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Environment, Safety and Health
Office of Environmental Audit

Environmental Survey Preliminary Report

Ames Laboratory
Ames, Iowa

March 1989

MASTER

PREFACE TO
THE DEPARTMENT OF ENERGY
AMES LABORATORY
ENVIRONMENTAL SURVEY PRELIMINARY REPORT

This report contains the preliminary findings based on the first phase of an Environmental Survey at the United States Department of Energy's (DOE) Ames Laboratory, located in Ames, Iowa. The Survey is being conducted by DOE's Office of Environment, Safety and Health.

The Ames Laboratory Survey is a portion of a larger, comprehensive DOE Environmental Survey encompassing all major operating facilities of DOE. The DOE Environmental Survey is one of a series of initiatives announced on September 18, 1985, by Secretary John S. Herrington to strengthen the environmental, safety, and health programs and activities within DOE. The purpose of the Environmental Survey is to identify, via a "no fault" baseline Survey of all the Department's major operating facilities, environmental problems and areas of environmental risk. The identified problem areas will be prioritized on a Department-wide basis in order of importance in 1989.

The preliminary findings in this report are subject to modification, based on the results from the Sampling and Analysis phase of the Survey. Preliminary findings are also subject to modification based on comments from the Chicago Operations Office concerning the technical accuracy of the findings. The modified findings will be incorporated into the Environmental Survey Summary Report.

March 1989
Washington, D.C.

PRELIMINARY

CONTENTS

PRELIMINARY

CONTENTS (Continued)

PRELIMINARY

CONTENTS (Continued)

PRELIMINARY

TABLES

PRELIMINARY

FIGURES

PRELIMINARY

EXECUTIVE SUMMARY

Introduction

This report presents the preliminary findings of the first phase of the Environmental Survey of the United States Department of Energy's (DOE) Ames Laboratory, conducted April 18 through 22, 1988.

The Survey is being conducted by an interdisciplinary team of environmental specialists, led and managed by the Office of Environment, Safety and Health's Office of Environmental Audit. Individual team members are being supplied by private contractors. The objective of the Survey is to identify environmental problems and areas of environmental risk associated with the Ames Laboratory. The Survey covers all environmental media and all areas of environmental regulation. It is being performed in accordance with the DOE Environmental Survey Manual. This phase of the Survey involves the review of existing site environmental data, observations of the operations carried on at the Ames Laboratory, and interviews with site personnel.

The Survey team developed a Sampling and Analysis (S&A) Plan to assist in further assessing certain of the environmental problems identified during its on-site activities. The S&A plan is being developed by the Idaho National Engineering Laboratory. When S&A is completed, the results will be incorporated into the Ames Laboratory Environmental Survey findings for inclusion in the Environmental Survey Summary Report.

Site Description

The Ames Laboratory occupies two locations in the City of Ames, Iowa, approximately 40 miles north of Des Moines, Iowa. Major research laboratories and support facilities of the Ames Laboratory are located in several buildings on the campus of Iowa State University (ISU). The Ames Laboratory also occupies space at the Applied Science Center, an ISU facility situated approximately 1 mile northwest of the main ISU campus. Although several buildings and facilities at the Ames Laboratory are United States Government-owned, some are leased from ISU. The

PRELIMINARY

Ames Laboratory is managed by DOE and operated by ISU's Institute for Physical Research and Technology.

The Ames Laboratory was formally dedicated in 1947. At the time, the Laboratory was recognized for its expertise in separating and purifying uranium. Since then, the expertise of the Ames Laboratory in separating, purifying, and characterizing metals has expanded to include thorium, alkaline earth metals, rare earth elements, transition elements, and other metals. Present research is centered in material science programs in support of energy technologies.

Environmental concerns regarding residual radioactive contamination from past Ames Laboratory operations were raised in meetings with local officials.

Summary of Findings

The major preliminary findings of the Environmental Survey at the Ames Laboratory are associated with Laboratory inactive waste sites which have contaminated the soil with chemicals and/or radionuclides and represent potential sources of contamination to the groundwater and surface water.

Overall Conclusions

The Survey found no environmental problems at the Ames Laboratory that represent an immediate threat to human life. The preliminary findings identified at the Ames Laboratory indicate that there may be significant environmental problems which are the result of past operational practices.

The environmental problems described in this report vary in terms of magnitude and risk. Although the Survey-related S&A will assist in further identifying some suspected environmental problems associated with the Ames Laboratory, a complete understanding of the significance of these and other identified environmental problems requires a level of study and characterization that is beyond the scope of this Survey. Actions currently under way or planned will contribute toward meeting this requirement.

PRELIMINARY

Transmittal and Follow-up of Findings

The preliminary findings of the Environmental Survey for the Ames Laboratory were shared with the DOE Chicago Operations Office and the Ames Laboratory at the Survey closeout briefing held on April 22, 1988. The Chicago Operations Office has developed a draft action plan, dated June 27, 1988, to address the Survey preliminary findings. A final action plan, addressing all the Survey findings cited herein, will be prepared by the Chicago Operations Office within 45 days after receiving this Preliminary Report. Those problems that involve extended studies and multiyear budget commitments will be the subject of the DOE-wide Environmental Survey Summary Report and the DOE-wide prioritization.

Within the Office of the Assistant Secretary for Environment, Safety and Health, the Office of Environmental Guidance and Compliance (OEG) has immediate responsibility for monitoring environmental compliance and the status of the Ames Laboratory Survey findings. The Office of Environmental Audit will continue to assess the environmental problems through a program of systematic environmental audits that will be initiated toward the conclusion of the DOE Environmental Survey in 1989.

PRELIMINARY

1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings developed during the Environmental Survey, conducted April 18 through 22, 1988, at the U.S. Department of Energy's (DOE) Ames Laboratory, Ames, Iowa. As a Preliminary Report, the contents are subject to revision. Revisions to the preliminary findings based on technical accuracy review comments from the DOE Chicago Operations Office and the results from the Survey's Sampling and Analysis program at the Ames Laboratory will be incorporated into the Environmental Survey Summary Report. The DOE manages the Ames Laboratory, which is operated by Iowa State University's Institute for Physical Research and Technology.

The Ames Laboratory Survey is part of the larger DOE-wide Environmental Survey announced by Secretary John S. Herrington on September 18, 1985. The purpose of this effort is to identify, via "no-fault" baseline surveys, existing environmental problems and areas of environmental risk at DOE facilities, and to rank them on a DOE-wide basis. This ranking will enable DOE to more effectively establish priorities for addressing environmental problems and allocate the resources necessary to correct them. Because the Survey is "no-fault" and is not an "audit," it is not designed to identify specific isolated incidents of noncompliance or to analyze environmental management practices. Such incidents and/or management practices will, however, be used in the Survey as a means of identifying existing and potential environmental problems.

The Ames Laboratory Environmental Survey was conducted by a multidisciplinary team of technical specialists headed and managed by a Team Leader and Assistant Team Leader from DOE's Office of Environmental Audit. A complete list of the Ames Laboratory Survey participants and their affiliations is provided in Appendix A.

The Survey team focused on all environmental media, using Federal, state, and local environmental statutes and regulations, accepted industry practices, and professional judgment to make the preliminary findings included in this report. The team carried out its activities in accordance with the guidance and protocols of the DOE Environmental Survey Manual. Substantial use of existing information and of interviews with knowledgeable field-office and site-contractor personnel accounted for a large part of the on-site effort. A summary of the site-specific Survey activities is presented in Appendix B, and the Survey Plan is presented in Appendix C.

Preliminary Survey findings, in the form of existing and potential environmental problems, are presented in Sections 3.0 and 4.0. Section 3.0 includes findings that pertain to a specific environmental medium (i.e., air, soil, surface water, and groundwater), whereas Section 4.0 includes those that are non-media-specific (i.e., waste management, toxic and chemical materials, radiation, quality assurance, and inactive waste sites and releases). A list defining the abbreviations, acronyms, and initialisms appearing throughout the report is provided in Appendix D. Because the findings are highly varied in magnitude, risk, and characterization, and consequently require different levels of management attention and response, they are further subdivided into four categories within Sections 3.0 and 4.0.

The criteria for placing a finding into one or more of the four categories are as follows:

- Category I includes only findings that, based on information available to the Team Leader, involve immediate threat to human life. Findings of this category shall be conveyed immediately to the Environment, Safety and Health personnel at the scene or in control of the facility or location in question for action. Category I findings are environmental problems with the highest potential risk, the strongest confidence in the finding, based on the information available, and the most restrictive appropriate response in terms of alternatives.

- Category II findings encompass one or more of the following situations:

  - Multiple or continuing exceedances, past or present, of a health-based environmental standard where there is immediate potential for human exposure, or a one-time exceedance where residual impacts pose an immediate potential for human exposure.

PRELIMINARY

- Evidence that a health-based environmental standard may be exceeded, as discussed in the preceding situation, within the time of the DOE-wide Survey.

- Evidence that the likelihood is high for an unplanned release due to, for example, the condition or design of pollution abatement or monitoring equipment or other environmental management practices.

- Noncompliance with significant regulatory procedures (i.e., substantive technical regulatory procedures designed to directly or indirectly minimize or prevent risks), such as inadequate monitoring or failure to obtain required permits.

Category II findings include environmental problems where the risk is high but where the definition of risk is broader than in Category I. The information available to the Team Leader is adequate to identify the problem but may be insufficient to fully characterize it. Finally, in this category, most discretion is available to the Operations Offices and Program Offices as to appropriate response; however, the need for that response is such that management should not wait for the completion of the DOE-wide Survey to respond. Unlike Category I findings, a sufficient near-term response to Category II findings by the Operations Office may include further characterization before any action is taken to rectify the situation.

- Category III findings encompass one or both of the following criteria:

  - The existence of pollutants or hazardous materials in the air, water, groundwater, or soil resulting from DOE operations that pose or may pose a hazard to human health or the environment.

  - The existence of conditions at a DOE facility that pose or may pose a hazard to human health or the environment.

PRELIMINARY

Category III findings are environmental problems for which the broadest definition of risk is used. As in Category II, the information available to the Team Leader may not be sufficient to fully characterize the problems. Under this category, the range of alternatives available for response and the corresponding time limits for response are the greatest. Environmental problems included within this category will typically require lengthy investigation and remediation phases, as well as multiyear budget commitments. These problems will be included in the DOE-wide prioritization to ensure that DOE's limited resources are used effectively.

In general, levels of pollutants or materials that constitute a hazard or potential for hazard are those that exceed some Federal, state, or local regulations for release of, contamination by, or exposure to such pollutants or materials. However, in some cases, the Survey may determine that the concentration of some nonregulated material is sufficient to be included as an environmental problem. Likewise, concentrations of regulated materials even though below limits established by regulatory authorities, that nevertheless present a potential for hazard or concern may be classified as an environmental problem. In general, however, conditions that meet regulatory or other requirements, where such exist, should not present a potential hazard and will not be identified as an environmental problem.

Conditions that pose or may pose a hazard are generally those that are violations of regulations or requirements (e.g., improper storage of hazardous chemicals in unsafe tanks). Such conditions present a potential hazard to human health and the environment and should be identified as an environmental problem. Additionally, potentially hazardous conditions are those where the likelihood of the occurrence of release is high.

The definition of the term "environmental problem" is broad and flexible to allow for the wide differences among the DOE sites and operations. Therefore, a good deal of professional judgment must be applied to the identification of environmental problems.

- Category IV findings include instances of administrative noncompliance and of management practices that are indirectly related to environmental risk but are not appropriate for inclusion in Categories I through III. Such findings can be based on any level of information available to the Team Leader, including direct observations by the team members. Findings in this category are generally expected to lend themselves to relatively simple, straightforward resolution without further evaluation or analysis. These findings, although not part of the DOE-wide prioritization effort, will be passed along to the Operations Offices and appropriate Program Office for action.

Based on the professional judgment of the Team Leader, the findings within categories are arranged in order of relative significance. Comparing the relative significance of one finding to another, either between categories within a section or within categories between sections, is neither appropriate nor valid. The categorization and listing of findings in order of significance within this report constitute only the first step in a multistep, iterative process to prioritize DOE's problems.

The next phase of the Ames Survey is sampling and analysis (S&A). An S&A Plan was prepared by DOE and the Idaho National Engineering Laboratory (INEL), the S&A team for the Ames Laboratory, in accordance with the protocols in the DOE Environmental Survey Manual. The S&A Plan is designed to fill existing data gaps or weaknesses. The INEL collected samples in late 1988, and results generated by this effort will be used to assist the Survey Team in further defining the existence and extent of potential environmental problems identified during the Survey.

It is clear that certain of the findings and observations contained in this report are highly varied in magnitude, risk, and characterization. Consequently, the priority, magnitude, and timeliness of near-term responses will require careful planning to ensure appropriate and effective application. The information in this Preliminary Report will assist the Chicago Operations Office in planning these near-term responses.

The Chicago Operations Office submitted a draft action plan dated June 27, 1988, in response to the preliminary findings presented at the conclusion of the on-site Survey activities and summarized in the Ames Laboratory Survey Status Report dated May 4, 1988. The draft action plan for the Ames Laboratory Survey has been reviewed by the Office of Environmental Guidance and Compliance (OEG), which has immediate responsibility for monitoring the status and overseeing the adequacy of corrective actions taken by the Operations Office in response to the Survey findings.

As required in the December 2, 1987, memorandum from the Assistant Secretary for Environment, Safety and Health to the Operations Office Managers entitled Follow-up of Environmental Survey Findings, the Chicago Operations Office will prepare and submit a final action plan to the Deputy Assistant Secretary (DAS) for Environment within 45 days after receiving this Preliminary Report. The final action plan for the Ames Laboratory Survey will address all of the preliminary findings cited herein, and will incorporate OEG's comments on the draft action plan.

PRELIMINARY

2.0 GENERAL SITE INFORMATION

Much of the information in this section is summarized from the Ames Laboratory Institutional Plan (ISU, 1984) and information provided by the Ames Laboratory.

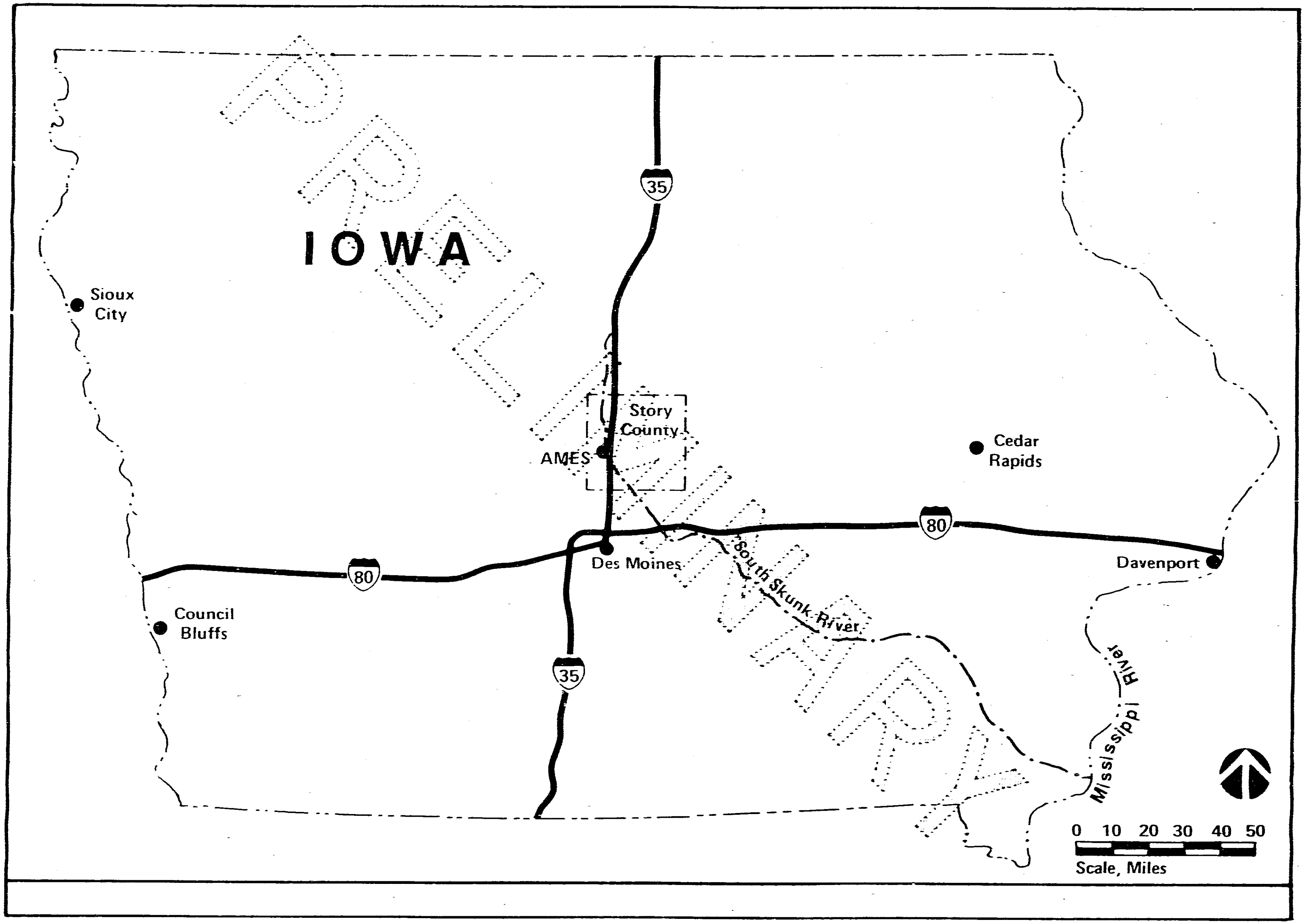
2.1 Site Setting

The Ames Laboratory occupies two locations in the City of Ames, in Story County, Iowa, approximately 40 miles north of Des Moines, Iowa. The general location of Ames, Iowa, is shown in Figure 2-1. Major research laboratories and support facilities of the Ames Laboratory are located in several buildings on the campus of Iowa State University (ISU). The Ames Laboratory also occupies space at the Applied Science Center (ASC), an ISU facility approximately 1 mile northwest of the ISU main campus. The general location of the ISU campus and the ASC is shown in Figure 2-2. The locations of the Ames Laboratory buildings with respect to ISU buildings on the ISU campus and at the ASC are shown in Figures 2-3 and 2-4, respectively.

The ISU campus is bordered on the north by the Chicago and Northwestern Railroad right-of-way and covers roughly 1 square mile. The campus is bordered on the west by Hyland Avenue, on the east by Elwood Drive, and on the south by Lincoln Way, each of which is a public access road. The ASC, roughly 18 acres in area, is bordered on the north, east, and west by agricultural land, and on the south by Ontario Road.

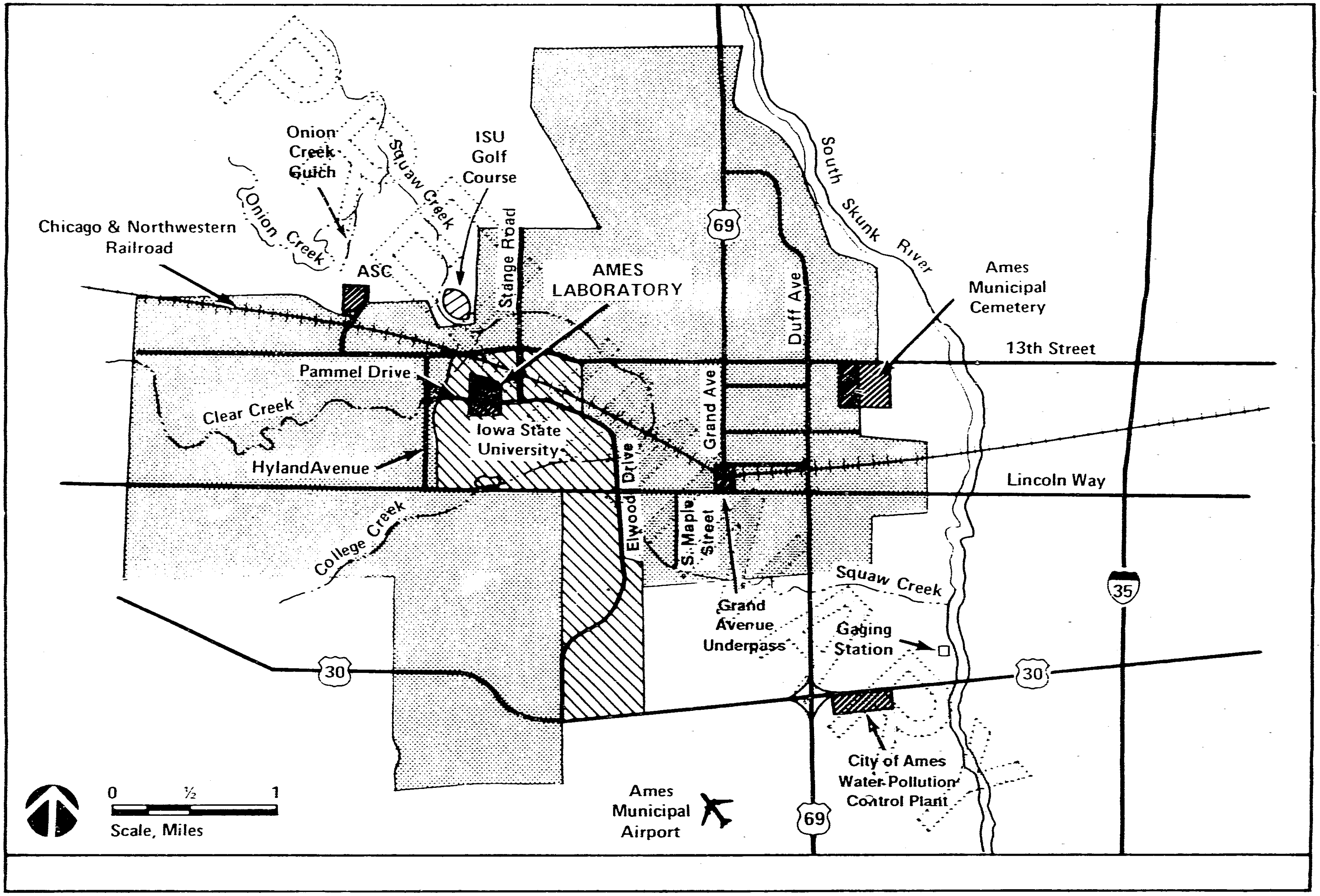
The population of Story County was 72,326 according to the 1980 U.S. census, and the total population within a 50-mile radius of ISU was 600,500 in 1980. Story County experienced a 15-percent growth in population between 1970 and 1980, and the 1987 population was estimated to be approximately 80,000 (Voss, 1981; DOC, 1983). The ISU student population was approximately 25,000 in 1987. Approximately 600 people currently work at the Ames Laboratory, including approximately 200 graduate students.

ISU is surrounded by medium-density residential and commercial areas, and some agricultural land is located north and west of the site. With the exception of the ISU and City of Ames electric power plants, there are no large industrial facilities within several miles of the site. Squaw Creek flows south and east through the center of Ames passing near the northern and eastern boundary of the ISU campus (Figure



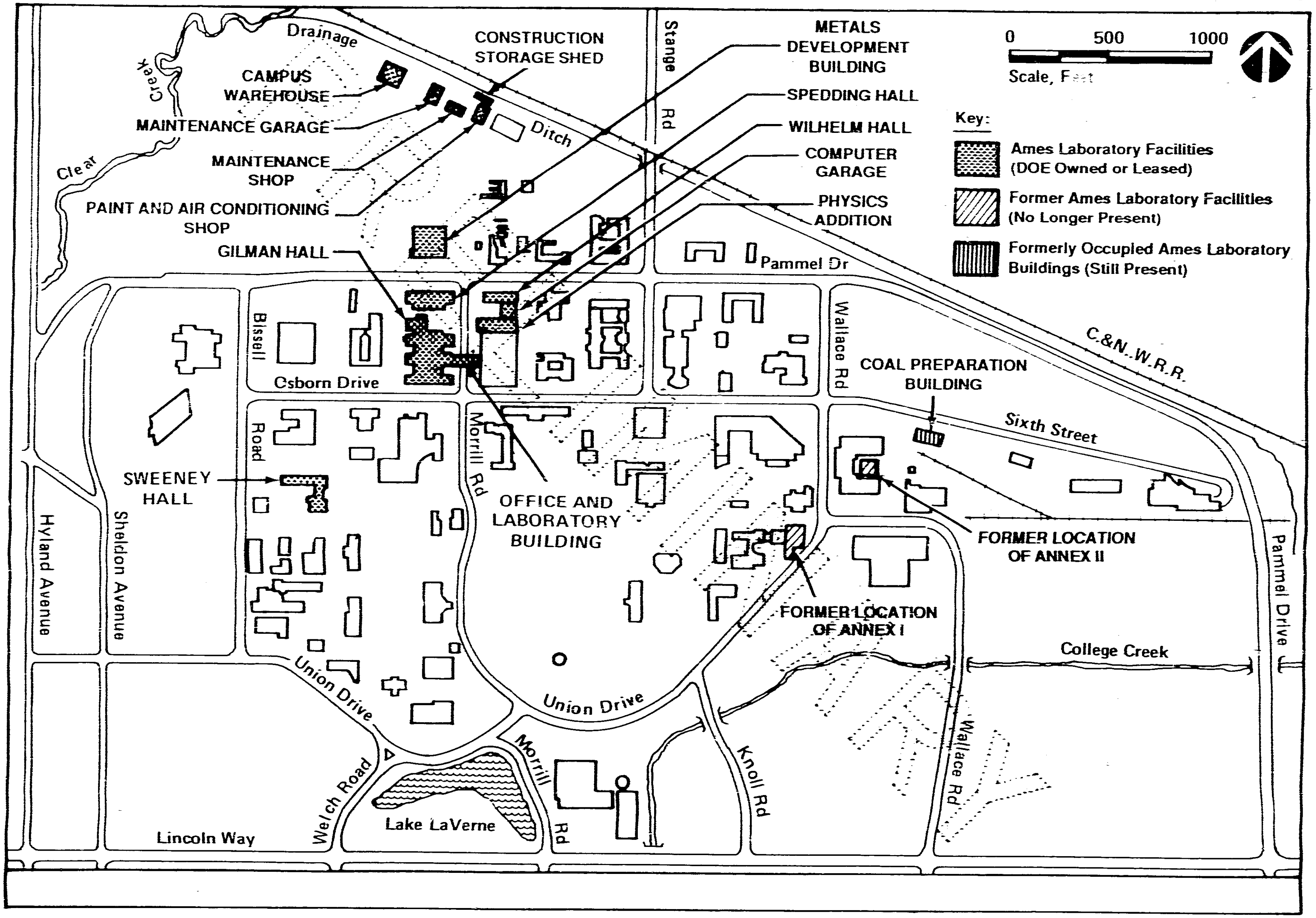
LOCATION OF AMES IN THE STATE OF IOWA

FIGURE 2–1



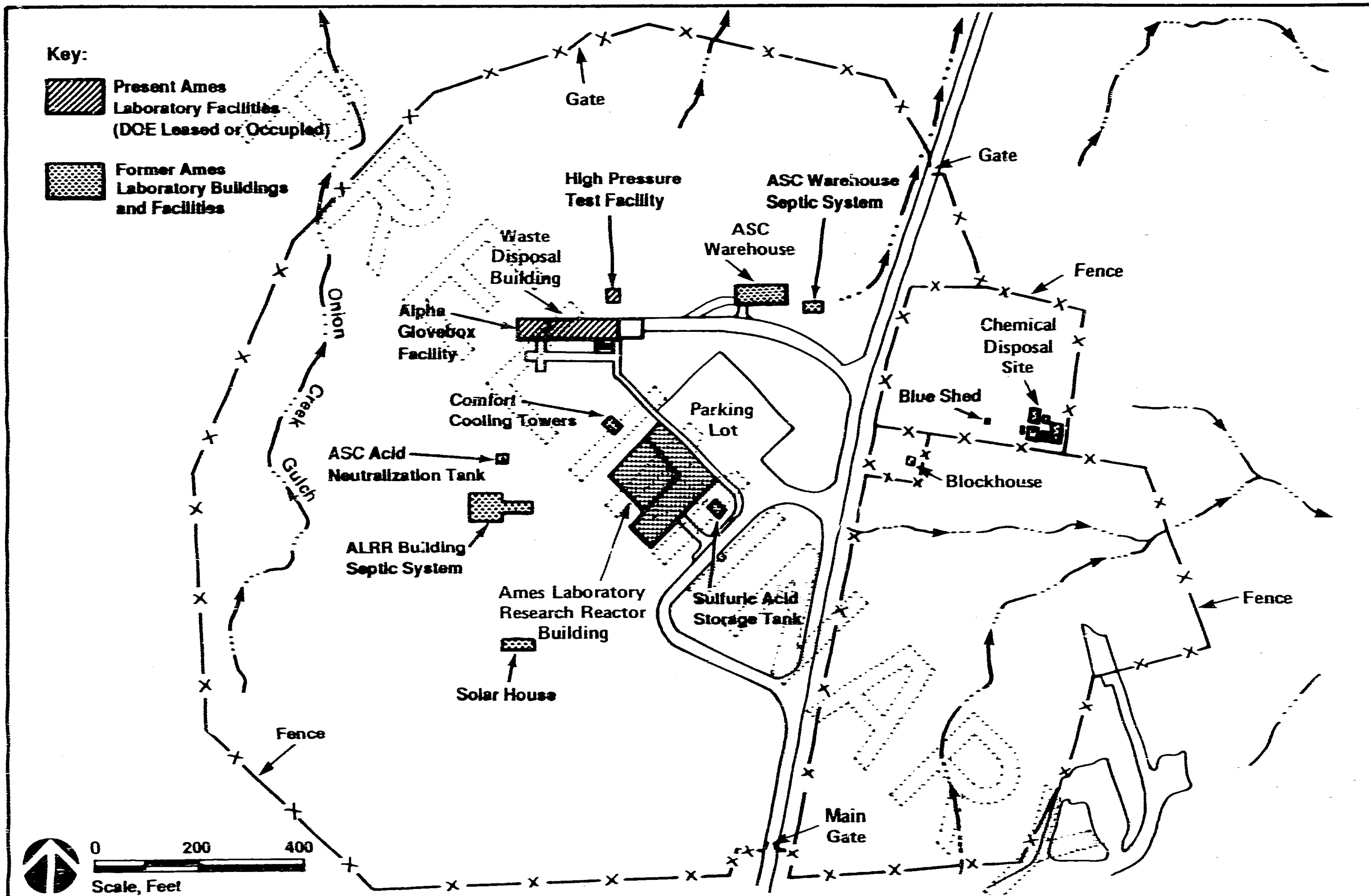
CITY OF AMES, IOWA

FIGURE 2–2



AMES LABORATORY FACILITIES ON THE IOWA STATE UNIVERSITY MAIN CAMPUS

FIGURE 2-3



AMES LABORATORY APPLIED SCIENCE CENTER

FIGURE 2-4

2-2); it then flows into the South Skunk River. The immediate area around the site is extremely flat, and the site elevation is approximately 900 feet above sea level, with the flat upland areas only about 50 feet above the Squaw Creek floodplain. Vegetation in the immediate vicinity of the site is typical of that of landscaped residential and agricultural areas. Local land use is approximately 34 percent residential, 23 percent wooded, and 43 percent agricultural, primarily corn, soybeans, and wheat.

The nearest location for which complete meteorological data are available is Des Moines Airport in Des Moines, Iowa, approximately 40 miles south of Ames. Wind roses and other meteorological data from Des Moines are expected to be only qualitatively representative of the Ames area because of the distance between Des Moines and Ames.

The climate in central Iowa is temperate, typical of the central continental areas of the United States. Central Iowa is, however, subject to periodic high winds and tornadoes and sudden changes in temperature. Prevailing winds in Des Moines are from the southeast in the warmer months, averaging 12 to 14 miles per hour (mph). Winds are generally from the northwest in the colder months, and average 18 to 20 mph. Average July and January temperatures in Des Moines are 76°F and 19°F, respectively. The average annual precipitation in the Des Moines area is approximately 32 inches, and ranges from a normal low of 1.01 inches in January to a high of 4.18 inches in June. Annual precipitation is very variable, however, and ranges from a minimum of 17 inches to a maximum of 56 inches, with up to 20 percent of the precipitation being snowfall (Voss, 1981; GRC, 1983).

2.2 Overview of Major Site Operations

The Ames Laboratory was founded in the early days of the atomic energy program because of the expertise available at ISU in separating and purifying uranium. During and immediately after World War II, ISU (then Iowa State College) was under contract to the Manhattan District of the U.S. Army Corps of Engineers to develop and implement processes to produce pure uranium and thorium and to recover these metals from scrap. Following the end of World War II, the Ames Laboratory, then the Iowa State University Institute for Atomic Research (ISU IAR) was established, and the facility was formally dedicated in 1947. Since that time, the expertise of the Ames Laboratory in separating, purifying, and characterizing metals has expanded to include the alkaline earths (e.g., magnesium, calcium, strontium), all the rare earths, certain transition elements (e.g., vanadium, chromium, niobium, yttrium, scandium), and other elements. Present research at the Ames Laboratory is centered in material science programs in support of energy technologies.

The Ames Laboratory is operated by the ISU Institute for Physical Research and Technology for the U.S. Department of Energy (DOE) through the Chicago Operations Office (CH). Since the Ames Laboratory exists in a university environment as a research facility, it is not operated as a restricted-access facility. The Ames Laboratory can undertake private contracts in this relationship with ISU.

The Ames Laboratory is organized into 13 major research programs that reflect the disciplinary organization of the Laboratory. The major objectives of each program and specific projects under each program are summarized below:

- Applied Nondestructive Evaluation

  This program is devoted to the development and application of new techniques for quantitative nondestructive evaluation of materials and structures. This program is supported in part by the U.S. Department of Defense (DOD). Other work under this program involves development of ultrasonic inspection systems for measurement of stress in materials. This work is coordinated with the Engineering and Mathematical Sciences programs.

- Engineering, Mathematical, and Geosciences

  Projects under the Engineering, Mathematical, and Geosciences programs are devoted to the development of analytical equipment and techniques for nondestructive testing and remote sensing. Specific projects include development of new techniques for nondestructive testing using ultrasound and development of mathematical models for wave propagation and materials solidification processes.

PRELIMINARY

- Environmental Sciences

The two primary projects under this program relate to development of new analytical techniques to identify and quantify toxic organic compounds present in the environment in trace amounts. One project involves development of spectrographic techniques for analysis of toxic organics such as polynuclear organic materials (POMs), and another project focuses on development of new chemical separation techniques for similar compounds.

- Experimental Nuclear Physics

The Experimental Nuclear Physics program at the Ames Laboratory is focused on the study of unstable neutron-rich nuclei. Most of the physical research for this program is conducted at the DOE Brookhaven National Laboratory. On-site research includes theoretical modeling and experimental design.

- High Energy Physics

The High Energy Physics program emphasizes the study of atomic and subatomic particles (e.g., quarks and gluons). Most of the physical research for this program is conducted at the DOE Fermi Laboratory and at several non-DOE facilities. On-site research includes theoretical modeling and experimental design.

- Metallurgy and Ceramics

The Metallurgy and Ceramics program focuses on the study of interactions of atomic structures and the properties of materials, and involves production, characterization, and analysis of extremely high-purity metals and metal compounds. Ongoing projects include study of crystal growth of ceramic materials and thin-film growth using metal, metal oxide, and semiconductor materials. Material production activities are organized under the Metallurgy and Ceramics program as the Materials Preparation Center (MPC).

PRELIMINARY

- Solid State Physics

The Solid State Physics program emphasizes the synthesis, characterization, and modeling of new bulk and thin-film materials. Materials are produced using a variety of physical and chemical techniques including vacuum deposition, and may be tested under extreme conditions of temperature and pressure. Materials produced in this program include semiconducting and superconducting materials. The Solid State Physics program is closely coordinated with the Metallurgy and Ceramics and Materials Chemistry programs.

- Materials Chemistry

The Materials Chemistry program includes surface chemistry, characterization of ceramic powders, and synthesis and characterization of strongly bonded materials. Current projects include study of catalytic hydrodesulfurization reactions, study of ceramic particle nucleation and growth, and synthesis and characterization of metal-nonmetal compounds.

- Fundamental Interactions

Projects in this program include study of gas-phase reactions and ion-molecule reactions. The two main areas of study are gas phase reactions relevant to combustion processes and aspects of solar energy conversion processes.

- Processes and Techniques

This program is involved in studies related to catalysis, catalytic reactions, and coal chemistry. Catalysts being studied include those for hydro-sulfurization, hydrodenitrification, methanation, and selective oxidation. Current projects include synthesis and study of reaction kinetics in organometallic systems such as thiophene-metal complex systems, and

PRELIMINARY

development of new spectroscopic methods for chemical speciation and analysis.

- Fossil Energy

  The Fossil Energy program focuses on coal conversion processes. Specific projects focus on the study of chemical and physical processes for coal desulfurization, development and application of analytical techniques for coal, flyash, and process by-product characterization, and development of on-line instrumentation for monitoring of coal conversion processes. Fossil Energy program projects are coordinated with the DOE Morgantown Energy Technology Center (METC) and DOE Pittsburgh Energy Technology Center (PETC).

- Safeguards and Security

  The objectives of this program are to determine the feasibility of applying atomic spectroscopic analytical methods, particularly Inductively Coupled Plasma (ICP) techniques developed at the Ames Laboratory, to the on-line determination of uranium, plutonium, and other isotopes in the nuclear fuel process.

- Microelectronics

  The Microelectronics program is devoted to basic and intermediate-level research on electronic materials and device physics, and is jointly operated with ISU through the interdisciplinary Microelectronics Research Center (MRC). Projects under this program include thin-film deposition studies and development of microwave materials and devices. This program is coordinated with the Solid State Physics program and is supported in part by the DOD.

