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EG&G
MOUND APPLIED TECHNOLOGIES

Mound Site Environmental Report for Calendar Year 1995

MOUND
is operated for the
U. S. Department of Energy
under contract No. DE-AC04-88-DP43495

Fractions and Multiples of Units

Multiple	Decimal Equivalent	Prefix	Symbol
10^6	1,000,000	mega	M
10^3	1,000	kilo	k
10^2	100	hecto	h
10	10	deka	da
10^{-1}	0.1	deci	d
10^{-2}	0.01	centi	c
10^{-3}	0.001	milli	m
10^{-6}	0.000001	micro	μ
10^{-9}	0.000000001	nano	n
10^{-12}	0.000000000001	pico	p
10^{-15}	0.000000000000001	femto	f
10^{-18}	0.000000000000000001	atto	a

Conversion Table

Multiply	by	to Obtain	Multiply	by	to Obtain
in	2.54	cm	cm	0.394	in
ft	0.305	m	m	3.28	ft
mi	1.61	km	km	0.621	mi
lb	0.4536	kg	kg	2.205	lb
qt (U.S.)	0.946	L	L	1.057	qt (U.S.)
ft^2	0.093	m^2	m^2	10.764	ft^2
ft^3	0.028	m^3	m^3	35.31	ft^3
L	1×10^{-3}	m^3	m^3	1000	L
Ci	3.7×10^{10}	Bq	Bq	2.7×10^{-11}	Ci
rad	0.01	Gy	Gy	100	rad
mrem	0.01	mSv	mSv	100	mrem

Ci = Curie, Bq = Becqueral = 1 disintegration/second, Rad = Roentgen Absorbed Dose, Gray = 100 Rad

Mound Site Environmental Report for Calendar Year 1995

August, 1996

Prepared by the
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for the
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LIST OF ACRONYMS

AIL	ALARA Investigation Level
A-I-P	Agreement-In-Principle
ALARA	As Low As Reasonably Achievable
APG	Analytical Products Group, Inc.
ARARs	Applicable or Relevant and Appropriate Requirements
ATSDR	Agency for Toxic Substances and Disease Registry
BOD	Biological Oxygen Demand
BVA	Buried Valley Aquifer
CAA	Clean Air Act
CBOD	Carbonaceous Biochemical Oxygen Demand
CEDE	Committed Effective Dose Equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	Chlorinated Fluorocarbons
CFR	Code of Federal Regulations
COD	Chemical Oxygen Demand
CRD-LV	Characterization Research Division-Las Vegas
CWA	Clean Water Act
DCG	Derived Concentration Guide
D&D	Decommissioning and Decontamination
DF&O	Director's Findings and Order
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U. S. Department of Energy
DWS	Drinking Water Standard
EA	Environmental Assessment
EDE	Effective Dose Equivalent
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ER	Environmental Restoration
ESA	Endangered Species Act
ES&H	Environment, Safety, and Health
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement or Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
FWPCA	Federal Water Pollution Control Act
GPD	Gallons per Day
HEPA	High Efficiency Particulate Air
HSWA	Hazardous and Solid Waste Amendments
HT	Tritium, elemental
HTO	Tritium, oxide
HWFB	Hazardous Waste Facility Board
IEMP	Integrated Environmental Management Project
LDL	Lower Detection Limit
LSA	Low Specific Activity
MB	Miamisburg Area Office of the U.S. DOE
MCL	Maximum Contaminant Level

LIST OF ACRONYMS (continued)

MDL	Method Detection Limit
MGD	Million Gallons per Day
MRC	Monsanto Research Corporation
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTS	Nevada Test Site
NVO	Nevada Operations Office of the U. S. DOE
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OU	Operable Unit
PCBs	Polychlorinated Biphenyls
PRS	Potential Release Site
PWA	Process Waste Assessment
QA	Quality Assurance
RAPCA	Regional Air Pollution Control Agency
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RIR	Remedial Investigation Report
RMMAs	Radioactive Materials Management Areas
ROD	Record of Decision
RQ	Reportable Quantity
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
TSCA	Toxic Substances Control Act
TTOs	Total Toxic Organics
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds
WM/PP	Waste Minimization/Pollution Prevention

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EXECUTIVE SUMMARY

The purpose of this report is to provide the results of Mound's effluent and environmental monitoring program in calendar year 1995. The report also contains information about the site's regulatory compliance status. Mound is a government-owned facility operated by EG&G Mound Applied Technologies for the U. S. Department of Energy (DOE). The site's historical mission included production, development, and research in support of DOE's weapon and energy related programs. The defense mission is being phased out. Current Mound objectives include the expansion of environmental restoration activities and the pursuit of new business opportunities for the site.

The Mound Plant, named after the Miamisburg Indian Mound adjacent to the site, comprises 120 buildings on 124 hectares (306 acres) of land in Miamisburg, Ohio, approximately 16 km (10 mi) southwest of Dayton. The Great Miami River, which flows through the city of Miamisburg, dominates the landscape of the five-county region surrounding Mound. The river valley is highly industrialized. The rest of the region is predominately farmland dotted with residential areas, small communities and light industry. Many city and township residences, five schools, the Miamisburg downtown area, and six of the city's 17 parks are located within one mile of the plant. The climate is moderate. The geologic record preserved in the rocks underlying Mound indicates that the area has been relatively stable since the beginning of the Paleozoic Era more than 500 million years ago. No buildings at Mound are located in a floodplain or in areas considered wetlands. The southwestern portion of the plant site is located over the Buried Valley Aquifer which has been designated as a sole source aquifer by the U.S. EPA.

ES.1 Perspective on Radiation

Radionuclides, radioactive species of atoms, emit ionizing radiation. Ionizing radiation is radiation possessing enough energy to remove electrons from the substances through which it passes. Most consequences to humans from exposure to radionuclides arise from the interactions of ionizing radiation with human tissue. These interactions are measured based on the amount of energy deposited in the tissue. This value is the absorbed dose. Since different types of ionizing radiation cause different degrees of biological harm, it is necessary to weight the doses to account for those differences. The unit used to make this comparison possible is the dose equivalent. The units used to report dose equivalents are the rem and the Sievert (Sv). Because doses associated with environmental exposures are typically only fractions of a rem or Sievert, it is common to report doses in terms of millirems (mrem) or millisieverts (mSv). There are 1000 mrem per rem; 1000 mSv per Sv.

Our bodies are exposed to ionizing radiation each day. Most of this radiation comes from natural sources. The average dose to a resident of the United States from natural sources is about 300 mrem (3 mSv) per year. The primary contributors to this average dose are radon, cosmic and terrestrial sources, and medical sources such as x-rays or other diagnostic exposures.

