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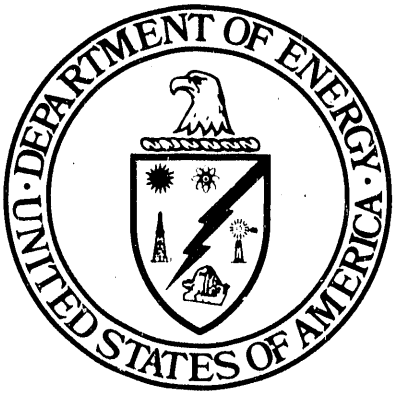

Environmental Survey
Preliminary Report

Argonne National Laboratory
Argonne, Illinois

November 1988

PREFACE TO
THE DEPARTMENT OF ENERGY
ARGONNE NATIONAL LABORATORY
ENVIRONMENTAL SURVEY PRELIMINARY REPORT

This report contains preliminary findings based on the first phase of an Environmental Survey at the U.S. Department of Energy's (DOE) Argonne National Laboratory (ANL), located at Argonne, Illinois. The Survey is being conducted by DOE's Office of Environment, Safety and Health.

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

November 1988
Washington, D.C.

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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) Argonne National Laboratory (ANL), conducted June 15 through 26, 1987.

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. The team includes outside experts supplied by a private contractor. The objective of the Survey is to identify environmental problems and areas of environmental risk associated with ANL. The Survey covers all environmental media and all areas of environmental regulation. It is being performed in accordance with the DOE Environmental Survey Manual. The on-site phase of the Survey involves the review of existing site environmental data, observations of the operations carried on at ANL, 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 will be executed by the Oak Ridge National Laboratory (ORNL). When completed, the S&A results will be incorporated into the Argonne National Laboratory Environmental Survey findings for inclusion in the Environmental Survey Summary Report.

Site Description

ANL is located on a 1,700-acre site in Du Page County in northeastern Illinois, approximately 22 miles southwest of downtown Chicago. It is operated for DOE by the University of Chicago. ANL had its inception during the World War II effort to develop an atomic bomb. In the early 1940s, ANL, then known as the Metallurgical Laboratory, was housed in buildings on or near the University of Chicago campus. The world's first experimental demonstration of a controlled nuclear reaction was performed at this facility, under the direction of Enrico Fermi. In 1943, the laboratory was relocated to the Argonne Forest portion of the Palos Park Forest

Preserve, 20 miles southwest of Chicago, and between 1947 and 1954, it was moved 3 miles west to its present site. The Atomic Energy Commission (AEC), assumed control of ANL in 1947. Only the two sites occupied by ANL while under the auspices of the AEC, the Palos Park Forest Preserve and the present site, are covered in this Survey. Initially, ANL's mission was to be the principal DOE center for basic nuclear reactor research. Over the years, interests at the laboratory have broadened and today its mission is the conduct of basic research in the physical and life sciences, and applied research to further the development of advanced nuclear, fossil, conservation, and renewable energy technologies.

No substantive concerns were raised in a meeting with Federal and state regulators. However, the regulators expressed an interest in the Environmental Survey process and their role in the review of documents produced during the Survey.

Summary of Findings

The major preliminary findings of the Environmental Survey for ANL are:

- Inadequate physical and institutional controls to prevent intrusion into Plot M (a radioactive waste disposal site) by human or natural processes may result in unacceptable human exposures to, and environmental releases of, radioactive and hazardous wastes; and

- There are sites at ANL that are actual and potential sources of environmental contamination. These sites include currently operating facilities and inactive waste sites, and may involve hazardous and radioactive wastes.

Overall Conclusions

The Survey found no environmental problems at ANL that represent an immediate threat to human life. The environmental problems identified at ANL by the Survey team confirm that the facility is affected by several potentially significant environmental problems which are the result of both current and past practices.

The environmental problems vary in terms of magnitude and risk, as described in this report. Although the Survey-related S&A to be performed at ANL will assist in further identifying some suspected environmental problems at the site, 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 at the site will contribute toward meeting this requirement.

Transmittal and Follow-up of Findings

The preliminary findings of the Environmental Survey for ANL were shared with the DOE Chicago Operations Office (CH) and ANL at the Survey closeout briefing held on June 26, 1987. By September 1987, the CH had developed a draft action plan to address the Survey preliminary findings. A final action plan addressing all the Survey findings cited herein will be prepared by the CH within 45 days after receiving this Preliminary Report. Those problems that involve extended studies and multiyear budget commitments will be the subject of the 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 ANL 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.

1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings made during the Environmental Survey, June 15 through 26, 1987, at the Department of Energy's (DOE) Argonne National Laboratory (ANL), Argonne, Illinois. 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 (CH) and results from the Survey's Sampling and Analysis program at ANL, will be incorporated into the Environmental Survey Summary Report. The CH manages ANL, which is operated by the University of Chicago. The ANL Environmental Survey covered all facilities on the ANL property including the New Brunswick Laboratory, which is operated by DOE, and Site A and Plot M, which are located in the Palos Park Forest Preserve, 3 miles east of ANL.

The ANL 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 means of identifying existing and potential environmental problems.

The ANL 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 ANL 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 (e.g., air or soil), whereas Section 4.0 includes those that are non-media-specific (e.g., waste management, direct radiation, and quality assurance). 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. A list defining the abbreviations used throughout the text is provided in Appendix D.

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 environment[al] standard where there is immediate potential for human exposure, or a one-time exceedance where residual impacts pose an immediate potential for human exposure.

- 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.

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 ANL Survey will be Sampling and Analysis (S&A). The Oak Ridge National Laboratory (ORNL), the S&A team for ANL, will collect samples over a 2-week period beginning in late October 1987. An S&A Plan is being prepared by DOE and the ORNL in accordance with the protocols in the DOE Environmental Survey Manual. The S&A Plan is designed to fill existing data gaps or weaknesses. Results generated by the S&A 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 in September 1987 in response to the preliminary findings presented at the conclusion of the on-site Survey activities and summarized in the ANL Survey Status Report dated July 27, 1987. The draft action plan for the ANL 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 ANL Survey will address all of the preliminary findings cited herein, and incorporate OEG's comments on the draft action plan.

2.0 GENERAL SITE INFORMATION

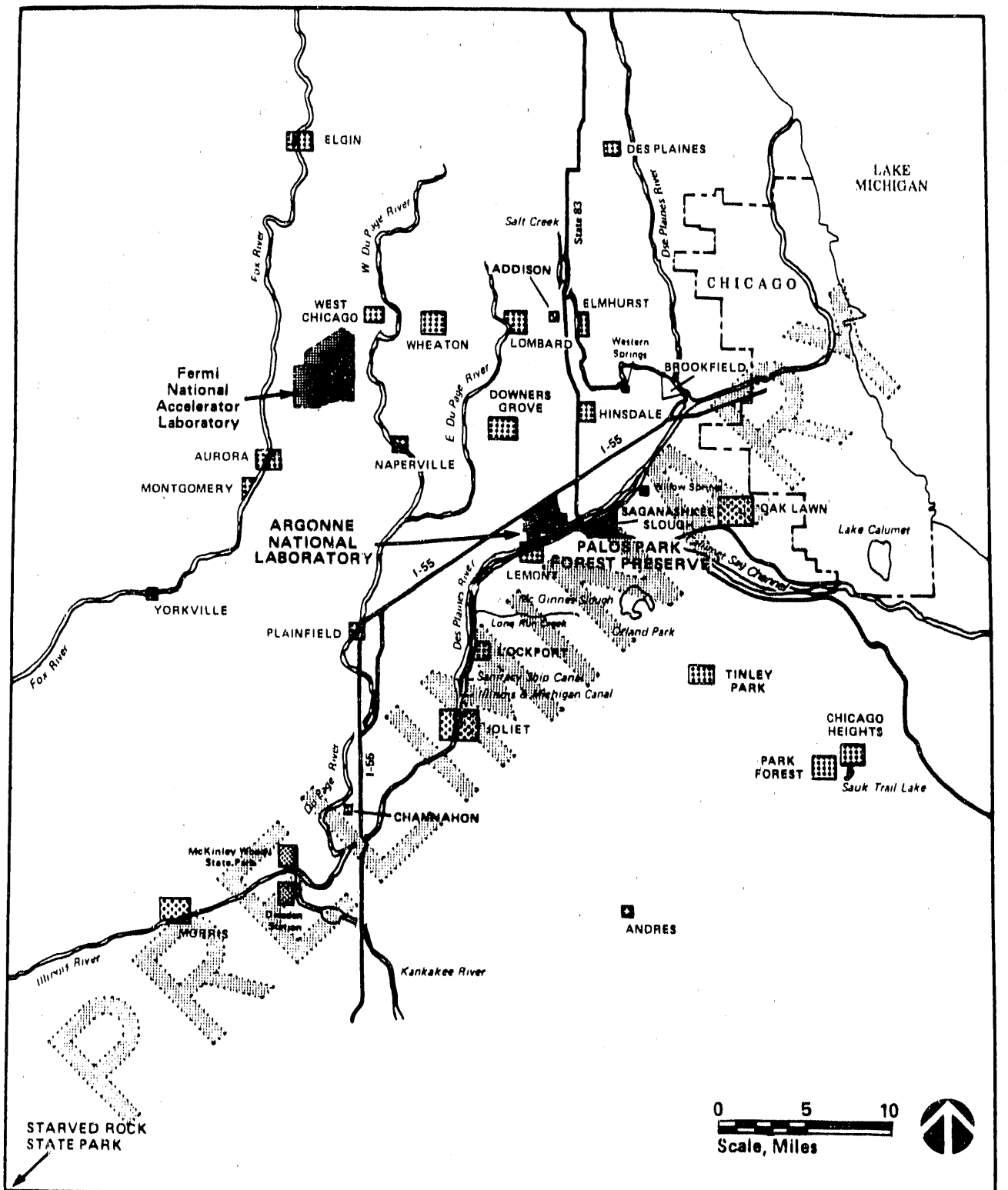
Much of the information contained in this section is summarized from the Site Development Plan (ANL, 1986) and the ANL Environmental Assessment (DOE, 1982).

2.1 Site Setting

ANL occupies a 1,700-acre tract in Du Page County, Illinois, about 22 miles southwest of downtown Chicago (Figure 2-1). The laboratory and support facilities, located in six distinct areas (200 Area, 300 Area, ZGS Complex, 600 Area, 800 Area, and East Area), encompass about 200 acres, with the remaining 1,500 acres being devoted to forested and landscaped areas (Figure 2-2). Waterfall Glen Nature Preserve, a 2,041-acre nature preserve operated by the Du Page County Forest Preserve District, completely encircles the ANL site. It is used as a public recreation area, nature preserve, and demonstration forest. From 1947 to 1973, the nature preserve land was part of ANL property. In addition, as described in Section 2.2, ANL was located in the Palos Park Forest Preserve from 1943 to 1956. This preserve, 3 miles east of present-day ANL (Figure 2-3), is now a public recreation area .

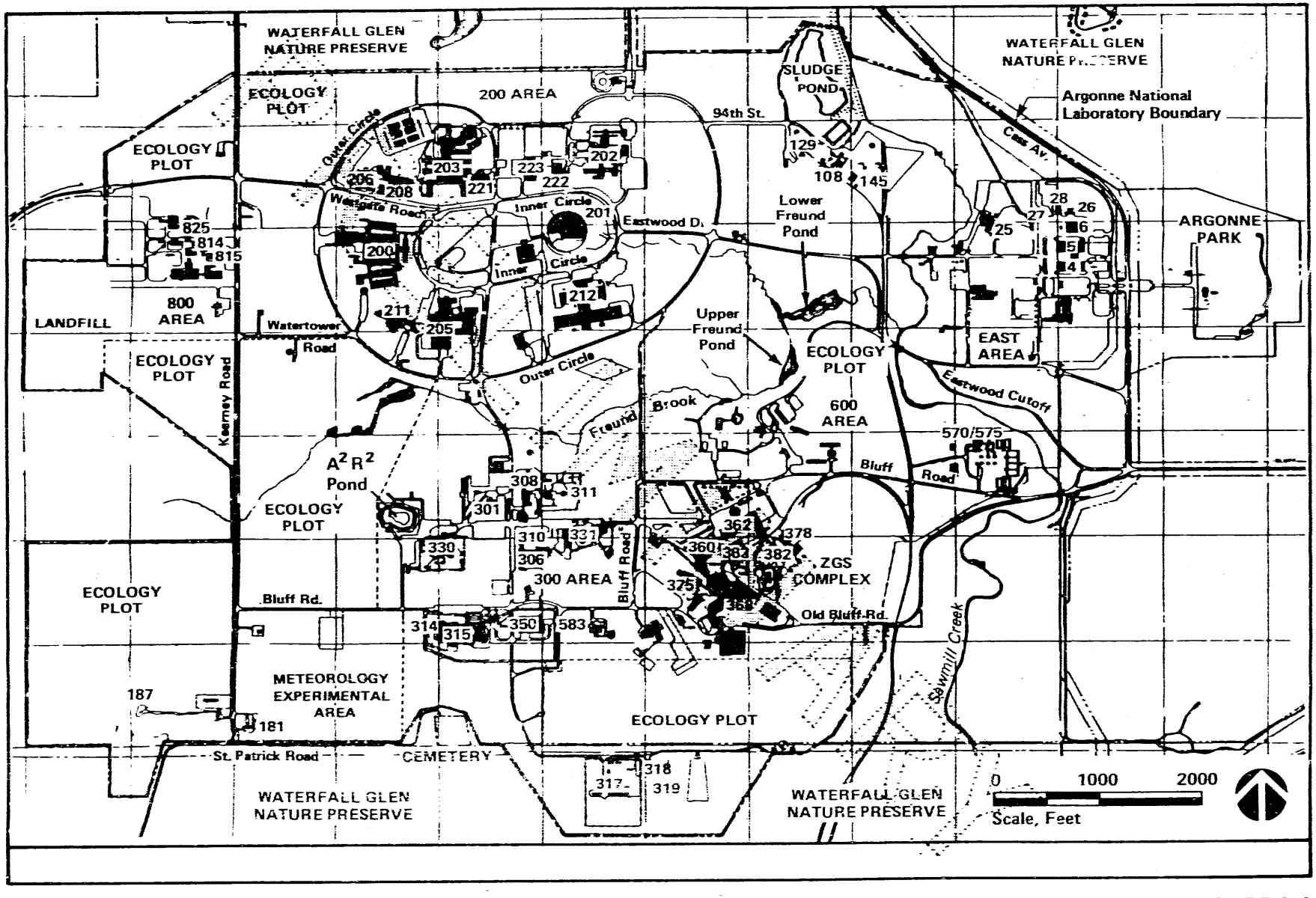
ANL and the Waterfall Glen Nature Preserve lie in the Des Plaines River Valley. A number of industrial parks are located north and northwest of ANL and many commercial and low-density residential structures are found within a few miles surrounding ANL. The terrain of the site is gently rolling, partially wooded, former prairie and farmland. An exception is the southern border of the site, which contains ravines that slope at 15- to 60-degree angles to the Des Plaines River floodplain. Elevations at the site average 772 feet above sea level. With the exception of the ravines, elevation changes at the site are no more than 25 feet over a horizontal distance of 492 feet.

A number of small ponds and streams are situated throughout the ANL grounds. Sawmill Creek, the principal surface-water feature, flows through the site in a southerly direction and enters the Des Plaines River about 1.3 miles southeast of the center of the site (Figure 2-3). Its average annual flow is about 0.3 cubic meter per second (m^3/sec) with extremes of 0.10 m^3/sec and 27.9 m^3/sec. Most of the ANL property drains to Sawmill Creek and one of its tributaries, Freund Brook. However, the extreme southern portion of the site drains directly into the Des Plaines River.



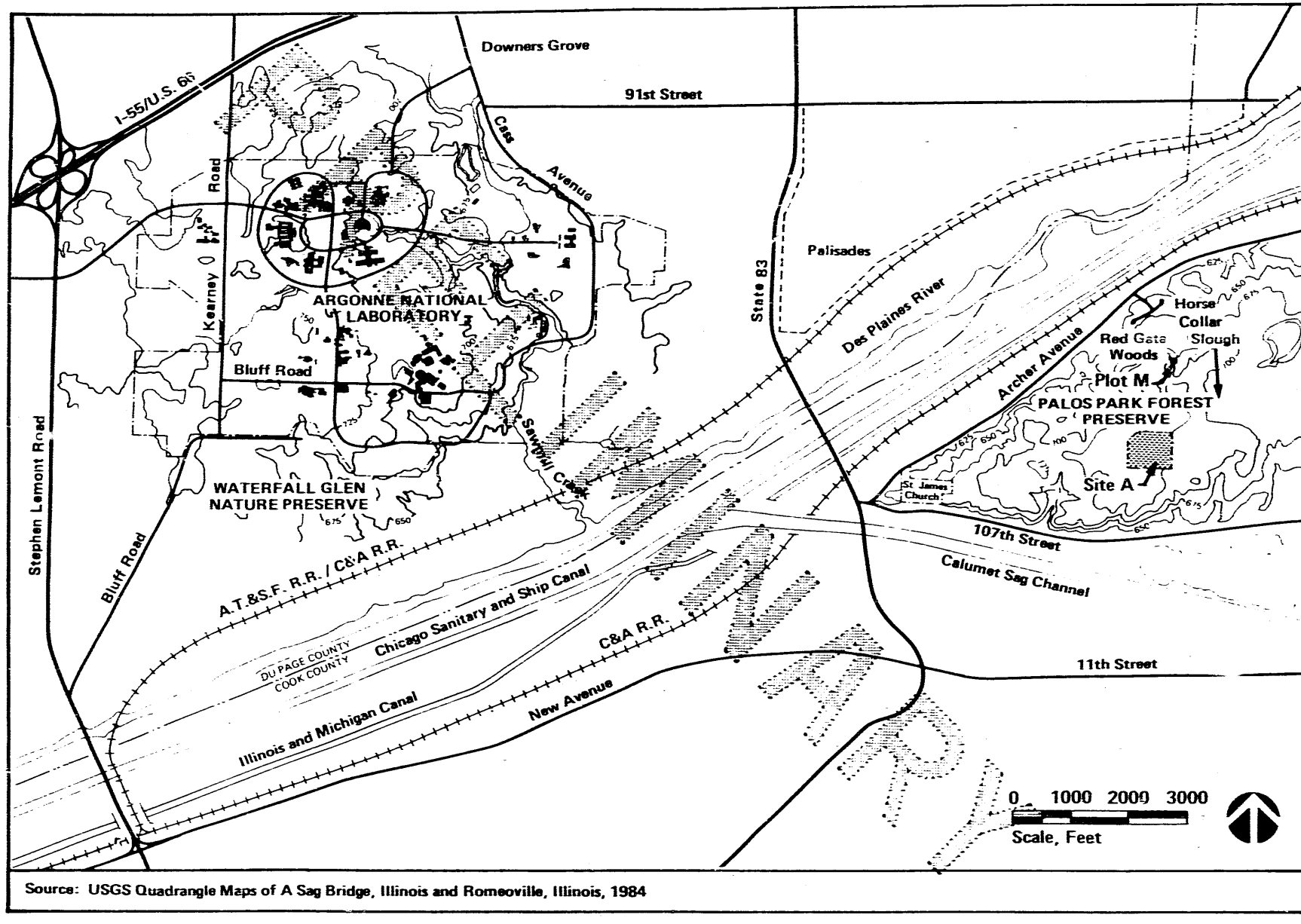
Source: DOE, 1978

ARGONNE NATIONAL LABORATORY AREA MAP FIGURE 2-1



ARGONNE NATIONAL LABORATORY SITE PLAN

FIGURE 2-2



Source: USGS Quadrangle Maps of A Sag Bridge, Illinois and Romeoville, Illinois, 1984

RELATIONSHIP OF LOCATIONS OF ARGONNE NATIONAL LABORATORY AND PALOS PARK FOREST PRESERVE

FIGURE 2-3

The Des Plaines River courses southwest until it joins the Kankakee River about 30 miles southwest of ANL to form the Illinois River (Figure 2-1); flow ranges from 12 to 340 m^3/sec.

The Palos Park Forest Preserve (Figure 2-3) lies in the Calumet Sag Channel and Des Plaines River valleys and is bordered on the north and northwest by the Des Plaines River and the Chicago Sanitary and Ship Canal and to the south by the Calumet Sag Channel. The terrain is wooded and slopes from 725 feet above sea level to 625 feet above sea level at the Canal. Surface water at Palos Park consists of swamps, ponds, and intermittent streams that drain either to the Chicago Sanitary and Ship Canal or the Calumet Sag Channel.

Du Page County had a population of 658,858 as recorded by the 1980 census; in 1985 its population was estimated at 737,100. The two nearest towns to the ANL site, Downers Grove to the north and Lemont to the south, had populations of 42,691 and 5,640, respectively, based on the 1980 census. A directional and annular 80-kilometer (50-mile) population distribution for the area, modifying a 1981 distribution based on the 1980 census, is presented in Table 2-1 (Golchert and Duffy, 1987). Approximately 4,450 people worked at ANL as of July 1985. Regular employees numbered about 3,530, while an additional 920 individuals may be present on a short-term or special-term basis. An average of 130 people reside on a temporary basis at the lodging facilities in the 600 Area of the ANL site.

The regional climate of the ANL area is characterized as continental with relatively cold winters and hot summers. The area is subject to frequently changing weather as storm systems move from the Great Plains toward the east. The weather is slightly modified by Lake Michigan, which is about 22 miles east-northeast of ANL.

The average daily air temperature was 8.9°C at ANL for the period 1950 to 1964 and 10.3°C at Midway Airport, 12 miles east-northeast of ANL, for the period 1941 to 1970. Monthly mean temperatures at ANL for the period 1950 to 1964 were lowest in January, -4.3°C, and highest in July, 23.2°C. The average wind speed at ANL at a height of 45 meters is 5.5 meters per second (m/sec); calm periods prevail 2.0 percent of the time. At a height of 5.8 meters, wind speed averages 3.4 m/sec with calm periods occurring 3.1 percent of the time. Data from Midway Airport indicate that the predominant wind direction is from the south, accounting for 17 percent of

TABLE 2-1

INCREMENTAL POPULATION DATA IN THE VICINITY OF ANL, 1981

Direction	Distance									
	0 - 1[a] 0-1.6[b]	1 - 2 1.6-3.2	2 - 3 3.2-4.8	3 - 4 4.8-6.4	4 - 5 6.4-8.0	5-10 8-16	10-20 16-32	20-30 32-48	30-40 48-64	40-50 64-80
N	0	344	1,504	863	4,115	37 200	179,200	312,100	133,300	202,100
NNE	0	188	2,086	14,685	5,882	38,800	290,700	493,400	95,900	0
NE	0	528	6,544	1,450	1,219	44,000	710,100	940,700	0	0
ENE	0	2,630	3,640	1,854	985	35,600	639,500	240,800	0	0
E	0	14	212	20	15	34,400	514,900	249,400	10,700	25,200
ESE	0	0	85	275	120	11,300	206,200	291,900	271,000	69,000
SE	0	5	155	225	68	29,000	69,500	119,200	24,400	13,300
SSE	0	44	2,299	1,422	120	1,900	21,700	9,300	9,200	20,000
S	0	100	574	2,114	725	5,500	18,500	1,800	33,000	39,500
SSW	0	60	4,407	1,928	705	19,100	100,900	9,400	17,700	7,500
SW	0	620	1,304	50	915	11,100	31,500	6,500	15,000	7,800
WSW	0	492	50	409	12,261	3,300	7,100	2,100	6,300	9,400
W	0	2,853	905	14,000	16,464	4,100	58,700	19,600	15,000	6,600
WNW	0	1,007	140	5,100	5,960	39,800	85,500	8,700	7,700	50,300
NW	0	215	2,032	3,367	7,741	28,500	65,200	87,200	10,500	16,600
NNW	0	323	987	2,156	7,710	41,100	151,200	167,100	107,700	79,500
Total	0	9,423	26,924	49,918	65,005	386,700	3,141,400	2,959,200	757,400	546,800
Cumulative Total	0	9,423	36,347	86,265	151,270	538,000	3,679,400	6,638,600	7,396,000	7,942,800

Source: Golchert and Duffy, 1987

[a] Distance in miles

[b] Distance in kilometers

the observations. Winds come from the south through west sectors nearly 50 percent of the time.

Average annual precipitation is 31.5 inches at ANL and 34.4 inches at Midway Airport. Most of the precipitation falls in spring and summer and is associated with thunderstorms, of which 40 occur annually. Annual average accumulation of snow and sleet is 32.2 inches. Snowstorms resulting in accumulations greater than 6 inches occur only once or twice annually. The theoretical probability of a tornado strike at ANL is once every 1,171 years. However, ANL was struck by tornadoes in 1976 and 1978.

ANL lies within the Prairie Peninsula Section of the Oak-Hickory Forest Region, which is characterized by a mosaic of oak forest, oak openings, and tall-grass prairie. Most of the fields at ANL are in various stages of old field succession, dominated by bluegrass and various forbs including yarrow, Queen Anne's lace, goldenrod, asters, and bindweed. Crown vetch has been planted in some areas, especially in the developed tracts, to help control soil erosion. The deciduous forests on the remainder of the site are dominated by various oak species, including bur, white, red, and black oak. Some of the peripheral areas of the site are planted with jack, white, and red pine.

The ANL site is an effective refuge for many animal species due to the diversity of vegetational communities and the large degree of protection from human intrusion. Species present are those characteristically found in open fields, forests, and forest-edge communities and include eastern cottontail; opossum; raccoon; striped skunk; woodchuck; a variety of other rodents, snakes, turtles, and frogs; and numerous suburban and urban bird species. The site is inhabited by a herd of 400 fallow deer, a species imported from Europe.

Aquatic habitats at ANL include streams and man-made impoundments and drainage ditches. The ditches and smaller ponds are dominated by cattail and rushes. Fishes, mainly sunfishes and minnows, and some waterfowl species, are found in the larger ponds. Freund Brook supports crayfish and several types of insect larvae, including Diptera, caddisfly, and midges; however, fish are rare. The biota of Sawmill Creek reflect its high silt and organic load. Dense filamentous green algae grow attached to the rocky substrate. The macroinvertebrate and fish

communities are not diverse and consist of blackfly and midge larvae, isopods, flatworms, segmented worms, creek chub and other minnows, sunfishes, and catfishes.

No threatened or endangered species have been reported on the ANL site. However, the federally-designated endangered Indiana bat, bald eagle, peregrine falcon, and Kirtland's warbler have been reported in the vicinity. The Natural Land Institute has published an endangered/threatened species list for Illinois which contains 12 animal and 26 plant species distributed in the three counties (Du Page, Cook, and Will) surrounding ANL.

Cultural resources have been surveyed on a portion of the ANL property. As of summer 1981, 18 prehistoric and three historic sites had been identified. Five of the 18 prehistoric sites were lithic tool-making and remanufacturing areas during the late Middle Archaic and early Late Archaic periods (4,000 years before present). Numerous historic homesteads were once located on ANL property, although the remains of only three homesteads have been identified.

2.2 Overview of Major Site Operations

ANL began operations during the World War II effort to develop an atomic bomb. The laboratory, code-named the Metallurgical Laboratory, was housed in university and temporary buildings on or near the University of Chicago campus. Under Enrico Fermi's leadership, the laboratory personnel developed nuclear reactor theory and, in December 1942, performed the first experimental demonstration of a controlled nuclear reaction. The reactor used was known as CP-1 (Chicago Pile-1). The laboratory also led in development of the basic chemistry and nuclear physics of uranium, plutonium, and other transuranic elements created in CP-1.

As the research activity outgrew available space and as the need increased for remoteness for secrecy and safety, the Manhattan District of the U.S. Army Corps of Engineers leased 1,025 acres of land in Argonne Forest, part of the Palos Park Forest Preserve, 20 miles southwest of Chicago and 3 miles east of the present ANL site (Figure 2-3), for continuing research. Only about 20 acres of land were actually used; Site A was a 19-acre parcel where reactors and associated buildings, laboratories, and living quarters were located, while Plot M was a 1-acre radioactive

waste burial site about 2,000 feet north of Site A. During March 1943, the CP-1 reactor was moved from the University of Chicago and rebuilt at Site A as CP-2. In 1944, a second reactor, CP-3, was built and operated at Site A.

After World War II, a Federal decision was made to continue nuclear research, development, and production activities. As a result, the Argonne Division of the Metallurgical Laboratory became Argonne National Laboratory on July 1, 1946. In 1947, at the time the Atomic Energy Commission (AEC) assumed control of ANL, the present Du Page County site was obtained. By 1949, the first permanent buildings at the new location were completed and by 1954, virtually all ANL activities were accommodated on-site. Meanwhile, both reactors at Site A continued to operate until 1954. By June 30, 1956, the area was completely abandoned, the buildings and facilities were decontaminated and demolished, and the area reverted to the Palos Park Forest Preserve, a public recreation area.

The AEC accepted broadly defined basic research as a major element of the ANL mission and assigned it the principal responsibility for reactor development. The laboratory rapidly developed strong basic research programs in nuclear and reactor physics, nuclear and radioactive-element chemistry, and biology of radiation effects. Applied programs in support of reactor development included chemical engineering, metallurgy, reactor engineering, applied mathematics, and instrumentation. As a result, ANL developed many successful reactor designs; several of the reactors, including CP-5 and the Experimental Boiling Water Reactor (EBWR), are still located at the current site.

During the 1950s and 1960s, research emphasis included development of the liquid-metal-cooled fast breeder reactor (LMFBR). In addition, research efforts strengthened in the areas of high-energy physics, as a result of construction of the Zero Gradient Synchrotron (ZGS), materials science, and fundamental molecular biology and biochemistry. In the 1970s, research extended into fossil and alternative energy sources and systems, systems analysis, economics, management, and environmental analysis and research.

Presently, ANL is operated by the University of Chicago under contract to DOE. Its mission is to conduct basic research in the physical and life sciences, and technology-

directed work to further the development of advanced nuclear, fossil, conservation, and renewable energy technologies. ANL's base program has five major elements:

- Conduct research and development for design of all types of advanced nuclear energy plants, assuming a leadership role among the national laboratories;

- Conduct basic research in the physical and life sciences that supports the national trust missions of DOE and that provides the scientific base for development of advanced energy technologies. This includes research in atomic physics; materials science; chemistry; high-energy physics; computer sciences; biological effects of low-level radiation and complex organic chemicals; and transport, fate, and effects of energy-related by-products and wastes;

- Perform technology-directed work in the areas of fusion, fossil, conservation, and renewable energy technologies;

- Develop and operate capital-intensive research facilities, based on the Laboratory's special technologies and skills, for use in research by scientists and engineers in academic, industrial, and other government organizations; and

- Engage in outreach activities in the areas of technology transfer and commercialization, other industry interactions, university interactions, and education of the interested nonscientific public.

ANL presently contains a wide variety of facilities and equipment to carry out its mission. Most facilities are clustered within six distinct areas (Figure 2-2). The 200 or Core Area is the central and major developed area of the ANL site; it contains 15 permanent buildings and 1 semipermanent building. Many of these are research-oriented light laboratory and office buildings. Most buildings in the 300 Area, located south of the 200 Area, were constructed in the early 1950s to house nuclear reactors and special-purpose nuclear laboratories. They are permanent and have major, specialized heavy laboratories. The ZGS Complex, which operated from 1964 to 1979, is located just to the east of the 300 Area. It comprises 29 distinct facilities

that supported the ZGS accelerator. Some of the ZGS facilities are now used for the Intense Pulsed Neutron Source (IPNS).

The 600 Area, north of the ZGS Complex, contains lodging and recreational facilities for students and visiting research associates. A group of temporary buildings used for equipment and supply storage, shops, and vehicle and grounds maintenance is located in the 800 Area. These buildings were constructed during initial site development and are still being used due to lack of funding to construct permanent facilities. A 25-acre plot in the southwestern portion of the 800 Area is used for landfill disposal of site-generated solid waste. The East Area also contains many temporary buildings constructed during initial site development. Most have been demolished recently although six that constitute the ANL Supply Facility remain. Several of the demolished facilities were used for reactor development programs and had varying degrees of radioactive contamination.

Other areas at ANL include the Central Heating Plant, which contains the domestic water treatment plant (Building 129), Central Boiler House (Building 108) and coal pile; the Waste Treatment Plant (Building 570/575); the Meteorology Experimental Area, with a 150-foot micrometeorological tower; several ecology plots, which provide on-site field areas for environmental research; and Argonne Park, which provides sports fields, picnic areas, and a social hall for ANL and DOE employees.

2.3 State and Federal Concerns

A meeting was held on May 5, 1987, with representatives from the U.S. Environmental Protection Agency and Illinois Environmental Protection Agency. The representatives were asked to present their concerns about existing and potential environmental concerns associated with ANL operations. They raised no issues of substantive concern but did express an interest in the Environmental Survey process and their role in the review of documents produced during the Survey.

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

3.1.1 Background Environmental Information

Du Page County, in which ANL is located, is part of the Metropolitan Chicago Interstate Air Quality Control Region (AQCR) 67. Table 3-1 presents the National Ambient Air Quality Standards (NAAQS) adopted in the State of Illinois Air Pollution Control Regulations, which are designed to protect the health and welfare of the general public and are applicable to AQCR 67. The Division of Air Pollution Control within the Illinois Environmental Protection Agency (IEPA) is responsible for administration and enforcement of the state air regulations governing these criteria pollutants, of which ANL emits all those listed. However, emissions of lead are insignificant. In addition, ANL is a source of radioactive and other hazardous air emissions regulated by IEPA and Region V of the U.S. Environmental Protection Agency (EPA). Because ANL is a DOE facility with radioactive air emissions, the National Emission Standard for Hazardous Air Pollutants (NESHAP) of Title 40, Code of Federal Regulations, Part 61 (40 CFR 61), Subpart H, is applicable to the facility. The NESHAP regulations of 40 CFR 61, Subparts C (Beryllium), E (Mercury), F (Vinyl Chloride), and M (Asbestos) are also applicable to ANL air emission sources.

Figure 3-1 presents the monthly and annual average wind rose data for a 15-year period (1950 through 1964) measured at the 19-foot level at the on-site meteorological station. This is the most recent period for which data are readily available. On an annual average, the prevailing directions are from the south-southwest through west, with a primary peak from the south-southwest. However, winds from the west-northwest through east-northeast occur with about the same

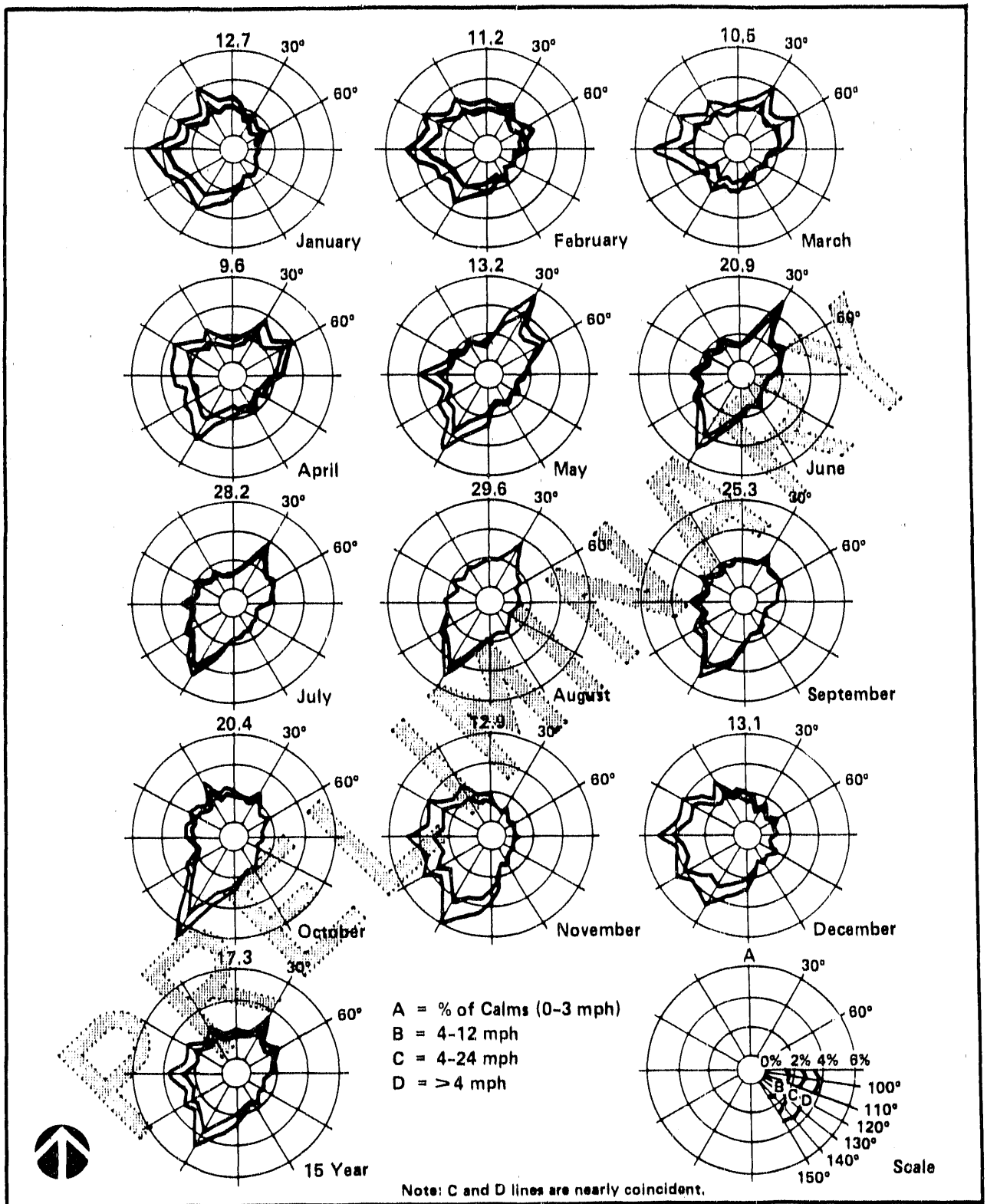
TABLE 3-1

AMBIENT AIR QUALITY STANDARDS, STATE OF ILLINOIS

Air Contaminant	Standard		Units	Averaging Period
	Primary	Secondary		
Sulfur Dioxide	80 360 --	-- -- 1300	µg/m³[a] µg/m³ µg/m³	Annual 24 hours 3 hours
Total Suspended Particulates	75 260	60 150	µg/m³ µg/m³	Annual 24 hours
Carbon Monoxide	10 40	60 150	µg/m³ µg/m³	8 hours 1 hour
Nitrogen Dioxide	100	Same as Primary	µg/m³	Annual
Ozone	244	Same as Primary	µg/m³	1 hour
Lead	1.5	Not Established	µg/m³	3 months

Source: 40 CFR 52.1883
State of Illinois Air Pollution Control Regulations, Part III

[a] Micrograms per cubic meter



Source: Golchert et al., 1979

MONTHLY AND ANNUAL AVERAGE WIND ROSES FIGURE 3-1
BASED ON HOURLY OBSERVATIONS
JANUARY 1950 – DECEMBER 1964, 19-FOOT LEVEL
ARGONNE NATIONAL LABORATORY

frequency, with a secondary peak from the north-northeast. The mean and median wind speeds for the 15-year period are 7.6 and 7.0 miles per hour (mph), respectively.

The monthly average wind roses obtained from the 15-year data base show more dramatic variations. During the cooler months of the year (January, February, November, and December), the winds are predominantly from the west (south-southwest through north-northwest). In the warmer months (May, June, July, and August), the winds develop pronounced north-northeast and south-southwest components. The frequency of north-northeast winds noticeably decreases during the transition months (April, September, and October), but the south-southwest component remains prominent in the wind rose data. Since ANL is located about 22 miles from Lake Michigan, it is likely that lake breeze circulations influence the ANL meteorology during the warmer months. Land breeze circulations may also develop, but these are generally weaker than the lake breeze and are less likely to penetrate as far inland as ANL.

3.1.1.1 Nonradioactive Air Contaminants

Du Page County, AQCR 67, is designated an attainment area for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and lead. The township of Addison, approximately 14 miles north of ANL (Figure 2-1), is designated as a nonattainment area of the primary and secondary standard for total suspended particulates (TSP), while all other townships within Du Page County are designated to be in attainment of the TSP standards. The entire county does not meet the primary standard for ozone (O_3).

The location of the TSP nonattainment area is not considered to be a concern to ANL because of the distance of the township of Addison from the facility. However, the nonattainment status of Du Page County with respect to the primary NAAQS for O_3 requires special attention to the emissions of volatile organic compounds (VOCs) from ANL. The formation of ozone in the lower atmosphere occurs through a complex air chemistry that involves photochemical reactions with atmospheric hydrocarbons. Thus, the emissions of photochemically reactive hydrocarbons are considered precursors to the ambient levels of ozone in the atmosphere, and

implementation plans for the attainment and maintenance of the ozone standard involve the control of VOC emissions.

The emission of chlorofluorocarbon (CFC) compounds presents a different problem to ANL, since CFCs have been implicated in aerochemical reactions for stratospheric ozone depletion. CFC compounds are considered to have negligible photochemical reactivity, and, at the discretion of individual state regulatory agencies, can be exempt from VOC control requirements in implementation plans (42 Federal Register 35314). The very low reactivity of CFCs gives these compounds a long lifetime in the atmosphere and allows the CFCs to diffuse and accumulate in the stratosphere where they deplete ozone in the protective layer. This is a global problem, since the total CFC burden in the stratosphere relates to the worldwide emissions of these substances. Recognition of this problem has led to CFCs being banned as aerosol propellants under the Toxic Substances Control Act (TSCA), but CFC compounds are extensively used as refrigerants and degreasers. CFCs are used for some of these purposes at ANL. While CFCs are not regulated under the Clean Air Act (CAA), recent data on the depletion rate of the ozone layer have refocused attention on the possible need to regulate atmospheric emissions of these compounds.

There is also a growing national concern relative to the anthropogenic emissions of toxic air pollutants (TAP). At present, NAAQS have not been established for TAPs, but many state regulatory agencies have developed, or are in the process of developing, regulations and guidelines governing these pollutants. EPA has published the intent to issue NESHAP regulations on 21 hazardous air pollutants (40 CFR 61, Subpart A), and lists approximately 300 toxic chemicals for the emissions inventory regulation of Section 313 of the Superfund Amendments and Reauthorization Act of 1986 (SARA, Title III). Table 3-2 lists some of the more frequently encountered toxic substances that are being considered for regulation at industrial facilities.

ANL is a source of SO_2, NO_2, CO, O_3, and TSP, as well as various VOCs used in various locations throughout the laboratory; lead emissions are insignificant.

TABLE 3-2

COMMON INDUSTRIAL TOXIC AIR POLLUTANTS

Acetaldehyde	Ethylene
Acetonitrile	Ethylene dibromide
Acrylonitrile	Ethylene dichloride
Ammonia	Ethylene oxide
Arsenic and compounds	Fluorine
Benzene	Formaldehyde
Benzo (a) pyrene	Hydrogen cyanide
Beryllium and compounds	Maleic anhydride
Bromine	Methyl chloride
Butadiene	Methyl methacrylate
Cadmium and compounds	Methylene chloride
Carbon disulfide	Phosgene
Carbon tetrachloride	Styrene
Chlorine	Tetrachloroethylene
Chlorobenzene	Titanium tetrachloride
Chloroform	Toluene
Chromium (VI) compounds	Toluene diisocyanate
Cyanide and compounds	Vinyl chloride
Dioxin	Xylene
Ethylbenzene	

3.1.1.2 Radioactive Air Contaminants

Northern Illinois contains a large number of commercially-owned and government-owned nuclear facilities. As a result, extensive radiological environmental monitoring has been conducted in association with these facilities. The monitoring program at ANL includes off-site sampling and monitoring locations selected to provide a measure of background radioactivity levels for comparison with site perimeter results. Section 3.1.3.2 contains additional information on the radioactive air emission monitoring program at ANL.

Gross alpha and gross beta measurements of airborne particulates are used as general indicators of radioactivity. In 1986, the ANL measurements off-site averaged 1.8 and 25 femtocurie (fCi)/cubic meter for gross alpha and beta, respectively (Golchert and Duffy, 1987). The average gross beta levels were adjusted by exclusion of the results for May and June when levels increased sharply as a result of the Chernobyl accident. The gross alpha activity averaged the same as for the past four years. The gross beta results are consistent with the results reported for the Dresden Nuclear station for 1983 which averaged 23 fCi/cubic meter (Teledyne, 1984) and results reported by the EPA for Chicago, which averaged 10 fCi/cubic meter (EPA, 1987).

Analyses for specific alpha, beta, and gamma emitters in air were also conducted as part of the ANL and EPA programs. The parameters measured in these studies are naturally occurring or result from fallout of nuclear weapons testing. Others, including some of those emitted at ANL, are not measured since they are not expected to occur because of short half lives or, if they do occur, would be below detection limits. The results of the two programs are in reasonable agreement and are summarized in Table 3-3.

3.1.2 General Description of Pollution Sources and Controls

The discussion of air emissions, controls, and problems at ANL is presented in terms of nonradioactive and radioactive materials. The nonradioactive air emissions include a wide range of substances generated by the burning of fuels and diverse research and development activities conducted at the facility. Radioactive air emissions, including thoron (radon-220), tritium, carbon-11, argon-41, krypton-85,

TABLE 3-3

BACKGROUND AMBIENT AIR CONCENTRATIONS OF RADIOACTIVE AIR EMISSIONS

Media	Radionuclide	Type of Decay	ANL Average[a]	EPA Average[b]	Units
Particulates	Be-7	Gamma	93	NA	fCi/m^3
	Pb-210	Beta	33	NA	fCi/m^3
	U-234	Alpha	9	19	aCi/m^3
	U-235	Alpha	ND	1	aCi/m^3
	U-238	Alpha	7	19	aCi/m^3
	Pu-238	Alpha	NA	0.4	aCi/m^3
	Pu-239	Alpha	0.5	0.1	aCi/m^3

Source: Golchert and Duffy, 1987; EPA, 1987

[a]Off-site average for 1986
[b]Chicago results for January to June 1986
NA means not available
ND means none detected
fCi = 1 femtocurie = 10^{-15} Ci
aCi = 1 attocurie = 10^{-18} Ci

antimony-125, radioiodines (iodine-129 and 131), cesium-137, and plutonium-239, are generated by the various operations and potentially by the resuspension of contaminated soils.

3.1.2.1 Nonradioactive Air Contaminant Sources

The sources and emissions of nonradioactive air contaminants generated by ANL are, for the purposes of the Survey, categorized into fuel burning and laboratory sources. Each is discussed below. The contaminants generated by these sources include, in part, the criteria pollutants with established ambient air quality standards, and those air contaminants regulated under either a New Source Performance Standard (NSPS) or NESHAP. The Survey also considered the emissions of unregulated toxic air pollutants and other unregulated air contaminants which might pose a future problem.

Fuel-Burning Sources and Emission Controls

There are several nonradioactive fuel-burning sources at ANL, as discussed in the following paragraphs. The Central Boiler House (Building 108) produces most of the steam needed throughout ANL. This steam is used primarily for space heating and for emergency steam turbine generators. Two oil-fired package boilers (Buildings 814 and 825) provide steam for space heating in the 800 Area. In addition, small gas-fired package boilers are used for space heating in the 600 Area lodging facilities.

The Central Boiler House, with its associated coal and ash/sorbent handling facilities, is the largest source of nonradioactive emissions at ANL. Five boilers are housed in Building 108; four gas/oil-fired boilers (Unit Nos. 1-4) each rated at 85,000 pounds per hour (lb/hr) steam-generation capacity, and one coal-fired boiler (Unit No. 5) rated at 170,000 lb/hr steam-generation capacity.

The four smaller boilers operate on an interruptible natural gas supply, with No. 2 fuel oil fired in the boilers when natural gas is unavailable. Unit Nos. 1 through 4 are designated as peaking units during normal operation, and as standby units in the event of an outage of the larger boiler. Two of the three stacks located on Building 108 serve the smaller boilers, the flue gases from two boilers being ducted

to one stack. The flue gases are emitted to the atmosphere without any add-on control equipment, and, in view of the boiler sizes and fuels fired, no flue gas treatment is required. However, these boilers are subject to administrative controls which require the burning of only distillate fuel oils (No. 1 and No. 2) with a nominal maximum 0.3 weight percent sulfur content.

The coal-fired boiler provides most of the steam requirements for the facility. Unit No. 5 burns a high-sulfur (3 weight percent) Illinois coal, but it is also allowed to blend up to 10 weight percent waste rubber with the coal. In addition, there is a temporary variance to the operating permit for the test burning of 700 tons of lime-bound pellets of refuse-derived fuel (RDF). ANL is allowed under the variance to blend RDF up to 30 percent by heating value of the coal fired in the boiler. The flue gases are first passed through a multistage cyclone separator to remove flyash, then through a spray dryer (Niro Atomizer Spray Unit) to remove SO_2, and finally through a baghouse to remove sorbent and residual flyash before release to the atmosphere from the third Building 108 stack. The Unit No. 5 stack is continuously monitored for opacity, SO_2, and carbon dioxide (CO_2).

Coal is delivered to the site by truck. Two piles are maintained in the coal yard (located east of Building 145 in Figure 2-2), a larger stockpile of high-sulfur coal and a smaller stockpile of low-sulfur coal. The low-sulfur coal must be burned when the dry scrubber is not operational. A front-end loader is used for coal pile maintenance and for blending the waste rubber and RDF with the coal. At the time of the Survey team visit, a blend of high-sulfur coal, 5 weight percent waste rubber, and 20 percent RDF was being fired in Unit No. 5.

The coal feed hopper is located below grade within a two-sided structure. This tends to reduce fugitive coal dust emissions, and water is sprayed as a dust suppressant if heavy coal dust loadings are observed. The coal is transferred from the feed hopper to the bunkers by an enclosed conveyor system. The conveyor system and transfer points are ventilated by open windows. Windage losses are minimized by enclosing the conveyor system, but any coal dust suspended during the transfer operations can be released to the atmosphere through the open windows. Magnetic separation is the only process performed in the coal feed operations. An examination of materials rejected by magnetic separation indicates that some waste rubber and RDF, as well as coal, contain ferromagnetic materials.

The lime used in the dry SO_2 scrubber is also delivered to the site by truck and stored in three silos. The silo exhaust vents are equipped with fabric filters to limit fugitive dust emissions during the load-in operations.

Flyash, collected from the multistage cyclone separator, and bottom ash are stored in a silo for subsequent removal by truck to the landfill. Fugitive dust from the silo load-out operations is controlled by a water spray system. The spent sorbent and some flyash are also stored in a silo for subsequent disposal at the landfill. The handling of the spent sorbent is a dry operation, since the material will set if wetted and would be difficult to handle. Trucks used to carry the spent sorbent are covered with a tarpaulin, and the spent sorbent transfer chute is inserted through a hole in the cover during silo load-out operations. The use of a covered truck is an acceptable fugitive dust emission control technique to limit losses during load-out operations and during transport from the load-out area to the landfill.

There are two oil-fired package boilers in the 800 Area, one in Building 814 and the other in Building 825. The Building 814 boiler supplies steam for space heating to Buildings 813 and 815, and the Building 825 boiler serves the space heating needs of Buildings 809 and 810. Both boilers fire distillate fuel oil (Grade No. 2) stored in 2,000-gallon underground tanks. The nameplate rating of these boilers specifies 18 gallon per minute fuel supply capacity. It is estimated that about 4,000 gallons per month is burned in each boiler during cold weather. Because of the small size of these boilers and the fuel used, there is no need for air emission controls.

ANL has 29 emergency generator sets available for use in the event of a loss of electrical power to the site. Ten of these emergency generators are steam turbines that operate off the site steam distribution system. One generator is fired with liquid propane gas, and the remaining 18 are diesel-fired. Table 3-4 lists the location, type, and ratings of these emergency generators, including three diesel generators considered abandoned in place. These emergency generators are tested periodically to ensure their operability in the event they must be brought into service during a power outage. However, they are considered a very minor source of air pollutants at ANL.

TABLE 3-4

EMERGENCY POWER GENERATORS AT ANL

Building No.	Type	Rating (Kilowatts)	Status[a]
108	Steam Turbine	400	
200	Steam Turbine	175	
200	Steam Turbine	400	
201	Diesel	180	
202	Diesel	500	
203	Steam Turbine	200	
205	Diesel	300	
211	Diesel	150	
212	Steam Turbine	300	
212	Steam Turbine	300	
212	Steam Turbine	300	
212	Diesel	125	Shutdown
212	Diesel	125	Shutdown
221	Diesel	100	
222	Diesel	60	
223	Diesel	75	
301	Diesel	60	
302	Diesel	100	
306	Diesel	50	
306	Diesel	60	
308	Diesel	100	
315	Steam Turbine	300	
330	Diesel	60	
330	Diesel	60	Shutdown
331	Diesel	60	
333	Liquid propane gas	15	
350	Diesel	200	
362	Steam Turbine	400	
368	Diesel	200	
368	Diesel	200	
375	Steam Turbine	250	
395	Diesel	45	

Source: List provided by site personnel
[a] Operational unless otherwise specified

The Fossil Energy Utilization Laboratory (FEUL) in Building 145 is a magnetohydrodynamic (MHD) research facility with an oil-fired and a coal-fired test train. The flue gases from these test trains are treated by a venturi scrubber for removal of particulates and SO_2 before being emitted from a 135-foot stack. Since the emission control equipment is common to both test trains, only one of the test trains can be operated at a given time. There is an interlock to prevent startup of a test train when the scrubber is not in operation, which will cause an automatic shutdown of a test train if flow is lost to the scrubber. Continuous in-stack monitoring is performed for CO, CO_2, SO_2, and nitrogen oxides (NO_x) during an experiment, with maximum SO_2 and NO_x concentrations reported to be 300 parts per million (ppm) and 500 ppm, respectively, in the flue gases emitted to the atmosphere (Personal communication with FEUL personnel).

Room J-117 in Building 205 has an experimental, coal-fired fluidized bed combustor facility. The fuel usage in this research facility is small, with the coal supply kept in 55-gallon drums. SO_2 emissions are controlled within the combustion chamber by the addition of lime to the coal being fired. A venturi scrubber is used to control particulate emissions in the flue gas stream. The facility is not operated frequently and is considered only a minor source of air emissions.

Laboratory Sources and Emission Controls

Aside from the fuel-burning sources, almost all other sources of nonradioactive air emissions arise from diverse engineering, physics, and laboratory programs conducted throughout the complex and the support services to these research programs. ANL has an estimated 1,200 sources of nonradioactive air emissions throughout the complex. Most of these sources are laboratory ventilation hoods that handle a wide spectrum of inorganic and organic chemicals. It is a difficult task to identify these individual sources and to inventory all the air contaminants emitted by these sources.

However, in an attempt to define the types and amounts of chemicals that may contribute to atmospheric releases at ANL, chemical purchases recorded in ANL's central Automated Materials Payable System (AMPS) were reviewed by the Survey team. Since AMPS cannot be readily used to trace the actual amounts of purchased chemicals distributed to specific laboratories, release points for individual chemicals

could not be identified. Nonetheless, most of the chemicals listed on Table 3-2, as well as others, were identified on AMPS. ANL purchases for 1986 included about 11 tons of CFCs, 4.8 tons of tetrachloroethylene, 1.8 tons of methyl chloride, 0.40 ton of carbon tetrachloride, and 0.05 ton of methylene chloride. Also, alcohols (methanol, ethanol, propanols, and butanols) and acetone are extensively used as solvents and cleaners at ANL, but there is no convenient means to obtain the total amounts of these chemicals purchased. Even with a laboratory-wide inventory of annual purchases of each chemical, the annual emissions of hydrocarbons cannot be reliably estimated. This depends on individual practices within each laboratory, since most of these materials will be in the form of liquid wastes. For example, some laboratories (e.g., Buildings 212 and 223) evaporate solvents under hoods rather than dispose of these materials as liquid wastes.

In view of the laboratory-scale programs conducted at ANL, the Occupational Health and Safety Department places considerable emphasis on control of the workplace environment through a program of measuring laboratory hood flows and ensuring the hoods' proper operation. However, control of fumes and vapors in the workplace leads to their emissions to the outside atmosphere. In general, the Survey team found that air emission controls are installed where hot acid operations are performed (B-Wing, Building 200; B-Wing, Building 202; and H-Wing, Building 212) or where potent carcinogenic agents are used in animal experiments (Building 202). Otherwise, fumes and vapors are usually exhausted to the atmosphere without emission controls. The quantities of chemicals used in individual hoods are small, and there is very little need to install emission control equipment.

ANL conducts engineering experiments with alkali metals as a heat transfer medium. Sodium, sodium-potassium eutectics, and lithium are often used for this purpose. These materials can burn readily, leading to caustic particulate fumes. Three facilities conduct intentional burning of these materials. Buildings 206 and 308 have Alkali Metal Reaction Booths for cleaning the alkali metals off machine components. Emissions from these booths are controlled by a venturi scrubber, a demister, and high-efficiency particulate air (HEPA) filters in series. The demister prevents water carryover from the scrubber wetting, which can cause failure of the HEPA filter.

Lithium-water experiments are performed in Building 311. Currently, these tests are performed once per day and involve 11 grams of lithium dropped into water. The lithium oxide aerosols formed in these tests are vented uncontrolled to the atmosphere. There are plans to perform experiments with 20 grams of lithium in an explosion booth behind Building 311. The aerosols will be emitted directly to the atmosphere in these tests. Since total lithium usage is now about 10 pounds/year, and might increase to about 22 pounds/year, the caustic aerosol emissions from these experiments are not considered a concern.

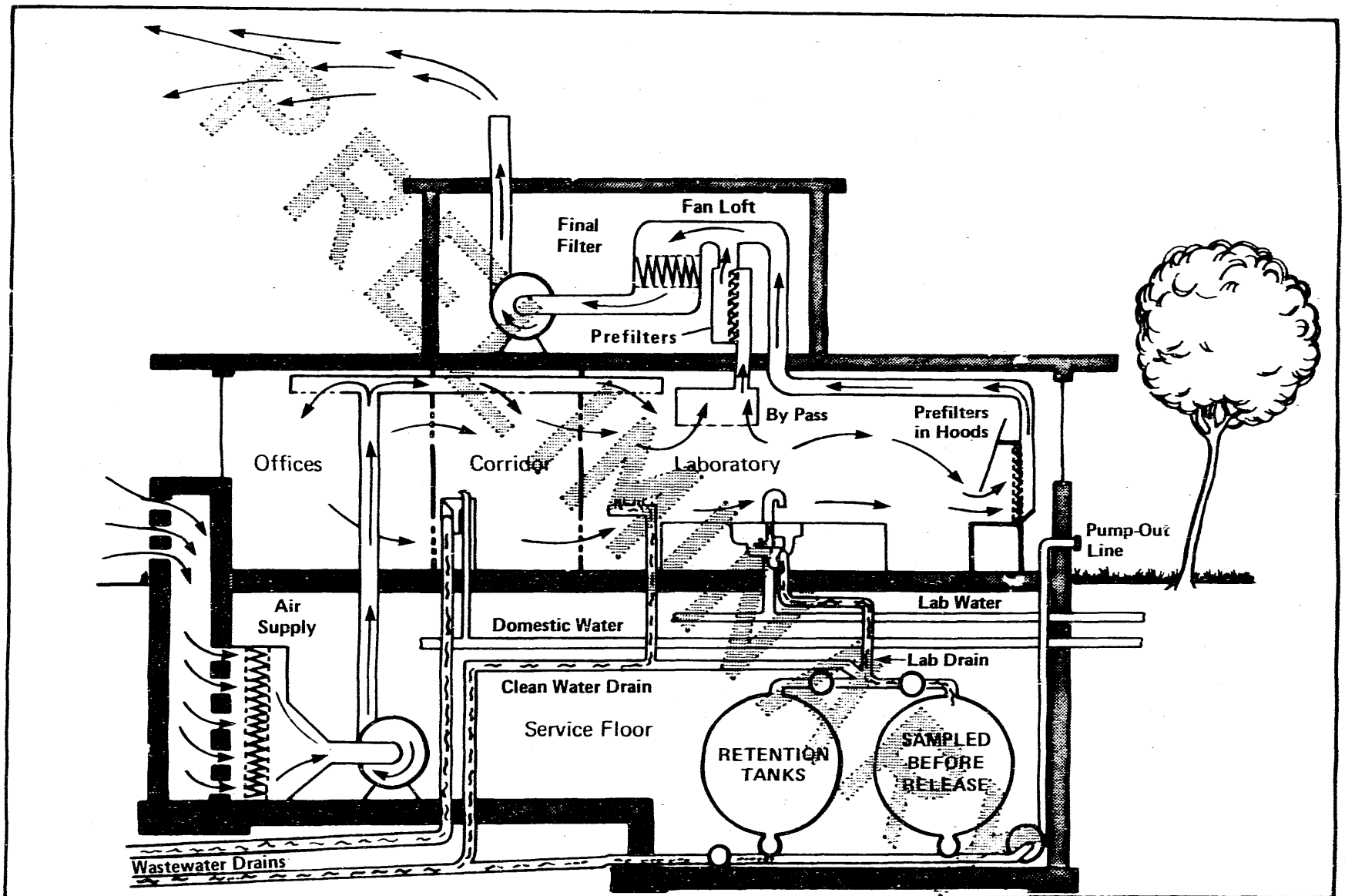
3.1.2.2 Radioactive Air Contaminant Sources

Radioactive materials and radiation, some of which could result in radioactive air emissions, are used throughout ANL. Major sources at the laboratory include sealed sources for calibration and testing; a variety of liquids, gases, and solids used in experiments; reactor fuel; accelerator targets; and contaminated material from past activities.

The primary method for control of airborne emissions from these sources is the container in which the source is placed. Major sources are further confined within hoods, glove boxes, or caves. The confining devices are generally within buildings whose air flow systems are designed to pass air from areas with low potential for airborne contamination toward the sources. Finally, air discharged from the confining devices and buildings is passed through one or more HEPA filters and in two instances charcoal filters. An idealized schematic of these control systems is shown in Figure 3-2.

Effluent monitoring or sampling is conducted at points within buildings where the ANL Health Physics staff believes the highest potential for significant airborne releases exists. This monitoring and sampling is conducted as shown on Table 3-5, and the results are shown in Table 3-6 and discussed below.

The M1 and K1 caves in Building 200 were previously used in the proof of breeding project. The project involved destructive testing of highly irradiated core material from the Shippingport nuclear reactor. The core was comprised of uranium and thorium oxides. Most of the highest levels of contamination have been removed from the caves. However, the cells are not completely decontaminated and



Source: ANL, 1976

CROSS-SECTION OF TYPICAL ENVIRONMENTAL CONTAINMENT CONTROL SYSTEMS IN BUILDINGS AT ARGONNE NATIONAL LABORATORY

FIGURE 3-2

TABLE 3-5

ANL BUILDING EFFLUENT MONITORING AND SAMPLING PROGRAM

Building	Source	Probable Radionuclides	Methods of Detection
200	M1 Cave	Rn-220 & Daughters, MFP[a]	Alpha scintillator, particulate & charcoal sampling device
	K1 Cave	Rn-220 & Daughters, MFP[a]	Alpha scintillator, particulate & charcoal sampling device
	A2 Cell	Rn-220 & Daughters	Alpha scintillator
	A3 Cell	Rn-220 & Daughters	Alpha scintillator
202	Janus Reactor	Ar-41	Ionization chamber
212	AGHCF	H-3, Pu, MFP[a]	Alpha & beta particulates; alpha, beta, and gamma gases
330	CP-5 Reactor	H-3	Reactor building air samplers
350	NBL	Various	Alpha particulates
375	IPNS	C-11	Iodine sampler, beta particulate, beta gas

[a]MFP = Mixed Fission Products

TABLE 3-6

SUMMARY OF ANL AIRBORNE RELEASES (in curies) - 1986[a,b]

Building	Area	H-3	C-11	Ar-41	Kr-85	I-129	I-131	Sb-125	Cs-137	Rn-220	Pu-239/240
200	A2									578[c]	
	A3									2103[d]	
	A4[e]	0.94									
	K1					7.8E-6				2477	
	M1					8.3E-7				3293	
	SUBTOTAL	0.94				8.6E-6				8451	
202	Janus			1.5							
205	A125[e]	7.4E-5									
	G117[e]	2.9E-2									
	SUBTOTAL	2.9E-2									
212	AGHCF	10.4			1.7		1.5E-6	6.6E-5	4.6E-7		5.6E-9
330	CP-5	40[f]									
350	NBL[g]										
375	IPNS		90[f]								
	TOTAL	51.4	90	1.5	1.7	8.6E-6	1.5E-6	6.6E-5	4.6E-7	8451	5.6E-9

[a]Results from Marchetti, 1987 unless otherwise noted
[b]Results from effluent monitoring (Table 3-5) unless otherwise noted
[c]Rn-220 releases include daughter products
[d]From average of 87 monitoring results
[e]Results are from estimates based on releases of short duration
[f]From Golchert and Duffy, 1987
[g]No detectable releases

continue to release radon-220 and its daughters and iodine-129 to the atmosphere (Table 3-6).