The Ames Laboratory consists of 13 buildings and facilities on the ISU campus and four at the ASC that are fully or partially occupied by the Laboratory. Buildings and facilities occupied or formerly occupied by the Ames Laboratory that are still present are summarized in Table 2-1.

PRELIMINARY

TABLE 2-1

BUILDINGS AND FACILITIES PRESENTLY OR FORMERLY OCCUPIED BY THE AMES LABORATORY

ISU Campus Research Buildings Owned and Fully Occupied by the Ames Laboratory	Spedding Hall Metals Development Building Wilhelm Hall Computer Garage
ISU Campus Research Buildings Partially Leased by the Ames Laboratory	Gilman Hall Physics Addition Office and Laboratory Building Sweeney Hall
Applied Science Center Facilities Leased by the Ames Laboratory	Alpha Glovebox Facility Waste Disposal Building Blue Shed (Occupied but not Leased) High Pressure Test Facility
ISU Campus Support Buildings/Areas Owned and Fully Occupied by the Ames Laboratory	Maintenance Garage Maintenance Shop Paint and Air Conditioning Shop Construction Storage Shed Campus Warehouse
ISU Buildings Formerly Occupied by the Ames Laboratory	Ames Laboratory Research Reactor Building (at the Applied Science Center) Solar House (at the Applied Science Center) Blockhouse (at the Applied Science Center) Coal Preparation Plant (at the ISU campus) ASC Warehouse (at the Applied Science Center)

PRELIM

The Ames Laboratory fully occupies four DOE-owned research buildings on the ISU campus: Spedding Hall, Wilhelm Hall, the Computer Garage, and the Metals Development Building. The Laboratory leases space from ISU in four other research buildings on the ISU campus under a series of lease agreements; these buildings are Gilman Hall, the Physics Addition, the Office and Laboratory Building, and Sweeney Hall. The Coal Preparation Plant, originally a joint effort between the Ames Laboratory and ISU, is now owned and operated by ISU and is for the most part inactive.

The Ames Laboratory operates several support service buildings on the ISU campus in addition to the research facilities. These are the Maintenance Garage, Maintenance Shop, Paint and Air Conditioning Shop, Campus Warehouse, and Construction Storage Shed.

The ASC, site of the former Ames Laboratory Research Reactor (ALRR), was leased by the Ames Laboratory from ISU up until 1987, when it was transferred back to ISU. The research reactor was shut down in 1979 and decommissioned and dismantled in 1981. The ISU Center for New Industrial Materials (CNIM) is now located in the ALRR building. However, the Ames Laboratory still leases several buildings at the ASC from ISU, including the Alpha Glovebox Facility, the High Pressure Test Facility, and the Waste Disposal Building, used for storage and packaging of radioactive and chemical wastes. The Ames Laboratory also uses the Blue Shed at the ASC for reactive material storage and an outdoor facility operated by ISU near the ASC for the disposal of small amounts of combustible waste by shoot-and-burn technique.

2.3 State and Federal Concerns

An information meeting was held on March 23, 1988, with representatives of the DOE Environmental Survey team and the Story County and City of Ames environmental regulatory agencies. Representatives of Iowa State University also attended. The meeting was held to discuss the upcoming Environmental Survey and to identify environmental concerns.

PRELIMINARY

Story County and the City of Ames expressed two environmental concerns. The first involves four areas within the City of Ames where sludge containing radionuclides from the Ames Laboratory was disposed of, and the other was the possibility of residual radionuclide contamination at the Applied Science Center facilities.

PRELIMINARY

3.0 MEDIA-SPECIFIC SURVEY FINDINGS AND OBSERVATIONS

The discussions in this section pertain to existing or potential environmental problems in the air, soil, surface water, and groundwater media. They include a summary of the available background environmental information related to each medium, a description of the sources of pollution and their control techniques, a review of the environmental monitoring program specific to each medium, and a categorization and explanation of the environmental problems found by the Survey team related to each medium.

3.1 Air

Discussions within this section relate to the ambient air quality in the Ames area, air and radionuclide emission sources and controls, the facility environmental monitoring program, and findings and observations related to air and radionuclide emissions. Area meteorology is discussed in Section 2.0.

3.1.1 Background Environmental Information

The State of Iowa operates two air quality monitoring stations in the Ames area. These monitor ambient concentrations of sulfur dioxide and total particulates. Iowa State University (ISU) has also conducted monitoring of ambient air concentrations of sulfur dioxide and total particulates to obtain an air emission permit for modifications to the University power plant. Data for 1976-1985 for the state-operated monitoring stations are published in the 1985 Iowa Air Quality Report (Iowa DNR, 1986). The data indicate that the Ames area is in attainment of state and Federal ambient air quality standards for sulfur dioxide and total suspended particulates. The area is also in attainment of Federal and state standards for nitrogen oxides, carbon monoxide, ozone, and lead (Iowa DNR, 1986). Federal and state ambient air quality standards for criteria pollutants, which are applicable to the Ames Laboratory are shown in Table 3-1. As discussed in Section 3.1.2, the Ames Laboratory does not emit significant amounts of these pollutants, and does not have a significant effect on local air quality.

PRELIMINARY

TABLE 3-1

SUMMARY OF AMBIENT AIR QUALITY STANDARDS (CRITERIA POLLUTANTS - NONRADIOACTIVE)

Parameter	Averaging Time	NAAQS	Iowa AAQS
Total Suspended Particulate[a]	Annual Geometric Mean Primary[b]	- -	75 $\mu g/m^3$
	Annual Arithmetic Mean Primary[b]	50 $\mu g/m^3$	- -
	Annual Geometric Mean Secondary[d]	- -	60 $\mu g/m^3$
	24-Hour Primary[b,c]	150 $\mu g/m^3$	260 $\mu g/m^3$
	24-Hour Secondary[c,d]	150 $\mu g/m^3$	150 $\mu g/m^3$
PM-10 Particulate[a]	Annual Arithmetic Average, Primary and Secondary[b,d]	50 $\mu g/m^3$	- -
	24-Hour Average Primary and Secondary[b,d,e]	150 $\mu g/m^3$	- -
Sulfur Dioxide	Annual Arithmetic Mean Primary[b]	80 $\mu g/m^3$	80 $\mu g/m^3$
	24-Hour Primary[b,c]	365 $\mu g/m^3$	365 $\mu g/m^3$
	3-Hour Secondary[c,d]	1300 $\mu g/m^3$	1300 $\mu g/m^3$
Carbon Monoxide	1-Hour Primary and Secondary[b,c,d]	35 ppm	35 ppm
	8-Hour Primary and Secondary[b,c,d]	9 ppm	9 ppm
Nitrogen Oxides	Annual Arithmetic Mean Primary and Secondary[b,d]	0.05 ppm	0.05 ppm
Ozone	1-Hour Primary and Secondary[b,d,e]	0.12 ppm	0.12 ppm
Lead	Calendar Quarter Primary and Secondary[b,d]	1.5 $\mu g/m^3$	1.5 µg/ppm

Sources: NAAQS-40 CFR 50; Iowa Air Pollution Regulations, Regulation 28.1, Chapter 28

[a] National Ambient Air Quality Standards (NAAQS) for total suspended particulate superseded in July 1987 by PM-10 particulate standards.

[b] Primary NAAQS are intended to protect public health.

[c] Not to be exceeded more than once a year.

[d] Secondary NAAQS are intended to protect public welfare.

[e] Statistically estimated number of days with concentrations in excess of the standards is not to be more than 1.0 per year.

3.1.2 General Description of Pollution Sources and Controls

The Ames Laboratory emits small quantities of a large variety of metals, metal oxides, organic solvents, and acids from laboratory operations and materials preparation operations. The Laboratory also occasionally emits combustion products from several emergency diesel-fired internal combustion engines.

In general, the air emission sources at the Ames Laboratory do not fall within Federal regulations because they are below the minimum source size or otherwise exempt. As viewed by the Survey team, air and radionuclide emissions from laboratory and support service activities at the Ames Laboratory are in general very low, as materials are used in small quantities and potential sources of significant emissions are controlled. The State of Iowa regulations, however, do not specifically exempt research facilities from air emission permit requirements. New air emission sources at the Ames Laboratory may therefore require state operating permits. With the exception of shoot-and-burn activities near the Applied Science Center (ASC), existing air emission sources at the Ames Laboratory do not require state operating permits. There are no operations at the Ames Laboratory that could be considered continuous emission sources.

Air and radionuclide emissions and controls in laboratory and support facilities are discussed below by area as identified in Table 3-2. Laboratory and support service activities that have negligible potential for emissions, such as nondestructive testing, electron microscopy, inert gas laser, and cryogenics laboratories are not discussed in this section.

3.1.2.1 <u>Research Laboratory Buildings</u>

Spedding Hall

Spedding Hall is owned and fully occupied by the Ames Laboratory. Research activities conducted in Spedding Hall include analytical organic and metallurgical chemistry, solid state chemistry, organic synthesis, and vacuum deposition/thin-film sputtering and X-ray diffraction of metals and metal compounds. Several laboratories in Spedding Hall are part of the Materials Preparation Center (MPC). Activities in these laboratories involve the preparation and machining of various high-purity metals. Emissions from activities in Spedding Hall include metal and

TABLE 3-2

AMES LABORATORY AIR EMISSION SOURCES

PRELIMINARY

Area	Facility	Location/Activity
Research Laboratory Buildings	Spedding Hall	Third Floor - Vacuum deposition/thin film sputtering, X-ray diffraction
		Third Floor - physical chemistry
		Third Floor - darkroom
		Second Floor - rare earth sample preparation
		Ground Floor/Basement - laser laboratories
		Ground Floor - mercaptan chemistry/ organic synthesis
		Basement - coal chemistry
	Metals Development Building	Metals purification and fabrication
		Nondestructive evaluation
	Wilhelm Hall	Electron microscopy
		Second Floor - materials chemistry
		Second Floor - fossil energy chemistry
		First Floor/Basement - laser laboratories
		First Floor/Basement - materials science
		Basement - metals sample preparation
	Physics Addition	Vacuum deposition/thin-film sputtering
	Gilman Hall	Basement - laser laboratories
		Second Floor - mercaptan, thiophene chemistry
	Sweeney Hall	Third Floor - catalyst development
	Office and Laboratory Building	First Floor - laser laboratories
		Basement - laser laboratories
Support Service Buildings and Facilities	Physics Addition and Metals Development Building	Emergency power diesel engines
	Maintenance Garage	Degreaser, sandblaster
	Paint and Air Conditioning Shop	Paint spray booth
	Maintenance Shop	Woodworking
Applied Science Center (ASC) Buildings and Facilities	Waste Disposal Building	Waste management
	Alpha Glovebox Facility	Nuclear fuel reprocessing laboratory
	Shoot-and-Burn Area	

metal oxide fumes; sulfur compounds including thiols, hydrogen sulfide, and sulfur dioxide, hydrogen fluoride and other acids; ammonia; and volatile organic compounds (VOCs).

Specific laboratory operations in Spedding Hall that have air emission implications are discussed individually as follows:

Rare Earth Sample Preparation - Rooms 237, 239, 240, and 246 - Research activities in this area include preparation, machining, and analysis of rare earth metals. Pure metals are prepared from commercially procured metal oxides in gram to kilogram batches. Several batches per day may be prepared, depending on demand. In furnaces within enclosed hoods in Room 246, the oxides are reacted with hydrogen fluoride gas to form the respective metal fluorides. The fluoride compounds are then out-gassed in a vacuum system and heated in one of two vacuum induction furnaces located in Room 237. The metal fluorides are thereby reduced to the pure metals which are distilled as vapors and condensed on cold surfaces. The prepared metal is then machined off the condensing surface and further processed. Emissions from metal preparation operations in Rooms 237 and 246 include small amounts of hydrogen fluoride and metal/metal oxide fumes, as well as organic solvents from associated laboratory operations.

The hydrogen fluoride gas is generated by heating low-pressure [10-15 pounds-per-square-inch (psi)] tanks containing liquid hydrogen fluoride. Approximately one 30-cubic-foot cylinder of hydrogen fluoride is used annually. Both the hydrogen fluoride hood exhausts and the metal vapor distillation apparatus are equipped with water scrubbers to control acid vapor emissions. Scrubber water is piped to the building drain system. The efficiencies of the water scrubbers have not been measured; however, water scrubbers are generally greater than 90 percent efficient in removing soluble gases such as hydrogen fluoride. The out-gas and induction furnace vacuum pumps exhaust into the room and are equipped with oil vapor filters and cold vapor traps. The efficiencies of these filters and traps are not known; however, based on the amount of metals used in the laboratory, the emissions of metal dust and oil vapor to the room are insignificant.

Room 237 also contains a machine shop and welding area in which rare earth metals are cut and encased in 3-by-6-inch cylindrical metal crucibles. The machines are ventilated by flexible trunks to the building exhaust system and are not equipped with particulate filters. Radioactive metals are not machined in Room 237; all machining of these metals is conducted in a dedicated machine shop in Room 161 of the Metals Development Building.

Room 240 contains inert atmosphere apparatus used to conduct studies of metal hydrides. Melting point and phase transition point analyses of metal compounds are conducted in vacuum apparatus in Room 239. Analytical studies involve gram quantities of metal compounds. The vacuum pumps for these systems exhaust into the room. Emissions of metal compounds from metal compound analyses conducted in Rooms 239 and 240 are insignificant, based on the small quantities of metal compounds used.

Vacuum Deposition/Thin-Film Sputtering and X-Ray Diffraction - Adsorption studies of oxygenated organic compounds on metals, and thin-film sputtering of metals onto metal substrates are conducted in several third floor laboratories. Typical thin-film studies being conducted involve application of gram quantities of rhodium on silver or platinum on palladium. Organic compounds being studied include fluorodiethylether and hexafluoro-acetone, which are applied in gram quantities to various substrates to simulate lubrication of computer disks. Sputtering apparatus exhaust through vacuum systems and flexible trunks to laboratory hoods or into the room. Vacuum systems for organic compound adsorption apparatus exhaust through laboratory hoods, as some of the organic compounds used are toxic. Benzene, carbon tetrachloride, and perchloric acid are used to support the analytical studies in these laboratories. Small amounts of these compounds, as well as the metal and oxygenated organic compounds studied, are emitted through the laboratory hoods.

Physical Chemistry - Rooms 335 and 326 - Studies conducted in Room 335 involve synthesis and characterization of niobium nitride. Niobium foil is reacted with ammonia and nitrogen in an inductively heated reactor in a laboratory hood. Unreacted ammonia is collected in a water bubbler. Small amounts of ammonia are emitted through the laboratory hood.

Metal and metal halide solid-solid reactions are studied in Room 326. Studies involve gram quantities of selenium and tellurium, which are heated in a furnace in a laboratory hood. Small amounts of metal dust may be emitted from this operation.

Mercaptan Chemistry/Organic Synthesis - Thin-film chemistry and organic synthesis studies are conducted in chemistry laboratories on the ground floor. Experiments are usually conducted in laboratory glassware. Emissions to laboratory hoods include small amounts of thiols, organic solvents, fluorinated hydrocarbons, silane-substituted hydrocarbons, pyridine, and sulfur dioxide.

Metals Development Building

The Metals Development Building is owned and fully occupied by the Ames Laboratory and is the primary facility of the MPC. Rare earth and other metals are prepared in batches of up to 25 pounds at very high purity for in-house use and commercial sale. Metals preparation involves chemical processing and melting, machining, and metalworking operations. Metals prepared at the MPC are listed in Table 3-3. The quantity of each metal prepared depends on availability and demand. Other activities conducted in the Metals Development Building include analytical metallurgical chemistry, ion exchange process development, and vacuum deposition/metal plasma coating studies.

Specific laboratory operations in the Metals Development Building which have air emission implications are as follows:

Metals Purification and Fabrication - Rooms 131 and 135 - Room 135 contains three electron beam melters used primarily to melt refractory metals such as vanadium, yttrium, zirconium, niobium, and tungsten under vacuum. The largest melter has a power rating of 60 kilowatts (kW), and can process 2-inch-diameter metal ingots of 12 to 18 inches in length. Each melter is exhausted through a custom in-house-fabricated particulate filter consisting of a high-speed fan, prefilter, and absolute high-efficiency particulate air (HEPA) filter, that removes metal and metal oxide fumes from the exhaust gases. Filters are changed every 6 months to 1 year, depending on the amount of use of each melter, the type of metal processed, and the level of impurities in the metal. The efficiency of the custom-designed filters has not been measured. The efficiency of an absolute filter is generally greater than 99 percent.

TABLE 3-3

METALS PREPARED AT THE AMES LABORATORY MATERIALS PREPARATION CENTER

Metal Category	Element
Alkaline Metals	Magnesium Calcium Strontium (natural) Barium
Transition Metals	Scandium Yttrium Lanthanum Titanium Zirconium Hafnium Vanadium Niobium Tantalum Chromium Molybdenum Tungsten Manganese
Rare Earths (Lanthanides)	Cerium Praseodymium Neodymium Samarium Europium Gadolinium Terbium Dysprosium Holmium Erbium Thulium Ytterbium Lutetium
Actinides	Thorium Uranium (depleted)

PRELIMINARY

Also in Room 135 are two small resistance-heated furnaces and one small arc melter. The resistance furnaces can process metal ingots of 2.5 by 3 inches in size, and the capacity of the arc melter is about 100 grams of metal. The resistance furnaces are vented through flexible hoses to a common exhaust duct and custom-fabricated filter similar to that described above that removes metal and metal oxide fumes from the exhaust gases. The arc melter is vented to the same filter as one of the electron beam melters. Metal dust and fume emissions from the apparatus in Room 135 are small, based on the high efficiency of the absolute filters and small amount of metals processed.

Room 131 contains a 100-kW vacuum induction furnace with a capacity of 12 to 14 pounds of metal. Vacuum is drawn by ion pumps that exhaust into the room. A canopy hood is used to exhaust heat from the furnace area. Room 131 also contains three arc melters that can process metal ingots up to 6 inches in diameter and 20 inches in length. Emissions of metal and metal oxide fumes result from the opening of these melters, and they are vented to a custom-fabricated filter similar to those used for the electron beam melters in Room 135.

Room 131 also contains an enclosed hood in which depleted uranium, carbon-14, and thorium samples are prepared and stored in glass jars. Small amounts of carbon-14 are used for diffusion studies in metals, and 6-inch by 1/8-inch rods of depleted uranium are used for metallurgical studies. The hood is exhausted to a bagfilter and equipped with emergency power to maintain fan operation during a power outage. Potential emissions from the hood are small, based on the enclosed storage of the samples and the low usage of radioactive materials. The efficiency of the bagfilter has not been measured. The efficiency of a commercial bagfilter is generally on the order of 99 percent. The bagfilter will effectively control emissions of carbon-14, uranium, and thorium.

<u>Metals Purification and Fabrication - Rooms 144, 150, and 161</u> - These rooms are used for metals fabrication, and contain lathes, cutoff saws, grinders, hammer mills, a large extrusion press, a rolling mill, and one cold solvent degreaser. The rolling mills and extrusion press in Room 150 can process metal ingots of the sizes produced in the metal purification processes. Usually, a stainless steel "jacket" is welded to the metal before processing in the extrusion press and rolling mills, as most of the

metals prepared oxidize in air. Graphite and/or linseed oil are used as lubricants in the rolling mills and extrusion press, and emissions of smoke and oil fumes generated by the processes are exhausted by the room ventilation system. Small amounts of nonchlorinated petroleum distillate solvents are emitted from the degreaser. Air emissions from the hammer mills in Room 144 are negligible.

Machining of metals prepared by the MPC, including toxic and radioactive metals, particularly depleted uranium and thorium, is conducted exclusively in Room 161. This room contains lathes, cut-off saws, grinders, and other machine tools. A written log is kept of all uses of the room, including the type and amount of metal used in the room, which machines tools were used, and the date of use. Metal and metal oxide fumes and dust are generated by the metal fabrication activities conducted in Room 161, and machines are exhausted by flexible hoses to a bagfilter. The maintenance group changes the filter bags as required by the volume and type of metals processed, under the supervision of the health physics group. The efficiency of the bagfilter has not been measured. The efficiency of a commercial bagfilter is generally on the order of 99 percent, and emissions of metal oxide fumes and dust are small, based on the amount of materials processed and the efficiency of the bagfilter. Small amounts of nonchlorinated petroleum distillate solvents are used in a cold solvent degreaser in Room 161. Some of the solvent used evaporates to the atmosphere; the remainder is disposed of as liquid hazardous waste.

Metals Purification and Fabrication - Rooms 190 and 290 - Rooms 190 and 290 contain the ion exchange facility, which is used for chemical separation and purification of rare earth metals. Metals are separated in several ion exchange columns in Room 190, and ammonium acetate is used to strip the metal ions from the ion exchange resin. Oxalic acid is added to precipitate metal oxalate, which is converted to metal oxides in electric furnaces. The oxalic acid is decomposed to carbon monoxide and carbon dioxide in the furnaces, which exhaust through hoods. The decomposition reaction is less than 100 percent efficient, and low concentrations of oxalic acid are emitted from the furnace exhausts.

Rooms 190 and 290 both contain metal fluorination furnaces similar to those located in Room 246 of Spedding Hall. Approximately 600 grams per day of hydrogen fluoride used in each of the fluorination systems are provided from low-pressure liquid hydrogen fluoride tanks. Each furnace is enclosed in a hood and is exhausted through a water scrubber. Scrubber water is piped to the building drain system. The efficiencies of the water scrubbers have not been measured; however, water scrubbers are generally greater than 90 percent efficient in removing soluble gases such as hydrogen fluoride. Emissions of hydrogen fluoride from the scrubber exhaust are small, based on the high efficiency of the scrubber and low usage of hydrogen fluoride in the laboratory.

Metals Purification and Fabrication - Metals Development Machine Shop - This area contains several large metalworking machines, an arc welder and an electron beam welder. Parts are generally machined from stainless steel or aluminum. The oil fumes from the metalworking machines are removed by the room ventilation system. Emissions of metal dust from the machines are negligible. The arc welder, which is used infrequently, is ventilated through a water-filled trench to a hood. Approximately 55 gallons of nonchlorinated petroleum distillate solvent are used annually in a cold solvent degreaser in the machine shop. Some of the solvent used evaporates to the atmosphere; the remainder is disposed of as liquid hazardous waste as discussed in Section 4.1.1.2.

Wilhelm Hall

Wilhelm Hall is owned and fully occupied by the Ames Laboratory. Research activities include electron microscopy, superconductor materials development and materials chemistry, fossil energy chemistry, metals sample preparation, and laser studies. Quantities of materials used in research activities in Wilhelm Hall are generally measured in grams, and air emissions from the majority of laboratories are negligible.

Specific laboratory operations in Wilhelm Hall that have air emission implications are as follows:

Fossil Energy Chemistry - Room 236 - Research activities in this laboratory are devoted to chemical methods of cleaning coal. Coal samples are heated in a 6-inch cylindrical crucible in a furnace located in a hood. The heated coal is then reacted with sodium hydroxide at 300° F, which drives off methane and hydrogen gases. Sulfur and other acid compounds are primarily removed in the hot caustic, which is recycled into the process. The coal is finally neutralized with sulfuric acid. Small amounts of sulfuric acid and caustic fumes are generated from this process and exhaust through the laboratory hoods without emission controls.

Superconductor Materials Development - Rooms 30, 36, and 234 - Materials development and characterization studies for research in superconductivity are conducted in several laboratories in Wilhelm Hall. Rooms 30 and 36 contain giass-tube furnaces used to prepare metal samples for preparation of metal/metal oxide/metal carbonate alloys. The furnaces are in fully enclosed hoods, and materials are processed in gram-quantity batches. Thallium oxide, used in some alloys, as well as yttrium and barium compounds, is prepared in the furnace in Room 36. Thallium is a toxic metal and samples are handled in a glove box or in fully enclosed laboratory hoods. The hoods are not equipped with filters as only small quantities of minerals are processed. The glass tube in the furnace failed during the Survey, releasing several grams of thallium into the hood. Most of the thallium was contained in the hood and removed by the researchers; a small amount was entrained in the hood exhaust.

Room 234 is also used for superconductor materials development. Gram quantities of various metals, including bismuth, yttrium, and natural strontium, are prepared in furnaces similar to those in Rooms 30 and 36. Tungsten and molybdenum chlorides are reacted with niobium to form metal oxides. Batches of materials of 1 to 10 grams are prepared in this laboratory. Emissions from this laboratory are generally negligible; however, the operations are subject to the same accidental release scenario described for the Room 36 thallium laboratory, and could release small amounts of metal dust under these circumstances.

Physics Addition

The Physics Addition is partially leased and occupied by the Ames Laboratory, and most of the activities are related to the preparation and characterization of materials. Activities include analytical organic and metallurgical chemistry, solid state chemistry, organic synthesis, vacuum deposition/thin-film sputtering, and cryogenic systems. With the exception of one vacuum deposition laboratory discussed below that handles small amounts of toxic gases, the Physics Addition laboratories do not have the potential for significant air emissions, based on the types and quantities of materials used.

Vacuum Deposition/Thin-Film Sputtering - Vacuum deposition apparatus located in several laboratories in the Physics Addition are used to prepare thin metal films. A wide variety of metals are used in gram quantities, and vacuum pumps for the apparatus exhaust into the laboratory rooms. One vacuum apparatus in Room 212 is used to prepare doped silicon samples; phosphine (5 percent in argon) and diborane (1 percent in argon) gases are used as dopants, and the laboratory contained one 30-cubic-foot cylinder of each mixture at the time of the Survey. The cylinders were located behind a heavy plastic curtain under a canopy hood, but were not fully enclosed. The laboratory air is not monitored for phosphine or diborane. The routine emissions of diborane and phosphine through the laboratory hood are small, based on the low concentration and small quantity of gases used in the vacuum system. However, a release of an entire cylinder of gas (such as from a defective valve) may cause toxic gases to enter the laboratory area.

Gilman Hall

Gilman Hall is partially leased and occupied by the Ames Laboratory. Activities include analytical organic and metallurgical chemistry, photochemistry, organic and organometallic synthesis, vacuum deposition, and laser spectroscopy. Chemicals used in the analytical and synthesis laboratories include furans, benzene, pyridine, mercaptans, acrylonitrile, thiophene, other organic compounds, and mineral acids. Gram quantities of organometallic compounds are synthesized and purified by solvent distillation in several laboratories. Solutions of organometallic compounds containing precious metals such as platinum and palladium are evaporated in a hood in one laboratory to recover the metals. With the exception of the Eximer laser laboratories in Room 57, discussed below, which use small amounts of acid gases, Gilman Hall laboratories do not have the potential for significant air emissions, based on the types and quantities of materials used.

Laser Spectroscopy - Room 57 - Laser laboratories in Room 57 use pure hydrogen fluoride, hydrogen chloride, and fluorine gases in Eximer lasers. During the Survey, the laboratory contained three 150-cubic-foot gas cylinders stored in a fully enclosed, ventilated cabinet. Two to three cylinders of the gases are used annually. The high ventilation rate of the storage cabinet allows the rapid exhaust of any accidental release from the cylinders. Routine releases of acid gases are of very low concentration.

Sweeney Hall

Sweeney Hall is leased and partially occupied by the Ames Laboratory, and most of the activities are related to the development and characterization of metal-containing catalysts and organometallic compounds. Materials used include flammable gases (e.g., butane), various metals and metal compounds, ethers, and other organic chemicals. Hydrogen sulfide is used in Room 319 to form sulfites of metal catalysts. One 22-pound cylinder of hydrogen sulfide is stored in a ventilated laboratory hood, and has been in use for several years. The hood is not kept fully closed when the cylinder is in use. An Eximer laser laboratory in Room 305 uses a mixture of 5-percent fluorine gas in helium. During the Survey, the laboratory contained three 150-cubic-foot gas cylinders stored in a fully enclosed, ventilated cabinet that exhausts to a hood. Two to three cylinders of the gases are used annually. The high ventilation rate of the storage cabinet allows the rapid exhaust of any accidental release from the cylinders. Routine releases of acid gases through the laboratory hoods and gas cylinder cabinet vents are of very low concentration based on the quantities of materials used.

3.1.2.2 Support Service Buildings and Areas

Several facilities at the Ames Laboratory provide support services to research operations and to the Ames Laboratory facilities department. The support service operations within these facilities emit small amounts of organic compounds, combustion products, and particulate materials to the air. Support service operations are discussed below.

Emergency Power Diesel Engines

The Ames Laboratory operates three stationary diesel engines to provide emergency power to critical equipment during power outages. One 85-kW diesel engine on the second floor of the Metals Development Building provides emergency power for that building. Two diesel engines under the loading dock of Wilhelm Hall, one 188-kW and one 125-kW, provide backup power for Spedding and Wilhelm Halls, respectively. The engines are tested for a few hours each month and otherwise are operated only during power outages. Total operation of the engines is on the order of 100 hours/year. The engine in the Metals Development Building was installed in 1959, and the two engines at Wilhelm Hall were installed in 1970. Particulate and sulfur dioxide emissions from these engines are limited to 0.6 and 2.5 pounds per million British thermal unit (Btu), respectively, by state regulations. Operation of the engines with commercial diesel fuel does not cause these standards to be exceeded, based on U.S. Environmental Protection Agency (EPA) emission factors for stationary diesel engines (EPA, 1986a).

Maintenance Garage

The Maintenance Garage is used to maintain Ames Laboratory fleet vehicles, and contains a small cold solvent degreaser that uses nonchlorinated petroleum distillate solvents. The degreaser does not have local ventilation, and solvent emissions are exhausted by the building ventilation system. The facility also contains a large sandblaster (approximate volume 200 cubic feet) that is used to remove paint from metal parts. Dry sand is used in the sandblaster, and used sand is collected by a bagfilter in the building and a rotoclone outside the building. Coarse sand removed by the bagfilter is recycled into the sandblaster, and fine sand removed by the rotoclone is collected in drums and disposed of in a municipal landfill.

Paint and Air Conditioning Shop

The paint and air conditioning shop contains a walk-in paint spray booth, a paint spray bench, and a heat drying area for drying painted articles. Various types of paints, including latex, epoxy, enamel, and metal-based primers are used, and some paint is formulated in the shop from solvent bases, thinners, and pigments. Approximately 120 gallons/year of organic solvent thinners such as toluol and xylol are used, a small amount of which evaporates during mixing and is emitted to the atmosphere. The amount of paint used in the shop annually is not known.

The paint spray booth is exhausted through an unwoven cloth filter to a roof vent. The spray bench area is exhausted by both a slot vent and overhead vent and is not equipped with filters. The heat drying room is exhausted through a ceiling vent.

PRELIMINARY

The spray booth filter is changed as required depending on the use of the booth. Small amounts of VOCs are emitted from paint spraying and drying operations. Particulate emissions from surface coating operations such as paint spray booths are limited by State of Iowa air regulations to 0.01 grain per standard cubic foot of exhaust gas. Although particulate emissions from the shop have not been measured, they are controlled by the cloth filter. Based on the operation of the facility, emissions from the shop are not expected to exceed the state standard. Emissions from the spray bench and heat drying areas of the facility are primarily from solvent evaporation, and are small based on the quantity of materials used.

Maintenance Shop

The carpenter shop in the Maintenance Shop contains several woodworking machines, such as saws and lathes, which are vented by flexible hoses when in use. The ventilation system exhausts through a cyclone dust collector outside the building. The sawdust removed by the cyclone is collected in drums and disposed of in a municipal landfill.

3.1.2.3 Applied Science Center

Several buildings located at the ISU ASC are fully or partially occupied by the Ames Laboratory. These include the Waste Disposal Building, used for the storage and packaging of radioactive and hazardous wastes, and the Alpha Glovebox Facility, which is used to conduct studies of plutonium and uranium chemistry. Air and radionuclide emissions from these facilities and their controls are discussed in the following paragraphs.

Waste Disposal Building

Radioactive waste generated by the Ames Laboratory is packaged and stored in the Waste Disposal Building at the ASC. Several gallons of volatile organic compounds contaminated with depleted uranium and thorium, including acrylonitrile and cyclohexane, are stored in containers in a laboratory hood in the building. The containers are not sealed, and the organic compounds evaporate into the hood,

PRELIMINARY

eventually leaving a solid residue. The hood exhausts to a roof vent, and is not equipped with a filter. Essentially all of the organic compounds stored in the hood are emitted to the atmosphere; emissions of particulate radionuclides are insignificant based on the low level of contamination of the evaporated liquids.

Alpha Glovebox Facility

The Alpha Glovebox Facility at the ASC is used to conduct analytical studies of depleted uranium and plutonium solutions in support of fuel reprocessing studies. Liquid solutions of these radionuclides are analyzed using an Inductively Coupled Plasma (ICP) apparatus in a 3-foot by 6-foot glovebox. The glovebox is designed for use exclusively with alpha-emitting radionuclides and, therefore, is not shielded. A test cell, presently unused but intended for future analytical studies, is located adjacent to the glovebox room. A chemical laboratory in the building is used to prepare depleted uranium solutions and dyes for the chemical lasers used by the ICP.

The depleted uranium solutions prepared contain approximately 1 gram of uranium. A total of approximately 1 gram of plutonium has been used in the laboratory since 1983. Tests involving technetium-99 are planned, but none had been conducted at the time of the Survey.

The ICP apparatus vaporizes approximately 3 percent of the solution during an analytical study; the remaining 97 percent is handled as liquid radioactive waste. The glovebox is exhausted through three HEPA filters to a vent on the roof of the building; the inlet air to the glovebox is also filtered. The exhaust rate of the glovebox is approximately 20 to 25 cubic feet per minute (cfm). The primary HEPA filter is located inside the glovebox, the second in the glovebox room, and the third on the roof of the building. The glovebox, glovebox room, and test cell are ventilated by an exhaust system separate from the office and chemical preparation areas of the facility, and the glovebox and test cell are maintained at a negative pressure relative to the office and chemical laboratory areas of the facility.

The efficiency of the secondary and tertiary HEPA filters is tested at the DOE Rocky Flats Plant before shipment to the Ames Laboratory. The efficiency of the filters is certified by dioctyl phthalate (DOP) testing to be 99.9 percent for 0.3-micrometer particles. The primary filter is an integral part of the glovebox and therefore cannot be DOP tested. The HEPA filters are not routinely retested by DOP procedures by the Ames Laboratory. The filters were tested by the Ames Laboratory by releasing radon gas (thoron) into the glovebox. The radon decays to lead and bismuth particles that are collected by the filters. Analysis of the filters showed the overall efficiency of the filter system to be greater than 99.9 percent.

The exhaust rate of the glovebox is monitored, and the glovebox exhaust and glovebox room air are sampled whenever the glovebox is being used. The secondary and tertiary HEPA filters are also analyzed when they are replaced. Analysis of the secondary filters has shown no contamination above background, indicating that emissions of radionuclides from the glovebox are negligible. The glovebox facility radionuclide sampling and monitoring program is discussed in Section 3.1.3.

Iowa State University Shoot-and-Burn Area.

The Ames Laboratory periodically disposes of small amounts of waste ether and other flammable and potentially explosive chemicals by removing the waste chemical containers to the ISU Shoot-and-Burn Area, located 1/3 mile north of the ASC on ISU property. The waste containers are placed in an open 55-gallon drum and shot at from some distance. This method of disposal allows the waste chemicals to either evaporate or occasionally detonate without presenting a hazard to personnel. The types and amounts of wastes disposed of by the Ames Laboratory by this method are discussed in Section 4.1.1.4.

Air emissions from the disposal activities are not expected to have a measurable effect on air quality, based on the types and quantity of wastes disposed of. However, neither ISU nor the Ames Laboratory has requested an air emission variance from the state for the shoot-and-burn activity, as required by Regulations 23.2(1) and 23.2(2) of the State of Iowa Air Pollution Control Regulations. Open burning of combustible materials other than for fire training and agriculture is prohibited by the regulations unless a variance is obtained.

3.1.3 Environmental Monitoring Program

With the exception of radionuclide sampling at the Alpha Glovebox Facility, the Ames Laboratory does not conduct any sampling or monitoring of exhaust gas emissions or ambient air concentrations. As a result, the Ames Laboratory does not prepare annual environmental monitoring reports. Emissions of pollutants, as discussed in Section 3.1.2, are small and are not expected to significantly impact local ambient air quality. The Ames Laboratory is not required under state regulations to maintain either an emission sampling or air monitoring program.

Emissions of particulate radionuclides from the Alpha Glovebox Facility at the ASC are monitored when tests are conducted in the glovebox. The glovebox exhaust is sampled from a sample port located between the primary and secondary HEPA filters. Sample gas is drawn through a 2.5-inch filter at a flow rate of about 2 cfm. The filters are analyzed one day and one week after the glovebox test, and analysis has indicated that there is no release of particulate radionuclides after the primary filter. Analysis of the secondary HEPA filters upon their replacement has shown no radioactive contamination above background, supporting the conclusion that particulate radionuclides are not released past the primary filter.

The ambient air in the glovebox room is also monitored for particulate radionuclides when tests are conducted in the glovebox. Room air is drawn through a 2.5-inch filter at a flow rate of about 1 cfm. The filters are analyzed one day and one week after the glovebox test, and no radioactive contamination above background has been detected. Radiation smears taken around the glovebox after radioactive materials are transferred to or from the glovebox also do not show any alpha-emitting radionuclide contamination.

3.1.4 Findings and Observations

3.1.4.1 Category I

None

3.1.4.2 Category II

None

3.1.4.3 Category III

None

3.1.4.4 Category IV

1. Open burning of combustible material without variance. The Ames Laboratory disposes of small amounts of waste ether and other combustible materials by shoot-and-burn without having obtained an air emission variance, as required by Iowa Air Pollution Control Regulations 23.2(1) and 23.2(2).