ES.2 Radionuclide Releases from Mound

Table E-1 lists the quantities of radionuclides released by Mound into the air and water during 1995. The unit used to report these quantities is the curie (Ci), a unit of radioactivity equal to 3.7×10^{10} disintegrations per second. The quantities, or activities, shown in Table E-1 were measured at the point of release.

A specific point of interest regarding environmental monitoring in 1995 involved elevated airborne plutonium levels associated with the Decontamination and Decommissioning (D&D) of SM Building. Though elevated levels were observed, they were small fractions of the DOE Derived Concentration Guides (DCG's).

Table E-1. Radiological Effluent Data for 1995

Radionuclide	Released to	Activity, Ci
Tritium	Air	769[a]
	Water	2.2
Plutonium-238	Air	8.7×10^{-6}
	Water	3.4×10^{-4}
Plutonium-239,240	Air	2.7×10^{-8}
	Water	7.7×10^{-6}
Radon-222	Air	2.4
Uranium-233,234	Air	3.0×10^{-9}
	Water	3.5×10^{-4}
Uranium-238	Air	1.7×10^{-9}

[a] Tritium in air consists of: Tritium oxide, 640 Ci
Elemental tritium, 129 Ci

ES.3 Dose Limits

Dose limits, or more precisely, dose equivalent limits, for members of the public are presented in Table E-2. These limits are expressed in terms of a committed effective dose equivalent (CEDE) and an effective dose equivalent (EDE) for the DOE and U. S. Environmental Protection Agency (EPA), respectively. Values shown in Table E-2 represent annual limits on dose equivalents established by the DOE and EPA.

ES.4 Doses from Mound Operations

In calculating the maximum dose received by a member of the public from Mound operations, a committed effective dose equivalent is used. The CEDEs are the doses received by a hypothetical adult individual who remained at the site boundary 24 hours per day throughout 1995. This individual was assumed to have:

- breathed only air containing the highest average radionuclide concentrations measured at an onsite or offsite air sampling station,
- drawn all of his drinking water from the Miamisburg water supply, and
- consumed produce exhibiting the average concentrations measured in the samples collected from the Miamisburg area.

The CEDEs from all of these pathways are added to obtain an estimate of a maximum CEDE received by this hypothetical individual. Table E-3 shows the results for Mound in 1995. The results are reported for tritium, plutonium-238, and plutonium-239. The absence of a radionuclide, or an exposure pathway, from Table E-3 indicates that the 1995 concentrations were below background levels or were too small to affect the overall doses reported in the table.

The data presented in Table E-3 were calculated using environmental monitoring data measured at and near Mound. Mound also evaluates doses using the EPA's computer code CAP-88. CAP-88 uses air effluent data as input to transport, dispersion, and dosimetry codes. By executing these codes, one generates an estimate of a maximum offsite dose from airborne releases. For 1995, the CAP-88-estimated maximum offsite dose was 0.05 mrem. As reported in Table E-2, the EPA's annual dose limit for airborne releases is 10 mrem. Therefore, Mound's releases in 1995 represented 0.5% of the dose limit set by the EPA.

Table E-2. Radiation Dose Limits for Protection of the Public from All Routine DOE Operations

Pathway	Regulatory Standard	Effective Dose Equivalent[a] mrem	mSv
All exposure media	DOE Order 5400.5	100	1
Air	40 CFR 61 (EPA)	10	0.1
Drinking water	40 CFR 141 (EPA)	4	0.04

[a] Annual Dose Limits

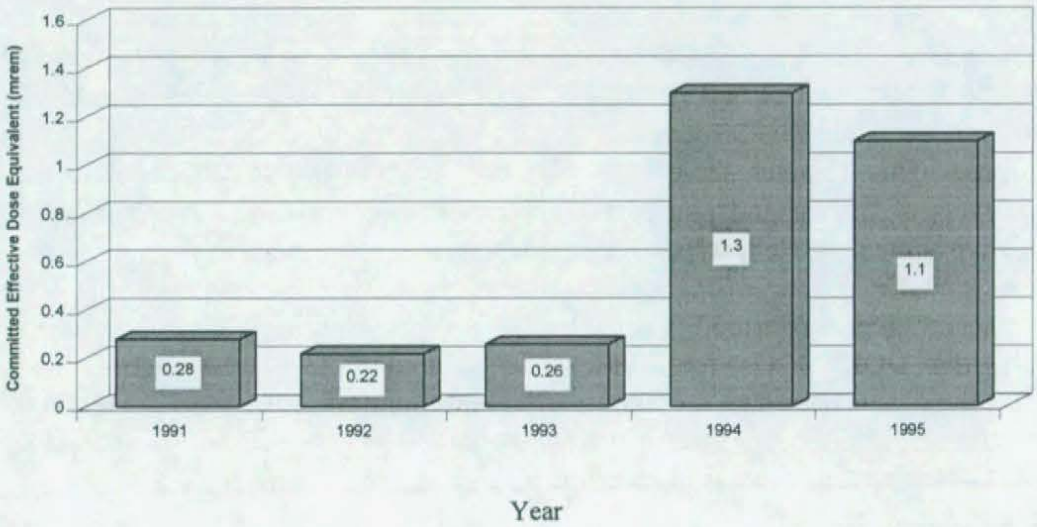
Table E-3. Maximum Committed Effective Dose Equivalents to a Hypothetical Individual in 1995

Radionuclide	Pathway	mrem	mSv
Tritium	Air	0.003	0.00003
	Water	0.009	0.00009
	Produce	ND	ND
	Total	0.01	0.0001
Plutonium-238	Air	1.04	0.0104
	Water	ND	ND
	Fish	0.003	0.00003
	Produce	0.03	0.0003
	Total	1.07	0.0107
Plutonium-239	Air	0.006	0.00006
	Water	ND	ND
	Fish	ND	ND
	Produce	0.01	0.0001
	Total	0.02	0.0002
Total		1.10	0.0110

ND = not detected (below the environmental level or reagent blank)

Figure ES-1 shows the five year trend in CEDEs. The increase in CEDE over the last two years is attributable to the decontamination and decommissioning (D&D) activities at the site. Although the dose from Mound operations has trended higher in the past two years, the CEDEs are still small fractions of the 100 mrem DOE dose limit for members of the public.

Figure ES-1. Calculated CEDE's from Mound Operations, 1991 - 1995



CAP-88 also estimates doses to the population surrounding Mound. The population (approximately 3,035,000 persons) within a radius of 80 km (50 mi) of Mound received an estimated 2.4 person-rem from Mound operations in 1995. CAP-88 arrived at that value first by calculating doses at specific distances, and in specific compass sectors, relative to Mound. The computer code then multiplied the average dose in a given area by the number of people living there. For example, an average dose of 0.001 rem x 10,000 people in the area yields a collective dose of 10 person-rem. CAP-88 then sums up all the collective doses for the 80-km radius region and reports a single number.

