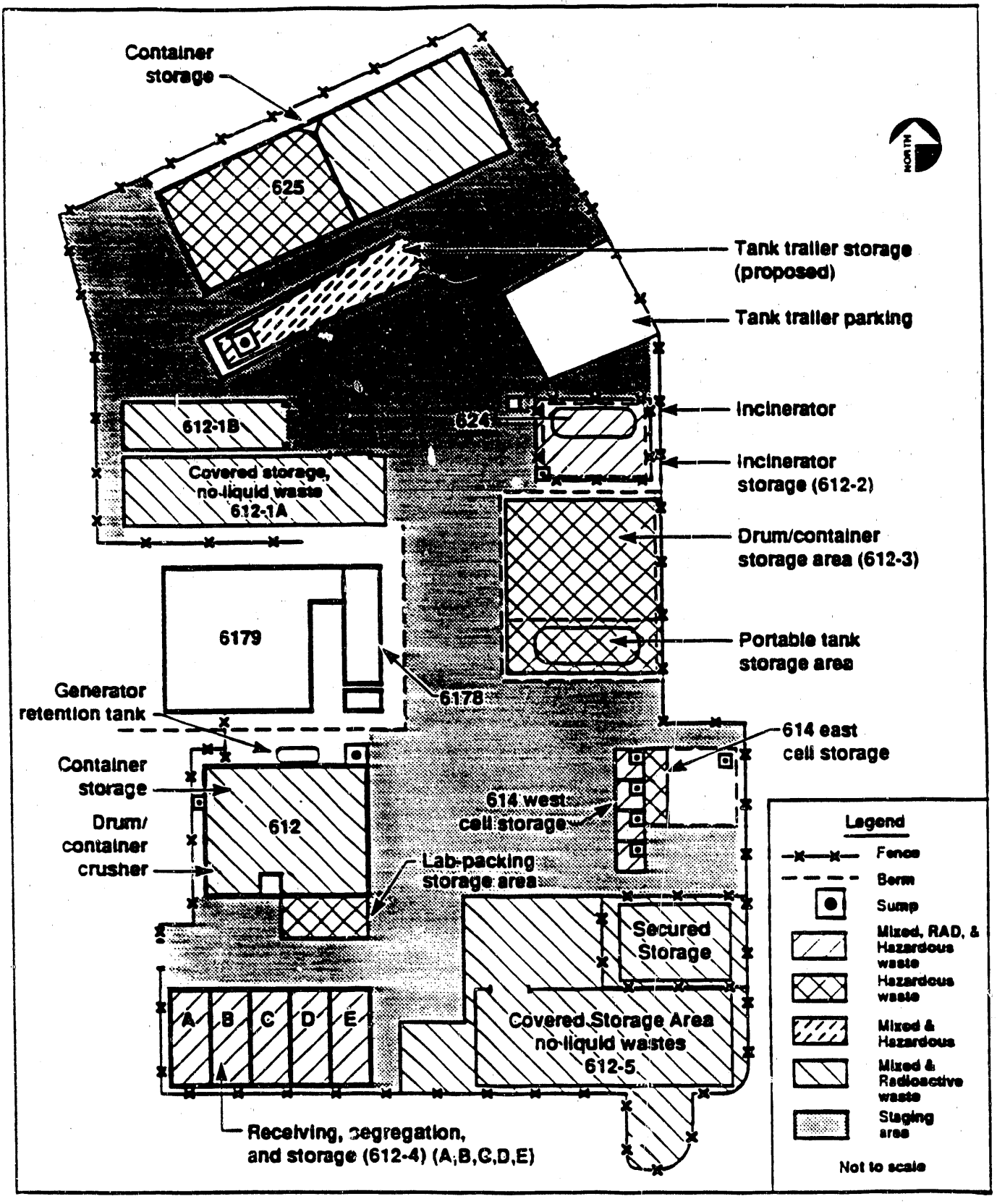
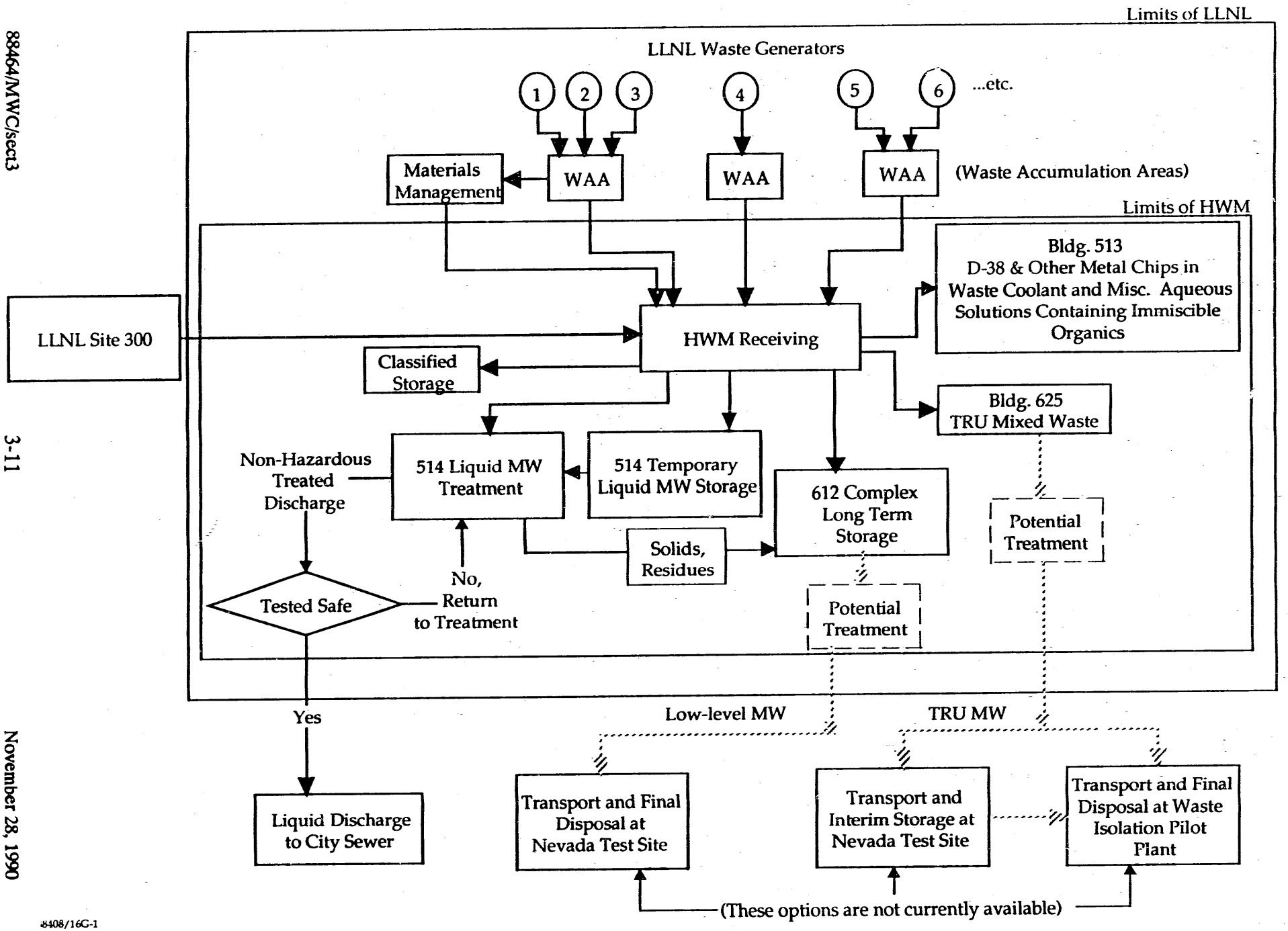


Figure 3-2. Location of 612 Area Waste Management Facilities.

Figure 3-3. LLNL Mixed Waste Flow Paths (Current and Future)



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3.2 CURRENT INVENTORIES OF STORED MIXED WASTE

Inventories of mixed waste, current to October 1, 1990, are listed in Appendix A. These inventories were compiled from the HWM computer database of non-TRU radioactive waste. The inventories are based upon information provided on waste disposal requisition forms (WDRs). WDR information includes the date received, the type of container, a description of the waste, and the quantity, as well as other information. The information compiled in the HWM database through October 17, 1990, was used to prepare the following figures.

3.2.1 Total Storage Volumes

Table 3-3 and Figure 3-4 present the volumes of mixed waste placed in storage by HWM on an annual basis. The volumes of waste are shown in cubic yards. The trend in the totals for mixed waste generated and stored since 1983 demonstrates the inability to adequately treat and dispose of mixed waste.

The quantities of stored mixed waste have risen dramatically since 1984. Annual stored volumes increased from 4.2 yd^3 in 1984 to 83.3 yd^3 in 1986. The 1988 contribution to mixed waste storage actually decreased to 67.0 yd^3, but the 1990 year-to-date total (93.7 yd^3) already exceeds the total for any previous year.

The cumulative mixed waste total in storage indicates 471 yd^3 of waste that are currently managed by HWM. This total includes 370 yd^3 of solid waste and 101 yds^3 of liquids. The solid waste total is based on actual container volumes, while the liquid total is a conversion based upon the density of water as an approximation of the actual average density of liquid waste which is currently in inventory. In addition, the total liquid volume calculation was refined to account for the average densities of liquid waste stored in Building 513 (depleted uranium, metal chips, and oil, having a volume of 12.5 yd^3) and Areas 612-2 and 614W. This yields a liquid mixed waste volume of 94 yd^3, or a total of 464 yd^3 when combined with the 370 yd^3 of solid mixed waste.