   The Ames Laboratory periodically disposes of small quantities of combustible materials by shoot-and-burn, which may result in combustion or explosion of these materials. The Shoot-and-Burn Area is owned and controlled by ISU, and ISU disposes of potentially explosive waste chemicals by the same practice. The Shoot-and-Burn Area activities are included in the Resource Conservation and Recovery Act (RCRA) Part A permit application submitted by ISU to the state. Open burning of combustible materials is prohibited under Iowa Air Pollution Control Regulations 23.2(1) and 23.2(2), unless an air emission variance is obtained from the state. Although only small amounts of material are disposed of by shoot-and-burn, the Ames Laboratory expects the practice to continue. There is no de minimis amount of material below which a variance for open burning is not required.

PRELIMINARY

3.2 Soils

This section describes the soils at the Ames Laboratory on the ISU campus and the ASC, and the soils at the City of Ames Water Pollution Control Plant (WPCP) and the City of Ames Municipal Airport, all of which have been impacted by past Ames Laboratory operations. Pollution sources and controls of selected areas of soil contamination resulting from Ames Laboratory operations and the Ames Laboratory soils monitoring program are also discussed. The findings and observations related to soils contamination are also presented within this section and, where more appropriate, within Section 4.5.2 (Inactive Waste Sites and Releases).

3.2.1 Background Environmental Information

In general, soils at and in proximity to the Ames Laboratory are nearly level to steep, well-drained to poorly drained, loamy soils formed in upland glacial till and loamy and silty soils formed in bottomland alluvium (USDA, 1984). The specific soil types found at each of the four areas discussed in this section (ISU campus, ASC, WPCP, and Ames Airport), along with some of the specific characteristics associated with each soil type, are presented in Table 3-4.

The radiological and chemical makeup of the soils at and in the vicinity of the Ames Laboratory have not been well characterized. However, the Ames Laboratory did perform a one-time radiological screening program in 1976 to identify sites possibly contaminated with radioactivity as a result of past Ames Laboratory activities. As part of that study, background soil samples were collected from the ISU Golf Course (Figure 2-2) and analyzed for selected radionuclides as discussed in Section 3.2.3. These background results ranged from 0.61 picocurie per gram (pCi/g) to 1.28 pCi/g for actinium-228, 0.21 pCi/g to 0.51 pCi/g for thallium-208, and 0 pCi/g for uranium-234; the former two radionuclides are daughters of thorium-232.

DOE has established guidelines for residual radioactivity in soils at Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote Surplus Facilities Management Program (SFMP) sites (DOE, 1985; Gilbert et al., 1985). The guidelines specify concentrations of 5 pCi/g for thorium-232. However, there are no regulatory standards for nonradiological contaminant concentrations in soil. A determination

TABLE 3-4

CHARACTERISTICS OF THE AMES LABORATORY AND VICINITY SOIL TYPES

Location	Soil Type	Depth (Inches)	USDA Texture	Permeability (inches/hour)
ASC	Hayden	0-8	Loam	0.6-2.0
		8-53	Clay loam, loam	0.6-2.0
		53-60	Loam, sandy loam, fine sandy loam	0.6-2.0
ASC	Orthents, loamy[a]	NA[b]	NA[b]	NA[b]
WPCP, ISU	Wadena	0-12	Loam	0.6-2.0
		12-25	Loam, sandy loam, sandy clay loam	0.6-2.0
		25-60	Sand and gravel	>6.0
WPCP	Lester	0-11	Loam	0.6-2.0
		11-35	Clay loam, loam	0.6-2.0
		35-60	Loam, clay loam	0.6-2.0
Airport	Nicollet	0-17	Loam, clay loam	0.6-2.0
		17-36	Clay loam, loam	0.6-2.0
		36-60	Loam	0.6-2.0
Airport	Webster	0-17	Clay loam	0.6-2.0
		17-38	Clay loam, silty clay loam, loam	0.6-2.0
		38-60	Loam, sandy loam, clay loam	0.6-2.0
Airport, ISU	Clarion	0-13	Loam	0.6-2.0
		13-33	Loam, clay loam	0.6-2.0
		33-60	Loam, sandy loam	0.6-2.0

Source: USDA, 1984

a These are areas that have been disturbed by Man and include borrow areas, cut-and-fill areas and reclaimed gravel pits.

b NA = Not applicable

of "safe" or "acceptable" levels in soils depends on contaminant migration pathways and potential human exposure routes. Therefore, acceptable levels must be determined on a site-specific and chemical-specific basis

3.2.2 General Description of Pollution Sources and Controls

The major pathways for potential contamination of soil at the Ames Laboratory are routine and accidental airborne releases, routine and accidental liquid releases, and activities associated with waste disposal practices. To reduce the potential for soil contamination, the site has established administrative and physical controls for handling radioactive and hazardous materials. The administrative controls include packaging, handling, storage, and disposal requirements, as discussed in Section 4.1. Physical controls consist of air filtration and water treatment systems, as discussed in Sections 3.1.2 and 3.3.2, respectively.

At various localized areas, operations of the Ames Laboratory have resulted in soils contaminated with radionuclides and hazardous materials. Radioactive soil contamination is associated with two former buildings on the ISU campus, known as Annex I and Annex II, and a sewer release incident, and is discussed below. These areas are also discussed in Section 4.3.3 since they represent sites that are potential sources for direct penetrating radiation. In addition, past operations at several other facilities may have resulted in soils contaminated by chemical or radioactive constituents. They are the Chemical Disposal Site, the Blockhouse, the ALRR Building septic system, the ASC comfort cooling towers, the ASC Warehouse septic system, the ASC acid neutralization tank, and the ASC sulfuric acid storage tanks, and are discussed in Section 4.5.1.

3.2.2.1 Annexes I and II

During World War II, under the Manhattan District, a project was started at ISU [then known as Iowa State College (ISC)] to develop processes for producing pure materials, especially uranium. Production facilities consisted of a remodeled one-story wooden building referred to as Annex I (Figure 2-3). In connection with the uranium production program, a process was developed at ISC late in 1943 for the conversion of scrap uranium recovered from all Manhattan District sites in the United States into metal ingots. Annex II was constructed in 1944 for this purpose

(Figure 2-3). Although uranium production was halted in 1945, a production program was started in that year for thorium metal. The initial thorium production was performed at Annex I and II until approximately 1951. Additionally, thorium production and recovery took place in Wilhelm Hall on the ISC campus from the late 1940s to the early 1950s (Figure 2-3).

Annexes I and II have been razed but residual radioactive contamination remains in the soil, as discussed in Section 3.2.3. Although there are no controls employed by the Ames Laboratory for these areas of soil contamination, these sites are currently either paved or are covered with vegetation. Section 4.5.1.2 further discusses the history of Annexes I and II and Wilhelm Hall.

3.2.2.2 Sewer Release Incident Sites

As stated above, a production program for thorium metal was started in 1945 at Annexes I and II of the Ames Laboratory. Thorium production also took place from the late 1940s to the early 1950s in Wilhelm Hall on the ISC campus. Metallic thorium was produced from thorium nitrate tetrahydrate. Between July 1951 and August 1952, a filtrate from the production process, containing thorium and thorium daughters, was discharged from Wilhelm Hall into the sewage lines and flowed to the City of Ames WPCP (Figure 2-2). Section 3.3.2.2 provides a more detailed discussion of the WPCP and the WPCP treatment process.

Since the WPCP treatment process removed the thorium and thorium daughters effectively, the effluent water from the WPCP was found to contain negligible quantities of thorium or thorium daughters (Vierzba, 1985). However, as a result of the removal of the thorium and thorium daughters from the wastewater, the sewage sludge became radioactively contaminated. The contaminated dry sewage sludge cake was temporarily stored in an unprotected pile on the ground at the western end of the WPCP until a disposal method was identified. In 1953, most of the dry sewage sludge cake containing measurable thorium and thorium daughters was reportedly placed on the City of Ames Airport grass runway (which has since been paved over), the Municipal Cemetery, and the grass areas of the Grand Avenue underpass (Figure 2-2), as a result of the Atomic Energy Commission's (AEC) recommendations (Vierzba, 1985). Section 4.5.1.2 provides a more complete discussion of the history and location of these sites. The temporary storage at the

WPCP and the disposal of the contaminated sludge at the disposal areas resulted in residual radioactive contamination of soils at the WPCP and the Ames Airport, as discussed in Section 3.2.3.

Although there are no controls employed by the Ames Laboratory for these areas of soil contamination, these sites are either currently paved or are covered with vegetation. In addition, the WPCP is fenced although access is not controlled at the entrance gate. Nonetheless, during the Survey, team members observed evidence that some of the contaminated soil at the WPCP had recently been removed. An investigation during and after the Survey by site personnel revealed that the WPCP had an overflow of nonradioactive sewage sludge from adjacent sludge drying beds during early 1988. The material flowed over part of the area contaminated by thorium-232 and thorium daughters. The sludge, along with some of the underlying soil, was retrieved and placed by WPCP personnel in a pile next to the fence north of the contaminated area for storage. The mixture was eventually spread by City of Ames personnel on adjacent city land using a farm manure spreader. According to Ames Laboratory personnel, some residual contamination was found where the sludge/soil mixture was temporarily piled. However, the material was spread in an area large enough to make thorium levels less than the FUSRAP/SFMP maximum permitted surface level of 5 pCi/g soil averaged over a 100-square-meter area.

3.2.3 Environmental Monitoring Program

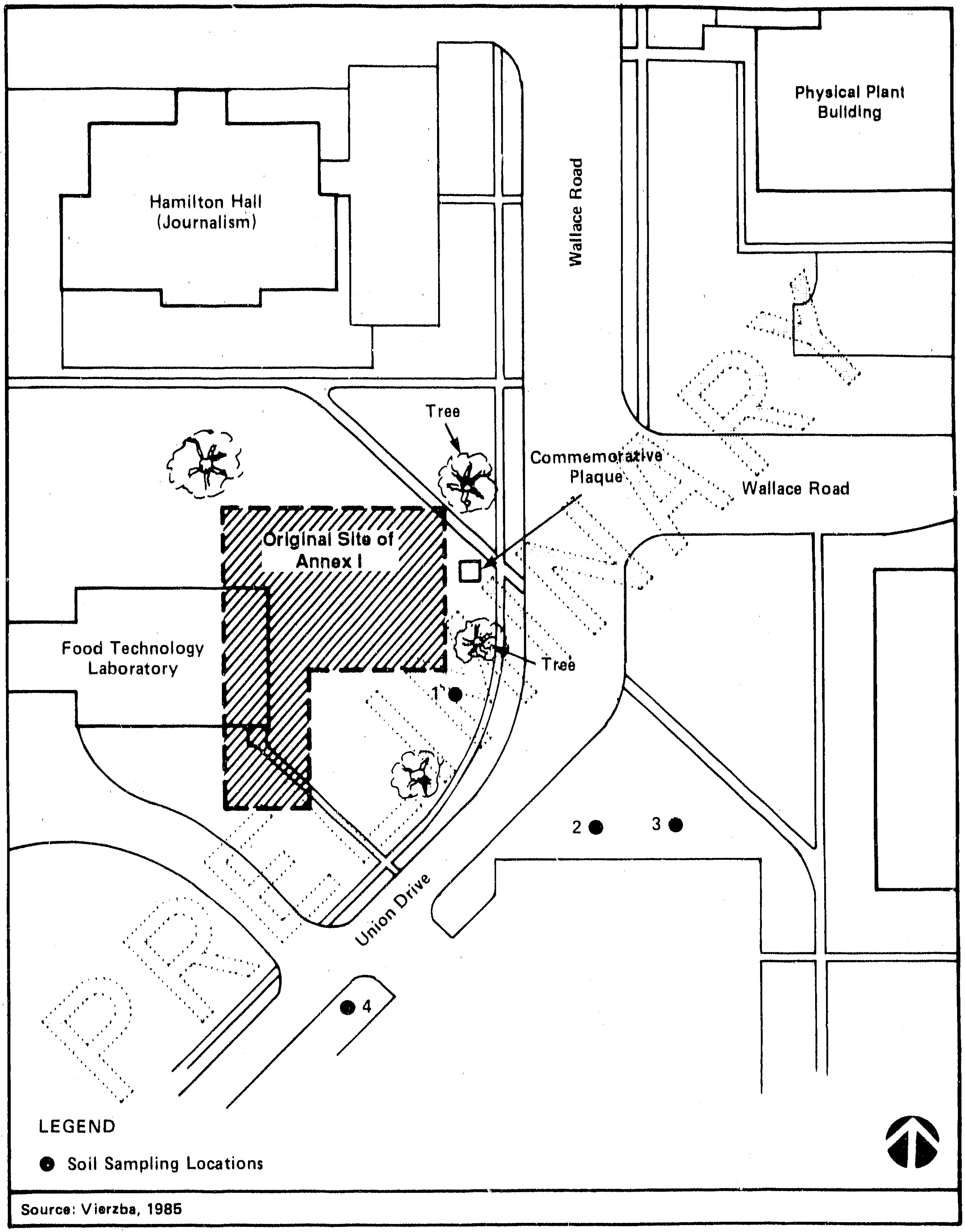
Because current laboratory activities do not have a significant potential to contaminate soils, the Ames Laboratory does not have a routine monitoring program for soils. However, in May 1976, at the direction of the DOE Chicago Operations Office, a radiological screening program was performed by the Ames Laboratory to identify sites possibly contaminated with radioactivity as a result of Ames Laboratory operations at the Annexes and the sewer release incident sites. The radiological screening program included soil sampling and/or direct penetrating radiation screening at Annex I, Annex II, the WPCP, City of Ames Airport, Municipal Cemetery, and Grand Avenue underpass. Section 4.3.3 further discusses the direct penetrating radiation screening results.

The Ames Laboratory has written protocols for the non-routine radiological environmental sampling they may occasionally need to perform and operation/quality control protocols for the equipment used for the analyses. These protocols were used for the 1976 radiological screening program. Soil samples were taken at all sites designated for radiological screening, except Annex II and the Grand Avenue underpass. The Annex II area was in 1976 and is currently covered with concrete so only survey meter readings were performed. Survey meter readings at the Grand Avenue underpass did not locate any areas above background levels. In addition, site personnel could not confirm through interviews and record reviews that contaminated sludge was actually placed at this area (Vierzba, 1985). As a result, no soil samples were collected at the underpass. Additionally, a background soil sample was collected at the ISU Golf Course (Figure 2-2).

In general, soil samples were taken, using a 0.75-inch (2-cm) diameter soil core sampler, to a depth of 6 to 8 inches (15 to 20 cm). At the WPCP, a 2-inch (5-cm) diameter core sampler was used to obtain samples to a depth of 30 inches (76 cm). These soil cores were then divided into 4-inch (10-cm) segments to determine distribution levels of the radioactive materials in the soil. Soil samples were placed in a standard geometry container holding approximately 400 g of soil. These samples were analyzed qualitatively and quantitatively for gamma-emitting isotopes using a gamma spectrometer with a germanium lithium [Ge(Li)] detector.

Of the areas sampled, above-background levels were detected at only the razed Annex I area, the WPCP, and the City of Ames Airport; the results of this 1976 program are discussed below.

<u>Annex I</u> - Four soil samples were collected at the original site of Annex I (Figure 3-1) and a background soil sample was collected at the ISU Golf Course. According to interviews with site personnel, these locations were selected because of the direction the wind would carry airborne material from the original building. The results of the gamma analysis (Table 3-5) detected levels of uranium-234 (a uranium-238 daughter) ranging from 0.0 to 40.5 pCi/g of soil. The uranium-234 should be in secular equilibrium with its parents, uranium-238 and thorium-234. Therefore, the uranium-238 and thorium-234 would have the same activity in pCi/g as the uranium-234 in the respective soil samples. No uranium-234 was detected in



RADIOLOGICAL SOIL SAMPLING LOCATIONS AT THE AREA OF THE ORIGINAL SITE OF ANNEX I

FIGURE 3-1

TABLE 3-5

GAMMA ANALYSIS RESULTS OF SOIL SAMPLES FROM THE FORMER ANNEX I AREA

Sampling Location	Radionuclide Concentration (pCi/g)		
	^{228}Ac[a]	^{208}Tl[b]	^{234}U[c,d]
1[e]	0.644	0.222	12.1
2[e]	0.737	0.269	40.5
3[e]	0.635	0.280	12.5
4[e]	0.789	0.295	0.0
Background[f]	0.607	0.213	0.0

Source: Adapted from Vierzba, 1985

a ^{228}Ac = Actinium-228 (a thorium-232 daughter)
b ^{208}Tl = Thallium-208 (a thorium-232 daughter)
c ^{234}U = Uranium-234 (a uranium-238 and thorium-234 daughter)
d The uranium-234 concentration was calculated using the parent protactinium-234m's 1001 kiloelectronvolt gamma energy peak.
e Location shown on Figure 3-1
f Background location: ISU Golf Course

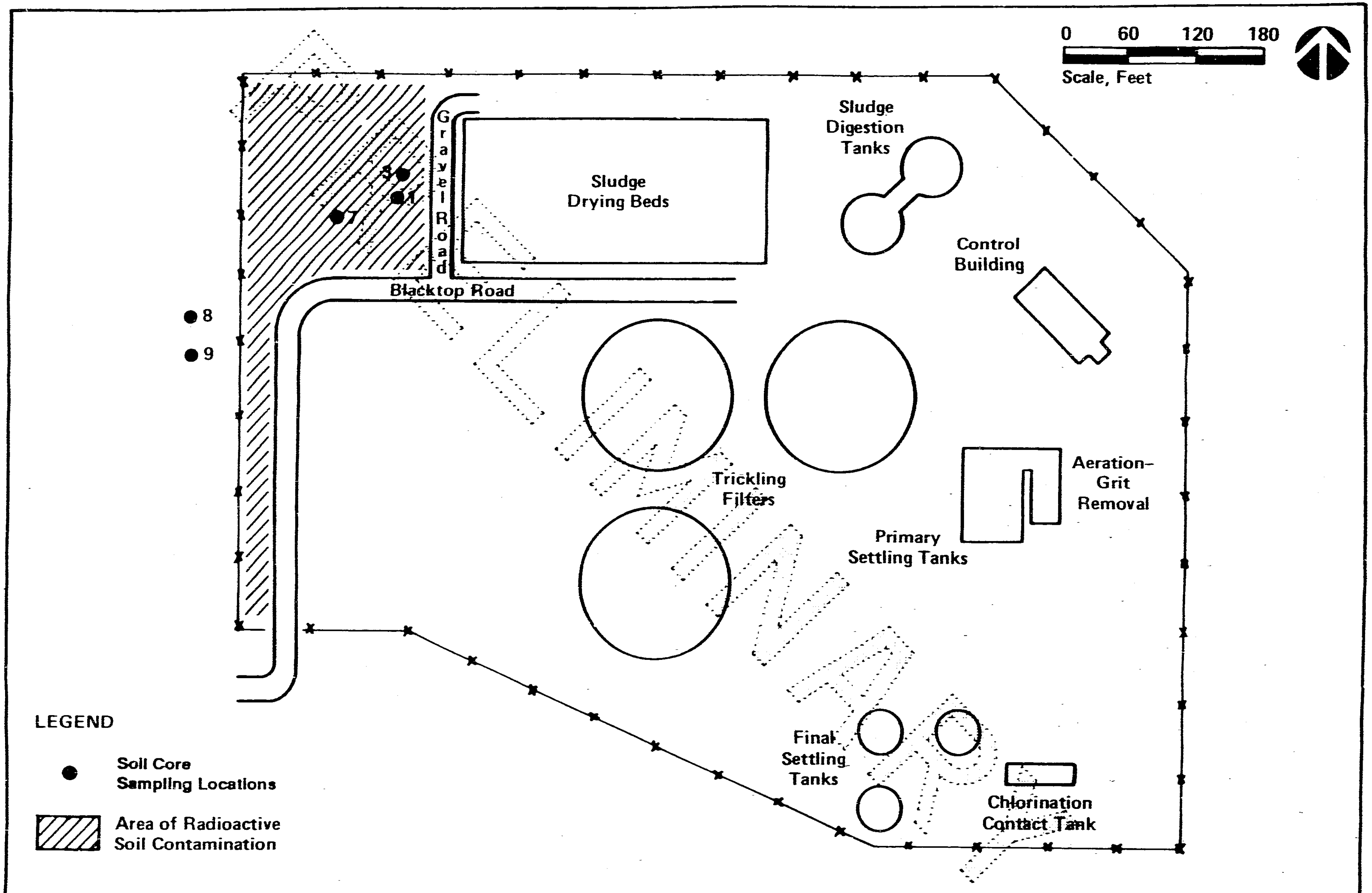
the background sample collected from the ISU Golf Course. Levels of the thorium-232 daughters actinium-228 and thallium-208 from the razed Annex I area were similar to the background sample's levels.

WPCP - Five soil samples were collected at the WPCP (Figure 3-2) and one background soil sample was collected at the ISU Golf Course. The gamma analyses (Table 3-6) detected levels of the thorium-232 daughters actinium-228 and thallium-208 ranging from 0.0 to 66.0 pCi/g and from 0.14 to 23.8 pCi/g, respectively, of soil at the surface. Actinium-228 and thallium-208 levels at the surface in the background sample were 0.77 and 0.38 pCi/g of soil, respectively. Above-background levels of the thorium-232 daughters actinium-228 and thallium-208 were seen at core depths to 76 cm in some WPCP samples.

Soils were also sampled at the WPCP in 1985 in the area of contamination identified during the 1976 program (Figure 3-2). Concentrations of thorium-232 daughters (actinium-228 and thallium-208) in the upper 1 foot of soil ranged from 10 to 50 pCi/g in the vicinity surrounding sample points 1 and 3 in Figure 3-2 and from background to 10 pCi/g in the surrounding area. The 1985 samples confirmed the presence and relative concentrations established for thorium-232 daughters in the 1976 study.

The WPCP is the only site of the sewer release incident sites that currently has direct penetrating radiation dose rates above background levels, and is discussed in Section 4.3.3.

City of Ames Airport - Nine soil samples were collected at the City of Ames Airport (Figure 3-3) and one background soil sample was collected at the ISU Golf Course. The gamma analysis showed significantly above-background levels of the thorium-232 daughters actinium-228 and thallium-208 at only one location (Table 3-7). The concentrations of both actinium-228 and thallium-208 at this location were nearly 20 times the background levels in the sample collected from the ISU Golf Course.



Source: Vierzba, 1985

RADIOLOGICAL SOIL SAMPLING LOCATIONS AT THE CITY OF AMES WATER POLLUTION CONTROL PLANT

FIGURE 3-2

TABLE 3-6

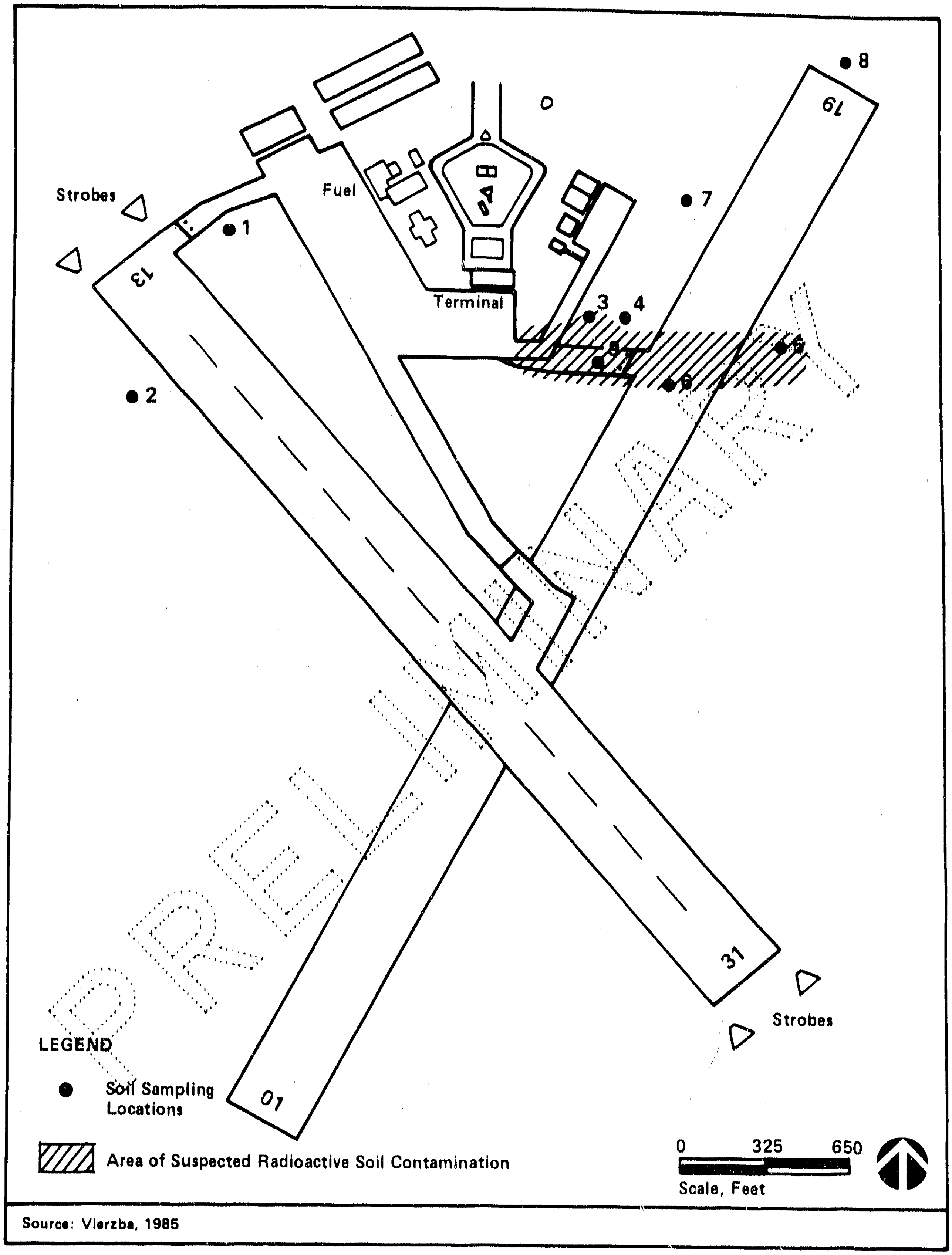
GAMMA ANALYSIS RESULTS OF SOIL SAMPLES FROM THE CITY OF AMES WATER POLLUTION CONTROL PLANT (WPCP)

Sampling Location	Radionuclide	Core Depth (cm) 0-10	10-20	20-31	31-41	41-51	51-62	62-76
		Radionuclide Concentration (pCi/g)						
1[a]	^{228}Ac[b]	58.6	69.6	8.47	4.02[c]	4.02[c]	2.03	1.02
	^{208}Tl[d]	21.3	25.4	3.09	1.25[c]	1.25[c]	1.24	0.39
3[a]	^{228}Ac	66.0	71.9	6.62	6.07	8.46	0.97	1.07
	^{208}Tl	23.8	27.9	2.60	2.11	3.02	0.42	0.37
7[a]	^{228}Ac	7.03	7.90	4.38	2.06	1.13	0.89	0.66
	^{208}Tl	2.96	3.14	1.94	0.77	0.42	0.25	0.22
8[a]	^{228}Ac	0.0	0.52	0.64	e	e	e	e
	^{208}Tl	0.25	0.22	0.23	e	e	e	e
9[a]	^{228}Ac	0.30[f]	0.30[f]	e	e	e	e	e
	^{208}Tl	0.14[f]	0.14[f]	e	e	e	e	e
Background[g]	^{228}Ac	0.77	1.28	0.90	1.01	0.85	0.74	0.76
	^{208}Tl	0.38	0.51	0.35	0.35	0.31	0.30	0.30

Source: Adapted from Vierzba, 1985

a Location shown on Figure 3-2
b ^{228}Ac = Actinium-228 (a thorium-232 daughter)
c Concentration determined from depth of 31-51 cm
d ^{208}Tl = Thallium-208 (a thorium-232 daughter)
e No sample collected at this core depth
f Concentration determined from depth of 0-20 cm
g Background location: ISU Golf Course

PRELIMINARY



RADIOLOGICAL SOIL SAMPLING LOCATIONS AT THE CITY OF AMES AIRPORT

FIGURE 3-3

TABLE 3-7

GAMMA ANALYSIS RESULTS OF SOIL SAMPLES FROM THE CITY OF AMES AIRPORT

Sampling Location	Radionuclide Concentration (pCi/g)	
	^{228}Ac[a]	^{208}Tl[b]
1[c]	0.77	0.34
2[c]	0.99	0.29
3[c]	0.0	0.11
4[c]	0.73	0.23
5[c]	0.54	0.20
6[c]	0.61	0.30
7[c]	0.80	0.29
8[c]	0.77	0.25
9[c]	12.1	4.07
Background[d]	0.61	0.21

Source: Adapted from Vierzba, 1985

a ^{228}Ac = Actinium-228 (a thorium-232 daughter)
b ^{208}Tl = Thallium-208 (a thorium-232 daughter)
c Location shown on Figure 3-3
d Background location: ISU Golf Course

PRELIMINARY

3.2.4 Findings and Observations

The findings that involve soil contamination are the result of past releases, spills, and disposal practices. They are presented here as well as within the context of other findings in Section 4.5.2 (Inactive Waste Sites and Releases).

3.2.4.1 Category I

None

3.2.4.2 Category II

1. Uncontrolled removal or disturbance of radioactively contaminated soil. Uncontrolled removal or disturbance of the radioactively contaminated soil at the City of Ames WPCP may result in expanded areas of contamination.

   From July 1951 until August 1952, radioactive material released from Wilhelm Hall at the Ames Laboratory to the sanitary sewer contaminated sludge at the WPCP with thorium and thorium daughters. The contaminated sludge was temporarily stored in an unprotected pile on the ground at the WPCP adjacent to the sludge drying beds until a disposal method was identified. Section 3.2.2.2 provides a discussion of the disposal method. The pile was removed, but the temporary storage of the contaminated sludge caused contamination of the underlying soil with thorium and thorium daughters. Soil sampling results from the 1976 radiological screening showed elevated levels of the thorium-232 daughters actinium-228 and thallium-208. Additionally, the WPCP is the only site that the Ames Laboratory has surveyed that currently has direct penetrating radiation exposures above background levels (Section 4.3.3). There are no controls employed by the Ames Laboratory or the City of Ames for this area of soil contamination.

   During the Survey, Survey team members observed evidence that some of the contaminated soil had recently been removed from this area. An investigation during and after the Survey by site personnel revealed that the WPCP had an overflow of sewage sludge from adjacent sludge drying beds during early 1988. The material flowed over part of the area contaminated by thorium-232 and thorium daughters. The overflow sludge, along with some of the underlying contaminated soil, was retrieved and placed by WPCP personnel in a pile next to the fence north of the contaminated area for temporary storage. The mixture was eventually spread by City of Ames personnel on adjacent city land using a farm manure spreader. According to Ames Laboratory personnel, some residual contamination was found where the sludge/soil mixture was temporarily piled. However, the material was spread in an area large enough to make thorium levels less than the FUSRAP/SFMP maximum permitted surface level of 5 pCi/g soil averaged over a 100-square-meter area.

3.2.4.3 Category III

None

3.2.4.4 Category IV

None

PRELIMINARY

3.3 Surface Water

This section deals with surface-water features in the Ames area; surface-water pollution sources and controls at the Ames Laboratory; current and historical surface-water and liquid waste monitoring programs at the Laboratory, including the ASC; and findings and observations related to surface water. Drinking water sources and uses are also discussed.

3.3.1 Background Environmental Information

3.3.1.1 Surface-Water Drainage

The Ames Laboratory is centered in buildings on the northern side of the ISU campus (Figure 2-3), although use is also made of several buildings at the ASC, located 1 mile northwest of the ISU campus (Figure 2-2). Both areas are located within the Squaw Creek basin. The Ames Laboratory buildings on the ISU campus are 1/4- to 4/10-mile south of Squaw Creek while the ASC is approximately 1/2 mile west of the creek (Figure 2-2). Tributaries to Squaw Creek that are affected by Ames Laboratory operations include Onion Creek, Onion Creek Gulch, and several unnamed tributaries, which drain the ASC, and Clear Creek and College Creek, which receive drainage from the main ISU campus (Figures 2-2, 2-3, and 2-4).

Squaw Creek flows into the South Skunk River approximately 4 miles downstream of the ISU campus (Figure 2-2). The City of Ames WPCP is located on the South Skunk River, 1/2 mile downstream of the confluence with Squaw Creek. The South Skunk River flows into the Mississippi River on the southeastern border of Iowa, 160 miles southeast of Ames (Figure 2-1). Squaw Creek and the South Skunk River are the major sources of recharge to the Ames aquifer, as discussed in Section 3.4.1.2.

A gaging station is located on Squaw Creek at the Lincoln Way overpass, east of th ISU campus (Figure 2-2). Flows at the station have averaged 131 cubic feet per second (ft^3/s) for a 29-year period of record (October 1919 through September 1927 and October 1965 through September 1986). Extremes in flow have ranged from lows of no flow, which has occurred during most years of record, to a high of 11,300 ft^3/s, in June 1975 (Melcher et al., 1987). Flow measurements for the above-mentioned tributaries into Squaw Creek have not been reported.

The Ames Laboratory facility on the ISU campus has no permanent surface-water features. During rainfall events and snowmelt, drainage occurs by overland runoff from permeable grassy and landscaped areas and from impermeable areas such as parking lots, sidewalks, streets, and rooftops. Overland flow is then collected in the ISU street and parking lot gutters and routed to the storm sewers in those areas, as described in Section 3.3.2.1.

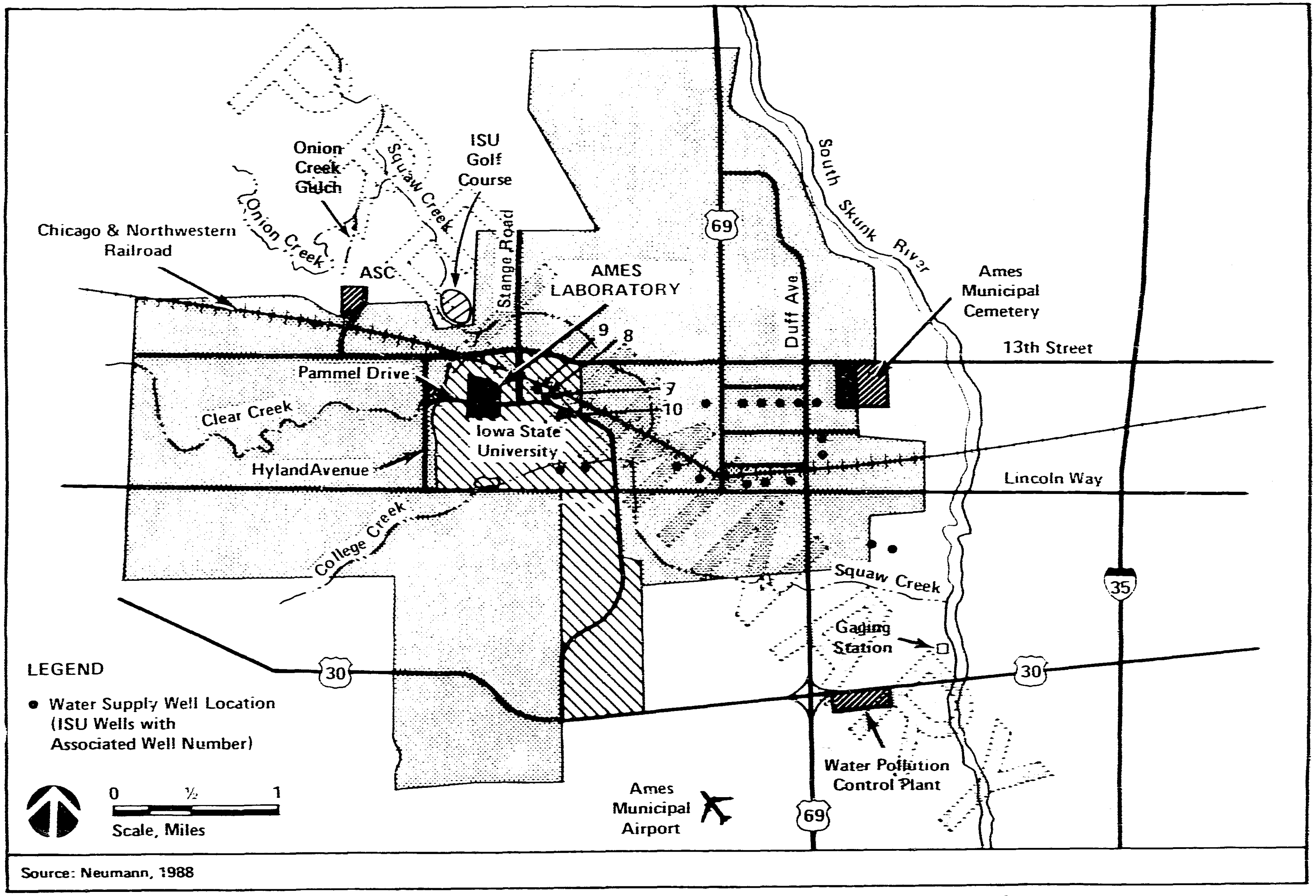
The ASC is located on a drainage divide between Onion Creek Gulch to the west and several unnamed headwater streams to the north and east (Figure 2-4). The crest of the divide runs north-south, just west of the Ames Laboratory Research Reactor (ALRR) Building. Onion Creek Gulch is an intermittent headwater tributary that originates 1/4 mile southwest of the ASC. It flows into Onion Creek approximately 1/2 mile north of the ASC (Figure 2-2). Onion Creek, also an intermittent stream, flows into Squaw Creek nearly 1/2 mile below its confluence with Onion Creek Gulch. The unnamed streams also flow into Squaw Creek 1/4 mile north and east of the ASC.