Thorium-228 is stored and used in the A2 and A3 cells of Building 200 to produce a medical product containing lead-212 and bismuth-212. Large quantities of radon-220, an intermediate gaseous decay product, are released from the storage and processing. Tritium is used in experiments in the A4 cell, and small quantities are released as a result.

The releases from Buildings 200 and 205 for 1986 resulted from small spills and accidents in individual laboratories.

The Janus reactor is a small water-cooled medical research reactor in Building 202. The maximum power level of the reactor is 189 kilowatts; it is intended to produce neutrons for biological research, and its primary effluent is argon-41.

The Alpha-Gamma Hot Cell Facility (AGHCF), located in Building 212, does destructive testing on irradiated fuel from a variety of nuclear reactors in the DOE system. The AGHCF releases tritium, plutonium, and some fission products to the atmosphere.

The CP-5 reactor, located in Building 330, is a partially decommissioned heavy water reactor. The fuel and heavy water have been removed. A large number of highly radioactive components and materials are stored in the reactor. Small amounts of heavy water remain in the reactor systems and result in a continuing release of tritium from the facility.

The New Brunswick Laboratory (NBL) is operated by DOE in Building 350. The facility produces radioactive standards for general sale. Gaseous effluent monitors have shown no detectable releases from the facility in 1986.

The Intense Pulse Neutron Source (IPNS), located in Building 375, is a series of machines which produce a large source of neutrons through proton bombardment of a heavy metal target. The machine includes two pre-injector accelerators, a linear accelerator (Linac), a rapid cycling synchrotron (RCS), and a neutron generating target. A second target is no longer in use. IPNS is the major source of carbon-11 air emissions.

3.1.3 Environmental Monitoring

3.1.3.1 Nonradioactive Ambient Air Monitoring

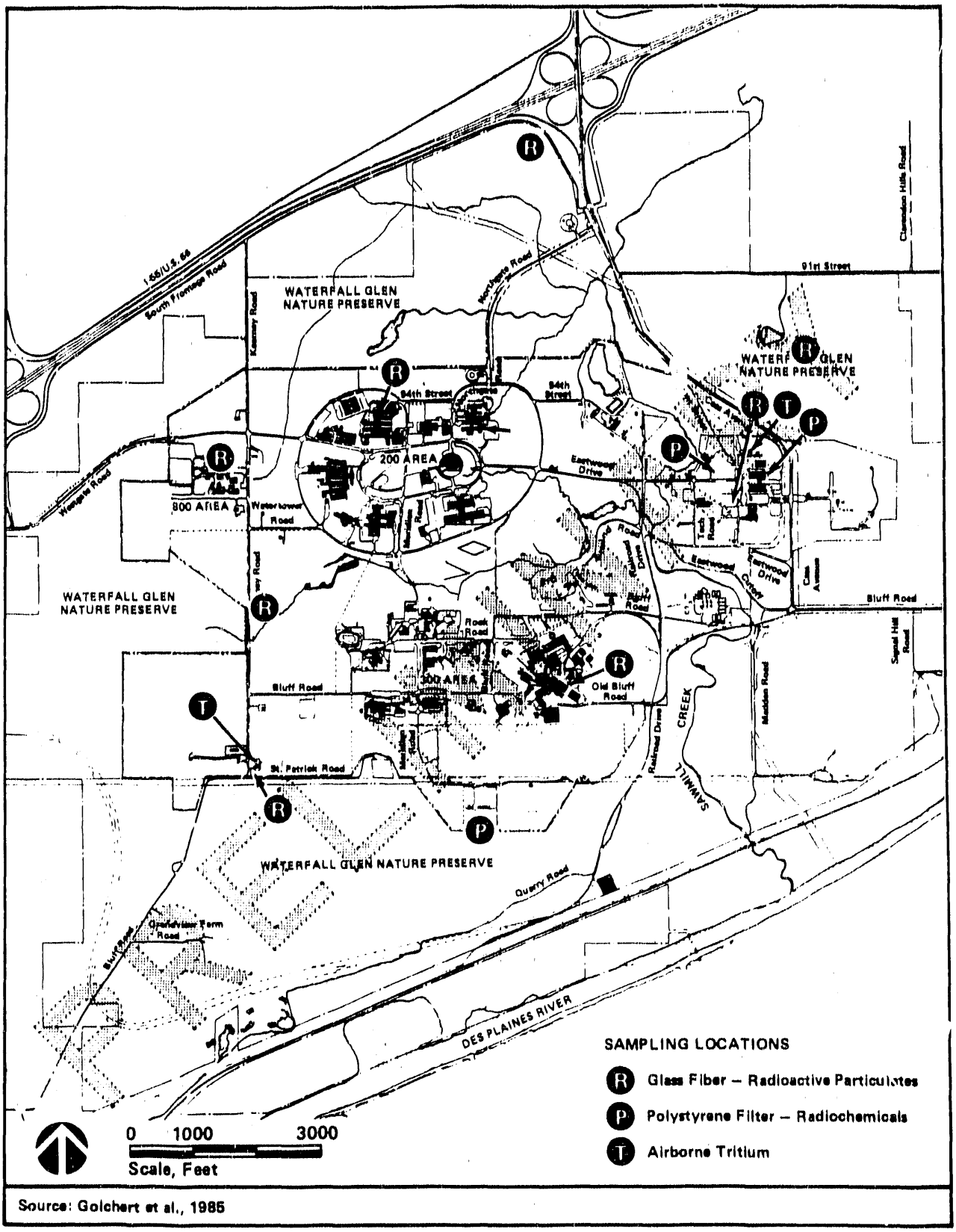
ANL does not conduct, nor is it required to conduct, ambient air monitoring for nonradioactive emissions.

3.1.3.2 Radioactive Ambient Air Monitoring

ANL conducts a routine ambient air monitoring program for radioactive water vapor and particulates. Most of the resulting data are used in the calculation of off-site doses. Water vapor samples are collected on silica gel at two perimeter sites and one off-site location in Woodridge, Illinois (Figures 3-3 and 3-4). The samples are analyzed for tritium and the results for 1986 are presented in Table 3-7. The average on-site concentrations, although low, are twice the off-site concentration. This is due to releases from the principal sources, including the CP-5 reactor (Building 330) and Building 212 (Golchert and Duffy, 1987), as described in Section 3.1.2.2.

Particulates are collected on 13 samplers and are analyzed for gross alpha, gross beta, lead-210, beryllium-7, and other gamma-emitting radionuclides (Golchert and Duffy, 1987). Eight of the samplers are located on the perimeter of the site and are intended to detect airborne radioactive contaminants from site operations. The five off-site monitors are located between 5 and 16 miles from the site and are intended to provide background data. The air monitoring sites are shown on Figures 3-3 and 3-4.

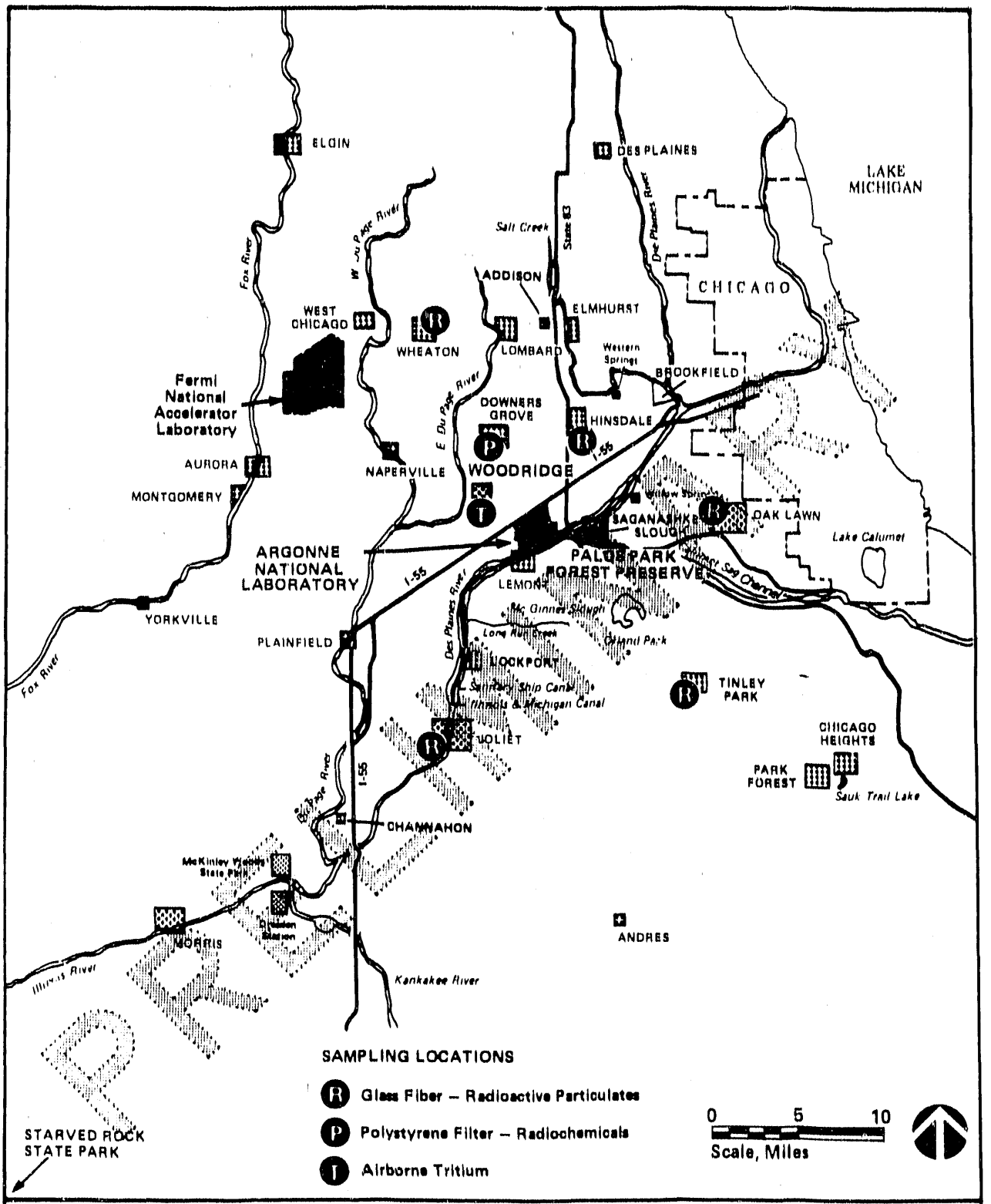
Weekly particulate samples are collected on large glass fiber filters at either 2.4 or 25 cubic meters/hour, depending on the sampler used. The samplers are housed in either a small shed at ground level or in the second story of various buildings. The filters are changed weekly. Monthly samples for radiochemical analysis of such parameters as plutonium, thorium, uranium, and strontium, are collected on polystyrene filters by a second sampler located at two perimeter locations and one off-site location in Downers Grove.



Source: Golchert et al., 1985

ON-SITE RADIOACTIVE AIR MONITORING SITES: ARGONNE NATIONAL LABORATORY

FIGURE 3-3



Source: Golchert and Duffy, 1987

OFF-SITE RADIOACTIVE AIR SAMPLING LOCATIONS NEAR ARGONNE NATIONAL LABORATORY FIGURE 3-4

TABLE 3-7

SUMMARY OF AIRBORNE CONTAMINANT ANALYSES, 1986

Annual Average of All Results			
Analysis	Perimeter	Off-Site	Units
Gross Alpha	2.1	1.8	fCi/m^3
Gross Beta	40	37	fCi/m^3
Be-7	95	93	fCi/m^3
Pb-210	29	33	fCi/m^3
Sr-89	<0.4	<0.3	fCi/m^3
Sr-90	15	10	aCi/m^3
Th-228	10	4	aCi/m^3
Th-230	19	8	aCi/m^3
Th-232	9	3	aCi/m^3
U-234	13	9	aCi/m^3
U-235	<0.4	<0.3	aCi/m^3
U-238	13	7	aCi/m^3
Pu-239 & 240	0.9	0.5	aCi/m^3
H-3	1.1	0.5	pCi/m^3

Source: Golchert and Duffy, 1987

aCi = 1 attocurie = 10^{-18} Ci
fCi = 1 femtocurie = 10^{-15} Ci
pCi = 1 picocurie = 10^{-12} Ci

Results indicate that concentrations are higher along the perimeter of ANL than off-site (Table 3-7). However, when standard deviations are considered (not presented in Table 3-7), the increases are small. Elevated concentrations may be due to site operations, as described in Section 3.1.2.2, such as plutonium from the AGHCF and thorium from the A2 and A3 cells in Building 200.

3.1.3.3 On-Site Meteorology

ANL operates an on-site meteorological station near Building 181 (Figure 2-2), consisting of three towers to collect data at 1.5-meter, 6.0-meter, and 44.5-meter levels. The 1.5-meter mast is instrumented to measure wind speed, dry bulb temperature, and dew-point temperature. The 6-meter mast is instrumented to measure wind speed, dry bulb temperature, and temperature gradient (6 meters-1.5 meters). A mast is mounted atop a fire tower to collect wind speed and direction at the 44.5-meter level. In addition, a pyrometer is mounted on a fourth mast to measure solar and net radiation, and a rain gauge is located near Building 187.

The data from the on-site meteorological station have not been reported in the Annual Site Environmental Reports since 1980. Instead, ANL has used data collected from the National Weather Service (NWS) station at O'Hare Airport. ANL is about 18 miles south-southwest of the O'Hare NWS station, but these NWS data are probably not representative of the meteorology at ANL, since a lake breeze effect is considerably more dominant at O'Hare Airport than at ANL. At the same time, the data currently acquired by the on-site meteorological station cannot be used because certain equipment is lacking and suitable quality assurance (QA) and quality control (QC) procedures are not in place.

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

1. Release of radioactivity from CP-5 Reactor and M1/K1 caves and A2/A3 cells in Building 200. The CP-5 reactor and the M1/K1 caves and the A2/A3 cells in Building 200 are unnecessarily releasing radioactivity to the atmosphere.

The CP-5 reactor in Building 330 is presently inactive and awaiting decontamination and decommissioning and the M1/K1 caves in Building 200, formerly used for experiments, are also presently inactive. Without decontamination, these facilities will continue to release radioactivity to the atmosphere. The releases could, in fact, increase due to the deterioration of the facilities. The CP-5 reactor released 40 curies of tritium to the environment in 1986. The M1/K1 caves released about 5,800 curies of radon-220 and its daughter products in 1986. Inhalation of radon-220 and its daughters released from the M1/K1 caves results in a dose equivalent of approximately 28 mrem/year to the bone of the maximally exposed off-site individual. Additional information on the calculation of this dose is contained in Finding 7 of Section 3.1.4.4. The mentioned facilities are no longer in use and are awaiting decontamination.

The A2/A3 cells in Building 200 are used for production of a medical product. One-half curie of thorium-228 is stored in a capped jar in the A2 cell. Aliquots are removed from the jar and transferred to the A3 cell, where the material is dispensed into small containers for shipment off-site. Thorium-228 decays to radium-224 which decays to radon-220. The process results in the release of about 2,700 curies per year of radon-220 and its daughters to the atmosphere (based on 1987 stack monitoring results through May). Much of the released radon-220 results from failure to cap the jar in the A3 cell after use and from spills of material during the transfer process. The releases result in an inhalation bone dose of about 12 mrem/year dose equivalent to the maximally exposed off-site individual. Finding 7 of Section 3.1.4.4 contains details on the dose calculation.

3.1.4.4 Category IV

1. Exceedances of SO_2 emission limitation at Central Heating Plant. Sulfur dioxide emissions from Unit No. 5 of the Central Boiler House regularly exceed the emission permit limits.

   There are repeated violations of the allowable emission limit by Unit No. 5 of the Central Boiler House (Building 108), as established by IEPA Permit 043802AAA issued August 4, 1986. The Survey team's review of the Unit No. 5 operating log and interviews with plant personnel indicate that 4 to 5 excursions per month occur in the SO_2 emission rate in excess of the State of Illinois emission limitation of 1.8 pounds SO_2 per million British thermal units (lb/MMBtu) of heat input for 1 hour of operation. The SO_2 excursions noted in the operating logs were in excess of 2.0 pounds SO_2/MMBtu. Emission limitations for specific air pollutants by source category are established in Implementation Plans as a means to attain and maintain primary (health-based) and secondary (welfare-based) air quality standards. Exceedances of an emission limitation do not necessarily imply that an air quality standard is violated.

   The lime feed to the dry SO_2 scrubber is adjusted to control emissions to a nominal value of 1.6 lb/MMBtu. However, the ratio of lime to SO_2 in the dry scrubber determines the removal efficiency. If the sulfur content of the coal increases or the slaked lime feed rate to the scrubber decreases, then there will be an increase in SO_2 emission rate. The exceedances noted involve a 22 percent or more increase in the SO_2 emission rate from the nominal control point. The frequency of exceedances of SO_2 emissions suggests that the control point of 1.6 pounds SO_2/MMBtu does not provide enough margin to accommodate variations in coal sulfur content and the slaked lime feed rate to the atomizers.

2. Fugitive emissions from material handling operations at the Central Boiler House. Small and uncontrolled fugitive particulate emissions from material handling operations at the Central Boiler House may result in particulate emissions to the atmosphere.

Material handling operations at the Central Boiler House (Building 108) include coal and lime delivery, coal pile maintenance, coal transfer operations, ash transfer and disposal operations, and spent sorbent transfer and disposal operations.

Coal pile load-in, maintenance, and load-out are performed by a front-end loader without application of fugitive dust controls. In colder weather, the coal pile is treated with No. 2 fuel oil to prevent freezing, but no other water spray or dust suppressant is used. Waste motor oil from the 800 Area garage was formerly used, but this practice is no longer employed and only No. 2 fuel oil is now used to prevent coal pile freezing.

Similarly, the conveyor system and transfer points are ventilated by open windows. These ventilation windows serve as sources of fine particulates suspended during these operations. Based on emission factors for coal storage, load-in, and transfer operations, it is estimated that about 30 tons/year of fugitive dust will be emitted from these coal handling operations.

The spent sorbent handling operation has the potential for being a significant source of fugitive particulate emissions, since the materials must be handled dry. The spent sorbent load-out operations were observed by the Survey team. The trucks used to transport spent sorbent are covered with a tarpaulin and the transfer chute is inserted through a hole in the tarpaulin. Air displaced as the spent sorbent is loaded carries noticeable amounts of dust. However, this process is considered an effective means of control during the load-out operation and of prevention of windage losses during transport. During the Survey, it was noted that the tailgate on a truck was sprung and a small pile of spent sorbent was on the ground. During transport, additional spent sorbent would be lost from the truck. On another occasion, an obvious jet of spent sorbent was observed to emanate from the platform and impinge against the baghouse. The source of this jet could not be identified, but the Survey team did identify to plant personnel the general location of this fugitive source from accumulations on the side wall of the baghouse.

These emissions may exceed the recently promulgated NAAQS PM_{10} standard (respirable particles of 10 microns or less) which replaced the former TSP standard. However, there are no PM_{10} data available to determine whether or not this is the case.

3. Inadequate operation of pollution control equipment. Operation of critical nonradioactive air emission control devices is not assured at Buildings 206, 308, and 363, and may result in unnecessary air emissions of alkali oxides to the atmosphere.

Unnecessary air emissions of alkali oxides can occur to the outside environment due to the condition of the equipment or the inability to ensure that control equipment is properly operating at the Grinding Shop in Building 363 and the Alkali Metal Reaction Booths in Buildings 206 and 308. In sufficient concentrations, these oxides can be corrosive to any tissue with which they come in contact.

The Survey team observed a large opening in the dust collector serving the Grinding Shop in Building 363 (Central Shops) permitting caustic alkali oxides to be emitted directly to the outside atmosphere. The operator became aware of this occurrence only when he went outside during the burn and noticed the visible plume.

There are two Alkali Metal Reaction Booths operated at ANL for cleaning machine components. One booth is located in Building 206 and the other in Building 308. The emissions of caustic alkali oxides formed in the burn are controlled by a venturi scrubber and HEPA filter. A demister is located between the scrubber and HEPA filter to prevent filter failure associated with liquid carry-over from the scrubber. The water flow to the venturi scrubber must be assured if the control equipment is to function properly. There is no positive indication of water flow to the venturi scrubber in Building 206, and it is unlikely that the existence of a flow can be heard above the noise of the exhaust fan. Although the reaction booth in Building 308 is equipped with an alarm activated by a loss-of-water flow to the venturi scrubber, the alarm failed in two attempts after the water flow was intentionally shut off. (The

alarm did activate while the Survey team was in the building, but this test by plant personnel was not observed).

Copious quantities of alkali oxides are formed during a reaction within the Alkali Metal Reaction Booths, and failure of the venturi scrubber might cause heavy loadings on the HEPA filter and lead to filter failure. Thus, alkali oxides could be emitted to the outside atmosphere that would not be detected unless the operator went outside and observed the plume. One such event was recounted at the Building 206 reaction booth before the demister was installed between the scrubber and the filter. The filter became wet and failed, and when water flow was lost to the scrubber, sodium oxide was emitted to the atmosphere.

4. Uncontrolled and unnecessary hazardous air emissions. Operations at FEUL (Building 145) and the handling of liquid waste at Building 306 may have led to and may continue to cause uncontrolled and unnecessary emissions of hazardous and toxic vapors to the atmosphere.

During tests at the Fossil Energy Utilization Laboratory (FEUL) (Building 145), pyridine, a hazardous material, was blended with fuel oil for firing in a test train. Pyridine was added to increase NO_x formed during the burns. According to plant personnel, 55 gallons of pyridine was mixed per 1,000 gallons of fuel oil during these experiments. The permit to operate does not allow for the blending of pyridine, or any other substance, with the fuel oil during operation of the facility.

Hazardous nonradioactive liquid wastes collected from throughout ANL are processed at Building 306. These wastes are separated into 55-gallon drums for eventual disposal at a commercial hazardous waste facility. The separation of liquid waste is performed on an outdoor loading dock by open pouring from the waste container to an appropriate 55-gallon drum. The liquids are siphoned into the drum only if the waste container is too heavy for the operator to lift. Open pouring may result in the emission of small quantities of hazardous and toxic vapors and is not considered a good management practice.

5. Inadequate testing and calibration of sampling and monitoring devices. Inadequate testing and calibration of gaseous radioactive effluent sampling and monitoring devices can lead to errors in the determination of stack release estimates.

Effluent monitoring and sampling results are used to estimate radioactivity releases to the environment and radiation doses to the public and to ensure compliance with release and dose limits. The devices used to measure stack flow, sample or monitor flow, and radiation are generally not tested or calibrated on a routine basis. Without this testing and calibration, the precision and accuracy of these devices cannot be ensured.

Examples of inadequate testing and calibration observed by the Survey team are as follows:

- The Janus reactor effluent flow manometer was last calibrated in 1977, while the radiation detector has not been calibrated or tested since installation;
- The CP-5 reactor (Building 330) effluent flow rate is not measured. Release rates are estimated based on the rated capacity of the ventilation system;
- The NBL (Building 350) effluent flow monitor has been out of service for 2 years;
- The M1 cave (Building 200) effluent monitor was out of service and removed from the fan loft during the on-site portion of the Survey; and
- The IPNS (Building 375) effluent sampler/monitor rotometer had not been tested or calibrated since installation.

6. Inadequate HEPA filter testing procedures. Inadequate HEPA filter testing procedures may result in release of radioactive materials to the atmosphere.

There are hundreds of HEPA filters on the ANL site. Every active hood, cell, or cave includes at least one HEPA filter on the air exhaust system. These filters provide the primary control of airborne contaminants from the facility. Site records show that 91 exhaust systems with a total of 151 HEPA filters are tested on a regular basis. The remaining filters, most of which are actively used, are not tested regularly. HEPA filter testing policy for ANL is stated in Chapter III-5 of the ANL Health and Safety Manual:

> "As a minimum acceptable practice in-place efficiency tests shall be conducted on initial installation, periodically at intervals not to exceed two years, and following filter replacement on all final HEPA filtered exhaust systems that service facilities where there is
>
> (a) one milligram or more of plutonium-239 in powder form, or amounts of other radioactive and/or toxic materials in this form that are estimated to present an equivalent health hazard potential, or
>
> (b) one gram or more of plutonium-239 in solid or liquid form, or amounts of other radioactive and/or toxic materials in these forms that are estimated to present an equivalent health hazard potential."

This policy is viewed by the Survey as adequate for the protection of off-site individuals and the environment. However the present lax implementation of this policy could lead to significant releases of radioactive material to the atmosphere in concentrations which could present an equivalent health hazard potential. A review of a source inventory provided by the site indicates that unsealed sources in Buildings 202, 301, 311, 314, 317B, and 330 could represent an equivalent health hazard potential to those stated in the above policy. In addition, HEPA filter testing is not routinely performed in these buildings.

The Survey team attempted to identify filters that filtered air from locations in which stored materials could pose an equivalent health hazard. The filter lofts were found to house filters which were not tested. However, the team could

not in all instances determine which rooms or operations were being vented through the specific HEPA filters that were observed. It is possible that some HEPA filters in these buildings are not tested in accordance with the ANL policy. No documentation or formal review of observations against this policy was available to the team. Finally, no physical steps are taken to ensure that systems without tested HEPA filters are not used for radioactive materials with health hazard potential equivalent to the policy stated above.

7. Improper environmental dose assessment. Failure to properly assess off-site radiological doses could prevent the demonstration of compliance with EPA dose limits.

EPA regulations related to airborne emissions of radioactive material require the use of the AIRDOS-EPA computer code or an alternative approved by the EPA. The site does not use this code and the methods that are used are not approved by the EPA. Additionally, the procedures which are used include a number of technical deficiencies, summarized below:

- Meteorological Data - The meteorological data used are from the O'Hare Airport and are believed not to be representative of the meteorological conditions at ANL (Finding 8 in this section). Further, only neutral stability wind data are used by ANL in the calculation of dispersion factors as opposed to all data.

- Source Collocation - The ANL analysis assumes that all releases occur at the same height at the approximate geometric center of the site. This assumption does not accurately represent the spatial distribution of sources and receptors. For example, the nearest residence is 1,070 meters north-northeast of the largest on-site release point (Building 200). The ANL dose analysis uses 2,410 meters north for all sources at this location. This results in a significant underestimate of doses at this location.

- The ANL analysis fails to consider all important pathways while no analyses have been done to demonstrate that any pathway is insignificant. Examples of important pathways which are not considered by ANL include inhalation or ingestion doses from airborne releases of

radon-220 and its daughters, ingestion doses from airborne releases of tritium, and population ingestion doses from liquid releases.

- The use of environmental monitoring data in dose calculations is inadequate for demonstrating compliance with EPA dose limits. The total error associated with environmental analyses (sampling, sample preparation, and counting errors) is higher than the concentrations of radioactivity in the environment necessary to cause an exceedance of DOE dose limits. Also, ANL excludes potential dose pathways because no increase in concentrations in the environment can be detected. In these instances, natural variability in environmental concentrations and total analytical error also exceed the concentration necessary to exceed EPA dose limits.

To demonstrate the magnitude of the errors these methods can cause, a simplified dose calculation was performed. Doses from radon-220 daughter inhalation at the maximally exposed residence just north of the site were calculated. This pathway was not analyzed by ANL because the environmental monitoring program detected no increase in environmental concentrations of these nuclides. The only pathway analyzed for these nuclides was external exposure. However, this analysis included the deficiencies noted above for meteorological data and spatial distribution of sources.

The calculation was based on simple straight line atmospheric dispersion (Turner, 1970) and meteorological data from the Dresden Nuclear Station (NRC, 1973). Dose factors were obtained from the International Commission on Radiological Protection (ICRP, 1978). The maximum organ dose was a dose equivalent of 40 mrem/year to bone surfaces. This dose is considerably higher than any other dose reported by ANL and is approximately 53 percent of the 75 mrem/year guideline in 40 CFR 61 for a dose from gaseous effluents from DOE facilities.

The 40 CFR 61 guideline specifically states that the rule does not apply to radon. However, in the rationale for the guideline, the following explanation is offered: ". . . available information suggests that the DOE facilities that are covered by this standard are likely only to have relatively small total quantities

of materials containing radium-224 and radium-226, the sources of radon-220 and radon-222, respectively. The quantities of these materials will be much smaller than uranium mill tailings piles, for example. In practice, EPA expects DOE will seal up all significant sources of radon emissions to air or take other appropriate control action as part of their (As Low As Reasonably Achievable) ALARA Program" (EPA, ND).

8. Unrepresentative meteorology data. Meteorological data used in calculating the ANL annual off-site dose estimates are not representative of conditions at ANL.

The calculation of annual on-site and off-site dose estimates for ANL is required by 40 CFR 61, Subpart H. The meteorological data used by ANL for estimating off-site doses from radioactive air emissions are obtained from the NWS station at O'Hare Airport. O'Hare Airport data are not considered representative of the site, as discussed below, and the air pathway dose estimates from sources, as reported in the Annual Site Environmental Reports, are unlikely to be representative of site conditions. This conclusion is based on the relative location of O'Hare Airport and ANL to Lake Michigan and the importance of lake breeze effects on the meteorology. Prior to its location at O'Hare Airport, the Class I NWS station was located at Midway Airport. Studies conducted by ANL showed that Midway Airport data were not representative of the site. A cursory review by the Survey of O'Hare Airport data and the 15-year climatological summary of on-site data suggests that the same problem exists with the O'Hare data.

The frequency of winds from the northeast at O'Hare Airport are characteristically in the range of 10 to 15 percent during the warmer months when lake breeze effects are dominant. From Figure 3-1, the reported on-site data show a north-northeast component in the wind rose, but this wind direction occurs with a frequency of only 2 to 4 percent. Thus, the northeasterly winds associated with lake breeze effects are considerably more dominant at O'Hare Airport. This suggests that the lake breeze front (convergence zone) does not penetrate inland as far as ANL with the same frequency as observed at O'Hare Airport. Indications are that about 30 to 40 percent of the time, the lake breeze penetrates to Midway Airport about 15

kilometers from the lake. O'Hare Airport is about 20 kilometers from the lake and may experience lake breezes with somewhat less frequency than Midway. However, it is clear from these field investigations that the lake breeze will not penetrate inland to ANL with nearly the same frequency.

A consideration of the Lake Michigan shoreline orientation also suggests that the wind directions measured at O'Hare during a lake breeze event will be different than those at ANL. Lake breeze fronts tend to propagate parallel to the shoreline and the winds behind the front tend to be perpendicular to the shoreline. The winds at O'Hare will tend to be more easterly than at ANL during a lake breeze event, since the front at ANL will be influenced by the southern shoreline of the lake. This effect appears to be indicated in the wind roses published by ANL in the Annual Site Environmental Reports. The lake breeze winds tend to be northeast at O'Hare, while they seem to rotate to the north-northeast at ANL.

In summary, the O'Hare Airport data are not likely to be any more representative of the conditions at ANL than Midway Airport data. Because of the importance of lake breeze effects on the mesoscale meteorology, particularly during the warmer months, the O'Hare data are expected to, and do, exhibit a greater frequency of northeasterly winds than at ANL. In addition, there does appear to be some rotation of this dominant wind direction between O'Hare and ANL.

9. Potentially ineffective emergency response. Emergency response to hazardous airborne releases at ANL may be ineffective as a result of meteorological system deficiencies.

In the event of a release of hazardous material to the atmosphere, the primary meteorologic information available to the ANL emergency response center comes from the ANL on-site meteorological station, Building 181. However, the station is not continuously staffed, and information, such as source of wind data, may not be readily available to the emergency response staff. Although a meteorological tower is also located at the Fire House, the tower is only used at night when qualified site meteorologists are not readily available. Additionally, there are no quality assurance/quality control procedures for

equipment maintenance and data validation, which makes data generated by the meteorological stations questionable in validity.

ANL had initiated a review of the problems associated with the collection of on-site meteorological data during the Survey team visit, including upgrading the data collection system and providing remote access to data at the emergency response center.

10. Questionable validity of data from ambient air monitoring network. The ANL ambient air monitoring network is providing data of questionable validity and defensibility because of unacceptable QA/QC and monitoring procedures.

Ambient air data reported in the Annual Site Environmental Reports are considered questionable and may not provide an accurate assessment of ANL's environmental impacts from atmospheric emissions as a result of problems associated with station location, monitor intake clogging, inadequate calibration, and sample collection, as discussed below.

Two of the three monitoring stations visited during the Survey were found not to meet accepted siting criteria that would accurately represent site conditions. Station 10F was located about 15 feet from a dense stand of trees and undergrowth which would influence the air flows at the particulate sampler location. Station D5/D6 was located in the upper level of Building 6 with the sampler intakes positioned outside windows approximately 20 to 25 feet above the ground. The building is an obstruction to the air flow sampled at this station, and the height of the sampler intakes would prevent a representative measure of any larger, resuspended particulates. Although the Survey team did not inspect any of the off-site ambient monitoring stations because of time constraints, many of these stations are located in building lofts and may suffer the same siting deficiencies as Station D5/D6.

The Survey team observed the filter change-out procedures at three ambient air monitoring stations (10F, 317/318, and D5/D6) and interviewed the responsible site technician. The sampler intake head has a wire screen to prevent wasps from entering the sampler train. At Station 10F the sampler intake head was heavily coated with materials that must be cleared each time

the site technician visits the station. The accumulation of these materials on the screen constitutes an obstruction to the flow entering the sampler train. In addition, the screens are cleared while the samplers are running, which would cause some of this material to be drawn into the sampler.

The monitoring stations are not calibrated regularly. In particular, the Silverman sampler flow rates have not been calibrated since their installation in the network. At Station 317/318, the Silverman sampler was installed in 1982. In addition, the Silverman samplers are not equipped with flow controllers, and the flow rates are affected by the filter loading and possibly the materials collected on the intake head screen. The filters changed out from the samplers were observed to be heavily loaded. None of the samplers have continuous flow recording devices to indicate the total volume of air sampled or if the samplers were in continuous operation during the period.

The site technician's handling of the filters and recordkeeping procedures can lead to a loss of collected data. The filters are folded and placed in a paper hand towel. The technician then records the date, sample location, and sampler flow rate on the paper towel with a ballpoint pen. This procedure can cause particulates on the filter to be loosened, and lost in subsequent handling, particularly with heavily loaded filters. The technician also records the sampler flow rates after filter change-out on another paper towel which is left in the shelter. There are no logbooks in the shelter nor recordkeeping forms used by the site technician during rounds of the air monitoring stations. The informal procedures observed by the Survey team are questionable and are considered to compromise the data collected by the network.

3.2 Soil

3.2.1 Background Environmental Information

The soil at ANL consists of 50 to 150 feet of glacial till, composed predominantly of clay and silt with trace amounts of sand and gravel. The coefficients of permeability of these deposits generally range from 10^{-6} to 10^{-8} centimeter per second (cm/sec) with a coefficient of permeability as great as 10^{-4} cm/sec in the noncontinuous sand lenses. Typically, soils with coefficients of permeability on this order of magnitude are considered to be practically impervious. These glacial deposits are underlain by dolomite bedrock with transmissivities estimated to range from 7,000 to 9,000 gallons per day/foot (Golchert and Duffy, 1987).

Soil types consist predominantly of Morley silty loam with scattered Ashkum, Sawmill, and Peotone silty clay loams, Markham and Beecher silt loams, and Urban land. The Urban land consists of buildings and pavements underlain by glacial till deposits. Each of these soil types, except the Markham silt loam, poses a high corrosion risk to uncoated steel (Mapes, 1979). The Markham silt loam is only found in the landfill and 800 areas of the ANL (Figure 2-2). In addition, a soil report prepared by C.P. Dillon and Associates for ANL referred to the soils on the property as being highly corrosive and promoting electrolysis (Dillon, 1985).

The radiological characteristics of the soil at the ANL site are typical for United States soils. Concentrations of naturally occurring radionuclides in the uranium and thorium decay chains were reported at between 1 and 2 picocuries per gram (pCi/g) (Golchert and Duffy, 1987). These values are consistent with those reported elsewhere (NCRP, 1975). The soils at ANL have also received some radioactive contamination resulting from worldwide fallout as discussed in Section 3.1.1, while the localized radioactive soil contamination from ANL operations is discussed in Sections 3.2.2 and 4.5.1.

The soils at the ANL site are generally not chemically contaminated except for those areas where localized accidents, spills, releases, or disposal have occurred. These chemically contaminated areas have been reviewed and are discussed in Sections 3.3.2, 4.1.1, and 4.5.1.

3.2.2 General Description of Pollution Sources and Controls

The major pathways for potential contamination of soil at ANL are routine and accidental airborne releases, routine and accidental liquid releases, and activities associated with waste disposal practices. To avoid soil contamination, the site has established controls on handling radioactive and hazardous materials. The controls include packaging, handling, storage, and disposal requirements, air filtration, water treatment systems, and incineration systems. ANL also contains numerous localized on-site areas of soil contamination by radionuclides and hazardous materials, resulting from intentional surface application, past spills, release of liquid wastes, and waste disposal practices. Soil contamination from intentional surface application is discussed in this section. All other sources and controls for soils are discussed in Sections 3.1.2, 3.3.2, 4.1.1, and 4.5.1.

Intentional surface application of contaminants has occurred at the ecology plots. Nine ecology plots are located around the ANL site. These plots have been used for a variety of experimental studies, and some plots are still active. Acid rain studies were conducted in which acid was applied to vegetation to examine its effects on plant life and soil. Similar studies were conducted inside tents where plants were exposed to sulfur dioxide and ozone. Some ecological studies involved the use of trace amounts of the radioisotopes tritium and mercury-203. All of the mercury-203, with a 47-day half-life, has decayed since its use in the early 1970s. The tritium experiment involved the application of tritiated water to plants and soil in amounts ranging from 1 to 40 millicuries (Jordon and Kline, 1971; Kline et al., 1971). These amounts were small and more than half of the original radioactivity has decayed.

One of the oldest ecology plots is located outside the present ANL boundary. Although originally within the ANL site, this parcel of land was decontaminated and released to the county forest preserve in the early 1970s.

3.2.3 Environmental Monitoring Program

This section discusses the environmental monitoring performed for soil and grass at and around the ANL site. The radioactive content of soil and grass was measured at the site boundary and off-site locations. The reason for the off-site sampling was for comparison with site-boundary samples, and with results obtained by other

organizations for samples collected at large distances from nuclear installations. Such comparisons are useful in determining if the soil activity near ANL is normal. For this purpose, the American Society for Testing and Materials site selection criteria, sample collection, and sample preparation techniques were used. Sites were selected in several directions and at various distances from the laboratory. Each site was selected on the basis that the soil appeared, or was known to have been, undisturbed for a number of years. Attempts were made to select open, level, grassy areas that were mowed at reasonable intervals. Public parks were selected when available (Golchert and Duffy, 1987).

3.2.3.1 Soil

The results for the gamma-ray emitting radionuclides in soil sampled in 1986 are presented in Table 3-8. The site-boundary and off-site sampling locations are shown on Figures 3-5 and 3-6, respectively. Sampling sites are a 1,000-foot by 1,000-foot-square area and are identified by grid location. The samples are collected from anywhere within the sampling site grid.

The cesium-137 levels in soil are similar to those found over the past several years and represent an accumulation from nuclear tests over a period of many years. The annual average concentrations of all measured radionuclides for the site-boundary and off-site samples are similar. The alpha particle-emitting transuranic radionuclides plutonium and americium concentrations measured in soils in 1986 are given in Table 3-9. Except for the three samples collected June 24, 1986, from Grid Location 7J, the ranges and concentrations of plutonium and americium in soil are similar at both perimeter and off-site locations. A sample collected from Grid Location 7J in 1985 gave plutonium and americium concentrations that were twice the ambient levels. The results of the analyses of the three samples collected in 1986 at Grid Location 7J confirm the previous measurement. The highest plutonium-239 concentration at Grid Location 7J, 80 x 10^{-9} microcurie per gram (μCi/g), was collected in line with the southeastern corner of the 317 Area (Figure 3-5). This radioactivity appears to be the result of previous operations in the 317 Area (Golchert and Duffy, 1987).

The results of radionuclide concentrations measured in grass in 1986 are given in Table 3-10, while Figures 3-5 and 3-6 show the site-boundary and off-site sampling

TABLE 3-8

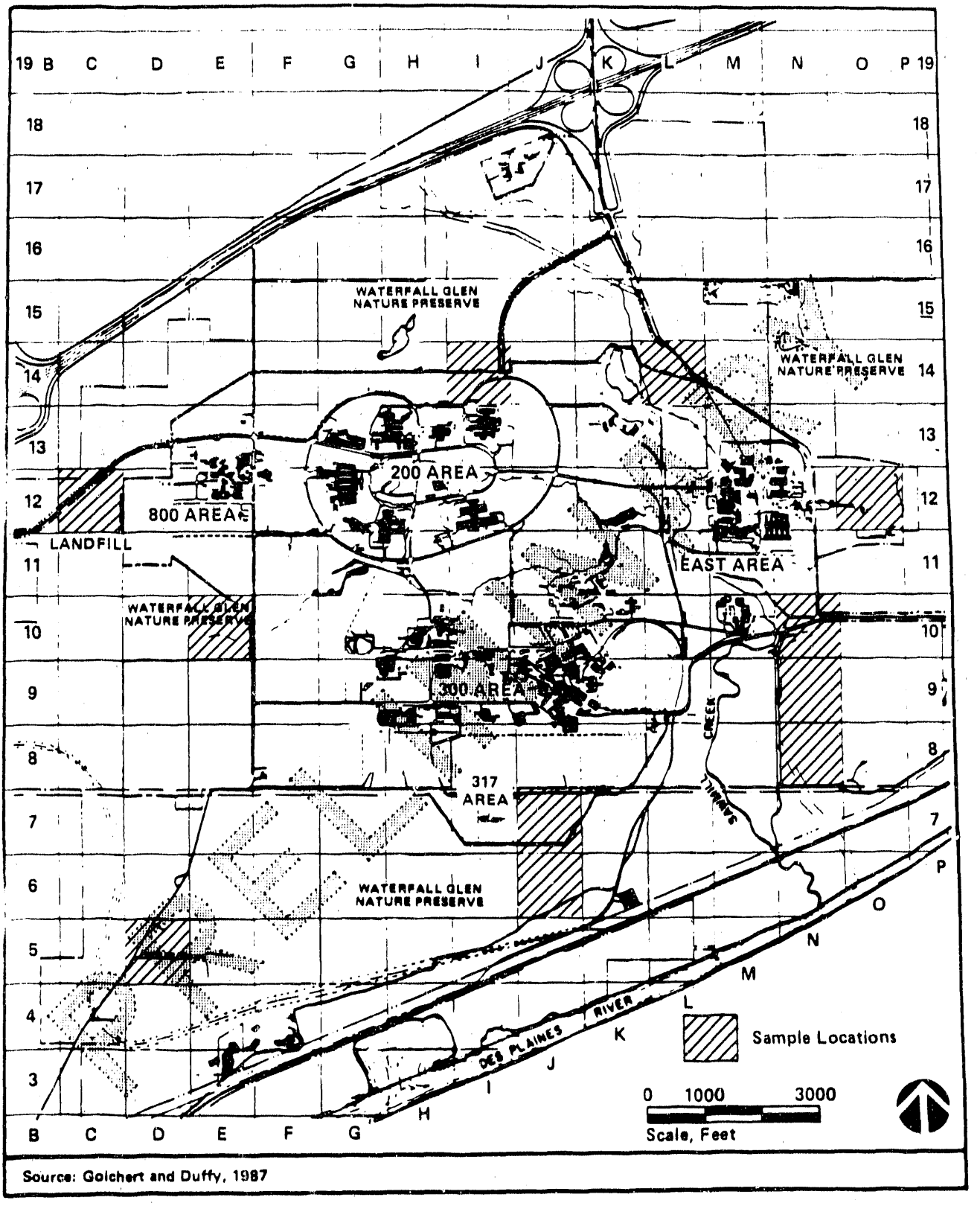
GAMMA-RAY EMITTING RADIONUCLIDES IN SOIL AT ANL, 1986
(Concentrations in 10^{-6} μCi/g)

Date Collected	Location	Potassium-40	Cesium-137	Radium-226	Thorium-228	Thorium-232
	Site Boundary[a]					
June 5	5D	16.68 ± 0.57	0.70 ± 0.03	1.06 ± 0.06	0.91 ± 0.03	0.71 ± 0.08
June 5	8N	18.96 ± 0.61	0.34 ± 0.02	1.23 ± 0.06	0.87 ± 0.03	0.81 ± 0.08
June 5	12-0	14.69 ± 0.61	0.97 ± 0.04	1.14 ± 0.06	0.91 ± 0.04	0.81 ± 0.09
June 5	14L	15.79 ± 0.56	0.06 ± 0.03	1.14 ± 0.06	0.88 ± 0.03	0.83 ± 0.08
June 5	12C	15.51 ± 0.55	0.84 ± 0.03	1.32 ± 0.06	0.86 ± 0.03	0.88 ± 0.09
June 24	7J	17.51 ± 0.59	0.96 ± 0.04	1.09 ± 0.06	0.95 ± 0.03	0.83 ± 0.08
June 24	7J	18.82 ± 0.61	2.15 ± 0.05	1.06 ± 0.06	0.94 ± 0.03	0.86 ± 0.08
June 24	7J	17.03 ± 0.57	0.76 ± 0.03	1.14 ± 0.06	0.94 ± 0.03	0.83 ± 0.08
October 27	10E	18.11 ± 0.77	0.84 ± 0.04	1.40 ± 0.07	1.02 ± 0.04	0.83 ± 0.09
October 27	9N	16.62 ± 0.59	0.85 ± 0.04	1.25 ± 0.06	1.01 ± 0.04	0.78 ± 0.08
October 27	10N	14.75 ± 0.55	0.45 ± 0.03	1.07 ± 0.06	0.68 ± 0.03	0.59 ± 0.07
October 28	6J	22.37 ± 0.78	0.76 ± 0.04	1.43 ± 0.07	1.15 ± 0.04	0.89 ± 0.09
October 28	14I	17.58 ± 0.60	0.85 ± 0.04	1.31 ± 0.06	1.04 ± 0.04	0.90 ± 0.09
	Average	17.26 ± 1.15	0.85 ± 0.24	1.20 ± 0.07	0.94 ± 0.08	0.81 ± 0.05
	Off-Site[b]					
June 3	West Chicago, IL	14.55 ± 0.67	0.44 ± 0.03	1.47 ± 0.08	1.07 ± 0.04	1.02 ± 0.11
June 3	Naperville, IL	13.79 ± 0.66	0.61 ± 0.04	1.49 ± 0.08	2.93 ± 0.07	2.57 ± 0.15
June 3	Lemont, IL	16.55 ± 0.58	1.08 ± 0.04	1.51 ± 0.06	0.79 ± 0.03	0.69 ± 0.08
June 5	Channahon, IL	15.51 ± 0.56	0.81 ± 0.03	1.13 ± 0.06	0.95 ± 0.03	0.93 ± 0.08
June 5	Starved Rock State Park, IL	15.31 ± 0.55	0.34 ± 0.02	1.98 ± 0.07	0.89 ± 0.03	0.83 ± 0.08
October 15	McKinley Woods State Park, IL	18.52 ± 0.75	1.81 ± 0.05	1.41 ± 0.07	0.86 ± 0.04	0.79 ± 0.09
October 15	Morris, IL	16.18 ± 0.72	0.32 ± 0.03	1.62 ± 0.07	1.06 ± 0.04	0.89 ± 0.09
October 15	Dresden Station, IL	22.06 ± 0.65	0.98 ± 0.04	1.46 ± 0.06	1.08 ± 0.04	0.88 ± 0.08
October 16	Western Springs, IL	20.21 ± 0.77	0.65 ± 0.03	1.89 ± 0.07	1.06 ± 0.04	0.83 ± 0.09
October 16	Brookfield, IL	17.93 ± 0.60	1.18 ± 0.04	1.48 ± 0.06	0.93 ± 0.04	0.71 ± 0.08
	Average	17.06 ± 1.65	0.82 ± 0.29	1.54 ± 0.15	1.16 ± 0.40	1.04 ± 0.35

Source: Golchert and Duffy, 1987

[a] The site-boundary locations are given in terms of the grid coordinates in Figure 3-5.

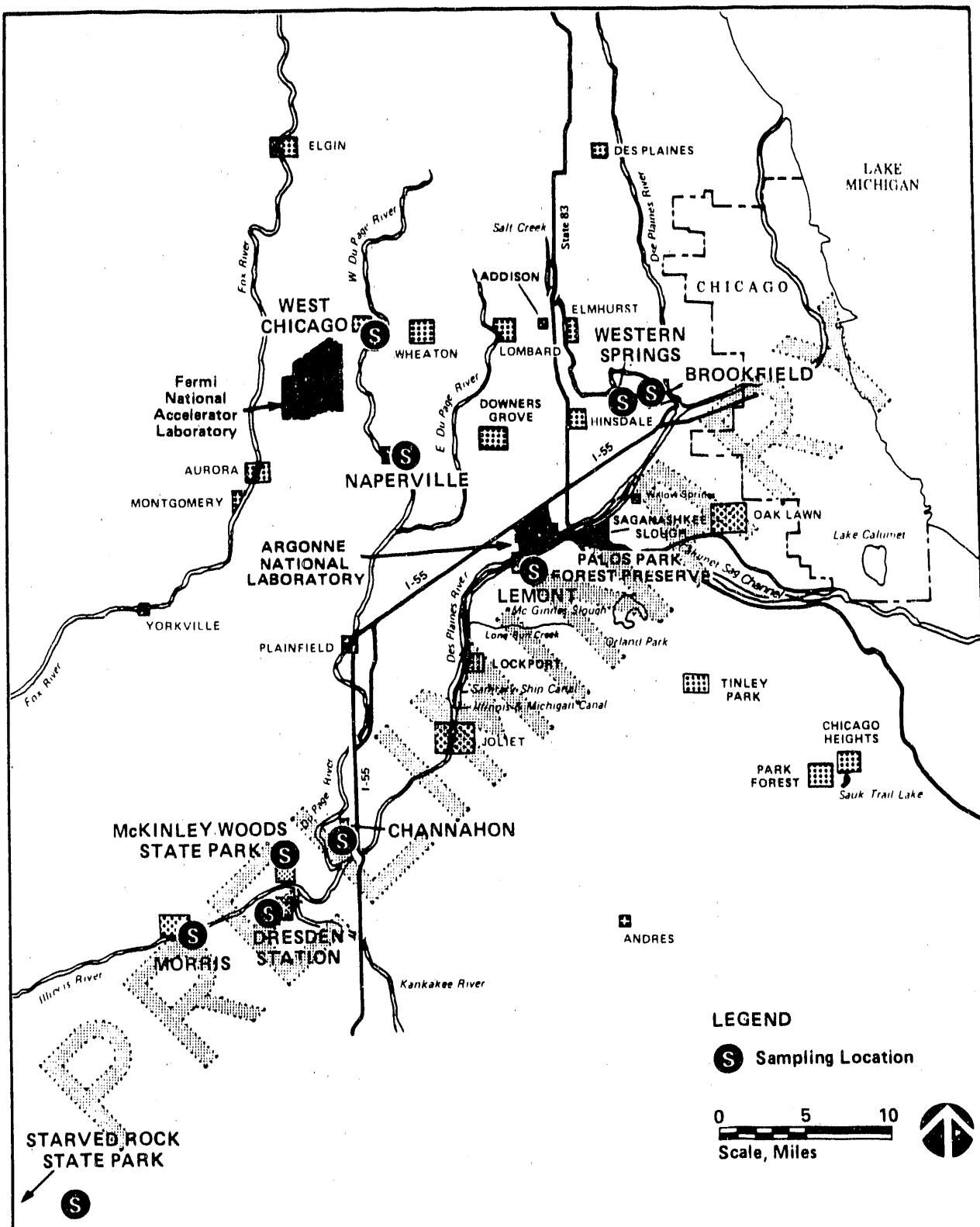
[b] The off-site locations are shown on Figure 3-6.



Source: Golchert and Duffy, 1987

SOIL AND GRASS SAMPLING GRID LOCATIONS ALONG THE SITE BOUNDARY AT ANL

FIGURE 3-5



Source: Golchert and Duffy, 1987

OFF-SITE SOIL AND GRASS SAMPLING LOCATIONS SURROUNDING ANL

FIGURE 3-6

TABLE 3-9

TRANSURANICS IN SOIL AT ANL, 1986

Date Collected	Location	Plutonium-238		Plutonium-239		Pu-238/Pu-239	Americium-241		Am-241/Pu-239
		10^{-9} µCi/g	10^{-3} µCi/m^2	10^{-9} µCi/g	10^{-3} µCi/m^2		10^{-9} µCi/g	10^{-3} µCi/m^2	
	Site Boundary[a]								
June 5	5D	0.8 ± 0.2	0.033 ± 0.008	13.4 ± 0.7	0.717 ± 0.037	0.045	3.2 ± 1.2	0.169 ± 0.067	0.24
June 5	8N	0.4 ± 0.1	0.031 ± 0.010	5.7 ± 0.4	0.413 ± 0.032	0.076	0.5 ± 0.9	0.034 ± 0.063	0.08
June 5	12-0	0.8 ± 0.2	0.039 ± 0.010	20.3 ± 1.0	0.949 ± 0.045	0.041	6.9 ± 1.9	0.322 ± 0.087	0.34
June 5	14L	0.6 ± 0.2	0.031 ± 0.009	12.7 ± 0.7	0.674 ± 0.039	0.046	3.2 ± 1.1	0.172 ± 0.059	0.26
June 5	12C	0.6 ± 0.2	0.031 ± 0.009	16.7 ± 0.8	0.888 ± 0.045	0.035	3.9 ± 1.8	0.205 ± 0.097	0.23
June 24	7J	0.9 ± 0.2	0.040 ± 0.009	56.0 ± 1.5	2.555 ± 0.067	0.016	4.9 ± 1.4	0.223 ± 0.063	0.09
June 24	7J	2.2 ± 0.3	0.096 ± 0.013	80.4 ± 1.8	3.509 ± 0.078	0.027	14.2 ± 2.0	0.617 ± 0.089	0.18
June 24	7J	0.8 ± 0.2	0.047 ± 0.015	19.7 ± 1.1	1.220 ± 0.067	0.038	3.4 ± 1.0	0.212 ± 0.061	0.17
October 27	10E	0.7 ± 0.2	0.038 ± 0.012	20.1 ± 1.0	1.035 ± 0.052	0.037	-	-	-
October 27	9N	0.6 ± 0.2	0.032 ± 0.011	19.2 ± 1.0	1.014 ± 0.052	0.032	-	-	-
October 27	10N	0.6 ± 0.2	0.031 ± 0.011	11.1 ± 0.8	0.534 ± 0.037	0.058	-	-	-
October 28	6J	0.6 ± 0.2	0.035 ± 0.013	17.5 ± 1.0	1.006 ± 0.057	0.035	-	-	-
October 28	14I	0.7 ± 0.2	0.033 ± 0.010	13.4 ± 0.9	0.909 ± 0.045	0.036	-	-	-
	Average	0.8 ± 0.3	0.040 ± 0.011	23.9 ± 12.9	1.186 ± 0.542	0.040	5.0 ± 3.6	0.244 ± 0.148	0.20
	Off-Site[b]								
June 3	West Chicago, IL	0.4 ± 0.1	0.016 ± 0.005	10.6 ± 0.6	0.435 ± 0.024	0.038	2.7 ± 0.8	0.107 ± 0.032	0.26
June 3	Naperville, IL	1.1 ± 0.2	0.057 ± 0.011	10.9 ± 0.6	0.564 ± 0.032	0.101	4.6 ± 0.6	0.237 ± 0.030	0.42
June 3	Lemont, IL	0.8 ± 0.2	0.032 ± 0.007	19.1 ± 0.9	0.724 ± 0.033	0.044	5.4 ± 0.3	0.204 ± 0.011	0.28
June 5	Channahon, IL	0.7 ± 0.2	0.027 ± 0.007	18.6 ± 0.8	0.758 ± 0.034	0.036	4.4 ± 1.2	0.386 ± 0.050	0.24
June 5	Starved Rock State Park, IL	0.3 ± 0.2	0.013 ± 0.007	3.3 ± 0.4	0.156 ± 0.016	0.053	1.1 ± 1.2	0.052 ± 0.056	0.34
October 15	McKinley Woods State Park, IL	1.2 ± 0.4	0.044 ± 0.014	35.3 ± 1.7	1.329 ± 0.064	0.033	-	-	-
October 15	Morris, IL	0.2 ± 0.2	0.009 ± 0.009	7.4 ± 0.7	0.432 ± 0.039	0.021	-	-	-
October 15	Dresden Station, IL	0.8 ± 0.2	0.029 ± 0.009	22.0 ± 1.1	0.844 ± 0.042	0.034	-	-	-
October 16	Western Springs, IL	0.9 ± 0.3	0.052 ± 0.016	17.0 ± 1.0	1.011 ± 0.061	0.051	-	-	-
October 16	Brookfield, IL	1.0 ± 0.2	0.057 ± 0.013	23.0 ± 1.0	1.305 ± 0.057	0.044	-	-	-
	Average	0.7 ± 0.2	0.034 ± 0.010	15.7 ± 5.8	0.754 ± 0.242	0.046	3.6 ± 2.2	0.197 ± 0.166	0.31

Source: Golchert and Duffy, 1987

a The site-boundary locations are given in terms of the grid coordinates in Figure 3-5.

b The off-site locations are shown on Figure 3-6.

TABLE 3-10

RADIONUCLIDES IN GRASS AT ANL, 1986

Date Collected	Location	Concentrations in 10^{-9} µCi/g	
		Cesium-137	Plutonium-239
	Site Boundary[a]		
June 5	5D	204 ± 19	<0.1
June 5	8N	291 ± 21	0.1 ± 0.1
June 5	12-0	373 ± 24	<0.1
June 5	12L	155 ± 23	0.4 ± 0.1
June 5	12C	219 ± 20	0.1 ± 0.1
October 27	10E	18 ± 20	0.3 ± 0.1
October 27	9N	36 ± 21	0.1 ± 0.1
October 27	10N	9 ± 18	<0.1
October 28	6J	33 ± 13	0.1 ± 0.1
October 28	14I	74 ± 22	<0.1
	Average	141 ± 81	0.1 ± 0.1
	Off-Site[b]		
June 3	West Chicago, IL	231 ± 21	<0.1
June 3	Naperville, IL	91 ± 16	<0.1
June 3	Lemont, IL	73 ± 16	<0.1
June 5	Channahon, IL	291 ± 21	<0.1
June 5	Starved Rock State Park, IL	291 ± 26	0.1 ± 0.1
October 15	McKinley Woods State Park, IL	43 ± 19	0.7 ± 0.1
October 15	Morris, IL	48 ± 21	0.5 ± 0.2
October 15	Dresden Station, IL	11 ± 12	0.5 ± 0.1
October 16	Western Springs, IL	26 ± 19	0.2 ± 0.1
October 16	Brookfield, IL	86 ± 28	0.9 ± 0.2
	Average	119 ± 69	0.3 ± 0.2

Source: Golchert and Duffy, 1987

a The site-boundary locations are given in terms of the grid coordinates in Figure 3-5.
b The off-site locations are shown on Figure 3-6.

locations, respectively. The annual averages and concentration ranges were similar at the site-boundary and off-site locations, as well as similar to previous years, indicating no contribution from ANL operations (Golchert and Duffy, 1987). Elevated cesium-137 concentrations in the June sampling were probably due to Chernobyl fallout, which had been washed into the soil by the time of the fall sampling (Golchert and Duffy, 1987). The concentration of cesium-137 added to the soil by the Chernobyl accident was small compared to that already present from previous atmospheric nuclear tests (Golchert and Duffy, 1987) and therefore, could not be detected as an increase in the analysis of the soil.

3.2.4 Findings and Observations

The findings which involve soil contamination are the result of current and past releases, spills, or disposal practices and are therefore discussed within the context of other findings in Sections 3.3.4 (Surface Water), 4.1.2 (Waste Management), and 4.5.2 (Inactive Waste Sites and Releases).

3.2.4.1 Category I

None

3.2.4.2 Category II

None

3.2.4.3 Category III

None

3.2.4.4 Category IV

None

3.3 Surface Water

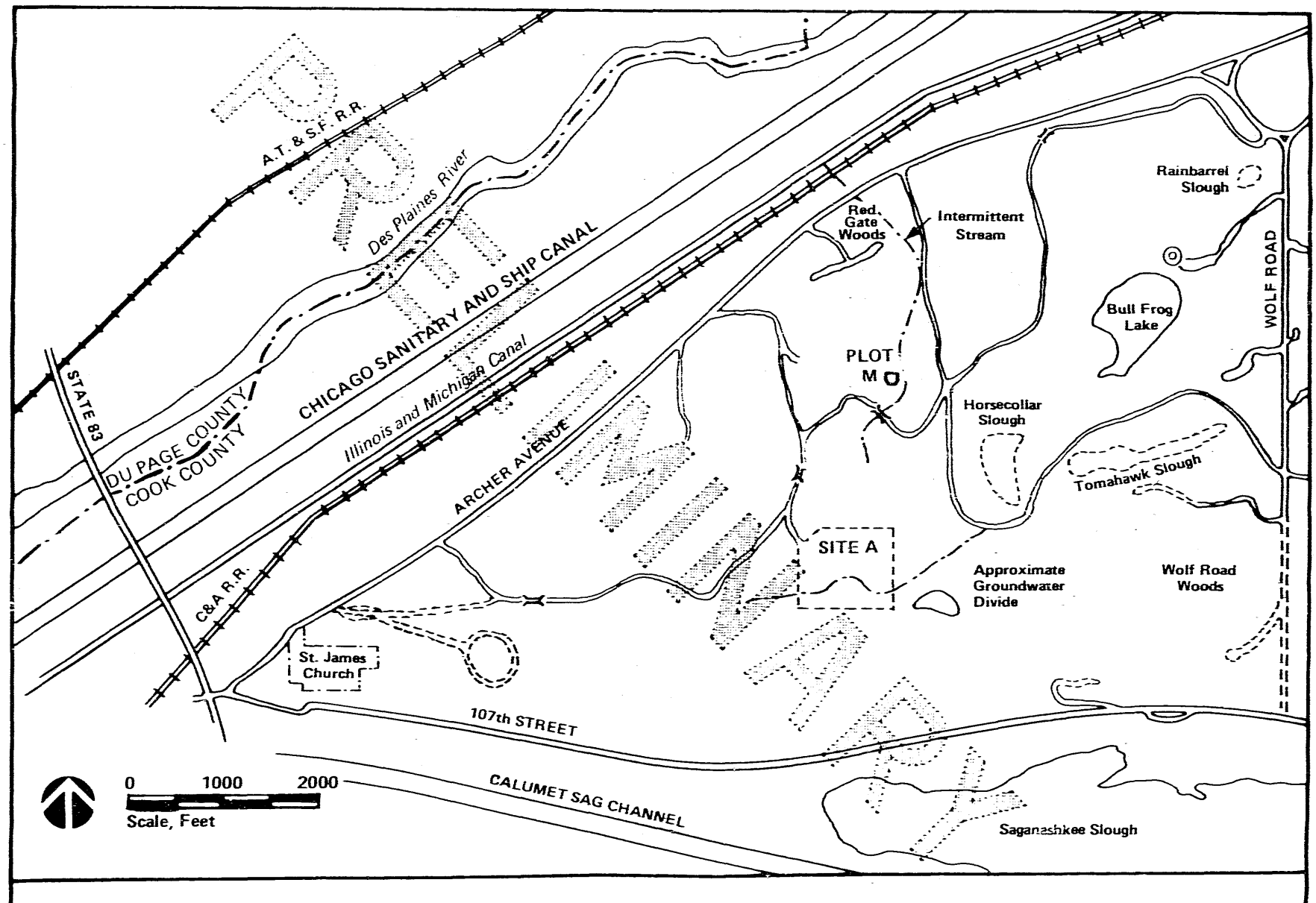
3.3.1 Background Environmental Information

The surface-water bodies on and in proximity to ANL are Sawmill Creek and the Des Plaines River (Figures 2-1 and 2-3). Sawmill Creek flows through the eastern portion of ANL. It originates north of the site, flows through the property in a southerly direction, and discharges to the Des Plaines River at a point approximately 1.3 miles southeast of the center of the site. The ANL property is drained primarily by Sawmill Creek and one of its tributaries, Freund Brook, although the extreme southern portion drains directly into the Des Plaines River. The Des Plaines River flows southwest for approximately 30 miles from its confluence with Sawmill Creek until it joins the Kankakee River to form the Illinois River. All three of these streams (Sawmill Creek, Des Plaines River, and Illinois River) are monitored by ANL as discussed in Section 3.3.3.