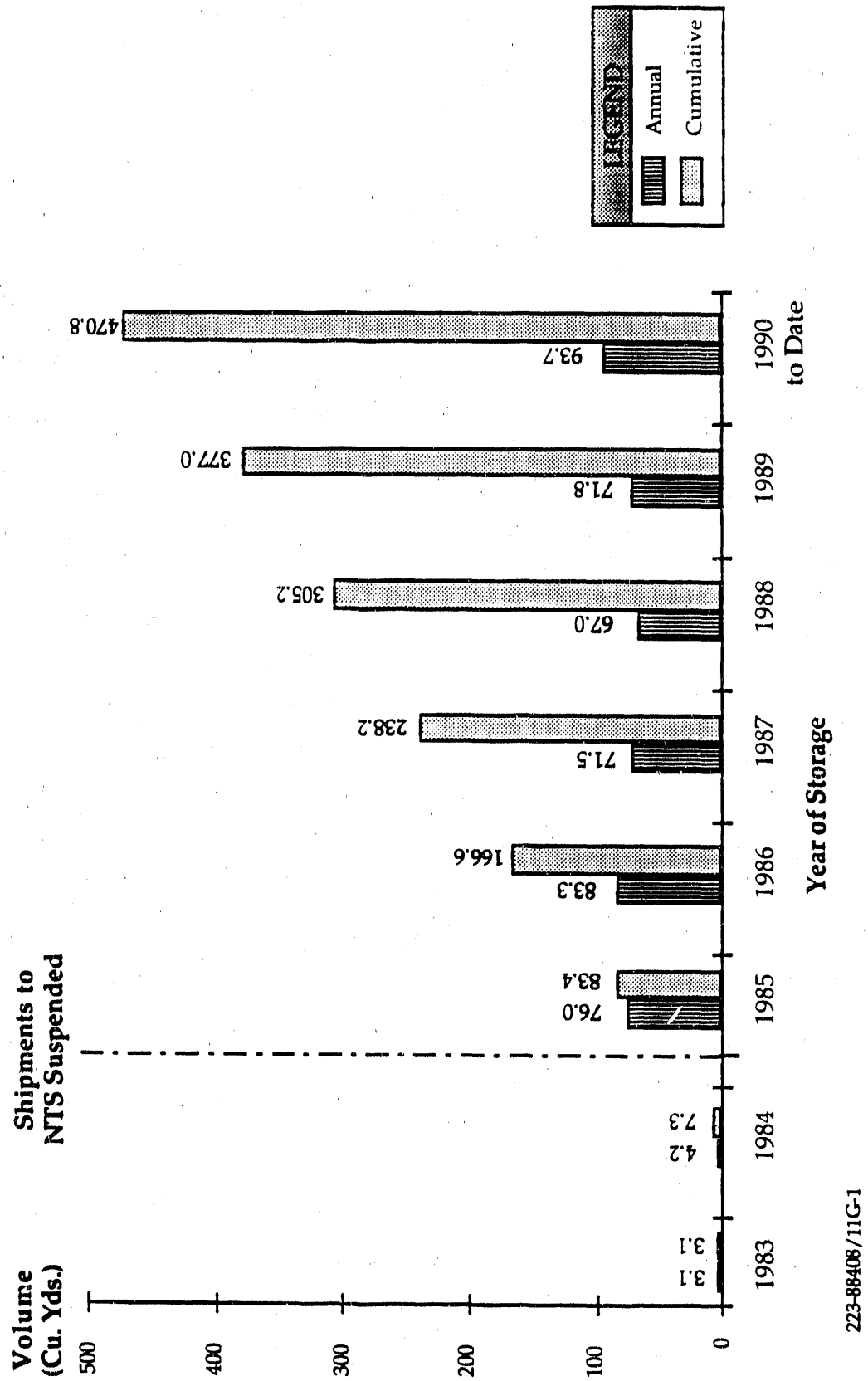


Figure 3-4. Mixed Waste in Storage at HWM (by Year).

3.2.2. Storage Quantities by HWM Facility

Figure 3-5 represents the location of the accumulated mixed waste stored by HWM. Current storage is located in one of about eleven storage locations, previously discussed and shown in Figures 3-1 and 3-2. The largest amount of mixed waste is currently located in Area 612-1, with a total 228.4 yd^3 stored at this location; this amount is approximately 50 percent of the HWM total of 464.2 yd^3 currently stored.

Other large volumes of mixed waste storage are located in Area 612-5 (81.3 yd^3), Area 512-2 (49.8 yd^3), and Building 625 (26.7 yd^3). The Building 625 quantity consists of a contaminated glovebox and a container of mixed LLW. None of the TRU mixed waste that is stored in Building 625 appears in the HWM database (non-TRU radioactive waste) consulted for this report, or in Figures 3-4 through 3-8. Also, according to the HWM database, no low-level mixed waste is currently stored in Area 514-1 and storage tank 514-R501. Approximately 0.6 yd^3 of waste did not have a storage area listed in the HWM database.

3.2.3 Storage Quantities by EPA Code

Figure 3-6 graphically illustrates the data presented in Table 3-1. The wastes are listed according to their EPA Hazardous Waste Number as identified in 40 CFR 261. Waste may be received with an individual waste number identification or may list a combination of EPA waste numbers to accurately represent the constituents of the waste.

RCRA-regulated hazardous waste can be classified as "listed" or "characteristic" wastes. Listed waste is generated by specific or non-specific sources. Characteristic waste can be ignitable, corrosive, reactive, or toxic. Waste currently in storage has been characterized predominantly by generator knowledge. The Extraction Procedure (EP) toxicity procedure has been used occasionally as a spot check. No mixed waste has as yet been recharacterized under the Toxicity Characteristic Leaching Procedure (TCLP), which became effective on September 25, 1990, replacing the EP method as the standard toxicity test required by the EPA.

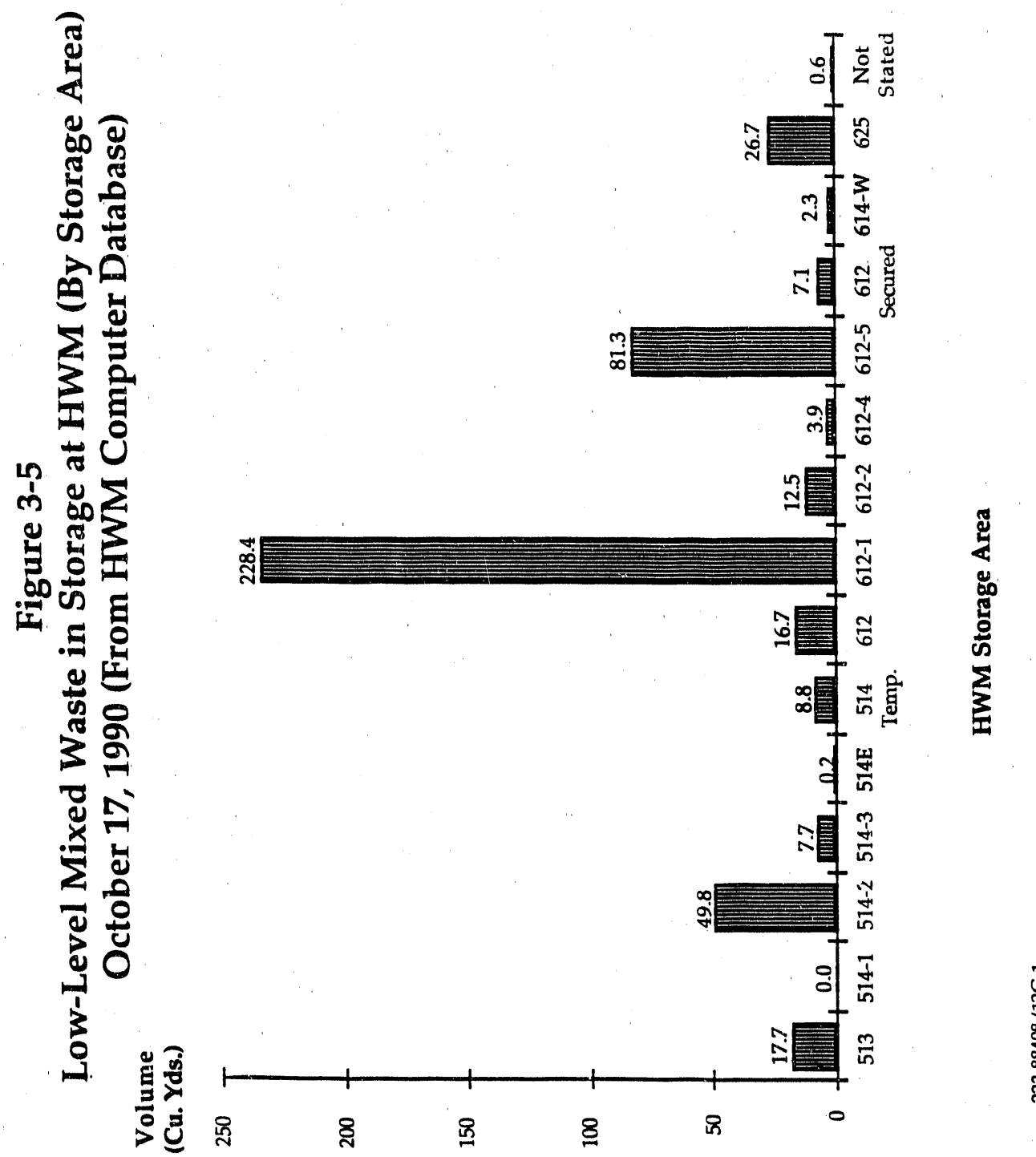


Figure 3-5. Mixed Waste in Storage at HWM Areas (by Storage Area).

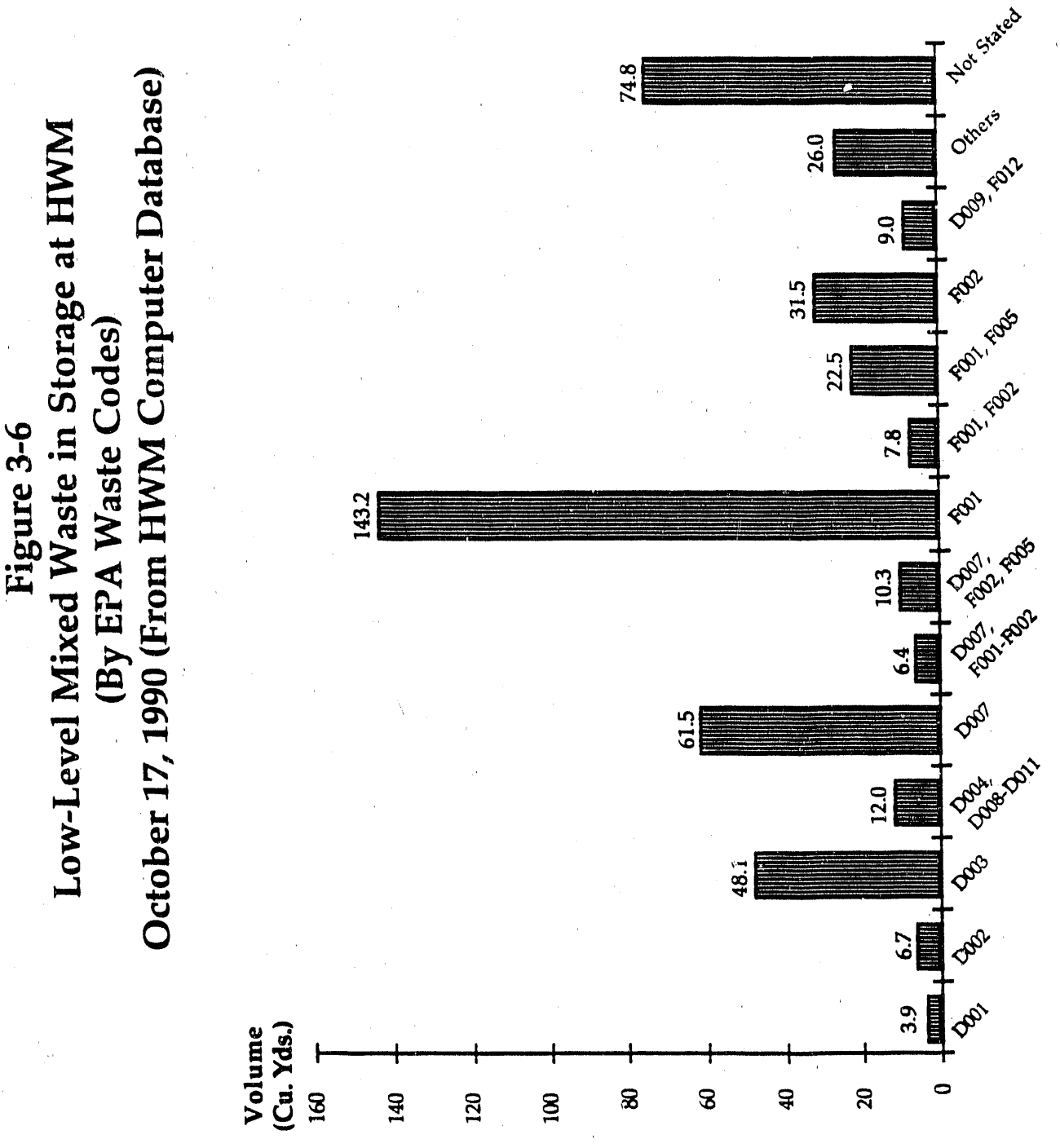


Figure 3-6. Mixed Waste in Storage at HWM (by Waste Codes).