With the exception of stream channels and banks, there are no wetlands or flood-prone areas at the Ames Laboratory.

3.3.1.2 Water Supply, Uses, and Treatment

Water supply to the Ames Laboratory is provided by the City of Ames municipal system. The source of water is the Ames aquifer, a deposit of alluvial sand and gravel, which underlies the City of Ames. The aquifer is recharged by the South Skunk River and Squaw Creek, as discussed in Section 3.4.1.2. The City of Ames pumps from 20 wells (Figure 3-4), of which Wells 7, 8, 9, and 10 belong to ISU. Wells 7, 8, and 9 supply ISU's power plant but can be diverted to the city treatment and distribution system, while Well 10 supplies the city system directly (Neumann, 1988).

The wells are in a 40- to 60-foot-thick deposit at a depth of approximately 130 feet and have a total average daily yield of 6.5 million gallons per day (mgd). The water is treated at the City of Ames water plant for iron removal, softening, solids removal, disinfection, and fluoridation before being distributed to users (Neumann, 1988). At the Ames Laboratory, municipal water is used at laboratory sinks, lavatory



CITY OF AMES, IOWA,
WATER SUPPLY WELL LOCATIONS

FIGURE 3-4

sinks and toilets, drinking fountains, for lawn irrigation, and in lasers and other research and maintenance equipment for cooling. With the exception of bottled deionized water that is used in laboratories, these are no other sources of water.

3.3.2 General Description of Pollution Sources and Controls

Three types of wastewater are generated as a result of Ames Laboratory operations--sanitary wastewater, industrial wastewater, and stormwater. The sources of these wastewaters and the treatment and disposal/discharge methods used are discussed in the following subsections.

3.3.2.1 Sources of Wastewater

Sanitary Wastewater

Sanitary wastewater is generated from all active Ames Laboratory buildings with the exception of the High Pressure Test Facility at the ASC. The major sources at all these buildings are lavatory sinks and toilets and drinking water fountains. Showers are also contributing sources at the Campus Warehouse and the Maintenance Shop. At both the ISU campus and the ASC, the Ames Laboratory building sanitary lines flow into ISU's sanitary sewer system, which also carries sanitary wastewater from ISU-owned and operated buildings. The combined flow at the ISU campus and at the ASC is then routed to the City of Ames sanitary sewer system, which terminates at the City of Ames WPCP, as discussed in Section 3.3.2.2.

This same system also carries industrial wastewater from the Ames Laboratory as discussed below.

Industrial Wastewater

The major sources of industrial wastewater at the Ames Laboratory are laboratory sink drains in Spedding Hall, Wilhelm Hall, the Metals Development Building, Gilman Hall, the Office and Laboratory Building, Sweeney Hall, and the Alpha Glovebox Facility at the rear of the Waste Disposal Building; shop sink drains at the Maintenance Garage, the Maintenance Shop, the Paint and Air Conditioning Shop, and the Campus Warehouse; and the washing machine at the Waste Disposal

PRELIMINARY

Building. Other minor sources include cooling water for welding at the shops and the Metals Development Building; cooling water for lasers at the Office and Laboratory Building, Gilman Hall, and Spedding Hall; condensate from the steam system and air compressor at the Paint and Air Conditioning Shop; and floor drains at several shops and laboratories in Spedding Hall, Wilhelm Hall, and the Metals Development Building. Based on Survey team observations, these minor sources contribute little, if any, contaminants to the wastewater.

The dominant component in the industrial wastewater is potable water discharged through the sinks in laboratories and shops. As discussed in Section 4.1, most liquid hazardous wastes, which are generated in small quantities in laboratories and shops at the Ames Laboratory, are segregated in separate containers and are either treated on-site for recovery or hauled off-site for disposal. However, a portion of these wastes, including acids, alcohols, solvents, and dilute metal solutions, is discharged into laboratory and shop sink drains.

The washing machine at the Waste Disposal Building is used for washing clothing that is suspected of being radioactively contaminated. The washwater is detained in holding tanks, located in the basement, for analysis. If concentrations of radioisotopes are below DOE Derived Concentration Guides (DCGs), the water is released to the sanitary sewer. Radioisotopes released to the sanitary sewer have included small quantities of tritium, cobalt-60, and cesium-134 and 137. From 1984 through 1987, 16,350 gallons, consisting predominantly of washwater (and some ALRR decommissioning wastewater in 1984), were discharged from the Waste Disposal Building tanks in four releases to the sanitary sewer (Table 3-8) (Voss, 1985a, 1986a; Mathison, 1987a, 1988).

The industrial wastewater is discharged into the sanitary wastewater system described above. There are no separate records for the volumes of sanitary and industrial waste discharges. However, all Ames Laboratory buildings and rented space on the ISU campus discharge an estimated 90,000 gallons per day (gpd) into the University system which, in turn, discharges 1.5 mgd into the City of Ames sanitary sewer system. The University discharge represents 30 percent of the volume received at the WPCP (Voss, 1985b).

TABLE 3-8

RADIOACTIVE WASTEWATER RELEASES FROM THE WASTE DISPOSAL BUILDING

Release Date[a]	Volume Released (gallons)	Radionuclide	Amount (μCi/L)	DOE DCG[b] (μCi/L)
November 11, 1984	7,500	Tritium	7.2×10^{-2}	2
		Cobalt-60	8.87×10^{-4}	5×10^{-3}
		Cesium-137	1.36×10^{-3}	3×10^{-3}
October 29, 1986	7,050	Tritium	1.9×10^{-2}	2
		Cobalt-60	3.67×10^{-4}	5×10^{-3}
		Cesium-134	1.12×10^{-5}	2×10^{-3}
		Cesium-137	9.74×10^{-4}	3×10^{-3}
February 18, 1987	300	Tritium[c]	2.5×10^{-5}	2
July 16, 1987	1,500	Cobalt-60[c]	8.0×10^{-7}	5×10^{-3}
		Cesium-137[c]	4.0×10^{-7}	3×10^{-3}

Sources: Voss, 1985a, 1986a; Mathison, 1987a, 1988

a No releases were made in 1985.
b DOE Derived Concentration Guides.
c February and July 1987 combined.

PRELIMINARY

At the ASC, approximately 8,000 gpd of sanitary and industrial wastewater are discharged to the municipal system (Voss, 1985b). However, DOE contributes an unspecified portion of this flow since its activities are restricted to two of the four actively used buildings at the ASC -- the Waste Disposal Building, which includes the Alpha Glovebox Facility, and the High Pressure Test Facility.

Concentrations of contaminants in the sanitary/industrial wastewater have not been well studied. Limited wastewater sampling has been conducted by the City of Ames and ISU as part of ISU's industrial pretreatment program agreement with the City of Ames. One sampling location is at the point where the entire ISU campus system enters the city system. Because flow from the Ames Laboratory only represents approximately 6 percent of the flow at this point, the data are not representative of the Ames Laboratory discharge.

Another sampling location is at the point where flow from the ASC enters the city system. In September 1987, DOE terminated its lease at the ASC and, since then, has occupied only two of the four actively used buildings. Before that time, DOE operated the entire ASC and was using chromates in the ASC comfort cooling towers. Thus, analysis of total chromium and pH was required by the pretreatment agreement. When ISU took control of the area, chromate use was discontinued. However, pH and chromate have still been analyzed, and the most recent data available (October 1987) yielded results as follows: pH of 7.6 units and total chromium of less than 0.02 milligram per liter (mg/L). These are well within the City of Ames recommended municipal sewerage system allowable discharge limits of 6 to 10 units and 3.5 mg/L, respectively (City of Ames, 1983).

Stormwater

Stormwater is generated by rainfall and snowmelt runoff from paved areas (parking lots, roads, sidewalks), rooftops, window wells, and lawns. It is collected in gutters and then routed to storm sewers. North of Pammel Drive (Figure 2-3), a storm sewer runs from the parking lots on the western side of the Metals Development Building, where it collects parking lot and roof runoff, north to the Ames Laboratory shops area. At that point, the sewer collects runoff from the paved areas and roof drains, and then discharges to a ditch between the Ames Laboratory shops area and the railroad tracks. Some of the roof and parking lot drains in the western part of the shops area discharge directly to the ditch along the railroad tracks. Most water in the ditch flows eastward into Squaw Creek. However, the western portion of the ditch, which receives direct discharges from the roof and parking lot drains on the west side of the shops area, drains westward to Clear Creek (Figure 2-3). Clear Creek flows into Squaw Creek 1/4-mile downstream of the ditch confluence (Figure 2-2).

Overland runoff from the Ames Laboratory area south of Pammel Drive on the ISU campus and discharges from window wells and roofs drainage from this same area flow into a series of storm sewers on Pammel Drive and beneath the Physics Addition (Figure 2-3). These sewers join east of the Physics Addition. The combined flow is carried eastward and discharges into College Creek. College Creek then flows into Squaw Creek, 1/2 mile downstream.

At the ASC, stormwater on the west side flows overland into Onion Creek Gulch. Roof and foundation drainage from the ALRR Building is piped to Onion Creek Gulch. On the east side, an intermittent drainage ditch originates at the northeastern corner of the ASC (Figure 2-4). This ditch receives overland flow and storm sewer discharges from the northeastern portion of the ASC. Roof drains from the ASC Warehouse are piped to this ditch as well. The ditch flows to the north, along a gravel road, approximately 1/4-mile to the Squaw Creek floodplain. Runoff from the southeastern portion of the ASC is collected in a storm sewer, which discharges to the head of an intermittent ravine immediately east of the ASC. This ravine flows into the Squaw Creek floodplain 1/4 mile east of the ASC.

Stormwater may act as a conduit for contaminants it contacts on the surface as it runs off and in the ground as it percolates downward.

3.3.2.2 Wastewater Control, Treatment, and Disposal

The Ames Laboratory has implemented several administrative procedures to control contamination of surface water. These include written policies and procedures concerning hazardous materials and chemical leaks, spills, and emission control. In addition, posted safety placards and the Waste Management Plan, described in Section 4.1.1, delineate procedures for minimizing discharge of liquid wastes into laboratory and shop sink drains.

Industrial and sanitary wastewater from the Ames Laboratory on the main ISU campus and at the ASC is routed to the City of Ames WPCP. Although there is no pretreatment of the wastewater, radioactive liquids, including washwater from suspect radioactively contaminated clothing can be treated in a liquid radioactive treatment system, located in the Waste Disposal Building. The system consists of holding tanks, a particulate filter, and an ion exchange column. However, the wastewater normally contains low levels of radioactivity and is therefore detained and analyzed in radioactive waste holding tanks prior to release into the municipal system, as described in Section 3.3.2.1.

The City of Ames WPCP, located along the South Skunk River (Figure 2-2), has a design capacity of 2.2 mgd but is presently treating 6.5 mgd. A new plant further down the South Skunk River, which is planned to begin operations in the spring of 1989, will have a design capacity of 12.1 mgd. The present plant (Figure 3-2), built in 1949 or 1950, uses settling tank and trickling filter treatment. Sludge is land-applied in fields next to the WPCP and the liquid effluent is discharged to the South Skunk River. That discharge is National Pollutant Discharge Elimination System (NPDES) permitted. Another municipal treatment plant on South Maple Street by Squaw Creek (Figure 2-2) no longer exists and preceded the present plant. However, the University had its own plant until the 1940s, when it was connected to the municipal system. The Ames Laboratory buildings on the ISU campus have always been connected to the University sanitary wastewater system.

Since 1978, wastewater from the ASC has been discharged to the municipal system. However, from 1961, when the ASC was first developed, until 1978, there were four separate treatment systems at the ASC. Sanitary wastes from the ALRR Building and the Waste Disposal Building flowed to a septic tank and then to a subsurface sand filter. Laboratory wastes from the ALRR Building drained to an acid neutralizing pit and suspected or known radioactive liquid waste from the ALRR Building was routed to holding tanks in the Waste Disposal Building. Effluents from the subsurface sand filter, the acid neutralizing pit, and the holding tanks were discharged through a single pipe to Onion Creek Gulch. Liquids were released from the holding tanks only if they were below AEC or DOE release criteria. The discharge to Onion Creek Gulch was NPDES permitted from 1975 through 1978. The ASC Warehouse had its own septic tank and drain field, and the effluent percolated into the ground. The ALRR Building and ASC Warehouse septic systems and the acid neutralizing pit are discussed in more detail in Section 4.5.1.2.

Stormwater flowing off the Ames Laboratory site at ISU and the ASC, as described in Section 3.3.2.1, is not treated.

3.3.3 Environmental Monitoring Program

Surface water is presently not sampled at the Ames Laboratory. However, washwater from the laundering of clothing suspected of being radioactively contaminated is sampled for radionuclides before it is batch-released from the radioactive liquid waste tanks in the Waste Disposal Building into the City of Ames sewer system. These samples are taken by Ames Laboratory personnel, following written protocol, and are analyzed at the Ames Laboratory, as discussed in Section 4.4.1. Samples have been taken from the waste tanks since the construction of the ALRR in 1962. Until 1978, these tanks discharged to Onion Creek Gulch, and after that to the City of Ames sewer system. Results of this sampling since 1984 are presented in Section 3.3.2.1. At no time have releases exceeded AEC or DOE standards.

In June 1984, ISU entered into an industrial waste pretreatment program agreement with the City of Ames, under which effluent from the ASC to the city's sanitary sewer system was to be grab-sampled semiannually for pH and total chromium. Although the ASC was operated by DOE through a lease from ISU until September 1987, the city has taken the samples and the University of Iowa Hygienic Laboratory has performed the analyses. Total chromium was required for analysis since DOE used water containing 30 mg/L chromates in the comfort cooling towers, the blowdown from which was discharged to the City of Ames sanitary sewer system. In 1985 and 1986, concentrations of total chromium in the discharge to the sanitary sewer system ranged from 0 to 0.019 mg/L, and pH ranged from 6.9 to 7.75 units; City of Ames recommended discharge limits to the sanitary sewer are, for total chromium, 3.5 mg/L average during a reporting period and 5.0 mg/L maximum at any time, and, for pH, 6.0 to 10.0 units (City of Ames, 1983). In October 1987, after ISU took control of the ASC and chromate use was discontinued, total chromium was measured at less than 0.020 mg/L and pH at 7.6 units.

Historically, two other environmental monitoring programs, one for radiological and the other for nonradiological parameters, have taken place at the Ames Laboratory. Results of these programs were reported in environmental monitoring reports. Environmental monitoring for radioactivity took place from 1963 through 1980 at the ASC. Both sampling and analysis were conducted by Ames Laboratory personnel following written protocols. Water and sediment samples were taken on Onion Creek Gulch upstream and downstream of the ASC effluent discharge point, on Onion Creek upstream and downstream of the Onion Creek Gulch confluence, on the South Skunk River downstream of the Squaw Creek confluence, and on Clear Creek as a control (Figure 2-2). The potential doses from the concentrations of radionuclides in the surface waters and sediments were always below the dose derived from the DCG (Voss, 1965 through 1981; Voss and Sobottka, 1964).

Environmental monitoring for nonradiological parameters (chlorides, hexavalent chromium, zinc, pH, five-day biochemical oxygen demand, and fecal coliform) took place from 1974 through 1978. These samples, taken as part of the Ames Laboratory NPDES permit monitoring requirements, were collected and analyzed by Ames Laboratory personnel using EPA and field test kit manufacturer's protocols. The permit was terminated in 1979 after the ASC effluent discharge was rerouted from Onion Creek Gulch to the City of Ames sanitary sewer system in September 1978. Water samples were taken from the discharge and from Onion Creek Gulch, upstream and downstream of the discharge. All parameters were analyzed in the discharge water, but only hexavalent chromium and pH were measured in Onion Creek Gulch water.

Nonradiological parameters were usually within the NPDES effluent limits. A notable exception was hexavalent chromium, which exceeded the NPDES limit of 0.05 mg/L nearly 70 percent of the time. However, hexavalent chromium concentrations in Onion Creek Gulch were not detectably different upstream and downstream of the discharge (Voss, 1977, 1978, 1979).

3.3.4 Findings and Observations

Findings that involve surface-water contamination are the result of current and past waste and materials management and control practices, and are discussed in findings in Section 4.1.2 (Waste Management) and Section 4.5.2 (Inactive Waste Sites and Releases).

3.3.4.1 Category I

None

3.3.4.2 Category II

None

3.3.4.3 Category III

None

3.3.4.4 Category IV

None

PRELIMINARY

3.4 Hydrogeology

This section discusses regional geologic conditions, aquifer characteristics, pollution sources and specific controls, environmental monitoring programs, and the effect that Ames Laboratory operations have on the groundwater.

3.4.1 Background Environmental Information

Most of the background environmental information in this section has been provided by an ISU doctoral dissertation entitled Occurrence, Movement, and Evaluation of Shallow Groundwater in the Ames, Iowa Area (Akhavi, 1970).

3.4.1.1 Geology

The region surrounding the Ames Laboratory is mantled by typically 220 feet of Holocene and Pleistocene deposits of surficial glaciofluvial deposits in the floodplain areas and glacial drift in the upland areas (Table 3-9). The Ames Laboratory is located between two alluvial valleys that correspond to the South Skunk River and Squaw Creek. The bedrock underlying the Pleistocene deposits consists of approximately 235 feet of Pennsylvanian shales and sandstone and thin layers of limestone. Underlying the Pennsylvanian deposits are up to 1,000 feet of Mississippian sandy, cherty limestone, shale, and dolomite. Underlying the Mississippian deposits is the St. Peter Sandstone Formation.

The floodplain deposits consist of channels, overbank, terrace, and colluvial detritus, which form a complex interwoven meander pattern of sand, silt, gravel, and clay that displays extreme variations of lithology over short horizontal and vertical distance. These geologically recent deposits follow the courses of the South Skunk River and Squaw Creek.

The upland deposits consist of Pleistocene-age glacial till, a heterogeneous mixture of sand, silt, clay, and gravel with occasional pebble or cobble lenses. These deposits impart a gently undulating topography with ridges that are oriented northwest-southeast and produce a scalloped pattern near the recent alluvial channels. The topography in the upland areas surrounding Ames is mature, with relief ranging from 20 to 50 feet. Relief in the low floodplain areas averages less than 20 feet. The

TABLE 3-9

IDEALIZED STRATIGRAPHIC SECTION, AMES LABORATORY

Age	Lithology	Formation	Thickness (ft.)	Depth Below Surface
Holocene & Pleistocene	Mixed Sand, Silt, Clay, Gravel	Surficial Soils	5 - 10'	0 - 10'
	Fine Grain Silt and Clay, Sand	Upper Till	60'	10 - 60'
	Fine to Medium Sand and Silt	Intermediate Till	30'	60 - 90'
	Coarse Sand & Gravel & Cobbles	Ames Aquifer	40'	90 - 130'
	Fine Grain Sand, Silt, and Clay	Lower Till	90'	130 - 220'
Pennsylvanian	Shale, Sandstone, and Thin Layers of Limestone	Cherokee Group	235'	220 - 455'
Mississippian	Sandy Limestone	St. Louis	29'	455 - 484'
	Shale and Dolomite	Warsaw	51'	484 - 535'
	Cherty Dolomite and Limestone	Keokuk	N/A	N/A

Source: Akhavi, 1970

PRELIMINARY

upland deposits in the area of the Ames Laboratory can be differentiated into four distinct units, the Upper Till, the Intermediate Till, the Ames aquifer (the lower portion of the Intermediate Till), and the Lower Till (Table 3-9). Above these tills lies a thin layer of surficial soil. The total depth of these deposits is typically 220 feet.

The Pennsylvanian shales and sandstones that lie beneath the upland deposits form two buried valleys that were formed by the South Skunk River and Squaw Creek. The valleys are separated by a local bedrock high and join at the southern end of the city at the confluence of the modern stream channels.

Scattered bedrock exposures occur along the channels of the South Skunk River and Squaw Creek. These outcrops typically are composed of Cherokee Group bedrock (Pennsylvanian period) and the St. Louis, Warsaw, Keokuk, and Burlington Formations (Upper Mississippian).

The most prominent structural feature in this area is an eastern-dipping, northwest-southeast-trending anticline that passes just north of the Ames Laboratory. The anticline consists of inliers of Mississippian rock surrounded by younger Pennsylvanian rock. The area is transected by several small faults but is historically low in seismic activity. Only two significant earthquakes have been recorded in the Iowa area that have had an effect on the Ames region. An earthquake of intensity 5 occurred in 1872 and affected a 3,000-square-mile area surrounding Sioux City, 180 miles to the west, and another intensity-5 earthquake occurred in 1905 and affected a 5,000-square-mile area surrounding Keokuk, 190 miles southeast of Ames.

3.4.1.2 Groundwater Regime

Groundwater in the Ames area occurs in floodplain deposits, in the Intermediate Till in the upland deposits (the Ames aquifer), and in deeper formations that occur over 1,000 feet below the surface.

Groundwater in the floodplain deposits does not constitute an aquifer. This shallow groundwater occurs east of the Ames Laboratory in the vicinity of the South Skunk River. Recharge is from localized surface infiltration, and discharge is primarily to the South Skunk River with minor discharge to the Ames aquifer beneath it.

Groundwater in the lower portion of the Intermediate Till constitutes the Ames aquifer, which supplies the City of Ames public water system. Beneath the City of Ames, the aquifer typically occurs at a depth of 90 feet and is 40 to 60 feet thick. The aquifer is recharged through the glacial drift deposits in buried river channels from the north and west, associated with the South Skunk River and Squaw Creek, respectively; however, some local surface infiltration does reach the aquifer. Aquifer gradients indicate that flow is generally to the southeast. North of the City of Ames, the South Skunk River discharges to the Ames aquifer; however, in the vicinity and south of the City of Ames, the aquifer discharges to the South Skunk River. The transmissivities of the Ames aquifer range from 50,000 to 437,000 gallons per day per foot. Information on the use of the Ames aquifer for drinking water is discussed in Section 3.3.1.2.

The Ames aquifer has been contaminated with phenol from activities not associated with the Ames Laboratory. An abandoned coal gasification plant located in downtown Ames approximately 2 miles east-southeast of the ISU main campus has been identified as the source of contamination (Ahkavi, 1970).

The deep bedrock aquifer lies below the Mississippian-age deposits listed in Table 3-10. It is a regional aquifer and supplies water for irrigation and watering of livestock in the surrounding area. This aquifer is effectively separated from the Ames aquifer by up to 1,000 feet of shales, limestones, and dolomites. The depth of the deep aquifer is variable and may be as much as 1,200 feet. Recharge to this aquifer is not known to occur in the area of the Ames Laboratory.

3.4.2 General Description of Pollution Sources and Controls

The Ames Laboratory has eight potential sources of pollution that could impact both the shallow groundwater and the Ames aquifer. Six of these sources are associated with past activities at the Ames Laboratory, and the remaining two sources are associated with current activities. These potential sources involving past and current activities are described generally below and in greater detail in Sections 4.5.1.2 and 4.2.1.5, respectively.

3.4.2.1 Inactive Sources

The inactive Chemical Disposal Site at the ASC is a potential source of contamination of both shallow groundwater and the Ames aquifer. The unlined pits were used in the past for disposal of radionuclides, laboratory chemicals, and toxic and reactive metals and metal compounds.

Also at the ASC is the inactive septic field used in conjunction with the Ames Laboratory Research Reactor (ALRR). Chromium-based corrosion inhibitors used in the cooling tower were discharged to the septic field and may have leached toward the Ames aquifer.

Annex I and Annex II, now demolished, were the sites of thorium and uranium processing in the 1940s and early 1950s. Radioactive contaminants were released from these buildings to the surrounding soil, and may be a source of contamination of the Ames aquifer.

The Ames Laboratory inadvertently released thorium-contaminated wastewater to the City of Ames Water Pollution Control Plant from 1951 to 1952. The resulting thorium-contaminated sludge from the plant was disposed of at the Ames Municipal Airport, at a small sludge field adjacent to the plant, and at several other locations throughout the city. The sludge at the plant and the airport may potentially be further distributed through inadvertent disturbances or leach into the shallow groundwater in these areas.

3.4.2.2 Active Sources

In addition to the inactive sources, there are two active underground storage tanks (USTs), one located at Wilhelm Hall and installed in 1970 and one located at the Metals Development Building and installed in 1965. Both tanks are asphalt-coated steel and are currently used to store diesel fuel. They have never been leak tested and may be releasing some tank contents to the underlying soils and groundwater.

3.4.3 Environmental Monitoring Program

The Ames Laboratory does not have a groundwater monitoring program. Wells have never been installed and background water quality data have not been compiled by the Laboratory.

3.4.4 Findings and Observations

The findings involving groundwater contamination are associated with underground tank storage of diesel fuel and past releases, spills, or disposal practices of hazardous substances, and are therefore discussed within the context of other findings in Sections 4.2.2.4 (Toxic and Chemical Substances) and 4.5.2.3 (Inactive Waste Sites and Releases).

3.4.4.1 <u>Category I</u>

None

3.4.4.2 <u>Category II</u>

None

3.4.4.3 <u>Category III</u>

None

3.4.4.4 <u>Category IV</u>

None

PRELIMINARY

4.0 NON-MEDIA-SPECIFIC SURVEY FINDINGS AND OBSERVATIONS

This section discusses findings and observations pertaining to waste management, toxic and chemical materials, radiation, quality assurance, and inactive waste sites and releases. These discussions do not include a background environmental information section because the areas addressed are not necessarily tied to one medium as was the case with the discussions in Section 3.0. The discussions include an environmental monitoring program section where appropriate and where information was available.

4.1 Waste Management

The Ames Laboratory generates and manages a variety of hazardous, radioactive, mixed, and nonhazardous wastes. These wastes are generated at the buildings on the main ISU campus and at the ASC. The generation rates and compositions of the Ames Laboratory waste streams are typical of those found at any specialized research facility; they fluctuate constantly depending on the size, number, and variety of research programs at the Laboratory which start, evolve over time, and eventually are discontinued. This profile of waste generation contrasts sharply with that of a typical DOE production facility, which would generate a much greater quantity of waste with a relatively constant composition and generation rate.

The Ames Laboratory has developed a Site Waste Management Plan to help control the generation, handling, and disposal of its waste. The plan, which was updated for 1987, gives general descriptions of waste types, quantities, and facilities, and provides flowcharts that show how each waste type is generated, handled, and disposed of (Ames Laboratory, 1987).

The following sections discuss the physical characteristics, generation processes and rates, and management methods for the hazardous, mixed, radioactive, and nonhazardous wastes produced at the Ames Laboratory. The characterization and management of toxic materials, including polychlorinated biphenyls (PCBs) and asbestos are discussed in Section 4.2.1.

4.1.1 General Description of Pollution Sources and Controls - Hazardous Waste

Hazardous waste at the Ames Laboratory is regulated, generated, accumulated, and disposed of as discussed below.

4.1.1.1 Hazardous Waste Regulatory Status

The Ames Laboratory classifies itself as a conditionally exempt small-quantity generator (SQG) of hazardous waste as defined in the Resource Conservation and Recovery Act (RCRA) of 1980, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984. This classification exempts the Laboratory from complying with the majority of requirements set forth in RCRA for generators of hazardous waste, including those relating to closed containers, container condition, container labeling, and storage area specifications. In order for the Laboratory to retain this exemption, it is not permitted to generate more than 100 kilograms (kg) of hazardous waste in any given month and must not store more than a total 1,000 kg of hazardous waste on-site at any time. Although the Ames Laboratory appears to be exempt from many RCRA regulations based on the Survey's review of waste generation at the Laboratory, the Survey found that the Laboratory was not accurately measuring its hazardous waste generation rate. Under 40 CFR (Code of Federal Regulations) 261.5(d) the Ames Laboratory must determine on a monthly basis the quantity of all hazardous waste that is treated or reclaimed either on-site or off-site, and the hazardous waste that is shipped off-site to RCRA-permitted treatment, storage, and disposal (TSD) facilities. However, the Laboratory is not reporting the relatively small quantities of hazardous chemicals that periodically undergo on-site treatment, as discussed in Section 4.1.1.4.

4.1.1.2 Hazardous Waste Generation

The variety of hazardous waste generated at the Ames Laboratory includes spent solvents, acids and bases, reactive substances, aqueous metal solutions, mercury, and unused chemical reagents. For each waste type, the associated generation rate at any generation point may vary from an occasional fraction of a milliliter to several kilograms per week.

The hazardous wastes at the Ames Laboratory are primarily generated in the research laboratories, although some wastes are also produced as a result of support activities in the shops. The specific waste types generated by each of the activities are summarized in Table 4-1 and are discussed below.

Laser Laboratories

Laser laboratories make up a significant portion of the Ames Laboratory. They also produce the most constant stream of hazardous waste in terms of its generation rate and composition. Many of the lasers use a solvent and dye mixture in their operation. The mixture is periodically replaced in the laser and the old mixture is handled as a hazardous waste in the laboratories. The solvent usually is methanol; however, other solvents including ethylene glycol, ethanol, benzene, and p-dioxane are used. Dozens of different dyes are used and the Ames Laboratory Safety, Health, and Plant Protection Division (SH&PP) staff and some researchers do not have access to safety or environmental data for the dyes. Some of the trade names of the dyes include Exciton, Kiton, Rhodamine, and Coumarin. In some cases the dyes had been identified and labeled as suspected human carcinogens. When used, the dyes are typically mixed with solvents in extremely low concentrations (i.e., less than 0.1 percent). A single laser laboratory may generate several gallons of the spent solvent/dye mixture each year. The Survey identified at least six general locations at the Ames Laboratory where solvent lasers are operated.

Some of the laser laboratories use inert gaseous media instead of solvent/dye mixtures, and these laboratories generate none of this waste.

Laser laboratories also produce other hazardous wastes, including used samples and spent solvents used to clean glassware. Solvents used to clean glassware include methanol, acetone, and 1,1,1- trichloroethane. Used samples typically consist of various reagents, including some toxic heavy metal compounds, dissolved in a specific solvent including n-hexane and n-octane. The reagent concentrations are extremely low, and little information is available regarding the generation rate of these wastes.

TABLE 4-1

PROFILE OF CURRENT HAZARDOUS WASTE GENERATION AT THE AMES LABORATORY BY ACTIVITY AND AREA

General Activity	Area/Location	Wastes Generated					
		Solvents	Dyes	Acids and Bases	Photographic Chemicals	Reagents	Other
Lasers	Wilhelm Hall, 1st floor and basement Spedding Hall, basement Spedding Hall, ground floor Gilman Hall, basement Office and Laboratory Building, 1st floor Office and Laboratory Building, basement	X	X			X	
Materials Chemistry & Science	Wilhelm Hall, 2nd floor Wilhelm Hall, 1st floor and basement	X		X	X		
Fossil Energy	Wilhelm Hall, 2nd floor Spedding Hall, basement	X		X			
X-Ray Diffraction	Spedding Hall, 3rd floor	X		X	X		
Physical Chemistry	Spedding Hall, 3rd floor	X		X			
Sample Preparation	Wilhelm Hall, basement Spedding Hall, 2nd floor	X		X			
Mercaptan Chemistry	Spedding Hall, ground floor			X			Mercury
Metals Purification & Fabrication	Metals Development Building, 1st floor	X		X			
Analytical Chemistry	Wilhelm Hall, 3rd floor Gilman Hall, 2nd floor Metals Development Building, 2nd floor	X		X		X	Metals, cyanide
Nuclear Fuel Reprocessing Research	Alpha Glovebox Facility	X		X			
Shops	Maintenance Garage, Paint and Air Conditioning Shop	X					Paint sludge

Other Laboratories

Most of the other laboratories at the Ames Laboratory generate small quantities (i.e., typically a few liters per week or less) of hazardous waste as part of their research.

Materials Science and Chemistry Laboratories - These laboratories generate several wastes, including spent perchloric, nitric, hydrofluoric, and sulfuric acids, which are used to clean glassware and etch metal and crystalline samples; spent photographic chemicals, which include aqueous silver and chromium salts and hydroquinone; and spent nonhalogenated solvents. A given laboratory typically generates a fraction of a liter of spent acid or spent photographic chemicals in a week. However, records are not maintained concerning the generation of these wastes at individual laboratories over the long term.

Fossil Energy Laboratories - These laboratories generate dilute aqueous sodium hydroxide solutions and small quantities of solvents. In addition, these laboratories generate waste acetone from cleaning glassware.

X-Ray Diffraction Laboratories and Physical Chemistry Laboratories - These laboratories generate wastes in composition and quantity comparable to those generated in the Material Science and Chemistry Laboratories. The wastes consist primarily of spent acids and photographic chemicals and small quantities of solvent used to clean glassware. These solvents include acetone, hexane, 1,1,1-trichloroethane, and chloroform.

Sample Preparation Laboratories - These laboratories generate spent perchloric and hydrochloric acids and solvents (acetone and methanol) used in electropolishing samples and cleaning glassware. A total of approximately 65 gallons per year of this waste is generated in these laboratories.

Mercaptan Chemistry Laboratory - This laboratory stores and uses a relatively large number and quantity of chemicals. However, little waste is generated since the solvents and aqueous solutions produced are evaporated in separation processes. The laboratory has an acid bath, used for cleaning glassware, which is periodically changed out, and also generates small quantities (i.e., a few grams per month or less) of dirty elemental mercury.

Metals Purification and Fabrication Laboratories - These laboratories generate small quantities of solvents from a parts washer used to clean metal samples. The solvent mixture in the parts washer is a commercial mixture containing only nonhalogenated species. Solvents and acids are also used outside the parts washers. However, no measurement of the quantity or composition of these materials was available.

Analytical Chemistry Laboratories - These laboratories use a variety of reagents, solvents, acids, and metals. These laboratories were observed to generate a larger volume of waste than that generated in other laboratories (except the laser laboratories) due to the nature of the research performed. However, accurate quantitative records on actual or average waste generation rates are not available. Spent solvents generated include acetone, ethanol, methanol, hexane, acetonitrile, toluene, ethyl ether, chloroform, tetrahydrofuran, tetrachloroethylene, dichlorobenzene, and methylene chloride. Used metals (not necessarily hazardous) include iron, sodium, mercury, tantalum, vanadium, thallium, osmium, rubidium, iridium, platinum, and palladium. Heavy metal and cyanide compounds also are used and eventually become waste.

Alpha Glovebox Facility - This laboratory conducts nuclear fuel reprocessing research at the ASC and generates small quantities of spent acids and solvents from used samples and cleaning glassware.

Shops

The Maintenance Garage and Paint and Air Conditioning Shop also generate small quantities of hazardous waste. The Maintenance Garage has a 55-gallon parts washer that uses a commercial, nonhalogenated solvent mixture. The parts washer is changed out very infrequently (less than once each year) because of its low usage. The Paint and Air Conditioning Shop generates approximately 5 gallons per month of paint sludge. The Ames Laboratory had no available information concerning the composition of the potentially hazardous sludge.

4.1.1.3 Handling and Disposal of Hazardous Waste at Generation Points

Once generated, hazardous waste is managed or disposed of by one or more of the following optional methods:

- accumulate at the point of generation in a satellite accumulation area and eventually turn over to the SH&PP staff for further action;
- accumulate at the point of generation and attempt to reclaim the material either in the laboratory or through an off-site commercial vendor;
- evaporate in a laboratory hood;
- pour down drain with possible neutralization or dilution as permitted under 40 CFR 261.3(a)(2)(iv); and
- accumulate at the point of generation in a satellite accumulation area and contact the ISU Environmental staff for pickup and disposal through ISU channels.

The option or combination of options used in a particular laboratory is determined by the laboratory supervisor or program director in that laboratory. The factors considered in choosing an option include convenience, the type of waste and its hazardous characteristics, and the dollar cost involved in carrying out the option in terms of staff time and laboratory space needed for temporarily accumulating the waste.

Guidance provided to researchers to ensure environmentally sound disposal of hazardous wastes consists primarily of the Ames Laboratory Safety Rules Placard, on which Item 32 states, "Waste hazardous materials shall not be placed in waste baskets, dumpsters or poured down sinks or drains," and Item 33 states, "Consult Safety, Health & Plant Protection concerning the proper disposal methods for all radioactive, chemical, and hazardous material or equipment" (Ames Laboratory, 1988a).

PRELIMINARY

Waste accumulated in the laboratories for turning over to the SH&PP staff is usually stored in several types of containers. Waste solvents and aqueous solutions are stored in 2- to 4-liter glass or polyethylene jugs. Metals and metal compounds are typically stored in small glass jars. Metal safety cans are not used. Laboratories typically closely track the availability of empty solvent and acid jugs since they are reused for the accumulation of waste. The containers sometimes have an original product label on them on which "WASTE" is handwritten. In other cases, the containers have no label indicating that the material in the container is waste or hazardous. In only a few cases are the containers labeled such that an observer would be able to identify their contents. In some cases, the containers are not kept closed.

The hazardous waste that is turned over to the SH&PP staff is stored temporarily and then subsequently managed in a variety of ways as discussed in Section 4.1.1.4.

Evaporation typically is performed as a waste reduction measure with either aqueous or solvent-based wastes. This activity is neither controlled nor encouraged by the SH&PP staff, however, and the extent to which it occurs is not known. It typically is performed by leaving a waste container open in a hood. However, waste containers may also be left open simply for convenience, resulting in unintentional evaporation losses and potential spills.