There are also several ponds on the ANL site including Upper Freund Pond, Lower Freund Pond and a pond near Building 205, all located along Freund Brook, and A^2R^2 Pond (Figure 2-2). The latter pond is man-made and was formed in 1967 when an excavation was dug for the foundation of the proposed Argonne Advanced Research Reactor (A^2R^2). The project was canceled and the 130-foot-diameter by 40-foot-deep hole subsequently filled with infiltrating groundwater.

Two former sites used by ANL, Site A and Plot M, are located in the Palos Park Forest Preserve, 3 miles east of ANL. Surface water there consists of swamps, ponds, and intermittent streams (Figure 3-7). An intermittent stream flows from the highest point north of Site A, past Plot M and Red Gate Woods, and discharges, when there is sufficient water, into the Illinois and Michigan Canal. This stream is monitored by ANL and monitoring results are presented in Section 3.3.3.

Directly upstream of ANL, Sawmill Creek had an average flow rate of 9.1 million gallons per day (mgd) from January to October of 1986, prior to the closing of a sewage treatment plant located a few miles north of ANL. After plant closure in October 1986, the average flow rate of the creek was 4.5 mgd for the rest of the year (Golchert and Duffy, 1987).

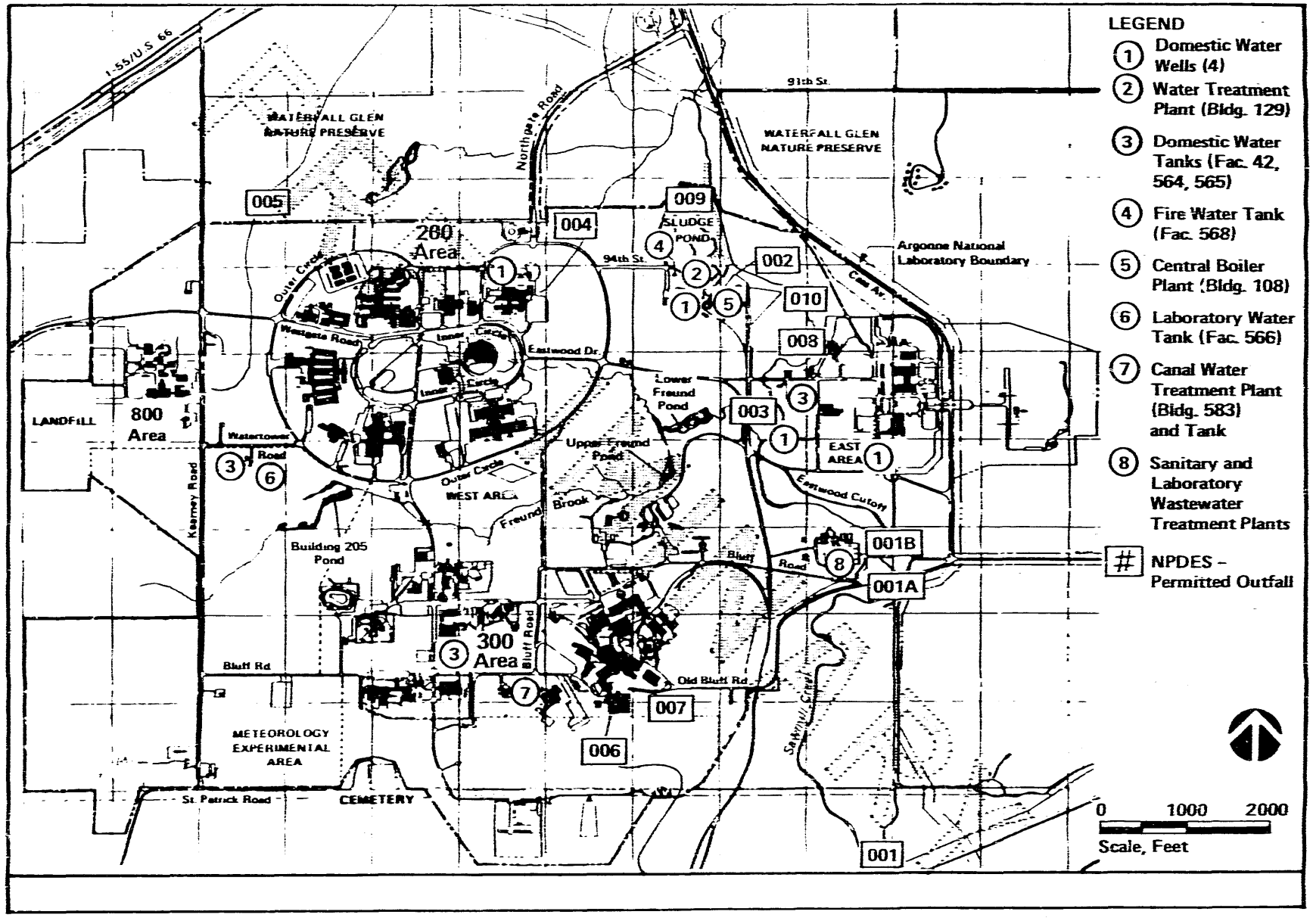


SURFACE WATER FEATURES AT PALOS PARK FOREST PRESERVE FIGURE 3-7

There are three principal wastewater systems on the site: stormwater (which also receives certain cooling water discharges), sanitary wastewater, and laboratory wastewater. The stormwater collection system is a combination of underground pipes, unlined ditches, and natural streambeds that eventually drain into Sawmill Creek or the Des Plaines River at various locations without treatment. Five of the stormwater discharges contain cooling water and as such are National Pollutant Discharge Elimination System (NPDES)-permitted outfalls (003 through 007) as described in Section 3.3.3.3 and depicted in Figure 3-8. The sanitary and laboratory wastewater sewer systems lead to their respective treatment units before discharging to Sawmill Creek. These units are, respectively, the sanitary wastewater treatment plant (Facility 570) and the laboratory wastewater treatment plant (Facility 575). Their locations are depicted on Figure 3-8. Effluents from the sanitary and laboratory wastewater treatment plants are combined and discharged through an outfall sewer, which is 0.83 mile long, to Sawmill Creek (NPDES Outfall 001). The wastewater sources, treatment plants, and discharge points are described in more detail in Sections 3.3.2 and 3.3.3.

A variety of piping materials are used in the above systems. Pipe in the storm sewer system consists of vitrified tile and concrete. Vitrified tile pipe has also been used in the sanitary sewer and laboratory sewer systems, except in short stretches where cast-iron and cement-asbestos pipe have been used. Cast-iron pipe, cement-asbestos pipe, and concrete encasement of the vitrified tile pipe have been provided where required by governing conditions. Sections of the sanitary and laboratory sewer systems in the 200 Area have been relined to reduce infiltration.

Other water-related utilities include domestic water, laboratory water, and canal water (cooling water supply) systems (Figure 3-8). Domestic water is pumped from four on-site wells (approximately 300 feet deep) to the water treatment plant (Building 129), where it is aerated, filtered, softened, and chlorinated. After treatment, domestic water is pumped to elevated storage tanks and into the general distribution system. All buildings use this water supply for drinking and process makeup. A portion of the treated water is stored in reserve for fire fighting and automatic sprinkler systems in various buildings. There are three elevated domestic water tanks (Facilities 42, 564, and 565) and one ground-level fire-water tank (Facility 568). The tank capacities are as follows: 42 150,000 gallons; 564 - 300,000 gallons; 565 - 500,000 gallons; and 568 - 650,000 gallons. Domestic water is



LOCATIONS OF NPDES - PERMITTED OUTFALLS AND WATER UTILITIES AT ANL

FIGURE 3-8

also used at the Central Boiler House (Building 108) for cooling purposes. Backflow prevention is provided where there is a possibility for contamination through cross-connections between potable and nonpotable water system piping. The cast-iron piping for potable water lines was installed in the late 1940s to early 1950s. The failure rate of this system has increased because of corrosion that appears traceable to the highly corrosive soils at ANL (Lindley and Sons, 1985). No domestic water lines are piped to laboratory sinks. In laboratory buildings, domestic water is piped only to restrooms (toilets, sinks, showers) and water fountains.

In laboratories, a separate laboratory water supply system, not connected to the main domestic water supply, is used to prevent contamination of domestic water by "back-siphonage." Water is pumped from the domestic water system to a point above the high water level and is discharged through an air gap into an elevated storage tank (Facility 566). From this tank, the laboratory water flows through a distribution system to the various laboratories in the buildings.

The nonpotable canal water (cooling water supply) distribution system serves the 200 and 300 Areas and includes an elevated storage tank. Water for the canal water treatment plant (Building 583) is obtained from the Chicago Sanitary and Ship Canal. The water is passed through treatment units to remove turbidity and to add chlorine and a corrosion inhibitor. Pipes used in this distribution system are polyvinyl chloride (PVC) and concrete. At one time, this system provided a raw-water feed to the Central Boiler House through an aboveground pipe that is now abandoned because of deterioration. As previously stated, water needs at the boiler plant are supplied from the domestic water system through a backflow preventer (double-check valve).

More details on the water treatment and supply systems are presented in Section 3.3.2.3.

3.3.2 General Description of Pollution Sources and Controls

3.3.2.1 Wastewater Sources

There are many sources of wastewater at ANL as summarized in Table 3-11 and described in the text that follows.

TABLE 3-11

WASTEWATER SOURCES AT ANL

Wastewater Source	Collection/Treatment System Receiving Wastewater Flow		
	Sanitary	Laboratory	Stormwater[a]
Sanitary:			
Toilets, lavatories, and showers	X		
Stormwater:			
Stormwater runoff from the Central Boiler House area	X	X	
Stormwater runoff from roofs, pavements, and ground surfaces			X
Process:			
Laboratory sinks		X	
Floor drains (laboratory buildings)		X	
Floor drains (plant services buildings)	X		X
Cooling water	X	X	X
Demineralizer, pressure filter, and water softener blowdown and backwash	X	X	
Waste Management Operations (Building 306, wastewater		X	
Lime Sludge Pond			X
Coal storage pile	X		X
Canal water treatment plant sludge ponds			X
Building 308 Alkali Metal Reaction Booth		X	
317 Area high activity vault footing drains			X
A²R² Pond[b]			

[a]Storm sewer or direct discharge to stream
[b]No outlet

Sanitary Wastewater: Wastewater from toilets, lavatories, showers, drinking fountains, and cafeterias/lunchrooms at all areas of ANL drains to the sanitary sewer system. No drains subject to radioactivity are connected to this sewer system.

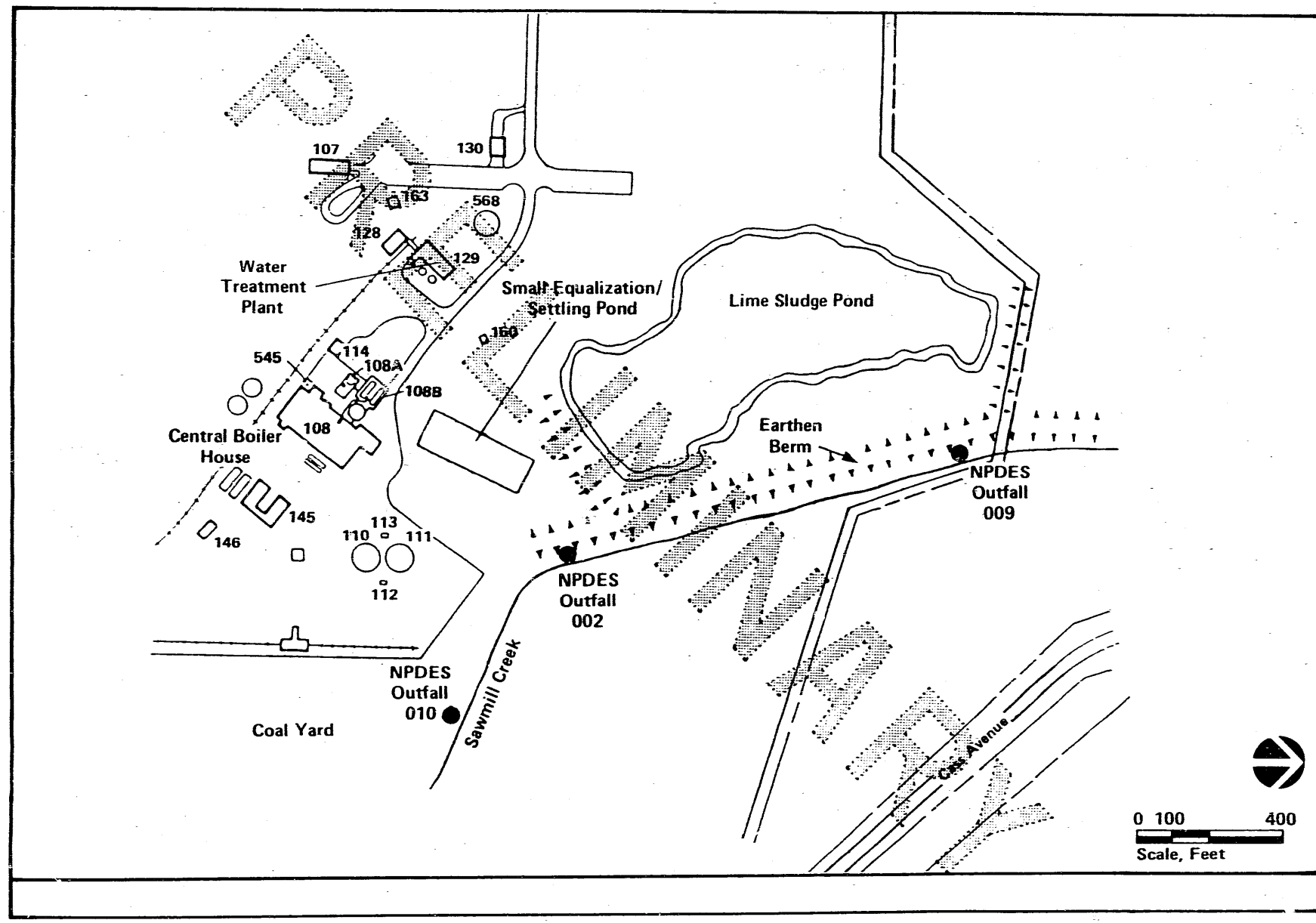
Stormwater: Stormwater runoff from roofs, paved areas, and ground surfaces at ANL flows to the stormwater collection system. No drains that may be subject to routine radioactive contamination are connected to this system.

Stormwater runoff from the Central Boiler House area discharges to a small equalization/settling pond located between the Central Boiler House and the Lime Sludge Pond (Figure 3-9). This pond discharges to the sanitary sewer system. This runoff may contain flyash and/or sorbent from boiler house air pollution controls devices.

Laboratory Sinks: There are usually one or more laboratory sinks in each of the numerous laboratories at ANL. The sinks drain to the laboratory sewer system. The sinks are used for cleaning glassware that contain chemicals, for rinsing empty chemical reagent storage bottles, and for the disposal of liquid effluents from experiments. Due to the nature of research performed at ANL, a wide variety of organic and inorganic chemicals are used for laboratory experiments. Solvents, such as alcohols and acetone, are used in larger quantities, relative to chemical reagent usage.

Small quantities of radioactive materials may also be disposed of in laboratory sinks. In all buildings where radioactive materials may be present, the laboratory sinks drain to basement retention tanks that are monitored for radioactivity prior to being discharged to the laboratory sewer. If radioactivity is above the operating limits established by ANL (Table 3-12), the wastewater is transported by truck to Building 306 for treatment and disposal. If radioactivity is lower than the operating limit, the wastewater is discharged to the laboratory sewer system. Any chemicals present would not be detected and would pass untreated through the laboratory wastewater treatment plant and discharge to Sawmill Creek.

Darkroom effluents from photoprocessing operations in Building 212 are discharged directly to the laboratory sewer, bypassing the retention tanks. Rinse



WASTEWATER SOURCES NEAR THE CENTRAL POWER HOUSE AT ANL

FIGURE 3-9

TABLE 3-12

BASEMENT RETENTION TANK OPERATING LIMITS AT ANL

Activity (dpm/mL)[a]	Disposition
Gross count (alpha plus beta) > 1,000	Process at Waste Management Operations (WMO), Building 306
Gross count < 1,000 but > 100 - Strontium - 90 > 10 and/or alpha > 5 - Strontium - 90 < 10 and alpha < 5	Process at WMO Discharge to laboratory sewer
Gross count < 100	Discharge to laboratory sewer

Source: ANL Site Waste Management Plan, February 1987

[a]disintegrations per minute per milliliter

baths are frequently allowed to run continuously and overflow to the laboratory drain during equipment operation.

Floor Drains in Laboratory and Plant Services Buildings: Floor drains in most of the laboratory and plant services buildings lead to the laboratory sewer system. However, floor drains in buildings located at older areas of ANL (800 Area and East Area) lead to the sanitary sewer system, because laboratory sewers do not serve these areas. In Building 815, which is used for degreasing operations and equipment maintenance, the drains lead to grease traps and then to a storm sewer that discharges to a drainage ditch.

Cooling Water: Cooling water is withdrawn from the Chicago Sanitary and Ship Canal (Figure 2-3), treated, and distributed to the 200 and 300 Areas of ANL for use in cooling towers. Of the water used in cooling towers, approximately 2.5 to 4 times the blowdown discharge is lost to evaporation. Most of the blowdown is discharged to the storm sewer/ditch system, with lesser quantities (approximately 10 to 20 percent) discharged to the sanitary and laboratory sewers. The effluents from the small quantities of cooling water used for laboratory experiments are discharged to the laboratory sewer.

Demineralizer, Pressure Filter, and Water Softener Blowdown and Backwash: Demineralizer blowdown from the boiler house and pressure filter backwash water from the water treatment plant discharge to a small equalization/settling pond located between the Central Boiler House and the Lime Sludge Pond (Figure 3-9). This small equalization/settling pond formerly discharged to Sawmill Creek through NPDES Outfall 002 but now discharges to the sanitary sewer system. Wastewater from the regeneration of the water softeners at the water treatment plant (Building 129) discharges to the laboratory waste sewer system. The water softeners have been in use since November 1986. Prior to this, ANL used the lime-soda ash softening water treatment process. Sludge from this process was disposed of at the Lime Sludge Pond, as discussed later in this section.

Waste Management Operations (Building 306) Wastewater: The waste processing building (Building 306) contains equipment used for decontaminating liquid radioactive waste and treating liquid hazardous waste. Decontaminated solutions

and neutralized hazardous waste are released to the laboratory sewer system. The activities at Building 306 are discussed further in Section 4.1.1.

Lime Sludge Pond: Over 30 years of lime-soda ash water softening treatment at the water treatment plant has generated approximately 100,000 cubic yards of lime sludge, which is presently stored in the Lime Sludge Pond. Formerly, the pond was used for sedimentation of the sludge, and the clarified supernatant continuously flowed through a discharge pipe to Sawmill Creek through NPDES Outfall 009 (Figure 3-9). This discharge had a pH value greater than 9 units and frequently had discharges of total suspended solids (TSS) that exceeded permitted discharge limits. The suspended solids consisted of the lime sludge that was entrained in the water. In November 1986, the water treatment plant was converted to an ion exchange softening process, and the pond was no longer used for lime sludge disposal. However, because the pond has approached capacity, accumulated rainfall could cause discharges to Sawmill Creek of high-pH waters having a high solids content and water could percolate through the dike separating Sawmill Creek from the pond.

Coal Storage Pile: The Coal Yard occupies approximately 2.5 acres east of the Central Boiler House, in which the coal is burned to generate steam. Precipitation that falls on the coal pile reacts with sulfur in the coal to form sulfuric acid, and the resulting runoff has a low pH (approximately 2 units) and a high concentration of iron (19,000 milligrams per liter [mg/L]). The runoff may also incorporate oils, possibly containing other contaminants, used on the coal pile to prevent freezing. Runoff formerly discharged to Sawmill Creek via NPDES Outfall 010, but is now pumped to the small equalization/settling pond (Figure 3-9) that discharges to the sanitary sewer. Outfall 010 is now used only as an emergency overflow. Such an overflow would be caused by a 100-year storm event. ANL has constructed a new pump station that will replace portable pumps that are currently used to pump runoff to the small equalization/settling pond.

Canal Water Treatment Plant Sludge Ponds: Settled sludge from the canal water treatment plant clarifiers is collected alternately in one of two unlined holding ponds near the plant. The ponds overflow to a storm sewer that discharges to Sawmill Creek through NPDES Outfall 006 (Figure 3-8). When one of the sludge ponds is full, the other pond is put into service. Each pond is cleaned approximately

once per year, and the sludge is disposed of in the 800 Area Landfill. The volume of this sludge (combined with sanitary sewage sludge), is approximately 25 cubic yards per year.

Building 308 Alkali Metal Reaction Booth: This facility is used for cleaning sodium and sodium-potassium eutectics from machine components and other metal parts. This process generates waste aqueous sodium hydroxide. This liquid waste stream flows to an underground tank that discharges to the laboratory sewer system. Wastewater from air pollution controls for the reaction booth also flows to the underground tank.

317 Area High Activity Vault Footing Drains: This vault is used for the temporary storage of low-level, high-activity wastes before shipment off-site for disposal. A footing drain system surrounds the vault and is believed to discharge through an outfall pipe to an off-site surface water stream in the Waterfall Glen Nature Preserve. In December 1986 and January 1987, water and sediment from this stream were sampled at several points upstream and downstream of the outfall pipe. The samples were analyzed for tritium, strontium-90, and gamma-ray emitters. Some of the samples from the downstream locations contained radionuclides above ambient concentrations. The 317 Area high-activity vault and the stream receiving the discharge are further discussed in Section 4.5.1.

A^2R^2 Pond: As described in Section 3.3.1, the A^2R^2 Pond was formed in 1967 when the A^2R^2 project was abandoned and the foundation excavation flooded. The excavation is located about 350 feet northwest of the CP-5 reactor in Building 330. During its operation, the CP-5 reactor exhausted about 1 Ci/day of tritiated water vapor. As a result of rainout and exchange, tritium accumulated in the pond. Since 1979, operation of the reactor was terminated, tritium concentrations have decreased. In 1982, about 2 million gallons of pond water disappeared by a subsurface route over a period of a few days,. The effect of this incident on groundwater is described in Section 3.4.3. The pond has since refilled and the tritium levels have continued to decrease from 2.2×10^{-6} µCi/mL in 1982 to 0.6×10^{-6} µCi/mL in 1986 (Golchert and Duffy, 1987). Except for loss to groundwater, there is no outlet from the A^2R^2 Pond.

3.3.2.2 Water Pollution Controls

ANL has two separate wastewater treatment facilities for water pollution control, a sanitary wastewater treatment plant and a laboratory wastewater treatment plant. These treatment plants are shown as Facility 570/575 on Figure 2-2. Wastewater flows to the two plants via the sanitary and laboratory wastewater sewer systems. The sanitary wastewater collection system is composed entirely of underground pipes and includes one pumping station. The system consists of a network of trunk sewers approximately 3.8 miles long ranging in diameter from 6 to 12 inches, and building laterals (exclusive of building connections) ranging in diameter from 6 to 8 inches. This system includes a sewage pumping station with a 600-foot-long force main.

The laboratory wastewater collection system consists of an underground gravity-flow piping system with no pumping stations. The system is comprised of a network of trunk sewers approximately 3.2 miles long ranging in diameter from 6 to 12 inches, and building laterals (exclusive of building connections) ranging in diameter from 6 to 8 inches.

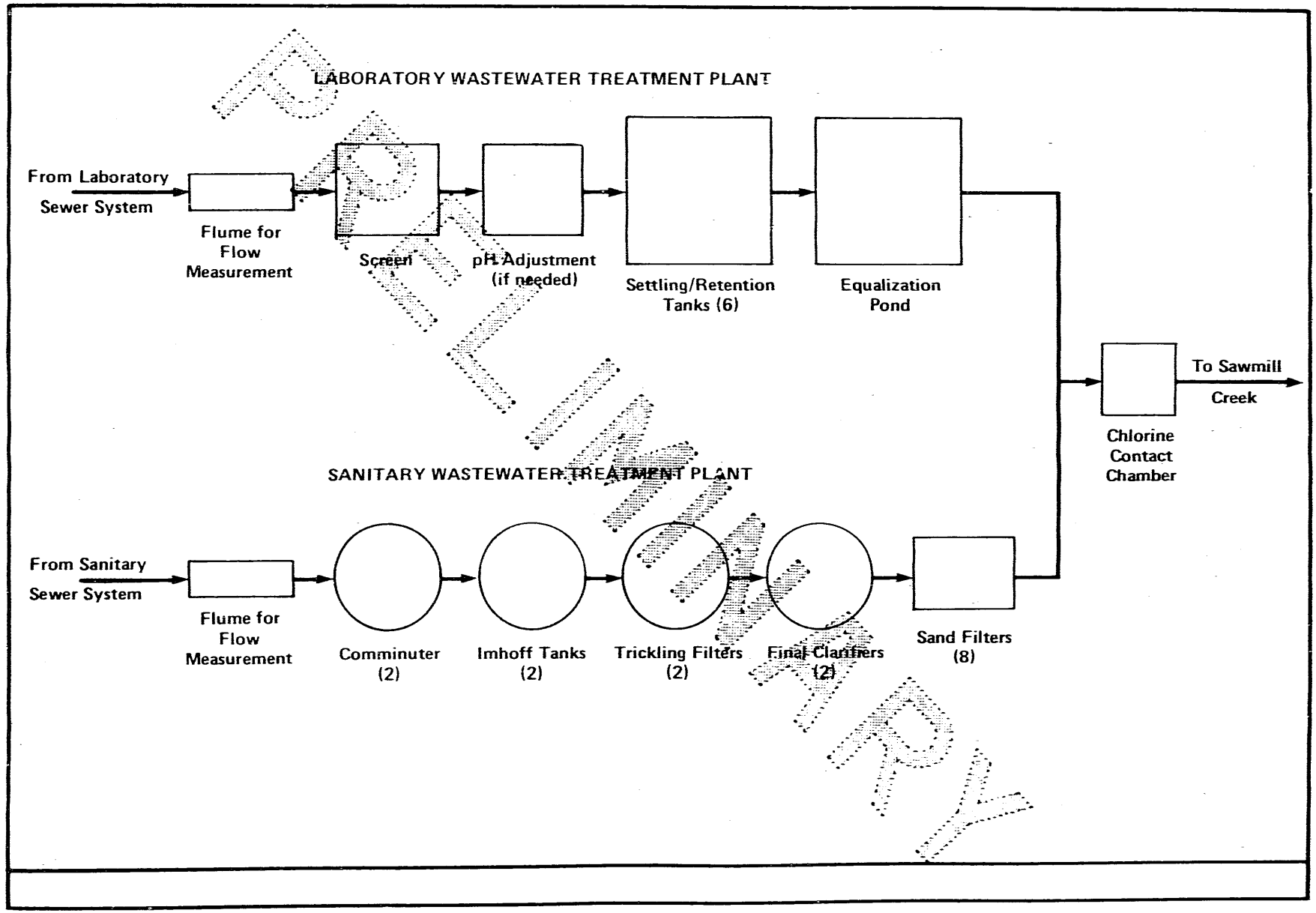
The laboratory wastewater sewer system closely parallels the sanitary sewer system for much of its length, and, where possible, both pipelines have been laid in a common trench. Dual-purpose manholes that serve both sewer systems have been provided. The flows are kept separate by a substantial dividing wall in the manhole. All combined manholes have been inspected within the past 5 years. ANL currently inspects these manholes at a minimum frequency of once per year.

In the past, there were serious infiltration and exfiltration problems in sections of both sewer systems in the 200 Area. A video survey of these lines was conducted, and problem stretches were cleaned out and relined. Although this solved the serious infiltration and exfiltration problems in the 200 Area, ANL personnel have noticed that wastewater in the sanitary and laboratory sewers is "backing up" in manholes, at times, at other areas of ANL. ANL suspects that this is caused by roots intruding through the pipe joints and impeding the wastewater flow. Root intrusion into the sewer lines is conducive to infiltration into the pipe, and possibly exfiltration out of it. Workers at the sanitary and laboratory wastewater treatment plants have noticed a small increase in the influent flow rates to these treatment

plants during periods of rain. It is also possible that there are losses of contaminated wastewater from these sewer systems to soil and possibly groundwater. Neither the amounts nor contaminant contents of this infiltration and exfiltration have been quantified. ANL plans to perform a study where the sewers will be inspected using video cameras. Based on the results of this study, ANL plans to take the necessary corrective actions.

The sanitary wastewater treatment plant and the laboratory wastewater treatment plant are used to control surface water pollution. A schematic flow diagram of these treatment plants is shown on Figure 3-10. The sanitary treatment plant discharges approximately 350,000 gallons per day (gpd). After passing through a Parshall flume for flow measurement, the incoming sanitary wastewater flow is split into parallel process trains. Unit processes include a comminuter, an Imhoff tank (primary sedimentation in an upper compartment and sludge digestion in a lower compartment), a trickling filter, and a final clarifier. A portion (approximately 50 percent) of the final clarified effluent is recycled to the trickling filter. Sludge that collects in the final clarifier is pumped back to the inlet of the Imhoff tank, where it is again separated by sedimentation and then treated by digestion. Clarified effluent that is not recycled is applied to sand filters (total of eight). The filtrate flows to the chlorine contact chamber and then discharges to Sawmill Creek through NPDES Outfall 001. Sludge from the digestion compartment of the Imhoff tanks is pumped to sludge drying beds at a frequency of approximately once per year. Filtrate from the drying beds flows to the flume and comminuter chamber. Naturally dewatered sludge is removed from the drying beds approximately once per year and is disposed of in the 800 Area Landfill. The annual volume of this sludge is approximately 25 cubic yards.

The laboratory wastewater treatment plant has an average flow rate of approximately 400,000 gpd. The main operating goals of this plant are to remove coarse screenings, adjust and equalize acid wastes, disinfect small quantities of organic matter, prevent the discharge of radioactivity above permissible levels, and provide for treatment of wastewater activity above permissible limits. Unit processes include flow measurement, screening, automatic pH adjustment (if required), settling/retention tanks, and an equalization pond. First the flow rate is measured at a parabolic flume. The pH is then monitored, and lime is automatically added if necessary, to neutralize acidic wastewater.



SCHEMATIC FLOW DIAGRAM
SANITARY AND LABORATORY WASTEWATER TREATMENT PLANTS

FIGURE 3-10

The wastewater then flows to one of six holding (or retention) tanks that each have a capacity of 69,000 gallons. After one tank is full, the water is checked for radioactivity, solids are allowed to settle, the flow is diverted to the next tank and, if the radiation level is below permissible limits (Table 3-13), the water is pumped to the equalization pond. However, if the radioactivity in a holding tank is above permissible limits, the wastewater is passed through ion exchange columns and then rechecked for radioactivity before it is released to the equalization pond. This has occurred only once in at least 20 years. The equalization pond discharges to the same chlorine contact tank that serves the sanitary wastewater treatment plant. The combined sanitary and laboratory treatment plant effluents are then discharged through an underground pipe to Sawmill Creek via NPDES Outfall 001.

Wastewater from regeneration of the ion exchange columns or the ion exchange resin is trucked to Building 306 (Waste Management Operations) for treatment or disposal. Solids that settle in the holding tanks are pumped to the laboratory waste sludge drying beds. The filtrate flows to the metering and screening chamber. Naturally dewatered sludge is handled as a low-level radioactive waste and is shipped to the Idaho National Engineering Laboratory (INEL) for disposal.

In addition to the sanitary and laboratory wastewater treatment plants, the following items contribute to the control of water pollution at ANL: management controls for hazardous materials handling, a Spill Prevention, Control, and Countermeasures (SPCC) Plan, the small equalization/settling pond near the Central Boiler House and the canal water treatment sludge ponds.

Management controls and procedures for the handling and disposal of hazardous materials and hazardous waste generated at ANL are discussed in Section 4.1.1.

ANL has an SPCC Plan for oil and hazardous materials. The SPCC Plan contains ANL policy on spills and responsibilities of ANL personnel. The plan contains a spill emergency plan, spill control procedures, ANL phone contacts for spill emergencies, government contacts for reporting and/or emergency response in spill incidents, and off-site spill control resources. The SPCC Plan also describes areas where a reasonable potential for a spill exists and the containment measures at these areas.

TABLE 3-13

LABORATORY WASTEWATER TREATMENT PLANT MAXIMUM PERMISSIBLE LIMITS FOR DISCHARGE, ARGONNE NATIONAL LABORATORY

Activity (dpm/mL)	Disposition
Gross count (alpha plus beta) >125	Hold for processing
Gross count <125, but >5	
- Strontium-90 >2 and/or alpha >1	Hold for processing
- Strontium-90 <2 and alpha <1	Discharge
Gross count <5 and alpha <1	Discharge

Source: ANL Site Waste Management Plan, February 1987

Note: These limits are used to determine if wastewater can be discharged to Sawmill Creek. Limits in Table 3-12, which are higher, are used to determine if basement retention tank wastewater can be discharged to the laboratory sewer system.

The small equalization/settling pond located at the Central Boiler House area receives influent wastewater from the following sources:

- Runoff from the boiler house area
- Demineralizer blowdown from the boiler house (Building 108)
- Pressure filter backwash from the water treatment plant (Building 129)
- Runoff from the coal storage pile

The effluent from this pond discharges to the sanitary sewer system. The pond serves to equalize the flow rate and contaminant concentrations from the above sources before the wastewater discharges to the sanitary sewer system. Suspended solids present in the wastewater also settle out in this pond.

The canal water treatment plant sludge ponds receive settled sludge from the canal water treatment plant clarifiers. This sludge is allowed to further concentrate in these ponds. The supernatant discharges to the stormwater collection system and eventually flows into Sawmill Creek (NPDES Outfall 006). The pond serves to reduce the suspended solids concentration of the pond water that discharges to the creek.

3.3.2.3 Water Treatment Systems

Potable water for domestic, fire protection, and laboratory uses is treated at the water treatment plant (Building 129). Influent water is provided by four on-site wells approximately 300 feet deep that can each produce 333,500 gpd. There is also a deeper well (1,600 feet deep) at ANL, but the water level of the deeper aquifer has fallen below the pump screen, and therefore the well can no longer be used. Well water is pumped to two aeration tanks used to aerate the raw water to convert dissolved iron to insoluble hydrated iron oxides and to remove dissolved carbon dioxide. These open-top, outdoor aeration tanks are close to the Central Boiler House. There is a possibility that emissions of particulate matter (flyash, spent scrubber sorbent, etc.) from the boiler house could enter the aeration tanks as suspended solids. Liquid sodium hydroxide is added to the aeration tank effluent, and the water is pumped through eight pressure filters for iron removal. Filtering also removes other suspended solids. Pressure filter backwash water flows to the small equalization/settling pond located between the Lime Sludge Pond and the boiler house.

A portion (volume dependent on hardness) of the aerated, filtered water then flows to four ion exchange softeners used to remove hardness. The softened water is then blended with aerated, filtered water to obtain water with the desired hardness. The blended water is then chlorinated and pumped to the distribution systems. The average flow rate of the plant is 1 mgd. Wastewater generated during the regeneration of the ion exchange water softeners flows to the laboratory sewer system.

Water for cooling purposes is treated at the canal water treatment plant (Building 583). The water is pumped approximately 1 mile from a pump station on the Chicago Sanitary and Ship Canal to reactivator tanks used for chemical addition and clarification. Current treatment involves adding alum and a polymer (Nalco 7109) to remove turbidity from the canal water. Treatment using lime and alum was used at one time, but has been discontinued. The treated water is chlorinated and flows to a ground-level storage tank. The water is then pumped to an elevated tank that feeds the distribution system. A corrosion inhibitor (Nalco 7317) is added when the water is pumped to the elevated tank. A heavy chlorine dose is applied once per week to destroy biofouling growth that may be present in the distribution system. The nonpotable canal water distribution system is completely separate from other water-related utilities and serves the 200 and 300 Areas at ANL. Additional corrosion inhibitors and biocides (e.g., chlorine) may be added to individual cooling towers at their respective buildings. The average flow rate in the system is 100,000 gpd. This increases to 300,000 gpd in the summer when cooling water demand is higher. Sludge from the reactivator tanks flows to one of two holding ponds, located approximately 200 feet south of Building 583 in the 300 Area (Figure 2-2).

3.3.3 Environmental Monitoring Program

The sampling phase of the environmental monitoring at ANL is depicted in Table 3-14. Personnel from various departments are responsible for the acquisition of samples. Samples from effluent or discharge points in the wastewater treatment plant (Building 570/575), Central Boiler House (Building 108), and water treatment plant (Building 129) are collected by Utility Services Department personnel. Personnel from the Industrial Hygiene Chemical Laboratory (IHCL), Department of Occupational Health and Safety (OHS), collect samples from NPDES Outfalls 003

TABLE 3-14

SAMPLING PERSONNEL AND METHODOLOGY FOR THE ENVIRONMENTAL MONITORING PROGRAM AT ANL

Sample Point	Bldg 570 US	Bldg 108 US	Bldg 200 OHS	Bldg 129 US	Bldg 306 WMO	Life-Guards	Area BM	Sampling Method
NPDES 001A	●							Grab
NPDES 001B	●							Time Proportional
NPDES 001	●							Grab
NPDES 002		●						Grab
NPDES 003			●					Grab
NPDES 004			●					Grab
NPDES 005			●					Grab
NPDES 006			●					Grab
NPDES 007			●					Grab
NPDES 008			●					Grab
NPDES 009			●					Grab
Landfill Wells			●					Grab
Sawmill Creek			●					Time Proportional
Des Plaines River			●					Grab
Wastewater Treatment Plant	●							Time Proportional
Retention Tanks							●	Grab
Raw-water Well				●				Grab
Treated-Domestic Water				●				Grab
Central Boiler House Boiler Water		●						Grab
Central Boiler House Condensate		●						Grab
Swimming Pool						●		Grab
Drinking Fountains				●				Grab
Lab Sewage	●							Grab
Suspect Waste Tanks					●			Grab
Acid Waste Tanks					●			Grab
Site A/Plot M			●					Grab

US - Utility Service Personnel
OHS - Occupational Health and Safety
WMO - Waste Management Operations Personnel
BM - Building Maintenance Personnel
ANL - Program

through 009, Sawmill Creek, and the Des Plaines River. Samples from NPDES Outfalls 001, 001A, and 001B from the wastewater treatment plant are collected by plant personnel. Acid tanks and suspect waste tanks are sampled by Waste Management Operations (WMO) personnel from Building 306. Samples from the retention tanks on the service floors in various buildings are collected by the appropriate Building Maintenance personnel.

Collection and validation of environmental samples by OHS personnel are delineated in Industrial Hygiene Operating Procedure IHCL-001, "Water Sampling Site Locations, Sample Collection, and Preservation" and in Chapter 13 of the Quality Assurance (QA) Plan for the IHCL. Operating Procedure IHCL-001 identifies the location of each sampling point, the frequency of sampling at that location, the sampling technique to be employed, and the appropriate preservation agent. Chapter 13 of the QA Plan for the IHCL describes handling, storage, and shipping requirements for environmental monitoring samples. Observations of sampling during the Survey indicate that, in general, these procedures were followed although preservation agents are not added to samples at the time of collection. Quality assurance with respect to sample analysis is described in Section 4.4.

Quality assurance policies and activities for the IHCL sampling program are implemented and maintained by the QA Coordinator, who, according to the organizational chart in the IHCL-QA Plan, reports to the Head of Industrial Hygiene. At the time of the Survey, the same person held both positions.

The environmental monitoring program for surface water and drinking water at ANL is composed of five programs to achieve regulatory and process control objectives and to evaluate ANL's impact on the environment. Both radiological and nonradiological contaminants are analyzed, but the parameters that are analyzed depend on the specific sampling objective. The five programs are:

- Sampling and analysis of surface water of receiving streams (Sawmill Creek, Des Plaines River, and Illinois River);

- Sampling and analysis of sediments at on-site, perimeter, and off-site locations;

- Sampling and analysis of wastewater treatment plant and NPDES regulated discharges;

- Sampling and analysis of potable water system; and

- Sampling and analysis of surface water and sediment in the vicinity of Plot M.

3.3.3.1 Surface-Water Programs

Samples of Sawmill Creek are collected upstream and downstream from the combined wastewater treatment plant discharge (NPDES Outfall 001) (Figure 3-8). Upstream grab samples for radiological analyses are collected once per month at the Cass Avenue Bridge, approximately 9,000 feet upstream of the outfall. The samples are analyzed for alpha (nonvolatile), beta (nonvolatile), tritium, strontium-90, uranium (natural), neptunium-237, plutonium-238 and 239, americium-241, curium-242 (and/or californium-252), and curium-244 (and/or californium-249). Upstream grab samples for nonradiological analyses are collected twice per month at a location approximately 50 feet above NPDES Outfall 001. These samples are analyzed for ammonia-nitrogen, chloride, cyanide, dissolved oxygen, total dissolved solids (TSS), pH, sulfate, and temperature.

Sawmill Creek is also sampled downstream of Outfall 001 using an automatic time-proportional sampler and analyzed for radiological and nonradiological parameters. Grab samples are taken at least 150 feet downstream from Outfall 001 if the automatic sampler is not operating. The sampler is located in a locked shed constructed above the outfall and is fed by a pipe extending approximately 30 feet downstream in the creek bed. Radiological analysis of the daily composite sample is performed each working day. Analyses are for the same radionuclides as the upstream sample. Nonradiological analyses are performed at the following frequencies:

- Twice per month - ammonia, chloride, cyanide, dissolved oxygen, total dissolved solids, pH, sulfate, and temperature.

- Once per month - arsenic, barium, beryllium, cadmium, fluoride, lead, nickel, selenium, and zinc.
- Once per week- chromium, copper, iron, manganese, mercury, and silver.
- Once per day - pH.

Monitoring results for 1986 for radionuclides and inorganics are presented in Tables 3-15 through 3-17. Results for nonvolatile beta activity and strontium-90 indicate that the Illinois Stream Standard has been exceeded in some of the downstream samples. Some of the inorganics in downstream samples exceeded the state standards at the following frequencies:

- Ammonia - 1 of 24 samples
- Cyanide - 3 of 24 samples
- Copper - 12 of 52 samples
- Iron - 8 of 52 samples
- Mercury - 1 of 52 samples.

Samples of the Des Plaines River are collected upstream and downstream of the confluence of Sawmill Creek and the Des Plaines River. Grab samples are collected once per month at Willow Springs, approximately 5 miles upstream of Sawmill Creek, and twice per month at Lemont, approximately 2.5 miles downstream (Figure 2-1). All samples are analyzed for mercury, alpha (nonvolatile), beta (nonvolatile), tritium, strontium-90, uranium (natural), neptunium-237, plutonium-238 and 239, americium-241, curium-242 (and/or californium-252), and curium-244 (and/or californium-249). Monitoring results for 1986 are shown in Table 3-18; mercury was not detected, and no state standards were exceeded.

In addition, the Illinois River is monitored for radioactivity. As previously mentioned, the Illinois River is formed downstream of ANL where the Des Plaines River joins the Kankakee River. Grab samples are collected twice per year at the following locations and approximate distances from ANL: McKinley Woods State Park (28 miles), below Dresden Power Station (28 miles), Morris (32 miles), and Starved Rock State Park (60 miles) (Figure 2-1). All samples are analyzed for alpha (nonvolatile), beta (nonvolatile), tritium, uranium (natural), and plutonium-239.

TABLE 3-15

RADIONUCLIDES IN SAWMILL CREEK WATER, 1986 (pCi/L)

Type of Activity	Location[a]	Average	Minimum	Maximum	Illinois EPA Stream Standard[b]
Alpha (nonvolatile)	Upstream Downstream	2.2 1.7	1.4 1.0	3.9 2.9	--
Beta (nonvolatile)	Upstream Downstream	20 32	7 9	35 345	100
Tritium	Upstream Downstream	<125 2,650	<100 <100	277 103,100	--
Strontium-90	Upstream Downstream	<0.28 3.74	<0.25 <0.25	0.46 78.3	2
Uranium (natural)	Upstream Downstream	1.0 0.9	0.5 0.4	1.8 2.1	--
Neptunium-237	Upstream Downstream	<0.001 0.002	<0.001 0.001	0.002 0.014	--
Plutonium-238	Upstream Downstream	<0.001 <0.0012	<0.001 <0.001	<0.001 0.004	--
Plutonium-239	Upstream Downstream	<0.001 0.0028	<0.001 <0.001	<0.001 0.0176	--
Americium-241	Upstream Downstream	<0.001 0.0122	<0.001 <0.001	<0.001 0.096	--
Curium-242 and/or californium-252	Upstream Downstream	<0.001 <0.0012	<0.001 <0.001	<0.001 0.0027	--
Curium-244 and/or californium-249	Upstream Downstream	<0.001 <0.002	<0.001 <0.001	<0.001 <0.0033	--

Source: Goldcher and Duffy, 1987

[a]Upstream - at Cass Avenue Bridge; Downstream - Below NPDES Outfall 001 (Figure 3-8).
[b]Illinois Administrative Code, Title 35, Subtitle C, Chapter 1, Part 302, Subpart B - General Use Water Quality Standards.

TABLE 3-16

INORGANICS IN SAWMILL CREEK WATER, 1986

Constituent	Location[a]	Concentration (mg/L)			Illinois EPA Stream Standard[b]
		Average	Minimum	Maximum	
Ammonia	Upstream Downstream	0.3 0.5	0.1 0.1	1.3 3.5	1.5
Chloride	Upstream Downstream	316 274	116 91	616 520	500
Cyanide	Upstream Downstream	<0.02 0.02	<0.02 <0.02	<0.02 0.07	0.025
Dissolved Oxygen	Upstream Downstream	11.3 10.8	7.7 7.7	15.3 13.3	5.0 (minimum)
Total Dissolved Solids	Upstream Downstream	1,040 940	460 445	1,600 1,340	1,000
pH (units)	Upstream Downstream	-- --	7.7 7.7	8.8 8.8	6.5-9.0
Sulfate	Upstream Downstream	151 166	68 72	237 241	500
Temperature (°C)	Upstream Downstream	14.0 15.2	0.4 2.4	26.0 25.7	<2.6°C rise

Source: Golchert and Duffy, 1987

[a]50 feet upstream from NPDES Outfall 00T; 200 feet downstream from NPDES Outfall 001 (Figure 3-8).
[b]Illinois Administrative Code, Title 35, Subtitle C, Chapter 1, Part 302, Subpart B - General Use Water Quality Standards

TABLE 3-17

INORGANICS IN SAWMILL CREEK WATER BELOW NPDES OUTFALL 001, 1986
(µg/L)

Constituent	Average	Minimum	Maximum	Illinois EPA Stream Standard[a]
Arsenic	<5	<5	<5	1,000
Barium	53	21	97	5,000
Beryllium	0.05	0.01	0.18	--
Cadmium	0.7	0.2	1.6	50
Chromium	8	3	37	50
Copper	17	9	45	20
Fluoride	487	280	670	1,400
Iron	698	193	3,670	1,000
Lead	4	1	8	100
Manganese	81	18	285	1,000
Mercury	0.09	<0.05	0.58	0.5
Nickel	32	2	62	1,000
pH (units)	--	7.1	8.9	6.5-9.0
Selenium	<5	<5	<5	1,000
Silver	1.7	0.2	3.1	5
Zinc	32	10	45	1,000

Source: Golchert and Duffy, 1987

[a]Illinois Administrative Code, Title 35, Subtitle C, Chapter 1, Part 302, Subpart B--General Use Water Quality Standards

TABLE 3-18

RADIONUCLIDES IN DES PLAINES RIVER WATER, 1986

Type of Activity	Location[a]	Average	Minimum	Maximum	Illinois EPA Stream Standard[b]
Alpha (nonvolatile)	Upstream Downstream	1.5 1.7	0.8 0.9	1.9 3.4	--
Beta (nonvolatile)	Upstream Downstream	11 12	6 5	19 21	100
Tritium	Upstream Downstream	<113 <114	<100 <100	223 170	--
Strontium-90	Upstream Downstream	0.31 0.31	<0.25 <0.25	0.49 0.44	2
Uranium (natural)	Upstream Downstream	0.9 1.0	0.3 0.3	1.3 2.1	--
Neptunium-237	Upstream Downstream	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	--
Plutonium-238	Upstream Downstream	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	--
Plutonium-239	Upstream Downstream	<0.001 <0.0011	<0.001 <0.001	<0.001 <0.002	--
Americium-241	Upstream Downstream	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	--
Curium-242 and/or californium-252	Upstream Downstream	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	--
Curium-244 and/or californium-249	Upstream Downstream	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001	--

Source: Golchert and Duffy, 1987

[a]Upstream - near Willow Springs; Downstream - near Lemont (Figure 2-1).
[b]Illinois Administrative Code, Title 35, Subtitle C, Chapter 1, Part 302, Subpart B - General Use Water Quality Standards.

Monitoring results for 1986, presented in Table 3-19,are similar to those from the Des Plaines River.

3.3.3.2 Sediment Sampling Program

Sediment samples are collected on-site, near the site perimeter, and off-site, and are analyzed for radioactivity. Samples are generally collected once per year. On-site and perimeter sampling locations (Figure 2-2) include the pond near Building 205, Upper and Lower Freund Ponds, and Sawmill Creek (upstream and downstream of the wastewater treatment plant discharge). Off-site locations include Du Page River, Long Run Creek, Illinois River, Des Plaines River, and Salt Creek (Figure 2-1). All samples are analyzed for potassium-40, cesium-137, radium-226, thorium-228, thorium-232, plutonium-238 and 239, and americium-241. Monitoring results for 1986 are presented in Table 3-20. On-site concentrations are similar to the off-site values.

3.3.3.3 Wastewater Treatment Plant and NPDES Outfall Sampling Program

The combined wastewater treatment plant effluent is sampled on a continuous basis. A flow-proportional, composite sample is obtained each working day and analyzed for the constituents of interest, which are listed below. The sampler is located in Building 573. The following analyses are performed at the following frequencies:

- Once per month - arsenic, barium, beryllium, cadmium, fluoride, lead, nickel, selenium, and zinc.
- Once per week - chromium, copper, iron, manganese, and mercury.
- Once per day - pH.

No radiological analysis is performed. This is the same discharge point monitored for the NPDES permit, Outfall 001. However, most of the constituents that are monitored are different than those required under the NPDES permit, and the results are used internally by ANL.

A summary of the monitoring results for 1986 is presented in Table 3-21. No state

TABLE 3-19

RADIONUCLIDES IN ILLINOIS RIVER WATER, 1986

Parameter	Average Concentration (pCi/L)			
	McKinley Woods State Park[a]	Below Dresden Power Station[a]	Morris[a]	Starved Rock[a] State Park
Alpha (nonvolatile)	1.1	1.0	1.15	1.2
Beta (nonvolatile)	8.35	5.95	7.25	5.9
Tritium	<142	<142	<159	154
Uranium (natural)	0.65	0.9	0.9	0.85
Plutonium-239	<0.001	<0.001	NA	NA

Source: Golchert and Duffy, 1987

[a]See Figure 2-1 for location
Note: Two samples from each location
NA - Not analyzed

TABLE 3-20

RADIONUCLIDES IN PERIMETER AND OFF-SITE BOTTOM SEDIMENTS IN THE VICINITY OF ANL, 1986

Location	Potassium-40[a]	Cesium-137[a]	Radium-226[a]	Thorium-228[a]	Thorium-232[b]	Plutonium-238[b]	Plutonium-239[b]	Americium-241[b]
Perimeter[c]								
Building 205 Pond	14.99	0.37	0.86	0.67	0.62	0.6	7.8	3.3
Upper Freund Pond	20.27	0.37	1.46	0.90	0.76	0.8	12.3	3.2
Lower Freund Pond Inlet	21.79	0.38	1.64	1.02	0.93	0.6	20.5	4.1
Lower Freund Pond Outlet	19.45	0.65	1.26	0.87	0.68	1.2	57.6	7.0
Sawmill Creek at Des Plaines River	12.44	0.99	1.05	0.63	0.58	1.5	19.1	6.4
Sawmill Creek - 100 m Below NPDES Outfall 001	8.55	0.34	0.84	0.38	0.38	0.5	10.8	3.5
Sawmill Creek - 5 m Below NPDES Outfall 001	7.60	0.16	0.73	0.35	0.41	0.4	10.1	1.5
Sawmill Creek at NPDES Outfall 001	6.24	0.26	0.71	0.29	0.41	0.8	10.4	1.3
Sawmill Creek - 50 m Above NPDES Outfall 001	13.20	0.41	1.34	0.68	0.76	0.3	8.3	2.5
Stream at South Perimeter Fence	15.24	0.12	1.24	0.76	0.63	<0.1	2.5	2.1
Off-Site[d]								
Du Page River, W. Chicago	16.12	0.27	1.98	1.24	1.20	0.2	4.9	1.6
Du Page River, Naperville	7.94	0.18	0.95	1.33	1.17	0.3	3.5	<0.1

TABLE 3-20

RADIONUCLIDES IN PERIMETER AND OFF-SITE BOTTOM SEDIMENTS IN THE VICINITY OF ANL, 1986 (Continued)

Location	Potassium-40[a]	Cesium-137[a]	Radium-226[a]	Thorium-228[a]	Thorium-232[b]	Plutonium-238[b]	Plutonium-239[b]	Americium-241[b]
Off-Site[d] (Continued)								
Du Page River, Channahon	9.23	0.05	0.92	1.02	0.78	<0.1	1.0	1.3
Long Run Creek near Lemont	20.68	0.19	1.22	1.18	0.95	0.2	4.7	2.2
Pond, West Side of Lemont Road at 75th Street	16.36	0.79	1.28	0.98	0.73	0.6	19.2	5.2
Illinois River, McKinley Woods	9.58	0.03	0.47	0.34	0.36	<0.1	0.5	--
Illinois River, Dresden	15.86	0.29	0.98	0.70	0.66	<0.1	2.0	1.3
Illinois River, Morris	12.89	0.10	0.67	0.45	0.41	<0.1	1.1	0.4
Illinois River, Starved Rock State Park	5.77	0.09	0.80	0.40	0.40	0.1	0.9	0.4
Des Plaines River, Brookfield	17.17	0.47	1.31	0.94	0.90	0.2	5.4	3.0
Salt Creek, Western Springs	11.31	0.10	1.96	0.80	0.88	<0.1	0.9	0.7
Off-Site Average	12.99	0.23	1.23	0.84	0.77	0.2	4.0	1.6

Source: Golchert and Duffy, 1987

a Concentrations in 10^{-6} µCi/g.
b Concentrations in 10^{-9} µCi/g.
c See Figure 3-8 for location.
d See Figure 2-1 for location.

TABLE 3-21

CHEMICAL CONSTITUENTS IN THE ANL TREATMENT PLANT EFFLUENT, 1986
(µg/L)

Parameter	Average	Minimum	Maximum	Illinois EPA Effluent Standard[a]
Arsenic	<5	<5	<5	250
Barium	17	7	39	2,000
Beryllium	0.03	0.01	0.08	--
Cadmium	0.5	<0.2	1.6	150
Chromium	7.8	2	35	1,000
Copper	22	10	65	500
Fluoride	330	272	388	15,000
Iron	187	50	1,210	2,000
Lead	2.5	<2.0	4.1	200
Manganese	51	10	374	1,000
Mercury	0.15	0.05	0.97	0.5[b]
Nickel	29	2	57	1,000
pH (units)	--	6.9	8.3	6 to 9
Selenium	<5	<5	<5	--
Silver	2.6	1.4	3.6	100
Zinc	59	33	103	1,000

Source: Golchert and Duffy, 1987

[a]Illinois Administrative Code, Title 35, Subtitle C, Chapter 1, Part 304, Subpart A; General Effluent Standards
[b]Exceptions of up to 3 µg/L (average) are permitted.

effluent standard was exceeded, although 2 of 52 samples exceeded 0.5 microgram per liter (µg/L) of mercury. The state standard has an exception up to 3 µg/L if the discharger uses mercury only in chemical analysis or in laboratory or other equipment and takes reasonable care to avoid contamination of wastewater. Therefore, ANL is not in violation of the standards.

There are 10 NPDES-permitted outfalls at ANL that discharge to surface water. Outfall 001 has two intermediate permitted discharges, referred to as Outfall 001A (sanitary wastewater treatment plant effluent) and Outfall 001B (laboratory wastewater treatment plant effluent). All NPDES outfalls (001 through 010) discharge directly to Sawmill Creek or to unnamed tributaries to Sawmill Creek (Figure 3-8). The current NPDES permit expires on March 1, 1989, but has recently been modified in draft form. The draft modified permit has been issued for public comment, but is not yet in effect. The effective date of the modifications has not been specified. NPDES Outfalls 001, 001A, and 001B are monitored weekly; all others (Outfalls 002 through 010) are monitored monthly. Results of monitoring are discussed below.

The combined wastewater treatment plant effluent (Outfall 001) consists of treated sanitary and laboratory wastewater. Each working day, the composite sample is transferred to a 1-gallon glass bottle by the plant operator. It is stored in a refrigerator in Building 574 in the treatment plant area until it is picked up by ANL Industrial Hygiene personnel the same day for transport to the laboratory where the analysis is performed. Samples for bacteriological analysis are collected in a special bottle. The following data and frequencies are required by the NPDES permit:

- pH, fecal coliform - once per week (grab).
- 5-day biochemical oxygen demand (BOD-5), total suspended solids (TSS) once per week (composite).
- Iron, lead, manganese, zinc - once per month (grab) following a storm event.

In addition, grab samples are collected twice per month from Sawmill Creek, 50 feet upstream and 200 feet downstream of this discharge, and are analyzed for chloride and TSS, as previously discussed under the surface-water monitoring program.

Outfall 001A, an internal waste stream, is the effluent from the sanitary wastewater treatment plant. A composite sample of this discharge is collected once per week and analyzed for BOD-5 and TSS. This sample is collected by the plant operator and stored in a refrigerator in Building 574 until it is picked up by ANL Industrial Hygiene Laboratory personnel the same day.

Outfall 001B, also an internal waste stream, is the effluent from the laboratory wastewater treatment plant. Two separate samples are collected from this discharge on a weekly basis. The first, stored in a 1-gallon glass bottle, is an 8-hour composite consisting of three equal aliquots collected throughout the working day. This sample is analyzed for mercury and TSS. The other is a grab sample collected in a small glass bottle at the same time as the first aliquot of the composite sample is collected that is analyzed for chemical oxygen demand (COD). Samples are collected by the plant operator and stored in a refrigerator in Building 574 until retrieved by ANL Industrial Hygiene Laboratory personnel the same day.

Outfall 002, the Central Boiler House process water discharge, is no longer active. The pipe that discharged to Sawmill Creek has been capped. Water that formerly discharged through this outfall, including cooling water from the boiler plant, now flows to a small equalization/settling pond that discharges to the sanitary sewer system.

The water discharged through Outfall 003 (Freund Brook discharge to Sawmill Creek) consists primarily of surface runoff; however, it does contain cooling water from a number of buildings in the southern portion of the 200 Area. The sample is collected after the stream passes under Railroad Drive (250 feet north of Eastwood Drive) and prior to its confluence with Sawmill Creek. A grab sample is collected once per month in a plastic bottle and analyzed for pH and TSS. The flow rate is approximated, and the temperature is measured.

Outfall 004 contains cooling water discharged from Building 202 (Biology). Two open channels converge just before passing under Outer Circle at a point approximately halfway between its intersections with 94th Street and Northgate

Road. A grab sample is collected once per month in a plastic bottle at a location approximately 50 to 100 feet northeast of Outer Circle and is analyzed for pH and TSS. The flow rate is approximated, and the temperature is measured.

Outfall 005 is an open storm channel that contains cooling water from Building 200 (chemistry), 206 (Reactor Safety and Analysis) and 208 (Reactor Safety and Analysis/Applied Physics) and drainage water from the 800 Area. It is sampled approximately 50 to 100 feet upstream from the point where it passes under the north boundary fence, approximately 600 feet east of Kearney Road. Grab samples are collected once per month in a plastic bottle for pH analysis and in a glass bottle for analysis of fat, oil, and grease content. The flow rate is approximated, and the temperature is measured.

The canal plant outfall (Outfall 006) consists of the overflow from the sludge ponds at the canal water treatment plant. The water flows to an open storm drain south of the ZGS complex. The sampling location is at the bottom of the hill behind the cooling towers (Facility 577) on Old Bluff Road. A grab sample is collected once per month in a plastic bottle and is analyzed for pH, TSS, and zinc. The flow rate is approximated.

The Outfall 007 (ZGS Area cooling water) open drainage ditch on the south side of Old Bluff Road carries noncontact cooling water, normally at a very low flow rate (less than 5 gallons per minute [gpm]). A grab sample is collected once per month in a plastic bottle at a location approximately 800 feet west of vehicle gate 7 and is analyzed for pH. The flow rate is approximated, and the temperature is measured.

East Area cooling water (Outfall 008) is discharged to Sawmill Creek through a concrete pipe that emerges from the east bank of the creek. This location is approximately 300 feet north of Eastwood Extension off an unnamed access road that leads to Building 25. If there is discharge, a grab sample is collected once per month (when there is flow) and analyzed for pH. The flow rate is approximated, and the temperature is recorded.

Outfall 009 is the discharge from the Lime Sludge Pond to Sawmill Creek. The discharge pipe passes through the dike at the northeast corner of the pond. There has been no discharge through this outfall because the pond was taken out of

service in November 1986. If there is a discharge, a sample is to be collected twice per month and analyzed for pH and TSS. The flow rate is to be approximated, and the temperature measured. The pond freeboard is measured once a month.

Outfall 010 is an emergency overflow from the coal storage pile to Sawmill Creek. Runoff from the coal pile is normally pumped to the small equalization/settling pond that discharges to the sanitary sewer system. A large amount of precipitation or snowmelt would be needed to cause an overflow through this outfall. If there is a discharge, it is to be sampled once a month following a storm event and analyzed for pH, TSS, iron, lead, manganese, and zinc.

A summary of NPDES permit conditions and monitoring results for 1986 is presented in Table 3-22. The concentration of TSS exceeded the permit levels at several locations, usually when excessive rainfall (and runoff) occurred. One sample from the combined treatment plant discharge (001) exceeded the limit for fecal coliform. The water discharged from Outfall 009 (Lime Sludge Pond) always had a pH greater than the limit and frequently had excessive suspended solids levels. The discharge is no longer routinely used.