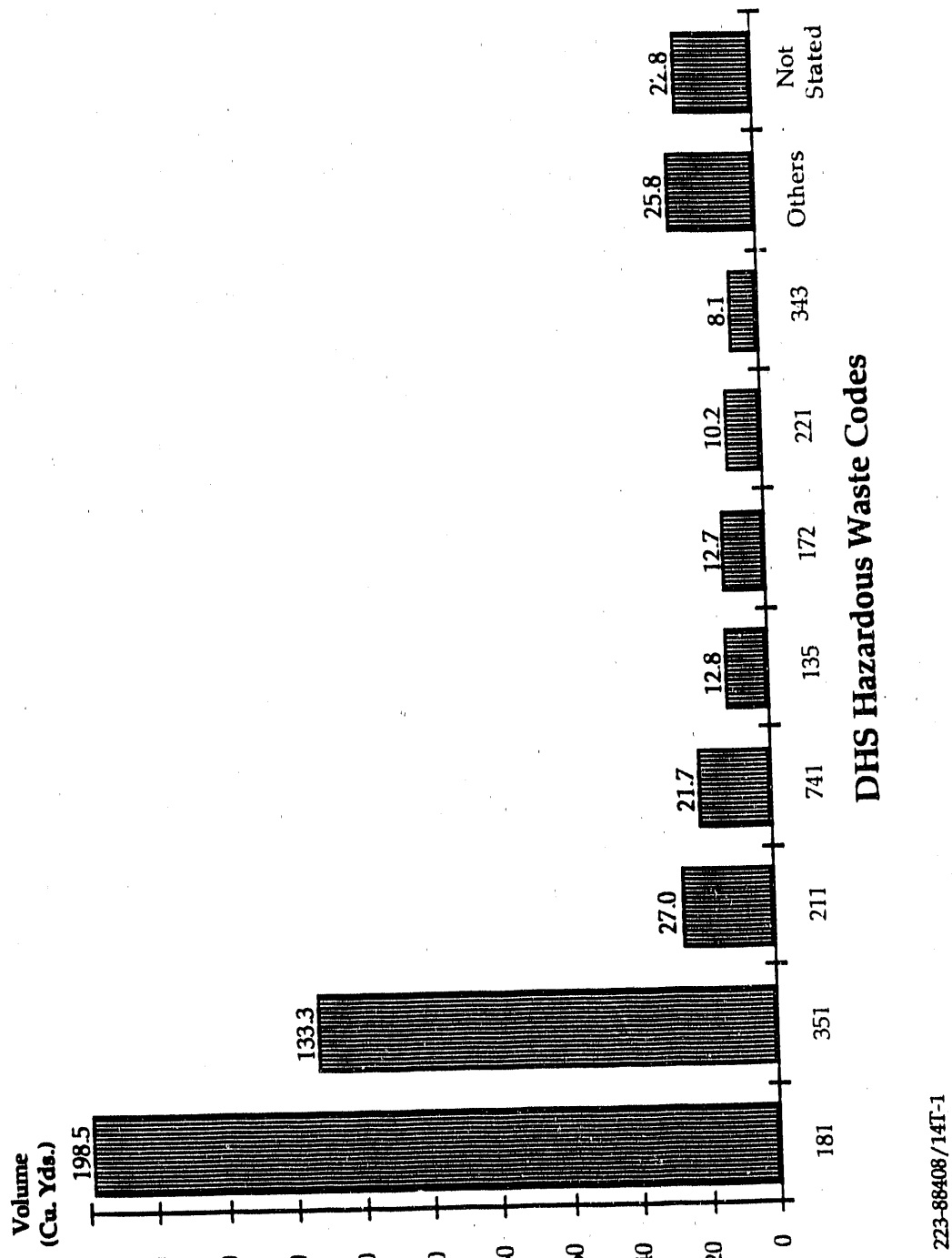
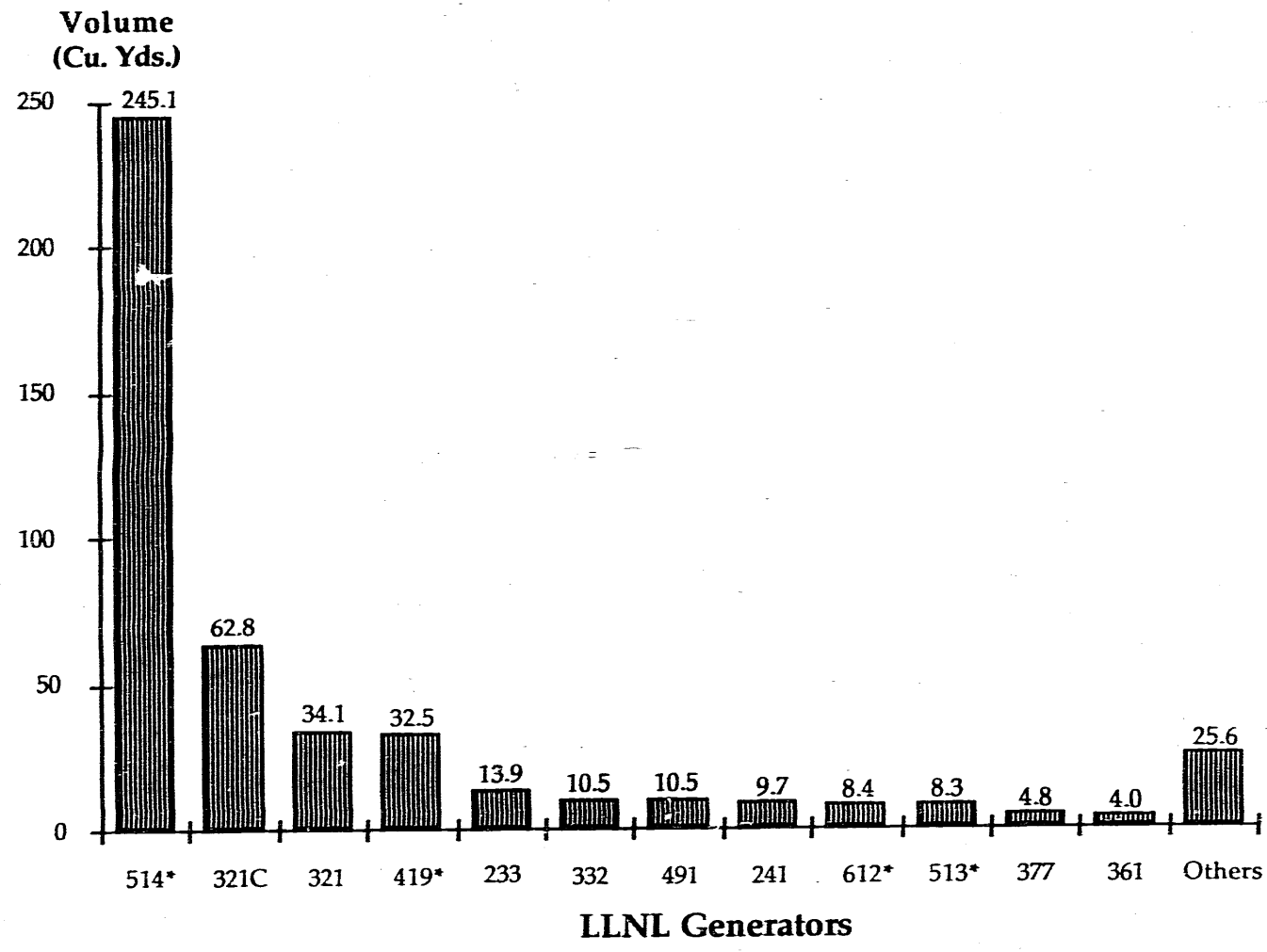


Figure 3-7. Low-Level Mixed Waste in Storage at HWM (by California DHS Waste Codes).

Figure 3-8
Low-Level Mixed Waste in Storage at HWM
(By LLNL Waste Generator)
October 17, 1990 (From HWM Computer Database)



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* Waste attributed to HWM Facilities is derived from multiple LLNL generators.

Figure 3-8. Low-Level Mixed Waste in Storage at HWM (by LLNL Waste Generator).

Figure 3-6 represents current waste amounts in HWM storage. The largest single mixed waste type, F001, consists of spent halogenated solvents (such as trichloroethylene, trichloroethane (TCE) and methylene chloride). These solvents, which currently make up 143.2 yd^3 of the mixed waste in storage, are used in degreasing operations. Several other mixed wastes are made up of a combination of F001 waste and other RCRA-regulated wastes.

The second most commonly generated mixed waste type is D007, or chromium-containing wastes. These wastes total 61.5 yd^3. Other significant quantities of RCRA-regulated waste streams include F001/F005, a spent solvent waste stream made up of combined halogenated and non-halogenated solvents (such as toluene, methyl ethyl ketone, and benzene) (22.5 yd^3); D003, reactive wastes (48.1 yd^3); and F002, a spent halogenated solvent waste stream (31.5 yd^3).

Approximately 74.8 yd^3 were identified as having no assigned EPA waste type. The major constituents of the no-EPA waste type category include the California DHS Codes of 181 (other inorganic solid waste), 211 (halogenated solvents), 135 (unspecified aqueous solution), 343 (unspecified organic liquid mixture), and 221 (waste oil and mixed oil). The largest LLNL generators in the no-EPA waste type category are Buildings 514, 361, and 321C.

3.2.4 Storage Quantities by DHS Code

Figure 3-7 illustrates the data presented in Table 3-2, which shows the stored mixed waste categorized by its California DHS restricted hazardous waste code. The largest single type is DHS Code 181 (other inorganic solid waste), comprising 198.5 yd^3. The next largest amount is 133.3 yd^3 for DHS code 351 (organic solids with halogens). Together these two codes comprise 70 percent of the total volume of mixed waste.

Other significant amounts include DHS codes 211 (halogenated solvents), 27.0 yd^3; 741 (liquids with halogenated organic compounds $\geq$ 1000 mg/l), 21.7 yd^3; and waste for which no DHS code is stated, 22.8 yd^3.

3.2.5 Storage Quantities by LLNL Generator

Figure 3-8 represents the amounts of stored mixed waste received from the various LLNL waste generators. HWM Building 514, which is a treatment facility for waste originating at other LLNL generators, is deemed the largest single generator, having produced 245 yd^3 now in storage. This is over 50 percent of the total and consists mainly of the solid residues from wastewater filtration and past solidification efforts. The next largest generators are Buildings 321C (62.8 yd^3) 321 (34.1 yd^3), and 419, a previously-used HWM facility (32.5 yd^3).

4.0 HISTORICAL TRENDS IN MIXED WASTE GENERATION AND STORAGE AT LLNL

Section 4 discusses and graphically presents historical trends at LLNL in both mixed waste generation rates and mixed waste storage quantities during the last 5 to 6 years. An outline of liquid waste treatment processes is also presented.