Within the laboratories, a variety of wastes are poured down drains, including both halogenated and nonhalogenated solvents used for cleaning glassware, acids used for cleaning glassware or cleaning or etching samples, and solvent- and aqueous-based liquid samples. Some researchers attempt to dilute or neutralize the wastes before or as they are poured down the drain, but this is not uniform since in some cases acids and solvents are disposed of at full strength. In other cases, acids are poured over limestone cobbles in a sink, or acids and solvents are poured down the drain with a large volume of water. The concentration of hazardous constituents in some wastes, such as aqueous samples, already may be very dilute. This activity is neither controlled nor encouraged by the SH&PP staff and accurate quantitative and qualitative data on the waste disposed of in this fashion are not available. However, the quantity released to the drains appeared to the Survey team, based on interviews with laboratory personnel, to be at least an order of magnitude less than the maximum allowed according to RCRA regulation 40 CFR 261.3(a)(2)(iv)(E) (approximately 55 lb/day of toxic listed wastes, based on the City of Ames 6.5-mgd WPCP). The SH&PP staff has implemented item 32 on the Ames Laboratory Safety Rules Placard, as revised January 1988, which states, "Waste hazardous materials shall not be placed in waste baskets, dumpsters, or poured down sinks or drains" in order to minimize disposal of chemicals to the drains (Ames Laboratory, 1988a).

The option of pickup and disposal through ISU channels is only available to the few laboratories where researchers have split appointments with ISU. These laboratories include those located in Sweeney Hall, at least one located in Gilman Hall, and possibly some located in the Office and Laboratory Building (OLB). When a split appointment occurs, a researcher may dispose of hazardous waste with either ISU or the SH&PP group. In these cases, the researcher decides through which channels the waste will be disposed of. The potential consequences of the split appointment arrangement with respect to liability and additional regulatory requirements are open to interpretation and could not be determined by the Survey team.

The handling of waste at the specific laboratories and shops as identified on Table 4-1 is discussed below.

Laboratories

Laser Laboratories generally accumulate waste solvent/dye mixtures and turn them over to the SH&PP staff. Liquid samples and acids and solvents used for cleaning glassware generally are turned over to the SH&PP staff. However, some are poured down drains. The Survey team observed open waste containers in the Laser Laboratories on the first floor of the OLB, in the basement of Spedding Hall, and in the basement of Gilman Hall.

Materials Science and Chemistry Laboratories in Wilhelm Hall dispose of most wastes down the drain, including spent acids, solvents, and photographic chemicals. One of these laboratories at the east end of the second floor of Wilhelm Hall accumulates its waste solvents and aqueous solutions for the SH&PP staff in open glass chemical product jugs.

PRELIMINARY

The Fossil Energy Laboratories in Wilhelm Hall and Spedding Hall accumulate most waste solvent-based solutions for the SH&PP staff, except acetone used for glass washing, which is disposed of down the drain. All waste aqueous solutions also are disposed of down the drain.

The X-Ray Diffraction Laboratory on the third floor of Spedding Hall disposes of small quantities of waste acids and solvents (mostly acetone but also 1,1,1-trichloroethane) by evaporation and down the drain.

The Physical Chemistry Laboratory on the third floor of Spedding Hall turns over waste solvents to the SH&PP staff.

The Sample Preparation Laboratory on the second floor of Spedding Hall disposes of small quantities of acids and solvents down drains.

The Mercaptan Chemistry Laboratory in Spedding Hall disposes of its acid bath and dirty mercury by turning it over to the SH&PP staff.

The Metals Purification and Fabrication Laboratories dispose of small quantities of acids and solvents down drains. The parts washer solvent is disposed of by turning it over to the SH&PP staff.

The Analytical Chemistry Laboratories on the third floor of Wilhelm Hall accumulate most solvent and aqueous wastes and turn them over to the SH&PP staff. However, some are disposed of down drains. Those in Sweeney Hall have them picked up by the ISU Environmental staff. The Chemical Engineering Laboratory in the Metals Development Building disposes of aqueous wastes and small quantities of solvent waste, including methylene chloride, down the drain. One of the chemistry laboratories on the second floor of Gilman Hall accumulates and redistills its metal/solvent mixtures to recover the rare metals for sale to off-site reclaimers. This laboratory also has an acid bath which is disposed of through the SH&PP staff.

The Alpha Glovebox Facility disposes of small quantities of spent acids and solvents down the drain.

PRELIMINARY

Shops

The Maintenance Garage turns over its parts washer solvent to the SH&PP staff.

The Paint and Air Conditioning Shop disposes of approximately 5 gallons of potentially hazardous paint sludge each month with its nonhazardous solid waste. The sludge is accumulated in a 5-gallon plastic paint bucket. As stated in the previous subsection, no information is available concerning the presence of any hazardous constituents in the sludge.

4.1.1.4 Handling of Hazardous Waste by SH&PP and ISU Staff

Once any hazardous waste is removed from its point of generation, it is generally handled by the SH&PP staff. The path of waste as it moves through the Ames Laboratory SH&PP system is described in the 1987 Site Waste Management Plan (Ames Laboratory, 1987). In addition, some hazardous waste from Ames Laboratory research activities is sent through the ISU system, as discussed in Section 4.1.1.3; however, the ISU waste management system will not be described since it was not part of the DOE Environmental Survey.

Typically, the SH&PP staff takes control of the waste after it is delivered to the SH&PP office located at the eastern end of the first floor of Spedding Hall. Individual generators hand-carry the waste containers to the SH&PP office or use a cart if the quantity of waste is too large to carry. However, SH&PP staff may pick up the waste at its generation point if it is reactive or unusually dangerous.

The SH&PP office serves several other administrative functions, and therefore is normally occupied during all working hours (8 a.m. to noon and 1 p.m. to 5 p.m., Monday through Friday). Generators delivering waste to the office are first required to fill out a waste characterization data sheet that identifies the generator and the quantity and approximate composition of the waste. The sheets do not specify the date of generation or date of delivery to the SH&PP office. In some cases, when the waste composition is unknown, the sheets are not filled out; this occurrence is not uncommon. The Survey team noted the presence of several containers of unknown potentially hazardous wastes within the facility.

PRELIMINARY

At the SH&PP office, the first step in categorizing the waste occurs. Since hazardous and radioactive wastes and some surplus materials (equipment and chemicals) are delivered to the SH&PP office in the same fashion, the SH&PP staff first separates the hazardous, potentially hazardous, and unidentified wastes. The wastes are then accumulated in their original containers in hoods, on countertops, and on the floor, depending on available space. When one cartload of waste and surplus chemicals has been accumulated (approximately eight gallon-sized jugs or the equivalent), the waste and chemicals are transported on the cart to Room B55 in the basement of Spedding Hall by the SH&PP staff. This occurs at irregular intervals averaging approximately once each week.

When received in Room B55, the waste and surplus chemicals are first logged into a logbook. Wastes may be stored for several days in a specified cabinet in Room B55 before being logged in. The logbook contains the following information for each waste if the information is available:

- the date logged in;
- the Chemical Abstract Service (CAS) number of the waste;
- the composition of the waste;
- the quantity of waste (volume);
- the weight of the waste;
- the source of the waste (i.e., the research group);
- the building and room number of the source;
- the hazard class of the waste (e.g., corrosive, toxic, flammable, reactive);
- how the waste was handled; and
- the date the waste was disposed of (e.g., shipped off-site).

No effort is made to compile the waste quantity data (excluding surplus chemicals) in the logbook to determine a monthly generation rate. The Survey team was not able to make this determination from using the logbook. However, after a review of the Ames Laboratory hazardous waste generation and management practices, the Survey team estimated that the monthly generation rate is less than 100 kg.

After being logged in, the hazardous waste containers and surplus chemicals are segregated. Unknown wastes and wastes that are to be treated are further segregated. The materials essentially are segregated according to how they are to be handled, as follows :

- store and analyze (unknown wastes);
- treat (neutralize and/or separate);
- store for reuse (surplus chemicals and metals);
- store for off-site reclamation, recycling, or resale;
- transport to Waste Disposal Building at the ASC for temporary storage (awaiting disposal); or
- transport to the Blue Shed at the ASC for indefinite storage (awaiting disposal).

Room B55 is approximately 12 feet by 20 feet in size and contains several metal cabinets for storage of equipment and chemicals, a hood, a drying oven, a sink, a flammable materials cabinet, a metal shelving unit, two large tables, and a desk. It is directly connected to Room B57, which is also used for the handling of waste and surplus chemicals. The flammables cabinet stores glass jugs of solvents waiting for analysis or transport to the Waste Disposal Building at the ASC. The hood contains containers of aqueous and solvent wastes being treated for metals removal, wastes awaiting treatment, and various miscellaneous chemicals. The cabinets under the hood contain a supply of acids and bases used for various treatments. The oven, which has not been used for several months, has been used for drying potentially radioactive soil samples. The shelving unit contains more than 100 bottles of various reagents and metals. These chemicals are in their original product containers and are being stored for potential use at the laboratory, sale to a chemicals broker, or disposal as hazardous waste. One of the cabinets contains a comparable quantity of surplus reagents also being stored for potential use at the Laboratory.

Approximately 40 liters of various waste acids were being stored in boxes on the floor of Room B55 at the time of the Survey, awaiting neutralization and recovery of metal salts (to be performed in the hood). This process is identified in the 1987 Site Hazardous Waste Management Plan. The contaminants present in the waste acids were not known. The treatment consists of pH adjustment across a wide range and the recovery of any precipitates generated during the adjustment. Depending on the identity and value of the material recovered, the material is to be stored in

Room B55 for either sale, reuse, or disposal. The liquid phase resulting from this treatment is further adjusted to within a nonhazardous range (i.e., approximately between pH 5 and 9) and is disposed of down the drain. This option of treating their own hazardous waste is strongly encouraged at the Ames Laboratory.

Room B57 also is occasionally used for the management of hazardous wastes. The room contains two hoods and an under-counter cabinet used for storing solvents used to perform separations. Several small plastic bags of various precipitates were being stored in the hood in Room B57 awaiting further action at the time of the Survey.

Rooms B55 and B57 are kept locked and access is available only through the SH&PP staff. Both rooms are equipped with fire extinguishers.

Hazardous wastes may accumulate in Rooms B55 and B57 for several weeks or months before being treated or moved. Nearly all potential wastes in the rooms are labeled in some fashion, but many of the labels are handwritten and are not readable, and a few substances have two or more different labels or are not labeled at all.

Hazardous wastes identified as being of no beneficial value are transported to the Waste Disposal Building at the ASC at irregular intervals averaging approximately once every 2 weeks. Approximately one cartload (8 gallons) of waste is transported each trip. The waste containers are transported in boxes with a liquid absorbent on a cart which is loaded into the back of an Ames Laboratory pickup truck and driven approximately 2 miles over public roads to the ASC. Here the waste is unloaded and placed on the loading dock of the Waste Disposal Building. A fenced-in area on the covered loading dock is used as an accumulation area for hazardous waste.

The accumulation area at the Waste Disposal Building is approximately 10 feet by 12 feet, is roofed, and has a concrete floor. The area is kept locked. At the time of the Survey, the area contained three 55-gallon drums of mixed solvents; two 55-gallon drums of a mixture of tributylphosphate, amasol, aluminum nitrate, and rare earths; one 55-gallon drum of waste oil (discussed further in Section 4.1.4.1); one 5-gallon can of sodium metal reported to be up to 20 years old; a small jar labeled zinc waste; approximately thirty 1/2- to 1-gallon glass jugs of methanol/dye waste; and approximately fifteen 1- to 4-liter jugs of other assorted solvents, aqueous solutions, and alcohols. The drums of solvent and oil and one of the tributylphosphate drums were located in metal drip pans with a small amount of absorbent material. All the drums were closed and at least partially full.

Once received at the accumulation area, solvents are poured from the glass bottles into one of the drums. Other wastes are kept in their original containers, which are identified by handwritten label. Wastes accumulate at this location until shipped to an off-site TSD facility or used in fire training. The empty glass bottles are allowed to evaporate dry and are discarded as solid waste.

The SH&PP staff performs small fire training exercises three or four times each year. Approximately 1 liter of waste methanol/dye mixture is used on each occasion. The waste is mixed in a one-to-three ratio with kerosene, ignited in a pan, and put out using a fire extinguisher. Students repeat this exercise several times. The Laboratory has burned both carcinogenic and noncarcinogenic dyes in this fashion. This exercise is performed during warm-weather months in front of the Campus Warehouse loading dock.

In the past, various hazardous wastes and other wastes have been transported to and stored in the metal Blue Shed at the ASC. Wastes are no longer regularly transported to the shed; however at the time of the Survey, several wastes were being stored there for an unknown time, including a 1-gallon container of potentially hazardous organic/aqueous solution, a 10-gallon container of rare earths in solution, a jar of sodium sulfide, a drum of metal yttrium turnings, and a bench saw contaminated with radioactive arsenic and tellurium. The shed was identified to the Survey team as a former storage location for pyrophoric or reactive wastes awaiting shoot-and-burn destruction, but no pyrophorics or reactives were being stored there at the time of the Survey.

Historically, reactive wastes were regularly shot and burned near the ASC several times a year. However, the practice was temporarily halted in 1987 (Joseph, 1987). Since that time, only one shoot-and-burn incident occurred on an unspecified date in early 1988, when approximately one-and-one-half liters of ether and one-quarter pound of lump sodium metal reportedly were shot and burned. The shoot-and-burn facility is located on ISU property in an undeveloped area on a nonpublic gravel road approximately one-third of a mile north of the ASC buildings. The shoot-and-burn facility consists of an open-ended steel drum with a large piece cut out on the side, set upright on a steel catch pan. The drum has a small grate placed inside onto which the waste containers are placed and surrounded with combustible material (e.g., cardboard). The material is then shot from approximately 50 feet away and allowed to burn. The material is ignited with a flame if the shot does not ignite it. The material is allowed to burn out and the residues collected and disposed of as nonhazardous waste.

The shoot-and-burn facility is owned by ISU, which has submitted a RCRA Part A hazardous waste treatment application for the facility to the U.S. Environmental Protection Agency (EPA).

4.1.1.5 Off-Site Disposal and Reclamation of Hazardous Waste

The Ames Laboratory disposes of hazardous wastes off-site and reclaims various chemicals and metals for on-site use and off-site sale.

At the time of the Survey, the SH&PP staff was maintaining documentation of the last three shipments of hazardous waste from the Ames Laboratory, which occurred in 1983, 1985, and 1987 (Ames Laboratory, 1988b). Table 4-2 summarizes available records associated with these shipments. In all three cases, RCRA-permitted hazardous waste transporters and disposers were used.

For the 1987 shipment, the disposer, GSX Services, Incorporated, laboratory-packed and laboratory-labeled all containers and prepared the shipping documentation with the assistance of the SH&PP staff. The ALRR Building was used as a staging area for segregating and laboratory-packing the wastes in preparation for shipment.

Although the Ames Laboratory is a conditionally exempt RCRA generator, the last waste shipment in 1987 exceeded the 1,000-kg maximum storage limit allowed for the exemption by over 1,800 kg (Table 4-2). This quantity does not include wastes saved for reclamation at that time.

TABLE 4-2

HAZARDOUS WASTE SHIPMENTS FROM THE AMES LABORATORY

PRELIMINARY

Date of Shipment	Waste Description[a] (EPA waste number reported)	Shipper or Broker	Disposal Site/Operator
February 1983	Approximately 700 pounds of laboratory chemicals, mercury sludges, cyanide waste, and PCB oil	Triangle Resource Industries	Pinewood, South Carolina Secured landfill/S.C.A. Services
March 1985	2000 pounds of flammable liquid, including nonspecific-source halogenated and nonhalogenated spent solvents (F001 and F003)	Waste Research and Reclamation; Tri State Motor Transit	Baton Rouge, Louisiana/Rollins Environmental Services
June 1987	Flammable solid NOS, 400 pounds Oxidizer NOS (D003), 25 pounds Liquid poison B NOS (D009), 200 pounds Solid poison B NOS (D003), 25 pounds Flammable liquid NOS (F005), 125 pounds Bromine (D002), 100 pounds Solid poison B NOS, 100 pounds Solid poison B NOS, (P098), 100 pounds Corrosive liquid NOS, (D002), 1650 pounds Liquid poison B NOS, 200 pounds Corrosive liquid NOS (D003), 200 pounds Oxidizer NOS (D001), 300 pounds Flammable solid NOS (D003), 175 pounds Corrosive solid NOS, 200 pounds Solid poison B NOS (D004), 400 pounds Flammable liquid (F001), 2000 pounds	GSX Services, Incorporated	1) Clarence, New York, incinerator and hydrolysis/Battery Disposal and Technology 2) Pinewood, South Carolina, secured landfill/GSX Services 3) Eldorado, Arkansas, incinerator/Ensco 4) Amelia, Louisiana, incinerator, reclamation/Marine Shale Processors 5) Detroit, Michigan, treatment/Cyanokem

Source: Ames Laboratory, 1988b

a Weights are approximate; the SH&PP staff reported that the weights of containers and packing materials have been included.

Two events in the months prior to the shipment reportedly resulted in a temporary large increase in the generation rate of waste chemicals. In December 1986, the SH&PP staff requested all research groups to inventory their chemicals and purge all unusable materials. One large research program was also terminated sometime during the first half of 1987. The month-by-month actual and average hazardous waste generation rates for the Ames Laboratory are not measured and are not known. Although the Survey observed the current hazardous waste generation rate to be below the 100 kg/month maximum limit, it is possible that this regulatory limit was exceeded between December 1986 and June 1987.

The Ames Laboratory reclaims or arranges reuse of metals and used and unused laboratory chemicals. These materials include both waste and nonwaste materials and both hazardous and nonhazardous materials. The reclamation is performed both on-site and off-site. The Survey identified the following three reclamation activities:

- on-site distillation of acid and organic solvents for on-site reuse;
- on-site extraction and purification of rare earths, rare-earth compounds, and other metals for on-site or off-site use; and
- accumulation of unused laboratory reagents for on-site and off-site use.

The Laboratory was not aware that some hazardous materials awaiting reclamation can indeed be recognized as hazardous waste by and can be subject to various RCRA regulations as specified in 40 CFR 261.2 and 261.3. As a conditionally exempt SQG of hazardous waste, the Ames Laboratory is permitted to treat (i.e., reclaim) its waste on-site, as specified in 40 CFR 261.5(g)(3)(v), without a RCRA TSD facility permit.

Table 4-3 summarizes available records associated with the off-site shipments of materials for reclamation or reuse.

Wastes reclaimed on-site include elemental mercury, various rare earth metals, acids, and various solvents. Complete records associated with the reclamation of these materials are not maintained, so accurate information concerning the quantities, compositions, and hazardous characteristics of the materials to be

TABLE 4-3

SHIPMENTS OF HAZARDOUS AND NONHAZARDOUS MATERIALS FOR RECLAMATION OR REUSE FROM THE AMES LABORATORY

Date of Shipment	Waste Description	Recycler
January 8, 1985	Approximately 600 pounds of miscellaneous hazardous and nonhazardous laboratory chemicals	Lake Road Warehouse Company St. Joseph, Missouri (reuse)
October 28, 1986	Approximately 600 pounds of miscellaneous hazardous and nonhazardous laboratory chemicals	Lake Road Warehouse Company St. Joseph, Missouri (reuse)
March 3, 1988	684 pounds used mercury (hazardous)[a]	Belmont Metals, Incorporated Brooklyn, New York (reclamation)

Source: Ames Laboratory, 1988c

a Used mercury is regulated as a hazardous waste according to 40 CFR 261.1, 261.2, and 261.3.

PRELIMINARY

reclaimed is not available. While rare earth metals can be reclaimed by the Metals Purification and Fabrication Laboratories, other materials are reclaimed by the SH&PP staff and reused elsewhere at the Laboratory.

4.1.2 General Description of Pollution Sources and Controls - Mixed Waste

This section discusses the physical characteristics of mixed waste generated at the Ames Laboratory, the handling of the waste at the points where it is actually generated, the handling of the waste elsewhere at the Laboratory, and treatment and off-site disposal of the waste.

Only one research project at the Ames Laboratory currently is generating mixed waste. This project is located at the Alpha Glovebox Facility, located in the back (western) half of the Waste Disposal Building at the ASC. The project generates milliliter quantities of acid solutions containing trace concentrations of plutonium. The project generates only a few milliliters of this waste each day. The solution is accumulated in a beaker in a glovebox and is periodically turned over to the SH&PP staff. The SH&PP staff neutralizes the waste acids and accumulates the residue for solidification in cement in a drum in the Waste Disposal Building. The plutonium concentration in the solidified waste falls below the 100-nanocurie-per-gram (nCi/g) limit established for classification as transuranic (TRU) waste, so the solidified residual waste is disposed of as a low-level radioactive waste. The Ames Laboratory disposes of its radioactive waste at the Hanford commercial radioactive waste burial facility in Washington State.

A discontinued project, formerly located in the chemistry laboratories on the third floor of Wilhelm Hall, generated approximately 2 gallons of mixed waste consisting of thorium and depleted uranium in an acetonitrile solution. This solution is currently stored in two glass jugs in a hood in the Waste Disposal Building. The solution is periodically poured into the end of a television tube, which is being used as an evaporation pan. At the time of the Survey, at least one-and-one-half gallons of the solution remained in the jugs, and the tube contained only a dry residue. After all the solution has been evaporated, the tube is expected to be solidified in cement and disposed of as low-level radioactive waste (Ames Laboratory, 1987).

The SH&PP staff recognized that current DOE orders pertaining to mixed waste required that mixed waste be stored on-site indefinitely; however, the staff had decided to separate the hazardous and radioactive portions of the mixed waste since the nonhazardous radioactive residue can then be shipped to Hanford as a low-level radioactive waste. The rationale for this decision was based on the as-low-as-reasonably-achievable (ALARA) principle for human radioactive exposure, on economics, and on the relatively small quantity of waste involved.

In addition to the above-mentioned mixed wastes, the Ames Laboratory periodically generates milliliter-sized quantities of radioactive acids and solvents from the fabrication and etching of various radioactive isotopes, including uranium, depleted uranium, and thorium. However, none of these wastes were being generated or stored at the time of the Survey. Typically, these wastes are allowed to evaporate or are neutralized and then solidified and subsequently handled as low-level radioactive waste.

Radioactively contaminated waste lead also is periodically generated at the Ames Laboratory. The waste includes lead drain pipes and fixtures from laboratory drains that have been contaminated over time with uranium and thorium. The contaminated lead (less than one 55-gallon drum) is currently in indefinite storage at the Waste Disposal Building.

4.1.3 General Description of Pollution Sources and Controls - Radioactive Waste

This section discusses the physical characteristics of radioactive waste generated at the Ames Laboratory, the handling of the waste at the points where it is generated, the handling of the waste elsewhere at the Laboratory, and the decontamination or off-site disposal of the waste.

Nearly all radioactive waste currently generated at the Ames Laboratory consists of contaminated equipment, construction debris, and soil. It is produced sporadically as various projects are terminated and the contaminated materials are demolished or dismantled. At the time of the Survey, the Waste Disposal Building contained dozens of pieces of contaminated equipment, including ductwork, valves, piping, filters, hoods, reactor vessels, pieces of concrete, and other objects. These materials typically are contaminated with low levels of uranium and thorium, from either recently completed experiments or older experiments which date from the Manhattan Project or the late 1940s or 1950s. Radioactively contaminated equipment and debris have been removed from Wilhelm Hall, the Metals Development Building, and other buildings on the main campus, and radioactively contaminated soil, from unknown past activities, has been excavated from within the fenced area surrounding the Chemical Disposal Site at the ASC. A current inventory is not maintained for these wastes until they are packaged for off-site shipment. The Ames Laboratory follows a standard set of procedures when removing contaminated equipment from a building. These procedures address how the equipment is to be handled during removal and transport to the Waste Disposal Building. Contaminated equipment and contaminated disposable anticontamination clothing are compacted in a waste compactor in the Waste Disposal Building and are stored there pending off-site disposal.

Liquid radioactive waste is also periodically generated at the Ames Laboratory from the following three sources:

- potentially radioactive laundry solutions generated at the Waste Disposal Building;

- aqueous solutions containing radioactive particulates occasionally generated from machining radioactive metals at the Metals Development Building; and

- neutralized acid solutions containing dissolved radioactive compounds generated occasionally in various laboratories.

Potentially radioactive laundry solutions are generated in the Waste Disposal Building from washing anticontamination clothing. The clothing becomes potentially contaminated in the equipment removal projects discussed in the previous paragraph. A liquid radioactive treatment system is located in the Waste Disposal Building for storing and if necessary treating these wastes (Ames Laboratory, 1987). The system includes four 3,000-gallon holding tanks, a particulate filter, and an ion exchange column. In the past, radioactive filters and resins generated from the system also have been accumulated in the Waste Disposal

PRELIMINARY

Building for off-site shipment. However, for the last several years, the level of radioactivity in the laundry wastewater has been at or near background levels and has been discharged without treatment, so no radioactive filters or resins have been generated. The wastewater is accumulated in one of the 3,000-gallon storage tanks in the basement of the Waste Disposal Building. At unspecified intervals, the wastewater is analyzed for radioactivity and, if activity levels are below DOE DCGs, is discharged to the City of Ames sanitary sewer system. A further discussion of these releases is provided in Section 3.3.2.1.

Occasionally, other liquid radioactive wastes are generated in the form of aqueous solutions containing particulates of radioactive isotopes, including uranium, depleted uranium, and thorium. In the past, these wastes were generated in the metal fabrication laboratories from a small grinding wheel, lathe, and drill press used to machine these metals. The machining was done infrequently and has not been done in several months. These wastes are turned over to the SH&PP staff which may or may not evaporate or filter them and then solidify either the residue or the solution in cement. Sometimes the residue is reclaimed and reused on-site rather than solidified. The solidified waste is accumulated in the Waste Disposal Building for off-site shipment.

The liquid mixed acidic wastes described in the previous section also become radioactive wastes once the hazardous component of the wastes is neutralized. These radioactive wastes are evaporated and then either solidified in cement or are reclaimed for reuse on-site.

All radioactive waste cement solidification is performed in the Waste Disposal Building where drums and cement-mixing equipment are stored.

All radioactive waste generated on-site is eventually either decontaminated or shipped off-site to the Westinghouse-Hanford Operations Site in Washington State. The last such shipments consisted of 66,940 pounds of waste and occurred in October, November, and December of 1987. Each shipment was accompanied by a radioactive waste disposal manifest and transported to the disposal site by Specialized Trucking, a licensed transporter of radioactive waste. Table 4-4 presents the material and radioactive content of these shipments. The SH&PP staff performs

TABLE 4-4

LOW-LEVEL RADIOACTIVE WASTE SHIPMENTS FROM THE AMES LABORATORY TO HANFORD

Date of Shipment	Waste Description	Radioactive Component of Waste
October 26, 1987	600 cubic feet (44,200 pounds) of bulk contaminated soil and building rubble	Natural uranium and thorium
November 24, 1987	250 cubic feet (19,590 pounds) of bulk contaminated soil Two 55-gallon drums containing 90 pounds of contaminated lead and other materials (paper, plastic, steel, etc.) Two 129-cubic-foot boxes containing contaminated equipment	Natural uranium and thorium, cobalt-60, cesium-137
December 14, 1987	Five 55-gallon drums and nine 129-cubic-foot boxes containing contaminated paper, plastic, and metal	Natural uranium and thorium, depleted uranium, cobalt-60, cesium-137

Source: Ames Laboratory, 1988d

PRELIMINARY

the inventory, compacting, and packaging for these shipments in the Waste Disposal Building.

4.1.4 General Description of Pollution Sources and Controls - Nonhazardous Waste

This section discusses the generation, composition, handling, and disposal of nonhazardous waste at the Ames Laboratory. Nonhazardous waste at the Ames Laboratory includes nonhazardous waste oil and nonhazardous solid waste. These wastes are generated throughout the facility in the shops and laboratories both at the ISU main campus and the ASC.

4.1.4.1 <u>Nonhazardous Waste Oil</u>

Nonhazardous waste oil is generated in the laboratories primarily from vacuum pumps which are used with lasers, vacuum chambers, and gloveboxes. The oil reservoirs in the pumps are periodically changed out and the old oil is disposed of. Laboratory personnel typically store the old oil in polyethylene product oil bottles (approximately 1 to 4 liters) until they are full and then hand-carry the bottles to one of three outdoor satellite collection points where they pour the oil into drums. These collection points each have two 55-gallon drums and are dedicated exclusively to nonhazardous waste oil. The collection points are located on the covered west loading dock of Spedding Hall, the northern side of the Physics Addition, and the covered north dock of the Metals Development Building.

Waste oil generated from a vacuum pump at the Alpha Glovebox Facility at the ASC is driven to the main campus and transferred to drums at one of the three satellite collection points.

A secondary generation source of nonhazardous waste oil is the Maintenance Garage where vehicles belonging to the Laboratory receive their oil changes. These vehicles include automobiles, trucks, tractors, and other vehicles. The waste oil is poured into and stored in two drums in the garage that have been identified by the SH&PP staff as a fourth satellite collection point.

PRELIMINARY

Replacement of all hydraulic fluids for tractors, forklifts, and other vehicles is performed by contracted off-site garages. These hydraulic fluids do not contribute to the Ames Laboratory waste stream.

The waste oil is picked up by an off-site oil recycling contractor approximately twice each year. The contractor, Willet Oil Company of Des Moines, cleans the oil and uses it to heat asphalt.

Willet Oil Company picks up approximately six to eight 55-gallon drums of waste oil on each visit. The oil is pumped from the drums into a tanker truck so that the drums can be reused on-site; however, the SH&PP staff provides new drums once every 1 or 2 years to help prevent leaks due to drum deterioration. The Willet driver tests each drum with a halogen detection device, which indicates when a halogen level is in excess of 1,000 parts per million (ppm). In February 1988, one drum gave a reading in excess of 1,000 ppm and the drum was not picked up. No information was available regarding whether the disposal of hazardous halogenated solvents contributed to the high halogen level in the oil. The drum was transferred to the hazardous waste accumulation area at the Waste Disposal Building at the ASC where it is awaiting further action. The SH&PP staff intends to bubble air through the oil in order to reduce the chloride content below 1,000 ppm.

4.1.4.2 Nonhazardous Solid Waste

Nonhazardous solid waste is generated throughout the Ames Laboratory. Little information was available to the Survey team concerning the composition or generation rate of nonhazardous solid waste at the Laboratory. However, the waste was observed by the Survey team to include wood and cardboard packing materials, glass chemical bottles, and excess equipment. Occasionally construction debris contributes to the waste stream.

Solid waste is accumulated in receptacles in the offices and laboratories and is picked up periodically by the Ames Laboratory janitorial staff. The waste is hauled to dumpsters outside the buildings. The Ames Laboratory contracts with ISU to empty the dumpsters approximately every day. The waste is disposed of off-site at the City of Ames Resource Recovery Plant.

At irregular intervals, on average once or twice each year, the Laboratory will generate varying quantities of construction/demolition waste from remodeling and building projects. The Laboratory arranges disposal of this waste directly with the Ames Municipal Landfill since the landfill requires that construction debris disposal be scheduled and charges a special tipping fee.

A pile of green-tinted scrap wood remaining from the 1981 demolition of the ALRR cooling towers was being stored in the fenced-in area around the Blockhouse at the ASC at the time of the Survey. The wood has been stored in this location for an indefinite period. The SH&PP staff reported that the wood had passed an Extraction Procedure Toxicity test for chromium; however, chromium reportedly was never used in the operation of those cooling towers.

4.1.5 Findings and Observations

4.1.5.1 Category I

None

4.1.5.2 Category II

None

4.1.5.3 Category III

None

4.1.5.4 Category IV

1. Improper waste oil storage. Improper storage of waste oil could result in a release to the surface water.

   Two drums of waste oil are being stored outside on a concrete sidewalk on the northern side of the Physics Addition. The area where the drums are stored is exposed to the elements, lacks secondary containment, and is 6 feet from a storm drain leading to College Creek, which flows to Squaw Creek. If a release

PRELIMINARY

were to occur, the oil could flow into the drain and contaminate both College Creek and Squaw Creek.

2. Unauthorized treatment of mixed waste. The Ames Laboratory treats small quantities of mixed wastes under conditions not in accordance with RCRA regulations.

The Ames Laboratory treats small quantities of mixed waste in the ASC Waste Disposal Building. Approximately two gallons of a waste acetonitrile-thorium solution is being treated by evaporation to remove the hazardous component of the waste. In addition, less than one liter of an acidic plutonium solution is being treated by neutralization in the Waste Disposal Building. These wastes are hazardous by virtue of their ignitable and corrosive characteristics, respectively. These activities are not being performed in accordance with the five technical and administrative requirements listed under RCRA regulation 40 CFR 261.5(g)(3), which describes the conditions under which conditionally exempt small quantity generators may treat or dispose of RCRA hazardous waste, including mixed waste.

PRELIMINARY

4.2 Toxic and Chemical Substances

This section discusses the usage, storage, disposal, and management of polychlorinated biphenyls (PCBs), asbestos, herbicides and pesticides, and other toxic chemicals, and possible environmental contamination resulting from release of these substances to the environment.

4.2.1 General Description of Pollution Sources and Controls

4.2.1.1 Polychlorinated Biphenyls

At the time of the Survey, the Ames Laboratory had 56 pieces of equipment that contained PCBs, which are regulated by the Toxic Substances Control Act (TSCA). The equipment consists of 8 transformers and 48 capacitors. Fifty-five of the units were identified by the Ames Laboratory as containing 100 percent PCB oil, and one transformer contained 384 ppm PCB oil. Descriptions, sizes, and locations of the equipment are presented in Table 4-5.

The Ames Laboratory maintains specific protocols concerning the handling, storage, and disposal of PCB and PCB-contaminated transformers and capacitors (Staggs, 1980). All items are inventoried and inspected quarterly. The last quarterly inspection before the Survey occurred in April 1988.

The Safety, Health, and Plant Protection (SH&PP) group arranges the off-site disposal of all PCB and PCB-contaminated equipment. The SH&PP group arranges sampling and analysis of the oil in the equipment suspected of containing PCBs, and transports the equipment to the Waste Disposal Building at the ASC for temporary storage. The building is locked and the PCB-containing equipment is stored in a placarded cabinet having secondary containment. Records on all PCB and PCB-contaminated equipment, both active and decommissioned, are maintained by the SH&PP group. The records indicate that 16 capacitors and 1 generator were disposed of off-site during 1987 (Staggs, 1987). Outside contractors, including National Electric, Incorporated, of Lakeville, Minnesota, perform the off-site disposal of all equipment containing PCBs for the Ames Laboratory.

PRELIMINARY

TABLE 4-5

INVENTORY OF EQUIPMENT CONTAINING PCB OIL (GREATER THAN 50 PPM) AT THE AMES LABORATORY, 1987

PRELIMINARY

Number of Units	Location	Unit Description	PCB Concentration	Total Volume PCB (gallons)
10	Office & Laboratory Building, Room 15	Capacitors	100%	2
5	Physics Addition, Rooms A112 & A116; Metals Development Building, Room 258	Capacitors	100%	5
4	Waste Disposal Building	Capacitors	100%	4
5	Spedding Hall, Rooms 236 & 248; Waste Disposal Building	Capacitors	100%	10
1	Spedding Hall, Room B-47	Capacitor	100%	0.1
12	Metals Development Building, Room 131	Capacitors	100%	24
1	Metals Development Building, Room 144	Capacitor	100%	1
10	Metals Development Building, Rooms 105, 130, & 199; Waste Disposal Building; Campus Warehouse	Capacitors	100%	20
5	Metals Development Building, Rooms 105, 130, & 199; Waste Disposal Building; Campus Warehouse	Transformers	100%	105
1	Metals Development Building, Room 145	Transformer	100%	10
1	Metals Development Building, Room 144	Transformer	100%	160
1	Campus Warehouse (outdoors)[a]	Transformer	384 ppm	unknown

Source: Staggs, 1987

a This transformer was not equipped with secondary containment.

With the exception of one PCB-contaminated (384 ppm) transformer near the campus warehouse, the Survey found all the PCB units listed in Table 4-5 to be labeled, stored, and contained in accordance with TSCA requirements. The PCB-contaminated transformer near the campus warehouse was not equipped with any secondary containment at the time of the Survey.

4.2.1.2 Asbestos

Asbestos at the Ames Laboratory is managed by the SH&PP group. The SH&PP group has removed and arranged for off-site disposal of approximately 1,700 cubic feet of asbestos between August 1982 and February 1988. The SH&PP group typically removes and transports the asbestos to the disposal site; outside contractors are not used. SH&PP records indicate that at least seven asbestos removal and disposal projects occurred during this period. Records for two of the removal/disposal projects identified Spedding Hall, Wilhelm Hall, the Metals Development Building, the Campus Warehouse, and the ASC Blockhouse as sources of asbestos. The asbestos was disposed of off-site at the City of Ames Sanitary Landfill. On each occasion, a Special Asbestos Waste Authorization certificate was issued to the Ames Laboratory by the landfill prior to disposal (Ames Laboratory, 1988e).

At the time of the Survey, no friable asbestos was known to be on-site; however, an unknown quantity of non-friable asbestos still remains in Ames Laboratory buildings.

The Ames Laboratory maintains a formal policy and compliance program for the handling and disposal of asbestos. The policy addresses worker safety and health and procedures for asbestos removal and disposal (Ames Laboratory, ND).

4.2.1.3 Herbicides/Pesticides

Most of the herbicides and pesticides used at the Ames Laboratory are handled by outside contractors. The contractors provide their own chemicals, which are prepared and mixed off-site.

PRELIMINARY

Only a few pesticides and herbicides are stored and used by on-site personnel. Storage occurs in an unknown number of locations throughout the laboratory. The Survey identified four such locations.