Since the average dose received each year by an individual is about 300 mrem, the collective background dose for the 80-km population is approximately one million person-rem (0.3 rem x 3,035,000 persons). Mound's contribution of 2.4 person-rem represents on the order of 0.00024% of the background value.

ES.5 Environmental Monitoring Program Results

Besides setting limits on the CEDE to any member of the public, DOE has established Derived Concentration Guides (DCGs) for individual radionuclides. The DCG is defined as the concentration of a radionuclide in air or water that will result in a CEDE of 100 mrem (1 mSv) following continuous exposure for one year. The concentrations of radionuclides resulting from Mound's 1995 releases were small fractions of the corresponding DCGs.

Radiological Monitoring of the Atmosphere

Ambient air is sampled for tritium and plutonium by an onsite network of seven perimeter stations and by an offsite network of 15 stations. Ten of the offsite samplers are located in the Miamisburg area. One sampler is located far enough away to receive virtually no impact from Mound operations. This sampler serves as a reference location to establish background or environmental levels of tritium and plutonium. The amount by which a sample exceeds the background or environmental level is reported as an incremental concentration.

Incremental concentrations measured at the onsite samplers were 0.002% and 0.16%, respectively, of the DOE DCGs for tritium and plutonium-238. Average incremental concentrations at the offsite samplers for tritium and plutonium-238 were 0.0012% and 0.008%, respectively, of the DOE DCGs. Incremental plutonium-239,240 concentrations averaged 0.0013% and 0.0004% of the DOE DCGs for the onsite and offsite stations, respectively.

Radiological Monitoring of Water

Water samples were collected from locations along the Great Miami River and were analyzed for tritium, plutonium-238, plutonium-239, 240, uranium-233,234, and uranium-238. Other surface water locations were sampled for tritium and plutonium. Additionally, both river and pond sediment samples were analyzed for plutonium.

River water. The average incremental concentrations of plutonium-238 and plutonium-239,240 in water from the Great Miami River were 0.002% and 0.001% of the DOE DCGs, respectively. Average incremental concentrations of uranium-233,234 and uranium-238 averaged 0.004% and 0.003% of their respective DCGs. Average incremental tritium concentrations in the river were 0.002% of the DOE DCG for tritium in water.

Sediment. Average concentrations of plutonium-238 in sediment samples collected from the Great Miami River suggest some accumulation of Pu-238 relative to other sampling locations. However, at such low concentrations, the error limits are quite large and the potential risks are quite small.

Radiological Monitoring of Produce and Vegetation

Locally-grown foodstuffs, vegetation, and fish samples were collected from the surrounding area. These samples were then analyzed for tritium and/or plutonium as appropriate. Concentrations of tritium in vegetation and tomatoes were at or very near environmental levels (levels established at locations not impacted by operations at Mound) in most cases. Similar results were observed for concentrations of plutonium-238 and plutonium-239 in vegetation, root crops, and fish.

Nonradiological Monitoring of Air

Particulate loadings are measured at all of the onsite and offsite air sampling locations. Particulate concentrations appeared to be independent of distance. This result suggests Mound exerts little or no influence on the levels of airborne particulates in the ambient environment.

Nonradiological Monitoring of Water

Mound's nonradiological liquid discharges are regulated by the National Pollutant Discharge Elimination System (NPDES) permit. In 1995, samples were collected to demonstrate compliance with the NPDES permit. There were no exceedances pertaining to the NPDES permit discharge limitations.

ES.6 Groundwater Monitoring Program

Mound maintains an extensive network of onsite and offsite monitoring wells. In addition, a number of onsite and offsite production wells and drinking water systems are routinely monitored. Drinking water from the Miamisburg area is analyzed for tritium, plutonium, and uranium. Other regional water supplies are sampled for tritium. Samples from monitoring and production wells are analyzed for various constituents including volatile organic compounds, polychlorinated biphenyls, metals, and inorganic cations and anions. As in previous years, monitoring data collected in 1995 indicated that volatile organic compounds and tritium, respectively, are the primary nonradiological and radiological contaminants of concern.

ES.7 Environmental Restoration Program

Mound was designated a Superfund site, i.e., placed on the National Priorities List, in November of 1989. A Federal Facilities Agreement (FFA) between the DOE and the U. S. EPA followed in October of 1990. The FFA was expanded to a tri-party agreement in 1993 when the Ohio EPA became a signatory. The purpose of the FFA remains unchanged; it defines the responsibilities of each party for the completion of Superfund-related (CERCLA-related) activities.

CERCLA assessments of contamination at Mound have identified approximately 345 locations of known or suspected releases. In 1995, comprehensive evaluations of these areas continued.

ES.8 Quality Assurance for Environmental Data

To ensure the reliability of environmental data, Mound maintains an internal quality assurance (QA) program that consists of running blanks, internal standards, and duplicate samples. Mound also participates in comparison exercises with external laboratories to validate further Mound's environmental results. Comparisons of Mound's performance with that of other laboratories are shown in Chapter 7 of this report. The close agreement between Mound and the external labs demonstrates that Mound's Environmental Monitoring Program generates reliable data.

1.0 INTRODUCTION

1.1 Description of Mound Plant

Location

The Mound Plant, named after the Miamisburg Indian Mound adjacent to the site, comprises 120 buildings on 124 hectares (306 acres) of land in Miamisburg, Ohio, approximately 16 km (10 mi) southwest of Dayton (Figure 1-1). The Great Miami River flows southwest through the City of Miamisburg and dominates the geography of the region surrounding Mound (Figure 1-2). The river valley is highly industrialized. The rest of the region is predominately farmland dotted with residential areas, small communities and light industry. Many city and township residences, five schools, the Miamisburg downtown area, and six of the city's 17 parks are located within one mile of the plant.