This section references the following LLNL data sources, which are contained in Appendix B to this document:

- 1988 Defense Programs Integrated Data Base (IDB) mixed waste data information sheets, Vol. II, Section 4.5
- 1989 IDB mixed waste data information sheets, Vol. III, Section 4.24
- 1989 Hazardous Waste Report, EPA Form GM, pgs. 106 - 114 (Biennial TSDR), Vol. II, Section 4.22
- Input sheets for National Report on LDR-Prohibited Mixed Waste and Treatment Options (9/19/89), Vol. II, Section 3.3
- Thirds Radioactive Mixed Waste Data Input Forms (4/1/90), Vol. III, Section 4.21
- Status Review of Mixed Waste in Storage, 1985-1988 at HWM, prepared by HWM staff (5/25/89), Vol. I, Section 1.10
- Historical Generation Rates of Mixed Waste, 1983-1989, prepared by D. Hoyt, C. vanWarmerdam, and D. Nakahara (3/18/90), Vol. III, Section 4.19
- Hazardous Waste Treatment and Storage Facilities, LLNL, Main Site, RCRA, Part B Permit Application (1989) Section XI, UCAR-10275.

4.1 MIXED WASTE GENERATION AND STORAGE

As indicated in Figure 4-1, the amount of mixed waste managed between 1984 and 1989 has increased every year with the exception of 1987. Table 4-1 and Figure 4-1

Table 4-1. Mixed Waste Treatment and Storage*.

Calendar Year	Post Treatment Waste	TRU Mixed Waste in Storage	Incinerated Waste	Waste** Awaiting Treatment	Liquid Waste in Temporary Tank Farm Storage***
1984	25.75	N/A	25.75	NA	100.00 (est)
1985	43.10	N/A	12.17	NA	100.00 (est)
1986	43.20	N/A	1.38	NA	120.20
1987	18.20	0.72	1.35	NA	27.32
1988	13.50	0.48	1.93	NA	168.68
1989	5.17	0.23	0.00	77.17	119.41
Total	148.92	1.43	42.58	77.17	635.61

Note: All quantities in tons.

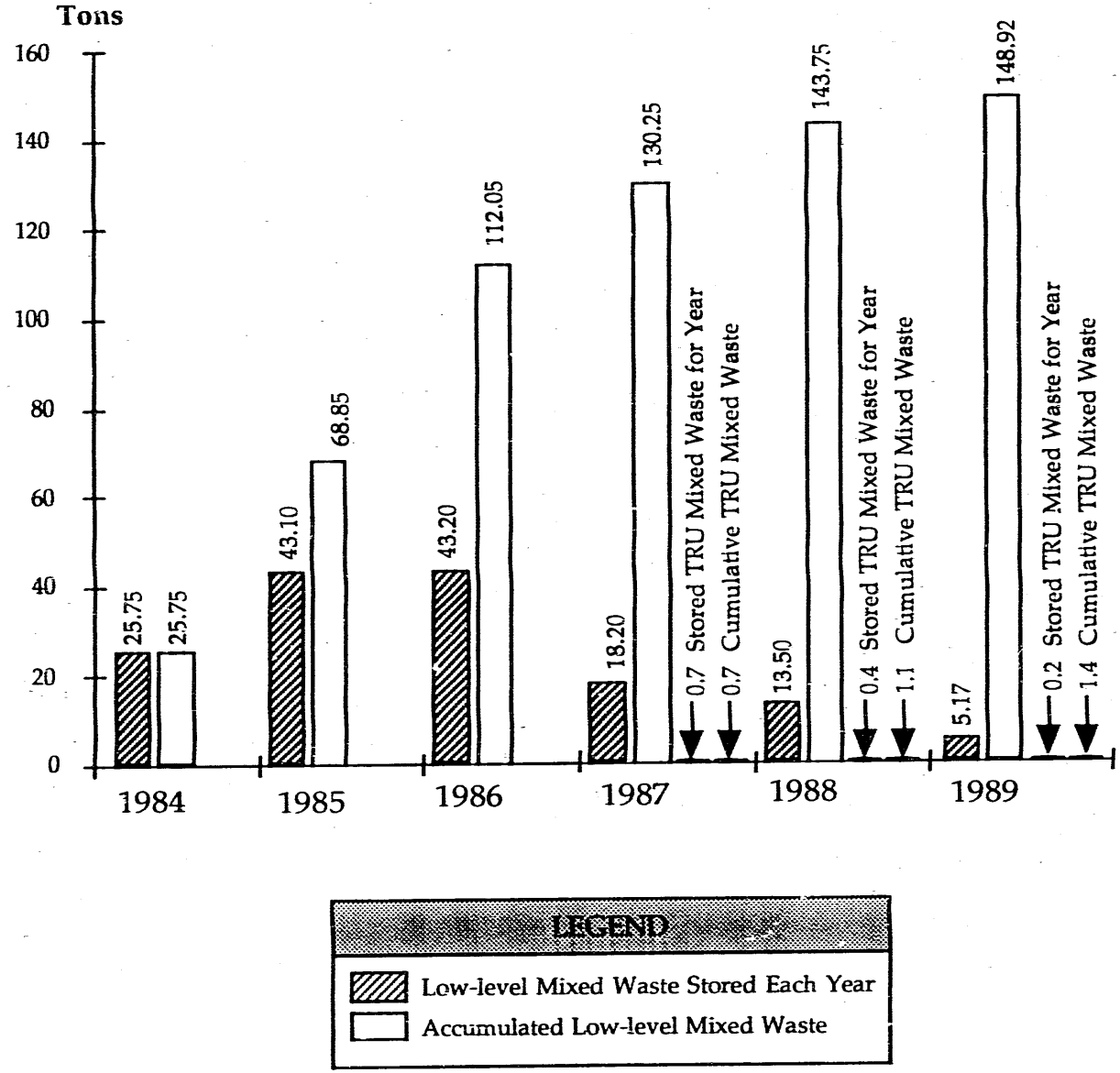
* Data Provided by "Historical Waste Generation Rates" table. HWM, 3/18/90.

** Waste awaiting treatment includes the following categories:

- Previously incinerated laboratory wastes and scintillation vials
- Contaminated equipment awaiting decontamination and/or size reduction
- Waste awaiting water filtration treatment or solidification by cementing agents

*** This category is made up of liquid wastes awaiting tank farm treatment described in Section 4.2.

Figure 4-1
Low Level and Transuranic Mixed Waste Storage By Year Placed in Storage



* Note: TRU Mixed Waste data not available for 1984, 1985 & 1986.

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have been generated from data provided by the HWM document, "Historical Generation Rates of Mixed Waste, 1983-1989," and from a site inventory of TRU mixed waste in storage at Building 625 East. The total quantity of mixed waste managed at LLNL is composed of amounts stored in pre- and post-treatment status as shown in Table 4-1. Total mixed waste managed does not represent the total generation rates for the periods shown. Table 4-1 also indicates that approximately 1.4 tons of TRU mixed waste was placed in storage between 1987 and 1989. It is considered reasonable that about as much as 40% of approximately one hundred 55-gal drums and thirty Type 7A boxes of TRU waste will be re-certified as TRU mixed waste as a result of the current TRU waste verification project.

4.2 MIXED WASTE TREATMENT AT HWM FACILITIES

Mixed waste is received at the 612 Complex from LLNL program waste accumulation areas and Site 300 for disposal processing. From the 612 Receiving Area, liquid mixed waste is sent to the Building 514 area for temporary storage, tank treatment, separation, and filtration.

Within the waste water treatment tank farm, liquid mixed waste undergoes neutralization, flocculation, oxidation, reduction, precipitation, and separation to remove metal cations and other dissolved impurities. Figures 4-2, 4-3, and 4-4 show the amounts of typical metal cations removed for the years 1987 through 1989 by the above methods. Alpha and beta activity levels are also reduced by approximately 99% to levels that are below sewer discharge limits. At the same time pH is adjusted and selected organics are removed. The separation process consists of skimming approximately the top 4 inches of whatever oil/water mixture may be present after emulsion destruction.

Filtration by rotary drum vacuum filter (Dorr-Oliver) is one of the final steps in liquid mixed waste treatment. The effluent from filtration is transferred to another tank in the tank farm, analyzed, and released to sanitary sewer if contaminant levels are determined to be below discharge limits. Effluent with contaminant levels above sewer discharge limits are treated again until effluent is dischargeable. Filtration residuals are placed in lined 55-gal drums and returned to the 612 area for long-term storage. For a

Figure 4-2
Building 514
Tank Farm and Filtration Treatment
For 1987

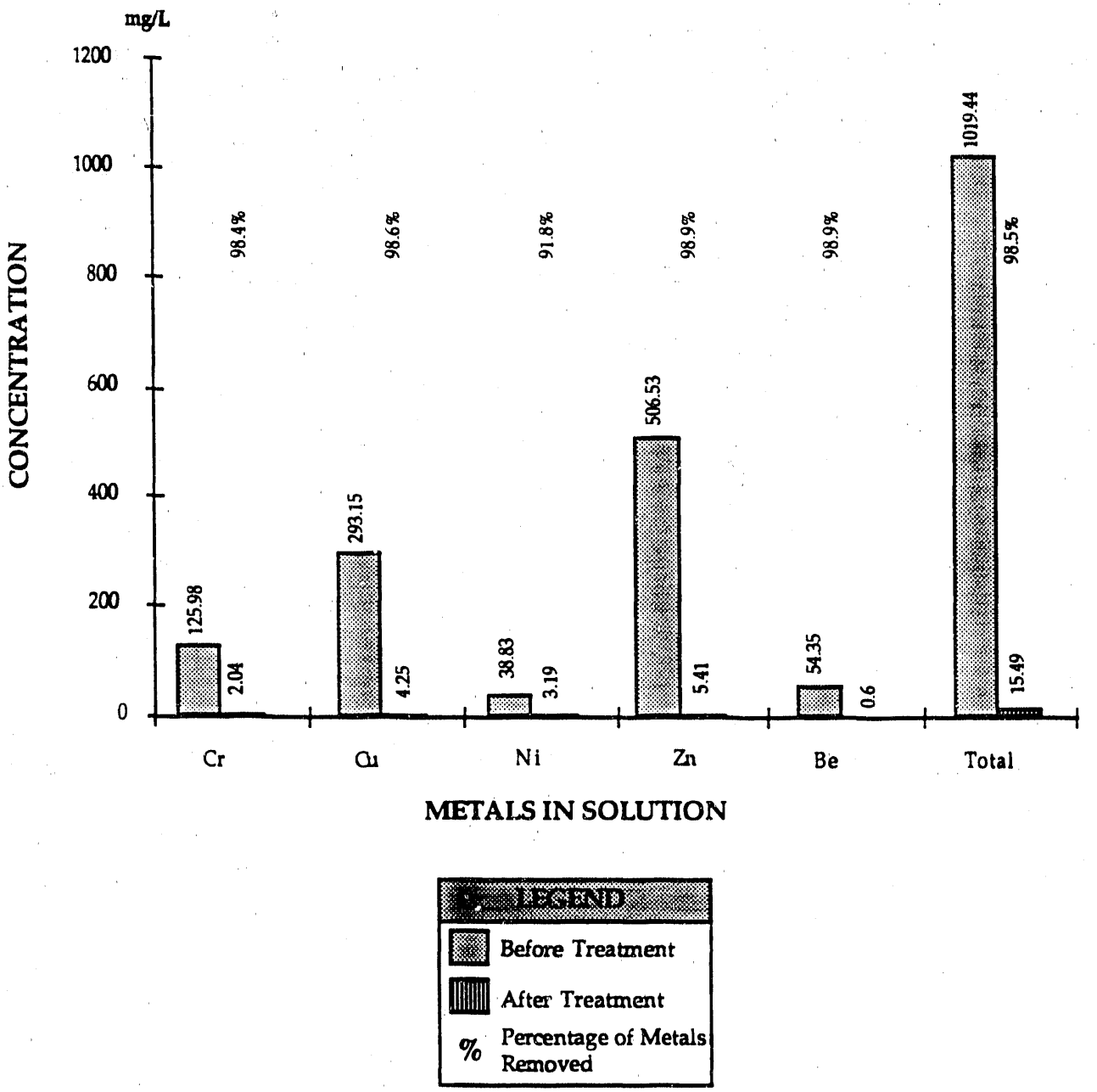

Figure 4-2. Building 514 Tank Farm and Filtration Treatment For 1987.