Room B-3 in the basement of the Metals Development Building is an office and lunchroom for the janitorial staff; it is also used to store and dispense pesticides. A 55-gallon drum of Diazinon-based pesticide and a 17-gallon drum of liquid Pestox pesticide were stored in the room. The drums were stored on their sides in a metal rack with a drip pan under the bung taps. The drums themselves had no secondary containment, and an open floor drain leading to the sanitary sewer was located in the same room. Material Safety Data Sheets (MSDSs) for these and several other pesticides were filed in the room.

Three other locations storing small quantities of retail pesticides and herbicides are a closet in the Maintenance Shop, a closet in the Maintenance Garage, and some open shelves in the Maintenance Garage. The Maintenance Shop closet stored one 15-ounce can of Ortho Wasp and Hornet spray. The Maintenance Garage closet stored one 14-ounce can of Airwick Insecticide and 4-pounds of Craig Weed Killer. The open shelves in the Maintenance Garage stored 4.5 pounds of solid sodium 2,4-dichlorophenoxyethyl sulfate, 2 pounds of solid S-ethyl dipropylthiocarbamate, and 1 liter of EPTAM Liquid. The pesticides stored in the Maintenance Garage had not been used for several years prior to the Survey, and no future use is planned for them.

4.2.1.4 Toxic and Process Chemicals

The Ames Laboratory uses numerous varieties of toxic chemicals in small quantities, primarily in wet chemistry research and development activities. Much of the activity centers on the development of procedures for refining, analyzing, and metallurgical handling of exotic metals and rare earth elements. As a research facility, the laboratory typically does not use or store large quantities of bulk chemicals for process applications. Most of the chemical inventory is typical of what would be used at any large university engaged in experimental chemistry. However, many of the materials studied at the Ames Laboratory have unique storage and handling requirements such as ultra-pure metals and reactive substances that may not be allowed to contact air or moisture.

Procurement and Inventory Control

Nearly all chemicals at the Ames Laboratory are procured by the Procurement and Property Office (PPO) in Spedding Hall. This office makes regular purchases and stores a supply of many of the common reagents used by researchers at the Ames Laboratory. When researchers need chemicals, they prepare a requisition that is approved by the laboratory supervisor and delivered to the PPO. If the PPO has the chemical in stock, it will fill the requisition. If the PPO does not have the chemical in stock, the order will be sent to the SH&PP office for review and approval. These orders are typically for chemicals that are not commonly used at the Ames Laboratory. The SH&PP group checks the order to determine the hazards associated with the chemical. The SH&PP group also checks whether or not an MSDS is on file for the chemical and, if necessary, ensures that an MSDS is requested from the vendor. Only after the SH&PP group returns the approved order form does the PPO actually place the order.

Researchers with split appointments, that is, those who receive funding from both the Ames Laboratory and ISU, also have the option of purchasing chemicals directly through the ISU Chemistry Supply Stores. When these purchases are made, the computerized accounting system of ISU notes automatically that the purchaser is an employee of the Ames Laboratory. In order to track these purchases, ISU and the SH&PP group have a voluntary agreement whereby ISU reports to the SH&PP group any purchases by the Ames Laboratory staff.

All chemicals purchased by the PPO are received at the Campus Warehouse. When a chemical is received, it is logged into a computerized inventory which checks if an MSDS is on file. If an MSDS is on file or was provided with the shipment, the chemical is released to the researcher and a copy of the MSDS is forwarded to the SH&PP group. The computerized inventory contains the Chemical Abstract Service (CAS) number, the purchaser's account number (from which the purchaser's identity can be derived), the order date, the quantity purchased, a hazard flag, and a grave flag. The hazard flag may be used to denote the hazard, if any, associated with the chemical, but this data field typically is not filled out. The grave flag may be used to denote when the chemical will exceed shelf life, but it also is not used.

The SH&PP group maintains a computer database of MSDSs for all substances known to be used at the laboratory. In addition, an MSDS typically is filed at each laboratory where a given chemical is used. However, the Survey found some laboratories using laser dyes for which no MSDSs were available.

In December 1986, the SH&PP group undertook the task of purging old, unused, or out-of-date chemicals from the laboratory. The group sent out a memorandum to all laboratory supervisors requesting a written inventory of chemicals currently used and stored in each laboratory. Laboratory supervisors had the option of turning in unused chemicals to the SH&PP group rather than listing them in their inventory. In this fashion, the SH&PP group removed virtually hundreds of such chemicals from the laboratories. The chemicals were sorted by the SH&PP group and a majority were either disposed of as hazardous waste or sold to recyclers. The remainder were restocked in Room B55 of Spedding Hall, a hazardous waste storage area, for use by other researchers at Ames Laboratory and recorded in a computerized database, separate from the database discussed above.

At the time of the Survey, some laboratories were still performing their inventories. However, the Survey noted that many of the laboratories contained several shelves of unused compounds, including hundreds of reagents and solvents, some of which are listed as hazardous wastes in RCRA regulations (40 CFR 261, Appendix VIII). These substances typically included heavy metal and cyanide compounds and chlorinated solvents. In many cases, the laboratory supervisors knew the compounds had been stored in the laboratories for several years but were not aware of any past or future need or use for the compounds. In some instances, the researchers reported that, should a need arise for one of these substances, the existing container would not be used and a fresh one would be purchased.

Receiving, Distribution, and Storage

Outside purchases for supplies, including chemicals, are received at the Campus Warehouse. From this location, chemicals are distributed to the PPO and laboratories.

One corner of the Campus Warehouse is dedicated to storage of various bottled chemicals. These chemicals are stored in the original shipping crates on wooden pallets on the concrete warehouse floor, which has no floor drains or spill containment curbing. Incompatible acids and bases are stored on adjacent pallets. A supply of spill absorbent material is stored in the building, and the building is equipped with numerous dry powder and carbon dioxide fire extinguishers and a sprinkler system.

Once chemicals are distributed to the laboratories where they are used, their storage and handling are controlled by the laboratory supervisors. Small quantities (typically more than a dozen containers no larger than 4 liters each) are typically stored in wooden cabinets, in metal cabinets under hoods, on open shelves, in metal flammable materials cabinets, and in gloveboxes, as warranted by the nature and use of the chemical. Several laboratories are storing incompatible chemicals together in cabinets (Table 4-6).

The Ames Laboratory has a safety policy requiring incompatible chemicals to be segregated and storage cabinets to be properly marked in accordance with regulatory requirements. Although storage cabinets containing chemicals are not always identified as to their contents, the quantities of chemicals in all unmarked cabinets are below the minimum regulatory limit above which markings are required.

Some laboratories regularly use small quantities of 1,4-dioxane, anhydrous ether, and tetrahydrofuran. These substances can react with oxygen over time to form unstable, shock-sensitive, organic peroxides. For this reason, these substances have a limited useful life and must be used or disposed of within a given time frame. At the Ames Laboratory, most of these substances are used up quickly; however, some open bottles were discovered by the Survey without expiration or "chemical control" dates that would be used to determine the age of the substance, as shown in Table 4-6.

TABLE 4-6

CHEMICAL STORAGE CONCERNS AT THE AMES LABORATORY

Location	Incompatible Chemical Storage	No Chemical Control Dates on Peroxide-Forming Reactives
Wilhelm Hall, Room 129	reactives and pyrophorics	
Wilhelm Hall, Room 204	acids, solvents, and pyrophorics	
Wilhelm Hall, Room 210		X
Wilhelm Hall, Room 213		X
Wilhelm Hall, Room 216		X
Wilhelm Hall, Room 217	acids and solvents	
Spedding Hall, Room B24		X
Spedding Hall, Room B54		X
Spedding Hall, Room B51		X
Spedding Hall, Room 225	acids and solvents	
Spedding Hall, Room 346	pyrophorics	
Gilman Hall, Room G18	acids, caustics, and solvents	
Gilman Hall, Room G57	acids and solvents	
Gilman Hall, Room A209	acids, caustics, solvents, and reactives	
Office and Laboratory Building, Room 114	acids and caustics	
Metals Development Building, Room 209	acids, caustics, and solvents	
Metals Development Building, Room 281	acids, caustics, and solvents	

4.2.1.5 Aboveground and Underground Storage Tanks

Aboveground Storage Tanks

The Ames Laboratory has four aboveground tanks. They are all 3,000-gallon steel tanks and are part of a radioactive liquid waste treatment system in the basement of the Waste Disposal Building at the ASC. The tanks are used for the accumulation of potentially radioactive wastewater generated from laundry operations at the Waste Disposal Building. Releases from these tanks are routed to the City of Ames sanitary sewer system, and are discussed in Section 3.3.2.1. The tanks were observed by the Survey team to be in good condition.

Underground Storage Tanks

The Ames Laboratory has two underground storage tanks (USTs) currently used to store number 2 fuel oil for emergency generators. A 2,000-gallon, asphalt-coated steel UST is located at the Metals Development Building, and a 3,000-gallon UST of similar construction is located at Wilhelm Hall. The UST at the Metals Development Building was installed in October 1965, and the Wilhelm Hall UST was installed in May 1970. Neither UST has been leak tested nor does it have monitoring wells, secondary containment, liners, or cathodic protection. Both USTs are registered with the State of Iowa Department of Water, Air, and Waste Management (Voss, 1986b). The Ames Laboratory stated that it is planning to install soil gas monitoring wells for the two USTs before May 1, 1988, in accordance with Chapter 135 of the State of Iowa UST Rules.

A third 500-gallon UST on the east side of Spedding Hall was being removed at the time of the Survey. This UST was installed in June 1970 and was used for sulfuric acid storage until June 1982. The tank reportedly passed a leak test on an unknown date (Core, 1984). The Ames Laboratory tested the soil pH adjacent to the UST when it was removed and found no evidence of an acid release.

Seven other USTs, now owned by ISU and located at the ASC, were controlled and used by the Ames Laboratory until 1987, when the ASC was turned over by the Ames Laboratory to ISU. The Ames Laboratory notified both ISU and the State of Iowa of these tanks when the facility was turned over to ISU in accordance with State of

PRELIMINARY

Iowa UST Rules (Mathison, 1987b,c). Two of these tanks are exempt from regulation because they contain heating oil to be used on-site, and three other tanks reportedly passed leak tests on unknown dates (Core, 1984). The remaining two tanks have not been leak tested. There are no monitoring wells, secondary containment, or cathodic protection devices associated with any of these USTs.

4.2.2 Findings and Observations

4.2.2.1 Category I

None

4.2.2.2 Category II

None

4.2.2.3 Category III

None

4.2.2.4 Category IV

1. Incomplete tracking of chemicals subject to peroxide formation. Shelf lives of some dioxane and tetrahydrofuran containers are not being monitored to ensure safe storage and use.

   Dioxane and tetrahydrofuran can form explosive peroxides if stored for extended periods after contact with oxygen. Although the Ames Laboratory Safety Rules Manual specifies container dating requirements designed to reduce this hazard, the Survey noted several instances where dioxane and tetrahydrofuran containers had no chemical control dates or grave flags, which are used to denote when chemicals will exceed shelf life, and were not being tracked. Laboratories where such chemicals were identified include Wilhelm Hall Rooms 210, 213, and 216 and Spedding Hall Rooms B24, B54, and G51.

PRELIMINARY

2. <u>Improper storage of chemicals</u>. Incompatible chemicals are being stored together in some laboratories, contrary to the Ames Laboratory Safety Rules, and may result in an explosion or generation of toxic gases in the event of a fire or other accident.

Some examples of laboratories where incompatible chemicals are stored together and, in the event of a fire or other accident, may result in an explosion or generation of toxic gases are as follows.

In Wilhelm Hall, Room 204, four 4-liter bottles of miscellaneous acids were stored in an underhood cabinet with three 4-liter bottles of various organic solvents.

In Wilhelm Hall, Room 129, one bottle of picric acid and one bottle containing 0.25 pound of perchloric acid in 70 percent ethanol is stored in the same cabinet with cupric sulfate, potassium ferricyanite, glycerin, zinc chloride, silver nitrate, and sulfamic acid.

In Spedding Hall, Room 225, one 4-liter bottle each of methanol and hydrochloric acid are stored together on the floor.

In Gilman Hall, Room G18, several containers of hydrochloric acid, sodium hydroxide, chloroform, acetone, and miscellaneous reagents are stored together in a wooden cabinet under a hood.

In the Metals Development Building, Room 281, pyridine, toluene, and benzene are stored with sulfuric acid, ammonium hydroxide, hydrochloric acid, and nitric acid.

Additional areas of concern with regard to incompatible chemical storage as identified by the Survey are Wilhelm Hall, Room 217 (acids and solvents); Spedding Hall, Room 346 (pyrophorics); Gilman Hall, Rooms G57 (acids and solvents) and A209 (acids, caustics, solvents, and reactives); Office and Laboratory Building, Room 114 (acids and caustics), and Metals Development Building, Room 209 (acids, caustics, and solvents).

3. Inadequate management of a PCB-contaminated transformer. A PCB-contaminated transformer at the Ames Laboratory Campus Warehouse lacks secondary containment.

   A 150-kVA (kilovolt-ampere) transformer containing 384 ppm PCB is installed outside on a concrete pad adjacent to the building. Although the transformer appeared to be in good condition and there was no evidence of oil leaks, the concrete pad is surrounded by gravel and is less than 50 feet from a surface-water drainage swale. If a PCB release did occur, it could cause contamination of a nearby drainageway. This transformer is scheduled for removal during the summer of 1988.

4. Unknown integrity of underground storage tanks. The integrity of two active Ames Laboratory USTs containing fuel oil is unknown, and the USTs may be contaminating the soil and groundwater through undetected leaks.

   Two USTs located by the Metals Development Building and Wilhelm Hall are currently used to store fuel oil. The Metals Development Building UST was installed in 1965 and the Wilhelm Hall UST was installed in 1970. The USTs are not equipped with secondary containment or cathodic protection. The Ames Laboratory does not currently have a leak detection program for USTs. If the USTs are leaking, the leaks would not be detected, and the leaking fuel oil could potentially contaminate the soil and groundwater.

   The Ames Laboratory is planning to install soil gas monitoring wells at the USTs by May 1, 1988, in accordance with Iowa State regulations.

5. Inadequate storage procedures for bulk chemicals. Incompatible bulk chemicals, including acids, caustics, and solvents, are being stored together in shipping containers in the Ames Laboratory Campus Warehouse and, additionally, the warehouse has no secondary containment.

   In the Campus Warehouse, bulk shipments of various acids, solvents, and caustics are stacked together on wooden pallets on the concrete floor. The chemicals are not segregated and the area has no secondary containment. In the event of a spill, fire, or other accident, these chemicals could mix to form toxic or explosive gases. Without secondary containment, bulk toxic chemical releases could potentially escape the building and contaminate the soil and surface water.

PRELIMINARY

4.3 Radiation

This section discusses the actual or potential radiological impacts to the environment from the Ames Laboratory's past and present operations that are multi-media in nature (i.e., air, soils, surface water, and hydrogeology). Radionuclides can be transported via any or all of the primary media and result in contamination of ambient air, soils, drinking water, groundwater, vegetation, and food (Figure 4-1).

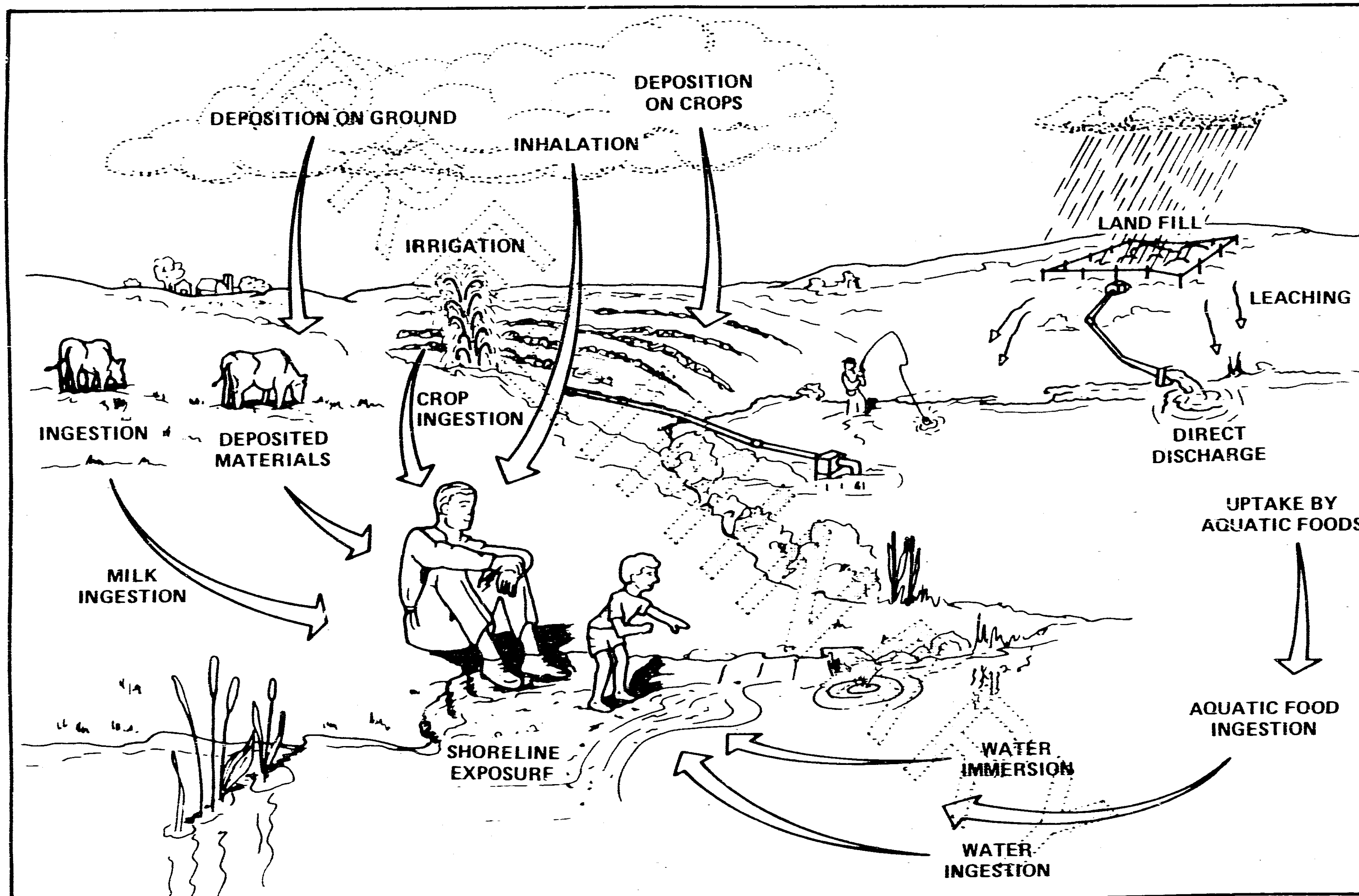
4.3.1 Background Environmental Information

Background radiation in the vicinity of the Ames Laboratory is a consequence of both natural and man-made sources. These sources include natural cosmic radiation; natural radioactive materials in soils and building materials; fallout from past global atmospheric weapons detonations; and releases of radioactive materials from nuclear power plants and other facilities handling radioactive materials worldwide. Human exposure is through the intake of natural and man-made radioactive materials in air, drinking water, and food. The most significant exposure is that to the lungs from background levels of radon. The annual average effective dose equivalent (EDE) from natural background radiation in the United States is approximately 189 millirem per year (mrem/yr) (Table 4-7). About one-half of the EDE is attributable to the inhalation of naturally occurring radon-222 and its decay products.

The data in Table 4-7 were derived in accordance with the approach recommended by the International Commission on Radiological Protection (ICRP) in ICRP Reports 26 and 30 (ICRP, 1977, 1978). This approach allows direct comparison of the effective dose for different organs by reflecting the distribution of and organ sensitivity to various radionuclides. This is accomplished by applying "weighting factors" to the effective doses received by individual organs. The weighting factors are expressed as the fraction of the total risk for the entire body attributable to the organ (e.g., the EDE).

The EPA reports on a quarterly basis ambient gamma exposure rates, including those from natural cosmic radiation, for selected locations throughout the continental United States. These ambient gamma exposure rates do not measure

PRELIMINARY



Source: MEPAS, 1987

TRANSPORT/EXPOSURE SCENARIOS

FIGURE 4-1

TABLE 4-7

AVERAGE ANNUAL EFFECTIVE DOSE EQUIVALENT TO HUMANS FROM NATURAL BACKGROUND RADIATION

Organ	Annual Effective Dose Equivalent (mrem)
Gonads	24
Breast	14
Lung (Total)	100
Red Bone Marrow	13
Bone Surfaces	6
Thyroid	3
Other	29
Total	189

Source: Adapted from EPA, 1986b

PRELIMINARY

the contribution attributable to the inhalation of naturally occurring radon-222 and its decay products. The latest available data are for the 12-month period from April 1986 to March 1987. For this period, the EPA reported a range of ambient gamma exposure rates equivalent to annual doses between 136 ± 58 mrem dose equivalent (DE) in Denver, Colorado, and 58 ± 72 mrem DE in Berkeley, California. The annual dose for the same period was 81 ± 31 mrem DE in Chicago, Illinois. This is the EPA monitoring location closest to the Ames Laboratory. The average measured ambient gamma exposure rate equivalent to an annual dose at the 22 locations monitored throughout the continental United States was 89 ± 49 mrem DE (EPA, 1986c, 1987a, b, c).

DOE establishes radiation protection guidelines for its facilities. Radiation standards for the protection of the public in the vicinity of the Ames Laboratory are given in DOE Order 5480.1A, Chapter XI, as amended on August 5, 1985 (Vaughan, 1985). These standards are based on the recommendations of the ICRP and the National Council on Radiation Protection and Measurements (NCRP). The amended order also included the EPA limits for the atmospheric pathway radiation dose received from DOE facilities as contained in 40 CFR 61, Subpart H. The DOE dose limit is 100 mrem/yr EDE, excluding natural background and medical exposures, for all pathways to any member of the general public for a prolonged exposure from normal DOE operations. The previously recommended limit of 500 mrem/yr EDE is retained for non-continuous exposures. In addition, as stated in EPA regulations (40 CFR 61, Subpart H), any member of the general public shall not receive a radiation dose from the air pathway of greater than 25 mrem/yr DE to the whole body or 75 mrem/yr DE to any organ from normal DOE operations.

DOE Order 5484.1 requires its facilities to make an annual assessment of releases and potential dose to the public. The results are to be reported in an annual environmental summary or annual environmental monitoring report.

4.3.2 General Description of Pollution Sources and Controls

Direct penetrating radiation sources and controls are discussed in this section. Radionuclide contamination in environmental media and the associated controls are discussed in Sections 3.2.2, 3.3.2, and 4.5.1.

The major possible sources of direct penetrating radiation at the Ames Laboratory and associated with past Ames Laboratory operations can be divided into three categories. These categories, discussed below, are soil radiation sources, calibration sources, and building radiation sources.

4.3.2.1 Soil Radiation Sources

There is only one site associated with the Ames Laboratory that has residual radioactive contamination in the soil and currently is also a known source of direct penetrating radiation. This site is at the City of Ames WPCP, which was radioactively contaminated by thorium releases from past Ames Laboratory operations, as discussed in Sections 4.5.1.2. Levels of direct penetrating radiation at the WPCP resulting from residual thorium contamination are discussed in Section 4.3.3.1. The WPCP is fenced although access is not controlled at the entrance gate. No individuals reside at or in immediate proximity to the WPCP.

4.3.2.2 Calibration Sources

There are several calibration sources in use at the Ames Laboratory. These sources are used to calibrate radiation detection equipment. A 20-curie cesium-137 source is the largest, with the remainder having activities in the microcurie to millicurie range. The sources are located in shielded, limited-access areas and are leak-tested or monitored every 6 months. Distance from the site boundary and shielding prevent off-site direct penetrating radiation resulting from the use of these calibration sources.

4.3.2.3 Building Radiation Sources

Past production of pure materials has left residual radioactive contamination in Gilman and Wilhelm Halls at the ISU campus portion of the Ames Laboratory. Additionally, former Ames Laboratory operations at the Ames Laboratory Research Reactor (ALRR) Building and the Blockhouse, both at the ASC, have resulted in residual radioactive contamination. A more detailed discussion of these four buildings is provided in Section 4.5.1.2. Control of direct penetrating radiation at these buildings results from a radiation monitoring program, removal of contaminated material, and posting, as described below.

The SH&PP Division of the Ames Laboratory has in place a comprehensive monitoring program for buildings that contain or may contain residual radioactive contamination, which may be a source of direct penetrating radiation. The monitoring program includes periodic radiation screenings of the buildings. Additionally, if renovations are to be performed in any parts or rooms of a building, a member of the SH&PP staff is present to ensure that any radioactive contamination is identified and removed if possible. If fixed (i.e., nonremovable) contamination is identified, the area is posted. Logbooks and survey records are kept of the screening activities. Users of the areas that contain radioactive contamination and emit radiation are informed of the contamination and any required training is provided. Interviews with site personnel and a review of logbooks and survey records by the Survey team indicated that the areas of contamination identified by SH&PP personnel, including the four buildings discussed above, are below the DOE action guideline of 25 mrem/yr and do not present a health risk to the general public or employees of DOE or ISU.

4.3.3 Environmental Monitoring Program

This section discusses the Ames Laboratory's direct penetrating radiation monitoring and the reporting of the environmental impacts to DOE from facility operations. Environmental monitoring for radionuclide contamination in individual media is discussed in sections for Air (Section 3.1.3), Soil (Section 3.2.3), and Surface Water (Section 3.3.3). The Ames Laboratory has written protocols for the direct penetrating radiation monitoring it performs and operation/quality control protocols for the equipment used for the radiological analyses.

4.3.3.1 Direct Penetrating Radiation

The Ames Laboratory does not have a routine direct penetrating radiation monitoring program. However, in May 1976, at the direction of the DOE Chicago Operations Office, a radiological screening program was performed by the Ames Laboratory to identify sites possibly contaminated with radioactivity as a result of past activities at the Ames Laboratory. Additionally, an aerial radiological survey of the Ames Laboratory area was conducted by EG&G in May 1977 (EG&G, 1979). This aerial radiological survey showed slightly elevated, above background levels of direct penetrating radiation at the City of Ames Airport and the WPCP. However, the 1976 radiological screening program provides more specific data and will be the only study discussed further.

The radiological screening program included direct penetrating radiation measurements and soil sampling at the sites associated with the former Annex I and Annex II, Gilman Hall, and the sewer release incident. The sewer release incident sites included the WPCP, City of Ames Airport, Municipal Cemetery, and Grand Avenue underpass. Section 4.5.1.2 provides the locations and a more detailed history of these sites.

Direct penetrating radiation screenings were made at all sites using beta-gamma gas proportional and Geiger-Mueller survey meters. At the WPCP, the screening was supplemented using thermoluminescent dosimeters (TLDs). Sets of 3 lithium fluoride (LiF) TLD chips were exposed for periods of 30 to 90 days at a height 3 feet above ground level. Two control sites were also monitored with TLD sets to obtain a background level. The TLD chips were processed in an Eberline Model TLR-5 dosimeter reader. Core samples were also taken of the soil and examined for gamma-emitting isotopes using a gamma spectrometer. The soil core samples' gamma spectrometry results are discussed in Section 3.2.3.

A direct penetrating radiation survey was conducted on May 12, 1976, at the City of Ames Airport, Municipal Cemetery, Grand Avenue underpass, and Annex I on the campus of the ISU using a Victoreen Model Thyac III Geiger-Mueller radiation survey meter. Readings were recorded with the detector probe held 3 feet from ground level. Background readings were also taken in this manner at the ISU Golf Course.

Later in 1976, a screening was made at the WPCP using an Eberline Model PAC-3 G gas proportional survey meter with a model AC2-B beta probe. Readings were recorded with the detector probe placed at ground level. The Annex II area and Gilman Hall were also screened using this instrument.

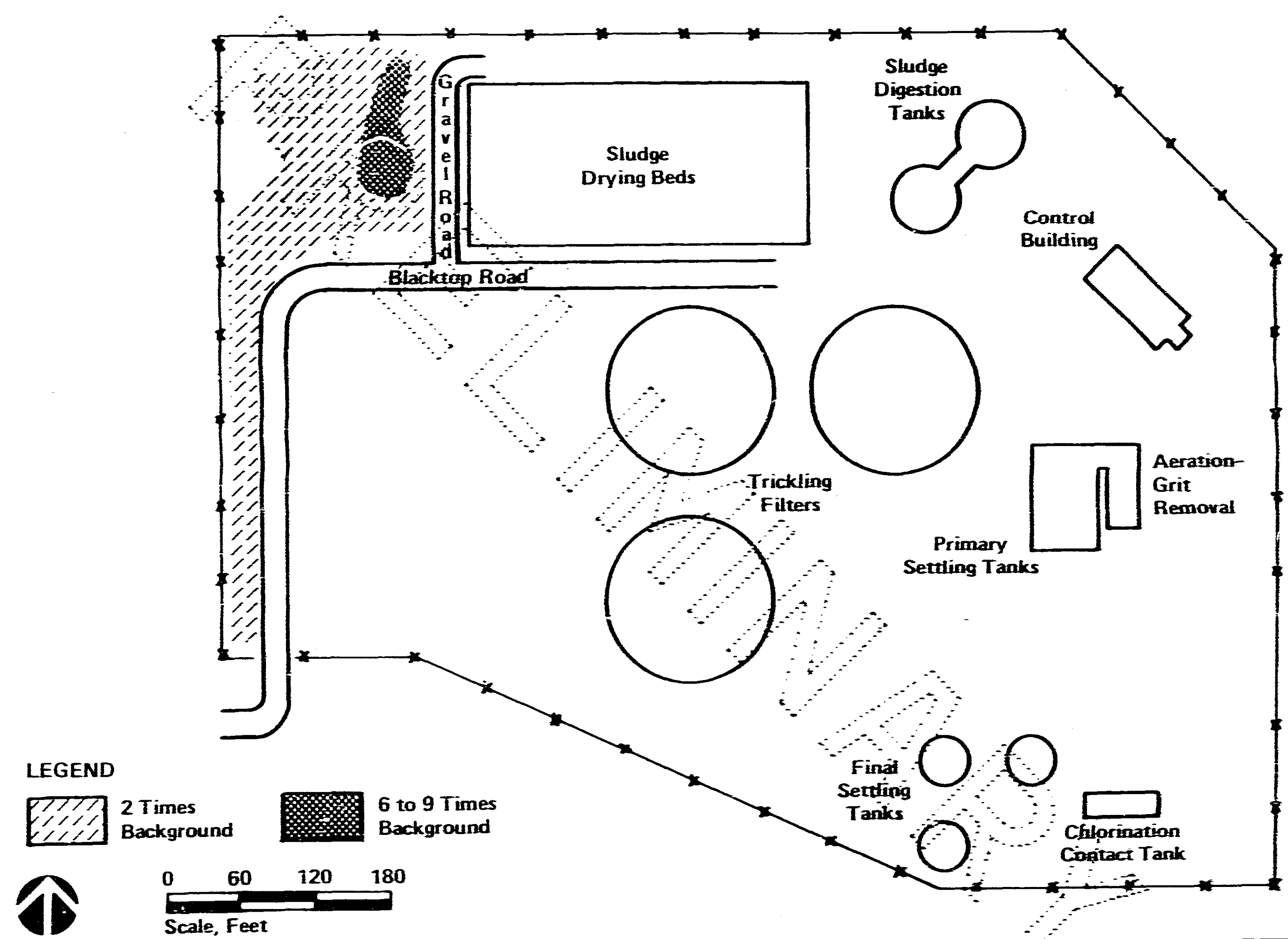
Only two of the sites screened yielded direct penetrating radiation levels above the background level (Vierzba, 1985). The two sites were the WPCP and the City of Ames Airport, which are discussed below. The Municipal Cemetery also had above-background levels of direct penetrating radiation but this was determined to be caused by the granite tombstones (Vierzba, 1985).

The screening with the survey meter revealed an area at the WPCP that had readings that ranged from two to nine times the background level (Figure 4-2). The instrument's background was 75-100 counts per minute (cpm), with the contaminated area yielding readings from 150 to 900 cpm. Additionally, TLDs were placed at the WPCP (Figure 4-3), and the results (Table 4-8) ranged from approximately 10 to 705 mrem/yr EDE above the background level. This dose would be received by an individual who resided at the sampling locations for a year. The DOE dose limit is 100 mrem/yr EDE, excluding natural background and medical exposures, from all pathways to members of the general public from normal DOE operations.

Survey meter screening at the City of Ames Airport revealed an area that had readings which ranged from two to seven times the background level (Figure 4-4). The instrument background was 100-150 cpm, with the contaminated area yielding readings from 200 to 1,100 cpm. The grass taxi strip at the City of Ames Airport has been graded and paved with asphalt since the radiation screening was performed in 1976. Interviews with site personnel indicated that subsequent unofficial screenings performed since the grass taxi strip was paved with asphalt have not yielded any survey meter readings above background.

4.3.3.2 Reporting Environmental Impacts

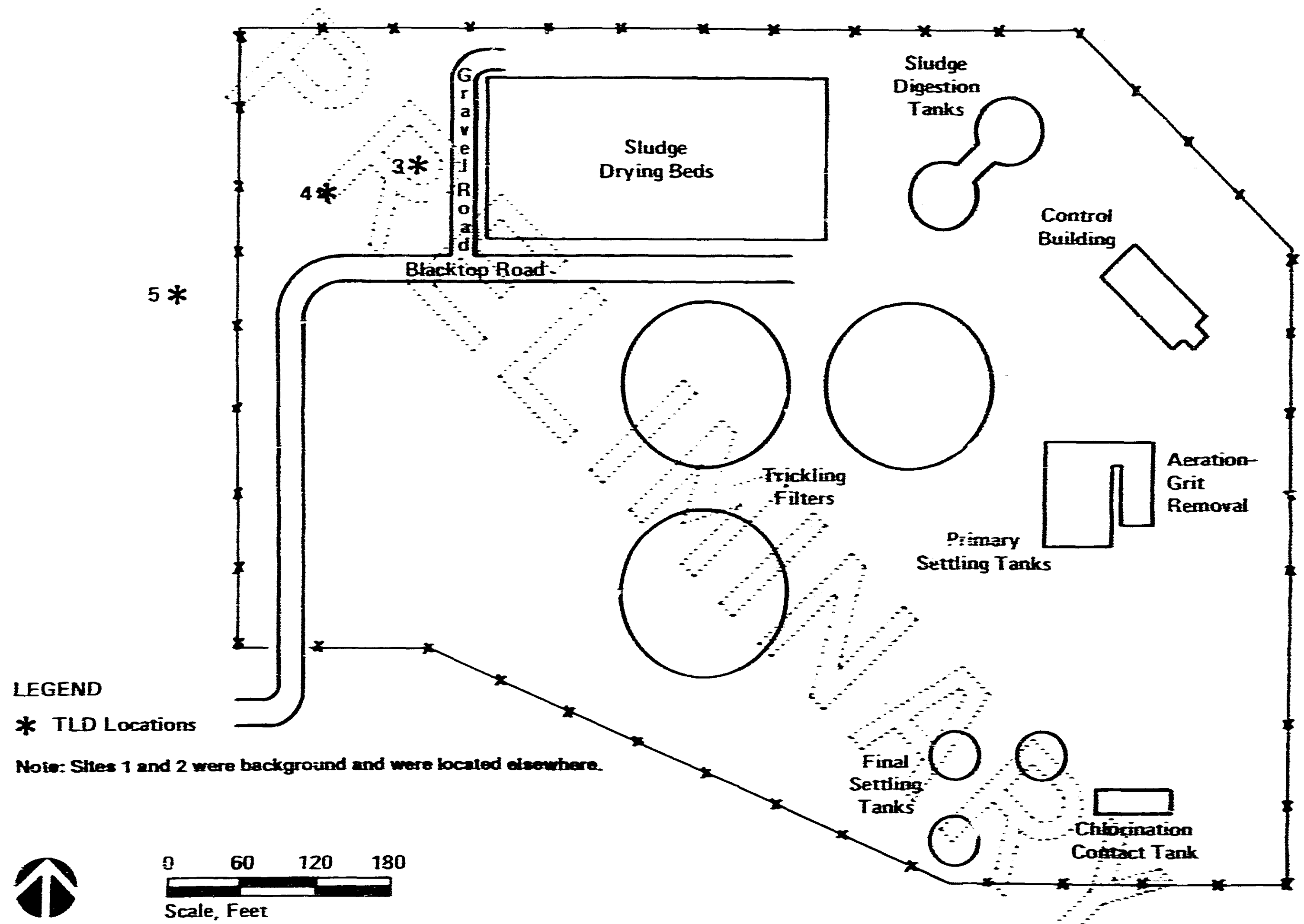
In 1981, CH granted the Ames Laboratory an exemption from preparing an Annual Environmental Monitoring Report, instead allowing the Ames Laboratory to prepare an Annual Environmental Summary. The Ames Laboratory has prepared Environmental Monitoring Reports for years 1982 through 1985 but has not prepared a report for any calendar year since 1985, as discussed in Section 4.4.2.