During the Survey team's visit, sampling procedures used by ANL Industrial Hygiene personnel were observed at Outfalls 003 through 007. There was no flow at Outfalls 008 through 010. Samples from Outfalls 003 through 007 were collected by submerging the sample bottles and allowing them to fill. The temperature was measured and recorded, and the samples were placed on ice in a small cooler. Samples are usually analyzed within 1 hour after they are returned to the analytical laboratory. The flow rates were approximated by measuring the cross-sectional area of the stream and timing a float passing through a measured stretch of the stream (area times length equals volume, which is divided by time to obtain an approximate flow rate).

3.3.3.4 Potable Water Sampling Program

The raw water supply is provided by four on-site wells. Well water is monitored on a quarterly basis for radiological and nonradiological contaminants. Analytes include arsenic, barium, chloride, copper, fluoride, iron, mercury, manganese, pH, selenium, sulfate, zinc, alpha (nonvolatile), beta (nonvolatile), tritium, strontium-90, radium-226, and uranium (natural). A tap water sample is also analyzed for the same

TABLE 3-22

ANL NPDES PERMIT EFFLUENT QUALITY SUMMARY, 1986

Discharge[a]	Permit Constituent	Concentration Limits (mg/L)		Number Exceeding Limit	Sample Frequency	Measured[b] / Permit
		Monthly Average	Daily Maximum			
001A	BOD	30	60	0	weekly	-
	TSS	30	60	1	weekly	1.5
001B	COD	-	-	-	weekly	
	TSS	15	30	1	weekly	1.3
	Mercury	0.003	0.006	0	weekly	-
001	pH	6-9	6-9	0	weekly	-
	Fecal coliform	-	400/100 mL	1	weekly	3.2
002	pH	6-9	6-9	0	monthly	-
	TSS	15	30	0	monthly	-
	Temperature	-	<5°F rise	0	monthly	-
003	pH	6-9	6-9	0	monthly	-
	TSS	15	30	3	monthly	1.2-3.4
	Temperature	-	<5°F rise	0	monthly	-
004	pH	6-9	6-9	0	monthly	-
	TSS	15	30	3	monthly	1.1-3.3
	Temperature	-	<5°F rise	0	monthly	-
005	pH	6-9	6-9	0	monthly	-
	Temperature	-	<5°F rise	0	monthly	-
	Fats, Oil, Grease	15	30	0	monthly	-
006	pH	6-9	6-9	0	monthly	-
	TSS	15	30	2	monthly	1.4-8.2
	Zinc	1.0	2.0	0	monthly	-
007	pH	6-9	6-9	0	monthly	-
	Temperature	-	<5°F rise	0	monthly	-
008	pH	6-9	6-9	0	monthly	-
009	pH	6-9	6-9	11	monthly	9.7-11.5
	TSS	15	30	5	monthly	1.4-6.2

Source: Golchert and Duffy, 1987

[a]See Figure 3-8 for location.
[b]Ratio of measurements exceeding limit divided by concentration limit, except for pH where actual values are given.

parameters on a quarterly basis. Chlorine residual is maintained through a hydrant flushing program. Domestic/fire water lines have a continuous, weekend hydrant flushing schedule. On Mondays through Fridays, hydrant flushing is performed if manpower permits. Hydrants are flushed until a trace of chlorine residual is detected.

A summary of monitoring results for 1986 is presented in Tables 3-23 and 3-24. The EPA issued proposed primary drinking water standards for radionuclides in 1986 (FR, 1986). These values are significantly different from the Interim Primary Drinking Water Standards in 40 CFR 141. These differences are the result of a new dose calculation methodology and information on concentrations of naturally occurring radionuclides in drinking water. The EPA will be adopting these proposed standards and therefore they are used for comparison to the measured values in this report. No drinking water standards in tap water were exceeded, although iron exceeded standards in raw water.

3.3.3.5 Plot M

During 1986, six sets of water samples were collected from the intermittent stream that flows near Plot M and were analyzed for tritium. A summary of the results is presented in Table 3-25, and sampling locations are shown on Figure 3-11. Levels upstream of the plot were below detection limits. However, concentrations increased as the stream flowed past the plot, where it received tritiated water leaching out of the burial area, then decreased because of dilution. The concentration of tritium at location 6 (seep) was the only sample that exceeded the proposed EPA drinking water standard for tritium of 90,000 pCi/L.

Surface water and sediment samples collected in April and December 1986 were analyzed for very low concentrations of radionuclides to determine whether any had migrated out of Plot M and entered the intermittent stream. Results are presented in Tables 3-26 (water) and 3-27 (sediment). Upstream levels were at background. At the downstream location, there appeared to be slightly elevated concentrations in water of strontium-90, uranium, and plutonium-239 as well as tritium. However, the concentrations of these radionuclides at the downstream location did not exceed the proposed EPA drinking water standards for these radionuclides. The radioactivity content of downstream sediment showed slightly

TABLE 3-23

CHEMICAL CONSTITUENTS IN ANL DOMESTIC WELLWATER, 1986

Constituent	Average Concentration (µg/L)					EPA Drinking Water Standard (µg/L)
	Well 1	Well 2	Well 3	Well 4	Tap Water	
Arsenic	<5	<5	<5	<5	<5	50(P)
Barium	112	102	54	87	6	1,000(P)
Chloride (mg/L)	70	53.25	52	37.25	52.5	250 (S)
Copper		2	7	2	6	1,000(S)
Fluoride	177	216	202	251	171	2,000(S)
Iron	1,446	1,271	1,231	1,204	108	300(S)
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	2(P)
Manganese	37	20	19	15	4	50(S)
pH (units)	7.1-7.2	7.2-7.3	7.1-7.2	7.2-7.3	9.6-9.9	6.5-8.5(S)
Selenium	<5	<5	<5	<5	<5	10 (P)
Sulfate (mg/L)	146	145.5	156.25	137.5	206.5	250(S)
Zinc	64	22	17	19	17	5,000(S)

Source: Laboratory analysis provided by ANL personnel during the ANL Environmental Survey.

p Primary drinking water standard, 40 CFR Part 141.
s Secondary drinking water standard, 40 CFR Part 143.

TABLE 3-24

RADIOACTIVITY IN ANL DOMESTIC WELLWATER, 1986

Parameter	Average Concentration (pCi/L)					Proposed EPA Drinking Water Standard[a] (pCi/L)
	Well 1	Well 2	Well 3	Well 4	Tap Water	
Alpha (nonvolatile)	3.3	4.3	2.8	2.6	0.4	b
Beta (nonvolatile)	6.2	8.0	6.7	6.4	5.2	b
Tritium	155	218	117	114	147	90,000
Strontium-90	<0.25	<0.25	<0.25	<0.25	<0.25	50
Radium-226	1.26	1.66	0.69	0.51	<0.10	b
Uranium (natural)	0.44	0.33	0.41	0.22	0.06	b

Source: Adapted from Golchert and Duffy, 1987

[a]Proposed 40 CFR 141 (FR, 1986)
[b]Standards for these parameters are under consideration by the EPA but no values have been issued.

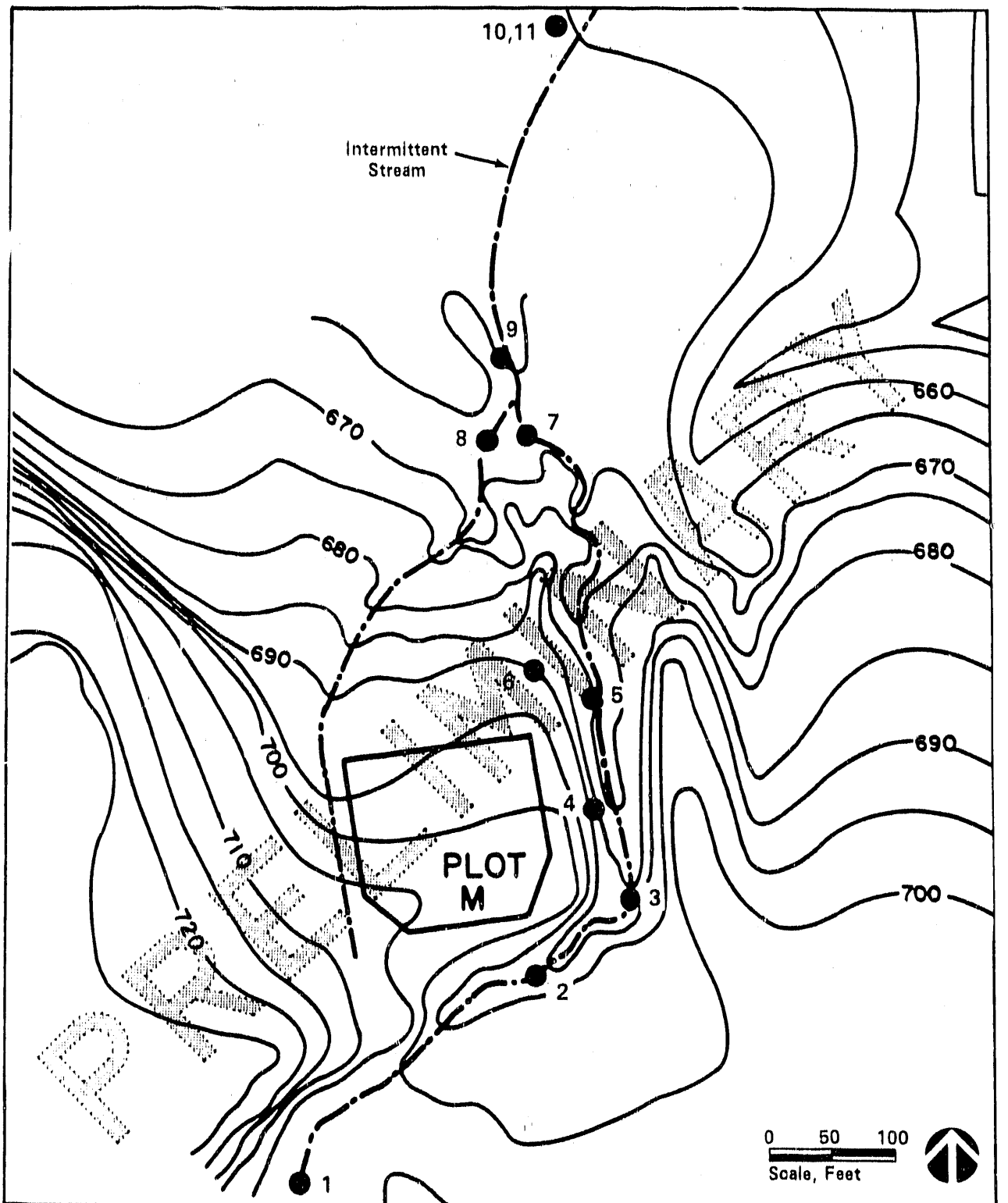
TABLE 3-25

TRITIUM CONCENTRATIONS[a] OF STREAM NEAR PLOT M, 1986

Location[b]	Average Concentration (pCi/L)
1	<200
2	1,200
3	74,500
4	50,300
5	51,000
6 (Seep)	140,600
7	43,300
8	76,900
9	43,000
10	22,200
11	15,400

Source: Golchert, 1987d

[a]The proposed EPA drinking water standard concentration for tritium is 90,000 pCi/L (FR, 1986).
[b]See Figure 3-11.



SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS NEAR PLOT M

FIGURE 3-11

TABLE 3-26

RADIOACTIVITY CONTENT OF WATER IN STREAM NEAR PLOT M, 1986

Parameter	Average Concentration (pCi/L)	
	1 (Upstream)[a]	9 (Downstream)[a]
Total Alpha[b]	0.9	1.5
Total Beta[b]	5.3	6.4
Tritium	<200	43,000
Strontium-90	1.23	1.69
Uranium-234	0.24	0.89
Uranium-235	<0.01	<0.01
Uranium-238	0.26	1.01
Neptunium-237	<0.001	<0.001
Plutonium-238	<0.001	<0.001
Plutonium-239	0.0011	0.0018
Americium-241	<0.001	<0.001
Curium-242 and/or californium-252	<0.001	<0.001
Curium-244 and/or californium-249	<0.001	<0.001

Source: Golchert, 1987d

[a]See Figure 3-11 for location.
[b]Non-volatile.

TABLE 3-27

RADIOACTIVITY CONTENT OF SEDIMENT IN STREAM NEAR PLOT M, 1986

Parameter	Average Concentration (pCi/g)	
	1 (Upstream)[a]	9 (Downstream)[a]
Potassium-40	21.82	18.03
Strontium-90	0.17	0.16
Cesium-137	0.14	0.41
Radium-226	1.95	1.98
Thorium-228	1.21	0.99
Thorium-232	1.04	0.92
Uranium-234	1.26	1.33
Uranium-235	0.02	<0.01
Uranium-238	1.40	1.47
Plutonium-238	0.0002	0.0010
Plutonium-239	0.0038	0.0447
Americium-241	0.0014	0.0020

Source: Golchert, 1987d

[a]See Figure 3-11 for location.

elevated concentrations of cesium-137, uranium, plutonium, and americium-241. However, standard deviations were not reported, so it is not known whether these elevated levels are significant.

3.3.4 Findings and Observations

The findings that involve surface-water contamination as a result of current and past releases, spills, or disposal practices are discussed within the context of other findings in Sections 4.1.2 (Waste Management), 4.2.2 (Toxic and Chemical Materials), and 4.5.2 (Inactive Waste Sites and Releases).

3.3.4.1 Category I

None

3.3.4.2 Category II

1. Potential violation of NPDES Permit. ANL may be exceeding NPDES discharge notification levels for some organic and inorganic constituents discharged through the laboratory wastewater treatment plant (NPDES Outfall 001B).

   A wide variety of chemicals are used in the laboratories at ANL, and during laboratory operations some hazardous chemicals are discharged to the laboratory wastewater treatment plant (Finding 1, Section 3.3.4.3). The treatment process, which includes pH adjustment, settling, and chlorination, is not designed to remove all hazardous and toxic chemicals. As a result, some chemicals may be released from the treatment plant through NPDES Outfall 001B.

   Under the current NPDES Permit, ANL is required to monitor flow, COD, TSS, and mercury. In addition, Standard Condition No. 14 states that all manufacturing, commercial, mining, or silvicultural dischargers must notify the Illinois Environmental Protection Agency as soon as they know, or have reason to believe, that any activity has occurred that would result in the discharge of any toxic pollutant (identified under Section 307 of the Clean

Water Act) that is not limited in the permit, if that discharge will exceed the highest of the following notification levels:

- 100 micrograms per liter (µg/L);
- 200 µg/L for acrolein and acrylonitrile;
- 500 µg/L for 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol; and
- 1,000 µg/L for antimony.

ANL is not monitoring for other constituents, as identified in Finding 1 of Section 3.3.4.3, that may be present in concentrations exceeding notification levels; nor have any engineering studies or calculations been performed which would indicate that the effluent should not be expected to contain these constituents. Therefore, ANL can not demonstrate permit compliance.

During the sampling and analysis (S&A) portion of the Survey, effluent from the laboratory wastewater treatment plant (Outfall 001B) will be tested to determine the type and concentration of contaminants present.

3.3.4.3 Category III

1. Potential contamination of Sawmill Creek through NPDES Outfall 001. ANL may be contaminating Sawmill Creek water and sediment, and adversely affecting aquatic life and other beneficial aspects of this stream by potentially discharging unregulated organics and inorganics through the wastewater treatment plant outfall (NPDES Outfall 001).

Wastewater generated in laboratories is, for the most part, collected in basement retention tanks. These tanks are discharged to the laboratory waste sewer system after being monitored for radioactivity. No analyses are performed for hazardous nonradioactive contaminants, although nonradioactive contaminants are expected to be present. The treatment processes at the laboratory wastewater treatment plant are pH adjustment, settling, and chlorination. The plant is not designed to eliminate or reduce many of the possible contaminants that may be present. Thus, if nonradioactive hazardous contaminants are present in the wastewater, they

will be discharged to Sawmill Creek and may be in sufficient concentrations to adversely affect the stream's biota.

The following practices, noted during the Survey, may result in hazardous materials being discharged to Sawmill Creek:

- In many of the laboratories visited, there were no waste containers for chemical, and possibly hazardous, liquid waste materials. Wastes may therefore be disposed of in laboratory sinks;

- At Building 211, unknown chemicals in glassware were present in a laboratory sink. Laboratory sinks are used to wash glassware that contain various chemicals;

- At Building 202, acids, bases, ethanol, and methanol are disposed of in laboratory sinks. Some high-pressure liquid chromatography extraction agents, such as acetonitrile and methylene chloride, are also disposed of in laboratory sinks. Laboratory glassware is cleaned in these sinks;

- At Building 205, laboratory sinks are used for cleaning glassware. Empty chemical bottles are rinsed out in laboratory sinks. These bottles may contain hazardous materials;

- At Building 203, spent solvents are evaporated under laboratory hoods; any residue is rinsed down the laboratory sink. Dilute acids and ammonia are also disposed of in laboratory sinks;

- At Building 212, darkroom effluents that may contain the hazardous metal silver are discharged to the laboratory waste sewer system; and

- At Building 362, liquid effluents from experiments are discharged to a laboratory sink. These effluents may contain hazardous materials.

In addition, oil and floating materials were observed at the laboratory wastewater treatment plant.

According to a map of the sewer system on file at ANL (Figure B523-3a, Laboratory Waste Sewer Distribution System Site Plan), the following buildings are connected to the laboratory wastewater sewer system:

- light laboratory and office buildings - 200, 202, 203, 205, 206, 208, 212, 223, 335, 350, 360;
- heavy laboratory (or shops) and office buildings - 306, 308, 310, 330, 331;
- heavy and light laboratory and office buildings - 301, 315, 362; and
- special purpose buildings - 145, 211.

Hazardous effluent may be discharging into the sanitary wastewater treatment plant from the Coal Yard located near Building 108 and may contaminate the surface water and sediment of Sawmill Creek.

Coal silt and liquids and some new and used oils, potentially containing unknown contaminants and used on the coal pile to prevent freezing, are discharging from an active coal pile. Heavy metals and organic compounds found naturally in the coal are being leached by rainwater, collected in a newly constructed sump, pumped to a small equalization/settling pond, and eventually pumped into the sanitary wastewater treatment system, which discharges to Sawmill Creek. The coal pile discharge in the collection sump has an oily sheen and there is heavy iron staining leading to the collection sump. The small equalization/settling pond for the coal pile discharge also receives wastes from the Central Boiler House and backwash from the water treatment facility. The treatment provided at the wastewater treatment plant may not remove all suspected contaminants, such as arsenic, that could environmentally degrade the water quality of Sawmill Creek. Although the discharge to Sawmill Creek has an NPDES permit, the required analyses do not include all constituents of concern.

During the S&A portion of the Survey, water from the wastewater treatment plant Outfall 001 to Sawmill Creek will be tested to indicate whether

nonradioactive chemical contaminants are present in the effluent. The water and silt in the coal pile collection sump will undergo sampling and analyses to determine the presence of contamination including organics, inorganics, and polychlorinated biphenyls (PCBs).

2. Potential contamination of Sawmill Creek near the Lime Sludge Pond. Sawmill Creek water, sediment, and biota may be adversely affected because of discharges from the Lime Sludge Pond.

   The Lime Sludge Pond is no longer used for the disposal of lime sludge or any other waste; however, the pond, which presently stores lime sludge, could still discharge to the creek during periods of heavy rainfall. At these times, the concentration of suspended solids may increase because of resuspension of lime sludge into the water phase. The contaminated water may then be discharged into Sawmill Creek through the overflow pipe in the pond (NPDES Outfall 009). Lime precipitate resulting from past discharges through NPDES Outfall 009 has been removed from the creek bed, although residual material may remain in the creek sediment.

   A past failure of the earthen dike between the pond and the creek resulted in the discharge of water that exceeded state water quality standards for pH. Also, there may be seepage of high pH (9 to 10) water through the bottom and dike of the unlined sludge pond through the subsurface soil into Sawmill Creek. The head differential between the pond surface and the creek is approximately 10 feet. Additionally, the integrity of the dike is in question, as described in Section 4.5.2.3, Finding 9.

   ANL currently monitors Sawmill Creek for pH and other parameters. However, the sampling locations are not close enough to the Lime Sludge Pond to indicate if discharges from the pond are adversely affecting Sawmill Creek in the vicinity of the pond. During the S&A portion of the Survey, water and sediment samples from Sawmill Creek will be tested to indicate whether pH levels in the creek are affected by discharges from the lime pond.

3. Potential contamination of Sawmill Creek near NPDES Outfall 002. A seep, located near NPDES Outfall 002, may contain toxic and hazardous constituents which could contaminate Sawmill Creek and adversely affect stream biota.

This seep, located near the now capped Outfall 002, was detected during the Survey site visit. It was causing a slight discoloration of Sawmill Creek water at the point where it enters the creek. The source of Outfall 002 was a small equalization/settling pond located between the Central Boiler House (Building 108) and the Lime Sludge Pond. Outfall 002 has been capped where the discharge pipe enters the stream channel, and the water from the small equalization/settling pond has been diverted to the sanitary sewer system. However, pond water may still be entering the pipe and leaking into the stream through cracks or holes located upgradient from the cap. Influent streams to the small equalization/settling pond include boiler house demineralizer blowdown, cooling water from the boiler house, filter backwash water from the water treatment plant, runoff from the coal storage pile (including oil formerly applied to the coal pile to prevent freezing), and runoff from loading and unloading areas at the boiler house. These waste streams could contain various organic and inorganic constituents.

During the S&A portion of the Survey, the seep will be tested to indicate the concentrations of organic and inorganic contaminants in the water column.

4. Contamination of Sawmill Creek from NPDES Outfall 010. Sawmill Creek's sediment and stream bank are visibly contaminated by past discharges of untreated coal storage pile runoff near NPDES Outfall 010, which may adversely affect the water and sediment of the creek.

During the Survey visit, stains were observed on the stream bank below NPDES Outfall 010, and Sawmill Creek sediment was discolored at and in proximity to this outfall. Visibly contaminated sediment may be an unnatural sludge or bottom deposit. The source of the outfall was coal storage pile runoff, which is known to be acidic and may also contain toxic organics and heavy metals. New and used oils, which may have contained unknown contaminants, may have also been discharged since the oil was applied directly to the coal pile to prevent freezing. Although this outfall is now used only for emergency overflow, the potentially contaminated sediments in the creek bed could be releasing hazardous materials that could affect the creek's ecosystem.

During the S&A portion of the Survey, discolored sediment from the creek will be tested to indicate if contamination exists and if the discolored sediment is an unnatural sludge or bottom deposit.

5. Potential contamination from Building 815. There is potential for contamination of surface water and sediment in the drainage ditch that receives untreated wastewater from Building 815 degreasing and equipment maintenance operations.

   In Building 815, which is used for degreasing operations and other equipment maintenance, the grease traps were found by the Survey team to be full. The grease traps, which are arranged in series, flow to a storm sewer. Oil, grease, and other floating materials were observed in the storm sewer manhole outside this building. The storm sewer flows through a culvert and discharges to the drainage ditch. Solvents and surfactants are also used in this building, and they could enter the storm sewer as well. There is, therefore, the potential for discharge of contaminants in untreated wastewater to the drainage ditch through the storm sewer. The water and sediment within the drainage ditch, and subsequently Sawmill Creek, which receives flow from the ditch, could be adversely affected by the discharge.

   There are no additional discharges to the drainage ditch upstream of the culvert; however, road runoff also flows to this culvert and may contribute some contamination. During the S&A portion of the Survey, water and sediment from the drainage ditch will be tested to indicate if contaminants are present in concentrations that could pose an environmental problem.

6. Drainage from the 317 Area. ANL is potentially passively discharging radioactive contaminants from the high-activity vault at the 317 Area to an off-site uncontrolled area in the Waterfall Glen Nature Preserve and, as a result, may be contaminating the water and sediment of a stream in the Nature Preserve.

   The active, although currently unused, waste storage vault is located in the 317 Area, approximately 400 feet from the southern boundary of ANL. The vault is used for temporary storage of low-level, high-activity wastes, such as

fission products and contaminated clothing, before shipment off-site for disposal. It is constructed of concrete walls and flooring, is approximately 25 feet deep, and is covered by a flat concrete lid. A footing drain system overlain by soil surrounds the vault and consists of stones and a drain pipe that discharges to an off-site stream in the Waterfall Glen Nature Preserve. There is no designed connection between the interior of the vault and the footing drain. Water that collects in the vault drains to a sump and is pumped to a holding tank for testing and subsequent treatment, depending on the contaminants found.

In late 1984, 4 to 5 feet of water was found in the high-activity vault. Some drums that contained radioactive materials were flooded, and as a result the water became radiologically contaminated. The source of the water was believed to be precipitation that entered the vault due to inadequate roofing. The water, which was thought to have been totally contained within the vault, was subsequently removed and handled by Waste Management Operations.

In December 1986, and in January 1987, water and sediment from the stream that receives discharges from the footing drains of the 317 Area vault were sampled and analyzed for tritium, strontium-90, and gamma emitters. Results are presented in Tables 3-28 and 3-29 for water and sediment, respectively (Golchert, 1987c). Concentrations of tritium and strontium-90 in surface water were elevated above ambient for at least 1,400 feet below the drain pipe outfall. Cesium concentrations were above ambient levels for at least 20 feet below the outfall. Cesium-137 was the dominant radionuclide in sediment samples; concentrations were above ambient levels for at least 1,100 feet below the pipe outfall. Strontium-90 and cobalt-60 values were slightly above ambient concentrations.

The isotopic ratios of the radioactivity measured in the stream were similar to those measured in the vaults. Thus, water may have seeped from the vaults into the footing drain system and discharged into the off-site stream. No sampling or analysis has been requested because this environmental problem has been identified by existing data. The leaks and seeps resulting from this facility are also characterized in Finding 4 in Section 4.5.2.3 (Inactive Waste Sites and Releases).

TABLE 3-28

RADIONUCLIDES IN WATER IN THE DRAINAGE SOUTH OF THE 317 AREA (pCi/L)

Parameter	(0)[a] 300 Feet Upstream[b]	(1) 20 Feet Downstream	(8) 1,100 Feet Downstream	(9) 1,400 Feet Downstream
Tritium	<200	1,733	855	916
Strontium-90	<1	24.3	9.8	5.2
Cesium-137	<2	11	<2	<2

Source: Golchert, 1987c; Samples Collected 12-16-86

[a]Sample station number.
[b]Distance from outfall pipe.

TABLE 3-29

RADIONUCLIDES IN SEDIMENT IN THE DRAINAGE SOUTH OF THE 317 AREA (pCi/g)

Sample Station Number	Location	Date	Cobalt-60	Strontium-90	Cesium-137
0	300 feet above pipe outfall	12/86	<0.1	<1	0.7
1	20 feet below pipe outfall	12/86 1/87	0.3 0.45	<1 1.08	62.1 107.80
2	100 feet below pipe outfall	1/87	0.25	0.90	25.03
3	200 feet below pipe outfall	1/87	0.18	0.53	15.51
4	300 feet below pipe outfall	1/87	0.16	0.96	10.23
5	400 feet below pipe outfall	1/87	0.11	--	6.54
6	500 feet below pipe outfall	1/87	0.08	--	9.88
7	800 feet below pipe outfall	1/87	0.07	--	7.86
8	1,100 feet below pipe outfall just above confluence with 319 drain	12/86 1/87	<0.1 0.05	<1 --	3.3 5.26
9	1,400 feet below pipe outfall at Quarry Road	1/87	<0.05	--	0.38
10	1,700 feet below pipe outfall	1/87	<0.05	--	0.73
11	North side of culvert under railroad spur	1/87	<0.05	--	1.86
12	North side of culvert under AT and SF railroad tracks	1/87	<0.05	--	1.56
13	50 feet south of AT and SF tracks in wetlands	1/87	<0.05	--	1.87

Source: Golder, 1987c

7. Potential leaks in sanitary and laboratory wastewater sewer systems. Leaks in the sanitary and laboratory sewer systems at ANL could result in soil and potentially groundwater contamination.

Personnel at ANL have noticed that wastewater in the sanitary and laboratory sewer systems is occasionally "backing up" in manholes. ANL suspects that this is caused by roots intruding through the vitrified clay pipe joints and impeding the wastewater flow. Root intrusion into the sewer lines is conducive to exfiltration to the underlying soils and infiltration of rainwater into the sewer lines. Workers at the sanitary and laboratory wastewater treatment plants have noticed a small increase in the influent flow rates to these treatment plants during periods of rain as a result of the suspected infiltration. Although the sanitary sewer only contains sanitary waste, the laboratory system waste could contain a wide variety of low-level radionuclides, organics and inorganics, as discussed in Finding 1 of this section. As a result of the suspected sewer line exfiltration, the soils underlying these systems, and potentially the groundwater, may be receiving contaminants as identified above. ANL plans to perform a study in which the laboratory and sanitary wastewater sewer systems will be inspected using video equipment. Based on the results of this study, ANL plans to take corrective action, as required. A similar study was undertaken in the 200 Area in 1985, and some sewer lines were repaired. Finding 5 in Section 4.5.2.3 describes potential past leaks from the 200 Area sewer lines.

3.3.4.4 Category IV

1. Building 306 Radiological Laboratory. Radioactive material stored near detectors 19 and 20 in the "hot" laboratory of Building 306 could result in the release of radioactively contaminated water to the laboratory sewer in excess of radioactive discharge limits.

These detectors are used to analyze liquid wastes that could be radioactively contaminated. The results of the analyses are used to determine whether the liquids can be discharged to the laboratory sewer. Radioactive material is stored near the location where the detectors are in use, resulting in high

background count rates. The high background count rates result in lower limits of detection that can be higher than the administrative limit of 100 dpm/mL gross activity (gross alpha plus gross beta activities) for discharge to the laboratory sewer. The following lower limits of detection were calculated by the Survey team from background data for the counters from March 23 to June 15, 1987:

	Limits of Detection, dpm/mL	
	Counter 19	Counter 20
Gross Alpha	12	3
Gross Beta	125*	89
Gross Activity (alpha plus beta)	137	92

* Anomalous Background for 3/23/87 excluded

2. Inadequate sampling protocols. Preservation agents are not added to certain surface-water samples at the time of collection and therefore may result in data of questionable validity.

Based on Survey team observations of water sampling events, the following samples were not preserved at the time of collection as required by the NPDES permit:

- Mercury and chemical oxygen demand from NPDES Outfall 001B;
- Fats, oils, and grease from NPDES Outfall 005; and
- Zinc from NPDES Outfall 006.

Failure to properly preserve samples increases the possibility of contaminant degradation and low analytical recovery.

3.4 Groundwater

3.4.1 Background Environmental Information

3.4.1.1 Regional Geology

ANL and the Palos Park Forest Preserve are located on a broad, gently sloping arch of Paleozoic bedrock called the Kankakee Arch. This arch connects the Wisconsin Arch and the Cincinnati Arch and separates two broad depressions, the Illinois Basin to the southwest and the Michigan Basin to the northeast.

The ANL site and the Palos Park Forest Preserve are underlain by glacial soils and bedrock. The glacial soils generally range from 50 to 150 feet thick, and were deposited by the Lake Michigan Lobe of the Wisconsin glacier that flowed over the northern Illinois area and built at least 19 moraines during a pulsating retreat. The underlying bedrock consists of Silurian dolomitic limestone, Ordovician shale, dolomite, and sandstone, and Cambrian sandstones to a depth exceeding 1,500 feet. The depth to Precambrian crystalline rocks is estimated to be 3,500 to 4,000 feet (Knowles et al., 1963).

The glacial deposits include till material, sands and gravels deposited by glacial outwash streams and lacustrine deposits accumulated in ice-dammed lakes. As the glaciers retreated, a large glacial lake named Lake Chicago was created behind the moraines and covered much of the eastern portion of Cook County. Lake Chicago drained through the Chicago Outlet River. This river carved the broad valley now occupied by the Des Plaines River and the Calumet Sag Channel (Figure 2-1) and eroded the glacial deposits to a point that these deposits have been completely removed. As a result, Silurian limestone is exposed along the Des Plaines River. An island was formed in the Chicago Outlet River that today has become a portion of the Palos Park Forest Preserve and is the site of Plot M and Site A (Figure 2-3).

3.4.1.2 Hydrogeology

The groundwater conditions for the ANL have been studied by Knowles, Drescher, and LeRoux (1963). The study determined that the Niagara Dolomite of Silurian Age and the St. Peter and Galesville Sandstones of Cambrian-Ordovician Age were

the two major aquifers below the ANL site (see Table 3-30). The Niagara Dolomite aquifer is separated from the other, deeper aquifer by the Maquoketa Shale and other formations. Recharge of the Niagara Dolomite is by migration of precipitation downward through the overlying glacial deposits. Recharge of the confined lower aquifer is from the west where these formations outcrop or are overlain by glacial deposits (Willman, 1971).

ANL has used both the Niagara Dolomite and the St. Peter and Galesville Sandstone aquifers. Four water supply wells penetrate to the Niagara Dolomite and one well to the Galesville Sandstone. This latter, deeper well was drilled to a depth of 1,595 feet into the Galesville Sandstone but is now dry and out of production. While in use, this deeper aquifer had a specific capacity of 4,300 gallons per day per foot (gpd/ft) of drawdown (Knowles et al., 1963). Another well had tapped the Niagara Dolomite in the 800 Area but it was abandoned once the 800 Area was connected to the laboratory water system.

The four water supply wells have been drilled into the Niagara Dolomite aquifer to depths ranging from 284 to 345 feet. These wells can each produce 333,500 gpd. As this is in excess of the laboratory needs of about 0.8 million gallons per day (mgd), only two wells usually operate at a time with a third well sometimes placed on-line.

The piezometric level within the Niagara Dolomite dropped about 12 feet beneath ANL between 1960 and 1980 as a result of water usage at the Laboratory. Analysis of drawdown data and pumpage rates of the water supply wells indicates that the transmissivity of the Niagara Dolomite aquifer is about 8,000 gpd/ft, based on long-term data (Knowles et al., 1963). This study used wells placed into the dolomite that had been constructed in the 1940s and are no longer in existence. Well construction data of these old wells are not available.

The hydraulic gradient within the Niagara Dolomite originally resulted in flow toward the Des Plaines River. However, pumping of the groundwater has modified flow in the vicinity of the site such that flow within the aquifer is now generally toward the on-site production wells. Water supply wells in Downers Grove (approximately 3 miles north of ANL) have similarly modified the flow north of the site (Figure 3-12). It appears that all the wells near ANL obtain groundwater from

TABLE 3-30

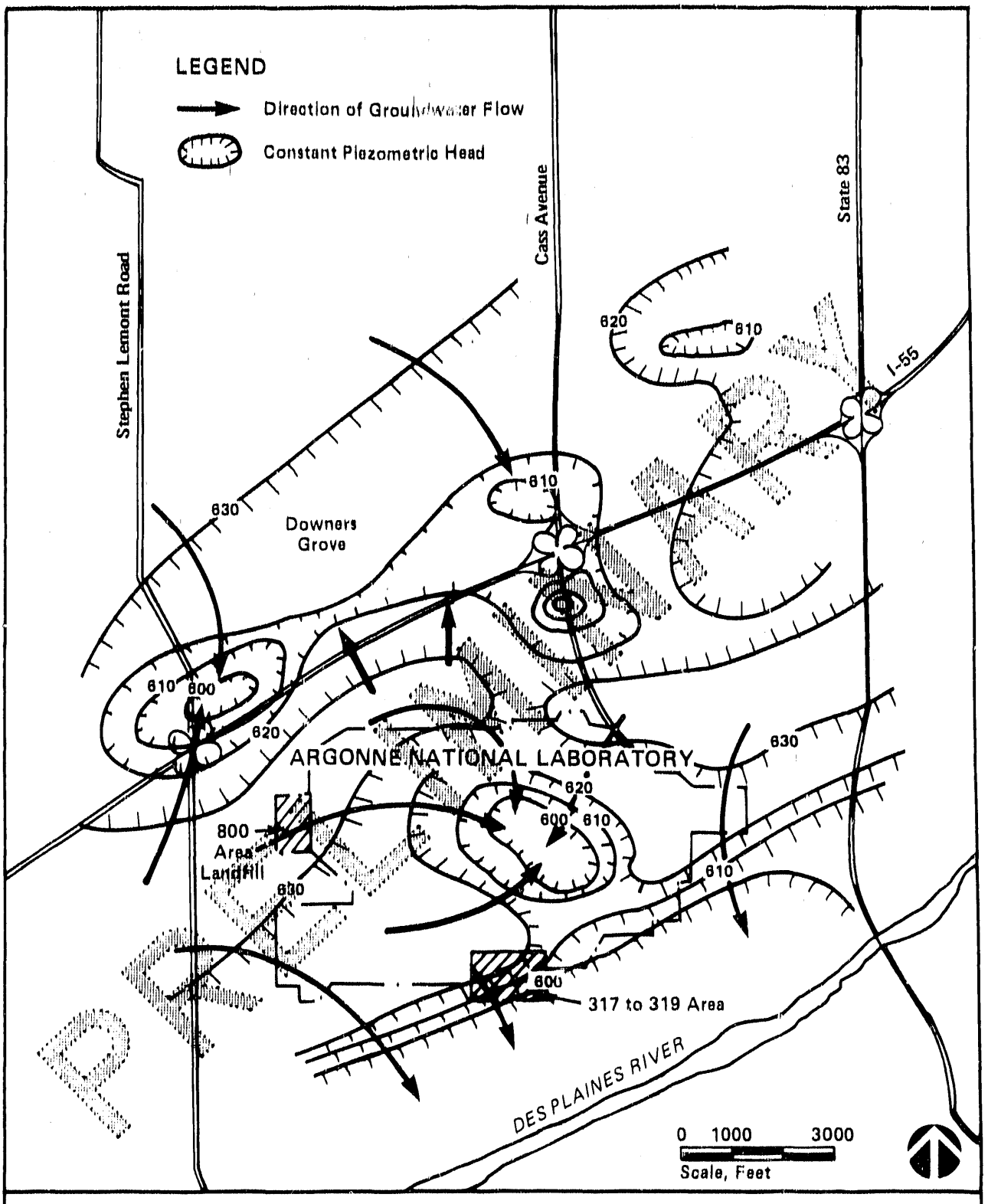
STRATIGRAPHY AND SUMMARY OF WATER-BEARING CHARACTERISTICS OF ROCKS UNDERLYING ANL

System	Rock Unit	Maximum Thickness (feet)[1]	Lithology	Water-bearing Characteristics
Quaternary	Pleistocene deposits	180	Unstratified till and stratified clay, silt, sand, and gravel.	Not important as aquifers. Generally yield only small quantities of water.
Silurian	Niagara Dolomite	225	Dolomite, light-to-dark-gray, fine- to medium-grained, thin- to massive-bedded, calcareous. Some white chert. Shaly near base at some places.	Yields moderate to large quantities of water from solutionally enlarged openings along joints and bedding planes. Some springs issue from aquifer near edge of Des Plaines River valley.
Ordovician	Maquoketa Shale	165	Shale, brownish-gray to green, dolomitic, compact, soft. Some thin dolomite beds.	Not important as an aquifer. Very low permeability.
	Galena Dolomite Decorah Formation Platteville Formation	347	Dolomite, buff—and in some places, brown and gray—very fine to medium-grained, massive-bedded. Some chert and sand. Few thin limestone beds.	Not important as aquifers. Yield only very small quantities of water.
	St. Peter Sandstone	498	Sandstone, white to gray, fine- to medium-grained, loosely cemented, locally dolomitic. Silty or clayey in places. Some thin shale and dolomite beds.	Yields moderate quantities of water.
Cambrian	Franconia Sandstone	82	Sandstone, dolomitic, glauconitic. Few thin beds of glauconitic dolomite.	Yields moderate to large quantities of water depending on permeability and thickness penetrated. Galesville Sandstone reported to be most productive. Water is probably highly mineralized in Mt. Simon Sandstone. Part of Eau Claire Sandstone acts as hydrologic barrier between water in the underlying Mt. Simon Sandstone and in overlying Galesville and Franconia sandstones.
	Dresbach Group Galesville Sandstone	179	Sandstone, white, fine-to coarse-grained, dolomitic. Some thin dolomite beds.	
	Eau Claire Sandstone	350[2]	Shale, sandstone, and dolomite.	
	Mt. Simon Sandstone	1,800-2,000[2]	Sandstone, pink, yellow, and white, fine- to coarse-grained.	
Precambrian		Unknown	Crystalline rocks.	Virtually impermeable. Yield little or no water.

Source: Knowles et al., 1963

1 Based on well logs

2 Estimated



Source: Bynoe, 1982

GROUNDWATER FLOW DIRECTION BASED ON PIEZOMETRIC SURFACE OF THE DOLOMITE AQUIFER, ARGONNE NATIONAL LABORATORY AREA, 1977

FIGURE 3-12

the Niagara Dolomite. The number of wells within 2 miles of ANL, their locations, and total pumpage have not been determined.

Recharge of the Niagara Dolomite aquifer has been estimated at 3 to 4 inches/year (Knowles et al., 1963). Flow within this aquifer generally occurs along solution-enlarged cavities within the surface weathered zone of the dolomite (Zeizel et al., 1962). Natural discharge of the aquifer occurs at dolomite outcrops along the Des Plaines River.

Flow in the glacial till is poorly understood at the ANL site. It has been postulated that a perched water table is present within the till that allows very little hydraulic connection to the underlying dolomite. This conclusion seems to have been based on the existence of several dry wells screened in the till in a hydrogeologic study conducted in the West Chicago area. As a result, ANL has limited its monitoring program to the shallow groundwater beneath the ANL site. However, one study done by the U.S. Geological Survey (USGS) (Olimpio, 1982) on the behavior of a tritium plume at Plot M indicates a significant vertical component to the groundwater flow. This vertical component had allowed tritium to migrate down to the underlying dolomite. This study also determined that permeability of the glacial till ranged from 1×10^{-6} centimeter per second (cm/sec) to 1×10^{-8} cm/sec.

Studies of several landfills in the northeastern Illinois area (Hughes et al., 1971) also determined the presence of regional vertical flow toward the dolomite. These reports are all in agreement with the earlier Knowles et al. report (1963) and the Zeizel et al. report (1962).

3.4.2 General Description of Pollution Sources and Controls

Known and potential sources for groundwater contamination at ANL and the Palos Park Forest Preserve typically consist of areas used for storage and/or disposal of waste products. Releases from these sources may eventually contaminate the Niagara Dolomite aquifer through vertical migration of contaminants, which can be carried through the soils and geologic formations by precipitation infiltration. The major areas of known concern are Plot M and the 800 Area Landfill Plot M is an inactive landfill used during the 1940s to the 1950s for disposal of radioactive and hazardous waste. A detailed discussion of this site is presented in Section 4.5.1. The

800 Area Landfill is an active sanitary landfill used by ANL. It has been in operation since 1968. A detailed discussion of this site is presented in Section 4.1.1.4. Environmental data associated with these areas are discussed in Section 3.4.3.

Another site which is known to have been a past source of groundwater contamination is the A^2R^2 Pond. As discussed in Section 3.3.2, the A^2R^2 Pond contains tritium and is closely linked to the groundwater, as evidenced by the sudden loss of pond water to the subsurface environment in 1982. The pond was a source of tritium contamination to the groundwater at the time of the water loss; tritium measured in a well downgradient of the pond in 1982 was 8 percent of the EPA drinking water standard at the time. More recent groundwater sampling in the vicinity of the pond indicates that concentrations of tritium are in the normal range and none was detected that could be attributed to the A^2R^2 Pond (Golchert and Duffy, 1987).

Potential sources of groundwater contamination also exist at ANL and the Palos Park Forest Preserve. These areas are those that have the potential to contaminate the groundwater but that lack monitoring to assess any potential problem. The areas of potential concern with respect to the groundwater are as follows:

1. The abandoned Nike Site.
2. The earthen lagoon at the Wastewater Treatment Plant.
3. The pipeline between Buildings 19 and 34.
4. The 317 Area High-Activity Vault.
5. The 317 Area French drain.
6. The ENE 319 Landfill.
7. The flue gas scrubber impoundment near Building 145.
8. Underwriters Pond.
9. Underground storage tanks.
10. The 319 Area Landfill.
11. The abandoned septic field at Site A.
12. Small equalization/settling pond near Building 108.

Known and potential sources are discussed in detail in Sections 3.3.2, 4.1.1, and 4.5.1.

3.4.3 Environmental Monitoring Program

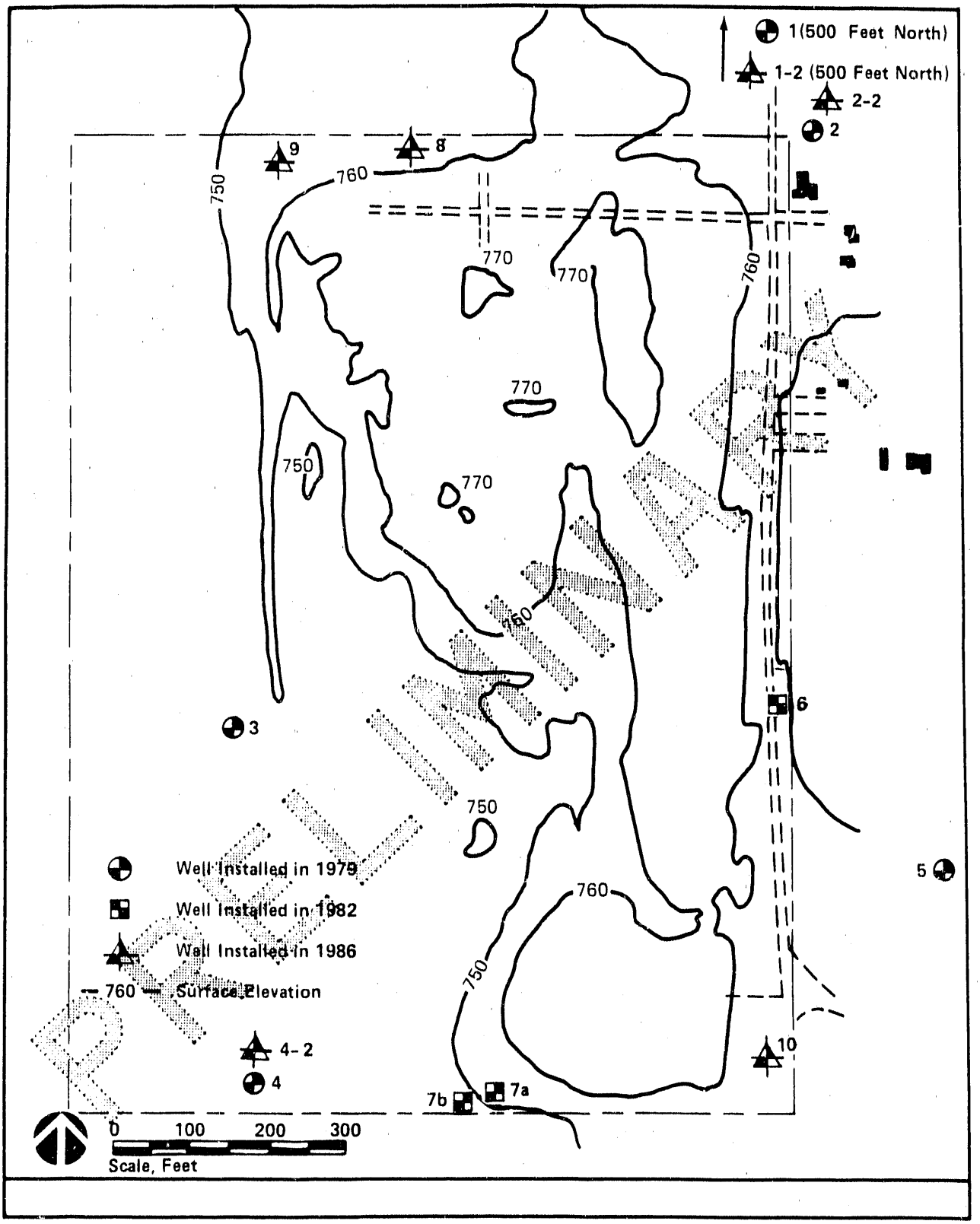
3.4.3.1 General Description of Groundwater Monitoring Program

Currently there is no routine, site-wide groundwater monitoring program at ANL. Instead, groundwater monitoring is conducted under different programs at three sites in response to individual environmental concerns. These three sites are the 800 Area Landfill, the 317 to 319 Areas, and Site A/Plot M. In addition, the four ANL water supply wells are also sampled. Monitoring programs at the 800 Area Landfill and the 317 to 319 Areas are conducted under ANL funding, while the program at Site A/Plot M is being carried out under the Formerly Utilized Sites Remedial Action Program (FUSRAP) in conjunction with USGS studies. Sampling and analysis of groundwater have been divided as well, into chemical and radiological segments, and are conducted separately by the chemical and radiological laboratories at ANL.

A total of 55 wells are sampled in the ANL groundwater monitoring program. The monitoring well locations and construction details, sampling procedures and monitoring frequency, parameters and data are discussed under Sections 3.4.3.2, 3.4.3.3, and 3.4.3.4. The analytical aspect of the program is covered in Section 4.4.

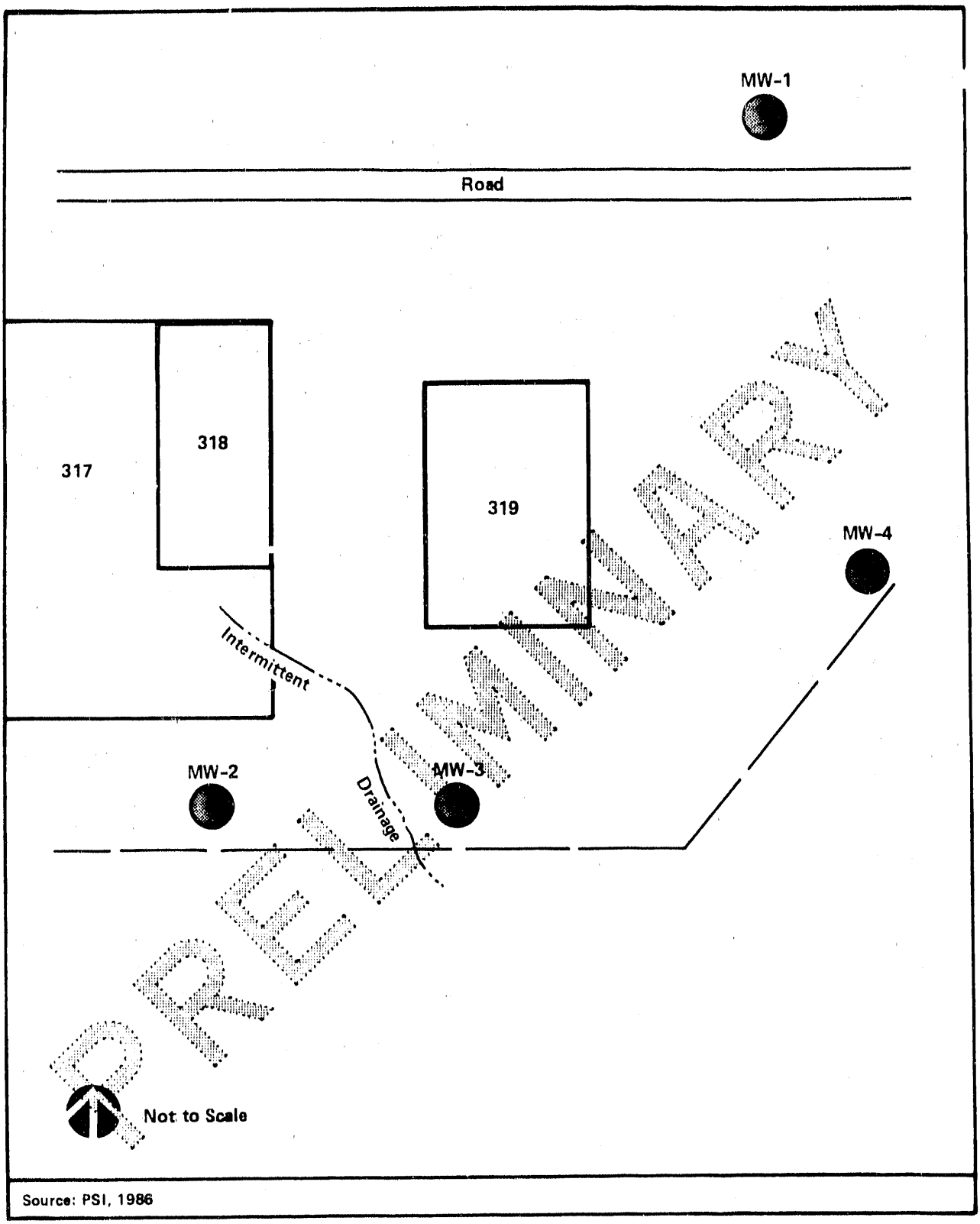
3.4.3.2 Monitoring Well Locations and Construction

Well locations at the 800 Area Landfill, the 317/319 Areas, and Site A/Plot M are presented in Figures 3-13 through 3-16. Construction details are reasonably complete for all the monitoring wells. In general, the depth of the well and the diameter of the casing have been measured. The monitoring wells constructed in the glacial till consist of polyvinyl chloride (PVC) casing and screen, generally of 2-inch diameter with 3- to 5-foot screen lengths at the well tip. The lengths of the gravel packs vary from 5 feet to 15 feet. The excessive length of the gravel pack ensures interception of flowing water in sand seams within the glacial till. The monitoring wells placed into the dolomite at Site A/Plot M, the ANL water supply wells, and the picnic wells at the Palos Park Forest Preserve consist of casing driven down to the top of the dolomite and an uncased core hole in the dolomite to the terminated depth. The dolomite wells at Site A/Plot M are currently used in hydrogeologic studies by the USGS, which has records on their construction. Specific

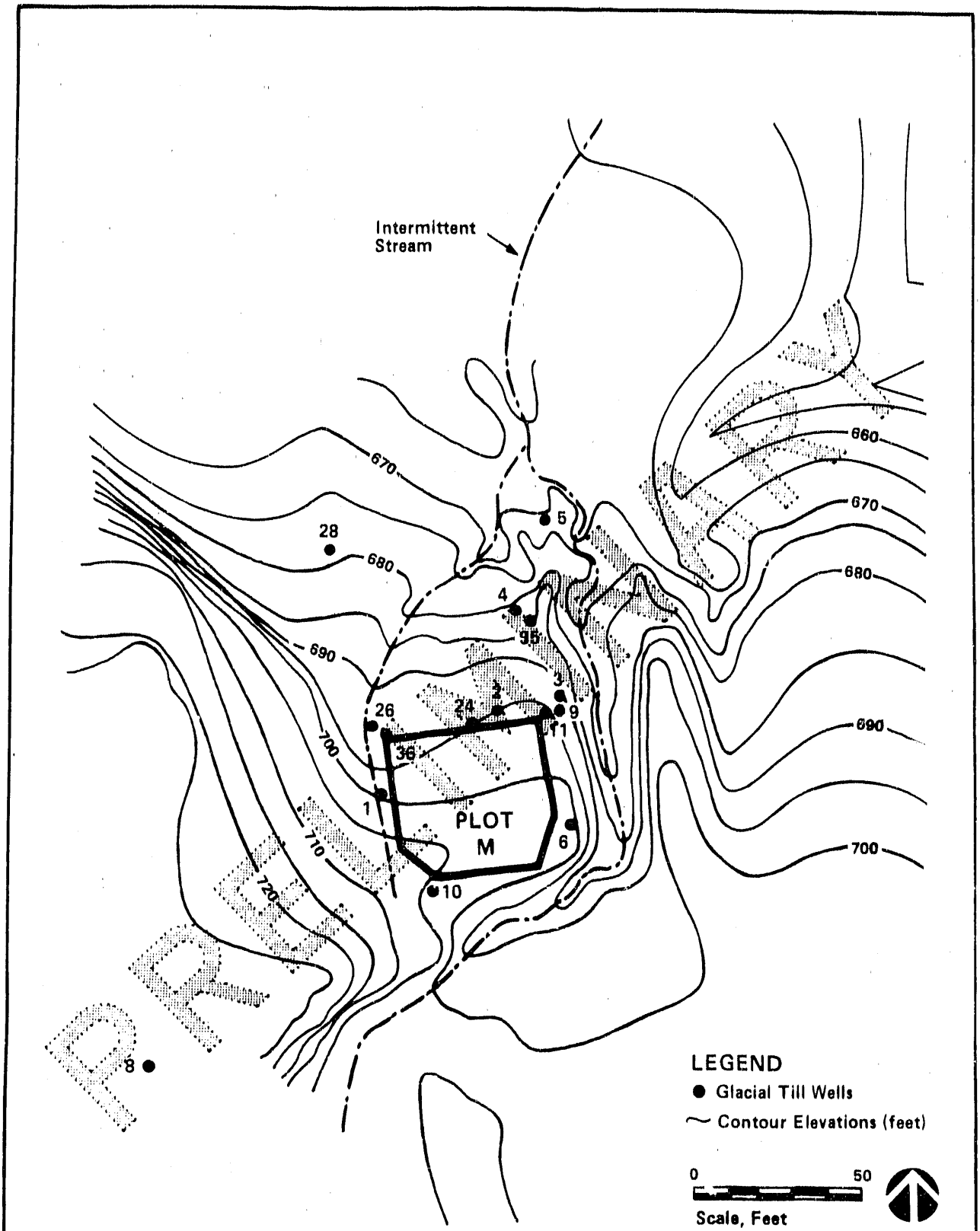


MONITORING WELL LOCATIONS AND INSTALLATION DATES AT THE ANL 800 AREA LANDFILL

FIGURE 3-13

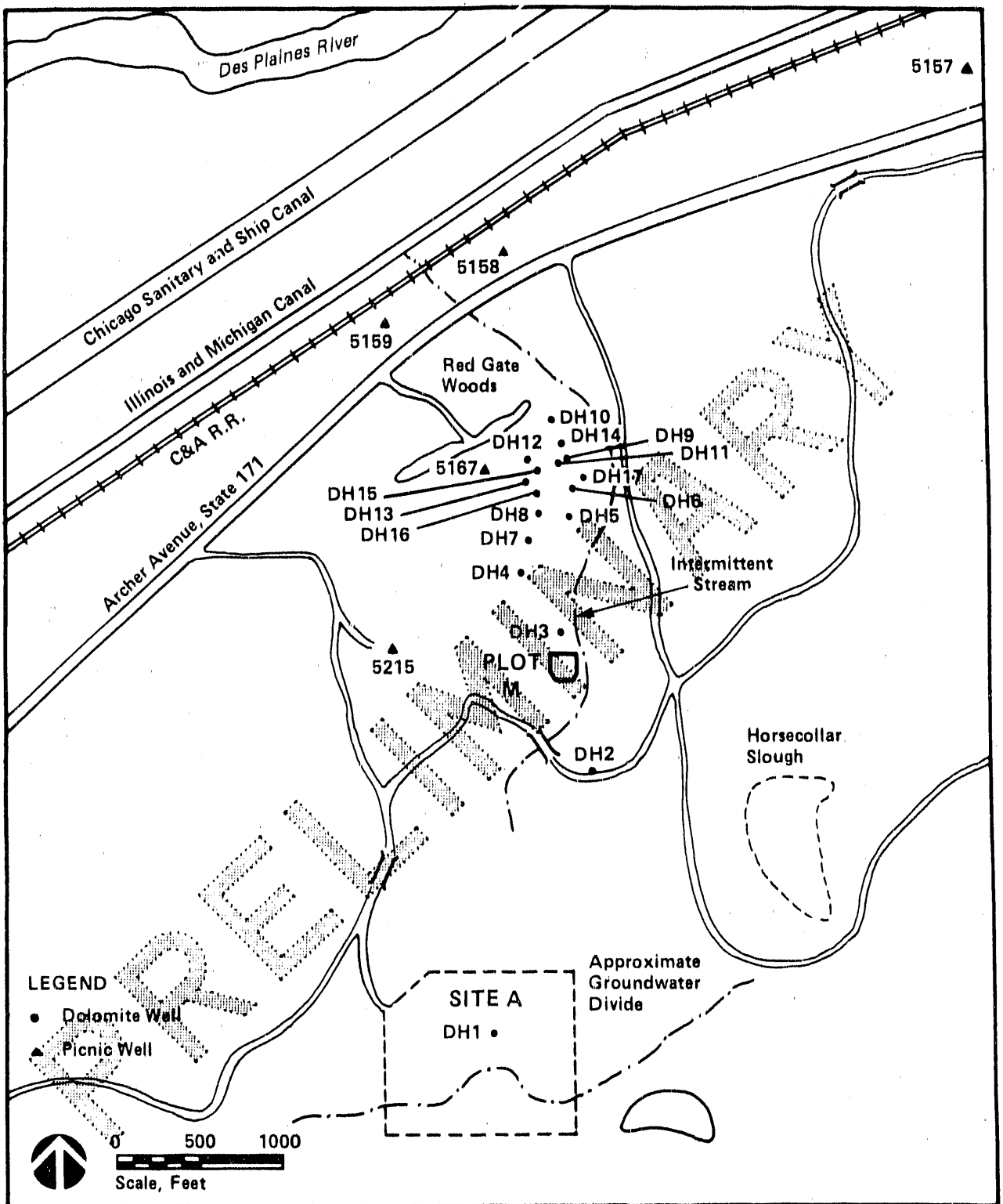


317 TO 319 AREAS MONITORING WELLS FIGURE 3-14



Source: Golchert, 1987d

LOCATIONS OF GLACIAL TILL MONITORING WELLS AT PLOT M FIGURE 3-15



LOCATIONS OF SITE A/PLOT M DOLOMITE WELLS AND PICNIC WELLS AT PALOS PARK FOREST PRESERVE

FIGURE 3-16

information on well construction for the 800 Area Landfill, the 317, 319 Areas and the Site A/Plot M is discussed below.

800 Area Landfill

Fourteen monitoring wells at the 800 Area Landfill have been placed in three phases (Figure 3-13). Five wells were originally placed around the 800 Area Landfill in fall 1979. These wells included the upgradient well along Westgate Road (Well 1), wells at the northeastern and southwestern corners of the site (Wells 2 and 4), one well along the western edge of the site (Well 3), and one well 200 to 300 feet east of the southeastern quadrant of the landfill (Well 5). Wells 1 through 4 were installed to depths of 20 to 31 feet; Well 5 was installed to a depth of 44 feet. Construction consisted of PVC casing with slots cut into the bottom 12 feet of casing by a hacksaw. Pea gravel was used as a filter pack. The bentonite seals were generally near the ground surface.

Three additional wells were installed in 1982 as a result of a geotechnical study for a landfill permit application. Two wells (7a and 7b), were placed in a cluster at the middle of the southern boundary of the site to depths of 25 feet and 45 feet, respectively. A third well, Well 6, was placed midway along the eastern boundary of the site to a depth of 44 feet. Construction consisted of PVC casing with a 3-foot PVC screen at the tip. A bentonite seal was placed 2 feet above the screen and the filter pack consisted of pea gravel.

In 1986, six more wells were placed. Three of these replaced Wells 1, 2, and 4, constructed in 1979, that appeared to be in poor condition. The other three wells were placed at the northwestern and southeastern corners of the landfill and midway along the northern boundary of the site and became Wells 8, 9, and 10. These six wells were drilled to a depth of about 10 feet below where water was encountered during drilling, which varied due to the depth of permeable zones within the glacial till. Construction consisted of PVC casing with a 5-foot screen at the tip. The bentonite seal in all wells except Well 2 was placed 10 to 15 feet above the well tip. In the replacement Well 2, the bentonite seal was placed 32 feet above the well tip. Pea gravel was used as a filter pack. The depths of the wells generally ranged from 20 to 30 feet with one well placed to 55 feet.