Figure 4-3
Building 514
Tank Farm and Filtration Treatment
For 1988

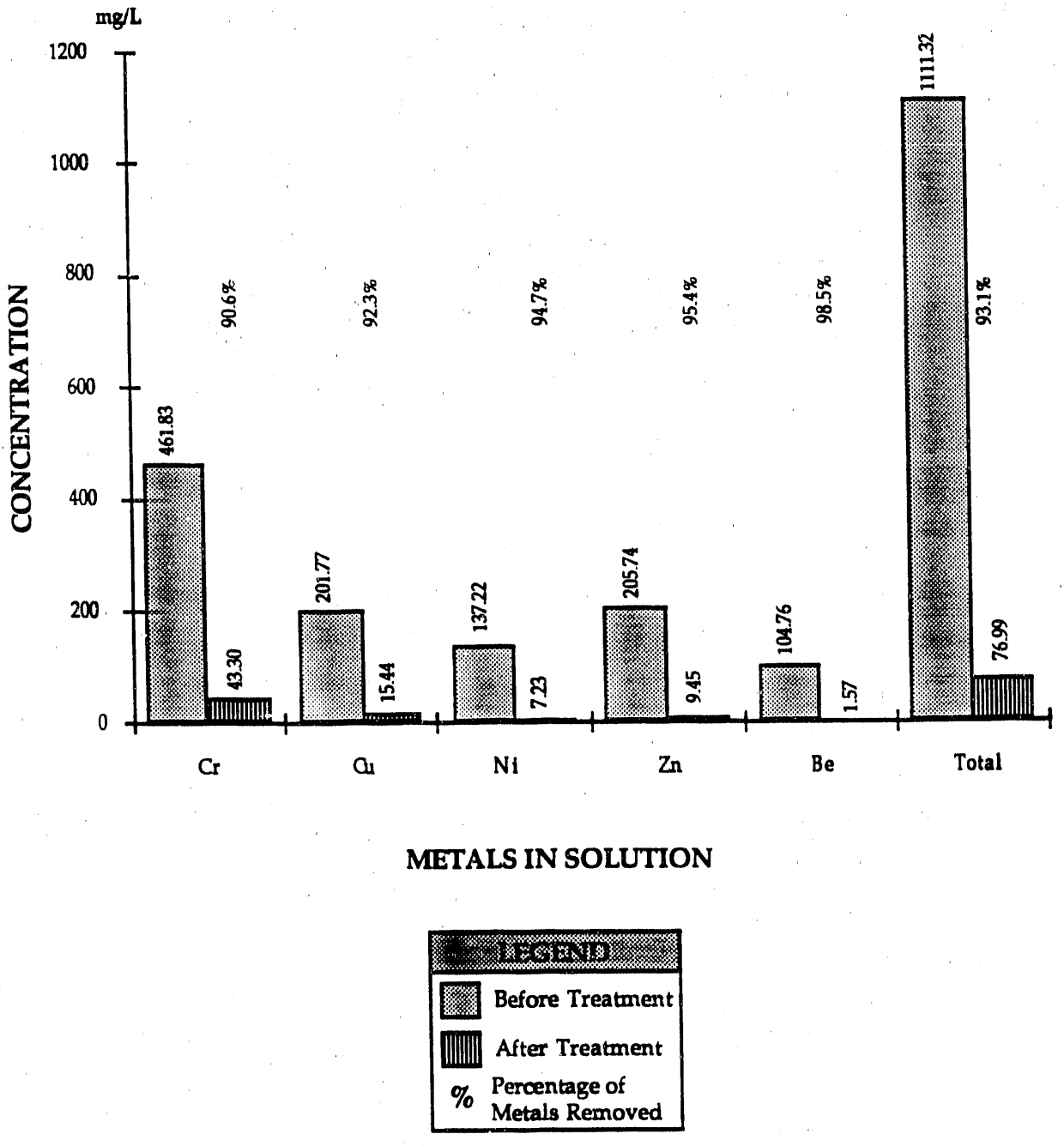

Figure 4-3. Building 514 Tank Farm and Filtration Treatment For 1988.

Figure 4-4
Building 514
Tank Farm and Filtration Treatment
For 1989

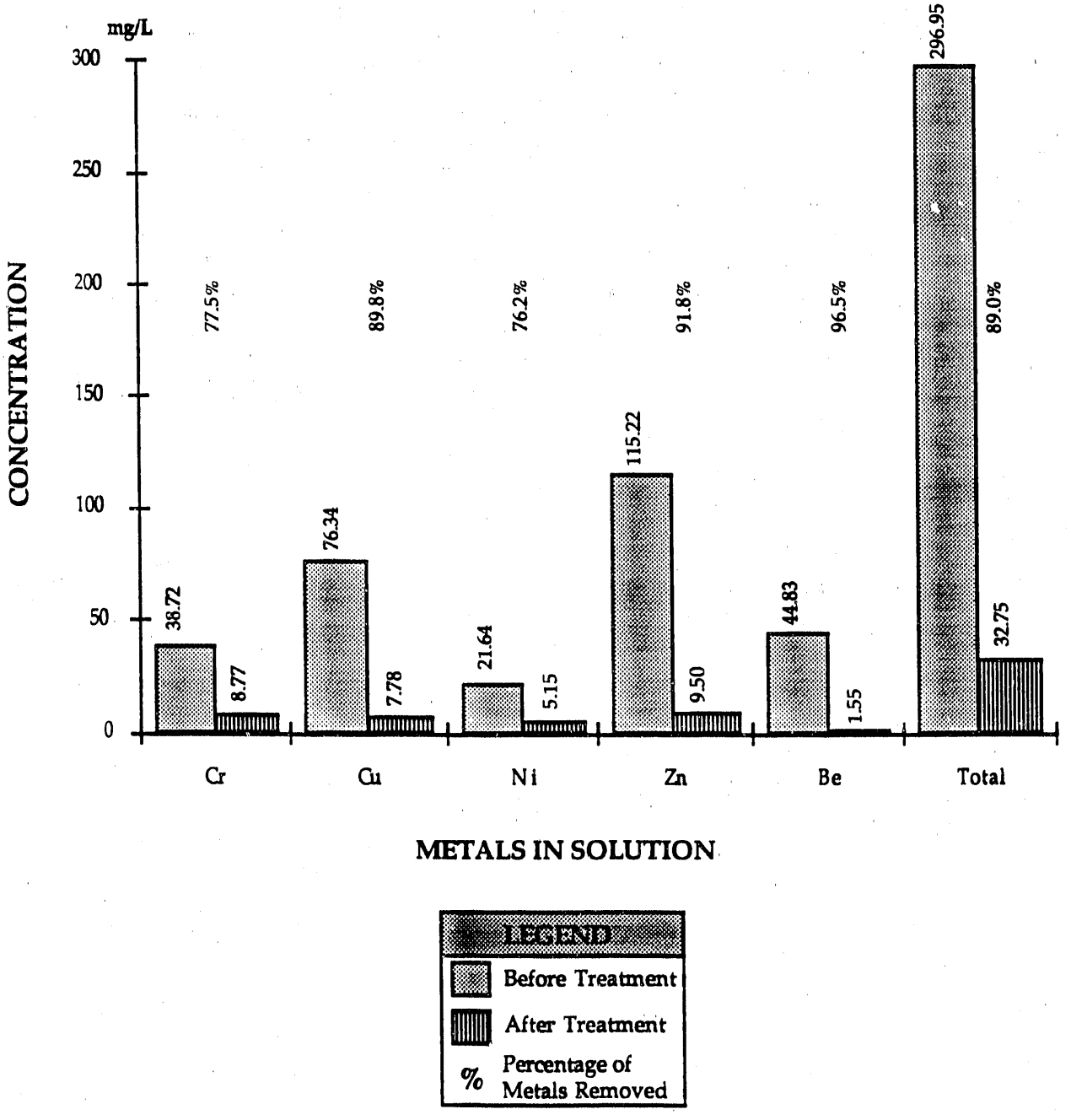

Figure 4-4. Tank Farm and Filtration Treatment For 1989.

more detailed description of liquid mixed waste treatment processes, refer to Section VI of the RCRA Part B permit application.

In 1987 both the quantity of residual placed in storage and the quantity sent to tank farm storage were reduced (only seven Dorr-Oliver treatments were performed that year, due to repairs being performed at the tank farm). Since that time, the number of Dorr-Oliver treatments has increased while solidification treatments have decreased, thus leading to reduced mass from liquid waste treatments going into storage each year and increased throughput to temporary tank storage. Solidification treatment consists of mixing cementing agents, such as Envirostone, with liquid waste. Because of the greater volume and questionable long-term land disposal performance of cemented wastes, solidification treatments have been suspended.

A total of 904.28 tons of low-level mixed waste was treated between 1984 and 1989, with 149 tons of residuals from treatment going into storage and 635.61 tons passing through temporary tank farm storage. Although incinerator operation ceased in 1988, 42.58 tons of mixed waste were incinerated between 1984 and 1988. Much of the incinerated waste consisted of pathologic waste from the Biomedical Research Program.

4.3 STORED MIXED WASTE BY EPA CODE, PER 1988 AND 1989 IDB.

The official database for defense programs' radioactive waste is the IDB program, maintained for the DOE by Oak Ridge National Laboratory. It provides a centralized national capability for the collection, integration, and publication of baseline information on all defense-related radioactive waste. The DOE Hazardous Waste Remedial Actions Program (HAZWRAP) office has the responsibility for collecting and managing mixed waste data for inclusion in the IDB.

For the years 1988 and 1989, some differences in reported quantities exist between portions of the IDB Reports pertaining to LLNL and the amounts indicated in HWM's historical review, dated March 18, 1990. The quantity of mixed waste in storage in 1988 is indicated as 143.75 tons by HWM's internal review, while 143.05 tons is reported in the 1988 IDB Report. 143.05 tons is also reported in the HWM Status Review of mixed waste in storage, dated May 25, 1989.

These slight differences can be attributed to the fact that, prior to June 1988, a uniform system of recordkeeping for mixed waste did not exist. Previously each treatment unit maintained an independent database. Separate databases were kept for incinerated waste, long-term stored mixed waste, and the 612 yard, for example. Mixed waste treatments at Building 514 were recorded manually in files.

Another factor contributing to slight differences in quantity between reports is that the weight of most mixed waste currently in storage was estimated by HWM technicians or the waste generator rather than actually being weighed. Because the waste density varies, most weight values in the database are only estimations.