Source: Adapted from Vierzba, 1985

RADIATION SCREENING RESULTS AT THE
CITY OF AMES WATER POLLUTION CONTROL PLANT

FIGURE 4-2



Source: Adapted from Vierzba, 1985

TLD LOCATIONS AT THE CITY OF AMES WATER POLLUTION CONTROL PLANT

FIGURE 4-3

PRELIMINARY

TABLE 4-8

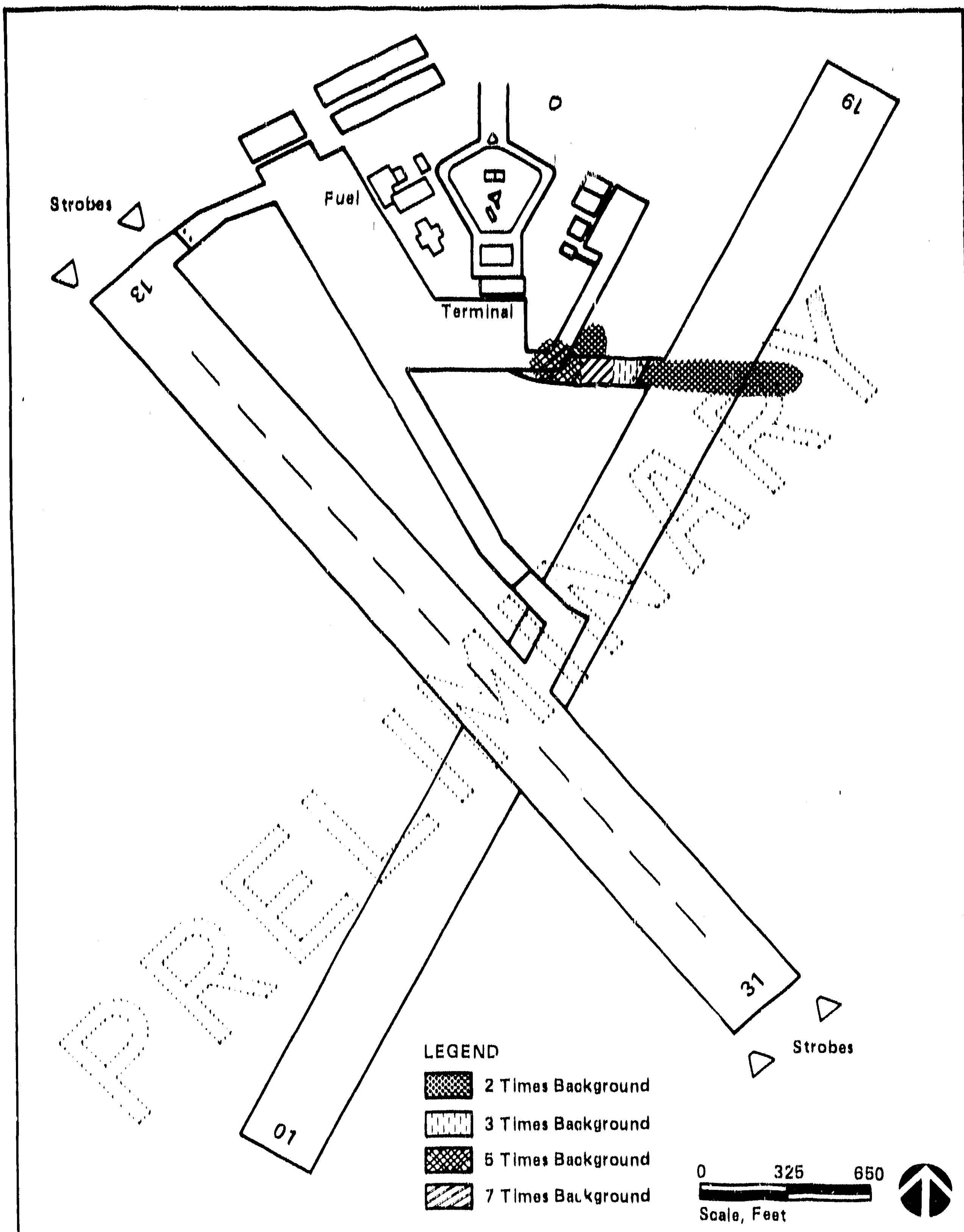
TLD RESULTS FROM THE CITY OF AMES WATER POLLUTION CONTROL PLANT

Site	1[a]	2[b]	3[c]	4[c]	5[c]
Average Dose[d] (mrem/yr)	77.4	75.5	781.0	342.4	86.9
Net Dose[d,e] (mrem/yr)	0	0	704.6	265.9	10.4

Source: Vierzba, 1985

a Background, residential location, City of Ames, Iowa
b Background, rural location, Story County, Iowa
c Location indicated on Figure 4-3
d Dose normalized to an annual DE
e Net dose = average dose minus background dose;
background dose = (77.4 + 75.5) + 2

PRELIMINARY



Source: Adapted from Vierzba, 1986

RADIATION SCREENING RESULTS AT THE CITY OF AMES AIRPORT

FIGURE 4-4

4.3.4 Findings and Observations

Although there are no findings directly attributable to direct penetrating radiation, the results of the radiation studies have helped define areas of environmental radionuclide contamination as specified in findings in Sections 3.2.4.2 (Soils) and 4.5.2.3 (Inactive Waste Sites and Releases).

4.3.4.1 Category I

None

4.3.4.2 Category II

None

4.3.4.3 Category III

None

4.3.4.4 Category IV

None

PRELIMINARY

4.4 Quality Assurance

This section references the quality assurance/quality control (QA/QC) aspects of environmental sampling at the Ames Laboratory and discusses the Ames Laboratory's QA/QC program and data management system.

4.4.1 Environmental Sampling

Environmental surveillance at the Ames Laboratory is the responsibility of the SH&PP staff. The environmental surveillance program had been scaled down in scope after the ALRR was decontaminated and decommissioned in 1981. This program currently consists of radiation screening of buildings that may contain residual radioactivity from former Ames Laboratory operations, as described in Section 4.3.2.3; sampling of the holding tanks at the Waste Disposal Building located at the ASC for radioactivity before being discharged to the City of Ames sewage system, as described in Sections 3.3.2.1 and 3.3.3; sampling/monitoring that may be required at the Ames Laboratory (e.g., soil sampling of areas that may contain residual radioactivity from former Ames Laboratory operations), as described in Sections 3.2.3 and 4.3.3.1; and monitoring glovebox emissions as described in Section 3.1.3.

4.4.2 Analysis and Data Management

The SH&PP staff conducts and has written protocols for the analysis of air, water, and soil samples; reduction of data from the analysis; radiation screenings of areas and materials; and calibration and maintenance of measurement equipment and systems used for analyses. Additionally, logbooks and records are kept documenting that the requirements of the written protocols are followed.

The Ames Laboratory also participates in two radiological QA programs administered by the DOE Division of Operational and Environmental Safety and the EPA Quality Assurance Branch. Quality assurance sample types and the radiation parameters analyzed are as follows:

Sample Type	Radiation parameters analyzed
Air	Gamma, Gross Alpha, and Beta
Water	Gamma Gross Alpha and Beta, Tritium
Soil	Gamma

Records documenting the Ames Laboratory's performance on these QA samples are kept in QA files in the SH&PP offices.

Data from the environmental surveillance program described in Section 4.4.1 are used to report releases from the Ames Laboratory and investigative information to DOE. However, some of these data, such as those from soil and direct penetrating radiation monitoring, were not incorporated in the site's Annual Environmental Summaries, which were prepared for the years 1982 through 1985. Additionally, the Ames Laboratory has not prepared an Annual Environmental Summary since 1985.

PRELIMINARY

4.4.3 Findings and Observations

4.4.3.1 Category I

None

4.4.3.2 Category II

None

4.4.3.3 Category III

None

4.4.3.4 Category IV

1. Incomplete compliance with DOE Order 5484.1. Assessments of environmental impacts of Ames Laboratory operations are not being reported to DOE in accordance with DOE Order 5484.1

DOE Order 5484.1 requires the site to summarize and interpret the levels of radioactive and nonradioactive pollutants in its environs resulting from facility operations in relation to applicable standards. This assessment is to be reported to DOE annually in either an Environmental Monitoring Report or Environmental Summary. Some data from the Ames Laboratory environmental sampling program, such as data from soil and direct penetrating radiation monitoring, were not incorporated into the site's Annual Environmental Summaries, which were prepared for the years 1982 through 1985. Additionally, the Ames Laboratory has not prepared a report or summary for the years 1986 through 1987 although it has measured radioactive airborne and liquid releases every year during this period.

PRELIMINARY

4.5 Inactive Waste Sites and Releases

This section of the report deals with inactive waste sites that are present and spills and other types of releases that have occurred at the Ames Laboratory. The pollution sources, findings, and observations described below are based on on-site observations made during the Environmental Survey; on a review of historical photographs and documents, maps, and radiological monitoring reports; and on interviews with active and retired Ames Laboratory personnel. The Ames Laboratory Phase I Installation Assessment Report (Ames Laboratory, 1988f), performed in accordance with DOE Order 5480.14, and Preliminary Assessments forms (Mathison, 1987d), submitted to the EPA by the Ames Laboratory in accordance with Section 120(c) of the Superfund Amendments and Reauthorization Act of 1986 (SARA), were also major sources of information used during the Survey.

4.5.1 General Description of Pollution Sources and Controls

4.5.1.1 Site History

The Ames Laboratory was established in 1947 by the U.S. Atomic Energy Commission (AEC), the predecessor agency to the DOE. Located on the Iowa State College (now ISU) campus, its mission has been to carry out fundamental research in physical, chemical, and materials sciences in support of energy-generating and other technologies essential to national interests.

Prior to 1947, Iowa State College (ISC) had been under contract to the National Defense Research Committee (NDRC), the Office of Scientific Research and Development (OSRD), and the Manhattan District of the U.S. Army Corps of Engineers (MED), to develop and implement processes to produce pure uranium and thorium, and to recover these metals from scrap. From 1947 to 1951, after the establishment of the Ames Laboratory under the AEC, thorium production and recovery was the major effort. Subsequent to this period, the Ames Laboratory broadened its mission of basic materials science research.

In 1961, the AEC leased approximately 27 acres of ISU land from the State of Iowa to develop the ASC. The Ames Laboratory Research Reactor (ALRR) and ancillary facilities were constructed at the ASC in 1961 and 1962, and the reactor operated from 1965 to 1977. The ALRR was decontaminated and decommissioned (D&D'd) in 1981. DOE terminated its ASC lease in September 1987, but as a condition of the termination agreement has been allowed unlimited access to and exclusive use and occupancy of the Waste Disposal Building and the High Pressure Test Facility until the year 2060. An additional condition of the agreement absolves DOE of any further liability for future costs for the ASC, including maintenance and disposal costs, with the exception of the two above-mentioned buildings.

4.5.1.2 Inactive Waste Sites and Releases

As a result of historical Ames Laboratory activities described in Section 4.5.1.1, 16 inactive waste sites and releases were noted during the Survey. Nine of them had been identified by the Ames Laboratory in its Installation Assessment Report (IAR) prepared as part of the DOE Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program and in Preliminary Assessments (PAs) provided to EPA pursuant to Section 120(c) of SARA, and the remaining seven were identified during the Survey. All 16 inactive waste sites and releases are described in this section and are organized based on their locations--sites on the main ISU campus, in the City of Ames, and at the ASC.

Sites on the Main ISU Campus

As described in Section 4.5.1.1, several activities took place on the ISU campus involving the production and recovery of uranium and thorium. Most of this work was performed from 1942 to 1947 under NDRC, OSRD, and MED contracts to ISU (then ISC), but continued to a lesser extent from 1947, when the Ames Laboratory was officially established under AEC auspices, to 1951. These activities took place at four on-campus buildings and may have resulted in releases of hazardous materials to the environment and in contamination of building interiors. The four buildings, Annex I, Annex II, Gilman Hall, and Wilhelm Hall, are described below. The former two buildings have been included in the Ames Laboratory IAR prepared in response to the DOE CERCLA program (DOE Order 5480.14) and in PAs provided to EPA pursuant to Section 120(c) of SARA.

Annex I - Annex I, also known as Little Ankeny and the Physical Chemistry Annex, was a 9,000-square-foot, one-story building located on the eastern side of the ISU campus (Figure 2-3). It was used for uranium production and recovery from 1942 to 1945 and for thorium production from 1945 to 1947; 2 million pounds of pure uranium and an unknown quantity of thorium were produced during this period at Annex I. After 1947, when the Ames Laboratory was established under the AEC, Annex I was used to a limited extent for thorium production and recovery, mainly during 1949 to 1951.

The building was D&D'd and razed in 1953 or 1954. Although the records of the D&D were not reviewed during the Survey, the building was dismantled and reportedly most of it, as well as an unknown volume of contaminated soil, was shipped off-site to Oak Ridge for disposal. The Annex I site presently is covered in grass, trees, and shrubs and is marked with a commemorative plaque. Part of the Food Technology Laboratory occupies a portion of the former location of Annex I.

Materials used at Annex I included uranium, thorium, calcium, magnesium fluoride, and calcium oxide. Most were contained within the building, although unreported quantities were discharged outside through the ventilation system. In addition, before 1945, open air burning of crucibles, floor sweepings, and scrap, which contained uranium, was conducted.

In 1942 and early 1943, scrap material resulting from Annex I operations, including uranium-bearing material, was discarded in the "ISC dump" on the south bank of Squaw Creek north of the ISC (now ISU) campus. In the fall of 1943, approximately 250 tons of material were removed from the dump and sent elsewhere in the MED system for uranium recovery. Subsequent sampling of the dump yielded uranium concentration of less than 0.1 percent.

In 1976, at the direction of the DOE Chicago Operations Office, a radiological screening program was performed, as described in Section 3.2.3. Surficial soil (top 6 to 8 inches) in the vicinity of Annex I was sampled for gamma emitters (Section 3.2.3), and the ground was surveyed for direct penetrating radiation (Section 4.3.3.1). Daughters of thorium-232 (thallium-208 and actinium-228) in surficial soil were measured at background levels (Table 3-5). Uranium-234 in surficial soil ranged from 0 to 40.5 pCi/g; no uranium-234 was detected in background samples. However, ground and aerial surveys did not detect any elevated direct penetrating radiation levels. No sampling for hazardous chemical constituents was performed.

Annex II - Annex II was a 5,300-square-foot, brick, fire-proof, one-story building, located on the eastern side of the ISU campus (Figure 2-3). Constructed in 1944, the building was used until 1945 for recovery of uranium from scrap. Approximately 600,000 pounds of uranium were recovered during this period. As with Annex I, open air burning of materials containing uranium were conducted outside Annex II. After that, Annex II was used to a limited extent for thorium production and recovery, especially from 1949 to 1951. In 1953, ISC (now ISU) purchased Annex II from the AEC and used it as the Plumbing Shop. Two dates are reported for the building's destruction, 1965 or 1972. The area has since been paved over as part of a parking lot for the ISU Physical Plant Building.

Hazardous substances potentially released to the soil from Annex II include uranium dioxide and thorium oxide. The amounts released, if any, are unknown as are extent of any contamination and environmental concentrations. As part of the 1976 radiological screening program, ground surveys for radiation dose were made and background levels were measured (Section 4.3.3.1). Soil samples were not taken since the area had previously been paved. Aerial surveys made in 1977 also yielded background results.

Gilman Hall - During the early 1940s, ISC's activities for MED required more space than was available in Annex I. Therefore, space in Gilman Hall, then known as the Chemistry Building, was taken over and used for the uranium analytical program. These activities resulted in internal building contamination by natural uranium and its daughters, as determined by a comprehensive monitoring program described in Section 4.3.2.3. However, interviews with site personnel and a review of the monitoring program data by the Survey team indicate that the radiation levels measured are below the DOE action guideline of 25 mrem/yr and do not present a human health risk or a source of environmental contamination.

Wilhelm Hall - From the late 1940s to the early 1950s, research on the production and recovery of thorium was conducted in Wilhelm Hall, then known as the Metallurgy Building. These research activities resulted in internal building contamination by thorium-232 and its daughters as detected through radiological monitoring (Section 4.3.2.3). However, interviews with site personnel and a review of the monitoring data by the Survey team indicate that the radiation levels measured are below the DOE action guideline of 25 mrem/yr and do not present a human health risk or a source of environmental contamination.

Sites in the City of Ames

In the early 1950s, metallic thorium was produced from thorium nitrate tetrahydrate in Wilhelm Hall. During an early stage of this process, a waste filtrate believed to contain trace amounts of thorium in the form of nitrate and oxalate was produced. Because of its supposedly low levels of radioactivity, the waste filtrate was disposed of to the City of Ames sanitary sewer. This disposal method was to be used until a chemical technique of further reducing radioactivity levels was developed and installed. During this period it was discovered that, due to a change in feed material supplied to the Laboratory, in actuality considerable quantities of mesothorium, a decay product of thorium, were being discharged in the filtrate. Thus, from July 1951 to August 1952, greater quantities of radioactivity than had been initially assumed were released to the City of Ames sanitary sewer system.

After the incident was discovered, disposal to the sewer was terminated. Subsequent studies indicated that almost all the mesothorium was bound in the sludge at the City of Ames WPCP (Figure 2-2). The contaminated sludge was segregated into a pile on the soil surface adjacent to the sludge drying beds at the WPCP until a disposal method could be found. The AEC recommended, and the Ames Laboratory and the City of Ames agreed, that the sludge should be land-applied in low-use areas in the City of Ames (Ames Laboratory, 1988f). Three areas were selected -- the Ames Municipal Airport, the Ames Municipal Cemetery, and Grand Avenue underpass (Figure 2-2). As a result of the thorium-contaminated sludge storage and disposal activities, the three sludge disposal areas and the WPCP have been identified as inactive waste sites and are included in the Ames Laboratory IAR prepared in response to the DOE CERCLA program (DOE Order 5480.14) and in PAs provided to EPA pursuant to Section 120(c) of SARA.

<u>Ames Municipal Airport</u> - The Ames Municipal Airport, south of Ames (Figure 2-2), was one of the areas chosen for disposal of the thorium-contaminated sludge. It is not known exactly where, in what quantity, or by what method it was disposed of, although it is suspected that it may have been applied on the ground surface with a manure spreader in 1953.

During the 1976 radiological screening program, ground direct penetrating radiation surveys (Section 4.3.3.1) and soil samples (Section 3.2.3) indicated contamination in the middle of the grass taxiway on the north side of the northeast-southwest runway (Figure 4-4). Survey meter screening indicated direct penetrating radiation readings up to seven times background level. However, only one soil sample had concentrations of thorium-232 daughters (actinium-228 and thallium-208) significantly above background--12.1 pCi/g as compared to background levels for this sampling of 0.21 to 0.61 pCi/g (Table 3-7). The total inventory of thorium-232 estimated by Ames Laboratory personnel to be disposed of at the airport is 2.7 to 3.4 pounds.

In approximately 1985, the runways and taxiways at the airport, including the taxiway that contained the contaminated soil, were paved. Interviews with site personnel indicated that ground surveys since then have not detected any radioactivity above background.

Ames Municipal Cemetery - The Ames Municipal Cemetery, on the eastern side of Ames (Figure 2-2), was a second area chosen for disposal of the thorium-contaminated sludge. As with the airport described above, it is not known exactly where, in what quantity, or by what method the sludge was disposed of, although it is believed that it was applied on the ground surface with a manure spreader in 1953.

Ground surveys taken in the cemetery during the 1976 radiological monitoring program indicated generally background radiation levels. In some parts of the cemetery, the natural radiation in large granite tombstones may have contributed to instrument readings. This monitoring program is discussed in greater detail in Section 4.3.3.1.

Grand Avenue Underpass - The third area chosen for disposal of thorium-contaminated sludge was the grass slopes on the sides of the Grand Avenue underpass (Figure 2-2). It is suspected that the sludge was applied on the ground surface with a manure spreader in 1953, although the quantities disposed of and the area covered are not known. Presently, the site is a grassy slope bordering Grand Avenue.

Ground surveys made during the 1976 radiological monitoring program, as described in Section 4.3.3.1, yielded background results.

City of Ames Water Pollution Control Plant - Before being spread at the previously described three sites, the thorium-contaminated sludge had been stored on the western end of the WPCP, next to the sludge drying bed. Once the sludge was removed, however, residual thorium contamination covering approximately 4,000 square feet down to a depth of 1 foot remained. It has been estimated by Ames Laboratory personnel that 187 pounds of thorium may be present in the former storage area.

In the 1976 radiological monitoring program, soil samples were taken, ground direct penetrating radiation surveys were made, and thermoluminescent dosimeters (TLDs) were deployed (Sections 3.2.3 and 4.3.3.1). All methods indicated elevated radiation levels. TLD and direct penetrating radiation measurements were up to 9 times background (Figure 4-2). Thorium-232 daughter products (actinium-228 and thallium-208) were 1 to 2 orders of magnitude higher than background levels, although these elevated levels were restricted mainly to the upper 2 feet (Table 3-6). The highest levels for all three methods were found in a drainage ditch along a gravel road on the eastern side of where the sludge had been stored (Figure 4-2). An aerial radiological survey made in 1977 showed a maximum level of three times background.

Soils were also sampled from the sludge storage area at the WPCP in 1985. Thorium-232 daughter concentrations in the upper 1 foot of soil ranged from 10 to 50 pCi/g in the vicinity of the ditch (surrounding sample points 1 and 3 in Figure 3-2 and measuring approximately 1,500 square feet) and from background (0.5 to 0.7 pCi/g) to 10 pCi/g in the surrounding area (approximately 2,500 square feet, Figure 3-2). The area is presently covered in grass and contains a few trees.

During the Survey, disturbed soil was noted in a small portion of the storage area. In early 1988, sludge had overflowed from an adjacent sludge drying bed onto part of the thorium-contaminated area. The spilled sludge along with some soil was removed and spread on adjacent City of Ames land. However, the soil on the adjacent land contained thorium at levels below maximum permitted concentrations, as described in Section 3.2.2.2.

Sites at the ASC

DOE occupied the ASC from 1961, when they first leased the land from ISU, until September 1987, when they terminated the lease and the land reverted to ISU. As a result of activities during this 26-year period, eight inactive waste sites, as identified during the Survey and discussed below, are located at the ASC. Three of these sites, the Chemical Disposal Site, the Blockhouse, and the ALRR, have been included in the Ames Laboratory IAR, prepared in response to the DOE CERCLA program (DOE Order 5480.14), and in PAs provided to EPA pursuant to Section 120(c) of SARA. The remaining five were identified during the Survey and are not described in the above reports.

Chemical Disposal Site - The Chemical Disposal Site is immediately outside the eastern boundary of the ASC on ISU property (Figure 2-4). Unlike the ASC, this area was not leased from ISU by DOE (AEC at the time). Reportedly, the Chemical Disposal Site had its beginnings in the early 1950s when it was used as an uncontrolled disposal area by ISU. Laboratory equipment and chemicals which ISU researchers were not sure how to dispose of were reportedly discarded there. However, quantities and types of materials disposed of during that period are unknown.

In the late 1950s, ISU erected a fence around the area and from 1958 to 1966, a total of nine discrete burials were made there by the Ames Laboratory. For each burial, an announcement was made within the laboratory that "hazardous chemicals and metals" would be picked up for removal to the burial area. The collected waste material was then evaluated for recovery, and unsalvageable material was sent to the Chemical Disposal Site. A 7- to 8-foot-deep pit was dug, the waste material was disposed of into the pit, and a cover of 3 to 4 feet of soil was placed over the waste. Each of the nine disposals was apparently performed with AEC approval and met the standards of that time.

The nine pits occupy a 2,800-square-foot area in the southeastern corner of the 85,000-square-foot fenced-in area. Table 4-9 provides a description of each disposal

TABLE 4-9

DESCRIPTION OF DISPOSAL PITS AT THE ASC CHEMICAL DISPOSAL SITE

Pit Number[a]	Date of Disposal	Size of Pit (square feet)	Volume of Disposal (cubic feet)	Major Contents
1	July 1958	777	3,100	Calcium oxide; calcium fluoride; uranium, thorium, and yttrium slag
2	July 1959	194	850	Yttrium slag; depleted uranium oxide, scrap, and fluoride; thorium scrap, waste, and impure fluoride; normal uranium sludge, waste, scrap, and ore; lime and wastes; beryllium oxide waste
3	November 1960	65	210	Potassium; lithium; sodium; thorium-containing asbestos ducts; cyanide; beryllium and mercury salts; miscellaneous chemicals
4	October 1961	65	210	No information available
5	October 1962	108	350	Mercury waste; potassium; yttrium slag; beryllium oxide waste; thallium waste; sodium; fluoride; cobalt fluoride; metal fines from electron beam melter
6	May 1963	162	636	Fused beryllium oxide
7	June 1963	259	990	Radioactively contaminated acoustic tile; asbestos ducts; zirconium waste
8	October 1965	65	280	No information available
9	November 1966	65	280	No information available

Source: Ames Laboratory, 1988f

[a]Locations depicted in Figure 4-5

pit and Table 4-10 provides estimated total amounts of hazardous wastes disposed of. The locations of the pits within the site are depicted in Figure 4-5. Available records for the Chemical Disposal Site do not indicate the presence of organic chemicals in areas used by the Ames Laboratory, nor did the employee involved in disposal activities at the site recall receiving any.

The area presently is covered in grasses, brush, and trees, and is situated at the head of a ravine that drains to Squaw Creek. No remediation has taken place with regard to the pits. However, Ames Laboratory personnel indicated that three areas of surficial radioactive contamination, apparently unrelated to the disposal pits, were discovered in 1987, immediately east of the pits. An unspecified amount of contaminated soil was removed and shipped to the Hanford Site, as described in Section 4.1.3. There has been no environmental sampling at the Chemical Disposal Site although ground surveys for radiation were made in 1984 and yielded background levels.

Blockhouse - The Blockhouse is an abandoned, 240-square-foot, concrete block building immediately east of the ASC eastern boundary (Figure 2-4). The date of construction was not reported although it may have been built in the early to mid-1960s, during DOE's development of the ASC. The structure was used for the handling of radioactive wastes from the Ames Laboratory and was abandoned in the early 1980s. There are plans for the building's removal in the summer of 1988. Portions of the floor are radioactively contaminated at levels up to 3,000 disintegrations per minute per 100 square centimeters (dpm/100 cm^2), and the isotopes present in these areas are less than 0.1 millicurie each of cobalt-60 and cesium-137 (Mathison, 1987d). Formerly Utilized Sites Remedial Action Program (FUSRAP) guidelines for residual radioactive surface contamination for cobalt-60 and cesium-137 are 5,000 dpm/100 cm^2 each.

The Blockhouse is in a wooded area, surrounded by grasses and bare soil. No external radioactive contamination was reported. However, a spill of 40 gallons of fuel oil from a small aboveground fuel tank along the eastern outside wall of the Blockhouse had occurred in 1987 or 1988 after ISU had taken control of the ASC. The affected soil had covered approximately 50 square feet. Following State of Iowa recommendations, the Ames Laboratory cleaned up the spill by removing the

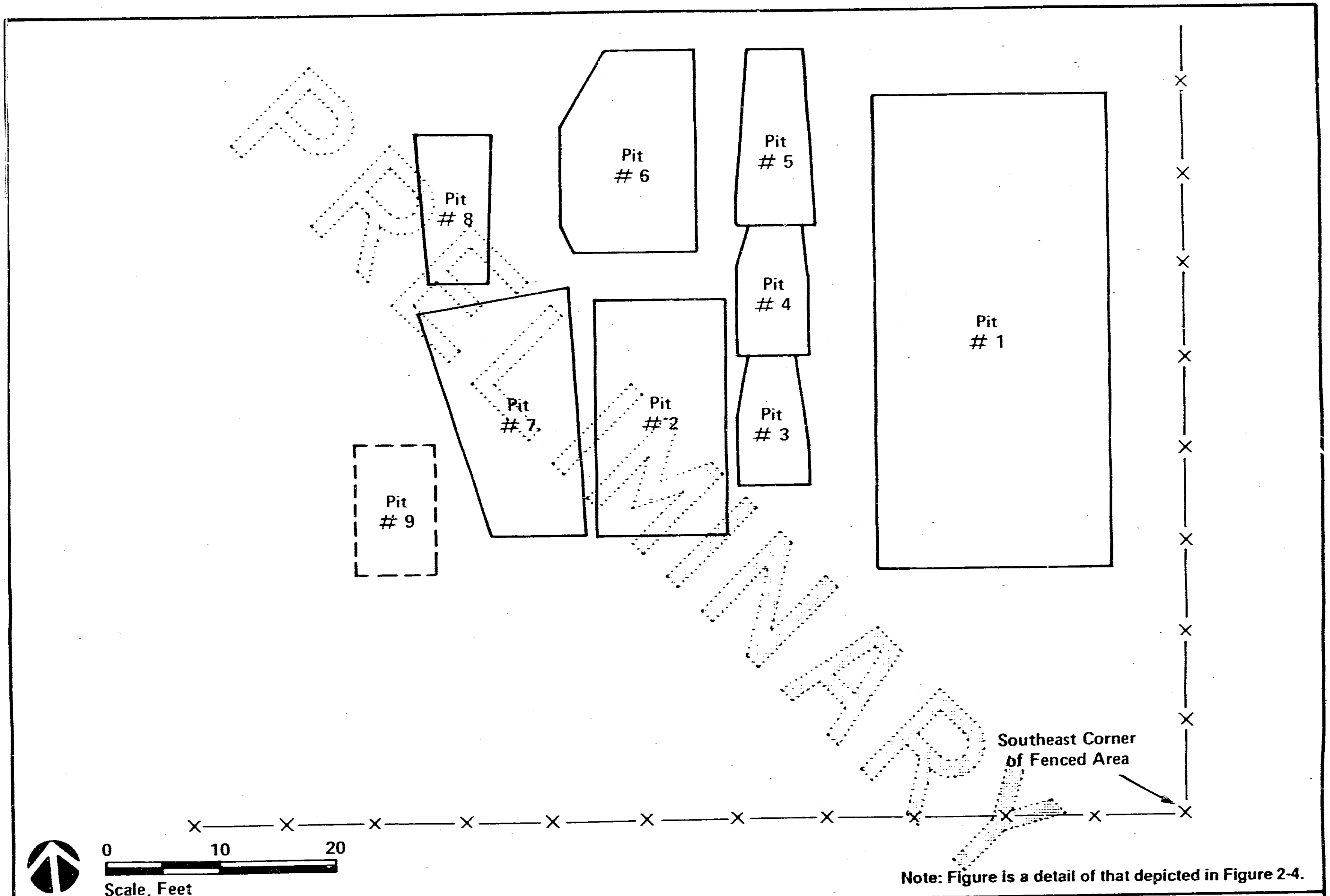
TABLE 4-10

ESTIMATED QUANTITIES OF WASTE DISPOSED OF IN THE ASC CHEMICAL DISPOSAL SITE PITS

Material	Quantity (pounds)
Thorium	1,000
Uranium	1,000
Yttrium	2,000
Beryllium (fused oxide)	3,000
Asbestos (ducts)	>110
Sodium (metal)	unknown
Potassium (metal)	unknown
Mercury (salts)	unknown
Thallium (salts)	unknown
Cyanide	unknown

Source: Ames Laboratory, 1988f

PRELIMINARY



Note: Figure is a detail of that depicted in Figure 2-4.

LOCATION OF DISPOSAL PITS AT THE ASC CHEMICAL DISPOSAL SITE

FIGURE 4-5

contaminated soil to a field approximately 1/4 mile north of the ASC and spreading it out to 3 to 4 inches deep to allow for bacterial degradation.

ALRR Building - The ALRR Building is located in the center of the ASC (Figure 2-4). It consists of two wings, the containment side and the laboratory wing. The former included the reactor and was built out of concrete in 1961 while the latter was built out of brick in 1968. The total area of the ALRR Building is approximately 20,500 square feet. The ALRR Building was built by the AEC, but in September 1987 was turned over to ISU.

The reactor operated from 1965 to 1977, and was D&D'd in 1981 with the cognizance of the DOE Chicago Operations Office. The reactor and its peripheral equipment were removed as were miscellaneous items such as ceiling tiles and pieces of contaminated concrete floor and walls. Some of the concrete in the containment wing is contaminated with tritium, which exchanges with moisture in the air. As a result, airborne tritium levels within the containment wing are 0.01 microcurie per cubic meter ($\mu Ci/m^3$), 5 percent of the Derived Concentration Guide (DCG). During the D&D, pipes contaminated with cobalt-60 and cesium-137 were left within the concrete walls and floor and, as a result of this shielding, the radioactivity cannot be detected. No residual radioactivity has been detected in the laboratory wing.

During the D&D effort, soil samples were taken at the ASC to determine whether radioactive contamination resulted from operation of the ALRR. No evidence of contamination was found. The first floor of the containment wing is presently used for storage whereas the basement is not in use. The laboratory wing is used by ISU research groups. The grounds surrounding the ASC consist of maintained lawns, parking lots, and roads.

ASC Acid Neutralization Tank - Laboratory sink drains in the ALRR Building were routed through a dedicated pipe system to an acid neutralizing pit on the western side of the ASC (Figure 2-4). The tank was constructed of poured concrete, most likely between 1961 and 1965. Its dimensions are 30 feet by 14 feet by 11 feet 8 inches deep and its top is located approximately 4 feet under the ground surface. Four manholes and four vents connect the tank with the surface. The acid neutralization tank was used until 1978, when the ASC was connected to the City of

Ames sanitary sewer system. Although the tank was constructed by the AEC, ISU assumed its ownership in 1987.

Wastewater, possibly containing acids, bases, metals, and organics, was conveyed from the ALRR Building to the tank via vitrified clay pipe. Within the tank, the wastewater passed through a 5-foot-deep bed of pulverized limestone. From the tank, the wastewater passed through a manhole to a discharge point on Onion Creek Gulch. This discharge is discussed in Section 3.3.2.2. After use of the tank was discontinued, it was abandoned in place. The limestone was removed and a portion of it was placed on the unpaved driveways within the ASC; the disposition of the remainder is unknown.

Presently, the ground above the tanks consists of maintained lawn and the manholes and vents. There is no indication whether the tank or lines to and from the tank have leaked.

<u>ALRR Building Septic System</u> - Sanitary wastewater from toilets and bathroom sinks in the ALRR Building and the Waste Disposal Building and blowdown from the ALRR cooling towers drained through a system separate from the laboratory wastewater system described above. This sanitary system was installed by the AEC in the early to mid-1960s and consisted of clay pipes, a septic tank, and a subsurface sand filter; the latter two facilities are on the western side of the ASC (Figure 2-4). Wastewater was routed from the two buildings through the clay pipes to a concrete septic tank. The tank is 24 feet, 8 inches in diameter and 10 feet deep, and its top is 2 feet below the ground surface. From the septic tank, the effluent flowed to a sand filter, which is approximately 55 feet by 55 feet and has a capacity of 100 gallons per minute (gpm). The sand filter consists of 1 foot of backfill overlying 1 foot of gravel containing feeder pipes. Between this layer and another 1-foot layer of gravel containing collector pipes is 2-1/2 feet of coarse sand that acts as the filter medium. The wastewater flowed out of the feeder pipes, through the sand, and was captured in the collector pipes. The filtered waste was then piped through a manhole to the discharge outlet on Onion Creek Gulch.

The septic system was abandoned in place when the ASC was connected to the Ames sewer system in 1978. Since September 1987, it has been under the ownership of ISU and is presently covered by maintained grass. It is unlikely that any wastes

PRELIMINARY

except sanitary waste entered the septic system from the lavatories. However, chromates at concentrations of 30 milligrams per liter (mg/L) were used in the comfort cooling tower water for corrosion inhibition. Since the blowdown from the two chromate-treated towers flowed through the subsurface sand filter, it is possible that chromates may have entered the soils. However, since the sand filter was designed with collectors, a majority of the wastewater probably flowed into the collectors rather than percolated into the soil.

The collectors discharged to Onion Creek Gulch until 1978 and then to the sanitary sewer from 1978 to 1987, after which chromates were no longer used. From 1976 to 1978, hexavalent chromium concentrations in the effluent at the discharge point to Onion Creek Gulch averaged 0.42 mg/L. The effluent included flows from the sand filter, the acid neutralization tank, roof drains, and foundation drains. Therefore, the concentrations of hexavalent chromium measured in the effluent may not be representative of hexavalent chromium concentrations in the wastewater flowing through the sand filter since the metal concentration at the discharge point would have been diluted by other sources. It is not known how much blowdown flowed through the sand filter, although 11,000 to 12,000 gallons of water were used for makeup in the comfort cooling towers each year. However, makeup consists of replacement for blowdown, drift, leaks, and evaporative loss, with the latter two probably accounting for most of the loss.

Comfort Cooling Towers - As described above, water used in the two comfort cooling towers, in the center of the ASC (Figure 2-4), was treated with chromates from the early 1960s until September 1987, when ISU assumed ownership of the towers from DOE and ceased chromate use. Two other cooling towers, used solely for cooling water from the ALRR, were located southwest of the comfort cooling towers. They operated from 1965 to 1977, when the reactor was shut down, and were removed in 1981, when the reactor was D&D'd. However, chromates were not used in these cooling towers.

Chromate concentrations in the comfort cooling tower water were maintained at 30 mg/L. An unknown amount of chromium-treated water was lost to the surrounding soil through drift and possibly leaks, although a total of 11,000 to 12,000 gallons of makeup water were used in the two towers per year. This make-up not only replaced water lost through drift and possible leaks but also that lost through evaporation and blowdown. However, assuming that all the makeup was lost through drift and leaks, approximately 70 pounds of chromates would have been deposited on the surrounding soil during 23 years of operation. The comfort cooling towers are still in place and are being used. They are surrounded by maintained lawns that show no signs of vegetative stress.

<u>ASC Warehouse Septic System</u> - Liquids from the ASC Warehouse drained to a dedicated septic system on the northeastern side of the ASC (Figure 2-4). The system consisted of piping, a septic tank, and a drain field. Wastewater flowed by vitreous clay pipe from the building to a 300-gallon-capacity steel septic tank and then to a 40-foot-by-40-foot drain field. The drain field consisted of 5-inch perforated agricultural tile in a 1-foot-thick gravel bed. The maximum depth of this gravel bed was 30 inches. Wastewater would then percolate into the ground. The system was probably built in 1965 when the ASC Warehouse was built. Although two dates of abandonment in place were reported during the Survey, 1978 and 1987, the Survey was not able to determine the correct date.