317 to 319 Areas

Four wells were placed at the 317 to 319 Areas in 1986 to monitor chemical parameters. Three wells (MW-2 through MW-4) were located downgradient in the glacial till and one (MW-1) was located upgradient in the glacial till (Figure 3-14). All were placed at depths of about 40 feet. Construction consisted of a PVC casing with a 5-foot PVC screen at the tip. The bentonite seal was placed 5 to 15 feet above the top of the screen. The filter pack consisted of pea gravel.

Site A/Plot M

To monitor the groundwater at Site A/Plot M, four wells were drilled into the Niagara Dolomite and 10 wells were placed in the glacial till in 1976 under the FUSRAP (Figures 3-15 and 3-16). One of the dolomite wells was constructed at Site A and the remaining 3 dolomite wells and 10 glacial till wells were placed downgradient of Plot M. The wells in the dolomite consisted of casing driven into dolomite and an open core hole in the rock. The depth of the core holes varied in the rock. Construction details for the wells in the glacial till are not fully available but the wells consist of 2½-inch PVC casing and screen. In 1980 an additional six wells were placed into the dolomite and six wells into the glacial till.

A current study by the USGS on the behavior of water in the dolomite has added 7 more wells to the 10 already in the dolomite. These were all constructed by driving casing down to the dolomite and coring the rock to the desired depth, leaving an uncased hole in the rock. Five picnic wells are also present near Plot M (Figure 3-16) and consist of casing driven down to the dolomite with a core hole into the rock. These wells are owned by the Cook County Forest Preserve District and are used to monitor for suspected contaminants leaching from Plot M.

3.4.3.3 Sampling Procedures

There is both chemical and radiological monitoring at ANL. Sampling at the site is conducted by two teams, one each from the chemical and radiological laboratories, respectively. Collection of environmental samples for chemical sampling is delineated in Industrial Hygiene Operating Procedure IHCL-001, "Water Sampling Site Locations, Sample Collection, and Preservation" and in Chapter 13 of the

Quality Assurance Plan for the IHCL. Operating Procedure IHCL-001 identifies the location of each groundwater sampling point, the frequency of sampling at that location, the sampling technique to be employed, and the preservation agent. Chapter 13 of the QA Plan for IHCL describes handling, storage, and shipping requirements for environmental monitoring samples. There were no written protocols for collection of radiological samples.

The chemical team consists of two individuals. This team samples wells at the 800 Area Landfill and the 317 to 319 Areas. A common submersible pump is used to purge the wells. The depth to water is measured using an electronic device prior to purging but not after sampling. The volume of purged water is measured in graduated bottles of 20 gallons. Because of the very slow recharge of the wells in the glacial till, usually only one borehole volume can be purged before the well is empty, and sampling must wait at least a day for sufficient recharge.

Groundwater samples collected by the chemical team are recovered using a Teflon bailer with a monofilament nylon cable. Decontamination is achieved by spraying or rinsing the equipment with deionized water and drying with a paper towel. All equipment is placed on a plastic sheet spread on the ground. Chain-of-custody documentation is not routinely maintained. A sampling exercise by the chemical team was not observed; however, discussions with team members indicated that sampling protocols were followed and that preservatives were added correctly.

The radiological team consists of one person. This individual samples the wells at Site A/Plot M, the picnic wells at the Palos Park Forest Preserve, the 800 Area Landfill, and the ANL water supply wells for radiological constituents. In addition, this individual samples the wells at Site A/Plot M and the picnic wells for inorganic constituents. The usual sampling procedure at Site A/Plot M does not involve purging the stagnant water in the well before sampling. The depth to water is measured prior to sampling with chalked steel tape. The wetted surface of the chalk indicates the depth of water. The tape is decontaminated with dry tissue paper. The groundwater is sampled using a copper bailer with a braided, stainless-steel cable. Decontamination is achieved by pouring deionized water over the bailer and coiled cable. Written sampling protocols were not available to the Survey.

The picnic wells are sampled by the radiological team using the existing pump mechanism to pump water into a gallon jug. Purging is not conducted. Sampling of the ANL water supply wells is conducted by opening a tap nearest each well, allowing about 2 gallons of water to drain from the open tap, and then filling a gallon jug. Chain-of-custody documentation is not routinely maintained. A sampling exercise was not observed by the Survey. Written protocols and preservatives used are presented in IHCL-001.

3.4.3.4 Monitoring Frequency, Parameters, and Results

Monitoring programs have been instituted at ANL on the basis of characteristics of the individual waste sites. These programs have begun at different times for the various sites and have been directed toward chemical or radiological parameters suspected at the particular site. A detailed summary describing the various aspects of each site monitoring program is presented below.

800 Area Landfill

The chemical parameters monitored at the 800 Area Landfill are listed in Table 3-31. The chemical parameters chosen for monitoring have changed over time. After several years of analyzing for the parameters listed in each phase in Table 3-31, the concentrations of the parameters are evaluated and some are deleted. The parameters removed from study are those not present at significant levels during the initial scans. Currently, all samples are collected twice yearly, except for samples for tritium analysis, which are collected quarterly. Samples cannot be collected at Well 7b since this well has been dry since installation.

Environmental data from the wells at the 800 Area Landfill indicate elevated levels of various chemicals and tritium when compared to levels at the upgradient well along Westgate Road (Well 1). However, it appears that background Well 1 has elevated levels of some contaminants such as chloride, dissolved solids, iron, manganese, and sulfate. Maximum concentrations for 1986 are presented in Table 3-32. EPA drinking water standards are included in the table for comparison purposes only since these wells and water at these depths are not used for potable purposes.

TABLE 3-31

PARAMETERS MONITORED AT THE 800 AREA LANDFILL

Phase	Parameters
I 1979-1981	pH, chloride, total dissolved solids
II 1982-1985	acetone*, arsenic, barium, benzene*, cadmium*, chloride, chromium (III)*, chromium (VI)*, copper*, cyanide*, dissolved solids, fluoride, iron, lead*, manganese, mercury, nickel*, pH, selenium, silver, sulfate, xylene, zinc
III 1986	Same as for 1982-1985 in addition to: benzene, ethylbenzene, m-dichlorobenzene, m-xylene, monochlorobenzene, o-dichlorobenzene, o-xylene, p-dichlorobenzene, p-xylene, tetrachloroethylene, toluene, trichloroethylene, 1,2,4-trichlorobenzene, tritium

* Monitoring for these parameters was discontinued at each well location after 1 to 2 years if measured concentrations were considered by ANL to be of no concern.

TABLE 3-32

MAXIMUM CONCENTRATIONS OF CHEMICAL CONSTITUENTS AND TRITIUM AT 800 AREA LANDFILL WELLS IN 1986

Parameter[a]	Well Number[b]													EPA Drinking Water Standards[d]
	1	1-2[c]	2	2-2[c]	3	4	4-2[c]	5	6	7A	8	9	10	
Arsenic, µg/L	<5	<5	<5	<5	13	<5	<5	<5	<5	<5	<5	14	<5	50
Barium, µg/L	277	262	269	628	367	179	62	256	225	86	128	338	83	1000
Cadmium, µg/L	-	4.4	-	0.30	-	0.8	0.60	-	-	-	0.70	0.70	<0.20	10
Chloride, mg/L	1110	667	27	82	12	355	53	294	49	10	65	175	22	250
Copper, µg/L	-	22	-	10	-	6	18	-	-	-	12	11	7	1000
Dissolved Solids, mg/L	2720	1970	366	739	852	1320	986	1350	829	403	745	1120	656	-
Fluoride, µg/L	162	172	154	282	150	212	304	154	138	158	210	212	248	4000
Iron, µg/L	840	<100	<100	196	3780	538	<100	15100	598	<100	<100	2060	<100	300
Lead, µg/L	-	3	-	2	-	4	1	-	-	-	1	1	1	50
Manganese, µg/L	184	424	34	3	224	1670	13	3230	400	285	93	3840	595	50
Mercury, µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.15	<0.05	2
Nickel, µg/L	-	161	-	23	-	35	52	-	-	-	29	45	23	-
pH	7.1	7.8	7.9	12	6.8	6.9	9.0	6.6	7.2	7.9	7.3	6.7	7.4	-
Selenium, µg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	10

TABLE 3-32

MAXIMUM CONCENTRATIONS OF CHEMICAL CONSTITUENTS AND TRITIUM AT 800 AREA LANDFILL WELLS IN 1986 (Continued)

Parameter[a]	Well Number[b]													EPA Drinking Water Standards[d]
	1	1-2[c]	2	2-2[c]	3	4	4-2[c]	5	6	7A	8	9	10	
Silver, µg/L	-	2.6	-			0.50	1.10	-	-	-	<0.20	0.03	<0.20	50
Sulfate, mg/L	168	148	75	31	139	274	175	137	165	147	136	53	147	250
Temperature, °C	12.7	13.2	12.3	13.2	12.5	12.7	11.8	13.2	14.1	10.9	12.3	13.5	13.5	-
Zinc, µg/L	-	20	-	20	-	20	20	-	-	-	20	20	20	5000
Tritium, pCi/L	-	267	-	323	<100		163	592	557	817	181	950	823	90,000[e]

Source: Golchert and Duffy, 1987

[a] Units as noted
[b] Well locations depicted in Figure 3-13
[c] Indicates replacement well
[d] Federal Register, Vol. 43, No. 243
[e] Proposed

The high pH level in Well 2-2 at the northeastern corner of the 800 Area Landfill appears to be the result of cement contamination in the gravel filter pack. The pH level has recently dropped in Well 2 from historically high levels. This drop may be due to the removal of the cement in the older well by repeated purging over the years. If this is the case, this would indicate that the actual pH of the groundwater near these wells is at or below the level of 7.9 units measured in the older of the two wells.

As reported in Table 3-32, maximum arsenic levels at the 800 Area Landfill range from below 5 micrograms per liter (µg/L) to 14 µg/L. Average arsenic levels measured in Well 3 have declined from 35 µg/L in 1983 to 7 µg/L in 1986 although arsenic has also recently been detected at Well 9 at an average of 9 µg/L. The source is unknown and has not been detected at any other location. In addition, manganese values are consistently above the EPA drinking water standard for aesthetic criteria of 50 µg/L and are as high as 3,840 µg/L. Iron is also frequently above EPA standards for aesthetic criteria. The reasons for the high iron and manganese levels are unknown. Chloride levels are high at Wells 1 and 1-2. This is probably due to the application of road salts on Westgate Road.

Sampling for most organics was initiated in all the wells at the 800 Area Landfill in 1986. Samples were collected at all wells and parameters were below detectable limits of 5 to 10 µg/L at all locations, although analytical error, as discussed in Section 4.4, reduces the data credibility.

Sampling for tritium also was begun at all wells at the 800 Area Landfill in 1986. These results show levels elevated above background [approximately 100 to 200 picocuries per liter (pCi/L)] but less than 1,000 pCi/L. The proposed EPA drinking water standard is 90,000 pCi/L. The tritium levels suggest that flow from the landfill is toward the east and northwest at shallow depths (Golchert and Duffy, 1987). The source of the tritium is unknown; if tritium has been disposed of at the landfill, it has not been recorded.

317 to 319 Areas

Monitoring wells were placed at the 317 and 319 Areas in 1986 and have been sampled for inorganic constituents. The chemical parameters monitored at the 317

to 319 Areas are the same parameters monitored during 1982 through 1985 at the 800 Area Landfill, as listed in Table 3-31. Currently, two of the four wells are dry. The results of these analyses for 1986, as presented in Table 3-33, indicate contaminant levels below drinking water standards. .

Site A/Plot M

From 1973 through 1986 all the wells at Site A/Plot M, consisting of the Palos Park Forest Preserve picnic wells, the glacial till wells, and the dolomite wells (Figures 3-15 and 3-16), were monitored for tritium and a few other radionuclides. In 1986, monitoring for organics and inorganics began in the glacial till wells and for inorganics in the picnic wells. However, tritium remains the only constituent monitored in the dolomite wells. This is because these wells are being used by the USGS to determine groundwater behavior in the dolomite. The parameters studied are listed in Table 3-34. It should be noted that 1986 was the most recent year for which groundwater data were available to the Survey.

Picnic Wells - When the groundwater monitoring program at Site A/Plot M began in 1973, one Palos Park Forest Preserve picnic well was sampled for tritium. The results of testing indicated tritium levels at about 12,000 pCi/L (DOE, 1978). Additional samples from other forest preserve picnic wells also indicated the presence of tritium but at lower levels (DOE, 1978). An ongoing monitoring program of the picnic wells was instituted for tritium, which indicated seasonally fluctuating levels peaking at 10,000 to 14,000 pCi/L in fall and winter. Table 3-35 presents tritium and uranium concentrations in the picnic wells for 1986. Both are below EPA standards. The standard used for uranium is a gross alpha standard of 15 pCi/L. Inorganic constituents have also been sampled in the picnic wells. Concentrations in picnic well number 5167 during 1986 exceeded Illinois State drinking water limits for lead, manganese, and sulfate (Table 3-36). However, the high lead and manganese levels may be due to well pump deterioration (Golchert, 1987d), while the high sulfate levels may result from the naturally high sulfate levels throughout the Des Plaines River valley.

Glacial Till Wells - Test results for the glacial till wells indicate that contaminants are below permissible limits for all parameters except sulfate (Tables 3-37 and 3-38). The concentrations of sulfate ranged between 72 and 2,363 milligrams per liter

TABLE 3-33

REPORTED MONITORING WELL DATA FOR 317 TO 319 AREAS IN 1986

Parameter[a]	Well MW-1[b]	Well MW-2[b]	EPA Drinking Water Standards
Arsenic	<0.01	<0.01	5.0
Barium	0.0276	0.0386	100
Cadmium	<0.0002	<0.0002	1.0
Chromium (total)	<0.0010	<0.0010	5.0
Copper	0.0087	0.0087	-
Iron	<0.100	<0.100	-
Lead	<0.0010	<0.0010	5.0
Manganese	0.0058	0.0400	15
Mercury[c]	<0.1	<0.1	200
Nickel	0.0218	0.0131	-
Selenium	<0.01	<0.01	1.0
Silver	<0.0001	0.0001	5.0
Zinc	<0.020	<0.020	-
pH	7.9	8.1	-
Chloride	23	12	250
Fluoride	0.172	0.112	-
Sulfate	164	64	250

Source: Written Communication from T.I.. Duffy at ANL

[a]Concentrations in mg/L unless otherwise indicated
[b]Well locations depicted in Figure 3-14
[c]Concentration in µg/L

TABLE 3-34

CHEMICAL PARAMETERS MONITORED IN THE VICINITY OF SITE A/PLOT M

Well Phase	Chemical Parameters
I 1973-1975	Picnic Wells: tritium
II 1976-1981	Picnic Wells: tritium and potassium Glacial Till Wells: tritium Dolomite Wells: tritium
III 1982-1985	Picnic Wells: tritium, uranium Glacial Till Wells: tritium, uranium, and strontium-90 Dolomite Wells: tritium
IV 1986	Picnic Wells: tritium, uranium, arsenic, barium, cadmium, chloride, chromium, copper, lead, manganese, mercury, nickel, pH, selenium, silver, sulfate, and zinc Glacial Till Wells: tritium, strontium-90, uranium, the organic parameters listed in Table 3-29 for 1986, and the inorganics listed above for the Picnic Wells. Dolomite Wells: tritium

TABLE 3-35

MAXIMUM AND MINIMUM RADIOACTIVITY CONCENTRATIONS IN PALOS PARK FOREST PRESERVE PICNIC WELLS IN THE VICINITY OF SITE A/PLOT M, 1986

Well Number[a]	Tritium[b]	Uranium[b]
5159	(0.43 - 0.94) x 10^3	0.06 - 0.63
5158	(<.2 - .28) x 10^3	0.04
5157	(<.2 - .26) x 10^3	1.36
5167	(<0.2 - 3.4) x 10^3	0.03 - 0.82
5215	(<.2 - .26) x 10^3	0.14
EPA Drinking Water Standard	90 x 10^3[c]	15[d]

Source: Golchert, 1987d

[a]Locations depicted in Figure 3-16
[b]Concentrations in pCi/L
[c]Proposed
[d]Gross alpha standard

TABLE 3-36

INORGANIC CONSTITUENTS IN PALOS PARK FOREST PRESERVE PICNIC WELL NUMBER 5167[a] NEAR SITE A/PLOT M IN 1986

Inorganic Constituent[b]	Number of Samples	Average	Minimum	Maximum	EPA Drinking Water Standards
Arsenic	4	-	-	<0.005	0.05
Barium	4	0.076 ± 0.073	0.033	0.142	1.0
Cadmium	4	0.002 ± 0.002	<0.001	0.003	0.01
Chloride	4	5.525 ± 8.477	<0.100	13.000	250
Chromium	4	0.005 ± 0.003	0.003	0.007	0.05
Copper	4	0.280 ± 0.748	0.002	1.088	-
Fluoride	4	0.106 ± 0.027	0.088	0.132	-
Iron	4	13.043 ± 12.571	7.438	26.471	-
Lead	4	0.070 ± 0.152	0.010	0.234	0.05
Manganese	4	0.087 ± 0.073	0.032	0.156	0.05
Mercury[c]	4	-	-	<0.050	2.0
Nickel	4	0.015 ± 0.020	0.002	0.028	-
pH	4	-	7.0	7.2	-
Selenium	4	-	-	<0.005	0.01
Silver	4	-	-	<0.001	-
Sulfate	4	307 ± 105	214	397	250
Zinc	4	12.215 ± 3.180	10.389	15.543	-

Source: Goichert, 1987d

[a]Location depicted in Figure 3-16
[b]Concentrations in mg/L unless otherwise noted
[c]Concentrations in µg/L.
-Indicates no standard exists

TABLE 3-37

MAXIMUM AND MINIMUM RADIOACTIVITY CONCENTRATIONS IN GLACIAL TILL WATER IN THE VICINITY OF SITE A/PLOT M (pCi/L), 1986

Well Number[a]	Tritium	Strontium-90	Uranium-234	Uranium-235	Uranium-238
1	(941-1461) x 10^3	.53 -- .58	7.15	0.06	6.60
2	(359-467) x 10^3	.56	6.98	0.06	7.84
3	(4179-4399) x 10^3	<.25	3.53	0.02	1.95
4	(401-741) x 10^3	<.25	0.25	<.01	0.21
5	(103-112) x 10^3	<.25	5.03	0.05	3.56
6	(21-604) x 10^3	5.9 - 6.1	1.25	0.04	1.23
8	(<0.2 - 2.2) x 10^3	<.25	35.0	-	36.07
9	(2085 - 24,300) x 10^3	7.2 - 11.1	3.77	0.05	3.72
10	(26,600-32,000) x 10^3	<.25 - .38	7.47	0.05	7.34
11 (39')	(208 - 2760) x 10^3	2.1 - 4.6	0.91	0.02	0.98
11 (124')	(63 - 104) x 10^3	0.5 - 1.8	0.61	<.01	0.70
24	(7 x 82) x 10^3	<.25	0.31	0.01	0.24
26	(1547 - 2246) x 10^3	<.25	0.10	<.01	0.09
28	(303 - 378) x 10^3	<.25		-	-
35	(4489 - 6963) x 10^3	.38 - 1.5	1.89	<.01	1.75
36	(81 - 538) x 10^3	<.25	0.21	<.01	0.27
EPA Drinking Water Standards	90x10^3[b]	8.0	c	c	c

Source: Golchert, 1987d

[a]Locations depicted in Figure 3-15
[b]Proposed
[c]Covered by the gross alpha standard of 15pCi/L

TABLE 3-38

INORGANIC CONSTITUENTS IN GLACIAL TILL WATER IN THE VICINITY OF SITE A/PLOT M, 1986

Inorganic Constituent[b]	Well Number[a]						
	1	2	3	6	8	26	EPA Drinking Water Standards[c]
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Barium	0.10	0.03	0.05	<0.01	0.04	0.03	1.0
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Calcium	560	438	122	94	516	244	-
Chloride	36.2	8.0	13.0	9.0	-	20.0	250
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Copper	0.05	0.14	<0.01	<0.01	0.03	0.18	-
Iron	<0.05	<0.05	<0.05	<0.05	0.60	<0.05	-
Lead	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.05
Manganese	0.69	0.05	1.31	0.04	1.34	0.01	0.05
Mercury[d]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2.0
pH	7.3	7.0	7.1	7.1	6.9	11.3	-
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Sulfate	2363	902	225	72	2612	625	250
Zinc	0.03	0.02	<0.01	<0.01	<0.01	<0.01	-

Source: Golchert, 1987d

[a]Locations depicted in Figure 3-15
[b]Concentrations in mg/L unless otherwise noted
[c]Federal Register, Vol. 43, No. 243
[d]Concentrations in µg/L

(mg/L), while the limit for sulfate is 250 mg/L (Golchert, 1987d). No other constituents exceeded EPA standards, which were used only for comparison since these wells are not used for water supply. Nonetheless, tritium concentrations in the glacial till monitoring wells immediately adjacent to Plot M were recorded as high as 3.2×10^7 pCi/L in 1986, well above background levels of 100 to 200 pCi/L. Organic concentrations were all below detection limits of 5 µg/L to 10 µg/L. However, analytical error, as discussed in Section 4.4, reduces data credibility at Site A/Plot M.

Dolomite Wells - Results of the tritiated water analyses in the dolomite wells (Table 3-39) indicate that 8 of the 14 wells sampled in 1986 had elevated tritium concentrations. The highest levels were in the six wells, DH 9 to DH 14, which are furthest north and generally nearest the intermittent stream that flows next to Plot M. As described in Section 3.3.3.5, elevated tritium concentrations have been found in the stream water. The stream is underlain by several thin sand and gravel lenses, and may be hydraulically connected to the dolomite in this area. This could provide a conduit for tritiated water from Plot M to maintain the elevated levels measured in these wells (Golchert, 1987d). Although the 1986 values are below the proposed EPA drinking water standards of 90,000 pCi/L, they are 2 to 190 times background.

Water Supply Wells

A groundwater monitoring program on the four domestic water supply wells for ANL was begun in 1984. The parameters studied have been nonvolatile alpha and beta, tritium, strontium-90, radium-226, uranium-234, and uranium-238. Since 1986, total uranium has been monitored instead of uranium-234 and uranium-238. Samples for alpha, beta, and tritium are taken quarterly, the remainder yearly. In 1986, alpha values were reported as high as 6.6 pCi/L, beta was recorded as high as 9.7 pCi/L, and tritium was recorded as high as 478 pCi/L (Table 3-40). All these values were recorded at Well 2. The remaining parameters have all been recorded at less than 1 pCi/L except for radium-226, which has ranged from 1.0 to 1.7 pCi/L at Wells 1 and 2 (Golchert and Duffy, 1987). All values are below the EPA drinking water standards for community water systems. No other sampling is conducted on the water supply wells.

TABLE 3-39

MAXIMUM AND MINIMUM TRITIUM CONCENTRATIONS IN DOLOMITE WATER IN THE VICINITY OF SITE A/PLOT M, 1986

Well Number[a]	Concentration (pCi/L)[b]	
	Minimum	Maximum
DH1	<200	<200
DH2	<200	<200
DH3	1,450 ± 120	1,960 ± 140
DH4	<200	<200
DH5	<200	310 ± 100
DH6	360 ± 100	1,180 ± 120
DH7	<200	<200
DH8	<200	<200
DH9	26,220 ± 310	28,460 ± 330
DH10	6,780 ± 140	7,700 ± 210
DH11	8,230 ± 320	10,390 ± 190
DH12	6,860 ± 180	8,430 ± 200
DH13	1,250 ± 120	5,150 ± 130
DH14	9,280 ± 160	12,350 ± 230

Source: Golchert, 1987d

[a] Locations depicted in Figure 3-16
[b] Proposed EPA Drinking Water Standard for tritium - 90,000 pCi/L

TABLE 3-40

HIGHEST MEASURED RADIOACTIVITY LEVELS IN ANL DOMESTIC WELLS IN 1986

Parameter[a]	Well Number				EPA Drinking Water Standard
	1	2	3	4	
Alpha (nonvolatile)	4.5	6.6	4.3	3.0	15.0
Beta (nonvolatile)	7.6	9.7	8.1	7.3	15.0
Tritium	239	478	169	158	90,000[b]
Strontium-90	<0.25	<0.25	<0.25	<0.25	8.0
Radium-226	1.26	1.66	0.69	0.51	5.0
Uranium (natural)	0.44	0.33	0.41	0.22	c

Source: Golchert and Duffy, 1987

[a]Concentrations in pCi/L
[b]Proposed
[c]Covered by the gross alpha standard of 15 pCi/L

3.4.4 Findings and Observations

The findings that involve actual and potential groundwater contamination are the result of current and past releases, spills, and disposal practices and are therefore discussed within the context of other findings in Sections 4.1.2 (Waste Management) and 4.5.2 (Inactive Waste Sites and Releases).

3.4.4.1 Category I

None

3.4.4.2 Category II

None

3.4.4.3 Category III

1. Inadequate groundwater monitoring program. The ANL groundwater monitoring program is not designed to identify all contaminants that may reasonably be expected to be present from current and past site operations and disposal practices.

   ANL has several operations and active and inactive waste sites, as discussed in Sections 3.3, 4.1, and 4.5, which may be contributing contaminants to the groundwater. Operations and active sites include potentially leaking laboratory and sewer pipes; the small equalization pond behind Building 108, which receives runoff from the coal pile, filter backwash water from the water treatment plant, and demineralizer blowdown and cooling water from the Central Boiler House; USTs; and the flue gas scrubber impoundment near Building 145. Although there are numerous organics and inorganics of potential concern from those sources, ANL is only analyzing for a portion of them.

   In addition, wells at active and inactive waste sites may not be placed in appropriate locations to identify contaminant migration toward the aquifer in the 317 to 319 Areas and the 800 Area Landfill. The Niagara Dolomite aquifer

in this region is recharged by vertical migration of precipitation. Consequently, contaminants that may be in the soils could be carried toward the aquifer by means of the infiltrating precipitation. As the water and any associated contamination seep through the glacial till, there is both vertical and some horizontal movement. However, monitoring wells placed at the 317 to 319 Areas and the 800 Area Landfill are not placed in such a manner that they would intercept the suspected plume of contaminated groundwater.

Also, screens on groundwater monitoring wells at Plot M are located below the top of the aquifer. Therefore they may not intercept organics which, because of their low density, may be floating on top of the aquifer.

As a result of the potential for organics and some inorganics to be present in the glacial till groundwater and the Niagara Dolomite aquifer and not be identified by the present sampling program, the Survey will conduct groundwater S&A for a broad range of suspected contaminants from selected wells within the glacial till soils and the dolomite aquifer beneath ANL and Plot M. Samples from existing wells will be taken at Plot M, the 800 Area Landfill, the 317-319 Areas, and the ANL water supply wells. New wells will be placed in the glacial till at Plot M and the 800 Area Landfill and in dolomite at the 317-319 Areas. Groundwater samples will also be analyzed for inorganics and radiological contaminants.

3.4.4.4 Category IV

1. Potentially questionable groundwater sampling data. The groundwater sampling procedures and practices produce data of questionable validity for sampled parameters and could be resulting in incorrectly quantified or undetected releases of contaminants to the groundwater.

   Observations indicate that ANL's sampling practices do not follow recognized QA/QC practices, which reduces the validity of the data. The Survey team observed a sampling exercise at Plot M by the radiological sampling team. Examples of deviations from recognized QA/QC procedures that were observed and that could compromise the validity of the collected data obtained from monitoring wells are (1) lack of well purging prior to sampling,

which may result in laboratory analysis of stagnant water; (2) use of stainless-steel, braided bailer cable, which may result in sample contamination; (3) use of poor equipment decontamination procedures, which may result in sample contamination; (4) use of chalk on steel tape to check wetted level on tape to obtain water depth determinations, which could result in well contamination; and (5) lack of chain-of-custody procedures. A sampling exercise by the chemical sampling team could not be scheduled during the on-site portion of the Survey.

4.0 NON-MEDIA-SPECIFIC SURVEY FINDINGS AND OBSERVATIONS

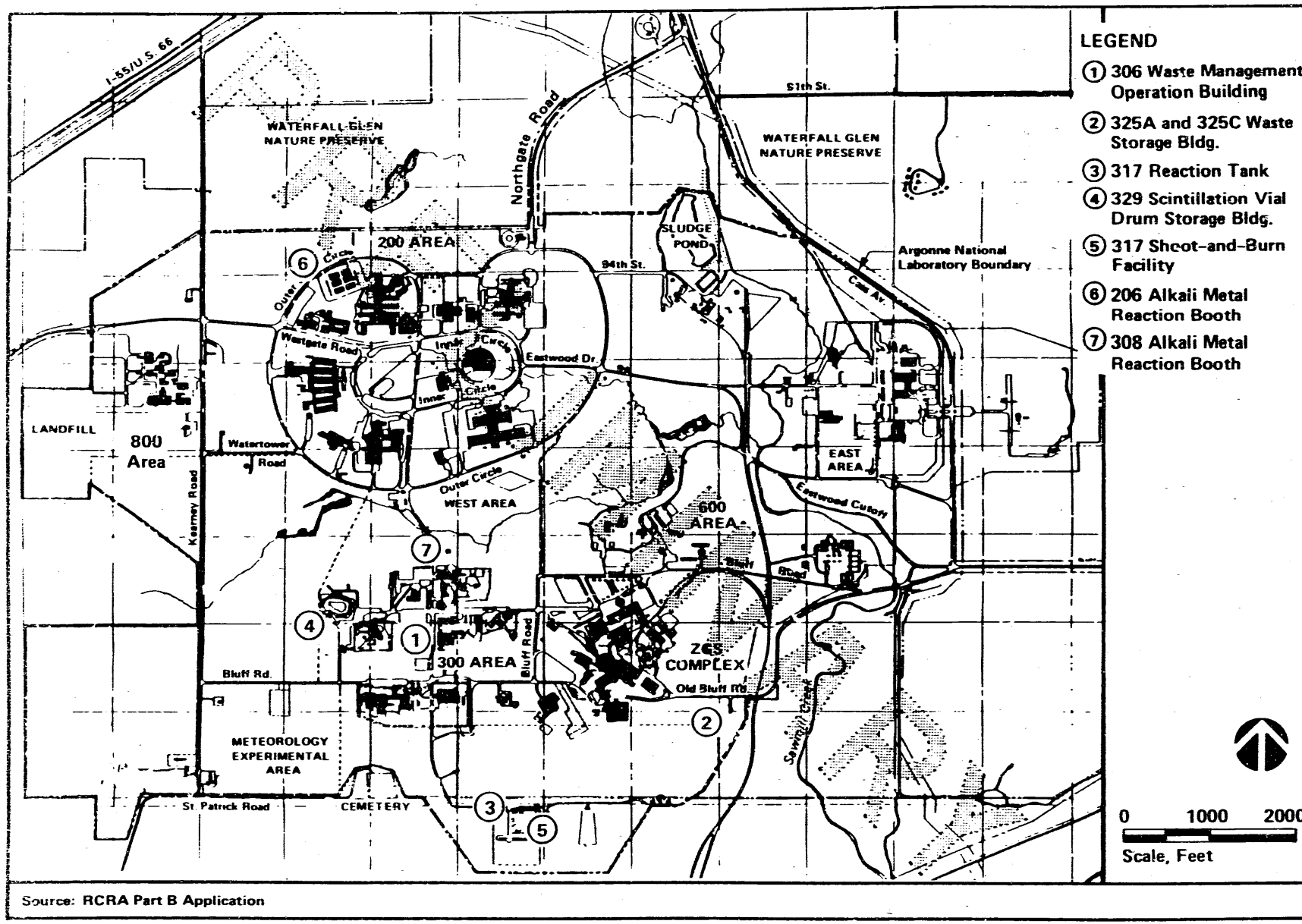
This section discusses findings and observations pertaining to waste management, toxic and chemical materials, radiation, quality assurance, and inactive waste sites and releases. These discussions do not include background environmental information because the areas addressed are not necessarily tied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

4.1 Waste Management

ANL is a multi-faceted research and development laboratory. Research involves engineering, physical, chemical, energy, environmental, and biological experiments utilizing radioactive and chemical substances. Because of this broad spectrum of research, the wastes generated from ANL include hazardous, radioactive, mixed (hazardous and radioactive) and nonhazardous wastes.

Wastes generated in laboratories can differ significantly from wastes generated in production facilities. Laboratories generate small quantities of many different wastes, whereas production facilities normally generate large quantities of relatively homogeneous wastes. The proper handling and disposal of laboratory wastes involve special procedures that are not typically utilized at production facilities. Laboratory wastes can even vary considerably from year to year because of new or modified research efforts.

In general, hazardous, radioactive, and mixed wastes generated at ANL are accumulated at satellite storage areas at various laboratory buildings and transferred to Building 306, Waste Management Operations (WMO) facility (Figure 4-1), where the wastes are repackaged, processed, neutralized, accumulated, solidified, or otherwise treated for eventual off-site disposal. In certain situations, wastes are disposed of at an on-site sanitary landfill, or are discharged to a laboratory wastewater or a sanitary wastewater treatment plant for treatment prior to release to Sawmill Creek. The specific details of the ANL waste management program as it pertains to hazardous waste, mixed waste, radioactive waste, and nonhazardous waste are each discussed in Section 4.1.1 which follows; sanitary and laboratory wastewater is discussed in Section 3.3.



Source: RCRA Part B Application

WASTE MANAGEMENT AREAS AT ANL

FIGURE 4-1

4.1.1 General Description of Pollution Sources and Controls

4.1.1.1 Hazardous Waste

ANL generates a wide variety of hazardous wastes that can be broadly categorized under the Resource Conservation and Recovery Act (RCRA) as flammable, corrosive, toxic, reactive, and RCRA-listed wastes. Due to the nature of research performed at ANL, different hazardous wastes in varying amounts are generated each year and the potential exists that many of the chemicals or chemical characteristics listed in the RCRA CFR Part 261, subparts C and D, may be generated by ANL.

Most of the operations within ANL produce hazardous waste streams that are collected and disposed of or are treated by the site as discussed below. However, some areas produce or may produce hazardous wastes that are not collected for disposal. Rather, they are released to the soil or surface water. Such areas include, but are not limited to, the Building 145 flue-gas scrubber which generates water potentially contaminated with heavy metals and sulfates that is recirculated within a leaking surface impoundment; a coal pile located near Building 108 that may be releasing heavy metals and organics to runoff water; some unprotected lead materials in storage areas outside Buildings 306, 378, and 382 that could be releasing lead to the soils; and a shoot-and-burn operation located near the 317 Area that could be releasing residual organics and reactive metals to the soils.

The ANL 1986 "Generator Annual Hazardous Waste Report," filed with the Illinois Environmental Protection Agency (IEPA), indicated that 104 labpacks and an additional 1,650 gallons of various bulk liquid or solid hazardous wastes, as identified in Table 4-1, were shipped off-site for treatment or disposal. Labpacks are normally 30- and 55-gallon drums into which smaller containers of hazardous liquid or solid wastes are placed. The void spaces in the drums are packed with an absorbent material to minimize breakage or spillage. The bulk liquids and solids are normally shipped in 55-gallon drums.

The ANL 1986 "Generator Annual Hazardous Waste Report" also indicated that 40 full or partially filled labpacks were being stored in various waste management facilities at ANL and that 4,163 gallons of additional bulk liquid or solid hazardous wastes were either being stored or treated at various waste management facilities

TABLE 4-1

HAZARDOUS WASTES SHIPPED FROM ANL FOR OFF-SITE TREATMENT OR DISPOSAL, 1986

Labpack Shipments
Ignitables
Mercury Contaminants
Corrosives
Phenols
Cresols
Chlorinated Ignitables
Halogenated Corrosives
Oxidizers
Arsenic Compounds
Lead Contaminants
Cyanides
Reactives
Dioxane
Solvents
Bulk Shipments
Trichlorofluoromethane
Ferric Chloride Solution
Lead-Contaminated Animal Feeds
Ignitables
Solvents

Source: 1986 Generator Annual Hazardous Waste Report

at ANL. The types of waste being treated and stored in labpacks and bulk containers at ANL are identified on Table 4-2.

The individual researcher who generates the hazardous waste is responsible by ANL policy to minimize, identify, segregate, package, and label hazardous wastes for further treatment or disposal. There is an ANL "Waste Handling Procedure "(WHP) dated September 18, 1986, which implements RCRA procedures and provides specific information to the waste generator regarding these responsibilities.

The waste generators may accumulate hazardous wastes in satellite storage areas at their work locations. Hazardous wastes may be accumulated in bulk storage containers, normally 5-gallon plastic bottles or metal cans located within the satellite storage areas, until the containers are full. Other nonbulk chemicals which are declared waste are typically stored in their original containers. Additionally, small quantities of actual and suspected hazardous waste generated in chemical laboratories throughout ANL are poured down sink drains as a result of glassware washing operations or experiment waste product discharges. The sink drains lead to temporary holding tanks that discharge to the laboratory wastewater sewer system, which is discussed in Section 3.3.2.2.

Hazardous waste generators are responsible for properly identifying the waste if the waste is corrosive, ignitable, reactive, toxic, or a specific RCRA-listed waste. The hazardous wastes identified by each waste generator determine the treatment or disposal method eventually selected by the WMO staff. Because multiple waste generators sometimes occupy the same laboratory work area and use the same bulk hazardous waste receptacles, labeling and record keeping to keep track of the various wastes going into each container are attempted, although in many instances the waste identification and subsequent labeling was found to be incomplete. Inventory sheets are in some cases filled out only after the waste containers are full and ready for shipment to the WMO facility. As a result, the Survey noted that the generators generally employ a "best guess" method of specifying the types and amounts of the various wastes that are in their containers.

When the waste container is full or when a sufficient quantity of laboratory chemicals have been accumulated, the waste generator makes a request to WMO to collect and transport the waste to the WMO facility for treatment or disposal. The

TABLE 4-2

HAZARDOUS WASTES TREATED OR AWAITING DISPOSAL AT ANL, 1986

Labpack Chemicals		
Acid	Cumene	Poisons B
Boron	Cesium	Mercury compounds
Dimethyl sulfoxide	Diethylamine	Amitrole
Chlorides	Ethylamine	Cyanides
Lead compounds	Ethylene glycol	Flammable solids
Chlorites	Ether acetate	Chloroform
Corrosives	Glycol monoethyl ether	Nitrates
Acetonitrile	Hexane	Metal compounds
Formic acid	Lead fluorobate	Ethylene dichloride
Benzene	Oxidizers	Ferric chloride

Bulk Chemicals	
Hydrochloric/tin salts	Hexane-N
Aluminum powder	Methyllithium
Barium-contaminated solids	Methylstyrene
Ethanol	Raney nickel
Ignitables	Mercurous nitrate
Sodium hydroxide	Potassium nitrate
Nitrates	Sodium nitrate
Solvents	Freon
Acetaldehyde	Nitromethane
Peracetic acid	Potassium permanganate
Perchloric acid	Tert-butyl peroxide
Ethyl alcohol	Hydrogen peroxide
Methyl chloroform	Sodium peroxide
Collodion	Dioxane
Decaborane	Tetrahydrofuran
Dimethoxymethane	Tetramethylsilane
Ethyl ether	Trichlorosilane
Isopropyl ether	Trifluoroacrylonitrile
Petroleum ether	Solvent containing dioxin
Chromic acid	Sulfuric acid containing dioxin
Chromerge	Sodium chromate
Sodium dichromate	Potassium dichromate
Metal primer	Paint stripper
Sodium hydroxide	Nitric acid
Barium	Barium acetate
Chromium plating solution	Barium oxide
Lithium	Cesium
Magnesium	Lanthanum powder
Phosphorus pentoxide	Lithium-sodium
Sodium	Sodium-potassium
Sodium hydride	Potassium hydroxide
Sodium perborate	Sodium dithionite
Cyclohexane	Sodium monoxide
Nitric/sulfuric acid mixture	Butanol
Battery acid/lead mixture	Methanol mixture
Mercury	Sulfuric acid

Source: 1986 Generator Annual Hazardous Waste Report

request is initiated by completing Form PFS-197 "Chemical Waste Disposal Requisition," which records the following information:

(1) Division, building, and room number

(2) Specific type of chemical waste

(3) Specific chemical compound name, vessel size, and weight

(4) Any precautions necessary

(5) Waste generator's signature, cost code, payroll number, telephone extension, and date

(6) Results of a radiation survey and the surveyor's initials

(7) Signature of the Property Management Representative if accountable materials are present.

When the WMO Manager receives the PFS-197, it is evaluated by the WMO staff to determine the proper treatment or disposal method for each waste. If the WMO Manager believes that all the information is correct, the request is approved by the manager for collection and eventual treatment or disposal. At that time, the WMO staff schedules a collection date and notifies the waste generator of that date.

On the scheduled date, the WMO staff goes to the building and room number indicated on the PFS-197. At this time, the WMO staff is responsible for ensuring that the waste is properly identified, containerized, labeled, and numbered with the requisition number, and that the information on the PFS-197 is correct in accordance with the ANL 1986 WHP. If any problems are encountered or the information cannot be verified, the waste is not collected. The WMO staff is then required to notify the WMO Manager immediately so that measures to rectify the problem can be initiated. If no problems are encountered, the waste is collected and transported by truck to the WMO facility for further processing. If the waste cannot be identified by the generator, the waste is transported to the WMO facility as an unknown and the waste is tested to identify hazardous characteristics.

In practice, waste identification, labeling, packaging, and segregation are not handled at ANL in full accordance with the ANL 1986 WHP. The Survey identified such instances where the procedure was not being followed. These instances are discussed in Finding 1 in Section 4.1.2.2 and Finding 2 in Section 4.1.2.4.

Building 306 (Figure 4-1) is the focal point for WMO at ANL. In Building 306, hazardous wastes that are accepted by WMO are either treated on-site or made ready for shipment off-site. If hazardous wastes can be treated to make them nonhazardous, there are several pretreatment alternatives available. These alternatives are as follows:

1. Flocculation Tank, Building 306 - Treatment is provided to remove the RCRA corrosivity characteristic D002 for batch quantities of corrosive liquids and may be used to react chemical solutions to change their valence state. This is a RCRA-permitted facility.

2. Reaction Tank, 317 Area (Figure 4-1) - Treatment is provided to react water-reactive chemicals such as alkali metals to remove their RCRA D003 water-reactive characteristic. It is a permitted facility under RCRA.

3. Shoot-and-Burn Facility, 317 Area (Figure 4-1) - Treatment is provided to react shock-sensitive waste such as outdated ethers by shooting these wastes with a high-powered rifle. This facility is not a permitted facility under RCRA and has not been used for 2 years. However, RCRA approvals have been requested and, if approvals are received, it will be relocated to the 319 Area where treatment can be initiated.

Wastewater generated in the 317 Area reaction tank is hauled by truck to Building 306 (WMO) and is treated/disposed of according to contaminant concentrations. This could involve discharging the wastewater to the laboratory sewer system at Building 306.

If hazardous wastes cannot be treated on site, they are prepared for off-site treatment or disposal by WMO personnel. Identified hazardous wastes transported to the WMO facility in small containers and in bulk 5 gallon containers are initially

received in Room C-157 of Building 306 for temporary storage. Waste is segregated in this room using the chemical information provided by the generator. The WMO staff then either open-pours the compatible chemicals into a larger bulk container until full or places the small individual containers into labpacks. During the open-pouring waste transfer operation in the waste transfer room of Building 306, the solvent odors were perceived to be sufficiently high such that the Survey team deemed it unsafe to proceed without respiratory protection. No respiratory protection was used by the WMO staff during the pouring operation.

Other identified hazardous wastes in ANL-approved 30- or 55-gallon drums that are received by WMO in good condition are either temporarily stored on open concrete floor areas within Building 306 or are sent to Building 325A (Figure 4-1) for storage until they are shipped off-site. Generators are responsible for recontainerizing waste into correct containers as necessary according to the 1986 WHP. ANL has utilized as many as eight EPA-approved treatment and disposal facilities for its hazardous wastes.

Suspected hazardous wastes that cannot be identified by the waste generator or the WMO staff are placed into the unknown waste storage room (C-157) within Building 306 to await analysis.

Area C in Building 325 (Figure 4-1) is used for the storage of polychlorinated biphenyl (PCB)-contaminated solid or liquid wastes. PCB wastes are not defined as hazardous under RCRA; however, a high level of human and environmental protection from PCBs is required under the Toxic Substances Control Act (TSCA). The waste management procedures for PCBs are discussed in Section 4.2.1.2.

Two Alkali Metal Reaction Booths are located in Buildings 206 and 308, respectively, and are operated by the Reactor Analysis and Safety Division and the Material and Component Technology, respectively. These facilities are used to remove sodium contamination from metal parts and they generate waste aqueous sodium hydroxide. The clean metal parts are reused elsewhere at ANL, and the wastewater flows to an underground retention tank. When this tank is full, the wastewater is pumped to an aboveground tank. WMO pumps out the aboveground tank and hauls the wastewater to Building 306, where it is treated/disposed of according to contaminant concentrations. Atmospheric emissions from these facilities are

discussed in Section 3.1.2.1. ANL has requested RCRA permit exemptions for these facilities. EPA approval of the exemptions is anticipated since these booths do not meet the RCRA definition of hazardous waste thermal treatment facilities.

4.1.1.2 Mixed Waste

DOE regulation 10 CFR Part 962, May 1, 1987, states that DOE-produced mixed waste (radioactive wastes that contain hazardous chemicals as specified under RCRA) will be subject to regulation under both RCRA and the Atomic Energy Act (AEA). A major source of mixed waste at ANL is scintillation cocktail vials, which are used in radiation detection instruments. Radioactive materials are introduced into the scintillation fluid, which is a solvent mixture containing mostly xylene, and the resultant low-level radioactive material/solvent mixture "cocktail" is analyzed by the detection instrument. Each vial contains approximately 10 to 20 milliliter of solution. Building 329 as shown on Figure 4-1 has space to store 330 drums of scintillation cocktail vials with each drum containing approximately 2,000 vials. Approximately 75 drums are currently in storage.

Building 306, Room C-157, is used to store other aqueous solutions of mixed wastes. These wastes either have corrosive characteristics or contain solvents. Sixty-four gallons of corrosive liquids were stored in Room C-157 at the time of the Survey. Additionally, Building 306, Room C-131, had approximately 6 pints of radioactively contaminated trinitrotoluene, stored under refrigeration at the time of the Survey. Building 329 also stores eight 15-gallon drums that contain radioactively contaminated sodium that has been reacted in butyl alcohol.

WMO is also collecting radioactively contaminated lead as a mixed waste. Radioactively contaminated lead bricks and shielding posts are currently being stored outdoors on unprotected pallets on asphalt behind Building 306. Some of this lead is encased in steel, making it impossible to ascertain whether the lead is radioactively contaminated without removing the steel encasement.

Another potential mixed waste at ANL is the sludge generated from the drying beds of the laboratory wastewater treatment plant. Although both radioactive and hazardous constituents may be discharged to the laboratory sewer, results of EP toxic analyses of the sludge performed by ANL have historically been below

minimum hazardous concentrations. Radioactivity analyses of the sludge performed by ANL have detected low levels of radioactive contamination. Since the sludge has been determined to be radioactive but not toxic, it has been identified as a low-level radioactive waste. The sludge has subsequently been transported to the Idaho National Engineering Laboratory (INEL) for disposal.

The decontamination and decommissioning (D&D) of inactive facilities represents another potential mixed waste source. ANL has demolished numerous buildings in the East Area and at other locations throughout the site as discussed in Section 4.5. The inactive reactor CP-5 will also require D&D. Radiation has been the only focus of concern; however, chemical usage occurred in these buildings and, as a result, any waste may require disposal as a mixed waste.

Since May 1982, there are no longer any approved facilities to treat or dispose of mixed wastes, and as a result the site is storing these materials indefinitely.

4.1.1.3 Radioactive Waste

ANL has three types of radioactive waste – low-level, high-level, and transuranic (TRU) wastes. Low-level wastes are those radioactive wastes not classified as intermediate-level, high-level, or TRU waste, spent nuclear fuel, or by-product material. High-level waste is defined to be the highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid that contains a combination of TRU waste and fission products in concentrations sufficient to require permanent isolation. TRU waste is radioactive waste contaminated with alpha-emitting transuranium radionuclides with half-lives longer than 20 years and concentrations greater than 100 nCi/g, regardless of source or form according to DOE Order 5820.20. High-level, TRU, and low-level wastes generated at ANL are discussed below.

High-Level Wastes

Historical high-level wastes produced at ANL have generally been in the form of irradiated reactive fuel. The fuel from six inactive ANL reactors (CP-1, CP-2, CP-3, CP-

5, EBWR, and Juggernaut) was removed and sent to other DOE facilities for storage and processing.

High-level waste is currently generated in the Alpha-Gamma Hot Cell Facility (AGHCF) from the processing of irradiated fuel from other DOE reactors. This waste is packaged by AGHCF personnel and returned to the site of origin.

TRU Waste

During the Survey, the AGHCF, located in Building 212, was the only generator of TRU wastes at ANL. The facility generates about 7 cubic meters per year of remotely-handled TRU waste. It is packaged at the AGHCF in accordance with the Waste Isolation Pilot Plant (WIPP) waste acceptance criteria certification plan and is shipped in shielded containers to the INEL via common carrier for later disposal at the WIPP. There are 125 30-gallon drums of TRU-RH (Remote Handled) wastes stored in the vaults at the 317 Area awaiting shipment to the INEL. The drums have surface radiation levels between 500 mrem/hr and 30 rem/hr and contain a total of 50.63 grams of plutonium (90 percent plutonium-239, 10 percent plutonium-240) and 90.8 grams of uranium-235. ANL did not ship any TRU-RH waste to the INEL in 1986.

Six more 55-gallon drums of TRU-CH (Contact Handled) waste were in storage during the Survey in the 317 Area awaiting shipment to the INEL. The six drums have a total of 25.65 grams of uranium-233 and 1,490 grams of thorium-232 contained in a cement matrix. Each drum contains internal lead shielding to lower the surface radiation levels to below 200 mrem/hr and weighs approximately 1,450 pounds. ANL shipped 1,800 cubic feet of TRU-CH to the INEL in 1986.

Low-Level Wastes

Low-level wastes are managed at ANL using many of the same procedures as are adopted for hazardous wastes, described in Section 4.1.1.1. The waste generator is responsible for minimizing, identifying, segregating, packaging, and labeling low-level wastes. An additional level of protection is integrated in the low-level waste management system in that each major building or operating unit has a health

physicist assigned to survey the waste before it is collected and transferred to the WMO facility at Building 306.

Separate requisition forms and labels are used to segregate radioactive from nonradioactive wastes. The labeling for radioactive waste segregates the waste into Combustible-TRU, Non-Combustible-TRU, Combustible-Non-TRU, and Non-Combustible Non-TRU.

ANL attempts to segregate all radioactively contaminated wastewater from its radioactively uncontaminated laboratory wastewater. In buildings where radioactive materials are used, wastewater is collected in retention tanks and analyzed for radioactivity before being discharged into the laboratory sewer. If the contents of a retention tank are radioactively contaminated above levels specified in Table 3-12, WMO staff can pump out the tank and transfer the contents by truck to Building 306 for treatment. Even though ANL places strict controls on the discharge of radioactively contaminated wastewater into the laboratory sewers, some low-level radioactive materials are discharged to the laboratory sewer and accumulate in the sludge drying beds at the laboratory wastewater treatment plant (Building 575). Because of this, the sludge is handled as a low-level waste and has historically been shipped to the INEL for disposal. The last time the drying beds were cleaned was in 1982. However, cleaning was scheduled for the summer of 1987. Additional discussion on the sludge drying beds was provided in Section 4.1.1.2.

Approximately 10,000 gallons of radioactively contaminated liquid wastes are collected at ANL per month. They are normally accumulated in small (5-gallon) containers in the various laboratory areas and on request, are collected and transferred to Building 306 for treatment. Treatment involves evaporating the water to increase the solids content. The solids are mixed with absorbents to control the free liquid and the resulting mixture is drummed for shipment to the INEL. ANL shipped 10,800 cubic feet of low-level solid waste to the INEL in 1986. Approximately 6,480 cubic feet of low-level solid waste presently is stored in bins at the 317 Area. Certain low-level solid wastes are baled at the 317 Area to reduce the volume for shipment.

4.1.1.4 Nonhazardous Waste

ANL staff collects nonhazardous wastes throughout the Laboratory property. The annual waste-generation for 1986 is summarized in Table 4-3. Each building has an 8-cubic-yard dumpster box outside to accumulate the nonhazardous waste from the building. The dumpster boxes are padlocked at buildings managing radioactive materials. A health physicist controls the key for the lock and surveys all nonhazardous wastes for radioactivity before they are deposited in the dumpster. The health physicist does not control chemical waste that might inadvertently be deposited in the dumpster. However, if any were found it would be removed and disposed of in accordance with the 1986 WHP. Other nonhazardous wastes, such as waste from the boiler house, construction debris, and sewage sludge, are hauled directly to the landfill by truck.

Most nonhazardous wastes at ANL are disposed of in the 21.78-acre on-site 800 Area Landfill. ANL began construction of the 800 Area Landfill in 1966 and first utilized it in 1968. Its expected remaining useful life is 13 years based on current waste generation rates. Between 1969 and 1978, a vertical French drain at the landfill was used for disposal of hazardous waste, waste oil, and PCBs. Detailed information regarding the use of the French drain is discussed in Section 4.5.1. ANL filed a permit application for the 800 Area Landfill with the Illinois Environmental Protection Agency on March 6, 1981, and received an operating permit on September 17, 1981.

At least 10 feet of clay having a permeability not greater than 1×10^{-7} cm/sec is required by IEPA to underlie sanitary landfill sites (STS, 1980). The purpose of this clay layer is to prevent leachate from migrating from landfills to the subsurface environment. The 800 Area Landfill is located in a natural deposit of clay that is reported to have a vertical permeability of about 1×10^{-8} cm/sec. However, it does not have leachate collection and treatment systems.

ANL also uses a small on-site water-filled pit for disposal of nonhazardous waste. The pit was originally excavated for the foundation of the Argonne Advanced Research Reactor (A^2R^2) as described in Section 3.3.1. The reactor was never built, and the pit has been used since 1982 for the disposal of concrete rubble, asphalt,

TABLE 4-3

ANNUAL NONHAZARDOUS WASTE GENERATION FOR 1986

Type	Annual Quantity (cu. ft.)
Office, cafeteria and food service	6,000
ANL Central Boiler House Bottom ash and flyash Limestone grit	 1,400 190
Experimental coal combustion scrubber sludge	4
Animal care wastes and animal carcasses	25
Construction debris	12,000
Sewage sludge	25
Asbestos	45
Total	19,689

and reinforcing rods from various D&D and construction projects. The amount of waste in the pit is unknown; however, it is approximately half full.

Asbestos removal is required as part of most demolition or reconstruction projects of older ANL buildings and facilities. Prior to 1987, asbestos was placed randomly throughout the landfill as it was generated. However, in 1987 ANL established a special area in the 800 Area Landfill for disposal of asbestos. Asbestos waste generation fluctuates based on the number of ongoing projects. Available records indicate the following yearly amounts:

Year	Amount
1983	1180 cu ft
1984	615 cu ft
1985	1462 cu ft
1986	926 cu ft
to June1987	2000 cu ft

Because of future D&D projects and large reconstruction projects, the amount of asbestos waste to be removed in the next few years is expected to increase. Asbestos control procedures are discussed further in Section 4.2.1.3.

4.1.2 Findings and Observations

4.1.2.1 Category I

None

4.1.2.2 Category II

1. Improper hazardous waste segregation. Some hazardous waste generators are not segregating hazardous wastes for shipment to the WMO facility in Building 306 in accordance with the ANL 1986 WHP. Improperly segregated hazardous wastes may result in a chemical fire or explosion, thereby releasing hazardous emissions into the atmosphere or discharges into the soil and surface water.

In Building 200, Room 182, three boxes of unsegregated hazardous wastes were found ready for collection and transportation to Building 306. The boxes held various containers, including bottles, metal cans, and glass-stoppered flasks. The flasks were not sealed and were subject to leakage. The waste containers held toxics, explosives, combustibles, and possible carcinogenic wastes as identified on the accompanying inventory sheet. However, many of the chemicals were listed by generic name only and some containers did not have labels, thereby resulting in the WMO group's inability to effectively segregate the waste.

In addition, 35 boxes of potentially hazardous wastes were transported to Building 306 from the plastics shop in Building 362. Many of the chemicals were listed by generic name only, some of the containers were not labeled, and Material Safety Data Sheets were not available for all waste chemicals identified on the accompanying inventory sheet, again making effective waste segregation difficult. Many of the wastes were solvents and hardeners commonly used in the plastic shop. A container in one of the 35 boxes had leaked and saturated the cardboard box.

This finding is closely related to Finding 2 in Section 4.1.2.4 regarding identifying, packaging, and labeling hazardous wastes.

2. Toxic wastes discharged to the laboratory sewer. Waste generators may be discharging toxic wastes to the laboratory sewer in quantities exceeding RCRA regulatory limits.

An unknown quantity of laboratory wastewater is poured down the laboratory sinks in several buildings, including Buildings 200, 202, 205, and 211, and subsequently discharged to the ANL laboratory sewer system as described in Finding 1 of Section 3.3.4.3. These laboratories may be releasing toxic wastes to the sinks in quantities exceeding the RCRA regulatory limits established in 40 CFR 261.3(a)(2)(iv)(E). For ANL, which processes approximately 400,000 gallons of laboratory wastewater per day, the annualized average flow limits are established at no more than 4,000 gallons

per day of toxic wastes at an annualized average concentration of less than one part per million.

During the Survey, laboratory sinks and fixtures in some facilities were found to be severely corroded and stained, indicating possible discharges of various chemicals. Also, many laboratories have no available liquid waste containers to collect potentially toxic wastewaters generated within the laboratories.

Although all material released through the laboratory sinks goes to retention tanks for radionuclide screening prior to release to the laboratory sewer (see Finding 3 in this section). The toxic chemical component of the wastewater is not assessed and ANL cannot demonstrate if, and at what levels, potentially toxic wastewaters are being released to the laboratory sewer.

3. Building 575 sludge may be a mixed waste. Low-level radioactive wastes may be contaminated with hazardous wastes in the laboratory wastewater treatment plant sludge drying beds near Building 575, posing a regulatory mixed waste concern.

Finding 1 in Section 3.3.4.3 and Finding 2 in this section identified the potential use of the laboratory sinks for the disposal of liquid hazardous wastes. These wastes may enter retention tanks in various buildings and be discharged through the laboratory sewer and treatment plant to Sawmill Creek. As described in Finding 1 of Section 3.3.4.2, the laboratory wastewater treatment plant is not designed to remove all these wastes. The solids from the treatment plant are spread out in drying beds, removed periodically, and finally disposed of at the INEL. Even though the contents of the retention tanks are surveyed for radioactivity before discharge to the laboratory sewer and are judged to be "radiation free," radioactive materials accumulate in the sludge and therefore the sludge is managed as a low-level waste.

The sludge may, however, be a mixed waste, as both radioactive and hazardous wastes may be accumulating in the sludge in sufficient concentration so as to pose a regulatory concern. The sludge will undergo sampling and analyses by the Environmental Survey to determine the presence of organic, inorganic, and radioactive contaminants.

4.1.2.3 Category III

1. Heavy metal contamination by flue-gas scrubber water. Leaking flue-gas scrubber water from an impoundment near Building 145 may be contaminating the underlying soil and groundwater with heavy metals and sulfates.

   Coal combustion flue-gas scrubber water is being recirculated from a membrane-lined impoundment to scrub contaminants from the flue gas. The same water, with whatever makeup water is necessary to replace that lost to leakage and evaporation, has been in use for approximately 5 years. The impoundment was not designed to discharge water. However, the soil around the impoundment is saturated due to suspected leakage through the membrane liner.

   The scrubber water may be contaminated with heavy metals and sulfates due to the removal of these substances from the flue gas. Since the soils were saturated, there may be a sufficient driving force to move the contaminants, if present, toward the groundwater.

   Since the flue-gas scrubber water has not been chemically analyzed, the Environmental Survey will conduct sampling and analysis of the impoundment's water and the surrounding soil to determine the presence of contaminants.

2. Hazardous wastes at the shoot-and-burn facility. Reactive waste residues and solvents at the shoot-and-burn facility in the 317 Area may have contaminated the soil.

   Reactive wastes (e.g., sodium metal, sodium-potassium metal, butylperoxide and butyllithium), stored in individual containers of solvents such as hexane, cyclohexane, kerosene, and mineral oils, were brought to the 317 Area and placed along the eastern edge of a sand pile. A security marksman used a nearby picnic table as a shooting stand and fired bullets into the reactive

wastes, exposing them to air. The reactive wastes burned or exploded, leaving the combustion residues in the sand pile.

This practice occurred for many years at this location; however, it was discontinued about 2 years ago pending the issuance of an EPA RCRA permit to relocate the shoot-and-burn facility to the 319 Area.

The shoot-and-burn facility is exposed to rain, and no controls are utilized to collect any seepage from the sand pile. Depending on the efficiency of the combustion and, therefore, the amount of residues left in the pile, contaminants may be leaching from the pile into the surface soils. The Environmental Survey will conduct sampling and analyses at the shoot-and-burn facility in the 317 Area to determine the presence of soil contamination.

3. Soil contamination in a lead storage yard. There is a potential for lead contamination of surface and subsurface soils between Buildings 378 and 382 and behind Building 306.

The area between Buildings 378 and 382 has been used for the last 20 years to store lead shielding and other recoverable lead materials. Currently there are three pallets partially filled with lead sheet-metal rolls and lead sheet and seven drums of lead wool. The area is exposed to rain and it is possible that lead may have accumulated in the soils. In the past, this area was used more actively than is reflected by current activities. The Environmental Survey will conduct sampling and analyses on the surface soils to determine the presence of lead.

Radioactively contaminated lead bricks were also found during the Survey to be stored in the open behind Building 306. Although the lead is stored on asphalt, runoff could carry contaminants to the nearby drainage area.

4. Contamination from the 800 Area Landfill. The active 800 Area Landfill may be releasing inorganic, radioactive, and organic contaminants into the soil, groundwater, and surface water.

The 800 Area Landfill has received a variety of wastes over its years of operation, as discussed in Sections 4.1.1.4 and 4.5.1, and in Finding 1 of Section 4.5.2.3. Results of routine ANL Sampling and Analysis from the 13 active 800 Area Landfill glacial till monitoring wells (Section 3.4.3.4) show levels of arsenic in 2 wells and manganese in 10 wells at concentrations that exceed Federal and state drinking water standards. In addition, tritium in concentrations ranging from 2 to 5 times background and possibly resulting from inadvertent disposal of radioactive material into the landfill has been found in 4 of the wells (Golchert and Duffy, 1987).

Although a link between the identified contaminants in the monitoring wells and the landfill has not been established, the data suggest that the landfill may be releasing these and potentially other contaminants which are not monitored, as discussed in Finding 1 of Section 3.4.4.3, to the glacial till groundwater. Contaminants which may be present in the landfill could also migrate through the soils and the glacial till groundwater to the deeper dolomite aquifer which underlies the ANL. Additionally, surface runoff and leachate from the landfill, which are not collected and treated, may contain contaminants that could degrade the nearby surface water.

4.1.2.4 Category IV

1. Inadequate space to segregate hazardous wastes. Inadequate space for segregating hazardous wastes at Building 306 could result in improper waste handling and represents a safety hazard.

   Building 306, Room C-157, the hazardous waste receiving room, and the "unknown" waste storage room, Building 306, Room C-131, appear to the Survey team to be too small to effectively segregate and store the volume of incompatible wastes processed through these rooms. Radioactive, toxic, explosive, combustible, reactive, and carcinogenic wastes are stored next to one another. There is no emergency exit from these rooms and the ventilation system is inadequate to service these rooms.

2. Inadequacies of identifying, packaging, and labeling hazardous wastes. Hazardous waste generators, in general, are not identifying, packaging, and

labeling hazardous waste for shipment to the WMO facility in accordance with the ANL 1986 WHP.