For 1989, the IDB Report indicates an accumulated tonnage of 276.12 tons, while HWM's internal review indicates 148.92 tons. The difference is accounted for in the fact the IDB value includes pre-treatment liquids. The value of 148.92 tons is only the amount of solid mixed waste in long-term storage.

For the period of 1985 to 1989, the amount of mixed waste accumulated in on-site storage can be categorized into groups by EPA code per the 1988 and 1989 IDB Reports, as shown in Figures 4-5 and 4-6. As indicated, the largest groups consist of spent halogenated and non-halogenated solvents, organic solvents, and liquid wastes containing the following metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

Ignitable wastes and combinations of other characteristic hazardous waste with discarded commercial chemical products, spent solvents, and off-specification species comprise a small percentage of the mixed wastes reported in the 1988 and 1989 IDB reports.

4.4 RADIOACTIVE AND LDR MIXED WASTE GENERATION AND STORAGE

For the years 1989 and 1990, a portion of the quantities of mixed waste being generated and in current storage were analyzed in terms of volume, as opposed to mass. This analysis is based on the data provided by the input sheets for the National Report on LDR-Prohibited Mixed Waste and Treatment Options (December 4, 1989) and the

"Thirds" Radioactive Mixed Waste Data input forms (May 17, 1990), as shown in Figures 4-7 and 4-8.

As indicated in the 1988 and 1989 IDB Reports, EPA characteristic waste and spent solvents represent the largest quantities reported in both the LDR National Report and the "Thirds" waste data input forms. It should be noted that the group labeled "No Applicable EPA Code" on Figure 4-7 represents a different waste stream than the group with the same label in Figure 4-8, as indicated by the large difference in quantities. In the case of the LDR report, the "No Applicable EPA Code" amounts (0.6 m^3 stored and zero generated) represent a small quantity of Biomedical Research Program material with no applicable EPA code. On the other hand, the "No Applicable EPA Code" quantities of 80.56 m^3 stored and 2,001 m^3/yr generated, indicated on Figure 4-7, represent a cumulative amount of corrosive coolant water containing small amounts of LDR metals and solvents. This waste stream is generated by many small waste generators at LLNL. While the LDR National Report and the "Thirds" waste data input forms do not include all mixed waste streams being handled by HWM, they do include specific streams of interest. The LDR-prohibited waste stream consists of those wastes restricted from land disposal by RCRA and is current to September 19, 1989. As components of the total mixed waste stream, these waste streams contain representative EPA hazardous waste codes such as D006-D009 (EP toxic wastewaters) and F001-F005 (spent solvents). The "Thirds" waste stream includes LLW and TRU waste and is current to April 1, 1990.

4.5 STORED MIXED WASTE BY EPA CODE FROM 1985-1988

The data presented in the HWM status review (Appendix B, Vol. I, Section 1.10) has been reorganized in Figure 4-9 by EPA code. Thus the change in mixed waste placed into storage for the period 1985 through 1988 is presented. This status review reinforces two general trends indicated by all the data presented: (1) over the past 6 years, mixed waste generated has consisted primarily of EP toxic and spent solvent waste; (2) although liquid mixed waste generation has in general increased since 1984, the

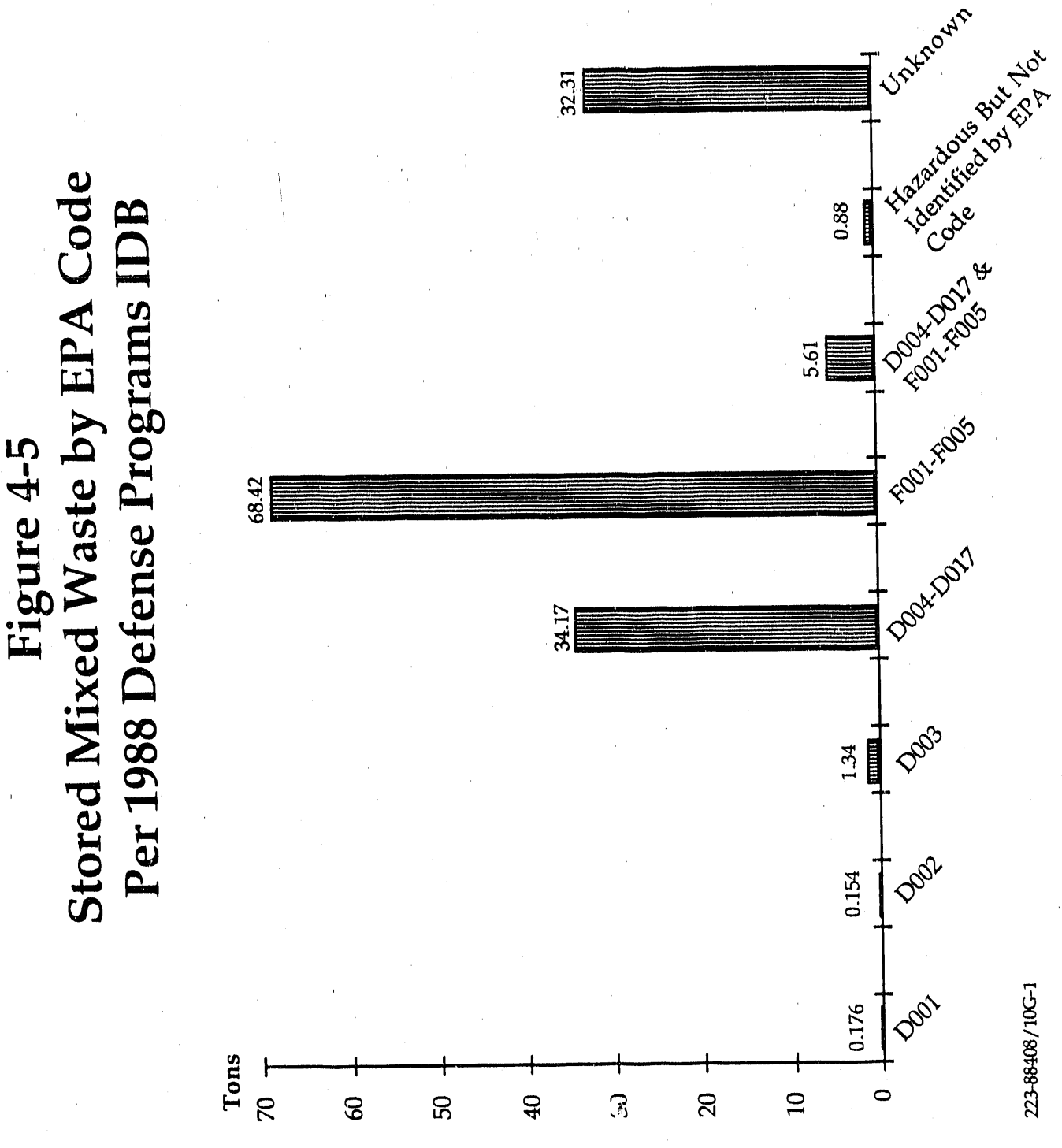

Figure 4-5. Stored Mixed Waste by EPA Code Per 1988 Defense Programs IDB.

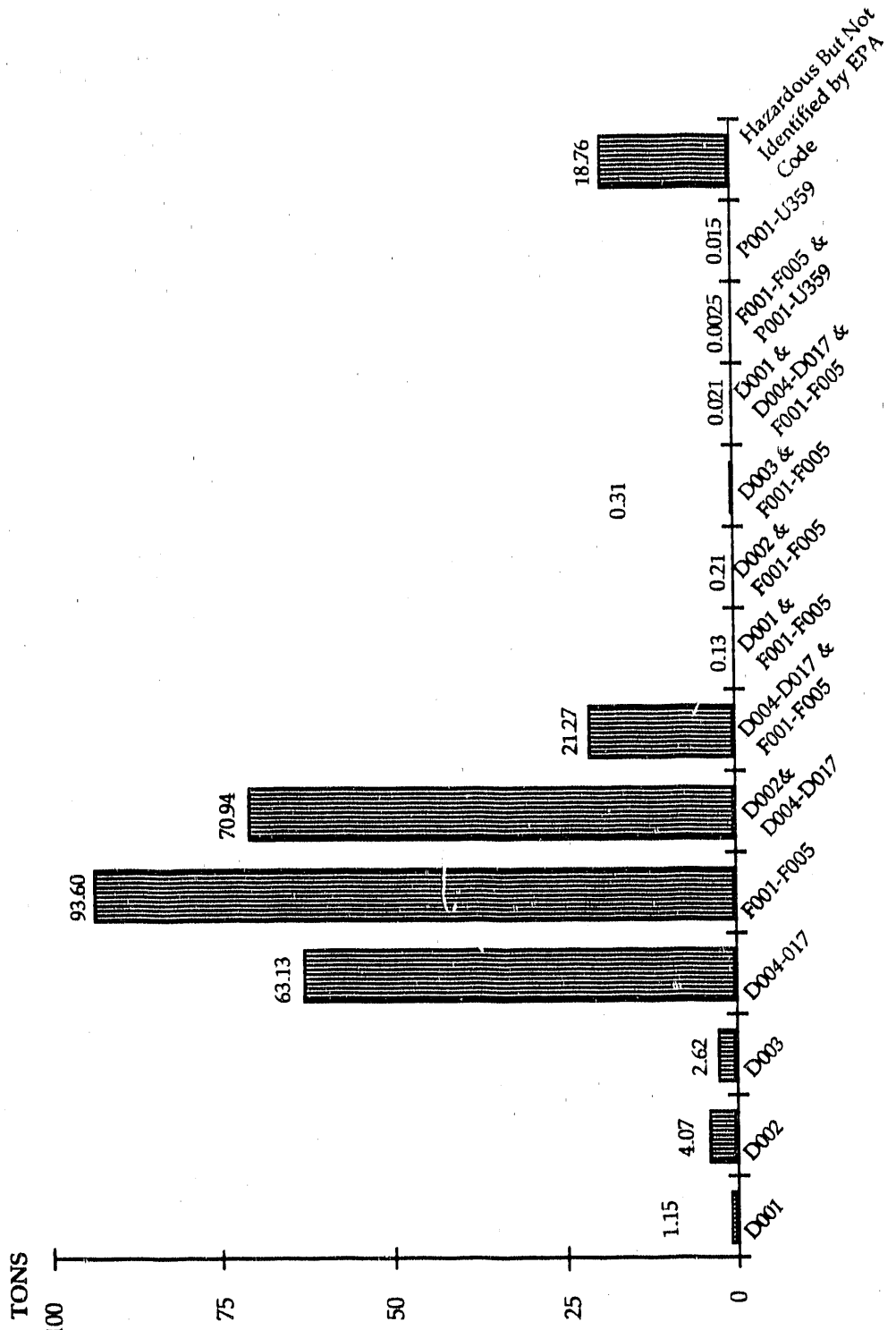

Figure 4-6. Stored Mixed Waste by EPA Code Per 1989 Defense Program IDB.