Wastewater draining to the ASC Warehouse septic system consisted of sanitary waste from one lavatory and laboratory wastes from two laboratory sink drains. The laboratories were used by the radiochemistry group for 2 years in the mid-1960s and by a biology group to study the effects of trace elements on vegetation, during 3 to 4 years in the late 1970s; the laboratories were not used in the intervening years. Thus, it is possible that small quantities of laboratory chemicals entered the septic system. Presently, the septic system is overlain by a gravel roadway and maintained lawn.

<u>Sulfuric Acid Storage Tank</u> - An abandoned 5,000-gallon sulfuric acid storage tank is located on the southwestern side of the ALRR Building (Figure 2-4). It was installed in approximately July 1962, and is constructed of ASTM A-285-A Grade steel with an exterior coating of coal tar pitch. The piping is Schedule 80 black iron. The sulfuric acid stored within the tank was used for regeneration of ion exchange columns. The tank was taken out of service in 1970 when the lines to or from the tank solidified. The indicator on the tank shows that 1,700 gallons of acid remain in the tank. Although this indicator may be broken, site personnel believe that acid does remain in the tank. The tank has not been closed nor has any leak-testing been

performed. The area over the tank is level and consists of maintained lawn that shows no signs of vegetative stress.

4.5.2 Findings and Observations

4.5.2.1 Category I

None

4.5.2.2 Category II

None

4.5.2.3 Category III

1. Potential soil, surface-water, and groundwater contamination from inactive waste sites. Inactive waste sites resulting from past activities at the Ames Laboratory have contaminated the soil with chemicals and radioactive materials and represent potential sources of contamination to the groundwater and surface water.

   Nine inactive waste sites and releases resulting from Ames Laboratory operations were identified by the site in its DOE Installation Assessment Report and its Preliminary Assessments, and an additional seven sites were identified during the Survey, as described in the finding in Section 4.5.2.4. Of these 16 sites, 6 were noted to be of particular environmental interest and concern based on the types and quantities of materials disposed of and the degree of potential or known contamination. These six--the Chemical Disposal Site at the ASC, City of Ames WPCP, Annex I, the Ames Municipal Airport, Annex II, and the ALRR Building septic system--are described below. It should also be noted that four sites--Gilman Hall, Wilhelm Hall, the Blockhouse, and the ALRR Building--contain internal building radioactive contamination and do not represent a source of environmental contamination.

PRELIMINARY

Chemical Disposal Site

The Chemical Disposal Site was used by the Ames Laboratory from 1958 to 1966 for the disposal of hazardous chemicals and metals. During this period, 9 discrete burials were made in a 2,800-square-foot area. For each burial, a 7- to 8-foot pit was dug, the waste was disposed of into the pit, and a cover of 3 to 4 feet of soil was placed over the waste. A total of 6,900 cubic feet of material was placed in these pits. These materials included 3,000 pounds of beryllium (fused oxide); 2,000 pounds of yttrium; 1,000 pounds each of thorium and uranium; and unknown amounts of sodium, potassium, mercury, thallium, and cyanide. Before the area was used by the Ames Laboratory, it was reportedly used in an uncontrolled manner by ISU for the disposal of laboratory equipment and chemicals.

The Chemical Disposal Site is covered by grasses, brush, and trees. It is situated at the head of a steep ravine that drains to Squaw Creek, one-fourth mile to the east. The flow in the ravine is intermittent, occurring mainly during storm events. Stormwater leaching through the waste may incorporate contaminants. Groundwater contamination may result from further downward migration, and surface-water contamination may result if the contaminated leachate seeps out to the ravine.

Soils will be sampled at the Chemical Disposal Site during the Environmental Survey's Sampling and Analysis (S&A) phase and will be analyzed for inorganic and organic compounds.

Water Pollution Control Plant

Thorium-contaminated sludge resulting from Ames Laboratory operations was stored on the western side of the City of Ames WPCP in an unprotected, unlined area for less than a year, from 1952 to 1953. Although the sludge was removed and placed in three low-use areas within the City of Ames, including the Ames Municipal Airport described below, residual thorium contamination has remained in the soils at the WPCP. No residual contamination has been detected in the other two low-use areas--the Municipal Cemetery and the Grand Avenue underpass.

In a 1985 study, thorium-232 daughters were found mainly in the upper 1 foot of soil at the WPCP. Concentrations of from 10 to 50 pCi/g were found in a ditch and covered approximately 1,500 square feet, and concentrations from background (0.5 to 0.7 pCi/g) to 10 pCi/g were found over 2,500 square feet. The DOE guideline for residual thorium concentrations at FUSRAP sites is 5 pCi/g. According to Ames Laboratory personnel, a total of 187 pounds of residual thorium may be present in the soil. Although thorium is thought to be relatively immobile in soil, contamination of groundwater and surface water may result. An additional finding regarding the spreading of the thorium contamination from the WPCP is discussed in Section 3.2.4.2.

Annex I

Annex I, also known as Little Ankeny and the Physical Chemistry Annex, was a 9,000-square-foot, one-story building on the east side of the ISU campus. Activities that took place there from 1942 to 1951 included uranium and thorium production and recovery. During operations, unreported quantities of compounds used within the building, such as uranium and thorium, were discharged outside through the ventilation system to surrounding soil. In addition, open air burning of uranium-containing materials was also conducted. The building was D&D'd and razed in 1953 or 1954.

In 1976, daughters of thorium-232 in surficial soils were measured at background levels. Uranium-234 in surficial soils ranged from 0 to 40.5 pCi/g; no uranium was detected in background samples. Since uranium is relatively immobile in soils containing a clay fraction such as that which is believed to underlie Annex I, contamination of groundwater and surface water is not expected.

Ames Municipal Airport

Thorium-contaminated sludge was removed from the WPCP, as described above, and spread at the Ames Municipal Airport. It is not known exactly where, in what quantity, or by what method the sludge was disposed of, although it is suspected that it may have been applied on the ground surface with a manure spreader in 1953. The total amount of thorium-232 disposed of has been estimated to be between 2.7 and 3.4 pounds. Soil samples taken in 1976 indicated the presence of thorium-232 in the middle of a grass (now paved) taxiway on the northern side of the northeast-southwest runway. The highest concentration of thorium-232 daughters in soil was 12 pCi/g, exceeding background levels of 0.21 to 0.61 pCi/g and FUSRAP guidelines for residual radioactivity of 5 pCi/g. In approximately 1985, the runways and taxiways were paved and subsequent ground surveys have not detected any elevated radioactivity. However, thorium contamination of soil may be present under the paved taxiway.

Annex II

Annex II was a 5,300-square-foot, one-story brick building on the eastern side of the ISU campus. Activities that took place at Annex II included uranium recovery from scrap from 1944 to 1945, and thorium production and recovery from 1945 to 1951. Annex II was transferred from the AEC to ISU in 1953 and was destroyed in 1965 or 1972. The area has since been paved over. A ground survey was made in the area after the site had been paved, yielding background results; no soil samples were taken. However, since activities at Annex II were similar to those at Annex I, as discussed above (although the building was of different design and construction material), there is a possibility that subsurface soils may be contaminated with uranium and thorium due to discharges outside to the surrounding soils. During the S&A phase of the Survey, soils from the former location of Annex II will be sampled and analyzed for uranium and thorium.

ALRR Building Septic System

The ALRR Building septic system at the ASC was constructed in the early to mid-1960s and consisted of clay pipes, a concrete septic tank, and a 55-foot by 55-foot sand filter. Wastewater flowed through the septic tank and into the sand filter through feeder pipes. After trickling through the sand filter, the effluent was captured in collector pipes and discharged into Onion Creek Gulch. This unit operated until 1978, when the wastewater was diverted to

PRELIMINARY

the City of Ames sanitary sewer system. The system was then abandoned in place.

Blowdown from the comfort cooling towers, containing chromates, flowed through this system from the early 1960s to 1978. Chromate concentrations were maintained at 30 mg/L in the cooling water. The amount of blowdown that flowed through the septic system is not known, although 11,000 to 12,000 gallons of makeup water were used each year. Makeup water consists of replacement for blowdown, drift, leakage, and evaporative loss; the latter two probably account for most of the loss.

It is possible that chromates entered the soils as the blowdown water flowed through the sand filter. However, since the sand filter was designed with collectors, most of the wastewater probably flowed into them rather than percolated into the soils. During the S&A phase of the Survey, soils beneath the sand filter will be sampled and analyzed for total chromium.

4.5.2.4 Category IV

1. Incomplete Identification of inactive waste sites. Not all potential inactive waste sites resulting from Ames Laboratory operations have been identified in its Phase I Installation Assessment Report performed in accordance with DOE Order 5480.14, or in its Preliminary Assessments completed in accordance with Section 120(c) of the Superfund Amendments and Reauthorization Act of 1986.

   Although the Ames Laboratory has reported nine inactive waste sites in a DOE Installation Assessment Report and in Preliminary Assessment forms submitted to EPA, information obtained during the Survey indicates the existence of an additional seven potential inactive waste sites and releases resulting from Ames Laboratory operations. These sites are portions of Gilman Hall and Wilhelm Hall, the ALRR Building septic system, the ASC acid neutralization tank, the ASC Warehouse septic system, the out-of-service sulfuric acid storage tank at the ASC, and potential chromium contamination of the soil as a result of drift from the ALRR Building comfort cooling towers.

However, two sites reported by the Ames Laboratory (ALRR Building and the Blockhouse) and two sites identified during the Survey (Gilman Hall and Wilhelm Hall) consist of internal building radioactive contamination and do not represent a source of environmental contamination.

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PRELIMINARY

APPENDIX A

SURVEY PARTICIPANTS

PRELIMINARY

AMES LABORATORY
SURVEY PARTICIPANTS
APRIL 18-22, 1988

PRELIMINARY

DOE

Team Leader	Joseph Boda
Assistant Team Leader	Lee Stevens
Chicago Operations Office Representative	Ronald Kolzow

Technical Specialists

Air	Robert Lanza (ICF)
Surface/Drinking Water	William Levitan* (NUS)
Groundwater	Wayne Downey (NUS)
Waste Management	Donald Habib (NUS)
Toxic and Chemical Materials	Wayne Downey (NUS)
Direct Radiation/Soils	Ernest Harr (NUS)
Quality Assurance	Ernest Harr (NUS)
Inactive Waste Sites and Releases	William Levitan (NUS)

*Contractor Coordinator

APPENDIX B

SITE-SPECIFIC SURVEY ACTIVITIES

PRELIMINARY

B.1 Pre-Survey Preparation

The DOE Office of Environmental Audit, under the Assistant Secretary for Environment, Safety and Health, selected a Survey team for the Ames Laboratory in the spring of 1987. The Ames Laboratory is managed by the DOE and operated by Iowa State University's Institute for Physical Research and Technology. Mr. Joseph Boda was designated the DOE Team Leader, Mr. Lee Stevens the Assistant Team Leader, and Mr. Ronald Kolzow was the designated Survey team DOE Chicago Operations Office Representative. The remainder of the team was composed of contractor specialists from the NUS Corporation and ICF, Incorporated.

Survey team members began reviewing Ames Laboratory general environmental documents and reports in December 1987. Messrs. Boda and Stevens, along with two members of the NUS Corporation, conducted a pre-Survey site visit on March 21 to 23, 1988, to become familiar with key DOE and Ames Laboratory personnel. They toured the site and completed a cursory review of the documents assembled in response to an information request submitted on January 27, 1988. The request listed environmental documents and reports required by the Survey team for Survey planning purposes. On March 23, 1988, Messrs. Boda, Stevens, and Kolzow and two NUS specialists met with representatives from local agencies to review environmental issues of concern to them and explain the scope of the Survey.

The Survey team reviewed the information received during the pre-Survey visit and prepared a Survey Plan (Appendix C) for the Ames Laboratory. This plan described the specific approach to the Survey for each of the technical disciplines and included a proposed schedule for the on-site activities. A Health and Safety Plan was also prepared for use by the Survey team.

B.2 On-Site Activities

The on-site phase of the Survey was conducted during the period of April 18 through April 22, 1988. The opening meeting was held on April 18, 1988, at the Ames Laboratory and was attended by representatives from the Chicago Operations Office, the Ames Laboratory, and the Survey team members (Appendix A). Discussions during this meeting primarily concerned the purpose of the Survey, logistics at the Ames Laboratory, and an introduction of the key personnel involved in the Survey.

During the Survey, team members reviewed pertinent file documents including permits and applications, background studies, engineering drawings, accident reports, chemical release and spill reports, as well as various operating logbooks. The site activities and associated processes were carefully analyzed to identify existing and potential pollutants. Site operations and monitoring procedures were observed, where possible. Extensive interviews were held with Ames Laboratory personnel concerning environmental controls, operations, monitoring and analysis, regulatory permits, and waste management.

The Survey team members met daily to report observations, discuss findings, and evaluate progress. These meetings were also useful for planning schedule changes, if required, to meet the overall objectives of the Survey. The Survey team developed Sampling and Analysis (S&A) requests to better define Survey observations that had few or no supporting data. The S&A requests were presented to the Idaho National Engineering Laboratory (INEL) representatives who were designated to perform the required S&A.

A site closeout briefing was held on April 22, 1988, at which the DOE Team Leader and Assistant Team Leader presented the Survey team's preliminary findings and observations. The findings were considered preliminary pending additional research and review, and, in some cases, field S&A to better define the Survey team observations.

PRELIMINARY

B.3 Sampling and Analysis

The INEL is performing the S&A portion of the Survey. The INEL evaluated the S&A requests made by the Survey team for the Ames Laboratory to determine logistics, costs, and schedules and to prepare an S&A Plan. The S&A Plan prepared by the INEL includes a quality assurance plan and a health and safety plan. It was completed during the fall of 1988, and the sampling team conducted work at the site in December 1988.

B.4 Report Preparation

The Environmental Survey Preliminary Report for the Ames Laboratory has been prepared for DOE review. The preliminary findings are subject to modification based on comments from the Chicago Operations Office concerning the technical accuracy of the findings and the results of the S&A. The modified findings will be incorporated into the Environmental Survey Summary Report.

PRELIMINARY

APPENDIX C

AMES LABORATORY SURVEY PLAN

PRELIMINARY

DOE ENVIRONMENTAL SURVEY
AMES LABORATORY
AMES, IOWA
April 18 through 22, 1988

1.0 INTRODUCTION

The Environmental Survey is a one-time baseline inventory of existing environmental information and environmental problems and risks at DOE operating facilities. The Survey will be conducted in accordance with the principles and procedures contained in the DOE Environmental Survey Manual.

The Survey is an internal management tool to aid the Secretary and Under Secretary in allocating resources for maintaining aggressive environmental programs and for mitigating environmental problems at DOE facilities.

2.0 SURVEY IMPLEMENTATION

The Environmental Survey at the Ames Laboratory will be managed by the DOE Team Leader, Joseph Boda, and the Assistant Team Leader, Lee Stevens. Ronald Kolzow will serve as the Chicago Operations Office (CH) representative on the Survey team. Technical support will be provided by contractor personnel as follows:

Radiation:	Ernest Harr, NUS Corporation
Surface/Drinking Water:	William Levitan, NUS Corporation*
Waste Management:	Donald Habib, NUS Corporation
Inactive Waste Sites/Releases:	William Levitan, NUS Corporation
Hydrogeology/Storage Tanks:	Wayne Downey, NUS Corporation
Toxic and Chemical Materials:	Wayne Downey, NUS Corporation
Air:	Robert Lanza, ICF Technology, Inc.

*Team Coordinator

PRELIMINARY

2.1 Pre-Survey Activities

Members of the Survey team began reviewing Ames Laboratory environmental documentation available at the DOE Office of Environmental Audit in December 1987. From that review, a memorandum dated January 27, 1988, was sent to the CH requesting additional information. Messrs. Boda, Stevens, Habib, and Levitan conducted a pre-Survey site visit on March 21-23, 1988, to become familiar with the site, to identify any potential environmental problems, and to coordinate plans for the upcoming Survey with CH and Ames Laboratory contractor personnel. During the pre-Survey visit, the team met with representatives of CH and the Ames Laboratory contractor and representatives of Iowa State University and local government agencies. In addition, the team toured the facilities and gathered documents assembled by site personnel in response to the information request memorandum. Additional information was requested and received from Ames Laboratory contractor personnel during the pre-Survey visit, based upon the review of available data on-site.

2.2 On-Site Activities and Reports

The Environmental Survey of the Ames Laboratory site will be conducted from April 18 through 22, 1988. The Survey will include the facilities operated by Iowa State University (ISU) located at the Ames Laboratory, facilities leased by DOE from ISU, and inactive waste sites historically associated with the Laboratory. The agenda for this Survey can be found in the attached Table 1. Modifications to this plan may be made during the course of the Survey. All modifications will be coordinated with the site officials designated as Survey contacts. The on-site activities of the Survey team will consist of interviews and consultations with, among others, environmental safety, operations, waste management, purchasing, and warehousing personnel; a review of files and documents unavailable prior to the on-site portion of the Survey; and project-specific and area-specific tours of the facility. Table 2 indicates specific areas of interest for each of the technical specialists.

A closeout meeting will be conducted on Friday, April 22, to describe observations and initial findings of the on-site activities. A status report stating the findings identified at the closeout meeting will be sent to CH within 4 weeks of the conclusion of the Survey. A Survey Preliminary Report will be prepared within approximately 4 months of the conclusion of the on-site effort. Subsequently, sampling and analysis (S&A) may be conducted at the site to strengthen the Survey findings and fill important data gaps. The results of the S&A effort, if implemented, will then be used along with CH and the Ames Laboratory contractor comments on the Survey Preliminary Report in the preparation of a Survey Interim Report. The findings of each of the Interim Reports from all scheduled Surveys will be updated as appropriate and included in the Survey Summary Report to the Secretary, which is scheduled for completion in 1989.

2.3 Sampling and Analysis

Based upon the results of the on-site portion of the Survey, the Survey team will identify S&A needs, if required. A sampling team under contract to DOE will draft an S&A Plan based upon these needs. The Assistant Team Leader, Lee Stevens, will coordinate the review of this S&A Plan with CH, the Ames Laboratory contractor, and EPA's Environmental Monitoring Systems Laboratory at Las Vegas, which has quality assurance responsibility for the Survey's S&A efforts. Results of the S&A effort, if conducted, will be transmitted to the Survey Team Leader for incorporation into the Interim Report. The Interim Report should be available in 1989.

3.0 AIR EMISSIONS

3.1 Issue Identification

The radioactive and regulated/hazardous air-related Survey activities will involve an assessment of the laboratory-wide air emission sources, emissions controls and sampling/monitoring data. Areas of investigation will include laboratory emissions of radionuclides, acid fumes, toxic metals, organics, nitrogen and sulfur oxides, and volatile hydrocarbons (VOCs), as well as the emissions of carbon monoxide, nitrogen and sulfur oxides, and VOCs from fuel burning equipment. Operational and procedural practices associated with emission controls will also be evaluated. Fugitive sources of radioactive and regulated/hazardous particulate and gaseous emissions, including emissions from chemical and waste storage/handling areas, will be investigated.

PRELIMINARY

The general approach to the Survey will involve a review of existing environmental reports, chemical inventories, operating procedures, ventilation diagrams, stack monitoring reports, radioactive effluent reports, and other relevant documents to identify significant sources of air emissions. Following the document review will be the physical inspection of significant processes and control and monitoring equipment, and potential fugitive sources. The Survey will identify air contaminants from significant emissions sources and fugitive sources; identify and evaluate existing control and monitoring equipment for the air contaminants, and assess the potential for environmental problems from the emissions.

The radiological air monitoring system assessment will involve inspection of any ambient air samplers and review of data acquisition, documentation and procedures, calibration procedures, data validation, and processing. The primary emphasis of the monitoring program review will be to determine the environmental impact of operations and evaluate the quality of the reported data.

3.2 Records Required

- Descriptive documentation on existing and proposed add-on air emission control equipment;
- Ventilation system drawings and hood inventory; and
- Operating, testing and maintenance procedures for air emission control and monitoring equipment.

4.0 RADIATION

4.1 Issue Identification

The radiological portions of the Environmental Survey will involve an assessment of the site-wide radioactive material and effluent control, on-site and off-site monitoring equipment, and the associated impact on the environment and general off-site population. The radiological assessment will encompass three major areas: (1) airborne radioactive emissions; (2) liquid radioactive effluents; and (3) liquid and solid radioactive waste management. Because of overlaps, the radiological assessment will be coordinated with the air, surface water, waste management, hydrogeology, and quality assurance activities.

The assessment will determine whether radioactive materials maintained on-site or released to the environment (or potentially released) create any actual or potential environmental problems. Existing environmental standards, regulations, and guidelines will be used for comparison to assess the potential magnitude of these problems. The review will also determine if appropriate actions are being taken or planned to minimize accidental releases and/or mitigate the consequences of such releases, and whether there are conditions that may lead to environmental problems.

During facility visits the team will work with appropriate Ames Laboratory contractor staff to understand the processes involved, and review radioactive material and airborne and liquid effluent controls, airborne and liquid effluent monitoring, historical records of releases, and laboratory practices associated with effluent monitoring.

In addition, the radiological environmental monitoring program will be assessed through review of documents and records, observation of field activities, and review of related laboratory practices. Finally, dose assessments conducted by the site staff for various purposes, including the annual environmental report, will be reviewed.

4.2 Records Required

- Environmental monitoring reports after 1981

5.0 SURFACE/DRINKING WATER

5.1 Issue Identification

A number of documents provided in response to the information request have been reviewed with regard to the surface water technical specialty area. The Ames Laboratory activities that generate wastewaters will be reviewed through a detailed field evaluation. Discrete liquid discharge points will be identified and evaluated to develop an inventory of wastewater sources. A review of the present condition of the wastewater collection and treatment systems will be made. Liquid waste treatment, processing, collection, and handling equipment will be examined and records of operations will be reviewed. The objective of the review is to build a Survey information data base for the identification of physical evidence of existing or potential environmental contamination. Additionally, drinking water sources, treatment and distribution systems, and drinking water quality data will be reviewed.

The Survey will concentrate on areas of potential concern, including the discharge of contaminants into surface waters. The Survey will also include an identification of potential cross-contamination between chemical/radiological, potable, sanitary, and stormwater sewer systems. Specific attention will be paid to unknown or potential discharges into an inappropriate sewer system, which might cause a particular contaminant to be undetected or untreated. This will be accomplished by a thorough review of site facilities in conjunction with a review of standard operating procedures (SOPs) for the operation and maintenance of wastewater discharge equipment, followed by record review, interviews with site personnel, and observation of procedures.

A review of past water and wastewater conveyance, treatment, and disposal systems will also be accomplished during the Survey to evaluate what environmental problems, if any, may exist as a result of past practices. Site surface drainage features, including channels, swales, culverts and catch basins, will also be reviewed.

5.2 Records Required

- Piping diagrams of sanitary/radioactive wastewater system at the Applied Science Center (ASC);

- City of Ames measurements of ASC discharge chromium levels; dates unknown; and

- 1984 monitoring of sewage plant effluent and sludge samples.

6.0 WASTE MANAGEMENT

6.1 Issue Identification

The Survey procedure for activities related to waste management is to review known sources or activities and identify any additional sources or activities that have the potential to result in contamination of environmental media.

Hazardous/radioactive/solid wastes will be tracked through the system and waste-related site activities and records will be reviewed to develop an inventory and assess Ames Laboratory's waste management practices.

During the hazardous waste portion of the Survey, the team will devote a significant portion of the time on-site to a detailed facility investigation of hazardous waste generation, storage, and disposal practices. Areas for specific inspection will include hazardous waste identification and documentation, solid waste management procedures, waste segregation practices, storage and disposal of scrap/salvage materials, and waste oil management practices. In addition, hazardous waste transfer and storage areas will be examined.

The review of radioactive and nonhazardous solid waste will be similar to that for hazardous wastes. Procedures will be evaluated to determine the Ames Laboratory waste classification practices. The detailed investigation described above will produce information on radioactive and nonhazardous solid wastes so as to delineate any previously unidentified sources of waste that have the potential to result in environmental contamination.

Discussions will be held with individuals knowledgeable on current and past waste management practices. This will be accomplished during the investigation and in the process of reviewing facility records and documentation. The objective is to develop an understanding of past and existing waste management activities that may serve as the basis for problem identification by the Survey team.

The review of activities related to waste management will be coordinated closely with the inactive waste site, hydrogeologic, toxic and chemical materials, and surface/drinking water discipline activities to identify any possible releases that may pose a threat to the environment.

6.2 Records Required

Documentation, procedures, and internal and external correspondences, not already submitted, associated with the following topics:

- The responsibilities and activities of lab personnel in identifying, segregating, storing, and handling (1) nonhazardous solid waste; (2) hazardous waste; (3) radioactive waste; (4) hazardous and nonhazardous biological waste, if any; (5) mixed waste; and (6) waste oil;

- Quantitative and qualitative characterizations of each of the six waste types listed above for the past three years of record;

- The responsibilities and activities of other Ames Laboratory personnel, including the site safety officers;

- The equipment used in picking up and transferring from the points of generation, transporting between on-site facilities, recontainerizing, analyzing, preparing for shipment, and shipping any of the above-mentioned six waste types;

- Hazardous and radioactive waste shipment manifests;

- Monthly chemical usage inventory; and

- Site Waste Information Management System Reports for the last three years of record.

PRELIMINARY

7.0 INACTIVE WASTE SITES/RELEASES

7.1 Issue Identification

The inactive waste sites/releases specialty area review will identify environmental problems associated with the historical handling, storage, and disposal of hazardous substances at the site. The review will involve the evaluation of information developed in response to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations. The Survey will focus on current and future environmental problems related to past land disposal practice and past spills/releases.

The draft Phase I Installation Assessment report, prepared under DOE Order 5480.14 CERCLA Program for Ames Laboratory, identified 9 inactive sites that could potentially result in a risk to public health or the environment. As part of the Survey, the background information sources used in developing the Phase I report will be reviewed, including the material gathered through interviews. As part of the Survey, records indicating the types and quantities of materials disposed of in inactive waste sites will be evaluated, as will the facility design and methods of waste containment. Information available through historical aerial photography, interviews, and site documents, such as Incident Reports, will be assessed to identify inactive waste sites and releases, disturbed land areas, and to further define site locations and associated changes in appearance over time. Visual inspections will be conducted for inactive sites and releases to note surface features and to locate potential monitoring points. Several areas of concern were identified during a review of available documentation, including areas where radioactively contaminated sludge was applied and the chemical disposal site.

Any inactive waste sites that have undergone remediation will also be addressed. Records and analytical data in support of site cleanup will be obtained for review. Inactive tanks or containers that may have held hazardous substances will be located and their status assessed. Former storage areas and staging locations will be included in this effort. Each of these facilities will be evaluated in terms of the potential to cause a present or future risk to workers, the neighboring population, or the environment.

7.2 Records Required

No additional information on inactive waste sites and releases is required at this time.

8.0 HYDROGEOLOGY

8.1 Issue Identification

A major concern for the Survey is the potential sources of groundwater contamination. In addition, the potential impacts of any existing contamination on aquifers and the impacts of off-site movement of contaminated groundwater will be assessed by the Survey team.

A general review of existing data will be required to determine the usefulness of this information for the purposes of the Survey. Interviews with site personnel will be conducted to define local groundwater conditions. In addition, information on regional geological and groundwater characteristics will be collected.

Several areas for specific investigation were identified during a review of available documentation including underground storage tank leak testing, age, construction material, content, and location; aboveground storage tank spill containment; solid and liquid waste management operations; and regional and local groundwater flows and quality.

8.2 Records Required

- Locations and depths of municipal water supply wells

9.0 TOXIC AND CHEMICAL MATERIALS

9.1 Issue Identification

The toxic and chemical materials review will address the raw materials and handling of chemical and petroleum products used at the Ames Laboratory. The use,

PRELIMINARY

handling, and disposal of PCBs, asbestos, pesticides, and herbicides will also be within the scope of this effort.

All toxic and hazardous substances purchased, used, or manufactured on-site will be evaluated. The tracking, control, and management of these substances will be reviewed. Records of usage will be evaluated to determine the potential for environmental contamination.

The inventory of PCBs and PCB-contaminated electrical equipment in use at the facility will be reviewed for completeness. The condition of this equipment, its potential for leakage, and the quantity of contaminated fluids will be identified. Disposal practices will be reviewed for current and past inventories to determine the methods of disposal and the locations of disposal sites. Procedures for PCB analysis, removal, handling, and disposal will be reviewed. Inspection and reporting requirements for PCB transformers will be evaluated in an effort to focus the Survey team's attention on potential problem areas.

The use of asbestos at the Ames Laboratory will be reviewed to identify pathways of environmental contamination. Also, asbestos removal and disposal practices will be evaluated to define potential areas of concern.

Pesticide/herbicide usage on the site will be reviewed to determine the risks of environmental contamination. The review will focus on application records, storage and disposal practices, and environmental monitoring procedures.

Several areas for specific investigation were identified during a review of available documentation including chemical procurement and material QA procedures; toxic and hazardous materials inventory; operator and technician training; decontamination/disposal manifests and records; maintenance/inspection logbooks; and chemical and petroleum storage.

9.2 Records Required

- Yearly chemical usage inventory

TABLE 1
AMES LABORATORY ENVIRONMENTAL SURVEY AGENDA

	Radiation (E. Hahr)	Surface Water/Inactive Waste Sites (W. Levitan)	Waste Management (D. Habib)	Toxic and Chemical Materials/Hydrogeology (W. Downey)	Air (R. Lanza)
Monday, April 18 AM	Orientation	Orientation	Orientation	Orientation	Orientation
	Interview to provide overview on radiation monitoring (procedures, QA)	Document review of waste-water piping and storm-water drainage at ASC and DOE bldgs	Interview with Bob Staggs	Wilhelm Hall	Gilman Hall, document review - chemical inventory, hood inventory
PM	Continuation of A.M. interview	Ames City Office - info on contaminated sludge, POTW, water supply and monitoring	Wilhelm Hall, Physics Addition	Wilhelm Hall, Spedding Hall	Spedding Hall
Tuesday, April 19 AM	Applied Science Center (w/Inactive Waste Sites, Air)	Applied Science Center (w/Radiation, Air)	Metals Development Bldg, Office and Laboratory Bldg	Spedding Hall, interview with geologist regarding groundwater	Applied Science Center (w/Radiation, Inactive Waste Sites)
PM	Sludge disposal areas, old ISU landfill (w/Inactive Sites)	Sludge disposal areas, old ISU landfill (w/Radiation)	Spedding Hall, Gilman Hall	Gilman Hall, Metals Development Bldg.	Metals Development Bldg, Physics Addition
Wednesday, April 20 AM	Interviews regarding residual radiation contamination surveys	Annex I and II sites, shops	Applied Science Center (Rad Waste Disposal Bldg, blue shed)	Office and Laboratory Bldg; Physics Bldg., Sweeney Hall (w/Air)	Coal Preparation Plant, Wilhelm Hall, Sweeney Hall (w/TSCA)
PM	DOE and DOE-leased laboratories - residual radiation contamination	DOE and DOE-leased laboratories - wastewater discharge sources	Shops, Sweeney Hall	Shops (w/Air)	Shops (w/TSCA)
Thursday, April 21 AM	Revisits	Interviews with long-term employees, revisits	Revisits	Applied Science Center	Revisits
PM	Findings development	Findings development	Findings development	Findings development	Findings development
Friday, April 22 AM	Close-out meeting	Close-out meeting	Close-out meeting	Close-out meeting	Close-out meeting

PRELIMINARY

TABLE 2

THE AMES LABORATORY ENVIRONMENTAL SURVEY

AREAS OF INTEREST FOR TECHNICAL SPECIALISTS

WASTE MANAGEMENT D. Habib	-	Hazardous Waste Non-Hazardous Waste RCRA/Solid Waste Permits Mixed Waste Radioactive Waste
RADIATION E. Harr	-	Radioactive Emissions and Effluents Source Controls and Monitoring Radioactive Waste Environmental Monitoring - Radiation
AIR R. Lanza	-	Meteorology Local Air Quality Data Emission Sources, Control and Monitoring Environmental Monitoring - Air Air Permits and Air Emissions Inventory
SURFACE/DRINKING WATER W. Levitan	-	Effluent Sources Wastewater (Process and Sanitary Treatment) Facilities Cooling Water System Drinking Water Distribution Stormwater Management Spill Prevention, Control and Countermeasure Plan
HYDROGEOLOGY/STORAGE TANKS W. Downey	-	Waste Storage and Disposal Sites (Past and Active) Spill/Accident Locations Regional Geology and Groundwater Well Inventory and Construction Groundwater Monitoring Program and Studies Underground and Aboveground Storage Tanks

PRELIMINARY

TABLE 2

THE AMES LABORATORY ENVIRONMENTAL SURVEY

AREAS OF INTEREST FOR TECHNICAL SPECIALISTS (Continued)

INACTIVE WASTE SITES/ RELEASES W. Levitan	-	Past Waste Site Locations Characterization Studies Spill/Accident Locations Remediation Work Former Production Locations
QUALITY ASSURANCE W. Downey	-	Environmental Sampling Program Environmental Analytical Program Data Management and Handling QA Program Overview
TOXIC AND CHEMICAL MATERIALS-TSCA W. Downey	-	Process Chemicals and Substances Inventory Asbestos Use Evaluation Asbestos Removal and Disposal PCBs In-Service, Storage, and Disposal Pesticide Use, Storage, and Disposal Warehousing and Storage Tanks for Process Chemicals

PRELIMINARY

APPENDIX D

LIST OF ABBREVIATIONS, ACRONYMS, AND INITIALISMS

PRELIMINARY

LIST OF ABBREVIATIONS, ACRONYMS, AND INITIALISMS

AAQS	-	Ambient Air Quality Standards
Ac	-	actinium
AEC	-	United States Atomic Energy Commission
ALARA	-	as low as reasonably achievable
ALRR	-	Ames Laboratory Research Reactor
ASC	-	Applied Science Center
Btu	-	British thermal unit
CAS	-	Chemical Abstract Service
CERCLA	-	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	-	cubic foot (feet) per minute
CFR	-	Code of Federal Regulations
CH	-	Chicago Operations Office (United States Department of Energy)
Ci	-	curie
Ci/g	-	curie per gram
CNIM	-	Center for New Industrial Materials
cpm	-	count(s) per minute
D&D	-	decontaminated and decommissioned
DAS	-	Deputy Assistant Secretary
DCG	-	Derived Concentration Guide
DE	-	dose equivalent
DNR	-	Department of Natural Resources
DOC	-	United States Department of Commerce
DOD	-	United States Department of Defense
DOE	-	United States Department of Energy
DOP	-	dioctyl phthalate
dpm/100 cm^3	-	disintegration (s) per minute per 100 square centimeters
EDE	-	effective dose equivalent
EPA	-	United States Environmental Protection Agency
ft^3/s	-	cubic foot (feet) per second
FUSRAP	-	Formerly Utilized Sites Remedial Action Program
Ge(Li)	-	germanium lithium (detector)
gpd	-	gallon(s) per day
gpm	-	gallon(s) per minute
HEPA	-	high-efficiency particulate air
HSWA	-	Hazardous and Solid Waste Amendments
IAR	-	Installation Assessment Report
ICP	-	Inductively Coupled Plasma
ICRP	-	International Commission on Radiological Protection
INEL	-	Idaho National Engineering Laboratory
ISC	-	Iowa State College
ISU	-	Iowa State University
ISU IAR	-	Iowa State University Institute for Atomic Research

PRELIMINARY

kg	-	kilogram(s)
kVA	-	kilovolt-ampere
kW	-	kilowatt(s)
LiF	-	lithium fluoride
MED	-	Manhattan District of the U.S. Army Corps of Engineers
METC	-	Morgantown Energy Technology Center
mg/L	-	milligram(s) per liter
mgd	-	million gallons per day
MPC	-	Materials Preparation Center
mph	-	mile(s) per hour
MRC	-	Microelectronics Research Center
mrem	-	millirem
mrem/yr	-	millirem per year
MSDS	-	material safety data sheet
NAAQS	-	National Ambient Air Quality Standards
nCi/g	-	nanocurie(s) per gram
NCRP	-	National Council on Radiation Protection
NDRC	-	National Defense Research Committee
NPDES	-	National Pollutant Discharge Elimination System
OEG	-	Office of Environmental Guidance and Compliance
OLB	-	Office and Laboratory Building
OSRD	-	Office of Scientific Research and Development
PA	-	Preliminary Assessment
PCB	-	polychlorinated biphenyl
pCi/g	-	picocurie(s) per gram
PETC	-	Pittsburgh Energy Technology Center
POM	-	polynuclear organic materials
ppm	-	part(s) per million
PPO	-	Procurement and Property Office
psi	-	pound(s) per square inch
QA	-	Quality Assurance
QC	-	Quality Control
RCRA	-	Resource Conservation and Recovery Act of 1980
S&A	-	Sampling and Analysis
SARA	-	Superfund Amendments and Reauthorization Act of 1986
SFMP	-	Surplus Facilities Management Program
SH&PP	-	Safety, Health, and Plant Protection (Division)
SQG	-	small quantity generator
Tl	-	thallium
TLD	-	thermoluminescent dosimeter
TRU	-	transuranic
TSCA	-	Toxic Substances Control Act
TSD	-	treatment, storage, and disposal

PRELIMINARY

µCi/m3	-	microcurie(s) per cubic meter
µCi/L	-	microcurie(s) per liter
USDA	-	United States Department of Agriculture
UST	-	underground storage tank
VOC	-	volatile organic compound
WPCP	-	Water Pollution Control Plant (City of Ames)

PRELIMINARY

END

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