Waste generators do not keep accurate records of the wastes that are placed in bulk waste containers. In a multiple-user laboratory, many researchers may use the same waste containers. Since the waste containers are not specifically labeled, there is ample opportunity to mix incompatible wastes. Also there is generally no attempt to "characterize" the waste in the containers until the containers are full. At this point, the PFS-197 "Chemical Waste Disposal Requisition" form must be completed so that the WMO staff can collect the waste. For the most part, an estimate of the waste content in the containers is made based on the "best guess" of the waste generators as to what chemical materials were used to conduct the research. Based on this "best guess," WMO staff members make decisions on what method of treatment or disposal is best suited for the hazardous waste; methods include sending the waste to the 800 Area Landfill.

No analytical laboratory support is provided to the researcher to even broadly characterize the wastes to determine if they are corrosive, ignitable, reactive, or toxic. The WMO laboratory in Building 306 is not capable of performing these tests. Although a flash point tester was bought a year ago, it has not been used. Two commercial analytical laboratories that could perform these tests are under contract to WMO. However, these laboratories have not been used since August 1986 and are not generally available for use by the waste generators. In cases where the researchers are discarding outdated chemicals in the original containers, lack of analytical support does not appear to be a problem. However, many of the chemicals are in poor condition and the labels are illegible, such that visual identification is not possible, as discussed in Section 4.1.2.2, Finding 1.

After the waste generator identifies the hazardous waste, the 1986 WHP requires that the waste be placed in a proper container to prevent spillage or breakage and that the container be properly labeled and identified with the "Chemical Waste Disposal Requisition" form identification number. As discussed in Section 4.1.2.2, Finding 1, hazardous wastes are not adequately labeled and packaged for shipment to Building 306.

3. Inadequate hazardous waste management training. ANL waste generators have not been fully trained to manage hazardous waste for shipment to Building 306. This lack of knowledge poses a potential safety and health hazard and may result in an accidental release of contaminants to the environment.

During interviews with the ANL staff, some members were unfamiliar with the content of the 1986 WHP and others did not know that the procedure existed. This is evident, considering the problems identified in Findings 1 and 2 in Section 4.1.2.2 and Finding 2 in this section.

4.2 Toxic and Chemical Materials

This section discusses the pollution sources and controls associated with toxic and process chemicals, polychlorinated biphenyls (PCBs), asbestos, herbicides, pesticides, and aboveground storage tanks (ASTs) and underground storage tanks (USTs) at ANL.

4.2.1 General Description of Pollution Sources and Controls

4.2.1.1 Toxic and Process Chemicals

The Materials Supply Division (MSD) of ANL is located in Buildings 4, 5, 6, 26, 27, and 28 in the East Area (Figure 2-2). Building 4 houses administrative offices, electronic component storage, new and used uniform storage, and replacement hardware. Building 5, Stores and Receiving, houses the materials receiving and shipping areas, temporary chemical storage, and nonprocess chemical inventories (such as cleaners, photo developers, etc.). Building 6 houses bulk chemical and reagent chemical (such as sulfuric acid, solvents, and small-quantity specialty chemicals) stores. Buildings 26, 27, and 28 are used for storage of compressed gas, solvents, and flammable materials.

ANL employs the Automated Materials Payable System (AMPS) and a companion system, the Stock Tracking System (STS), for inventory tracking and control. The systems are not set up to track or inventory individual classes of materials such as toxic or hazardous chemicals; rather, they provide information on individual purchase orders and materials in Stores. All materials purchased by ANL are tracked by the AMPS and it is possible to determine the quantity of toxic and hazardous materials received annually but only after retrieving information on the individual materials and manually summing the totals. The STS provides detailed information on materials in Stores and on distribution of those materials.

Requisition of materials is accomplished by two methods. The Procurement Department handles requests for non-stock items in Stores and screens requisitions for restricted materials. The MSD issues requisitions for standard stock items. The Procurement Department receives the requisitions for all material purchases and issues the purchase orders. The orders are then entered into AMPS. The MSD

Procedures Manual details procedures to be followed for receiving, distribution, and storage of material. The procedures include emergency response measures for material spills and releases during receiving and storage.

Incoming shipments are inspected for damage at Building 5 and the contents are checked against the corresponding purchase order to verify a complete shipment. The materials go either to temporary storage in Building 5 or 6 to await transfer to the requisitioner or are sent directly to Stores. There have been accidents and spills in Building 5 during receiving operations, but none have been large enough to reach the outside environment, and they have been quickly cleaned up. However, records of the accidents and spills have not been kept.

Transfer of material from temporary storage to the requisitioner is done by riggers from Plant Facility Services (PFS). Before being transferred, the material may stay in temporary storage for as long as 6 days. Materials labeled as radioactive are monitored by Industrial Hygiene (IH) personnel and are transferred to the requisitioner by the Special Materials Division.

Chemical Stores is located in Building 6, which is of Quonset hut construction with concrete floors. The building was previously used for vehicle repair and maintenance. Drain troughs running the length of the building have been backfilled with concrete, and area drains at the ends of the troughs have been plugged. No additional containment was noted during the Survey, even though six 55-gallon drums of tetrachloroethylene and several drums of trichlorofluoromethane (Freon) were stored inside the building. A small storage yard outside Building 6, which had a security fence but no roof or spill containment, held approximately 200 gallons of concentrated sulfuric acid in plastic drums, ten 55-gallons steel drums of hydraulic oil, and several gas cylinders, some labeled "acetylene", that were reported to be empty. The security fence was not labeled as to the contents of the drums and cylinders.

Compressed-gas cylinders of various gases are stored in Building 26, which is of cinder block construction with a concrete floor. The building has nonmechanical roof ventilation and a sprinkler system. Solvent Stores is located in Building 28, which is of cinder block construction with a concrete floor. Several floor drains with

small openings are located throughout the facility. These drains connect to the sanitary sewer system, which is described in detail in Section 3.3.2.2.

Flammable Stores is located in Building 27, which is of cinder block construction with a concrete floor. Survey team members noted an odor of ether as they entered the facility. Chemicals in the building include diethyl ether, petroleum ether, and sodium metal.

The Occupational Health and Safety Division conducts training and instruction of Chemical Stores employees about twice yearly, including information on storage of flammable materials.

Material Safety Data Sheets (MSDSs) for chemicals and materials in all of the Stores are kept by IH personnel in L-Wing of Building 200. New MSDSs are supplied to ANL whenever new information concerning the particular material is available. A computer listing of the MSDSs in Building 200 is available to all MSD personnel.

4.2.1.2 Polychlorinated Biphenyls

There are 77 PCB transformer units in operation at ANL; 36 units are located in the 200 Area, 27 in the 300 Area, and the remainder in the East and 800 Areas. Summaries of these units and potential environmental problems are presented in Tables 4-4 through 4-7. Thirty of the units in the 200 Area are located on the bottom level or service floors of various buildings and contain over 100,000 parts per million (ppm) PCBs (Table 4-4). These units rest on concrete floors but are not equipped with concrete containment dikes. Several units are located near open floor drains or other points of access to the environment; sandbags have been placed around the transformers to protect against release of PCBs to these drains. All the units inside buildings were labeled but units in Buildings 221 and 203 did not have access routes labeled. Combustible materials (scrap lumber, wooden ladders, carpets, sandbags, etc.) were located within 5 meters at 24 of the 30 unit locations on the service floors of buildings in the 200 Area. Six PCB transformers in the 200 Area are outside buildings (Table 4-4), mounted on concrete pads on an apron of loose gravel above the soil, with concrete containment curbs surrounding the apron. Scrap lumber had been piled on the containment curb of two of these exterior units and another had its marking label painted over during a recent

TABLE 4-4

200 AREA PCB TRANSFORMERS AT ANL

Building #	Unit	Serial #	Active or Storage	Interior or Exterior	Amount of PCBs (kg)	Combustibles Within 5 Meters	Inadequate Containment	Inadequate Labeling of Transformer	Inadequate Labeling of Access Area	Comments
202	C	ITE-8765-61	Active	Interior	1579	•				
202	C-SW	G&W-A832-5A	Active	Interior	132	•	•			
202	A	AC-1882838	Active	Interior	1692	•	•			Apparent leak
202	A-SW	AC-1882838	Active	Interior	132	•	•			
202	B	AC-1882237	Active	Interior	1692	•	•			No containment
202	B-SW	AC-1882237	Active	Interior	132	•	•			No containment
221	A	GE-E689859A	Active	Interior	978	•			•	
221	A-SW	GE-E689859A	Active	Interior	132	•			•	
221	B	GE-E689859B	Active	Interior	978	•			•	
221	B-SW	GE-E689859B	Active	Interior	132	•			•	
203	B	AC-1848711	Active	Interior	1692	•	•		•	Exterior exit door, no curbing
203	C	ITE-8766-61	Active	Interior	1579	•	•		•	Exterior exit door, no curbing
203	C-SW	G&W-A8327	Active	Interior	113	•	•		•	Exterior exit door, no curbing
203	A	AC-1848710	Active	Interior	1579	•	•			Sandbags
203	A-SW	AC-1848710	Active	Interior	27	•	•			Sandbags
208	A	AC-1848705	Active	Interior	1692	•	•			Sandbags
208	B	AC-1848619	Active	Interior	1147	•	•			Sandbags
208	B-SW	AC-1848619	Active	Interior	31	•	•			Sandbags
206	A	AC-1848707	Active	Interior	1692	•	•			Sandbags
206	A-SW	AC-1848707	Active	Interior	10	•	•			Sandbags

TABLE 4-4

200 AREA PCB TRANSFORMERS AT ANL (Continued)

Building #	Unit	Serial #	Active or Storage	Interior or Exterior	Amount of PCBs (kg)	Combustibles Within 5 Meters	Inadequate Containment	Inadequate Labeling of Transformer	Inadequate Labeling of Access Area	Comments
200	A	AC-1858036	Active	Interior	1692	•	•			Sandbags
200	A-SW	AC-1858036	Active	Interior	132	•	•			Sandbags
200	C	ITE-8764-61	Active	Interior	1579	•	•			Sandbags
200	C-SW	G&W-A8326	Active	Interior	132	•	•			Sandbags
211	A	AC-1858040	Active	Interior	1579	•	•			Sandbags
211	A-SW	AC-1858040	Active	Interior	113	•	•			Sandbags
205	B	AC-1858039	Active	Interior	1579					
205	B-SW	AC-1658039	Active	Interior	132					
205	A	AC-1858038	Active	Interior	1579	•	•			Sandbags
205	A-SW	Ac-1858038	Active	Interior	132	•	•			Sandbags
205	D	GE-15962713	Active	Exterior	1654	•	•		•	
212S		AC-3237045	Active	Exterior	1.2	•	•		•	No label on fence
212S		AC-3237046	Active	Exterior	0.7	•	•		•	No label on fence
212S		AC-3237043	Active	Exterior	0.5	•	•	•	•	
205		GE-E686888	Active	Exterior	0.1		•		•	No label on fence, no curbing
200		ITE-883062	Active	Exterior	0.1		•		•	No label on fence, no curbing

Source: ANL 1987 Annual PCB Transformer List

TABLE 4-5

300 AREA PCB TRANSFORMERS AT ANL

Building #	Unit	Serial #	Active or Storage	Interior or Exterior	Amount of PCBs (kg)	Combustibles Within 5 Meters	Inadequate Containment	Inadequate Labeling of Transformer	Inadequate Labeling of Access Area	Comments
330	B	ESCO-10233332	Active	Exterior	5.1		•		•	No curbing
306		Moloney-1754284	Active	Exterior	0.08	•	•		•	No curbing, wooden ladder
306		Moloney-1754293	Active	Exterior	0.07		•		•	No curbing
3705	US-32	AC-4183094	Active	Exterior	895		•		•	No curbing
370	US-46	AC-5272257	Active	Exterior	1617		•			No curbing
370W	TX-10	West-6996339	Active	Exterior	16		•		•	No curbing
370W	TX-8	West-6996341	Active	Exterior	2.7		•		•	No curbing
375S	US-22	ITE-21748-AO1	Active	Exterior	1716		•			Elevated metal grating floor
375S	US-30	AC-4320-760	Active	Exterior	2640		•			Elevated metal grating floor
375E	US-40	GE-F96271413	Active	Exterior	677		•		•	No curbing, next to area drain
375E	US-42	West-YBR-98471	Active	Exterior	1617		•		•	No curbing
375	US-50	ESCO-10233527	Active	Exterior	3670	•	•			Open drain, wooden ladder, and pallets within enclosure
311		GE-B339002	Active	Exterior	0.20		•		•	No curbing
335	TC	GE-B341891	Active	Exterior	0.476		•		•	No curbing
335	TE	GE-B341893	Active	Exterior	0.42		•		•	No curbing
335	TW	GE-B340299	Active	Exterior	0.15		•		•	No curbing
368		ITE-9077-62	Active	Exterior	0.12		•	•	•	Label cannot be seen from outside of fence
368		AC-3406945	Active	Exterior	1.5		•	•	•	Label cannot be seen from outside of fence

TABLE 4-5

300 AREA PCB TRANSFORMERS AT ANL (Continued)

Building #	Unit	Serial #	Active or Storage	Interior or Exterior	Amount of PCBs (kg)	Combustibles Within 5 Meters	Inadequate Containment	Inadequate Labeling of Transformer	Inadequate Labeling of Access Area	Comments
377		ITE-7875-60	Active	Exterior	0.71		•		•	No curbing
366N	US-33	West-PBY-1444-01	Active	Exterior	2030		•			Elevated metal grating floor
366S	US-34	West-PBY-1433-01	Active	Exterior	2027		•			Elevated metal grating floor
369	US-24	Niagara-30627	Active	Exterior	0.15	•	•		•	No curbing, cardboard under unit
369N	US-23	West-YBR-91551	Active	Exterior	1560		•			Elevated metal grating floor
364		ITE-7879-61	Active	Exterior	2.7		•	•		Concrete pad shifting, label not visible from outside fence
363	TX-7	West-6890816	Active	Exterior	16488		•			Located about 2 ft. from office building
362	US-45	AC-570250	Active	Exterior	1617		•			Located about 1 ft. from office building
350		Standard - 128250	Active	Exterior	0.18				•	No curbing

Source: ANL 1987 Annual PCB Transformer List

TABLE 4-6

EAST AREA PCB TRANSFORMERS AT ANL

Building #	Unit	Serial #	Active or Storage	Interior or Exterior	Amount of PCBs (kg)	Combustibles Within 5 Meters	Inadequate Containment	Inadequate Labeling of Transformer	Inadequate Labeling of Access Area	Comments
4W	US-6	GE-9252195	Active	Exterior	<0.01		•		•	No curbing
5		GE-B324466A	Active	Exterior	0.05	•			•	Wooden structure
28		West-4612278	Active	Exterior	0.03		•		•	No curbing
544		GE-B499615	Active	Exterior	0.91		•		•	No curbing
544		GE-B314624	Active	Exterior	0.91		•		•	No curbing
546		GE-7568058	Active	Exterior	3.7		•	•	•	No curbing, no label on unit
40		GE-9247062	Active	Exterior	0.01	•	•		•	Plywood within 5 m, no curbing
108	US-35	AC-5702508	Active	Exterior	161	•				Railroad tie wall
108	TRAN2	AC-1882236	Active	Exterior	24	•		•	•	Wooden support railing
108	TRAN1	AC-1858041	Active	Exterior	20	•	•			Wooden support railing
583		GE-E686028	Active	Exterior	0.68		•			No curbing

Source: ANL 1987 Annual PCB Transformer List

TABLE 4-7

800 AREA PCB TRANSFORMERS AT ANL

Building #	Unit	Serial #	Active or Storage	Interior or Exterior	Amount of PCBs (kg)	Combustibles Within 5 Meters	Inadequate Containment	Inadequate Labeling of Transformer	Inadequate Labeling of Access Area	Comments
548		AC-1852463	Active	Exterior	0.21		•		•	No curbing, fence not labeled
548		AC-2373754	Active	Exterior	0.24		•		•	No curbing, fence not labeled
548		AC-1852462	Active	Exterior	0.17		•		•	No curbing, fence not labeled

Source: ANL 1987 Annual PCB Transformer List

maintenance operation. Not all the access routes to these exterior units were labeled. Nearly all 200 Area transformer units indicated in Table 4-4 were in good condition. However, Unit A in Building 202 had an apparent leak but it was contained.

The 27 PCB transformers in the 300 Area, as identified by the 300 series building numbers (Table 4-5), were all exterior-mounted with 5 units on elevated platforms. All the ground-level units were mounted on concrete pads with aprons of loose gravel over soil. Security fences were in place for all the ground-level units with the exception of Unit B outside Building 330. The elevated units were accessible by ladder. All units in the 300 Area were labeled but three had labels that were not visible from outside the security fence. Fences for most of the units were not labeled. The elevated platforms that held transformers were labeled at ground level. The 300 Area transformer units were in good condition with very little rust or corrosion. No leaking units were detected in the 300 Area.

Eleven PCB transformers are located in the East Area (Table 4-6). All are exterior, ground-level units, except the unit in Building 5, which is in an elevated enclosure attached to the building. Exterior units are mounted on concrete pads, with aprons of loose gravel over soil, surrounded by security fences. The fences surrounding 2 of the 3 units at Building 108 and the unit at Building 583 were properly labeled. The enclosure outside Building 5, which contained a PCB transformer, was not labeled and consisted of a wooden support structure covered by sheet metal. The unit and security fence at Building 546 were not labeled and a superstructure of pressure-treated wood (considered non-combustible) was over the transformer. The East Area transformer units were in good condition with very little rust or corrosion on the carcasses. No leaking units were detected in the East Area.

There are three known PCB transformers in the 800 Area, all at Building 548. The units are mounted on concrete pads, with an apron of loose gravel over soil surrounded by a security fence. The units were labeled but the fence was not. There are several pole-mounted transformers in the 800 Area that have not been tested for PCBs. The 800 Area transformer units were in good condition with very little rust or corrosion on the carcasses. No leaking units were detected in the 800 Area.

Out-of-service PCB transformers were stored on a concrete pad in the East Area until early 1987 when a contractor was hired to remove the units from the site. The storage pad, No. 57, held as many as 33 PCB transformers, according to site records. At the time of the Survey, there were no transformers on Pad No. 57 that contained regulated concentrations of PCBs. No. 57 is a concrete pad near Sawmill Creek, approximately 50 feet by 30 feet, with no roof or walls and no containment. Oil stains were not evident on the pad. No labels or markings by the pad described the materials which were previously in storage. Other out-of-service PCB transformers were stored in Building 822. These units were removed from service in 1987. Building 822 was labeled as to what materials were stored there. However, at the time of the Survey, Building 822 did not contain any transformer units.

Before removal, PCB transformers are drained of dielectric fluid and the fluid is drummed and stored in Building 825C. The empty transformer carcasses are weighed and removed from the site as PCB-contaminated material. Building 825C has concrete containment curbing and is equipped to handle hazardous waste.

All PCB transformers are inspected quarterly by a site electrician. Records of these inspections have been maintained since 1981. Records of off-site shipments of the transformer carcasses are also kept.

4.2.1.3 Asbestos

Asbestos and asbestos-containing material were used throughout the site during construction from the 1940s up to the mid-1970s. The most common use was the application to structural members and roofs of buildings and for insulation for piping. Asbestos activities at the site are currently limited to monitoring suspected asbestos sources and removing asbestos-containing material for disposal. The IH section is responsible for monitoring asbestos, and Waste Management Operations (WMO) is responsible for packaging and removing small quantities of asbestos. Large asbestos-removal jobs, such as removal of asbestos from buried steam lines, are contracted to qualified companies. All the asbestos removed from site facilities, including material from contractors, is buried in the 800 Area Landfill (Section 4.1.1.4). Records have been maintained on asbestos removal and disposal since 1983.

The asbestos that is removed is placed in plastic bags and the bags are labeled. Before 1987, bags of asbestos were disposed of anywhere in the 800 Area Landfill. At the time of the Survey, there was a designated area for asbestos disposal; however, there was no permanent marker for the site and a tour of the designated area in the landfill during the Survey revealed several plastic bags of asbestos partially covered with soil.

4.2.1.4 Herbicides

No use-restricted herbicides are used or stored by ANL personnel. Application of unrestricted herbicides is performed by a licensed contractor, and records of the herbicides used and the area treated are maintained. Applications are scheduled by the Custodial Services Department at ANL. Before the service was contracted, herbicides were applied by site personnel, and no records of usage or application rates were kept. However, 2, 4-D was stored in Building 822 prior to 1982 (Astorino, 1987).

4.2.1.5 Pesticides

Pesticides are applied by licensed contractors monthly, semi-monthly, and weekly according to a predetermined schedule or by special request. No use-restricted pesticides are applied or stored on the site. All excess pesticides and equipment are taken off-site by the contractor. Records are kept as to the chemicals used and areas sprayed. Treatments are applied each Monday and are coordinated through the Custodial Services Department.

Before the service was contracted, pesticide applications were made by site personnel. No records are available detailing the chemicals used and areas sprayed by site personnel. Building 815 was used for pesticides storage previous to its current usage as a vehicle repair facility.

4.2.1.6 Storage Tanks

Aboveground Storage Tanks

Table 4-8 provides a list of selected ASTs at ANL, including tank location and capacity, construction material, and contents; a list of all ASTs at ANL was not available. Of the tanks on the list, four contain petroleum products, three of which are 100-gallon capacity and one of 420,000-gallon capacity. The majority of the remaining tanks at ANL are reported to be used for storage of liquid nitrogen, liquid argon, liquid propane, and ammonia.

A visual review was conducted of the ASTs at ANL to supplement the information on the list, although only a small fraction of the ASTs were observed. In general, the condition of the tanks appeared satisfactory. However, some of the observed ASTs at ANL did not have their contents clearly marked. For example, two tanks behind the Canal Water Treatment Plant (Building 583, Figure 2-2) were not labeled. In addition, one tank, near Building 370, is so badly rusted that 30 to 50 percent of its surface paint is flaked off and the contents label on the tank is illegible.

Underground Storage Tanks

ANL has developed a list of both in-service and inactive USTs. This list, presented in Table 4-9, includes tank location and capacity, construction material, installation date, contents, and date of leak test. The list was current as of June 1987. Inspection of this list indicates that the majority of the tanks are constructed of steel and many are more than 20 years old.

The vast majority of these tanks have been tested to determine if they have leaks that exceed National Fire Protection Association (NFPA) Standard 329 criterion of 0.05 gallon/hour. The device used was a bubble-pressure meter, which measures the pressure required to blow a stream of bubbles out the end of a tube placed in the tank fluid. If product is leaking from the tank during the test, the fluid level of the tank will drop and the pressure required to produce the stream of bubbles will be reduced. This reduction in pressure is recorded along with the product temperature. The product temperature is monitored during the test by one to three thermocouples suspended in the fluid. Corrections for temperature fluctuation are

TABLE 4-8

PARTIAL LIST OF ACTIVE ABOVEGROUND STORAGE TANKS AT ANL, JUNE 1987[a]

Tank No.	Building No.	Capacity (gallons)	Constructed of	Contents
A1	42 Elevated Tank	150,000	Steel	Domestic Water
A2	111 Ground Level Tank	420,000	Steel	Fuel Oil
A3	564 Elevated Tank	300,000	Steel	Domestic Water
A4	565 Elevated Tank	500,000	Steel	Domestic Water
A5	566 Elevated Tank	75,000	Steel	Lab Water
A6	568 Ground Level Tank	650,000	Steel	Fire Water
A7	584 Ground Level Tank	500,000	Steel	Canal Water
A8	585 Elevated Tank	250,000	Steel	Canal Water
A9	814 Elevated Tank	100 (est)	Unknown	#1 Fuel Oil
A10	331A Elevated Tank	100 (est)	Unknown	Fuel Oil
A11	26 Elevated Tank	100 (est)	Unknown	Fuel Oil
A12	108 Ground Level Tank	50,000 (est)	Steel	Condensate Return Tank
A13	108 Ground Level Tank	50,000 (est)	Steel	Condensate Return Tank
A14	108 Elevated Tank	2,000	Fiberglass	NALCO Boiler Feedwater Treatment Solution

Source: List supplied to Survey team by ANL

a There are numerous Liquid Nitrogen, Liquid Argon, Liquid Propane, and Ammonia tanks on-site. Helium (in the past) was stored in aboveground tanks, also.

TABLE 4-9

ACTIVE AND INACTIVE UNDERGROUND STORAGE TANKS AT ANL, JUNE 1987

Tank No.	Building No.	MDS No.	Capacity (gallons)	Construction Material	Contents	Date Installed	Date Last Leak Tested	Comment
1	6	None	4,050	Steel	Water	1961	9/85	Former gasoline tank; filled w/ water
2[a]	813	None	4,000	Steel	Waste Oil	1975	Never	Pumped out; filled w/ sand
3	6	None	4,050	Steel	Diesel Fuel	1961	9/85	Active
4	32	W-RAW-2-2	280	Coated Steel	Gasoline	3/86	3/86	Cathodic Protection; active
5	201	E-EMER-1-1	550	Steel	Diesel Fuel	1982	9/85	Active
6	202	E-EMER-B2-2	4,030	Steel	Diesel Fuel	1982	9/85	Active
7	212	E-EMER-2	9,000	Steel	Diesel Fuel	1966	4/86	Active
8	212	E-EMER-3	9,000	Steel	Diesel Fuel	1966	4/86	Active
9	205	E-EMER-S-1	1,030	Steel	Diesel Fuel	1956	9/85	Active
10	211	E-EMER-B2-4	275	Steel	Diesel Fuel	1971	9/85	Active
11	306 West	E-EMER-1	250	Steel	Diesel Fuel	1961	9/85	Active
12	306 North	E-EMER-3	550	Fiberglass	Diesel Fuel	2/86	2/86	Active
13	308	E-EMER-1	532	Fiberglass	Diesel Fuel	2/86	2/86	Active
14	350	E-EMER-1	846	Steel	Diesel Fuel	1959	9/85	Active
15	368	E-EMER-1	600	Steel	Diesel Fuel	1962	9/85	Active
16	395	E-EMER-1	110	Steel	Diesel Fuel	1976	9/85	Active
17	814	W-HTG-1-6	2,030	Steel	#2 Fuel Oil	1951	9/85	Active
18[a]	816 North	S-GEN-1-5	1,030	Steel	#2 Fuel Oil	1951	9/85	Active
19[a]	816 East	S-GEN-1-6	4,030	Steel	#2 Fuel Oil	1951	9/85	Active
20	825 West	S-GEN-1-5	6,000	Fiberglass	#2 Fuel Oil	3/86	3/86	Active
21	825 East	None	9,050	Steel	Diesel Fuel	1956	9/85	Active
22	827	None	10,000	Fiberglass	Gasoline (unleaded)	1980	11/85	Active
23	829	S-GEN-1-5	2,030	Steel	#2 Fuel Oil	1966	9/86	Active
24	Service Station	Center	8,000	Fiberglass	Gasoline (unleaded)	1966	4/86	Active

TABLE 4-9

ACTIVE AND INACTIVE UNDERGROUND STORAGE TANKS AT ANL, JUNE 1987 (Continued)

Tank No.	Building No.	MDS No.	Capacity (gallons)	Construction Material	Contents	Date Installed	Date Last Leak Tested	Comment
25	Service Station	East	6,000	Fiberglass	Gasoline (premium unleaded)	1966	4/86	Active
26	Service Station	West	10,000	Fiberglass	Gasoline (regular leaded)	1966	4/86	Active
27	813 (500' west of building)	None	4,400	Stainless Steel	Waste Oil	1975	8/86	Active
28	582	None	280	Coated Steel	Gasoline	3/86	3/86	Cathodic protection; active
29	302	E-EMER-1	550	Steel	Diesel Fuel	1985	Never	Active
30	221	E-EMER-1	2,000	Steel	Diesel Fuel	1986	Never	Active
31	222	E-EMER-1	550	Steel	Diesel Fuel	1985	Never	Active
32	827	None	6,000	Fiberglass	Methanol	8/86	Never	Active
33	Service Station	None	2,000	Steel	Waste Oil	1966	Never	Active
34	Service Station	None	550	Steel	#2 Fuel Oil	1967	6/87	Active
35	Nike Launch Site	None	4,000	Steel	#2 Fuel Oil	1957	Never	Empty
36	323 North	unknown	2,000	Stainless Steel	Empty-never used	1948	Never	Active
37	323 South	unknown	2,000	Stainless Steel	Empty-never used	1948	Never	Active
38	24 North	unknown	500	Stainless Steel	Condensate	1957	Never	Active
39	24 South	unknown	350	Stainless Steel	Condensate	1957	Never	Active
40[a]	813	unknown	500	Steel	Used Oil	1972	Never	Removed 1986
41	5	unknown	500	Steel	White Gas	1957	Never	Active
42	6 North	unknown	5,000	Steel	Gasoline	unknown	Empty?	Active
43	6 South	unknown	5,000	Steel	Gasoline	unknown	Empty?	Active
44	827	unknown	unknown	unknown	unknown	unknown	Never	Active

aRemoved and disposed of.

made for the final volume change and the loss of fluid is calculated. There are no records of tank abandonment procedures; however, tanks that leaked and were subsequently replaced with new tanks include tank nos. 4, 12, 13, 20, 28, 29, 30, 31, and 32.

The overall age of the steel tanks is a serious concern. As described in Section 3.2.1, the soils at this site are highly corrosive to unlined steel tanks. This was evidenced by one 30-year-old tank (now removed) at Building 825. Reportedly, a screwdriver could be pushed through the tank wall with minor effort, suggesting severe corrosion of the tank wall. The adjacent tank, which contains diesel fuel, has tested 'tight' and is still in use even though it is constructed of the same material and is the same age as the removed tank. Although this tank may not have a leak, the condition of the removed tank suggests that the remaining tank could start leaking soon.

Finally, many of these tanks are for emergency generator use and are refilled on approximately a yearly basis. Periodic measurements are made of the product level in the tank to be sure that fuel in the tank is sufficient for emergencies. If the tank is less than one-half full, fuel is added. There is no attempt made to determine from these measurements whether the drop in fuel level is due to generator usage or tank leaks.

4.2.2 Findings and Observations

4.2.2.1 Category I

None

4.2.2.2 Category II

1. Potential for release of PCBs and PCB combustion products into the environment. There is a potential for release of PCBs and PCB combustion products into the environment due to the increased risk of fire caused by storing and handling combustible materials within 5 meters of a PCB transformer.

Combustible materials, such as sawn lumber, cardboard, and cloth materials, cannot be stored within 5 meters of a PCB transformer (40 CFR 761). There are 45 active transformers or switches at ANL with PCB concentrations greater than 60,000 ppm, and 25 had combustible materials stored within 5 meters. Placement of combustible materials, such as wood, paper, or trash, near PCB transformers increases the risk of fire. When PCBs burn, toxic emissions, including TCDD (dioxin), are formed.

2. Potential for release of asbestos fibers to the atmosphere. Exposed plastic bags of asbestos in the active landfill could be ruptured, releasing asbestos fibers into the atmosphere.

Exposed plastic bags of asbestos and asbestos-containing material in the 800 Area Landfill could be ruptured due to inadequate covering and the nearby disposal of construction rubble. Rupture of an exposed bag of asbestos could result in release of asbestos fibers to the atmosphere.

Asbestos disposed of in landfills must be covered with 6 inches of soil or cover material (40 CFR 761) to prevent rupturing of the containment bag. The practice of disposing of construction rubble, such as scrap lumber, fractured concrete, and metal, along with the plastic bags of asbestos increases the potential of inadvertently rupturing a bag of asbestos during normal landfill operations.

4.2.2.3 Category III

1. Leaking USTs. There is a potential to release hydrocarbons into the groundwater from aged steel USTs used to store various fuel oils and gasoline.

Many USTs at ANL that primarily contain fuels are of steel construction, have no cathodic protection, are unlined, are more than 20 years old, and are situated in soil that is described by the United States Department of Agriculture Soil Conservation Service as being highly corrosive to steel. Because of lack of sensitivity inherent in the leak-testing procedures used at ANL, there is some concern that the integrity of the older tanks may not be

adequately determined and that the potential for leaks still exists, even though they have tested positive for tightness.

During leak testing, the product temperature is monitored by one to three thermocouples suspended in the fluid. Because the tank test measures the change in volume of the product in order to detect a leak, a slight error in the measurement of the temperature change of the product during the test may affect the test results significantly. For example, the coefficient of expansion for diesel fuel is 0.00046 per degree Fahrenheit. If an error of 0.03 degree is made in measuring the average change of temperature over an hour for the product in a 4,000-gallon tank, the calculated error would exceed the volume of product allowed to leak under NFPA criteria.

In addition, review of the leak-test results supplied to the Survey team revealed several math errors that significantly affected the calculated leak rate. For example, the test on 9/16/85 on tank No. 9 determined that a leak was present but that the leak rate was within NFPA guidelines. However, subsequent review of the data by the Survey indicated that the actual leak rate exceeded the guideline criteria, indicating that the tank should have been removed. Because the age of many of the tanks exceeds 20 years and the soils are highly corrosive, it is possible that these older tanks are corroded and may be releasing hydrocarbons into the environment. Review of tank data suggests that the old steel tanks numbered 3, 7, 8, 9, 17, and 21 and the tanks in the Nike Site and in the East Area could be leaking.

Additionally, there is insufficient inventory control. Although periodic dipstick measurements are taken of the product level, these level readings are not incorporated into an inventory control program to determine the occurrence of a leak. The Survey team has requested that soil samples be recovered from beneath several of these tanks during the sampling and analysis (S&A) effort and analyzed for the presence of hydrocarbons.

4.2.2.4 Category IV

1. Inadequate PCB spill containment. Sandbagging of PCB transformers does not constitute adequate containment for a release of PCB dielectric fluid and could result in a PCB release to the surface water.

   Sandbags were placed around the PCB transformers to protect various floor drains or other points of access to the environment from PCB infiltration in the event of a spill or release. The sandbags do not form a leak-proof containment and an undetected release of PCB dielectric fluid would not be completely contained.

   Eighteen transformer units with PCB concentrations of over 60,000 ppm (15 at 660,000 ppm) that are located inside buildings have sandbags for leak/spill containment. These units are inspected quarterly, providing ample time for an undetected release to collect on the concrete pads under the units and travel between, through, and under the sandbags to the laboratory sewer drains. Since the environmental monitoring laboratory does not analyze the presence of PCBs in environmental samples, a release that enters the laboratory sewer system of ANL could go undetected and enter nearby surface waters.

2. Inadequate labeling of PCB or PCB-contaminated transformers. Inadequate labeling of some PCB or PCB-contaminated transformers and of access areas to those transformers increases the risk of soil and surface-water contamination.

   Inadequate labeling of PCB or PCB-contaminated transformers increases the possibility of mishandling or of errors in judgment when personnel are working with these units and may result in releases to soil or surface waters at ANL. Inadequacies in labeling PCB units at ANL include absence of labels or labels that are obscured on transformers with PCB concentrations of 50 ppm or greater, absence of labels on security fences around PCB transformers, absence of labels in access areas leading to the transformers, and placement of labels on concealed areas of the transformers.

During the Survey, six transformers were noted to be inadequately labeled. The label of the PCB transformer at Station No. 546 in the East Area was representative of the inadequate labeling. It had been painted over during recent maintenance operations. The security fence surrounding the unit was not labeled. Personnel responding to a spill or failure condition at Station No. 546 could potentially mishandle the dielectric fluid and increase the potential for deposition of PCBs into the environment. Tables 4-4 through 4-7 show which transformers are inadequately labeled.

Access areas, such as hallways, aisles, and doorways in Buildings 221 and 203 were not labeled to indicate the presence of PCBs in nearby transformers. A spill or release of PCB fluid that travels beyond the immediate area of the transformer could potentially be improperly cleaned up or inadvertently spread into other areas of the building. Tables 4-4 through 4-7 indicate the 41 transformer access areas that were inadequately labeled.

Several PCB transformers, including units outside Building 368 and atop Building 364, were labeled in concealed locations and the labels could not be seen from outside the security fence. Only by crossing the fence and inspecting the entire unit could one read the labels. The security fences at Building 368 were not labeled as to the contents of the transformers. A spill or release of PCB fluid could go unreported because personnel would not know that the fluid was contaminated.

3. Lack of PCB testing of pole-mounted transformers in the 800 Area. The pole-mounted transformers in the 800 Area have not been tested for PCBs.

   Failure of a pole-mounted transformer and the subsequent release of dielectric fluid could potentially release unknown concentrations of PCBs into the surrounding soils and surface water.

4. Lack of permanent labeling of asbestos disposal area. The asbestos disposal area in the ANL 800 Area Landfill is not permanently labeled.

   At the time of the Survey, 40 CFR 61 required that labels marking asbestos disposal areas be permanent. However, during the Survey it was observed that

the label used to mark the asbestos disposal area at the 800 Area Landfill was attached to a pole set into a concrete base and was easily transportable. As a result, the sign could be moved, leaving the asbestos disposal area open for digging or excavation. These activities could lead to the rupture of asbestos containment and the release of fibers into the atmosphere.

5. Improper storage of chemical materials. Inadequate chemical reagent storage at Buildings 6, 27, and 28 may result in toxic chemical releases to the air, soil and water.

   Some facility ventilation and electrical inadequacies and improper storage practices for flammable organics in the East Area of ANL may result in fires or explosions, which could cause toxic emissions or discharges to the air, soil and surface water. The storage areas for flammables and solvents, Buildings 27 and 28, did not have mechanical ventilation systems; this may allow for the accumulation of flammable or explosive vapors. At the time of the Survey, the light switches and other electrical equipment in Building 27 were not explosion-proof and could produce a spark during operations.

   A storage area outside Building 6, containing numerous plastic barrels of concentrated acid and 55-gallon drums of oil and hydraulic fluid, did not have containment facilities or weather protection such as a roof and walls. A spill or release of concentrated acid would not be contained by the security fence and would enter the environment.

6. Absence of content labels on the exterior of ASTs. Two ASTs behind the Canal Water Treatment Plant and one AST near Building 370 did not have their contents clearly marked and if these tanks were ruptured, improper cleanup could occur, resulting in soil contamination.

   During the Survey, eight of the ASTs at ANL were inspected. Of these, two tanks with unknown contents behind the Canal Water Treatment Plant were observed that lacked content labels on their exteriors. In addition, one tank, also with unknown contents, near Building 370 was so badly rusted that the content label was illegible.

4.3 Radiation

This section discusses the actual or potential radiological impacts to the environment from past and present operations at ANL that are multi-media in nature (i.e., air, soil, 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.

4.3.1 Background Environmental Information

Background radiation in the vicinity of ANL 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. 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 4-10). About one-half of the EDE is attributable to the inhalation of naturally occurring radon-222 and its decay products.

The data in Table 4-10 were derived in accordance with the approach recommended by the International Commission on Radiological Protection (ICRP) in ICRP Reports 26 and 30. 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. The sum of the resulting dose equivalents (DEs) for the individual organs provides an estimate of the total effect of the radiation on the whole body [e.g., effective dose equivalent (EDE)].

The U.S. Environmental Protection Agency (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

TABLE 4-10

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, 1986a

gamma exposure rates do not measure 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 October 1985 to September 1986. For this period, the EPA reported a range of ambient gamma exposure rates equivalent to annual doses between 134 ± 42 mrem DE in Denver, Colorado, and 61 ± 55 mrem DE in Orlando, Florida. The annual dose for the same period was 94 ± 25 mrem DE in Chicago, Illinois. This is the EPA monitoring location closest to ANL. The average measured ambient gamma exposure rate equivalent to an annual dose at the 22 locations monitored throughout the continental United States was 92 ± 39 mrem DE (EPA, 1986b;c; 1987).

DOE establishes radiation protection guidelines for its facilities. Radiation standards for the protection of the public in the vicinity of ANL are given in DOE Order 5480.1A, Chapter XI, as amended on August 5, 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

This subsection discusses ANL's dose assessments for the general public and the dose models and radioactive releases used in the dose assessments. A comparison of each reported dose assessment of the ANL radiological effluent releases is made with the applicable standards. The radioactive sources and controls for the individual media

are discussed in the sections for Air (3.1.2), Soil (3.2.2), Surface Water (3.3.2), and Groundwater (3.4.2). Direct radiation sources are discussed in Section 4.3.2.3.

4.3.2.1 Dose Assessment for Releases to the Atmosphere

Section 3.1.2 discusses the radioactive releases to the atmosphere. The general public can be exposed to these radioactive releases through both inhalation of the contents of a plume, and through exposure to direct penetrating radiation from standing in or near a plume. In addition, radioactively contaminated particulates may be deposited onto the soil and vegetation surrounding the facility. The radioactive constituents of the particulates deposited onto the soil and vegetation emit direct radiation, can be inhaled or ingested by humans, and are available for uptake by vegetation. The radioactive constituents in and on the vegetation may be consumed by humans either directly or indirectly through animals that have consumed the vegetation (i.e., humans drinking milk or eating meat from a cow that has eaten grass grown in contaminated areas).

In the 1986 Annual Site Environmental Report for Argonne National Laboratory (Golchert and Duffy, 1987), the EDE due to the air pathway is reported to be calculated using the measured quantities of radionuclides released during the year, the EPA AIRDOS/RADRISK computer code, and the DOE recommended dose conversion factors. However, the Survey team identified that the EPA AIRDOS/RADRISK computer code was not used. This is discussed in Finding 7 of Section 3.1.4.4.

In the dose assessment calculation that was used, the maximum individual dose for 1986 from the air pathway predicted an EDE of 0.045 mrem to the maximum individual. This individual is assumed to be located about 0.3 mile north of the site boundary. The EDE of 0.045 mrem is 0.045 percent of the DOE EDE limit of 100 mrem for prolonged exposures. However, technical deficiencies in calculating this dose assessment were identified by Survey team members. These are also discussed in Finding 7 of Section 3.1.4.4.

4.3.2.2 Dose Assessment from Releases to Liquids

Sections 3.3.2 and 3.4.2 discuss radioactive releases to surface water and groundwater, respectively. The general public can be exposed to these releases through river bank exposure, and through immersion in and ingestion of the radioactively contaminated water. Additionally the radioactive constituents in the water are available for uptake by aquatic organisms. These aquatic organisms can then be ingested by humans either directly or indirectly through the consumption of animals that have ingested the aquatic organisms.

ANL wastewater is discharged into Sawmill Creek, and this stream was sampled for radioactive constituents above and below the site to evaluate the effect of ANL operations on its radioactive content. Section 3.3.3 contains a discussion of these results. The calculated ingestion dose from using the creek water as a potable water supply for 1986 was an EDE of 0.46 mrem (Golchert and Duffy, 1987). This dose is 0.46 percent of the DOE EDE limit of 100 mrem for prolonged exposures.

Sawmill Creek flows into the Des Plaines River, which in turn flows into the Illinois River. The radioactive levels in the rivers were similar to those in other streams in the area, and the activity added to Sawmill Creek by the ANL wastewater had no measurable effect on the radioactive content of or dose to the general public from either the Des Plaines or Illinois River (Golchert and Duffy, 1987).

4.3.2.3 Dose Assessment of Exposure to Direct Radiation

Direct radiation sources at ANL result from normal and accidental releases of radioactive atmospheric and liquid effluents, operating nuclear reactors, storage and burial of radioactive materials, and gamma irradiators. The shielding and buildings in which these sources are located usually prevent a measurable increase in direct radiation off-site.

Measurements of direct radiation were made at site-boundary and off-site locations as discussed in Section 4.3.3. The off-site location results averaged 78 ± 5 mrem/year for 1986, which is in the normal range for the area background (Golchert and Duffy, 1987). At two site-boundary locations, above-normal readings were recorded that were attributable to ANL operations (Section 4.3.3). The south fence

dose was about 366 mrem/year above background for 1986 (Golchert and Duffy, 1987). This elevated reading resulted from temporary on-site storage of radioactive waste at a temporary storage facility in the 317 Area. Along the north side of the site, the dose at the fence was 24 mrem/year above background due to radiation from cobalt-60 sources in Building 202. However, the land in both these areas is owned by the Du Page County Forest Preserve District and contains no residences. Since all of these locations are unoccupied, no individuals received these measured doses.

The calculated outdoor dose rate from these sources to the residents closest to the south boundary, about 1 mile from the fenceline, was about 0.08 mrem/year and closest to the north boundary, about 0.5 mile from the fence, was about 0.11 mrem/year (Golchert and Duffy, 1987). These doses are 0.08 percent and 0.11 percent, respectively, of the DOE EDE limit of 100 mrem for prolonged exposures. Observations by Survey team members revealed thermoluminescent dosimeters (TLDs) that were improperly placed, causing a downward bias of results. There is a finding associated with this observation in Section 4.3.4.4, Finding 1.

4.3.2.4 Summary of Exposures

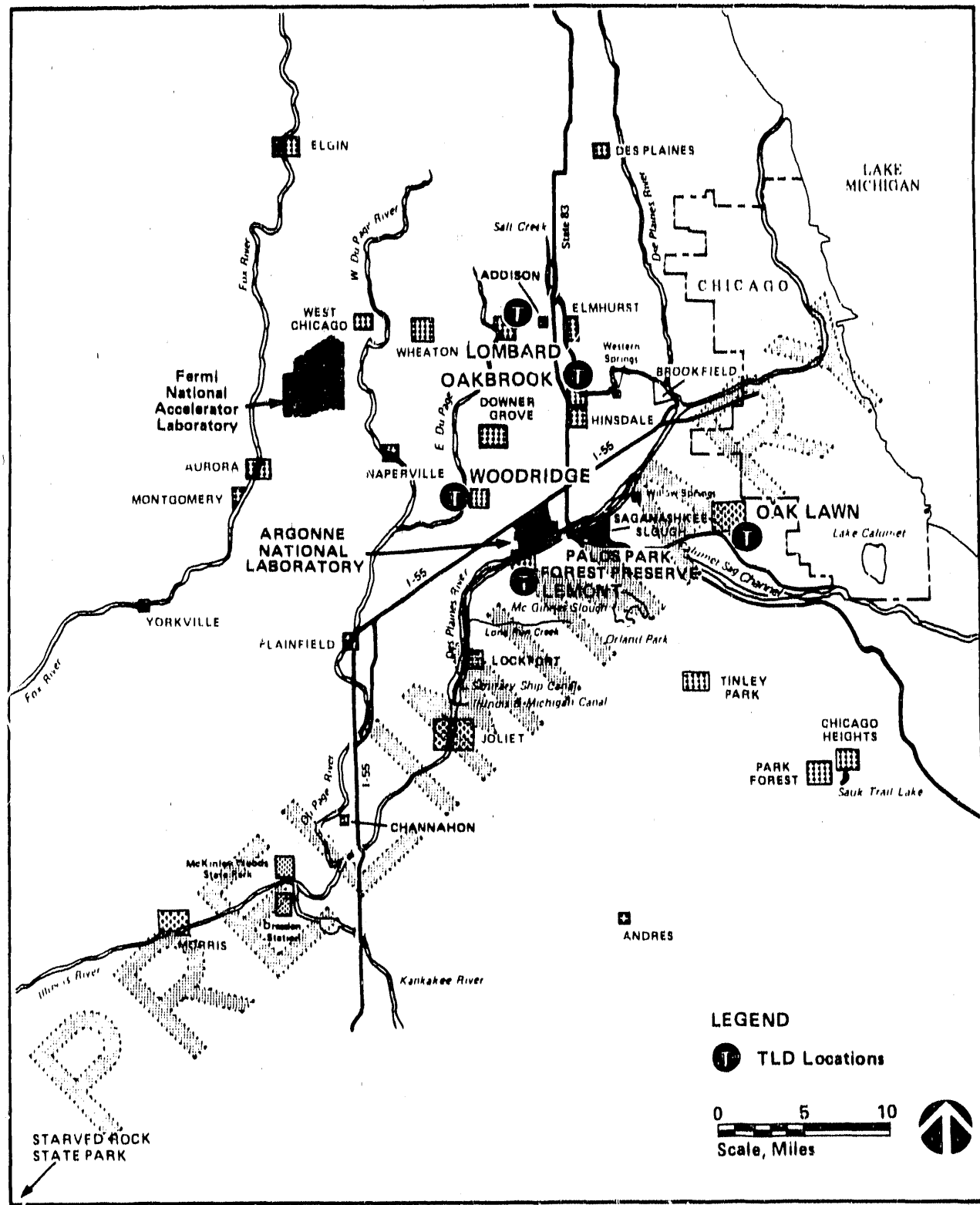
As discussed in Section 4.3.1, DOE imposes a limit for radiation exposure to any member of the general public of 100 mrem/year EDE from all pathways due to normal operations at a DOE facility. ANL evaluated the exposures to radiation from site operations for releases to the atmosphere, liquids, and direct radiation. To determine compliance with the 100 mrem/year EDE, all exposure pathways must be summed for an individual who would receive the highest doses. Based on the 1986 Annual Site Environmental Report, the highest reported off-site dose for 1986 was 0.46 mrem EDE from the liquid pathway. If it is assumed that the doses calculated for the atmospheric pathway (0.045 mrem EDE) and the direct radiation pathway (0.11 mrem EDE) were also received by the individual who received the liquid pathway dose, the maximum individual dose would be an EDE of 0.615 mrem for 1986. This dose is 0.615 percent of the 100 mrem/year EDE limit.

4.3.3 Environmental Monitoring Program

The environmental monitoring programs for radioactivity are discussed in the appropriate sections for Air (3.1.3), Soil (3.2.3), Surface Water (3.3.3), and Groundwater (3.4.3). In addition, TLDs are used to measure the direct penetrating radiation exposure at locations on and off the ANL site. The environmental monitoring program is performed by the Occupational Health and Safety Department of ANL. The measurements are made to determine if activities at ANL are contributing to the external radiation levels in the vicinity of the site.

There are three groups of TLD monitoring stations for ANL: (1) ANL off-site; (2) ANL on-site; and (3) ANL boundary. Figure 4-2 shows the five off-site TLD locations and Table 4-11 summarizes the results for 1986. The off-site dose rates averaged 78 ± 5 mrem/year and are similar to 1985's off-site average of 76 ± 5 mrem/year.

The seven on-site and seven boundary ANL TLD locations are shown in Figure 4-3 and the results for 1986 are summarized in Table 4-12. At two site-boundary locations, the southern half of Grid Location 7I and Grid Location 14I, the doses are above the background average of the five off-site TLD locations. At Grid Location 7I this was due to radiation from a temporary radioactive waste storage facility in the 317 Area. This facility is located in the northern half of Grid Location 7I of Figure 4-3. Waste is packaged and temporarily kept in this area prior to removal for permanent storage. The net, above-normal, dose at this location was about 366 mrem/year, about one-half the 1985 average. In previous years, this value has ranged from 865 mrem/year in 1985 to 114 mrem/year in 1977 (Golchert and Duffy, 1987). About 0.2 mile south of the fence at Grid Location 6I of Figure 4-3, the measured dose dropped to 78 mrem/year, within background measurements. At Grid Location 14I, at the northern boundary, the dose was 24 mrem/year above background, about the same as in 1985 (Golchert and Duffy, 1987). This dose is due to the use of cobalt-60 irradiation sources in Building 202. The elevated on-site measurements at Grid Locations 9H, 8H, and the northern half of Grid Location 7I are due to the storage facility in the 317 Area discussed above and the storage of activated equipment from the CP-5 facility (Building 330) in the yard next to the building.



Source: Goichert and Duffy, 1987

OFF-SITE TLD LOCATIONS IN THE VICINTY OF ANL

FIGURE 4-2

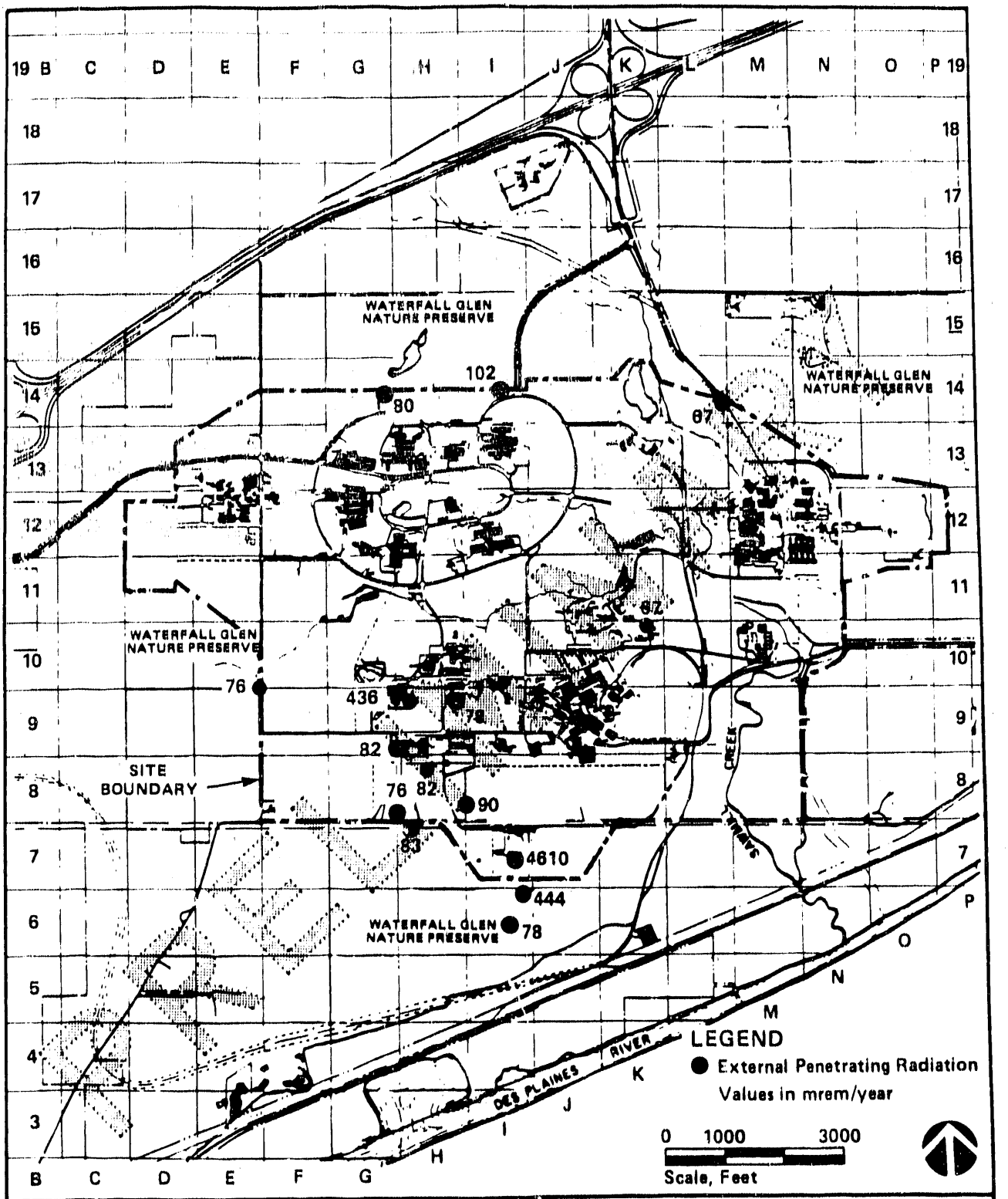
TABLE 4-11

DIRECT PENETRATING RADIATION AT OFF-SITE LOCATIONS IN THE VICINITY OF ANL, 1986

Location[a]	Dose Rate (mrem/year)				Average
	Period of Measurement				
	1/9-4/10	4/10-7/15	7/15-10/14	10/14-1/15	
Lemont	66	82	82	83	78 ± 8
Lombard	67	86	81	83	79 ± 8
Oak Brook	65	98	84	86	83 ± 13
Oak Lawn	61	75	71	75	70 ± 7
Woodridge	63	81	82	80	76 ± 9
Average	64 ± 2	84 ± 9	80 ± 5	81 ± 4	78 ± 5

Source: Golchert and Duffy, 1987

[a] The off-site locations are shown on Figure 4-2.



Source: Golchert and Duffy, 1987

ON-SITE AND BOUNDARY TLD LOCATIONS AND AVERAGE 1986 DOSE RATE AT ANL

FIGURE 4-3

TABLE 4-12

DIRECT PENETRATING RADIATION AT ON-SITE AND BOUNDARY LOCATIONS AT ANL, 1986

Location[a]	Dose Rate (mrem/year)				
	Period of Measurement				
	1/9-4/10	4/10-7/15	7/15-10/14	10/14-1/15	Average
Site Boundary					
14L	56	71	70	70	67 ± 8
14I	93	105	105	105	102 ± 6
14G	69	87	83	83	80 ± 8
9/10EF	63	79	80	80	76 ± 8
8H	66	80	82	78	76 ± 7
8H - Center, St. Patrick's Cemetery	76	85	85	87	83 ± 5
On-Site					
6I - 200 m N of Quarry Road	65	83	86	79	78 ± 9
7I - Boundary	424	413	389	549	444 ± 72
9H - 50 m SE of CP-5	512	462	385	385	436 ± 62
8H - 65 m S of Building 316	92	80	79	76	82 ± 7
8H - 200 m NW of Waste Storage Area (Heliport)	93	88	85	92	90 ± 4
7I - Center, Waste Storage Area Facility 317	4080	4400	3610	6340	4610 ± 1200
10/11K - Lodging Facilities	56	71	71	1	67 ± 7
9I - 65 m NE of Building 350, 230 m NE of Building 316	63	106	75	70	78 ± 19

Source: Golchert and Duffy, 1987

[a] The site-boundary and on-site locations are given in terms of the grid coordinates in Figure 4-3

Interviews with site personnel and inspection of TLD locations revealed that some TLDs are placed on utility poles in a way that shields them from the source they are intended to measure. Sodium-iodide detector measurements conducted by the Survey team showed that the shielding effect of the pole biased the TLD measurements downward by about 30 percent.

4.3.4 Findings and Observations

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

1. Improper TLD placement. Some TLD results are biased downward because they are mounted on utility poles in a way that shields them from the source they are intended to measure.

   Some of the TLDs mounted on utility poles yield direct radiation levels which are underestimated. The Survey team conducted sodium-iodide detector measurements at the TLD station inside the 317 Area (northern half of Grid Location 7I). These measurements showed that the shielding effect of the pole (downward bias) was about 30 percent. This type of mounting was observed at two locations, although interviews with site personnel indicated that other TLDs are also mounted in this fashion.

4.4 Quality Assurance

4.4.1 General Description of Environmental Monitoring at ANL

This section discusses laboratory quality assurance (QA) for the environmental monitoring samples analyzed by ANL. The field sampling program and the associated QA during the sampling events are discussed in Section 3.3.3 for surface water samples and Section 3.4.3 for groundwater samples.

The environmental analytical chemistry laboratories at ANL regularly analyze surface water, process water, wastewater, and groundwater for inorganic, organic, and radioactive parameters. Sampling is accomplished by site personnel at various National Pollutant Discharge Elimination System (NPDES) outfalls, at monitoring wells, and at waste tanks. The resulting data are used for the annual site environmental report, for dose assessments, and for process control.

4.4.2 Sample Collection

The procedures and responsibilities for the collection of surface water/wastewater and monitoring well samples at ANL are described in Sections 3.3.3 and 3.4.3, respectively. Surface water and wastewater samples are routinely analyzed for specified inorganic and radiological parameters. Monitoring well samples are routinely analyzed for inorganic, organic, and radiological parameters.

4.4.3 Analytical Laboratories

Two analytical chemistry laboratories at ANL, the Control Laboratory in Building 306 and the Industrial Hygiene Chemical Laboratory (IHCL) in Building 200, are responsible for the analysis of monitoring samples. The Radiological Laboratory (B-Wing, Building 200) in the OHS conducts all the environmental monitoring program radiological analyses. Each of these laboratories is discussed below.

4.4.3.1 Control Laboratory

The Control Laboratory in Building 306 is in the WMO Department and is used for analyzing samples from the potable water supplies; NPDES Outfalls 001, 001A,

001B, and 002; retention and suspect water tanks; and laboratory sewage. The frequency of monitoring, parameters monitored, and origin of samples are depicted in Table 4-13 and 4-14.

The Control Laboratory is divided into three main areas, Retention Tank Laboratory, Water Analysis Laboratory, and Hot Laboratory. The Retention Tank Laboratory contains a scintillation counter for measuring alpha and beta activity in samples from the retention tanks for several buildings at ANL. The Water Analysis Laboratory contains an atomic absorption unit, UV-Vis spectrophotometer, centrifuge, oven, several balances, and a pH meter. The Hot Laboratory contains an alpha/beta counter and a balance. Operating manuals were available for the atomic absorption unit and the scintillation counter.

Analytical work is initiated in the Control Laboratory, as with the other laboratories described below, with the submission of an Analytical Request form. The form identifies the sample location, analytical parameters and procedures to be used, and sampling date. As analyses are completed, the information is registered on the forms and this comprises the sample tracking system for the laboratories. Raw data and instrument readings are kept in the individual analyst's bound notebook. The Control Laboratory transfers the results from the analyst's notebook to a written report. The Supervisor of the Control Laboratory does not see any data unless they constitute an exceedance of a regulatory limit. All other data review is performed by the Lead Analyst.

At the time of the Survey, the Control Laboratory did not have a QA program in place, although limited radiological analysis QC practices were employed in the Hot Laboratory. Each piece of counting equipment had a daily performance logbook in which background and standard counting was recorded, and each batch of samples included blanks and standards used for calculating background count rates and efficiency. The scintillation counter was calibrated to tritium with standards provided by the OHS Department. The counter was "calibrated" if the result of the standard analysis was ± 10 percent of the stated value.

The Control Laboratory analyzes EPA proficiency check samples for biochemical oxygen demand (BOD) and total suspended solids (TSS), two of the analyses

TABLE 4-13

NPDES ANALYTICAL RESPONSIBILITY AT ANL

Parameter	Monitoring Frequency										
	Weekly			Monthly							
	001A	001B	001	002	003	004	005	006	007	008	009
BOD_5	306	-	306	-	-	-	-	-	-	-	-
TSS	306	306	306	306	200	200	-	200	-	-	200
COD	-	200	-	-	-	-	-	-	-	-	-
Hg	-	200	-	-	-	-	-	-	-	-	-
Fecal Coliforms	-	-	200	-	-	-	-	-	-	-	-
pH	-	-	306	306	200	200	200	200	200	200	200
Fats, Oil, Grease	-	-	-	-	-	-	200	-	-	-	-
Zn	-	-	-	-	-	-	-	200	-	-	-

Source: Golchert and Duffy, 1987

306 = Bldg. 306 Control Laboratory
200 = Bldg. 200 B-Wing Industrial Hygiene Chemical Laboratory

TABLE 4-14

CHEMICAL AND RADIOLOGICAL ANALYSES CONDUCTED AT BUILDING 306 CONTROL LABORATORY

Parameter	Retention Tanks	Raw Well Water	Treated Domestic Water	Steam Plant Boiler Water	Steam Plant Condensate	Swimming Pool	Drinking Fountains	NPDES 001/002	Laboratory Sewage	Suspect Waste Tanks
pH	•	•	•	•	•		•	•	•	•
Hardness		•	•		•			•		
BOD_5								•	•	
NH_3-N									•	
TDS				•						
NO_3		•	•					•		
SiO_2		•	•					•		
SO_4		•	•					•		
PO_4		•	•					•		
Cl		•	•	•				•		
Alkalinity		•	•	•				•		
Sulfites				•						
DO								•	•	
Stability								•		
Zn								•		
Fe		•	•					•		

TABLE 4-14

CHEMICAL AND RADIOLOGICAL ANALYSES CONDUCTED AT BUILDING 306 CONTROL LABORATORY (Continued)

Parameter	Retention Tanks	Raw Well Water	Treated Domestic Water	Steam Plant Boiler Water	Steam Plant Condensate	Swimming Pool	Drinking Fountains	NPDES 001/002	Laboratory Sewage	Suspect Waste Tanks
Na		•	•					•		
K		•	•					•		
Mg		•	•					•		
Ca		•	•					•		
Hg										•
Sr	•							•		
Ba	•							•		
Bacteriologic			•			•	•			
Alpha, beta counts	•							•	•	•
Tritium	•							•		•
Analytical Frequency	AR[a]	M[b]	M[b]	M[b]	M[b]	3 per W[c]	W[c]	001-W[c] 002-M[b]	W[c]	AR[a]

Source: Golchert and Duffy, 1987

[a]AR - As Required
[b]M - Monthly
[c]W- Weekly

performed by this laboratory for the NPDES program. The results are used to define the accuracy of the analyst and the methodology for a particular parameter.