View of the Plant Site Looking East Across the Great Miami River

Figure 1-1. Locations of the Mound Plant and Surrounding Communities

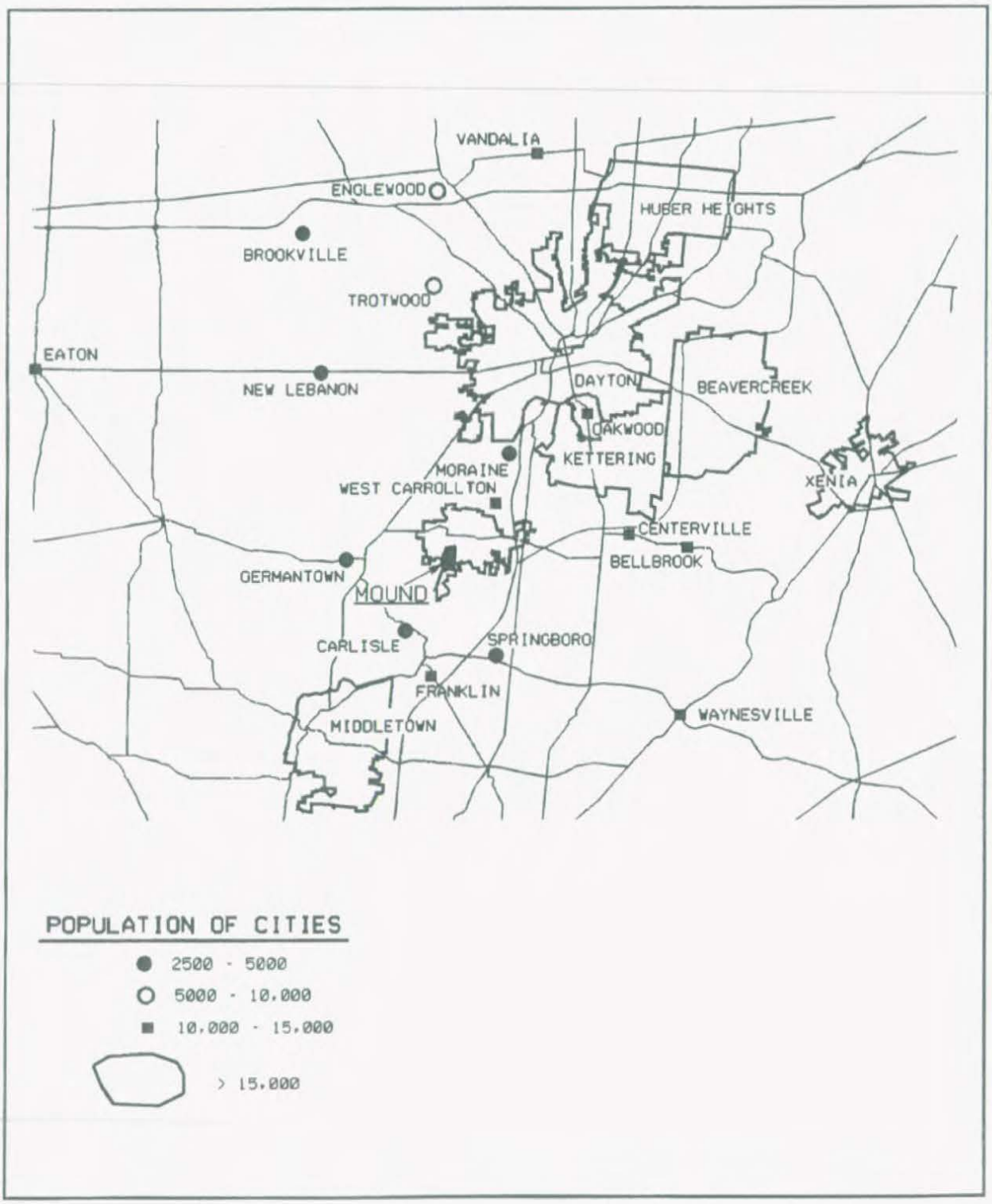
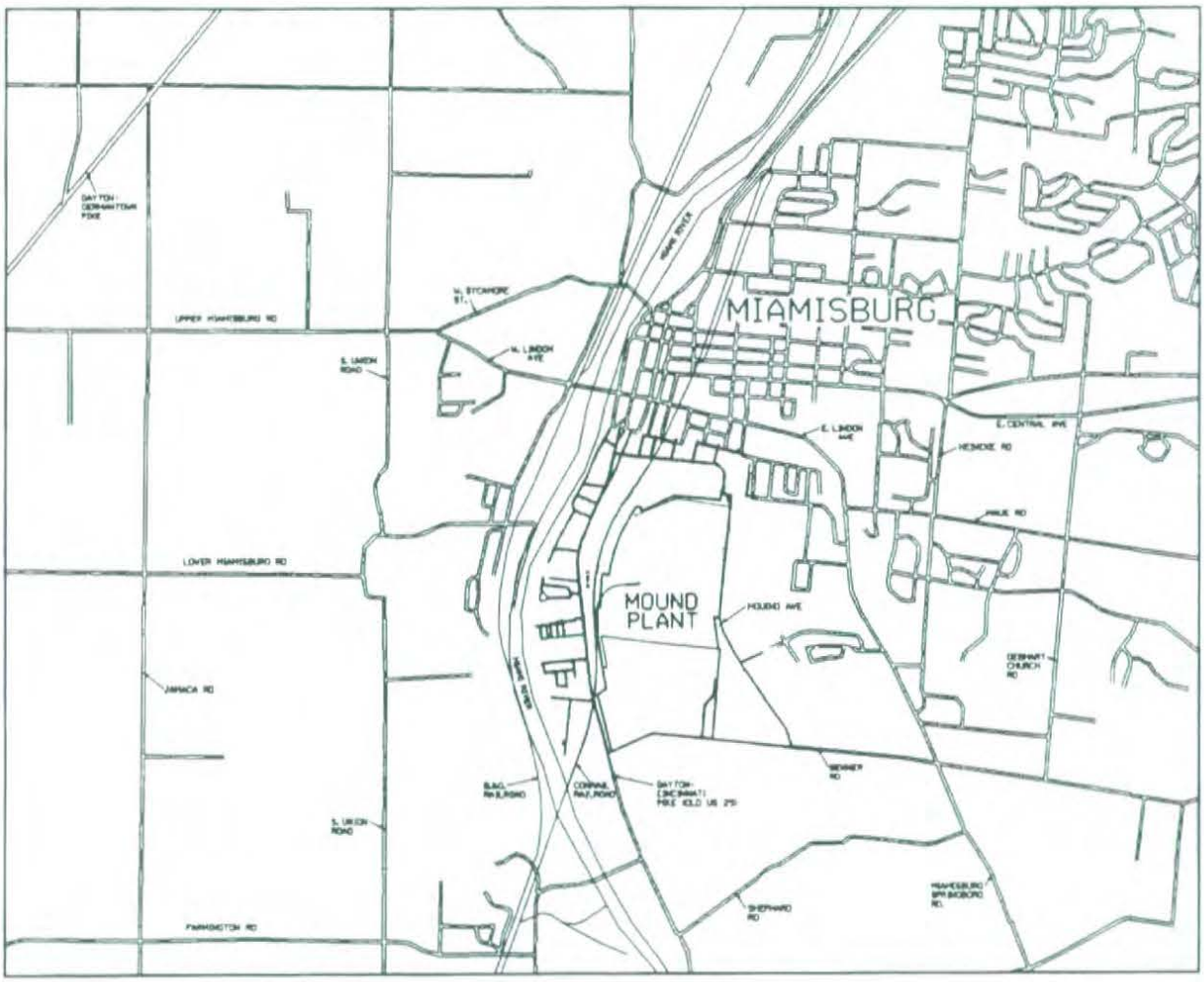


Figure 1-2. Location of the Mound Plant



Population and Land Use

Figure 1-3 shows the population distribution within 50 miles (80 km) of Mound. The population information was extracted from 1990 Census data by the Ohio Department of Development. The estimated number of individuals residing within the 50-mile radius is 3,034,679 (Table 1-1). The primary agricultural activity in the area is raising field crops such as corn and soybeans. Approximately 10% of the agricultural land is devoted to pasturing livestock.