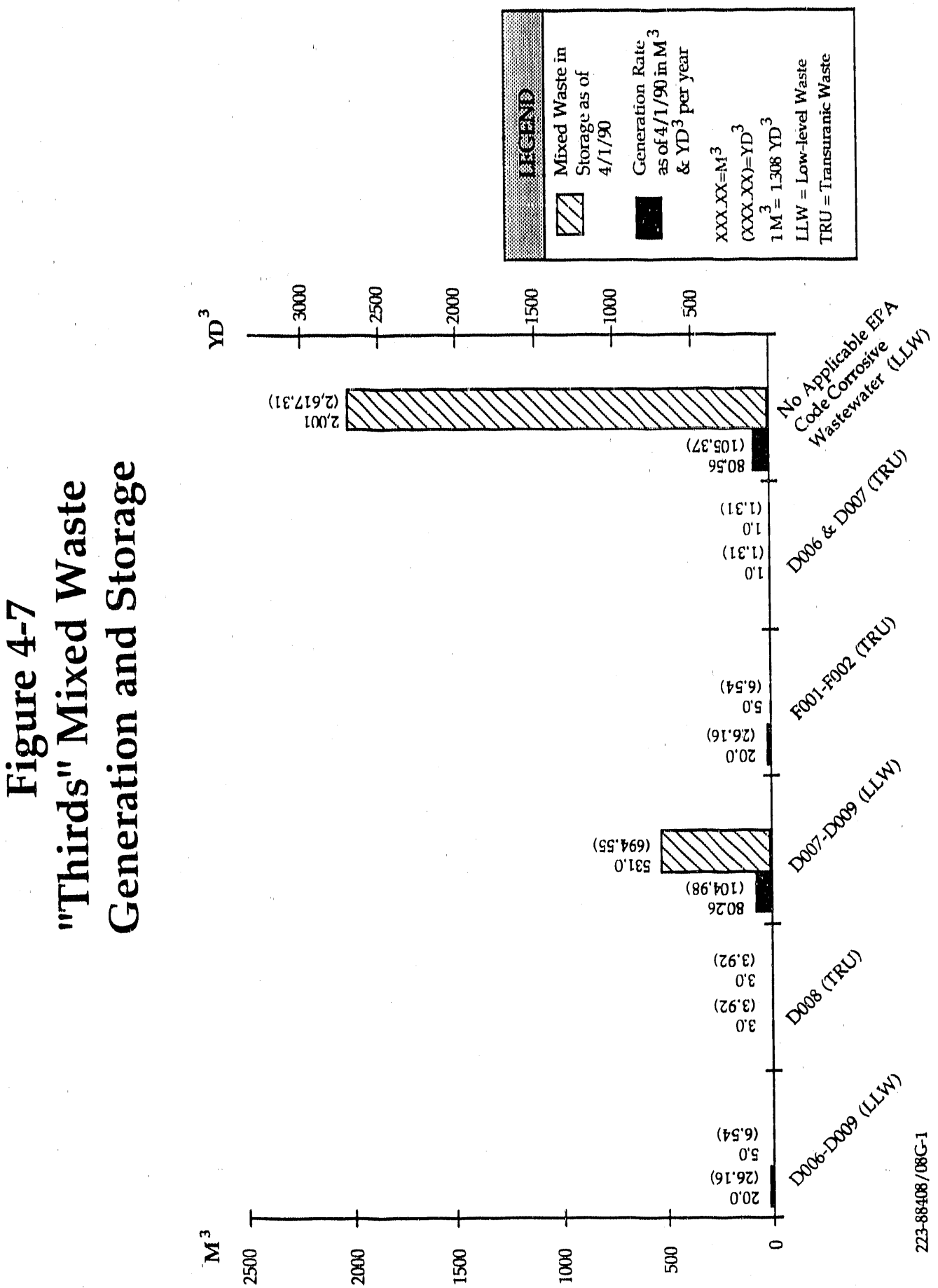

Figure 4-7. "Thirds" Mixed Waste Generation and Storage.

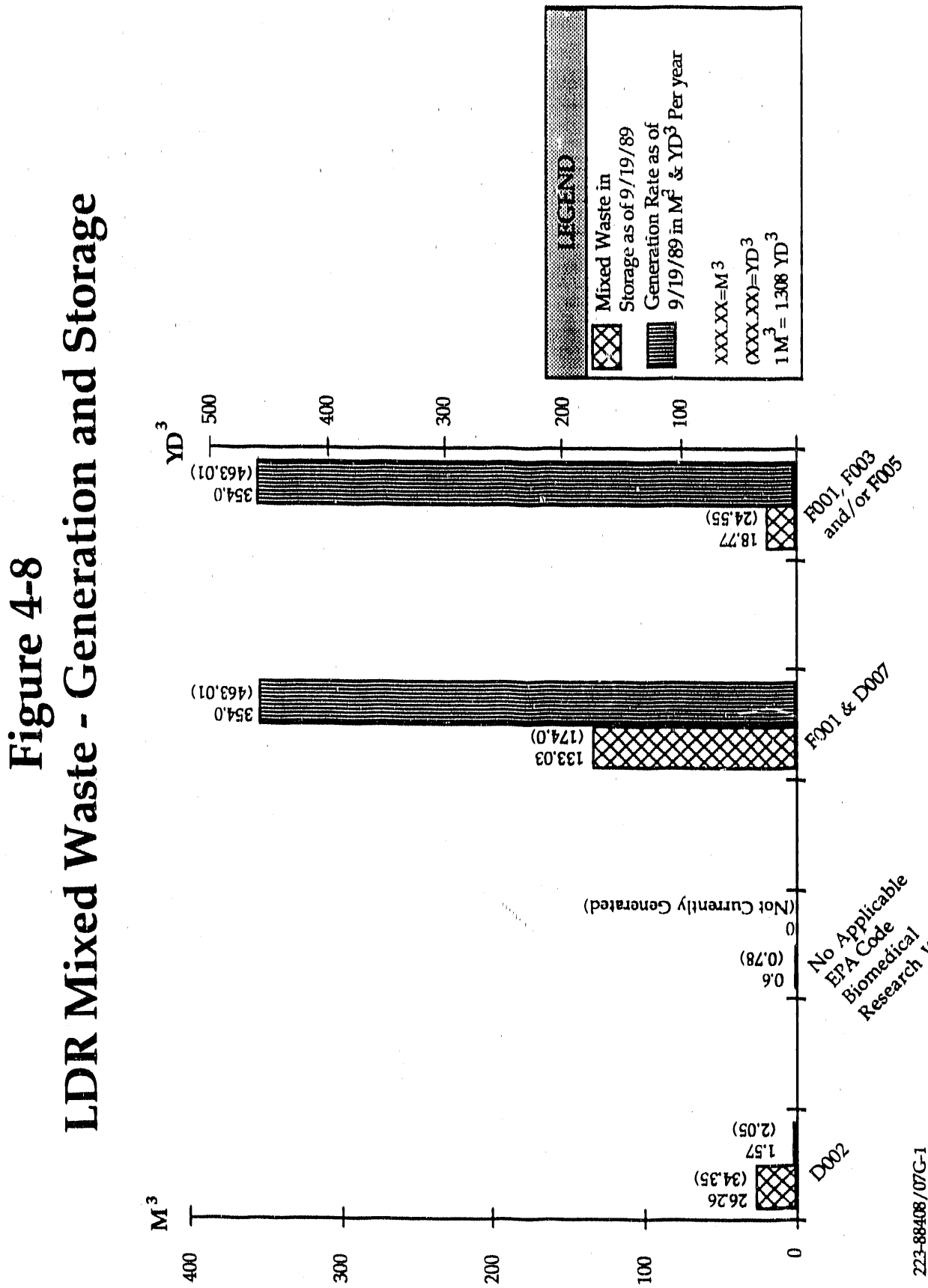

Figure 4-8. LDR Mixed Waste -- Generation and Storage.

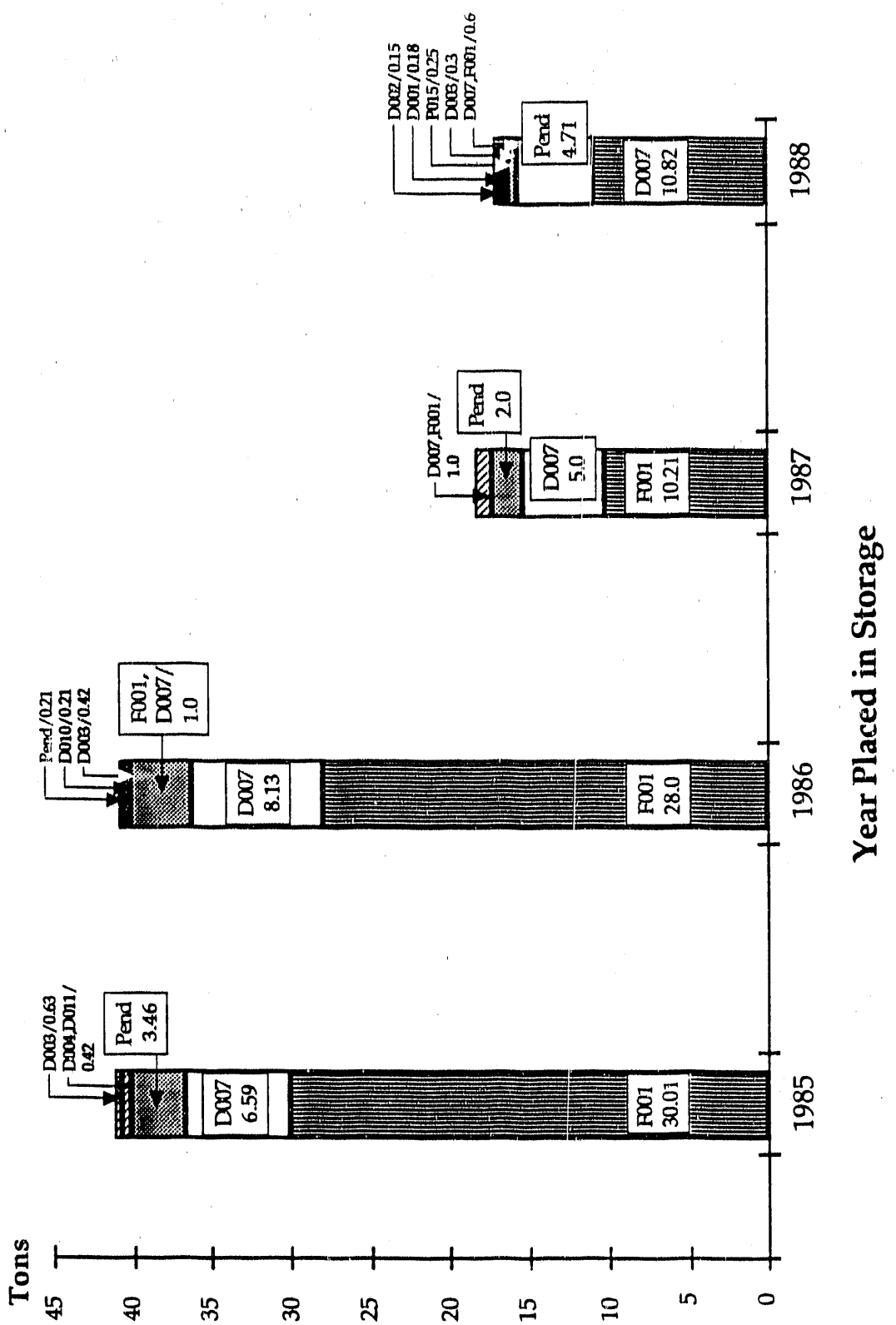

Figure 4-9. Mixed Waste in Storage for Years 1985-1988.

amount going into storage each year for later permanent disposal, as a percentage of liquid mixed waste quantities existing prior to treatment, has decreased.