4.4.3.2 IHCL

The IHCL is within the Department of Occupational Health and Safety (OHS) and is used for analyzing samples from NPDES Outfalls 003 through 009, groundwater wells in the landfill, effluent from the wastewater treatment plant, and surface-water samples from Sawmill Creek and the Des Plaines River as depicted in Tables 4-13, 4-15, 4-16, and 4-17.

The IHCL is located in two laboratory rooms of B-Wing, Building 200. One laboratory room is dedicated to sample handling and preparation, analysis of inorganics, and sample storage. Instrumentation in this laboratory room includes a pH meter, dissolved oxygen meter, incubator, autoclave, oven, and a balance. The other laboratory room contains a gas chromatograph, liquid chromatograph, atomic absorption spectrophotometer, balance, and refrigerator. The operation manuals for the instrumentation were located with the units. The calibration standards for the atomic absorption unit and the gas chromatograph are kept in a secured cabinet in this room. The standards are checked periodically against National Bureau of Standards certified materials to verify the concentrations of the analytes. The IHCL maintains calibration and maintenance logbooks for the major instrumentation in the laboratory.

Chemical analyses are performed in the IHCL according to EPA methodologies with the exception of arsenic, selenium, and organics. Arsenic and selenium analyses are performed by a methodology developed by IHCL personnel which is not EPA approved. The analysis of organic chemicals is also performed by an IHCL method which is not approved by EPA.

The IHCL maintains a QA Plan, the purpose of which is to specify quality-related activities that must be complied with to ensure the validity of data and results of work. The plan guides control of procedures and requirements for chemical work, procurement, materials, equipment standards, calibration, documents, and training. The QA responsibilities for the analysts, laboratory supervisors, QA coordinators, and department managers are delineated. An integral part of the QA

TABLE 4-15

QUARTERLY INORGANIC ANALYSES OF THE 800 AREA LANDFILL MONITORING WELLS CONDUCTED BY THE INDUSTRIAL HYGIENE CHEMICAL LABORATORY

	Well Number												
	1	1-2	2	2-2	3	4	4-2	5	6	7A	8	9	10
As	●	●	●	●	●	●	●	●	●	●	●	●	●
Ba	●	●	●	●	●	●	●	●	●	●	●	●	●
Cd		●		●		●	●				●	●	●
Cn		●		●		●	●				●	●	●
Fe	●	●	●	●	●	●	●	●	●	●	●	●	●
Pb		●		●		●	●				●	●	●
Mn	●	●	●	●	●	●	●	●	●	●	●	●	●
Hg	●	●	●	●	●	●	●	●	●	●	●	●	●
Ni		●		●		●	●				●	●	●
Se	●	●	●	●	●	●	●	●	●	●	●	●	●
Ag		●		●		●	●				●	●	●
Zn		●		●		●	●				●	●	●
Cl-	●	●	●	●	●	●	●	●	●	●	●	●	●
F-	●	●	●	●	●	●	●	●	●	●	●	●	●
TDS	●	●	●	●	●	●	●	●	●	●	●	●	●
pH	●	●	●	●	●	●	●	●	●	●	●	●	●
SO_4	●	●	●	●	●	●	●	●	●	●	●	●	●
Temp.	●	●	●	●	●	●	●	●	●	●	●	●	●

Source: Golchert and Duffy, 1987

TABLE 4-16

QUARTERLY ORGANIC ANALYSES OF THE 800 AREA LANDFILL MONITORING WELLS CONDUCTED BY THE INDUSTRIAL HYGIENE CHEMICAL LABORATORY

	Well Number												
	1	1-2	2	2-2	3	4	4-2	5	6	7A	8	9	10
Benzene	•	•	•	•	•	•	•	•	•	•	•	•	•
Ethyl Benzene	•	•	•	•	•	•	•	•	•	•	•	•	•
m-dichlorobenzene	•	•	•	•	•	•	•	•	•	•	•	•	•
m-xylene	•	•	•	•	•	•	•	•	•	•	•	•	•
Monochlorobenzene	•	•	•	•	•	•	•	•	•	•	•	•	•
o-dichlorobenzene	•	•	•	•	•	•	•	•	•	•	•	•	•
o-xylene	•	•	•	•	•	•	•	•	•	•	•	•	•
p-dichlorobenzene	•	•	•	•	•	•	•	•	•	•	•	•	•
p-xylene	•	•	•	•	•	•	•	•	•	•	•	•	•
Tetrachloroethylene	•	•	•	•	•	•	•	•	•	•	•	•	•
Toluene	•	•	•	•	•	•	•	•	•	•	•	•	•
Trichloroethylene	•	•	•	•	•	•	•	•	•	•	•	•	•
1,2,4-trichlorobenzene	•	•	•	•	•	•	•	•	•	•	•	•	•

Source: Golchert and Duffy, 1987

TABLE 4-17

INORGANIC ANALYSES OF SURFACE-WATER SAMPLES CONDUCTED BY THE INDUSTRIAL HYGIENE CHEMICAL LABORATORY

Sawmill Creek					Des Plaines River		Wastewater Treatment Plant		
Downstream from ANL				Upstream from ANL	Willow Springs	Lemont	Daily	Weekly	Monthly
Daily	Weekly	Bimonthly	Monthly	Bimonthly	Monthly	Monthly			
			●						●
			●						●
			●						●
			●						●
	●							●	
	●							●	
	●							●	
	●				●	●		●	
	●								
			●					●	●
			●						●
			●						●
	●								●
			●						●
		●		●					
		●		●					
		●		●					
		●	●						●
		●		●					
		●		●					
		●		●			●		
		●		●					
		●		●					

1987

program for the laboratory is preparation and maintenance of the procedures manuals. The procedures detail the specific methodology that is to be followed during sample analysis. The methodologies are presented in a step-by-step format and include information on instrument calibration, reagent quality, calculations, quality control requirements, and data handling, as well as the analytical method. Each analysis performed in the laboratories is covered by a procedure.

The QC program for the IHCL includes the analysis of blanks, duplicates, and spikes for each set of analyses, maintaining control charts depicting the accuracy of the analyst, and verifying of calibration standards against National Bureau of Standards certified materials. The QC requirements for each analysis are included in the individual procedures and a general overview of QC requirements is presented in IHCL-003-Calibration Plan of the procedures manual. Procedure IHCL-003 states that at least one reagent blank is to be processed with each group of samples, that at least one spiked sample must be analyzed with each set of samples and not less than every five samples with a recovery not to exceed the range of 75 to 125 percent, and that one duplicate must be analyzed from each set of samples with the relative percent difference not to exceed ± 20 percent. The results of the spike analysis determine the accuracy of the analysis, and the results of the duplicate analysis determine the precision of the analysis.

The IHCL analyzes samples from several proficiency testing programs, including EPA-QA intercomparison samples for radiological analysis, DOE Environmental Measurements Laboratory Quality Assurance Program samples for various combinations of radionuclides, the National Institute of Occupational Safety and Health Proficiency Analytical Testing Program for metals and inorganics, and the EPA Discharge Monitoring Report Quality Assurance Program for metals and inorganics.

4.4.3.3 Radiological Laboratory

The Radiological Laboratory in the OHS Department consists of a wet chemistry laboratory, a counting room, and a sample and standards storage area.

Samples in the Radiological Laboratory are tracked throughout processing and adequate records are maintained. Each sample and aliquot thereof is given a

unique identifier based on the type of sample and the number of samples of that type. This number is affixed to both sample container and records. The records include a file card completed for each analysis and a sample card on which all results for a sample are transcribed. These records are maintained indefinitely in the laboratory.

The Radiological Laboratory participates in three QA intercomparison programs, two for radiological analyses and one for dosimetry. ANL results compare reasonably well with those of the three programs.

4.4.4 Findings and Observations

4.4.4.1 Category I

None

4.4.4.2 Category II

None

4.4.4.3 Category III

None

4.4.4.4 Category IV

1. Questionable environmental monitoring data from the Control Laboratory.

   The [illegible] laboratory in Building 306 is producing questionable environmental chemical monitoring data.

   [illegible] the Control Laboratory may not be accurate and could [illegible] contamination of the potable water supply. Specific [illegible] are:

   - [illegible] laboratory does not have a QA Program Plan in place and does not have a complete procedures manual.

- Spike and duplicate analyses, which are intended to determine the accuracy and precision of the analysis, are not performed. The Laboratory cannot determine if or when an analysis is out of control;

- Calibration records for the analytical instrumentation are discarded shortly after the analysis is complete, destroying data which could be used to determine instrument or reagent quality;

- Analytical data are not reviewed by management staff unless an exceedance of a regulatory limit is indicated;

- Laboratory reagents and standards for the most part are not marked as to date of receipt nor are they initialed. Most stock solutions are dated and initialed but are of such an age that neither the initial concentration nor the present quality can be verified. Examples are a Stock Chromate solution labeled "3.0000 g/l 8/25/72" and a metal standard dated "January 1969;"

- The distilled water used in the laboratory is from a tank of condensed steam. The water is passed through organic removal cartridges but these cartridges had not been operational for 2 weeks prior to the Survey and analyses were still being performed;

- The incubator used for BOD analysis has never been calibrated. The laboratory cannot document compliance with the NPDES mandated procedures;

- The analytical balances are on a maintenance schedule with a certified technician but are not calibrated daily using a certified weight and do not have maintenance logs;

- Proficiency samples from EPA are not handled in the same fashion as a normal sample is handled. This alerts the staff to the nature of the samples and extra care is taken during the analysis that is not afforded to normal samples;

- Samples are not logged into a logbook and therefore there is no reference point for all the samples in the laboratory. Samples or the Analytical Request forms can easily be lost or misplaced with no method available for retrieving sample information;

- There are no set procedures for analyst training. This could lead to analysts not having the proper training to operate the instrumentation, prepare samples, or handle data properly; and

- Samples are stored in the same refrigerator as are standards, which increases the possibility of cross-contamination of both.

2. Questionable organic analysis data from IHCL. IHCL analytical procedures and QA used for defining organic contaminants within the groundwater are resulting in questionable data and an inability to detect and define organic contamination.

   The absence of both an EPA-approved analytical procedure and QA controls for the organics analyses indicates that the data being produced from the IHCL are of questionable defensibility.

3. Questionable inorganic analysis data from IHCL. IHCL analytical procedures and QA protocols used for inorganic measurements for surface water and groundwater may result in inaccurate detection of some contaminants and questionable data for all inorganic parameters analyzed.

   Specific aspects of the finding are discussed below:

   - Arsenic and selenium are being analyzed by a method, developed by IHCL personnel, that is not an EPA approved method as specified under 40 CFR 136 nor has it received approval as an alternate test procedure under 40 CFR 136.5;

   - The IHCL QA Plan states that three levels of analyte will be used for calibration curves. The analysis of sample No. 21438 for mercury had only

two points in the calibration curve. Several other samples for mercury were calibrated from this curve;

- The QA Plan calls for spikes and duplicates to be performed with every set of samples or not less than every five samples. For sulfate and chloride analyses, spikes and duplicates were never performed. No data are available on the accuracy and precision of these analyses;

- No formal training program is in place in the IHCL, contrary to the QA Plan; and

- Preservation agents are not added to surface water samples at the time of collection as described in Finding 2 of Section 3.3.4.4. Specifically, samples for mercury and chemical oxygen demand from NPDES Outfall 001B are not field-preserved; samples for fats, oils, and grease from NPDES Outfall 005 are not field-preserved; and samples for zinc analysis from NPDES Outfall 006 are not field-preserved. Failure to properly field-preserve samples increases the possibility of degradation and low sample results.

4. Lack of QA Plan and procedures in Radiological Laboratory. Implementation of an approved QA protocol for radiological analyses has not occurred and as a result the quality of analytical data from the Radiological Laboratories in Building 200 B-Wing and Building 306 cannot be ensured or demonstrated.

   Analytical results from the radiological laboratories are used for environmental monitoring and dose assessment, and for effluent monitoring and control. QA plans and procedures covering the radiological activities of these laboratories were in draft form at the time of the Survey and had not been approved or distributed to laboratory personnel.

4.5 Inactive Waste Sites and Releases

This section of the report deals with inactive waste sites, spills, and other types of releases that are present on the ANL site, or off-site in areas formerly controlled by ANL. Most sites of concern have contained or presently contain either hazardous or mixed hazardous and radioactive wastes. Findings are based on observations made during the on-site portion of the Environmental Survey, conducted from June 15 through June 26, 1987, and documents such as the revised draft ANL Phase I Installation Assessment Report (IAR) (Cheever, 1986a), and numerous other records including reports, photographs, interviews, and site plans. The IAR, as required by DOE Order 5480.14, identifies inactive hazardous waste disposal sites that may have resulted from ANL operations. It includes accidental-spill locations that may still contain hazardous or radioactive materials and off-site locations in which contamination may have resulted from past operations.

4.5.1 General Description of Pollution Sources and Controls

ANL had its beginnings in 1942 as the Metallurgical Laboratory, housed in permanent and temporary buildings on or near the University of Chicago campus. The laboratory was involved in nuclear reactor theory and aided in the development of the atomic bomb. In 1943, portions of the laboratory were relocated to Argonne Forest, part of the Palos Park Forest Preserve (Figure 2-3), 20 miles southwest of Chicago (Figure 2-1) and 3 miles east of the present ANL site. A 19-acre parcel in the Preserve, known as Site A, was used for reactors and associated buildings, laboratories, support shops, and living quarters. A 1-acre tract, known as Plot M, situated 2,000 feet north of Site A, was used for burial of radioactive and chemical waste. Although Site A continued to operate until 1956, the present ANL site was obtained in 1947 and nearly all activities were accommodated there by 1954 (DOE, 1978, 1982). A more detailed discussion of ANL's history and mission is presented in Section 2.2.

During the Environmental Survey, 17 inactive waste sites and releases resulting from ANL activities were identified (Table 4-18); 8 were previously described in the ANL IAR (denoted in Table 4-18), and 9 are newly described in the Environmental Survey. Of the 17 sites, 6 are former disposal areas such as French drains, landfills, and dumps (Sites 1, 2, 3, 4, 14, and 17), 1 of which (Site 17) is off-site; 1 site is a former

TABLE 4-18

INACTIVE WASTE SITES AND RELEASES IDENTIFIED DURING THE ANL ENVIRONMENTAL SURVEY

Site[a]	Period of Activity or Date of Occurrence	Activity	Size/Depth	Waste Types	Quantity	Status
1. 800 Area Landfill French Drain[b]	1/69 to 12/78	Disposal	20-foot diameter; unspecified depth	Organics including acetone, carbon tetrachloride, tetrachloroethylene, trichloroethylene, and benzene; ferric chloride; waste oil; diesel fuel; kerosene; machine coolant; "Skydrol" and "Pydraul" hydraulic fluids; "Wet Ege"; PCBs.	28,700 gallons total, including 8,531 gallons of waste oil, 110 gallons of PCBs, 530 gallons of diesel fuel/kerosene, 3,235 gallons of organic compounds.	French drain removed and backfilled although landfill is still active.
2. ENE 319 Landfill[b]	1948 to early to mid-1950s	Disposal	Unknown	Construction debris, shop turnings, pipe, rebar, wood, ductwork suspect radioactive building materials, possible hazardous wastes.	Unknown	Located in a ravine; covered with 2-3 feet of topsoil and overgrown with grasses and shrubs.
3. 317 Area French Drain[b]	Four or five years in the mid-1950s	Disposal	4 feet wide by 4 feet deep by? feet long	"Wet Ege" and toxic organics probably similar to 800 Area Landfill French drain.	Unknown	French drain removed and backfilled; was located in a drainage swale.
4. 319 Landfill and French Drain[b]	1958 to 1968 or 1969	Disposal	Landfill: three trenches, each 200 feet long by 30 feet wide by 5-10 feet deep; French drain: unknown	Burned garbage ash; construction debris; building materials; suspect radioactive materials; chemicals including metals and metal salts, non-toxic and toxic liquids such as paints; resins; organics; machine and waste oils; flammables.	During mid-1960s; 116 gallons of chemicals in French drain; 450 pounds of assorted chemicals, 46 gallons of liquids and 42 ft^3 of non-toxic solids in landfill.	Landfill covered; French drain at northern end of landfill removed.
5. Earthen Lagoon at Wastewater Treatment Plant[c]	Early 1950s to 1980	Storage	100 feet by 75 feet	Laboratory wastewater containing radioactivity and presumably hazardous substances.	Unknown	Still present but no longer in use; basin vegetated with herbaceous growth.

TABLE 4-18

INACTIVE WASTE SITES AND RELEASES IDENTIFIED DURING THE ANL ENVIRONMENTAL SURVEY (Continued)

Site[a]	Period of Activity or Date of Occurrence	Activity	Size/Depth	Waste Types	Quantity	Status
6. Nike Site[c] Fuel tank	Late 1950s to early 1970s	Storage	13 - acre tract	#2 Fuel Oil	Unknown	Tank still in ground; contents removed although tank may have been leaking before removal.
Drain field		Treatment/disposal		Sanitary wastes, possibly solvents	Unknown	Drain field still apparent; distribution boxes still present.
Acid drain pipe		Overflow disposal		Acids	Unknown	Pipes still present; discharged into swale; organic vapors detected in pipes.
7. Underwriters Pond[b]	1/65 to 1/72	Treatment/disposal	200 feet by 60 feet	Water-reactive chemicals (sodium, sodium-potassium), ferric chloride, metals (lithium, zirconium), miscellaneous chemicals.	2,800 pounds total; 1,500 pounds of sodium, 200 pounds of sodium-potassium	Pond, a flooded quarry, still present and located in a public forest preserve.
8. East Area Buildings 19/34 Pipeline[b]	Unknown but sometime during late 1940s/early 1950s to 1978	Leaking pipe and in-ground concrete tank	Pipeline: 3 feet by 40 feet; tank area: 60 feet by 20 feet	Radioactive liquids; possibly acids, metals, solvents	Unknown	Radioactive soils removed and backfilled; soils not surveyed for hazardous chemical materials during removal.
9. Off-site Unnamed Stream[c]	? to 1987	Possible discharge from footing and sump drains	1,400 linear feet	Radioactively contaminated water	Unknown	Outfall has been capped but leaking still has occurred.
10. 317 High-Activity Vault[c]	Discovered in 1984	Flooding and potential leakage of storage facility	50 feet by 4 feet by 22 feet deep	High-activity, low-level wastes	Unknown	Vault has been covered with roofing to prevent further flooding.
11. Building 145 Drum Leak[c]	6/87	Drum leak	10 square feet	Uncertain but possibly waste oil or pyridine	10 to 55 gallons	Drum removed but spill not cleaned up.
12. Sunoco Station Spill[c]	2/86	Gasoline spill	300 feet by 3 feet	Unleaded gasoline	15 to 20 gallons	Spill cleaned up; some contaminated soil removed.
13. Building 827 Gasoline Island[c]	1986 to present	Gasoline spill	Unknown	Gasoline	Unknown	Peastone surrounding gasoline tank fill pipe receives spillage during tank filling.
14. Lime Sludge Pond[c]	Early 1950s to 1986	Disposal	7 acres	Lime, soda, ash, alum	100,000 cubic yards	No longer used, closure planned beginning in 1988.

TABLE 4-18

INACTIVE WASTE SITES AND RELEASES IDENTIFIED DURING THE ANL ENVIRONMENTAL SURVEY (Continued)

Site[a]	Period of Activity or Date of Occurrence	Activity	Size/Depth	Waste Types	Quantity	Status
15. Past Leaks from Laboratory and Sanitary Sewer Lines[c]	7 to 8/85	Leaking pipes	6,000 to 8,000 linear feet	Low-level radioactivity, organic and inorganic chemicals, sanitary wastes	Unknown	Leaking pipes repaired by in-situ lining in 1985.
16. Site A[b]	1943 to 1954	Research reactors and laboratories	19 acres	Radioactivity and chemicals	Unknown	Site A has been demolished and is now part of a public forest preserve; overgrown with grasses, shrubs, and trees.
Lead melting	1943 to ? (before 1954)	Production		Lead	Unknown	
Septic field	1943 to 1954	Treatment/disposal		Sanitary wastes, photo lab wastes, possibly hazardous wastes	Unknown	
Landfill	1943 to ? (before 1954)	Disposal		Domestic wastes	Unknown	
Tank	1945 to ? (before 1954)	Storage		Gasoline	Unknown	
17. Plot M[b]	1943-1949	Disposal	1 acre	Low-level radioactive waste and possibly high-level radioactive and chemically hazardous wastes.	1,400 to 1,500 55-gallon drums(?)	Some materials were removed and a 1-foot-thick concrete cap and 8-foot-deep sidewalls were placed around the Plot, 2 feet underground. The area is now part of a public forest preserve.

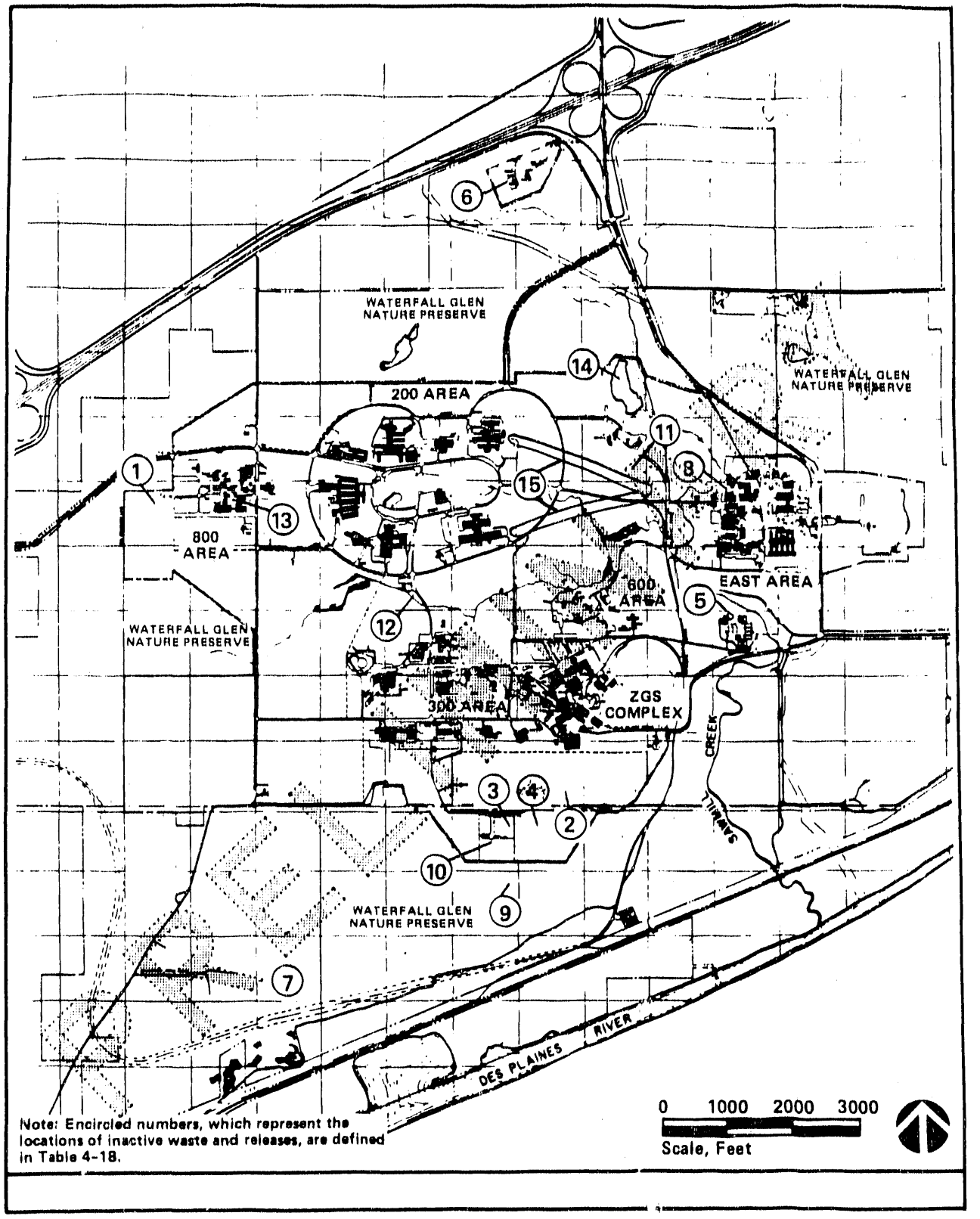
[a]Site numbers correspond to locations in Figures 4-4 and 4-5.
[b]Sites identified in the ANL Phase I Installation Assessment Report.
[c]Sites newly identified during the Environmental Survey.

storage lagoon (Site 5); 3 sites are abandoned or decontaminated and decommissioned (D&D'd) areas (Sites 6, 8, and 16), 1 of which (Site 16) is off-site; 1 site is an off-site former treatment area (Site 7); and 6 sites are leak or spill sites (Sites 9, 10, 11, 12, 13, and 15).

ANL's IAR identifies two sites that are not included in this section. The 317 Shoot-and-Burn Facility is active, although it has not been used in at least 2 years. Because it is still active, it is discussed in Section 4.1, Waste Management. The 318 Gas Cylinder Burial Area, in the northeastern corner of the 317 Radioactive Waste Staging Area, is not perceived to present an environmental hazard and is therefore not included. It is in a remote part of the site, is completely fenced, and has been posted "Warning No Digging." Approximately 100 cylinders of compressed gas, many of them lecture bottles (2 to 6 inches in diameter), were placed in 35 large postholes in the 318 Area. Although there are no records of the cylinders' contents, they are believed to have contained halogens, interhalogens, hydrocarbons, and sulfur dioxide. Most of the tanks were defective (i.e., either leaking, corroded, or having frozen valves). When possible, the cylinder contents were bled off. Lime was added to the postholes before burial to enhance corrosion (Cheever, 1986a; Kline, 1987a).

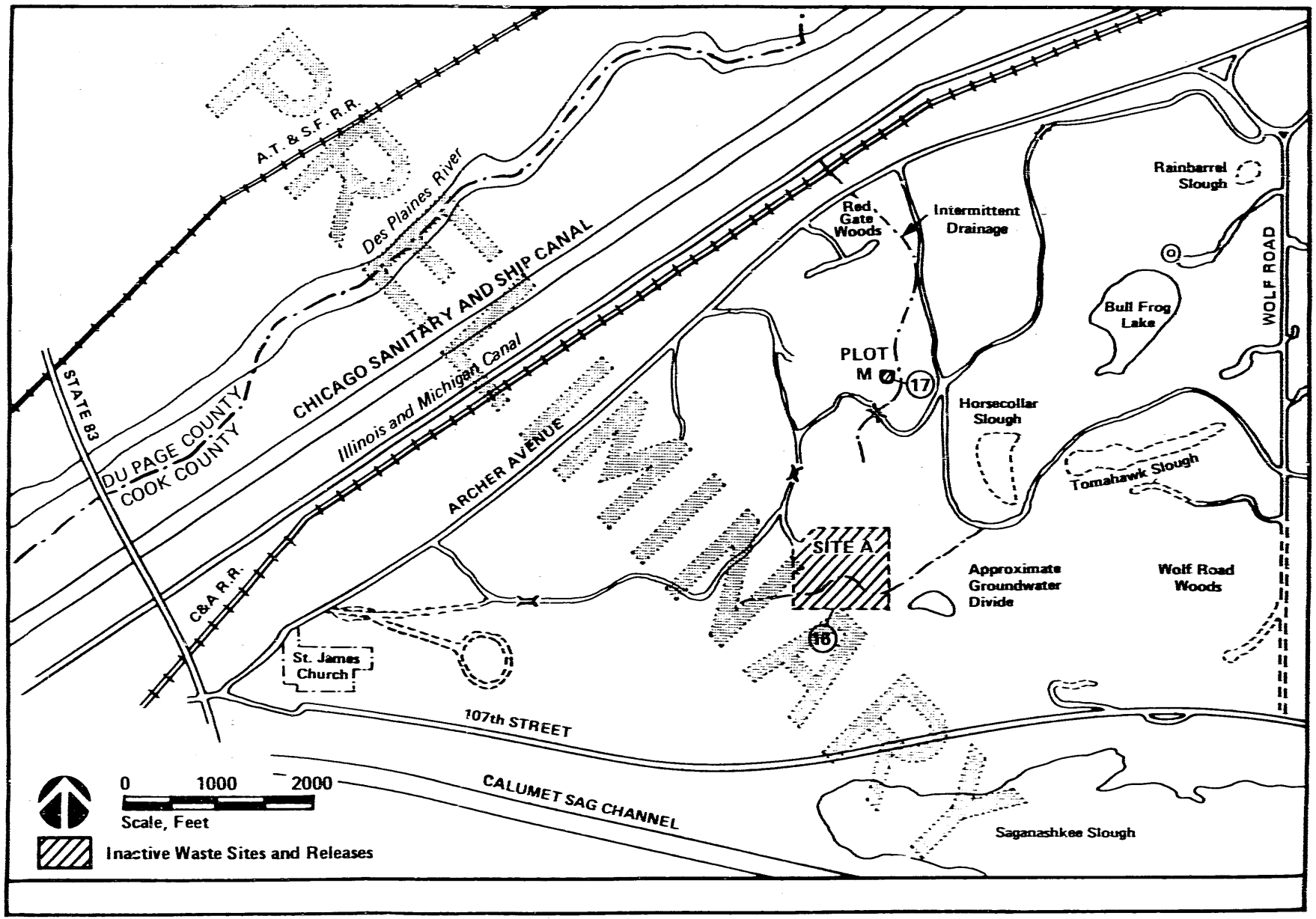
Figures 4-4 and 4-5 show the locations of the inactive waste sites and releases based on the site numbers denoted in Table 4-18. The regional context of the ANL site and the Palos Park Forest Preserve is illustrated in Figure 2-1.

Site 1 - 800 Area Landfill French Drain. A French drain was located in the northeastern portion of the currently active 800 Area Landfill. Information on the drain is based on the recollections of employees who constructed, operated, and dismantled it and from detailed disposal records (Astorino, 1987; Cheever, 1986a; STS, 1980). The drain operated from January 1969 through December 1978, and was removed in 1979. Although the drain site is presently covered by the landfill, the French drain was installed before refuse covered the area. Construction occurred by excavating a 20-foot-diameter area to an unspecified depth, filling it with 2 feet of stone, and then capping it with clay. An 18-inch-diameter corrugated pipe opened from the surface to the buried rock. Liquids were poured into the pipe with the intent that the volatile materials would evaporate in the drain. The French drain was located in soils of low permeability, 1×10^{-8} to 8×10^{-8} cm/sec, which



INACTIVE WASTE SITES AND RELEASES AT ARGONNE NATIONAL LABORATORY

FIGURE 4-4



INACTIVE WASTE SITES AND RELEASES
AT PALOS PARK FOREST PRESERVE

FIGURE 4-5

extend to at least 37 feet below the surface (STS, 1980). In 1979, the stone and pipe were removed; the removal crew recalled that the hole was dry upon excavation but that oily odors were present. The stone was placed in the 800 Area Landfill and clay was used to backfill the excavation.

Detailed records of materials disposed of in the French drain indicate that a total of 28,700 gallons of liquids were poured there over its 10 years of operation (STS, 1980). The dominant waste and quantities are listed in Table 4-19. Machine coolant was believed to contain mainly water. Wet Ege, a petroleum distillate solvent, is 47 percent paraffins, 42 percent naphthenes, 9 percent aromatics, and 2 percent olefins. Skydrol and Pydraul are phosphate ester-based hydraulic fluids.

A groundwater monitoring well network was established at the 800 Area Landfill in 1979 and has been modified since then; it is described in the Groundwater section of this report (Section 3.4.3). Most of the wells are located around the periphery of the landfill and because of this, results of the monitoring program do not differentiate between compounds contributed by the landfill and compounds contributed by the French drain. Metal levels in groundwater from several of these wells have been reported since 1983 and concentrations of manganese, arsenic, and iron have been elevated at various wells (Golchert and Duffy, 1987; Golchert et al., 1984, 1985, 1986). Thirteen organic constituents were analyzed for the first time in 1986 and none were found at concentrations above detectable limits (Golchert and Duffy, 1987). However, these data may be questionable since the ANL laboratory (IHCL) performing the analyses did not have EPA-approved analytical procedures and QA controls for organic analyses (Section 4.4.3.2).

Site 2 - ENE 319 Landfill. This inactive landfill is located in the southeastern corner of the ANL site on the slope of a steep ravine. An unnamed creek flows at its base. Information on its use is based on the recollection of employees who disposed of materials there (Astorino, 1985, 1987; Fassnacht, 1986; Finch, 1987; Lahey, 1986, 1987).

Known as the "suspect dump," the landfill operated from 1948 to the early to mid-1950s. Trucks came from the University of Chicago and dumped their contents directly into the ravine. Initially, materials were placed on native soil in the ravine.

TABLE 4-19

DOMINANT WASTES DISPOSED OF IN THE 800 AREA LANDFILL FRENCH DRAIN AT ANL, 1969 to 1978

Material	Quantity (gallons)
Waste oil	8530.8
Machine coolant	6545.0
Wet Ege	2370.0
Ferric chloride	1205.3
Skydrol	1119.0
Acetone	1058.8
Carbon tetrachloride	616.7
Water (with organic matter)	600.0
Kerosene	392.5
Trichloroethylene	326.2
Liquid scintillator	304.5
Pydraul	300.0
Wax	300.0
DMSO	189.3
Benzene	168.7
Tetrachloroethylene	161.8
Sodium azide	160.0
Diesel fuel	140.0
Alcohol	120.8
PCBs	110.0
Ether	80.9
Chloroform	66.8
Formaldehyde	51.2
Other organic compounds (17 compounds, each between 10 and 50 gallons)	402.5

Source: STS, 1980

As the ravine filled, the contents were covered with dirt and, upon closure, the landfill was covered with 2 to 3 feet of soil. Presently, the landfill is overgrown with herbs, shrubs, and trees.

There is no record of the total amount of materials disposed of at the ENE 319 Landfill. Contents included construction debris, shop turnings, pipe, rebar, wood, and ductwork; much of this came from demolition at the University of Chicago Metallurgical Laboratory. Some of the materials brought to this landfill were considered suspect (i.e., they were not believed to contain elevated radioactivity but their sizes and shapes made full surveillance impossible). In addition, use of the landfill was loosely controlled and it is possible that hazardous or known radioactive materials were disposed of there.

As part of Phase II of the U.S. Department of Energy Comprehensive Environmental Response, Compensation, and Liability Act (DOE CERCLA) characterization program, ANL personnel collected water and sediment samples from the drainage at the base of the landfill in the spring and fall of 1986 and six shallow subsurface soil samples around the landfill in the fall of 1986. These samples were analyzed for radioactivity and no elevated levels were found (Golchert, 1987a). In 1984, surface-water samples taken at the ANL fenceline approximately 1,000 feet downgradient of the ENE 319 Landfill were analyzed for metals. Mercury exceeded 1986 U.S. Environmental Protection Agency (EPA) water quality criteria for freshwater aquatic life (0.05 µg/L measured versus a 4-day-average-once-every 3-years criterion of 0.012 µg/L) (Cheever, 1986a; EPA, 1986d).

Site 3 - 317 Area French Drain. A French drain was located in the 317 Area Waste Storage Area in the southern portion of the site. Information on its construction and operation is based on the recollection of employees who used the facility (Astorino, 1987; Lahey, 1986, 1987). The drain, which operated for 4 or 5 years in the mid-1950s, was constructed by placing stones directly in a 4-foot-wide drainage ditch that may have been partially excavated to a depth of 3 to 4 feet. The stones were covered by smaller gravel, allowing trucks to drive over the drain field. The gravel also surrounded a corrugated 18-inch-diameter fill pipe that was placed into the deeper stone.

There are no records as to types or amounts of materials that were disposed of into the 317 French drain. However, ANL personnel believe that use of the 317 French drain was similar to that of other drains such as the 800 Area Landfill French drain, described previously. Therefore, it is suspected that a variety of hazardous materials, including toxic organics, were poured into the drain. One ANL employee remembers that Wet Ege, also described previously, was disposed of into the drain.

Upon closure, the 317 French drain was removed and the excavation backfilled with soil. Presently, there is no surficial evidence of the French drain. The topography and surface features of the drain location blend in with the surrounding 317 Area (i.e., flat, slightly sloping terrain with maintained grass and dirt roads). The drainage swale in which the French drain was originally constructed is apparent approximately 100 feet southeast of the drain location.

ANL has installed a monitoring well approximately 600 feet downgradient of the 317 French drain (MW-2, described in Section 3.4.3). Inorganics were analyzed and levels were below drinking water standards. However, organics, which are believed to have been disposed of in the French drain, were not analyzed.

Site 4 - 319 Landfill and French Drain. The 319 Landfill was located near the southern boundary of the ANL site, just east of the 317 Waste Storage Area, and may have succeeded the ENE 319 Landfill (Site 2 above). The associated French drain was situated at the northern end of the landfill and is believed to have succeeded the 317 French drain (Site 3 above). Information on the use of this landfill and French drain is based on aerial photographs, informal handwritten disposal records, and recollections of employees (ANL, ND; Astorino, 1985; Fassnacht, 1987; Kline, 1987a, b; Lahey, 1986, 1987).

The landfill and drain operated from approximately 1958 to 1968 or 1969. The landfill was located on a rise and was created by the excavation of two or possibly three trenches each approximately 200 feet long by 30 feet wide by 5 to 10 feet deep. There is no indication as to how the French drain was constructed but presumably it was similar to the 317 and 800 Areas French drains. Materials such as ash from garbage burn pits, construction debris, other noncombustible materials, and beryllium fluorescent tubes were disposed of into the trenches. Some of the

solids were suspect radioactive materials. There is no record of the total amounts of these materials that were disposed of at the 319 Landfill.

Additionally, both the French drain and the landfill received chemical wastes. Incomplete, informal records from the mid-1960s indicate that 116 gallons of chemicals were poured into the French drain from January 30, 1964, to July 19, 1966. These included various machine and waste oils, flammables, and organics such as chloroform and toluene. From December 1963 through October 1967, approximately 450 pounds of miscellaneous chemicals including metals and metal salts; 46 gallons of assorted nontoxic and toxic liquids, including paints, resins, and organics; and 42 cubic feet of assorted nontoxic materials were placed in the landfill.

Presently, the 319 Landfill is elevated above the surrounding terrain and the drainage swale from the 317 Area courses just south of the closed facility. The top of the landfill is covered with dirt, is topographically level, and is devoid of vegetation. There is no evidence of the French drain.

Within the past 3 years, ANL personnel have sampled soil in and around the landfill, and surface water and groundwater 500 feet downgradient at the site boundary. All three media were analyzed for radioactivity while soil and surface water were also analyzed for metals. Tritium and strontium-90 levels in surface water were 2.8×10^{-5} Ci/mL and 6.4×10^{-9} Ci/mL, approximately 150 and 20 times ambient levels, respectively; tritium levels in soil pore water of 1.2 to 3.0 nCi/L were also elevated above background of less than 0.2 nCi/L. One soil sample from the landfill contained 4.2×10^{-6} µCi/g of plutonium-239 and 1.8×10^{-6} µCi/g of americium-241, about 300 and 500 times ambient, respectively. Cadmium, iron, mercury, and lead levels in surface water were elevated above 1986 EPA water quality criteria (EPA, 1986d) for chronic exposure to freshwater organisms, while copper levels in surface water were elevated above 1986 EPA water quality criteria for acute exposure to freshwater organisms. Cadmium, copper, lead, and mercury levels in soils were elevated above background values in soils to the east (Cheever, 1986a; Golchert et al., 1986).

Site 5 - Earthen Lagoon at the Wastewater Treatment Plant. An unlined earthen lagoon is located in the northeastern portion of the wastewater treatment plant

(WWTP). It is situated in a grassy area that slopes downward to the northeast to Sawmill Creek, 200 feet from the lagoon. The lagoon, as part of the WWTP, was built during the initial development of the ANL site in the late 1940s and early 1950s. It originally was rectangular with approximate dimensions of 100 feet long by 75 feet wide by 6 feet deep. However, with the expansion of ANL, a new sedimentation basin was built in 1961 that infringed on the southwestern side of the lagoon. In 1980, a new lined pond was installed next to the unlined lagoon and the latter was taken out of service; however, the unlined lagoon still remains.

The original purpose of the unlined pond was to act as a temporary holding area for suspect radioactive wastewater. Water would be diverted from the laboratory drain system sedimentation basins to the pond for radiation monitoring. Thus, capacity could be maintained in the sedimentation basin for continued use. Depending on the results of the radiation monitoring, the pond water would either be released to Sawmill Creek or detained for radioactive decay (Cheever, 1987). An outflow from the pond led through a drainage swale to Sawmill Creek.

There are no records as to how frequently the unlined pond was used. However, the WWTP operator cannot remember a time between 1974 and 1980 when the pond was used (Bergland, 1987). Radiation monitoring in 1960 or 1961 indicated elevated alpha (74 pCi/g) and beta (248 pCi/g) activity in the soil in an area that carried overflow from the lagoon to Sawmill Creek (Golchert, 1987b). Since the pond received laboratory waste, it is possible that small quantities of inorganics and organics used in the laboratories and disposed of down the sink drains, as described in Section 3.3.2.1, may also be present in the pond soil.

Site 6 - Nike Site. The Nike Site is located within a 13-acre ANL tract that is not contiguous with the main portion of the site. It is north of the ANL campus, near Interstate Highway 55, and is surrounded by the Waterfall Glen Nature Preserve. The Department of Defense operated the site, which contained two abutting launch pads, from the late 1950s to the early 1970s. Presently, the site is overgrown with grasses and some trees and shrubs. Cement pad foundations still remain at the relatively level site.

Operations at the site that may have affected the environment, as determined by examination of a site engineering plan, include a machine shop, diesel generators

with an underground fuel tank, and an acid drain system. Hazardous materials used in the machine shop, such as solvents, may have been poured into the drains and entered the drain field, located in a grassy field in the southeastern portion of the tract. Acid drain pipes, which apparently carried excess acids used to fuel the rockets, discharged to a drainage swale that circumscribed the launch area. The swale flows to Sawmill Creek, just south of the Nike Site. The underground fuel tank used to power the site generators is still in place. In approximately 1987, it was emptied of 2,200 gallons of water and 1,750 gallons of No. 2 fuel oil. The presence of water in the tank indicates a possible leak. There is no information available on the volume of liquids that may have been discharged to the environment from these sources. Photoionization detector readings in the outlet of the drain pipe on the eastern side of the launch area, taken during the Survey, indicated an organic vapor concentration of approximately 100 ppm.

Site 7 - Underwriters Pond. Underwriters Pond is a flooded quarry located off-site in the Waterfall Glen Nature Preserve, 3,700 feet south of the southwestern boundary of ANL. During the pond's use, from January 1965 to January 1972, it was within the ANL boundary. However, in 1973, ANL turned over 2,041 acres surrounding the present facility, which included the pond, to the Nature Preserve. The southern, eastern, and western shores of the pond are nearly level with the water surface and are overgrown with bushes and trees, while the northern shore consists of a vertical rock wall. The pond itself supports abundant floating macrophytes and there appears to be no outlet.

The pond was used for the disposal of mainly water-reactive materials. On various occasions, personnel from the ANL Reclamation Department would bring containers of chemicals to the pond and either throw them directly into the pond water or against the vertical wall on the opposite side (Lahey, 1987). Based on an informal log, it is estimated that 2,800 pounds of chemicals were disposed of into Underwriters Pond including 1,500 pounds of sodium, 200 pounds of sodium-potassium, 22 gallons of ferric chloride, a variety of metals (lithium, zirconium), "miscellaneous," "various," and "assorted" chemicals, and some organics (ANL, ND; Cheever, 1986a).

Metal concentrations in the surface water of the pond were measured in 1984. Of the 12 metals, only mercury was elevated above 1986 EPA water quality criteria (Cheever, 1986a; EPA, 1986d).

Site 8 - East Area Buildings 19/34 Pipeline. Buildings 19 and 34 were located in the East Area of ANL and were razed in 1983 and 1985, respectively. Building 19 produced radioactively contaminated solutions generated by various "hot" machine shop operations and metal treating baths. These wastes flowed from retention tanks in Building 19 through an underground pipe to Building 34 (Industrial Waste Treatment Plant), located 40 feet south of Building 19, where they were processed (Kline et al., 1987).

During D&D work at Building 34 in 1985, soil surrounding the pipe that led from Building 19 to Building 34 was found to be radioactively contaminated. This pipe had apparently leaked at some time during its operating life, which extended from the late 1940s/early 1950s to 1978. In addition, radioactive soil was found next to one of the open in-ground concrete tanks abutting Building 34. This tank received "hot" machine shop wastes and also had apparently leaked (Kline et al., 1987b). There are no records on the types or quantities of materials that flowed through the pipe, were held in the tank, or leaked into the soil, although they are believed to have included radioactive wastes and possibly acids, metals, and solvents (Kline, 1987b).

All radioactively contaminated soil surrounding the pipe and concrete tank, which amounted to 7,800 ft^3 of dirt, was removed and shipped to the Idaho National Engineering Laboratory. The excavation has been backfilled and the area is now a level dirt field with some pioneering grasses.

Site 9 - Off-Site Unnamed Stream. The southern boundary of the ANL site is characterized by several ravines and streams that flow from the site, across the Waterfall Glen Nature Preserve, to the Des Plaines River. One of these streams has its headwaters in the 317 Area. A pipe that discharges into this stream, approximately 450 feet downstream of the site boundary (off-site), is believed to be the outfall for the footing drains and sumps of the radioactive materials storage vaults in the 317 Area, as described in Section 3.3.2.1 and in Site 10 below.

In December 1986 and January 1987, water and sediment from this stream were sampled at several points within the Waterfall Glen Nature Preserve upgradient and downgradient of the outfall. They were analyzed for tritium, strontium-90, and gamma emitters. Levels of tritium and strontium-90 were elevated above ambient concentrations in surface-water samples collected downgradient at least 1,400 feet below the drain pipe outfall (maximum concentrations: 1,733 pCi/L and 24.3 pCi/L, respectively), and cesium levels were elevated above ambient surface-water values 20 feet below the pipe outfall (11 pCi/L) (Golchert, 1987c). Cesium-137 was the dominant radionuclide in sediment samples, with concentrations above ambient in samples collected downgradient to 1,100 feet below the pipe outfall (maximum concentration 107.8 pCi/g). Strontium-90 and cobalt-60 values in sediments were slightly above ambient concentrations (maximum concentrations 0.45 and 1.07 pCi/g, respectively) (Golchert, 1987c). Detailed data are provided in Section 3.3.4.3 (Finding 6).

There are no records as to when the outfall was installed or the volume of liquids discharged. However, recent attempts have been made to cap the outlet. Nonetheless, discharges have still been observed from the outlet.

Site 10 - 317 High-Activity Vault. This currently active although recently unused waste storage vault is located in the 317 Area, 400 feet from the southern boundary of ANL. It is used for the temporary storage of low-level, high-activity wastes, such as fission products and contaminated clothing, before shipment off-site for disposal. The vault is in a gently sloping, maintained grassy area. It is constructed of concrete walls and flooring set approximately 22 feet into the ground, and is covered by a concrete lid. A footing drain system, overlain by soil, surrounds the vault and consists of stones and a drain pipe that is believed to discharge to a surface-water stream off-site, as described above in "Site 9 - Off-Site Unnamed Stream" and in Finding 6 of Section 3.3.4.3. There is no designed connection between the interior of the vault and the footing drain (Griffing, 1987).

In late 1984, 4 to 5 feet of water was found in the high-activity vault. Some drums containing radioactive materials were flooded and, as a result, the water was radioactively contaminated. It is believed that the water was from precipitation due to inadequate vault roofing (Lahey, 1987). The water was subsequently removed and analyzed, and a new roof was installed. The isotopic ratios of the

radioactivity measured in the vault water were similar to those in the off-site stream water described previously (Griffing, 1987). In addition, water in the manhole of the drain system in the 317 Area had elevated levels of tritium, strontium-90, and cesium-137 (Golchert, 1987c). Thus, it is possible that water may have seeped from the vault into the footing drain and connected drain system and discharged into the off-site surface stream.

Site 11 - Building 145 Drum Leak. During the Environmental Survey, a team member observed a slow-leaking 55-gallon drum labeled "Pyridine" at the northwestern corner of Building 145, next to the boiler house. The drum was on a wooden pallet and a puddle and stain on the ground at the base of the pallet occupied an area of 10 square feet. The ground consisted of compacted soil and gravel and sloped toward a temporary trench into which a cable was to be placed. ANL personnel indicated that the drum contents were actually waste oil. The spilled material appeared to be a reddish, somewhat viscous, organic liquid.

The volume of the spill is not known. However, when the leak was first discovered, the drum appeared to be rather full. During a revisit later in the week, the drum was reported to be nearly empty. Thus, the spill is estimated to have been between 10 and 55 gallons. The leaking drum was removed within 1 week following its discovery, but there was no evidence that the spill had been cleaned up.

Site 12 - Sunoco Station Spill. The Sunoco Station, located at the southern intersection of Outer Circle and Meridian Road near the center of the ANL site, provides maintenance and repair services and gasoline for employees' vehicles. It is operated on a contract basis to ANL. A stream that flows to Freund Pond and eventually to Sawmill Creek is situated south of the station. A grassy area separates the station driveways and Meridian Road from the stream. Runoff from the station's paved areas is carried in a shallow swale along Meridian Road in this grassy area to the creek. The fill pipes for the station's underground tanks are situated at the edge of the driveways near the grassy area.

In February 1986, an underground tank was overfilled and an estimated 15 to 20 gallons of unleaded gasoline spilled onto the paved area of the gas station. The gasoline ran down the grassy swale; the volume of runoff was increased by the ANL Fire Department washing down the spill to avoid a fire. Small soil and sand dams

were constructed in the path of the spill, which prevented any runoff into the stream. After the spill, it is reported that some contaminated soil was removed and the excavation was backfilled with clean soil (Astorino, 1987; Cheever, 1986b).

Site 13 - Building 827 Gasoline Island. In July 1986, an estimated 5 to 10 gallons of gasoline was found floating on the water surface of an excavation immediately north of Building 827 and adjacent to two underground gasoline tanks. It was thought by ANL personnel that the gasoline came from overflow spillage during fuel transfer operations, which then seeped through pea gravel surrounding the gasoline island and underground fuel tanks. The gasoline, which was floating on the water within the excavation was removed and the excavation backfilled after the installation of an alcohol tank (Cheever, 1986c).

Site 14 - Lime Sludge Pond. ANL's water treatment system, including a sedimentation pond, was first used in the early 1950s after initial development of the site. Until the end of 1986, domestic water treatment included adding hydrated lime, soda ash, and alum to reduce hardness and to coagulate fine particles. Sludge from this process was piped from clariflers to a 7-acre sedimentation pond, also known as the Lime Sludge Pond, located in the northeastern corner of the site. Initially, the pond was a low marshy area. As the volume of material in the pond increased, an earthen berm was built up on the east and south to contain the sludge and prevent it from flowing into Sawmill Creek. A standpipe at the northeastern side of the pond drained clarified water from the pond to Sawmill Creek (NPDES Outfall 009) (Kuljian, 1987), as described in Sections 3.3.2.1 and 3.3.3.3.

The Lime Sludge Pond contains an estimated 100,000 cubic yards of lime sludge (CDM, 1987). The southern two-thirds of the pond is composed entirely of alkaline sludge while the northern third contains sludge overlain by several inches of water; the pH of the water is between 9 and 10. On the eastern and southern sides of the pond, the berm has been built up to 15 feet above Sawmill Creek and has a freeboard of 2 feet. Grasses, shrubs, and trees vegetate the creek side of the berm and wetland plants such as cattails vegetate the pond side. On November 10, 1986, there was a slope failure of the berm when a small landslide occurred on the creek side. ANL personnel believed that it was caused by movement of a heavy truck on top of the berm; it was subsequently repaired. In addition, a small seep out of the berm was detected (Kuljian, 1987).

When the water treatment process was changed from lime/soda ash softening to ion exchange in late 1986, the discharge of alkaline sludge into the pond ended. Closure of the pond is planned to begin in 1988 and will extend over 3 years. It is anticipated that the sludge will be dredged and applied onto farmland (CDM, 1987).

Site 15 - Past Leaks from Laboratory and Sanitary Sewer Pipes. In 1985, ANL conducted a photographic examination of some of its laboratory and sanitary sewer pipes to determine their integrity. In the interpretation of the film, intrusion of roots into the vitrified clay pipes of both the laboratory and sanitary sewer lines between Buildings 202 and 212 and manhole 18 were noted, potentially resulting in infiltration or exfiltration. Manhole 18 is located south-southeast of Building 108, just north of Eastwood Drive. At one point, one of the pipes was fractured and offset (Simon, 1988). Building 202 is used for laboratory research in the biomedical sciences and contains the Janus reactor, and Building 212 is used for laboratory research in materials science and contains the Alpha-Gamma Hot Cell Facility. As described in Section 3.3.2.1, low-level radioactive materials and organic and inorganic chemicals are disposed of into the laboratory sewer system from such buildings as Buildings 202 and 212.

In August 1985, approximately 6,000 to 8,000 linear feet of sanitary and laboratory sewer lines between Buildings 202 and 212 and manhole 18 were repaired using an in-situ lining process after tree roots and other obstructions were removed (Simon, 1988). No sampling of subsurface soils has been performed to determine if soil contamination had resulted from exfiltration through the deteriorated lines.

Site 16 - Site A. After the successful operation of the first nuclear reactor (CP-1) in December 1942, at the University of Chicago, it was apparent that a move to a larger and more remote site was necessary for both secrecy and safety. The Manhattan Engineering District of the U.S. Army Corps of Engineers (MED) leased 1,025 acres of land within Argonne Forest, a part of the Palos Park Forest Preserve and located 20 miles southwest of Chicago (Figure 2-1), from the Cook County Forest Preserve District. Only about 20 acres of land was actually used: Site A was a 19-acre parcel where reactors and associated buildings, laboratories, shops, and living quarters were located, while Plot M (Site 17, discussed below), situated 2,000

feet north of Site A, was a 1-acre radioactive waste burial area (DOE, 1978). Site A is located 3 miles east of the present ANL site (Figure 2-3).

During March 1943, the CP-1 reactor at the University of Chicago was disassembled, moved to Site A, rebuilt as CP-2, and placed into operation. The reactor was constructed for uranium metal fuel with a graphite moderator. In May 1944, the first heavy-water cooled and moderated reactor, known as CP-3, began operation at Site A. It was later modified, primarily by replacing normal uranium fuel with enriched uranium, and designated CP-3'. Both CP-2 and CP-3' operated until 1954. During the early years of operation, Site A consisted of four major laboratory/office/reactor buildings, a dormitory and cafeteria, and several support buildings and facilities including a well and pump house, water tower, boiler house, cooling tower, guard houses, garage, septic tank and drain field, landfill, and a lead melting and forming operation. Later, at least 15 Quonset buildings and sheds, to house additional laboratory and storage areas, and a gas station were added. Among the programs carried out at Site A were fission product separations, reactor physics studies, tritium recovery from irradiated lithium, and studies of the metabolism of radionuclides in laboratory animals (DOE, 1978).

As a result of a revised lease agreement with the Cook County Forest Preserve District, it was necessary for the laboratory to completely evacuate the Argonne Forest area by June 30, 1956. The Government was required to "remove, destroy, or render harmless any or all installations, structures, appurtenances, materials, or conditions of the ground or terrain which shall be dangerous, perilous, or hazardous in nature or which, if permitted to remain, would interfere with the full use and enjoyment of the said premises by the public as a part of the Forest Preserve District" (DOE, 1978).

In the spring of 1955, work to comply with these requirements began. As research activities were moved to the present ANL site, which had been acquired in 1947, the empty buildings at Site A were surveyed, decontaminated if necessary, and razed. The buildings housing CP-2 and CP-3' were the only areas requiring extensive decontamination. The reactors were dismantled, the heavy water was removed, and the fuel shipped to Oak Ridge National Laboratory for reprocessing (DOE, 1978).

The tank that had contained the heavy water in the CP-3' reactor was filled with concrete. The space between the tank and the biological shield, into which had been dumped hardware, piping, and miscellaneous contaminated items, was also filled with concrete. A 40-foot-deep excavation was dug next to the CP-3' containment shell, and with the use of explosives, the reactor shell was tumbled into the pit. The shell was covered with CP-2 and CP-3' building rubble and then soil. After demolition was completed at Site A in summer 1956, the area was graded and an inscribed granite marker placed near the location of the buried reactor (DOE, 1978). Today, this area is contained within the Palos Park Forest Preserve, and is open to public access and such uses as picnicking and hiking.

Former activities and facilities that may have affected the environment at Site A include decommissioning of the CP-3' reactor; research with radioactive materials and chemicals; lead founding; and operation of a septic system, landfill, and gasoline station. As noted above, most of the facilities at Site A, including radioactively contaminated building materials, were removed from the site. However, the CP-3' reactor and biological shield were tumbled into a 40-foot pit, which was backfilled with soil.

Chemicals, including solvents, and radioactive materials were used in the laboratories at Site A. Many of these materials were disposed of at Plot M as described below; radioactive materials went into graves and bins, and chemicals were poured into a hole in the ground. However, researchers believe that some chemicals may have gone into the laboratory drains (Langsdorf, 1987; Novick, 1987; Steinberg, 1987). In addition, a weekly survey report of October 5, 1945, indicates that a saturated solution of uranium salts was accidentally poured into the Site A photographic darkroom drain (Crain, 1945). Based on engineering site plans and aerial photographs, it is likely that these drains led to a septic field on the eastern side of Site A.

Engineering site plans, aerial photographs, and references in the August 17, 1945, weekly health physics report (Wimunc, 1945a) also indicate the presence of a lead foundry at the southern boundary of Site A. In addition, a Site A researcher recalls that in the summer of 1943, a makeshift lead melting and forming operation consisting of an open fire and a kettle was used (Langsdorf, 1987). Residuals from these operations may have contaminated the soil.

A landfill is referenced in an August 24, 1945, weekly health physics report (Wimunc, 1945b) and is apparent in aerial photographs. It was located 300 feet west of the outer fence and was used for nonradioactive wastes. However, the weekly health physics report indicates the presence of radioactive contamination, but below the instrument detection limit of 1 milliroentgen per hour (mR/hour).

Finally, an underground gasoline tank is indicated in a site plan. The tank was not part of the original site but was added during later expansion. It is not known whether the tank was ever removed.

There are no definitive records as to whether any radioactive or hazardous materials were discharged from these facilities into the environment. However, certain suppositions have been made from an understanding of activities at Site A, as described above. In addition, some radiological environmental monitoring at the site has occurred. In 1976, four holes were drilled to depths of 60 feet and 50 feet north, east, south, and west of the buried CP-3 reactor. Gross alpha and beta activity, uranium, strontium-90, plutonium, and gamma-emitting nuclides were either less than detection limits or were at background levels. Tritiated water was detected at elevated levels in all four cores but was especially elevated to the west, where the maximum measurement was 444 nCi/L. Maximum levels in the other cores were 17.7, 92.7, and 2.26 nCi/L to the north, south, and east, respectively. Concentrations under 0.5 nCi/L are considered ambient. Tritium concentrations generally increased with depth to a maximum at 15 feet, then decreased to a minimum at 40 to 50 feet, then increased again at 60 feet (DOE, 1978). Annual monitoring of groundwater at 160 feet in the dolomite near Site A, as discussed in Section 3.4.3, has not detected any tritium (Golchert, 1987d).

Also in 1976, surface soil samples were sampled on a grid throughout Site A that produced 104 cores. Gross alpha and beta activities were in the background range for surface soils in the Chicago area. However, about 10 percent of the samples had elevated amounts of gamma emitters. In addition, 9 of 12 soil moisture samples had elevated tritium levels. Thus, the results show that small amounts of radionuclides from Site A operations remained at random locations (DOE, 1978).

Site 17 - Plot M. Plot M is a less than 1-acre waste site located in the Palos Park Forest Preserve about 3 miles east of the present ANL site (Figure 2-3). The information presented below was compiled by the Survey team through review of operational reports and records covering the period 1944 to 1950, reports and documents about the site prepared by others at later times, and environmental monitoring reports for the site.

As described above for Site A (Site 16), the U.S. Army Corps of Engineers leased 1,025 acres of land from the Cook County Forest Preserve District on July 11, 1942, for use by the MED. The MED was the organization responsible for the massive effort of developing the first atomic weapons. Site A, constructed on the leased land, and the "city sites" (New Chemistry, West Stands, Ryerson, Site B, and the Armory) on or near the University of Chicago campus, were all part of the MED effort. Plot M was a radioactive waste burial site for all of these locations from 1943 through 1948.

The types of material disposed of in Plot M varied over the years. These included liquid wastes, animal carcasses, and a variety of contaminated material ranging from laboratory coats to desktops. At the time, radioactive materials were rare and valuable from both a scientific and a national defense standpoint. Therefore, radioactive material in a usable form and of known origin was stored for later use. However, spills and accidents would often render the material useless. Once material was injected into an animal for biological testing, it could not be recovered. Often, radioactive materials in flasks, jars, or cans would be of unknown origin and would cause high exposure rates in occupied areas. These materials were buried in Plot M for the protection of the workers.

Insufficient data exist to estimate the quantity of radioactive material or the composition of waste disposed of in Plot M. However, health physics records for the period shed some light on the materials. The materials buried include various nuclides of plutonium, uranium, and thorium; radium-226; tritium; a wide variety of fission products from reactor operations; lead; and a variety of volatile chemicals. The external dose rates from the surface of the materials ranged from 1 mR/hour to 50 R/hour (Feldes, 1945). One mR per hour was the lower limit of detection of the survey equipment available at the time. The 50-R/hour material and other wastes exhibiting external dose rates greater than 10 R/hour usually

resulted from accidents involving the processing of irradiated "slugs." The slugs were targets that were placed in the reactors to produce various radioactive materials. Alpha contamination levels generally exceeded 1,000 disintegrations per minute (dpm), the limit of detection of the available equipment. The amounts of plutonium in individual items for disposal were as high as 1,000,000 dpm or about 25 microcuries (Floury, 1946).

During this period, some of the wastes were placed in containers ranging from glass bottles to wooden boxes for disposal. Metal shields, including lead shields, were used for disposal of high-activity wastes. Many odd-shaped and oversized items such as construction material and animal carcasses were disposed of without containers. The waste was placed in graves about 6 feet deep, 10 feet long, and 4 feet wide. Higher activity wastes were usually placed in the bottom of the graves. Soil was added to the graves to shield the wastes (Wimunc, 1945c).

The graves often filled with water from rainfall. One health physics report from May of 1945 suggests that the water from the trenches was pumped to a nearby gully (Wimunc, 1945d). This report and the results of analyses of vegetation samples taken in 1946 and 1950 indicate that extensive surface contamination existed while the site was active. Plant samples in 1946 showed plutonium concentrations as high as 30 nCi/g (Russell, 1946). In 1950, plants of various species were sampled and exhibited external dose rates as high as 20 mR/hour (Pancner et al., 1950).

Plot M was fenced through most of its operating life. The exact time the fence was installed is not known. On March 30, 1945, a health physics report indicated that "habitating animals" at the site would "feast" on the uncovered animal carcasses in the graves (Wimunc, 1945e). This biological intrusion undoubtedly caused the spread of some contamination. A report in May 1945 noted that grave 25 was outside the fenced grave plot (Wimunc, 1945f). These reports suggest that fencing was installed between March and May of 1945 since it is doubtful that grave 25 would have been dug outside an existing fence. This later report also suggests some uncertainty at the time as to the exact locations of the graves.