Table 1-1. Population Totals from the 1990 Census

Radius, miles	Total
0-10	322,876
0-20	887,114
0-30	1,477,621
0-40	2,541,609
0-50	3,034,679

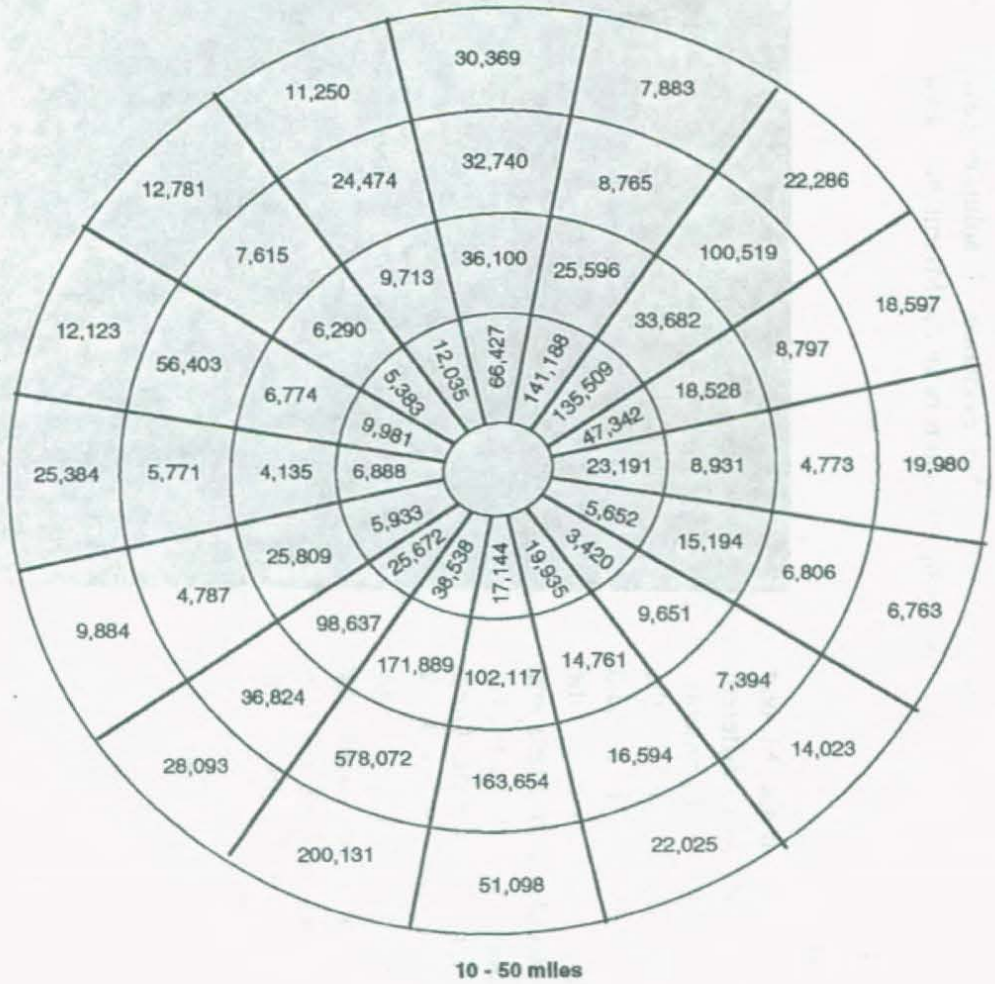


Figure 1-3. Distribution of Population within 50 mi (80 km) of Mound

Geology

The geologic record preserved in the rocks underlying Mound indicates that the area has been relatively stable since the beginning of the Paleozoic era more than 500 million years ago. There is no evidence indicating subsurface structural folding, significant stratigraphic thinning, or subsurface faulting. Limestone strata, which are interbedded with protective shale layers at the site, show no evidence of solution activity. No evidence of solution cavities or cavern development has been observed in any borings or outcrops in the Miamisburg area.

Hydrogeology

The aquifer system at the Mound Plant consists of two different hydrogeologic environments: groundwater flow through the bedrock beneath the hills and groundwater flow within the unconsolidated glacial deposits and alluvium associated with the Buried Valley Aquifer (BVA) in the Great Miami River valley. The bedrock flow system is dominated by fracture flow and is not considered a productive aquifer. The BVA is dominated by porous flow with interbedded gravel deposits providing the major pathway for water movement. The unconsolidated deposits are Quaternary Age sediments consisting of both glacial and fluvial deposits. The BVA is a highly productive aquifer capable of yielding a significant quantity of water. The BVA is considered a sole source aquifer.

Geologists mapping exposed interbedded limestone/shale bedrock

Climate

The climate is moderate. The average annual precipitation rate is on the order of 91 cm (36 in) per year. As shown in Figure 1-4, the total precipitation measured at Mound in 1995 was 103 cm (41 in). For 1995, winds were predominately out of the southwest (Figure 1-5). The annual average wind speed measured at Mound for 1995 was 4.3 m/s (9.6 mi/hr) (Table 1-2).