5.0 ESTIMATE OF REMAINING MIXED WASTE STORAGE CAPACITY AT HWM

The storage capacities for each HWM storage unit are established in the RCRA Part B permit application, Section VI, December 1989. Table 5-1 lists the proposed permit storage capacities. However, for the purpose of this estimate, three of the stated storage capacities require revision based on current operational constraints. When the storage capacities for Areas 612-1A, 612-1B, and 612-5 were computed for the Part B permit application, the capacities reflected theoretical design storage limits of the areas as they existed when mixed waste first became regulated under RCRA. This volume assumed triple stacking of containers. The current configuration of tents and security measures precludes use of the full design capacity in Areas 612-1A, 612-1B, and 612-5 (Gracely, 1990). For example, the placement of Tent 612-5 effectively cuts off access to approximately 50 yds^3 of storage space in the southeast corner. The tent structures themselves reduce the usage of the shaded areas indicated in Figure 3-2. Additionally, the northwest corner of the paved area outside of the 612-5 Tent is used as a staging area for both mixed and radioactive waste. Also, the secured storage area in 612-5 significantly reduces the total capacity of this area. Finally, at the present time mixed and radioactive waste storage boxes, such as the 4'x4'x7' Type 7A boxes, are double stacked. Triple stacking may be necessary in the future but is not currently practiced, nor is it considered in this estimate.

Therefore, on the basis of the tent dimensions and a site visit to the 612 area, the following revised storage capacities are used to determine the remaining availability of space.

Area	Stated Capacity in Part B	Revised Capacity
612-1A	3,800 yd^3	465 yd^3
612-1B	1,422 yd^3	300 yd^3
612-5	3,445 yd^3	400 yd^3

Table 5-1. Hazardous Waste Management Unit Storage Capacities (RCRA Part B Permit Application Section VI, December 1989)

Mixed Waste Storage Unit	Permitted Capacity[b]	Comment
513 514-1 514-2 514-3 514-R501	78.0 yd^3 69.7 yd^3 73.5 yd^3 87.1 yd^3 71.8 yd^3	These areas are used for storage, treatment, and solidification of liquid mixed waste, such as spent solvent and waste oils, and depleted uranium chips.
612 612-1A 612-1B 612-2 612-4[a] 612-5 614W	191 yd^3 3800 yd^3 1422 yd^3 52.3 yd^3 235 yd^3 3445 yd^3 3.3 yd^3	These areas are used for the storage and handling of low-level waste and mixed waste.
625 East	105 yd^3	This area is used for storage of TRU and TRU mixed waste

[a] Area 612-4 is primarily used for receiving, segregation, and temporary storage.

[b] Quantity requested in permit. This capacity is not firm until the permit is issued.

Table 5-2. Estimate of Mixed Waste Storage Capacity at HWM Facilities

Area	Current Storage 10-17-90 (yd^3)	Permitted Storage (yd^3)	Remaining Storage (yd^3)	Months Remaining	Calculated Years Remaining	Best Estimate-Years Remaining
513	17.7	78.0	60.3	13.5	1.1	1.1
514-2	49.8	73.5	23.7	5.3	0.4	0.[e]
514-3	16.5[d]	87.1	79.4	17.8	1.5	1.5
514-1	0	69.7	[b]	[b]	[b]	0
514-R501[c]	71.8	71.8	0	0	0	0
					3.0 years	2.6 years
	yd^3	yd^3	yd^3			
612	29.4	191	161.6	23.6	2.0	1.0[g]
612-1A	367	465[h]	98.0	14.3	1.2	0.6[g]
612-1B	297	300[h]	3.0	0.4	0.0	0.0
612-2	43.4	52.3	8.9	1.3	0.1	0.1
612-5	315	400[h]	85.0	12.4	1.0	0.5[g]
614W	2.3	3.3	1.2	0.2	0.0	0[g]
625 East	78.7	105	26.3	[f]	[f]	[f]
					4.4 years	2.2 years

[a] Time remaining based on generation rates of 53.6 yd^3/yr (liquids) and 82.2 yd^3/yr (solids)
[b] Area 514-1 is currently used as a processing area and is not available for storage.
[c] Tank 514-R501 is used for emergency storage only.
[d] Includes 8.8 yd^3 of temporarily stored material.
[e] Area 514 personnel stated that 514-2 is currently full.
[f] Not calculated. Area 625 East is limited to TRU waste only.
[g] Represents 50% of capacity made available for mixed waste, since other wastes are also stored.
[h] Storage capacity as area is currently configured with tents and security measures.

The revised capacities reflect current operations and are used in the estimate of remaining storage capacity presented in Table 5-2.

The storage capacities of Areas 612, 612-2, 614 W, and 625-East were also verified by a site visit and are believed to be accurate. The capacity of the 612-4 area has not been included in Table 5-2 because it is used primarily as a receiving, segregation, and temporary storage area. It is assumed that no mixed wastes are stored long-term at the 612-4 location.

A physical inventory of all waste containers in the Area 612 storage locations was conducted on October 18, 1990. The information gathered was used to estimate the volume of currently stored waste in Area 612. These volumes are used in the calculation of remaining capacity in Table 5-2.

The above information enables a determination of the remaining low-level mixed waste storage capacity at HWM. Furthermore, knowledge of the rate at which mixed waste is generated to storage enables calculation of the time remaining until the capacities are reached. For this projection, the quantity of solid mixed waste placed in storage between January 1 and October 17, 1990, as indicated by the HWM database of non-TRU radioactive waste, was used to estimate an annual generation rate of 82.2 yd^3 for solid mixed waste.

The HWM database listing (Appendix A) does not include quantities for pre-treatment liquids. Therefore, the liquid mixed waste generation rate was estimated from the quantity of liquid waste generated in 1989 as reported to the DOE in an Environmental Assessment prepared in July 1990 (vanWarmerdam, 1990). Based on that data, a liquid mixed waste generation rate of 53.6 yd^3/yr was estimated.

Based on a conversation with Area 514 personnel, the 514-1 area is currently used as a process area and is unavailable for storage (Nibert, 1990). Additionally, the 514-R501 storage tank is normally used for emergency overflow only. This tank was not considered in the estimate of remaining capacity.

In Area 612, four of the waste management facilities listed in Table 5-1 (Buildings 612, 612-1, 612-5, and 614W) are also used as storage and handling areas for LLW. The total storage capacity of these four areas does not change with respect to the type of waste stored. It is important to note that storage of mixed waste in these areas reduces

the amount of available space for LLW. The opposite is also true. The quantities listed in Table 5-2 for current storage as of October 17, 1990, include hazardous, LLW, and mixed waste. Remaining mixed waste remaining storage capacity in these areas would be reduced with an increase in volume of LLW requiring long-term storage. Additional mixed waste storage capacity in the 612 Complex may become available when Building 693 becomes operational. Building 693 will be used to store hazardous waste only. Also, the current storage in Building 625 East and Area 612-5 includes TRU wastes that are stored there. It is assumed in the calculation of time remaining that the available mixed waste capacities are not reduced in the future to make room for other waste.

Table 5-2 presents the calculations of the remaining mixed waste storage capacity at HWM and remaining time. Thus, it is estimated that at current rates of generation, the maximum storage capacity for liquid mixed waste (before any treatment) will be reached in 2.6 years, and solid mixed waste capacity will be reached in 2.2 years. It is possible that the time remaining for liquid mixed waste capacity is overestimated. The 2.6 year figure is attributable solely to available volume, as indicated from HWM database quantities, in Areas 513 and 514-3. However, Area 514 personnel have stated that very little space remains for storage in these areas. It is recommended that the reality of the permitted storage capacities be further investigated. Currently, approximately 25 percent of the solid mixed waste storage capacity, as revised to reflect actual conditions, and 43 percent of the liquid mixed waste storage capacity remain available for use.

Future LLNL activities, such as any large-scale decontamination activities or the start up of the Uranium Demonstration System, may have significant effects upon mixed waste generation rates. Reevaluation of storage capacities would thus be required.

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7.0 ACRONYMS

AEA	Atomic Energy Act
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DHS	California Department of Health Services
DO	Dorr-Oliver filtration unit
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy/Nevada Operations
DOT	U.S. Department of Transportation
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency
FR	*Federal Register*
HAZWRAP	Hazardous Waste Remedial Actions Program
HOC	halogenated organic compound
HSWA	Hazardous and Solid Waste Amendments
HWM	Hazardous Waste Management Division
IDB	Integrated Database
LDR	land disposal restriction, land disposal restricted
LLNL	Lawrence Livermore National Laboratory
LLW	low-level radioactive waste
LSA	low specific activity
MOU	Memorandum of Understanding
MW	mixed waste
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
SAIC	Science Applications International Corporation

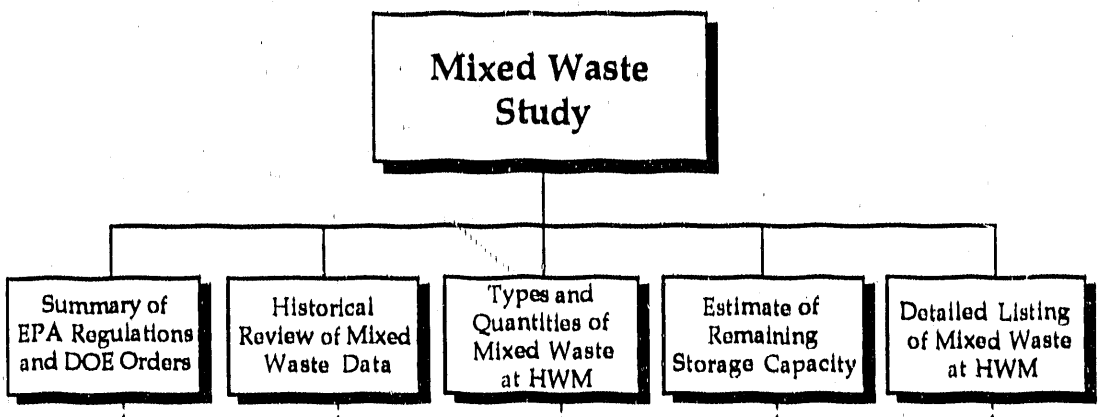
TCE	trichloroethane
TCLP	Toxicity Characteristic Leaching Procedure
TRU	transuranic
TSDF	treatment, storage, and disposal facility
TSDR	treatment, storage, disposal, and recycling
WAA	Waste Accumulation Area
WDR	waste disposal requisition
WIPP	Waste Isolation Pilot Plant

APPENDICES

Appendix A: Detailed Listing of Mixed Waste at HWM (October 1, 1990)

Appendix B: Compilation of LLNL HWM Correspondence and File Records Regarding Mixed Waste, Volume I through Volume V

Because of the size of the appendices, they are contained in six supplementary volumes. The table following relates each of the sections of this report to the sections of Appendix B.



HWM Mixed Waste Records					
Section 1. Waste Storage, Transport, & Correspondence	X			X	
Section 2. Regulation, Compliance, & Policy - DOE, RCRA, CERCLA, EPA	X	X			
Section 3. Land Disposal Restricted (LDR) Documentation	X				
Section 4. Mixed Waste Stream Characteristic by Type, Quantity, Composition, & Program Generations		X	X	X	X
Section 5. Mixed Waste Treatment			X		
Section 6. Guidance Documents & Interim Status Requirements	X				
Section 7. Workshop & Meeting Agendas & Reports	X				
Section 8. Miscellaneous Documents					

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Mixed Waste Study.

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02/13/91