Hazardous wastes disposed of during this period included lead and a variety of volatile liquids. A weekly health physics report ending October 5, 1945, indicates on

exposure rate of 5 mR/hour over "a small hole, down which volatile liquids have been poured" (Crain, 1945). The chemicals in use at the time included mineral acids; ammonium, sodium, and potassium hydroxides; potassium permanganate; potassium dichromate; potassium iodide; hydroxylamine; hydrazine; hydrofluoric acid; perchloric acid; acetone; ethanol; methanol; carbon tetrachloride; diethyl ether; chloroform; ethyl isobutyl ketone; trifluoroacetone; and tributyl phosphate.

With the end of World War II, many changes in Plot M operations occurred during 1946 and 1947. By June 1946, many of the more radioactive liquids were being shipped to Oak Ridge (then known as Clinton) for disposal (Stewart, 1946). By December of that year no liquids were to be disposed of in Plot M. However, up until then, 210 gallons per day of material had been buried at Plot M, including paper and biological wastes. By this time, 85 percent of the original plot (125 feet by 115 feet) was filled (Floury, 1946). By the next summer (1947), the plot was full and all radioactive wastes were shipped to Oak Ridge. However, in October the plot was expanded to 150 feet by 150 feet and the disposal of dry waste was resumed.

Sometime between October 1947 and July 1948, all wastes were placed in numbered steel vaults for disposal. Disposal in these vaults continued at Plot M until May 1949 (Ross, 1974), when it was discovered that a valuable radioactive source was missing and might have been placed in one of the vaults. The site began to remove the vaults to find the source. Four vaults were removed between May 24 and May 26, 1949. Their contents were dumped on the ground and inspected. It is likely that the source was found in one of these vaults, because the surface of the plot was cleaned up on May 27, 1949, and the removal process stopped. The cleanup was accomplished with a tractor and various hand tools. The recovery operation resulted in an expansion of the original waste volume so that all the waste could not be returned to the vaults. The excess waste was placed in the open trenches from which the vaults were removed (Pancner et al., 1949a).

Sometime during the next week, a decision was made to remove as much waste as possible from the site for storage at the present ANL site for future disposal elsewhere. Between June 4 and 8, 1949, the remaining vaults were removed and shipped to the ANL (Pancner, 1949b). Also, an attempt was made to remove older wooden waste containers. These containers broke in the process and so were not removed. The wastes remaining in Plot M today therefore are all wastes disposed of

between 1943 and 1947 or 1948 when the use of steel vaults was begun, plus portions of the contents of the four vaults dumped in late May 1949.

Shortly after the war, the Atomic Energy Commission (AEC), who assumed responsibility for MED activities and sites, began considerations on the future of Site A and Plot M. One option was acquisition of the site through condemnation in 1946 (Banahan, 1973). In 1947, the old lease was terminated and a new lease for the land containing Site A and Plot M (20 acres) was executed for a period extending to June 30, 1956. Various alternatives, including removal of the wastes, were evaluated in the early 1950s. It was decided that waste removal would be too risky for both workers and the environment. Instead, an inverted concrete box extending 8 feet below the ground was constructed over the plot. The top of the box was 1 foot thick and was covered with an additional 2 feet of soil (Ross, 1974). Uncertainty about the location of the graves as early as 1946, however, raises some doubt as to whether all the waste is covered under the inverted box.

Various types of environmental studies were conducted at Plot M between 1948 and 1973. In general these studies examined a limited number of media and locations for radioactivity, and showed very little migration of waste away from the plot. However, water samples from Forest Preserve picnic (drinking water) wells near the plot began to show elevated levels of tritium in 1973 (DOE, 1978). This was the first indication that significant amounts of radioactive material were leaving the site. Tritium concentrations up to 13,000 pCi/L (14 percent of the proposed EPA drinking water standard) were observed, as discussed in Section 3.4.3.4. These results prompted the DOE to conduct a major monitoring program under their Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1976. This study verified the migration of tritium from the plot and reported trace amounts of strontium and plutonium near the plot. The study concluded that the radiation exposures from the site in its condition at that time did not represent an immediate health risk to the public (DOE, 1978). Environmental studies for radiological constituents were conducted at Plot M throughout the 1980s (Golchert, 1987d). The conclusions of these studies have been similar to those of the FUSRAP study and the Survey team concurs with these conclusions.

In 1986, hazardous chemical constituents in groundwater samples at Plot M, including 12 metals and 13 organics, were analyzed for the first time (Golchert,

1987d). One sample was taken from each of five wells on the perimeter of Plot M and one was taken from a control well. All concentrations of metals were below any applicable standards and all organics were below detectable limits. However, no conclusions can be drawn since these data are from a one-time sampling effort; the constituents analyzed do not correlate well with chemicals potentially disposed of at Plot M; and the sampling and analytical procedures may be inadequate, as discussed in Sections 3.4 and 4.4.

Additionally, samples were collected quarterly in 1986 from the Red Gate Woods picnic area well and analyzed for 17 inorganic constituents (Golchert, 1987d). Lead, manganese, and sulfate levels were elevated above Illinois drinking water standards (State of Illinois, 1985), and iron and nickel levels exceeded EPA quality criteria for consumption (EPA, 1986d). As discussed in Section 3.4.3.4, elevated lead and manganese levels may be due to well pump deterioration, and elevated sulfates appear to be a regional phenomenon.

4.5.2 Findings and Observations

4.5.2.1 Category I

None

4.5.2.2 Category II

1. Potential contamination from uncontrolled waste disposal at Plot M. Due to inadequate physical and institutional control, radioactive and hazardous wastes disposed of in Plot M could result in unacceptable human exposures from human or natural disruption, and is resulting in soil, groundwater, and surface water contamination.

   Based on a review of past and present radiological monitoring data, the Survey team has concluded that there is no immediate health threat from radioactivity to the public using the area in its present state. However, human intrusion into the waste, now and in the future, or future natural disruption and dispersion of the waste could result in unacceptable human exposures.

Presently, Plot M is located in a forest preserve with full public access. The probability of human intrusion and the resulting exposures cannot be estimated. In addition, future natural disruption and dispersion of the wastes cannot be modeled because no waste inventory can be reconstructed. The Survey team's evaluations concerning potential exposures are based on a review of documents dating from early 1944 to the present. The major facts which support this evaluation are as follows:

- Waste containers exhibiting external radiation levels in excess of 50 R/hour were buried in Plot M (Feldes, 1945);
- Wastes containing plutonium and other transuranic nuclides in excess of 10^6 dpm were buried in Plot M (Floury, 1946);
- Other radionuclides such as radium, thorium, uranium, tritium, and a variety of fission products in unknown quantities and concentrations were buried in Plot M (Feldes, 1945; Ross, 1974);
- Lead and volatile liquids with hazardous characteristics were buried in Plot M (Crain, 1945);
- The physical properties of the waste buried in Plot M (often liquids) and their containers provide little isolation from the environment;
- Uncertainty about the locations of the "graves" within Plot M could mean that isolation measures taken after the site was closed may not totally contain the waste;
- Environmental monitoring of soils has shown that dispersion has resulted in the migration of significant amounts of tritium away from the original waste graves (DOE, 1978);
- Elevated levels of tritium have been found in the surface water stream that flows past Plot M and, in particular, in a seep down-gradient of Plot M that discharges to an intermittent stream, as described in Section 3.3.3.5 (Golchert, 1987d);

- During routine ANL groundwater sampling and analysis, low levels of strontium-90 and uranium-234, 235, and 238 have been identified in glacial till water in proximity to Plot M. In addition, levels of tritium up to 13,000 pCi/L (approximately 14 percent of the proposed EPA standard for community drinking water supply) have been identified in the picnic wells and other wells which tap the dolomite aquifer downgradient of Plot M (Golchert, 1987d); and

- Lead, manganese, and sulfate levels in the down-gradient public drinking water well were elevated above Illinois drinking water standards, as discussed in Section 3.4.3.4, and iron and nickel levels exceeded EPA quality criteria for consumption. Lead and manganese levels may be elevated due to well pump deterioration, and sulfates are elevated throughout the region (Golchert, 1987d).

Because the waste is not homogeneous, investigations in the Sampling and Analysis (S&A) phase of the Survey to determine the contents of the waste site are not practical. Also, drilling or boring into the waste could be a significant hazard to the investigators and the environment. However, groundwater from existing wells, including a public drinking water well, and a newly installed well, soil from a newly installed well, and water and sediment from a seep will be sampled during the S&A phase of the Survey to determine the presence and concentration of a broad range of organic and inorganic hazardous constituents. Although it is known that chemical hazardous wastes were disposed of into Plot M, environmental monitoring of chemicals has only recently been undertaken by ANL and only for a limited number of parameters (Section 3.4.3.4). Because these data are insufficient and the monitoring program may be inadequate (Section 3.4.4.3, Finding 2) to determine which hazardous substances are present and whether they pose a threat to human health, the additional chemical sampling and analysis are indicated.

4.5.2.3 Category III

1. Potential contamination from an abandoned French drain at the 800 Area Landfill. PCBs and nonradioactive hazardous wastes, including the toxic

constituents associated with motor oil, diesel fuel, and kerosene, were disposed of in a French drain, now inactive in the active 800 Area Landfill, and have the potential to contaminate the surrounding soil, groundwater, and surface water.

A French drain was constructed into the native soils in the northeastern corner of the 800 Area Landfill. Detailed records of materials disposed of into the drain were maintained; during its 10 years of operation (1969 through 1978), approximately 28,700 gallons of liquid, including 8,531 gallons of waste oil, 1,875 gallons of mainly volatile organic chemicals, 533 gallons of kerosene and diesel fuel, and 110 gallons of PCBs, were poured into it (STS, 1980). The liquid wastes have the potential to migrate downward and contaminate the soil and groundwater. However, the soils in this area are of very low permeability, 1 x 10^{-8} to 8 x 10^{-8} cm/sec, and extend down to at least 37 feet below the surface (STS, 1980). Lateral movement may also affect surface water surrounding the landfill, especially to the southwest and possibly through NPDES discharge point 005.

Because materials disposed of into the French drain have been well documented, no sampling is recommended. In addition, the most feasible location to place new wells or sample existing wells (around the periphery of the landfill) would not enable differentiation of compounds contributed by the landfill from compounds contributed by the French drain.

2. Potential contamination from the combined abandoned 319 Landfill/French drain. Suspect building materials and hazardous wastes disposed of into the 319 Landfill and associated French drain have the potential to contaminate the surrounding soil, groundwater, and surface water.

The 319 Landfill was created near the southern boundary of the ANL site by excavating two or three trenches approximately 200 feet long by 30 feet wide by 5 to 10 feet deep; a surface stream flowed at the southern edge of the trenches. A French drain was installed just north of the trenches. Both the landfill and the drain operated from 1958 to 1968 or 1969. The former received ash from burn pits; construction debris; other noncombustible materials; beryllium fluorescent tubes; suspect radioactive materials; solid and

liquid chemicals, including metals and metal salts; and assorted toxic and nontoxic liquids. The French drain received various machine and waste oils, flammables, and organics. There are no records of the total amounts of materials disposed of at these two facilities, (ANL, ND; Astorino, 1985; Fassnacht, 1987; Kline, 1987a, b; Lahey, 1986, 1987).

Elevated levels of radioactivity have been found in the soil, surface water, and groundwater surrounding the landfill (Cheever, 1986a; Golchert et al., 1986). Chemical contaminants may also be seeping or leaching from the landfill/French drain into the nearby stream or into the soil and groundwater. Cadmium, copper, iron, mercury, and lead levels in surface waters surrounding the landfill were found to exceed EPA water quality criteria for freshwater aquatic life (Cheever, 1986c; EPA, 1986d). Since sampling and analytical methods were unspecified and may result in questionable results, as described in Finding 3 of Section 4.4.4.4, the validity of these data is uncertain. To indicate whether contaminants are present during the sampling and analysis phase of the Survey, soils, groundwater, and sediment will be sampled near the disposal facility and analyzed for volatile and semivolatile organics, pesticides, PCBs, and metals.

3. Potential contamination from an abandoned French drain in the 317 Area. Unknown amounts and types of hazardous wastes that were poured into the 317 Area French drain have the potential to contaminate the surrounding soil, groundwater, and surface water.

A French drain was constructed in a surface drainage swale in the 317 Waste Storage Area, located near the southern boundary of the site. Although there are no records of what was disposed of into the drain during its 4 to 5 years of operation in the mid-1950s, it is suspected that a variety of hazardous materials, including toxic organics, were poured there (Astorino, 1987; Lahey, 1986, 1987). There are several pathways by which the contents of the French drain may have contaminated the environment. Liquid chemicals may have seeped directly into the surface drainage, contaminating surface water and sediment. They may also have migrated downward and affected the soil and groundwater.

Because there is a paucity of information on the concentration of chemicals in the surrounding environment, soil at the French drain and sediment in the drainage swale will be sampled during the Survey's S&A phase. Due to the uncertainty of what was disposed of into the drain, a wide variety of organics and metals will be analyzed. The resulting data will be used to indicate whether contaminants are present above background in the surrounding media.

4. Potential leak of a high-activity vault. Radioactive waste may have seeped from the high-activity, low-level waste storage vault in the 317 Area, contaminating the surface water, soil, and groundwater.

In late 1984, 4 to 5 feet of water was found in the high-activity vault in the 317 Area as described in Finding 6 of Section 3.3.4.3. The water had flooded some drums containing radioactive materials and was itself radioactive. In late 1986, radioactivity was detected in water and sediments in an off-site stream that is believed to have received discharges from the footing drain and sump system of the 317 Area. The isotopic ratios of the radionuclides detected in the stream were similar to those of the water collected from the flooded vault (Griffing, 1987).

Because there is no direct connection between the vault and the footing drain system, it is believed that water may have leaked from the vault into the surrounding drain. The water would then have the potential to migrate downward and contaminate the soil and groundwater. During the S&A phase of the Survey, soils will be sampled just outside the footing drain and analyzed for radioactive species as an indication of whether they are contaminated.

5. Potential contamination from past sewer pipeline leaks. Broken laboratory and sanitary sewer pipes may have resulted in releases of radioactive, organic, inorganic, and sanitary wastes into the underlying soil and groundwater.

During a 1985 photographic examination of the laboratory and sanitary sewer lines at ANL, intrusion of roots and a misalignment were noted in the pipelines extending from Buildings 202 and 212 to manhole 18, south-southeast of

Building 108. These breaches in the pipeline potentially resulted in exfiltration of low-level radioactive, organic, inorganic, and sanitary wastes coming from Buildings 202 and 212. The presence of radioactive and chemical contaminants in the wastewater is discussed further in Section 3.3.4.3, Finding 1, and Section 4.1.2.2, Finding 2. These releases may have contaminated the underlying soils. Also, with the driving force of continuous exfiltration and precipitation, the releases may have contaminated, and may continue to contaminate, the groundwater.

It is not known when breaks in the pipes first occurred or what quantities of suspected contaminants may have been released. However, in August 1985, 6,000 to 8,000 linear feet of sanitary and laboratory sewer lines between Buildings 202 and 212 and manhole 18 were repaired using an in-situ lining process. Residual contaminants which may be in the soil underlying the pipeline were not investigated and any necessary soil cleanup has not been initiated.

The integrity of other laboratory and sewer pipelines at ANL is also in question and is discussed in Section 3.3.4.3, Finding 7.

6. Potential contamination from former activities at Site A. Use of certain facilities at Site A, such as a septic drain field, lead foundry, landfill, and gasoline station, and the operation and demolition of research and reactor facilities may have resulted in contamination of soil and groundwater.

Site A is located in a forest preserve with public access, 3 miles east of the present ANL site. Historical aerial photographs, site plans, weekly health physics reports, and employee interviews indicate that a variety of facilities and activities at Site A during its operation and decommissioning from 1943 to 1956 have the potential to contaminate the environment. Chemical and radioactive materials may have been discharged through laboratory drains to the septic drain field. Residuals from lead foundry operations may have contaminated the soil. The site landfill was to be used for nonradioactive wastes but small amounts of radioactivity were detected in 1945. An underground gasoline tank was also present at Site A but its disposition is not known.

The CP-3 reactor and containment shield were buried at Site A. Radiological surveys in 1976 indicated elevated levels of tritiated water surrounding the buried reactor, which were attributed to heavy water used in the CP-3 reactor. Surface soil samples throughout Site A show that small amounts of radionuclides remain at random locations from site operations (DOE, 1978).

There are no definitive records as to whether hazardous materials were discharged to the environment, although certain inferences from an understanding of site activities indicate that inactive sites and releases are present. As a result, contaminants may be present in the soil that have the potential to migrate into the groundwater. The vicinity of the lead operations, the septic drain field, the landfill, and the gasoline tank will be sampled during the S&A phase of the Survey to aid in assessing whether the subsurface soils are contaminated.

7. Potential contamination from the abandoned ENE 319 Landfill. Unknown quantities and types of materials, believed to be mainly construction debris, piping, ductwork, and other metals, were disposed of into the loosely controlled ENE 319 Landfill and, as a result, contaminants may leach into the soil, groundwater, and nearby stream.

The ENE 319 Landfill, located in the southeastern corner of the ANL site, is situated on the slope of a ravine; a creek flows along its base. During its operation from 1948 to the early to mid-1950s, trucks came from the University of Chicago and dumped their contents, mainly building demolition debris, directly into the ravine. Some materials brought to this landfill were considered suspect (i.e., they were not believed to contain elevated levels of radioactivity but their sizes and shapes made full surveillance impossible). Because use of the landfill was loosely controlled, it is possible that radioactive or chemical wastes were disposed of into the ravine (Astorino, 1985, 1987; Fassnacht, 1986; Finch, 1987; Lahey, 1986, 1987).

Presently, the landfill face is relatively steep, covered by soil, and overgrown with grasses, shrubs, and trees. Rainwater may infiltrate through the fill and leach contaminants into the soil, groundwater, and surface-water stream. The

sediments in the stream may act as a sink, collecting and storing contaminants. Mercury levels in the water of the adjacent stream were measured in 1984 and were found to exceed EPA water quality criteria for freshwater aquatic life (Cheever, 1986a; EPA, 1986d). Since sampling and analytical methods were unspecified and may result in questionable results, as described in Finding 3 of Section 4.4.4.4, and since no upstream samples were collected, the validity of these data and the source of the mercury are uncertain.

Because of the unknown nature of disposal activities at the ENE 319 Landfill and the lack of chemical data in the surrounding environment, soil and stream sediment will be sampled during the S&A phase at the base of the landfill and analyzed for a variety of organics and metals to indicate whether contaminants have migrated into these media.

8. Potential contamination from past activities at an abandoned Nike Site. Past usage of an abandoned underground fuel tank, a septic drain field, and an acid drain pipe at the abandoned Nike Site may have introduced hazardous substances into the environment, resulting in localized contamination of the soil, groundwater, and surface water.

The Nike Site, located on ANL property but in a separate 13-acre tract 3,500 feet north of the main campus, was operated by the Department of Defense from the late 1950s to the early 1970s. Based on site engineering plans and Survey observations, several activities and facilities at the Nike Site may have affected the environment. Hazardous materials used in the machine shops and elsewhere may have been poured into the shop drain and entered the Nike Site septic drain field, and acid drain pipes may have discharged directly to a drainage swale that led to Sawmill Creek. There are no records as to whether these activities occurred or, if they did, the amounts of materials that were discharged. An abandoned underground tank of No. 2 fuel oil may have had a leak, since the tank was found to contain 2,200 gallons of water as well as 1,750 gallons of fuel oil when it was finally emptied.

Hazardous wastes possibly released from the fuel tank and into the drain field have the potential to migrate through the soil and into the groundwater. Liquids discharged from the acid drain pipe and into the drainage swale may

have flowed into and contaminated surface water or migrated into the soil and contaminated the groundwater. However, there are no estimates as to the amounts of materials that may have been released. During the S&A phase, soil samples will be taken near the underground tanks, in the drain field, and in the drainage swale and analyzed for organics and particular metals, where appropriate.

9. Potential spill from Lime Sludge Pond. A potential for failure of the Lime Sludge Pond berm exists and the resulting release could adversely affect Sawmill Creek water, sediment, and biota.

The 7-acre Lime Sludge Pond, located in the northeastern corner of the site, is no longer in use. However, it presently contains an estimated 100,000 cubic yards of hydrated lime, soda ash, and alum sludge (CDM, 1987). A 15-foot-high berm on the eastern side of the pond separates the pond sludge from adjacent Sawmill Creek. The berm was built up over the years of pond use (early 1950s to 1986) as the sludge level rose. Presently, grasses, trees, and shrubs vegetate the creek side of the berm.

A partial berm failure occurred shortly before the Survey, possibly caused by movement of a heavy truck on top of the berm. The berm failure resulted in seepage of pond contents into Sawmill Creek. At the same time, other seepages of pond contents through the berm, due to unknown causes, were also noted (Kuljian, 1987). During the Survey, the berm slope was observed to be overgrown with vegetation. This could cause a weakening of the berm and may result in a release of pond contents. These releases could adversely affect Sawmill Creek water, sediment, and biota, as described in Finding 2 of Section 3.3.4.3.

10. Potential contamination of an off-site pond. Water-reactive chemicals, including sodium, sodium-potassium, and other metals, disposed of into Underwriters Pond may have contaminated the surface water, sediment, and groundwater.

Underwriters Pond is located 3,700 feet south of the ANL site, in the Waterfall Glen Nature Preserve, a public access area. The pond was used from January

1965 to January 1972 for the disposal of mainly water-reactive chemicals. Based on an informal log, approximately 2,800 pounds of chemicals, including 1,500 pounds of sodium, 200 pounds of sodium-potassium, and a variety of other metals and organics, were disposed of into the pond (ANL, ND; Cheever, 1986a). Since not all materials were water-reactive, these potentially hazardous substances may have settled to the bottom of the pond. In addition, the solid by-products of the reactions may also have settled. This could result in contamination of the pond sediments; leaching from the sediment may further contaminate the pond water. Mercury levels in the pond water exceeded 1986 EPA water quality criteria for freshwater aquatic life (Cheever, 1986a; EPA, 1986d). However, since sampling and analytical methods were unspecified and may result in questionable results, as described in Finding 3 of Section 4.4.4.4, the validity of these data is uncertain. There appears to be no direct connection between the pond and other surface water. However, groundwater in this area discharges to the Des Plaines River. Thus, contaminants leaching to the groundwater may be released to surface water.

Because the sediments are the most likely sink for any contaminants, they will be sampled and analyzed for metals during the S&A phase of the Survey as an indication of whether residuals are still present.

11. Potential residual chemical contamination at a D&D site. Possible residual organic and inorganic wastes may be contaminating the soils between the former locations of Buildings 19 and 34 and potentially the groundwater.

Buildings 19 and 34, located in the East Area, were demolished in 1983 and 1985, respectively. Radioactively contaminated solutions were produced in Building 19 and flowed via a 40-foot-long underground pipeline to Building 34 (Industrial Waste Treatment Plant), where they were processed. The liquids may have contained acids, metals, and solvents. During D&D of Building 34, soils surrounding the pipeline and an open, in-ground concrete tank adjacent to Building 34 were found to be radioactively contaminated, presumably from leaks in the pipeline and tank. Although there are no records as to the chemicals or volume of liquids that leaked from the pipe and tank (the system

operated from the late 1940s/early 1950s to 1978), 7,800 cubic feet of radioactively contaminated dirt was removed (Kline et al., 1987).

Soil removal was based only on radioactivity levels and no chemical analyses were performed (Kline, 1987b). As a result, hazardous substances such as metals and organics may still be contaminating the soil. Any remaining wastes in the soil have the potential to migrate into the groundwater, thereby posing a hazard to two nearby ANL drinking water supply wells. Soil samples will be taken near the pipe during the Survey S&A and analyzed for metals and organics as an indication of whether residual chemical contamination is present.

12. Potential contamination from a storage pond. Radioactive, organic, and inorganic wastes from the laboratory drain system were detained in an unlined, earthen holding pond at the ANL wastewater treatment plant and may be present in the soil and have the potential to contaminate the groundwater and surface water.

The pond, located in the northeastern portion of the ANL wastewater treatment plant, was constructed to serve as a temporary holding area for suspect radioactive water discharged from the laboratory drain system. Because these liquids were from the laboratory drain system, they may have contained both radioactive and chemical contaminants. The detained water was monitored for radiation only and, depending on the results, would either be released to Sawmill Creek or held for further decay (Cheever, 1987). An outflow from the pond led through a drainage swale to Sawmill Creek, 200 feet away; elevated levels of alpha and beta activity have been detected in this swale (Golchert, 1987b). There are no records as to how frequently the pond was used during its operating life from the early 1950s to 1980.

Because the holding pond is unlined, contaminants may be present in the soil and, therefore, have the potential to migrate to the groundwater and Sawmill Creek. As an indication of the presence of this contamination, soil in the bottom of the pond will be sampled and analyzed during the Survey's S&A phase for organics, metals, cyanide, and radioactivity.

4.5.2.4 Category IV

1. Potential contamination from minor spills and leaks. Minor chemical and petroleum spills and leaks at ANL may result in localized surficial soil and possibly surface water contamination.

   Two examples of small spills and leaks, which were investigated during the Environmental Survey, are as follows.

   - A slowly leaking 55-gallon drum was observed during the Survey at the northwestern corner of Building 145, next to the boiler house. The barrel was labeled pyridine although site personnel indicated that the contents were actually waste oils. The spill occupied an area of 10 square feet and the volume was estimated at between 10 and 55 gallons. One week after discovery of the spill, the drum had been removed but a stain remained on the ground. As a result, the residual material may either run off into a nearby surface water ditch or migrate into the soil.

   - In February 1986, an estimated 15 to 20 gallons of unleaded gasoline spilled at the Sunoco Station, located in the middle of the site at the southern intersection of Outer Circle and Meridian Road. The fuel flowed down a 300-foot-long grassy swale along Meridian Road and was stopped with small sand and soil dams (Cheever, 1986b). The gasoline on the surface was removed by absorption, and contaminated soil was removed by excavation. No quantitative analyses were performed to determine whether all contaminated soils were removed during cleanup (Astorino, 1987). If spill residues were not sufficiently removed, residual material may have migrated further into the soil or run off to adjacent surface water, resulting in contamination.

2. Potential for a gasoline spill into the subsurface environment. During tank filling at the Building 827 gasoline island, gasoline may spill into the surrounding peastone and migrate into and contaminate the soil and groundwater.

During excavation activities just north of Building 827 in July 1986, 5 to 10 gallons of gasoline were observed floating on water in the excavated pit. The gasoline was believed to have come from the peastone under an adjacent gasoline dispensing pump (Cheever, 1986c). The Environmental Survey team noted that an approximately 3-square-foot area of peastone surrounding the underground tank fill pipe next to the pumps was exposed. During tank filling, gasoline may spill into the peastone and migrate downward. There is the potential that the gasoline could move deeper into the soil and contaminate the groundwater.

3. Insufficient surveillance during spill cleanup. No consistent or reliable surveillance method is used during cleanup of spills (mainly fuel) to ensure appropriate removal of chemical contaminants and, as a result, surface water and groundwater surrounding a spill may become contaminated.

   Several fuel spills have occurred at ANL over the past 6 years, including the Sunoco Station in 1986 (Finding 1 above) and incidents at Building 145 in 1981 and Building 814 in 1984. Interviews with emergency responders and cleanup crews (Astorino, 1987; Veermin, 1987) indicate that although spilled liquids and tainted soils are removed, no quantitative analyses are performed on soils to determine whether all contaminated soils are removed. If spilled materials are not reduced to sufficiently low concentrations, the hazardous constituents remaining may migrate to groundwater or surface water, resulting in contamination of the environment.

4. Potential sources of contamination remain unidentified. All inactive waste sites at ANL have not been identified during remedial actions to date; consequently, the potential exists for sources of contamination to be located on the site that may affect surface water, soils, and groundwater.

   As a result of actions taken under DOE Order 5480.14, ANL has identified 10 inactive waste sites and releases, as reported in the revised, draft ANL Phase I Installation Assessment Report. However, during the Survey, the Survey team identified an additional nine inactive sites and releases, including two ponds, a Nike missile site, and six spills and leaks. They are described in Section 4.5.1 and in Findings 4, 5, 6, 9, 10, and 13 in Section 4.5.2.3 and Findings 1 and 2 in

this section. These sites, as well as others possibly not yet discovered, may contain hazardous and radioactive materials. If not characterized under ANL's existing remedial action program, they may be a continuing source of contamination to the soil, surface water, and groundwater.

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APPENDIX A

SURVEY PARTICIPANTS

SURVEY PARTICIPANTS
ARGONNE NATIONAL LABORATORY
ARGONNE, ILLINOIS

DOE

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

Technical Specialists

Waste Management	Dwight Worley, NUS *
	Mike Malloy, NUS
Surface Water	Kim Turnbull, NUS
Radiation	David Dougherty, NUS
Inactive Waste Sites/Releases	William Levitan, NUS*
Hydrogeology/Storage Tanks	Fred Miller, NUS
QA/TSCA	Mark Notich, NUS
	John Connelly, NUS
Air	Henry Firstenberg, NUS

* Contractor Coordinator

APPENDIX B

SITE-SPECIFIC SURVEY ACTIVITIES

B.1 Pre-Survey Preparation

The DOE Office of Environmental Audit, Assistant Secretary for Environment, Safety and Health, selected a Survey team for the Argonne National Laboratory (ANL) in the spring of 1987. The site is managed by the DOE Chicago Operations Office (CH) and is operated for DOE by the University of Chicago. Mr. Joseph Boda was designated the DOE Team Leader and Mr. Ronald Peterson the Assistant Team Leader; Dr. Timothy Joseph was the CH representative.

Survey team members began reviewing ANL general environmental documents and reports in March 1987. Messrs. Boda and Peterson and two members of the NUS Corporation conducted a pre-Survey site visit on May 4-6, 1987, to become familiar with key DOE and ANL personnel. They toured the site and completed a cursory review of the documents assembled in response to an information request letter submitted on March 27, 1987. The request listed environmental documents and reports required by the Survey team for Survey planning purposes. During the pre-Survey visit, a meeting was held with representatives of CH and ANL, as well as officials of the U.S. Environmental Protection Agency and the Illinois Environmental Protection Agency. The purpose of this meeting was to review environmental issues of concern to the Federal and local government representatives 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 ANL site. 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 June 15-26, 1987. The opening meeting was held on June 15, 1987, at ANL and was attended by representatives from CH, ANL, and the Survey team members. Discussions during this meeting primarily concerned the purpose of the Survey, logistics at ANL, 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 releases, and spills, as well as various operating logbooks. The research activities were carefully analyzed to identify existing and potential pollutants. Site operations and monitoring procedures were observed, where possible. Extensive interviews were held with ANL 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.

During the last week of the Survey, the Survey team developed sampling and analyses (S&A) requests to better define Survey observations that had little or no supporting information. The S&A requests were presented to Oak Ridge National Laboratory (ORNL) representatives who were designated to perform the required S&A.

A site closeout briefing was held on June 26, 1987, 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. In some cases, field S&A was required to better define the Survey team observations.

B.3 Sampling and Analysis

ORNL will perform the S&A portion of the Survey. ORNL evaluated the S&A requests made by the Survey team for ANL to determine logistics, costs, and schedules and to prepare an S&A plan. The S&A Plan prepared by ORNL includes a quality assurance plan and a health and safety plan. It will be completed during the Fall of 1987 and the sampling team will begin work at the site in late 1987.

B.4 Report Preparation

The Environmental Survey Preliminary Report for ANL will be prepared for DOE review. The preliminary findings are subject to modification based on comments from CH concerning their technical accuracy and the results of sampling and analysis. The modified findings will be incorporated into the Environmental Survey Summary Report.

APPENDIX C

ARGONNE NATIONAL LABORATORY
SURVEY PLAN

DOE ENVIRONMENTAL SURVEY
ARGONNE NATIONAL LABORATORY
JUNE 15 through 26, 1987
ARGONNE, ILLINOIS

1.0 INTRODUCTION

The Environmental Survey is a onetime 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 Argonne National Laboratory (ANL) will be managed by the DOE Team Leader, Joseph Boda, and the Assistant Team Leader, Ronald Peterson. Timothy Joseph will serve as the Chicago Operations Office (CH) representative on the Survey team. Technical support will be provided by contractor personnel as follows:

Radiation:	David Dougherty, NUS Corporation
Surface/Drinking Water:	Kim Turnbull, NUS Corporation
Hazardous/Radioactive/ Solid Wastes:	Dwight Worley, NUS Corporation
Inactive Waste Sites/Releases:	William Levitan, NUS Corporation
Hydrogeology/Storage Tanks:	Fred Miller, NUS Corporation
QA and TSCA:	Mark Notich, NUS Corporation
Air:	Henry Firstenberg, NUS Corporation

2.1 Pre-Survey Activities

Members of the Survey team began reviewing ANL environmental documentation available at the DOE Office of Environmental Audit in March 1987. From that review, a memorandum dated April 2, 1987, was sent to the Chicago Operations Office requesting additional information. Messrs Boda, Peterson, Worley, and Miller conducted a pre-Survey site visit on May 4-6, 1987, to become familiar with the site, to identify any potential environmental problems, and to coordinate plans for the upcoming Survey with DOE/CH/AAO (Argonne Area Office) and University of Chicago personnel. During the pre-Survey visit, the team met with representatives of DOE/CH/AAO, the University of Chicago, and representatives of the EPA and Illinois regulatory agencies. In addition, the team toured the facility and gathered documents assembled by site personnel in response to the information request memorandum. Additional information was requested and received from CH and University of Chicago personnel during and after 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 ANL site will be conducted from June 15 through June 26, 1987. The Survey will include the facilities operated by the University of Chicago located on the ANL site and selected inactive sites historically associated with the Laboratory. The agenda for this Survey can be found in the attached Table I. Table II provides a summary of the separate technical discipline agendas contained in Table I. 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 III indicates specific areas of interest for each of the technical specialists.

A closeout meeting will be conducted on Friday, June 26, 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 the Chicago Operations Office within 4 weeks of the conclusion of the Survey. A Preliminary Report of the

Survey will be prepared within about 4 months of the conclusion of the Survey. At approximately this time, the Sampling and Analysis (S&A) Team will initiate its on-site sampling. Subsequently, S&A will be conducted to strengthen the Survey finding and fill important data gaps. The S&A on-site activities and data analysis will require approximately 6 months to complete. The results of this S&A effort will then be used in the preparation of an Interim Report, which should be completed 3 months after the finalized S&A data are received. The findings of each of the Interim Reports from all scheduled Surveys will be updated as appropriate and included in the Final Report to the Secretary, DOE, which is scheduled for completion in 1988.

2.3 Sampling and Analysis

Based upon the results of the on-site portion of the Survey, the Survey team will identify any sampling needs. Sampling and analysis for the ANL Survey will be conducted by a team from the Oak Ridge National Laboratory (ORNL). Mr. John Murphy will be the ORNL Sampling and Analysis Team Leader. The ORNL sampling team will draft an S&A Plan based upon the sampling needs identified by the Survey team.

The Assistant Team Leader, Ronald L. Peterson, will coordinate the review of this Sampling Plan with CH, ANL, and EPA's Laboratory at Las Vegas, which has quality assurance responsibility for the Survey's S&A efforts. The sampling is projected to start this fall. The sampling will take between 2 and 3 weeks to complete. Results of the S&A will be transmitted to the Survey Team Leader for incorporation into the Interim Report. The Interim Report should be available in the Summer of 1988.

3.0 AIR

3.1 Issue Identification

The radioactive and regulated/hazardous air-related Survey activities will involve the assessment of ANL-wide air emissions, and of emission control and monitoring equipment, and the acquisition and processing of ambient air quality data. Areas of investigation will include the process and laboratory emissions of radionuclides, nitrogen and sulfur oxides, acid fumes, toxic metals and organics, and volatile hydrocarbons (VOCs), as well as the emissions of nitrogen and sulfur oxides from

fuel burning equipment. Operational and procedural practices associated with emission control and monitoring equipment will 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.

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, control and monitoring equipment, and potential fugitive sources. The Survey will identify air contaminants from significant processes and fugitive sources, identify and evaluate the existing control 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 the 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

No additional air records are required at this time.

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 ANL staff to:

1. Understand the processes involved
2. Review radioactive material control
3. Review airborne and liquid effluent control
4. Review airborne and liquid effluent monitoring
5. Review historical records of releases
6. Review laboratory practices associated with effluent monitoring

In addition, the radiological environmental monitoring program will be reviewed 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

- Calibration and maintenance records for radiation and environmental testing and measurement equipment
- Effluent monitoring and sampling records
- Process-specific radioactive inventories
- Lab results for effluent and environmental samples
- Dose calculations and printouts

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. ANL 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.

The Survey will concentrate on areas of acknowledged concern, including the discharge of contaminants into Sawmill Creek. 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 may exist as a result of past practices, if any. Site surface drainage features, including channels, swales, culverts and catch basins, will also be reviewed.

5.2 Records Required

- Chemical and sanitary sewer inspection and maintenance data
- Cooling water treatment data and analytical information

- o Potable water treatment data and analytical information
- o Raw data from all surface water sampling by ANL

6.0 HAZARDOUS/RADIOACTIVE/SOLID WASTES

6.1 Issue Identification

The procedure for activities related to the hazardous/radioactive/solid waste survey 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 ANL's waste management practices.

The hazardous waste portion of the Survey will concentrate on those facilities mentioned in the ANL RCRA Part B application. The team will devote a significant portion of the time on-site to a detailed facility investigation of hazardous or mixed waste generation, storage, and treatment practices. In addition, hazardous waste storage and treatment 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 ANL 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 the hazardous/radioactive/solid waste Survey will be coordinated closely with the inactive waste site, hydrogeologic, QA/TSCA,

surface/drinking water discipline activities to identify any possible releases that may pose a threat to the environment.

Several areas for specific investigation have been identified during a review of available documentation:

- o Waste oil management practices
- o Hazardous waste disposal procedures and documentation
- o Solid waste disposal procedures and waste segregation practices
- o Storage and disposition of scrap/salvage materials

6.2 Records Required

No additional nazardous/radioactive/solid waste records are required at this time.

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 and radioactive 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 the Comprehensive Environmental Assessment Program for ANL, identified 10 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. Records indicating the types and quantities of materials disposed of in the inactive sites will be evaluated, as will the facility design and methods of waste containment. Information available through historical aerial photography

will be assessed to identify disturbed land areas and to further define site locations and associated changes in appearance over time. Visual inspections will be conducted for many of the sites included in the Phase I report, and for any newly-identified sites, to note surface features and to locate monitoring points.

Sites that have undergone remediation will also be addressed. Records and analytical data in support of the 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.

Several areas of concern were identified during a review of available documentation. Major areas of investigation include:

- Abandoned landfills, in particular the use of french drains for liquid waste disposal
- Decontamination and decommissioning activities for both radioactive and chemically contaminated areas
- Site A and Plot M radioactive waste disposal areas
- Spills and leaks of petroleum products, polychlorinated biphenyls (PCBs), and pesticides
- Other disposal areas, including Underwriter's Pond, Nike Site, shock and burn facility, and gas cylinder burial plot

7.2 Records Required

- Landfill 319--handwritten log of materials dumped in french drain
- Ray Ruthenberg/Dennis Hulet handwritten logs for what was disposed of in Landfill 319
- Blue notebook by Ray Ruthenberg regarding disposal of materials in Landfills 319 and 318, Underwriter's Pond, and 800-Area
- Any Decommissioning and Decontamination (D&D) report other than that for East Area (published in July 1987)
- Any oil spill reports other than those for 1981 and 1986

8.0 HYDROGEOLOGY

8.1 Issue Identification

A major concern for the Survey is the status of ongoing investigations of groundwater contamination. In addition, the potential impacts of the existing contamination on deeper aquifers need to be assessed by the Survey team. Furthermore, the potential impacts of off-site movement of contaminated groundwater in the shallow aquifer are also of concern.

A general review of data collection effects that have taken place will be required to determine the usefulness, for the purposes of the Survey, of existing information. This will include a review of sampling procedures, chain-of-custody and quality assurance/quality control procedures, and the compatibility of data from various sources. The reliability, construction, and placement of wells used for groundwater monitoring will be examined. Interviews with site personnel will be conducted.

Several areas for specific investigation were identified during a review of available documentation:

- o Underground storage tanks
- o Aboveground storage tanks
- o Solid and liquid waste disposal operations
- o Presence of volatile organics in the groundwater near the 800-Area landfill, 317- and 319-Area disposal sites, and East Area
- o Inadequacy of existing wells to characterize groundwater conditions in disposal areas

8.2 Records Required

- o Environmental Impact Statement (most recent)
- o Piezometric level records for all wells for last record date
- o Maps or records of locations of water supply wells within 2 miles of Argonne boundary
- o Well logs for all ANL wells

9.0 QUALITY ASSURANCE (QA)

9.1 Issue Identification

The quality assurance (QA) review of the environmental program will examine the site S&A capabilities. The intent of this review will be to assess the accuracy of the environmental monitoring data. All aspects of the QA program relating to the ANL environmental S&A effort will be reviewed.

The environmental sampling performed by ANL personnel will be evaluated by reviewing protocols, procedures, data handling, records, and logbooks. Field techniques will be observed to determine actual sampling practices.

The environmental analytical laboratories will be reviewed through the evaluation of procedures and records and the observation of laboratory operations. No visits to off-site laboratories are anticipated for these operations; however, all available QA manuals and procedures will be reviewed.

Several areas for specific investigations were identified during a review of available documentation:

- Operator and technician training
- Equipment and instrument calibration/maintenance
- Precision and accuracy studies
- Blank, split, and spiked sample analyses
- Sample handling and chain-of-custody procedures
- Data reduction and validation
- Sampling procedures
- Data reporting and documentation
- Calculation and logbook reviews

9.2 Records Required

No additional QA records are required at this time.

10.0 TOXIC AND CHEMICAL MATERIALS—TSCA

10.1 Issue Identification

The toxic and chemical materials review will address the raw materials and handling of chemical products used at ANL. The use, 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 ANL will be reviewed to identify pathways of contamination. Also, asbestos removal and disposal practices will be evaluated, and disposal sites visited, 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:

- o Chemical procurement procedures
- o Material QA procedures
- o Toxic and hazardous materials inventory
- o Operator and technician training
- o Decontamination/disposal manifests and records
- o Maintenance/inspection logbooks

10.2 Records Required

No additional TSCA records are required at this time.

TABLE I. ANL ON-SITE SURVEY AGENDA: AIR

6/15/87	AM	PM
MONDAY	Orientation	IPNS Facilities Buildings 360, 361, 365, 375, 390, 391, 391A, 399
TUESDAY	Meeting: Building 200/206/208 HVAC Personnel Building 200 Building 206 Building 208	Meeting: Building 202/205 HVAC Personnel Building 202 Building 205 Building 220 - Chem. Storage
WEDNESDAY	Ambient Air Monitoring Network (Procedures for Data Acquisition)	Meteorological Tower - Bldg 180 Meteorological and Ambient Air Data Processing Procedures
THURSDAY	Central Boiler House Facilities Buildings 108, 108A, 108B, 115, 116 Coal Storage Pile, Ash Handling Buildings 26, 27, 28	Meeting: Building 212 (GC&H)/223 HVAC Personnel Building 212 Building 223 Building 146
FRIDAY	Building 207 Boiler Houses: Buildings 814, 816, 825, 832 Revisits	Draft Preliminary Findings to Date

TABLE I. ANL ON-SITE SURVEY AGENDA: AIR (continued)

6/22/87	AM	PM
MONDAY	Building 203 Building 222	Building 308 - Components Tech Building 309 - Components Tech Building 310 - EBR-II Building 311 - Experimental
TUESDAY	Building 363 - Central Shops Building 301 - Hot Labs Building 331 Building 335	Revisits/Document Review Prepare Sampling Forms
WEDNESDAY	Building 362A Building 366A	Building 371 - Heavy Ion Fusion Building 373 - HEP Assembly Draft Preliminary Findings
THURSDAY	Revisits/ Document Review	Revisits Survey Team Debriefing
FRIDAY	Closeout meeting	

TABLE I. ANL ON-SITE SURVEY AGENDA: RADIATION

6/15/87	AM	PM
MONDAY	Orientation	Facility Visits - Cyclotron (211), Atlas (203), Dynamitron (203), IPNS (360/361/365/375)
TUESDAY	Facility Visits - Janus Reactor (202), CP-5 Reactor (330), EBWR (331), Juggernaut Reactor (335)	Facility Visits - 200 Building M-Wing Cave, MI, KI, Contaminated cell A4, Fluoride Chemistry, C-Wing Fluorination, K-Wing H-3, Vault; Bldg 205 Fusion Containment
WEDNESDAY	Environmental Monitoring Field Activities	Environmental Monitoring Field Activities
THURSDAY	Facility Visits - ZPR (314), Applied Physics (315), ATSR (316)	Facility Visits - New Brunswick Lab (350), Alpha-Gamma Hot Cell (212-Wing D), Vault (212-Wing F)
FRIDAY	Facility Visits - Radwaste Processing (306), Lab Waste Treatment (575) Revisits	Draft Preliminary Findings to Date

TABLE I. ANL ON-SITE SURVEY AGENDA: RADIATION (continued)

6/22/87	AM	PM
MONDAY	Facility Visits - Radwaste Staging Area (317) Revisits	Radiological Lab (Bldg 200) (All labs used in support of effluent calculations or annual environmental report)
TUESDAY	Radiological Lab (Bldg 306)	Environmental Monitoring Data Review, Prepare Sampling Forms
WEDNESDAY	Dose Assessment Review	Draft Preliminary Findings
THURSDAY	Revisits	Survey Team Debriefing Revisits
FRIDAY	Closeout meeting	

TABLE I. ANL ON-SITE SURVEY AGENDA: SURFACE/DRINKING WATER

6/15/87	AM	PM
MONDAY	Orientation	Bldgs 200, 211
TUESDAY	Bldgs 202, 203	Bldgs 205, 206
WEDNESDAY	Environmental Monitoring: Surface Water and Sanitary Wastewater Sampling	NPDES discharge evaluations Lime Sludge Pond evaluation Potable water treatment
THURSDAY	Bldgs 212, 223	Bldgs 301, 362, 308
FRIDAY	Bldg 306 FAC 575 FAC 570	Draft Preliminary Findings to Date

TABLE I. ANL ON-SITE SURVEY AGENDA : SURFACE/DRINKING WATER (continued)

6/22/87	AM	PM
MONDAY	Revisits NPDES discharge evaluations	800 Area Landfill & Waste oil storage A^2R^2 rubble pit Service station - Waste oil storage
TUESDAY	Revisits	Prepare Sampling Forms
WEDNESDAY	Cooling Water Treatment Revisits	Draft Preliminary Findings
THURSDAY	Chemical and Sanitary Sewer line evaluations Revisits	Survey Team Debriefing Revisits
FRIDAY	Closeout meeting	

TABLE I. ANL ON-SITE SURVEY AGENDA: HYDROGEOLOGY/STORAGE TANKS

6/15/87	AM	PM
MONDAY	Orientation	Site A and Plot M Including domestic wells at Palos Forest Preserve
TUESDAY	800 Area Landfill including French drain and wells	317-319 Area and ENE Landfill, including all old waste disposal operations and wells
WEDNESDAY	Environmental Sampling for Site A Plot M Inspection	Lime Slurry Pond and Coal Pile
THURSDAY	Storage Tanks at 813, 814, 816 825, 827, 829, 814 and Nike Site, including Inventory Review Records	Storage Tanks at 306, 368, 370, 395, 350 308, 300, 302, 323, 331, 111, and 108, including Inventory Review Records
FRIDAY	Storage Tanks at 201, 202, 205, 211, 212, 221, 222, 582, 564, 565, 566, 568, 584, 585 including Inventory Review Records	Draft Preliminary Findings to Date

TABLE I. ANL ON-SITE SURVEY AGENDA: HYDROGEOLOGY/STORAGE TANKS (continued)

6/22/87	AM	PM
MONDAY	Wastewater Treatment Plant, tour old retention ponds in the sewage treatment area	A^2R^2 Pond and Solar Pond at Facility 312
TUESDAY	East area including Building 34 site, Burn Pits and Storage tanks at 6, 32, 26 and 42, including Inventory Review Records	Prepare Sampling Forms
WEDNESDAY	Cooling Water Treatment and Sludge Pond	Draft Preliminary Findings
THURSDAY	Southern Edge of site along Des Plaines River	Survey Team Debriefing Revisits
FRIDAY	Closeout meeting	

TABLE I. ANL ON-SITE SURVEY AGENDA: INACTIVE WASTE SITES/RELEASES

6/15/87	AM	PM
MONDAY	Orientation	Meeting w/ C. L. Cheevers to discuss development of IAR and location of other potential sites. Answer questions developed during literature search View cooling towers
TUESDAY	800 area landfill, specifically use of french drain for disposal of liquid wates	317 french drain, 318 gas cylinder burial plot, 317 shock and burn treatment facility, 319 area landfill, E.N.E 319 landfill
WEDNESDAY	Site A Well sampling - observe this activity; note sampling procedure; any chemical sampling Plot M inspection	Cooling towers - past additives use and possible spills/deposition
THURSDAY	Fuel/other spills: Sunoco station (1986) Bldg 827 tank removal (1986); Bldg 814 fuel line break (1984); Bldg 827 excavation (1986); Bldg 145 (1981); Bldg 384 (waste oil storage area, 1979); Photo lab wastes (Bldg 362) went out Discharge 11-B; Former NPDES 010 discharge from coal pile Visit former Nike site	Pesticides/PCB spills: "Pesticide storage area" (1978) rusting 55-gal drums of 2, 4-D. PCBs near Bldg 382 (1979), 379 (1979), 818 (1979), 200 area bldgs (1979/1980), 800 area (1986), east of, ZGS cooling tower (1979)
FRIDAY	Garbage truck run (RCRA)	Draft Preliminary Findings to Date

TABLE I. ANL ON-SITE SURVEY AGENDA: INACTIVE WASTE SITES/RELEASES (continued)

6/22/87	AM	PM
MONDAY	Wastewater treatment plant - past practices Underwriter's pond - potential CERCLA site	Other disposal sites - "south of IPNS"; drums: near Bldg 360, East area, 800 area, 300 area
TUESDAY	East Area D&D activities: Bldg 34 where 7,800 ft^3 of oil removed, Bldgs 17/38 where 2,000 ft^2 were affected. Burn pits - 91st & Cass, Eastwood Dr., Austin Company	Prepare Sampling forms
WEDNESDAY	Revisits Cooling water treatment and sludge pond - past activities	Draft Preliminary findings
THURSDAY	Asbestos (TSCA) - 200, 300 area	Survey Team Debriefing Revisits
FRIDAY	Closeout meeting	

TABLE I. ANL ON-SITE SURVEY AGENDA: HAZARDOUS/RADIOACTIVE/SOLID WASTES

6/15/87	AM	PM
MONDAY	Orientation	Bldg 200 Chemistry & Sample Archives Bldg 211 Cyclotron
TUESDAY	Bldg 202 Bio & Med research Bldg 203 Phy & Envir research	Bldg 205 Chem Tech Bldg 206 Alkali Metal Reactor Booth
WEDNESDAY	Bldg 360 IPNS CNTL Bldg 325A Drum Storage Bldg 325C Drum Storage Bldg 374A Alkali Metal storage	Bldg 363 Central Shop Degreaser Bldg 366 Degreaser Bldg 108 Flyash storage Bldg 145 Sludge Storage
THURSDAY	Bldg 212 MAT Science & Tech Bldg 223 MST - Ed Prog	Bldg 301 Hot Lab Bldg 362 EES & HEP 308 Alkali Metal Reactor Booth
FRIDAY	Bldg 306 Waste Processing FAC 575 Lab Waste Treatment FAC 570 San. Waste Treatment	Draft Preliminary Findings to Date

TABLE I. ANL ON-SITE SURVEY AGENDA: HAZARDOUS/RADIOACTIVE/SOLID WASTES (continued)

6/22/87	AM	PM
MONDAY	Facility 317 - Waste Storage Bldg 329 - Waste Storage Area 319 - Shock and Burn Area Area 320	800 Area Landfill & Waste Oil Storage Argonne Advanced Research Reactor (A^2R^2) Rubble pit
TUESDAY	Bldgs 823, 828, 810, 815, 818	Prepare Sampling Forms
WEDNESDAY	Bldgs 26, 27, 28 Revisits	Draft Preliminary findings
THURSDAY	Survey Team Debriefing	Survey Team Debriefing
FRIDAY	Closeout meeting	

TABLE I. ANL ON-SITE SURVEY AGENDA: QA/TSCA

6/15/87	AM	PM
MONDAY	Orientation	PCB Inspection • Procedure Review • Records Review • 200 & 800 Areas
TUESDAY	PCB Inspection • 300 Area	PCB Inspection • East Area • 600 Area
WEDNESDAY	Environmental Sampling • Sawmill Creek • Treatment Plant • Site A	TSCA Review Bldgs 4, 5, 6 • Inventory Review • Usage/Disposal
THURSDAY	TSCA Review Bldgs 26, 27, 200, 202 • Inventory Review • Usage/Disposal	Bldg 306 Lab QA/QC Review • Tour • Procedures & Records Review
FRIDAY	Revisits	Draft Preliminary Findings to Date

TABLE I. ANL ON-SITE SURVEY AGENDA: QA/TSCA (continued)

6/22/87	AM	PM
MONDAY	TSCA Review • Pesticide Application, Handling, & Disposal	Bldg 200 Inorganics QA • Tour • Procedures & Records Review
TUESDAY	Bldg 200 Organics QA • Tour • Procedures & Records Review	TSCA - Asbestos Survey • Procedures Review • Records Review • 300 Area Prepare Sampling Forms
WEDNESDAY	Asbestos Survey • 300 Area • 200 Area	Asbestos Survey • 200 Area Draft Preliminary Findings
THURSDAY	Asbestos Survey • Finish 200 Area • 600 Area & East Area	Revisits for Asbestos Survey Team Debriefing
FRIDAY	Closeout meeting	

TABLE II ANL SURVEY SITE AGENDA SUMMARY

June 15, 1987		Air	Radiation	Surface/ Drinking Water	Hydrogeology/ Storage Tanks	Inactive Waste Sites/Releases	Hazardous/ Radioactive/ Solid Wastes	QA/TSCA	Sampling
MON	AM	———	———	———SITE	ORIENTATION	OF ANL———	———	———	
	PM	IPNS 360/361/365 375/398/391/39 1A/399	211/203/360/361/ 365/375	211/200	PLOT M/SITE A	Meeting C.L. Cheevers Cooling Towers	211/200	PCB 200/800 AREAS	
TUES	AM	200/206/208*	202/330/331/335	202/203	800 LF	800 LF	202/203	PCB 300 AREA	
	PM	202/205/220*	200/205	205/206	317-319 ENE LANDFILL	317-319 ENE Landfill	205/206	PCB EAST/600 AREAS	
WED	AM	ENV. MONITORING	ENV. MONITORING	ENV. MONITORING SURFACE H_2O & WASTE H_2O	SITE A Sampling Plot M Inspection	SITE A Sampling Plot M Inspection	360/325 A&C 374A	ENV MONITORING	
	PM	MET TOWER DATA	ENV. MONITORING	POTABLE H_2O NPDES/LIME POND	COAL PILE Lime Slurry Pond	COOLING TOWERS	363/366/108/145	PROCESS CHEMICALS 4,5, & 6 (TSCA)	
THURS	AM	108/108A/108B 115/116/26-28	314/315/316	212/223	800 Area NIKE SITE	Fuels/Chemicals 100/300/800 Areas NIKE SITE	212/223	PROCESS CHEMICALS 26, 27 200, 202 (TSCA)	
	PM	146/212GC&H Wings/ 223*	350/212 (D&F Wings)	301/362/308	100/300 AREAS STOR. TANKS	PESTICIDES/ PCB 200/300/800 AREAS	301/362/308	ADDITIONAL LABS 306	
FRI	AM	207/814/816/ 825/832	306/575	306/570/575	200/500 AREAS STOR. TANKS	GARBAGE TRUCK RUN	306/570/575	Revisits	
	PM	FINDINGS	FINDINGS	FINDINGS	FINDINGS	FINDINGS	FINDINGS	FINDINGS	

* HVAC COORDINATION

TABLE II ANL SURVEY SITE AGENDA SUMMARY (continued)

June 22, 1987		Air	Radiation	Surface/ Drinking Water	Hydrogeology/ Storage Tanks	Inactive Waste Sites/Releases	Hazardous/ Radioactive/ Solid Wastes	QA/TSCA	Sampling
MON	AM	203/222	317/REVISITS	REVISITS/ NPDES	WWTP	WWTP UNDERW'R'S POND	317/319/320/329	PESTICIDE APPLICATION	ORIENTATION
	PM	308/309/310/ 311	200 RAD LABS	800 LF/A^2R^2/ WASTE OIL	A^2R^2 POND 312 SOLAR POND	300/800 AREAS	800 LF/A^2R^2 POND	200 AREA QA INORGANICS	SITE TOUR/800 LF
TUES	AM	363/301/331/ 335	306 RAD LABS	REVISITS	EAST AREA/BURN PITS/STORAGE TANKS	EAST AREA D&D BURN PITS	823/828/810/815/ 818	200 AREA QA ORGANICS	EAST AREA
	PM	REVISITS/ SAMPLING FORMS	REMP DATA REVIEW & SAMPL. FORMS	SAMPLING FORMS	SAMPLING FORMS	SAMPLING FORMS	SAMPLING FORMS	300 AREA ASBESTOS & SAMPLING FORMS	REVISITS W/AIR
WED	AM	362A/366A	DOSE ASS REVIEW	COOLING WATER TREATMENT REVISITS	COOLING WATER TREATMENT & SLUDGE POND	COOLING WATER TREATMENT & SLUDGE POND	26, 27,28 Revisits	200/300 AREAS ASBESTOS	VISIT SAMPLING SITES
	PM	371/373 FINDINGS	FINDINGS	FINDINGS	FINDINGS	FINDINGS	FINDINGS	200 AREA ASBESTOS FINDINGS	VISIT SAMPLING SITES
THURS	AM	REVISITS	REVISITS	SEWERS EVAL REVISITS	SOUTHERN EDGE OF SITE	ASBESTOS 200/300 AREAS	TEAM DEBRIEF	200/600/EAST AREAS ASBESTOS	TEAM DEBRIEF
	PM	TEAM DEBRIEF Revisits	TEAM DEBRIEF Revisits	TEAM DEBRIEF Revisits	TEAM DEBRIEF Revisits	TEAM DEBRIEF Revisits	TEAM DEBRIEF	TEAM DEBRIEF Revisits	TEAM DEBRIEF
FRI	AM	CLOSEOUT	CLOSEOUT	CLOSEOUT	CLOSEOUT	CLOSEOUT	CLOSEOUT	CLOSEOUT	

TABLE III

ANL ON-SITE SURVEY

AREAS OF INTEREST FOR TECHNICAL SPECIALISTS

HAZARDOUS/RADIOACTIVE/ SOLID WASTES D. Worley	- Hazardous Waste Non-Hazardous Waste RCRA/Solid Waste Permits Mixed Waste
RADIATION D. Dougherty	- Radioactive Emissions and Effluents Source Controls and Monitoring Environmental Monitoring - Rad Laboratory Analysis - Rad Radioactive Waste
AIR H. Fristenberg	- Meteorology Local Air Quality Data Emission Sources, Control and Monitoring Environmental Monitoring - Air Air Permits and Air Emisssions Inventory
SURFACE/DRINKING K. Turnbull	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 F. Miller	- 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 Storage Tanks Aboveground Storage Tanks

TABLE III ANL ON-SITE SURVEY (Continued)
AREAS OF INTEREST FOR TECHNICAL SPECIALISTS

INACTIVE WASTE SITES/ RELEASES W. Levitan	- Past Waste Site Locations Characterization Studies Spill/Accident Locations Remediation Work Former Production Locations
QUALITY ASSURANCE M. Notich	- Environmental Sampling Program Environmental Analytical Program Data Management and Handling QA Program Overview
TOXIC AND CHEMICAL MATERIALS - TSCA M. Notich	- 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

APPENDIX D

GLOSSARY OF ABBREVIATIONS

GLOSSARY OF ABBREVIATIONS

A^2R^2	Argonne Advanced Research Reactor
aCi	attocurie
AEA	Atomic Energy Act
AEC	United States Atomic Energy Commission
AGHCF	Alpha - Gamma Hot Cell Facility
Am	americium
AMPS	Automated Materials Payable System
ANL	Argonne National Laboratory
AQCR	Air Quality Control Region
Ar	argon
AST	aboveground storage tank
Be	beryllium
BOD	biochemical oxygen demand
C	carbon
CAA	Clean Air Act
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CH	Chicago Operations Office (DOE)
CH	contact handled
Ci	curie
cm/sec	centimeter(s) per second
CO	carbon monoxide
CO_2	carbon dioxide
COD	chemical oxygen demand
CP	Chicago Pile
Cs	cesium
DAS	Deputy Assistant Secretary
D&D	decontamination and decommissioning
DE	dose equivalent
DOE	United States Department of Energy
dpm/mL	disintegration(s) per minute per milliliter
EBWR	Experimental Boiling Water Reactor
EDE	effective dose equivalent
EPA	United States Environmental Protection Agency
fCi	femtocurie
FEUL	Fossil Energy Utilization Laboratory
FUSRAP	Formerly Utilized Sites Remedial Action Program
g	gram
gpd	gallon(s) per day
H	hydrogen (H-3: tritium)
HEPA	high-efficiency particulate air
I	iodine

IAR	Installation Assessment Report
ICRP	International Commission on Radiological Protection
IEPA	Illinois Environmental Protection Agency
IH	Industrial Hygiene
IHCL	Industrial Hygiene Chemical Laboratory
INEL	Idaho National Engineering Laboratory
IPNS	Intense Pulsed Neutron Source
Kr	krypton
lb/hr	pound(s) per hour
LMFBR	liquid metal-cooled fast breeder reactor
m	meter
MED	Manhattan Engineering District, U.S. Army Corps of Engineers
MFP	mixed fission products
mgd	million gallons per day
mg/L	milligram(s) per liter
MHD	magnetohydrodynamic
MMBtu	million British thermal units
mph	mile(s) per hour
mR	milliroentgen
mrem	millirem
m/sec	meter(s) per second
m^3/sec	cubic meter(s) per second
MSD	Materials Supply Division
MSDS	Material Safety Data Sheet
NAAQS	National Ambient Air Quality Standards
NBL	New Brunswick Laboratory
nCi	nannocurie
NCRP	National Council on Radiation Protection and Measurements
NESHAP	National Emission Standard for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standard
NWS	National Weather Service
O_3	ozone
OEG	Office of Environmental Guidance and Compliance
OHS	Department of Occupational Health and Safety
ORNL	Oak Ridge National Laboratory
Pb	lead
PCB	polychlorinated biphenyl
pCi	picocurie
PFS	Plant Facility Services
ppm	part(s) per million
Pu	plutonium
PVC	polyvinyl chloride
QA	quality assurance

QC	quality control
RCRA	Resource Conservation and Recovery Act
RCS	rapid cycling synchrotron
RDF	refuse-derived fuel
RH	remote handled
Rn	radon (Rn-220:thoron)
S&A	Sampling and Analysis
SARA	Superfund Amendments and Reauthorization Act
Sb	antimony
SO_2	sulfur dioxide
SPCC	Spill Prevention, Control, and Countermeasures
Sr	strontium
STS	Stock Tracking System
TAP	toxic air pollutant
Th	thorium
TLD	thermoluminescent dosimeter
TRU	transuranic
TSCA	Toxic Substances Control Act
TSP	total suspended particulates
TSS	total suspended solids
U	uranium
µCi/g	microcurie(s) per gram
µg/L	microgram(s) per liter
$\mu g/m^3$	microgram(s) per cubic meter
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compounds
WHP	Waste Handling Procedures
WIPP	Waste Isolation Pilot Plant
WMO	Waste Management Operations
WWTP	wastewater treatment plant
ZGS	Zero Gradient Synchrotron

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