Figure 1-4. Monthly Rainfall Measured at Mound in 1995

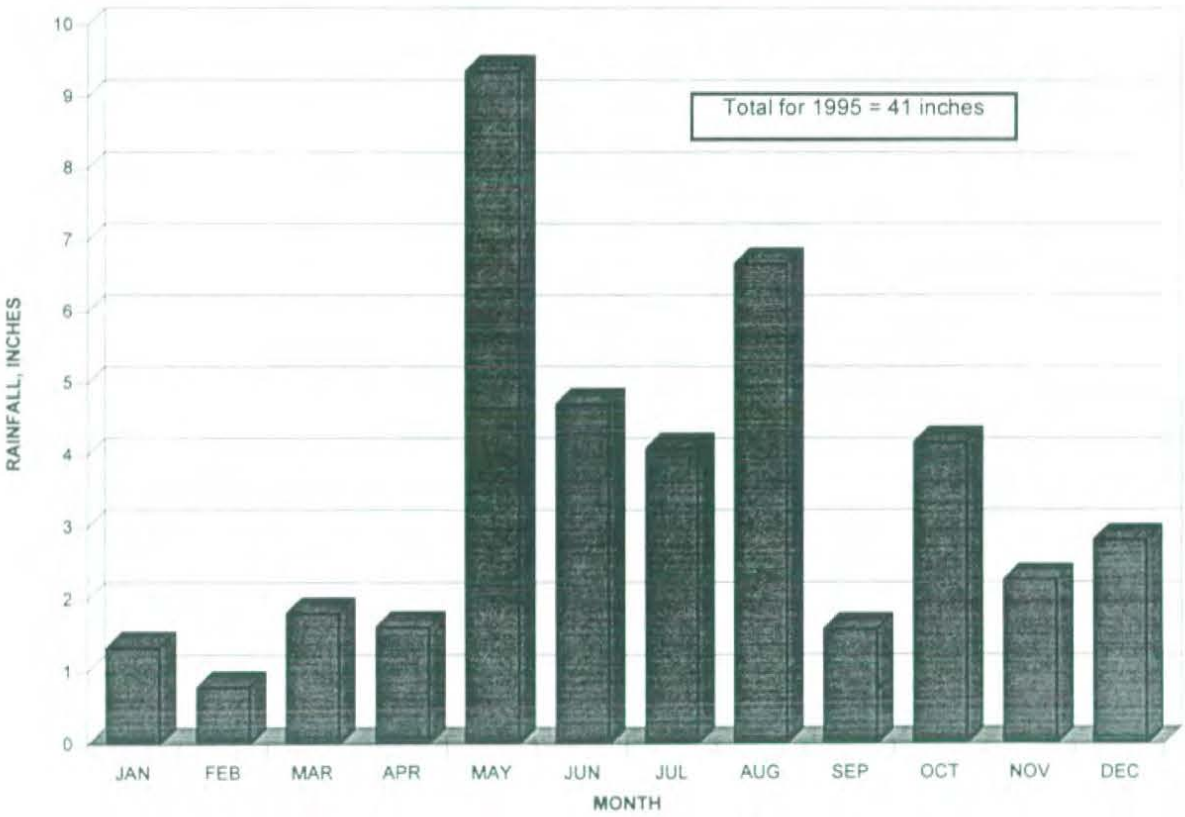
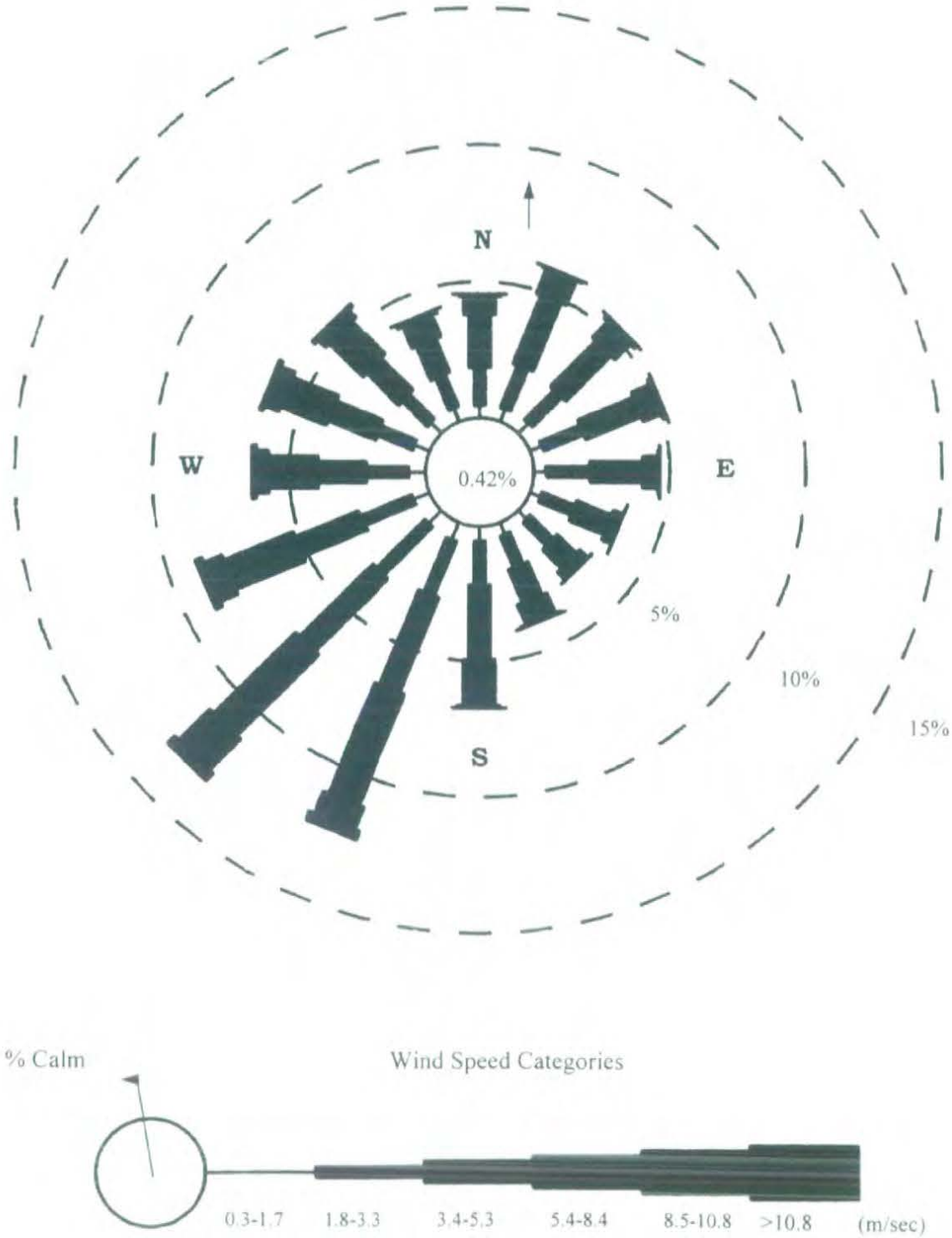


Figure 1-5. 1995 Wind Rose for the Mound Plant



(Figure indicates frequency of winds blowing *from* a given compass sector.)

Table 1-2. Percent Frequency of Wind Direction and Wind Speed from the Mound Plant 50-m Meteorological Tower for 1995

Direction	Percent	Average Speed (m/s)
N	4.56	3.90
NNE	5.90	4.00
NE	5.38	4.00
ENE	5.13	4.00
E	4.62	3.70
ESE	3.48	3.50
SE	3.05	3.50
SSE	3.92	3.90
S	6.71	4.30
SSW	12.27	5.30
SW	13.14	5.50
WSW	8.87	5.10
W	6.34	4.80
WNW	6.34	4.90
NW	5.74	4.80
NNW	4.15	4.00
		Average 4.32

Total relative frequency of calms distributed above is 0.42%

Topography

The site topography is shown in Insert 1-1, (see 11" x 17" foldout at end of chapter). Mound site elevations vary from 216 m to 268 m (700 ft to 900 ft) above sea level; most of the Plant is above 244 m (800 ft). No building in which radioactive material is processed is located below an elevation of 241 m (790 ft). The typical nonflood stage of the Great Miami River is 208 m (682 ft). The highest flood-water levels that can be reasonably postulated for the Great Miami River basin would result in flooding to 216 m (710 ft), which is approximately the lowest elevation at the site. No buildings at Mound are located on a floodplain or in areas considered wetlands.

Mission and Operations

Mound has served as an integrated research, development, and production facility in support of DOE weapon and nonweapon programs, especially in the areas of chemical explosives and nuclear technology. The principal mission of the Mound Plant has been to research, develop, and manufacture non-nuclear explosive components for nuclear weapons that are assembled at another DOE site. Other major operations at Mound have included:

- Manufacture of stable (nonradioactive) nuclides for medical, industrial, and general research.
- Development and manufacture of small chemical heat sources for the national defense program.
- Recovery and purification of tritium from scrap materials generated by Mound and other DOE sites.
- Development and fabrication of radioisotopic heat sources fueled with plutonium-238 to provide power sources for such projects as lunar experiments, satellites, and spacecraft.
- Surveillance of explosive and radioactive weapons components received from other DOE sites.

As a result of the November 22, 1993, DOE decision to phase out the defense mission at Mound, activities are currently underway to transfer Mound's defense-related programs to other sites within the DOE complex.

Therefore, in addition to completing the defense mission, current Mound objectives include the expansion of environmental restoration activities and the pursuit of new business opportunities for the site.

1.2 Perspective on Radiation

This section attempts to put into perspective the potential consequences of the radionuclide releases described in subsequent sections of this report. Additional background information on radiation can be found in Appendix 2, *Principles of Radiation.*

Most consequences to humans from radionuclides are caused by interactions between radiation emitted by the nuclides and human tissue. These interactions involve the transfer of energy from the radiation to the tissue, a process that may damage the tissue. The radiation may come from radionuclides located outside the body (i.e., in or on environmental media and man-made objects) and from radionuclides deposited inside the body via inhalation, ingestion, or absorption through the skin. Exposure to radiation from nuclides located outside the body is called external exposure and will last only as long as the exposed person is near the external source. Exposure to radiation from radionuclides deposited inside the body is called internal exposure and will last as long as the radionuclides remain in the body.

A number of specialized units are used to characterize exposure to ionizing radiation. Because the damage associated with such exposures is due primarily to the deposition of radiant energy in tissue, these units are described in terms of the amount of energy absorbed by the tissue and the biological consequences of the absorbed energy.

Some of the key units are defined below:

- **Absorbed dose** indicates the amount of energy absorbed by a material (e.g., human tissue), divided by the mass of the material. The unit of absorbed dose is the gray (Gy) or the rad (100 rads = 1 Gy).

- **Dose equivalent** indicates the biological effect of an absorbed dose on a particular organ or tissue. It equals the absorbed dose multiplied by factors that relate the absorbed dose to biological effects on that particular organ. The unit of dose equivalent is the sievert (Sv) or the rem (100 rem = 1 Sv).

- **Effective dose equivalent** indicates an individual's cancer risk from an exposure to ionizing radiation. It is calculated from the weighted sum of the dose equivalents from the irradiated organs. It is also expressed in rem or Sieverts.

- **Committed effective dose equivalent** indicates the total dose over the individual's projected remaining lifetime (assumed to be 50 years) that results from an intake during one year. The committed effective dose equivalent (CEDE) expresses the dose of internal radiation received when an individual has ingested or inhaled a radionuclide that will remain inside the body for months or years. It is also expressed in rem, mrem (1000 mrem = 1 rem), or Sieverts.

- **Collective committed effective dose equivalent** indicates the sum of the committed effective dose equivalents to the individuals in a population. It gives an estimate of the expected health risk to the population from a dose of radiation. It can be used to calculate probable risks that might be too small to predict on the basis of a single individual. It is expressed in person-rem or person-Sieverts.

Sources of Radiation

Every day our bodies absorb ionizing radiation. Most of it comes from natural sources. Consumer products and medical procedures that use radiation are other common sources of ionizing radiation.

Natural Sources. Natural radiation comes from two sources, cosmic and terrestrial. Cosmic radiation results when energetic particles from outer space, traveling at nearly the speed of light, collide with nuclei in our atmosphere, creating showers of radioactive particles that fall to earth. The average annual dose equivalent received from cosmic radiation is 26 mrem (0.26 mSv) for an individual living at sea level. Because cosmic radiation dissipates as it travels through the atmosphere, individuals living at lower altitudes receive less dose from this source than those living at higher altitudes.

Terrestrial radiation results when radionuclides that are a natural part of the earth's rocks and soils emit ionizing radiation. Because the concentrations of these radionuclides vary

geographically, an individual's exposure depends on his location. The average annual dose equivalent from terrestrial radiation for an individual living in the U. S. is 28 mrem (0.28 mSv).

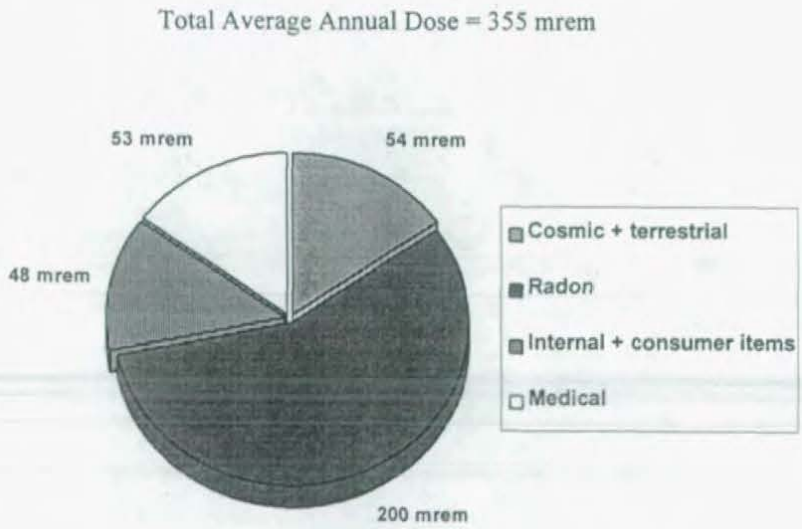
Besides absorbing radiation from external radionuclides, we can also absorb radiation internally when we ingest radionuclides along with the food, milk, and water we ingest or along with the air we inhale. Once in our bodies, radionuclides follow the same metabolic paths as nonradioactive forms of the same elements. The length of time a particular radionuclide remains and emits radiation depends on whether the body eliminates it quickly or stores it for a long period, and on how long it takes for the radionuclide to decay into a nonradioactive form. The principal source of internal exposure in the U. S. is believed to be radon. Inhalation of radon contributes about 200 mrem (2.0 mSv) to the average annual dose equivalent from internal radiation. Other radionuclides present in the body contribute approximately 39 mrem (0.39 mSv).

Consumer Products. Many familiar consumer products emit ionizing radiation. Some must emit radiation to perform their functions, e. g., smoke detectors and airport x-ray baggage inspection systems. Other products, e.g., TV sets, emit radiation only incidentally to performing their functions. The average annual effective dose equivalent to an individual from consumer products ranges from 6 to 12 mrem (0.06 to 0.12 mSv).

Medical Uses. Radiation is a tool for diagnosing and treating disease. The average annual dose equivalent for an individual in the U. S. from diagnostic radiation is 53 mrem (0.53 mSv). Individuals undergoing radiation therapeutic procedures may receive much higher doses.

Summary. The contributions to an average individual's annual radiation dose are shown in Figure 1-6. Mound's maximum contribution for 1995, 1.1 mrem, is too small to be included in the figure.

Figure 1-6. Average Annual Radiation Dose in the U.S. (NCRP, 1987)



Mound Site Topography

DRAWING NUMBER FSD

0 100 200 400 600 800 1000
Scale in Feet

TN GN MN

Legend

ISS	DATE	REVISION	BY	CHKR	ENG	M
0	05/29/96	ENVIRONMENTAL REPORT FOR CALENDAR 95	DCN ●	●		

PROJ ENG — DATE
PROJ MGR — DATE

SHEET	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ISSUE																					
SHEET	1	2	3	4	5	6															
ISSUE	●																				

TITLE: MOUND SITE TOPOGRAPHY
( ) TITLE CLASSIFICATION
PART CLASSIFICATION
DRAWING CLASSIFICATION: UNCLASSIFIED
SIZE: D
DRAWING NUMBER: FSD
JOB NUMBER: ●
DWG TYPE ● PRMG CAGEC ● SCALE ● SHEET 1 OF ●
STATUS MO-REL-**/**/** ORIGIN MSTATION 5.0

2.0 COMPLIANCE SUMMARY

The Mound Plant must operate in compliance with environmental requirements established by federal, state, and local statutes and regulations. Additional requirements have been imposed by Executive Orders, U. S. Department of Energy (DOE) Orders, and a Federal Facility Compliance Agreement (FFCA). As a result of recent economic development activities at the Mound site several private businesses have initiated operations on plantsite. These businesses are responsible for obtaining their own air permits and operating within the limits of Mound's current NPDES permit. Mound's status with respect to environmental requirements is summarized below.

2.1 Major Environmental Statutes, Regulations and Orders

Clean Air Act (CAA)

Nonradiological emissions. The Clean Air Act (CAA) of 1970, as amended in 1977, gave the EPA authority to regulate two groups of airborne pollutants: criteria pollutants and hazardous air pollutants. The CAA was again amended in 1990. The major impact of the amendments is the requirement that major emitters of pollutants obtain comprehensive air permits (Title V). In order to remain under the threshold at which a Title V permit is necessary, Mound applied for Federally Enforceable State Operating Permits (FESOPs). FESOPs were received for nine standby diesel generators, and an application was submitted to the Regional Air Pollution Control Agency (RAPCA) to obtain FESOPs for the powerhouse boilers. The permits place limits on annual fuel usage and thus limit the potential air emissions of the generators and boilers and enable Mound to remain under the Title V application emission threshold.

Mound is also subject to state and regional air pollution regulations (OAC 3745-31,-35,-15). Compliance with State of Ohio regulations requires that all applicable Mound operations be permitted or otherwise registered. Mound has twenty four air permits from the Ohio Environmental Protection Agency (OEPA). Nine other sources are registered with RAPCA. In order for a source to be considered for registration status, (1) the source owner must demonstrate compliance with all applicable laws including employment of best available technology, (2) maximum emissions of particulate matter, sulfur dioxide, nitrogen oxides, and organic compounds cannot exceed five tons per year, and (3) the source cannot be subject to U.S EPA new source performance standards or the National Emission Standards for Hazardous Air Pollutants (NESHAPs).

To ensure compliance with all state and local reporting requirements, chemical air emission data were collected in 1995. This information is maintained in a data base that is updated each calendar year. In addition to providing information on release levels for materials regulated by the CAA, the database is used to meet the reporting requirements of other statutes such as the Emergency Planning and Community Right-to-Know Act.

Non-radioactive air release data for 1995 have been compiled (Table 5-1, page 5-1). All emissions were within required limits and no enforcement actions were initiated in 1995.

Radiological emissions. Ten stacks and five building vents at Mound discharge radioactive effluents to the atmosphere. These releases are subject to NESHAPs for radionuclides. These "Radionuclide NESHAPs" regulations, 40 CFR 61, Subpart H, are components of the Clean Air Act (CAA) and are enforced by the U. S. Environmental Protection Agency (EPA).

The primary standard against which compliance with 40 CFR 61, Subpart H is measured is an annual effective dose equivalent (EDE). The regulations require that radionuclide air emissions from a given site do not exceed those amounts that would cause a member of the public to receive an annual EDE of 10 mrem (0.10 mSv). The regulations also state that each facility must determine this "maximum offsite dose" using an approved approach; the preferred approach is to use a computer code such as CAP-88.

Based on CAP-88 calculations performed for Mound's emissions in 1995, the maximum EDE received by a member of the public was 0.05 mrem. This value represents 0.5% of the dose limit and demonstrates that Mound releases for 1995 were well below allowable release levels.

The NESHAPs also define sampling and monitoring techniques which apply to stacks and vents that release radioactive materials. In July 1992, Mound submitted to the U. S. EPA, Region 5, a proposed compliance schedule to bring Mound's effluent sampling and monitoring practices into full compliance with the requirements of 40 CFR 61, Subpart H. Discussions between the U.S. EPA and DOE subsequently led to a Federal Facility Compliance Agreement (FFCA). The FFCA was signed July 7, 1994, between U. S. EPA Region 5 and the Miamisburg Area Office of DOE. The FFCA stipulates specific actions and deadlines for achieving compliance with NESHAPs requirements. Stack monitoring upgrades which will bring Mound into compliance with NESHAPs requirements are currently underway and are scheduled for completion June 30, 1997.

Clean Water Act (CWA)

The Federal Water Pollution Control Act (FWPCA) of 1972 was established to limit the types and rates of liquid effluents that may be discharged to the nation's waters. These limits are set for a specific site by the U. S. and/or state EPA using a National Pollutant Discharge Elimination System (NPDES) permit. An NPDES permit is also used to maintain compliance with more recent legislation, the Clean Water Act (CWA) of 1987.

Mound's current NPDES permit went into effect on October 1, 1992; it is valid through April 1, 1997. The permit defines discharge limits and monitoring frequencies for the Plant's liquid effluents and stormwater. Additionally, as a result of economic development activities at the site, numerous private businesses are providing information on their discharges for inclusion into the NPDES permit application.

Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act (SDWA) of 1974 instructed the U. S. EPA to establish a program to protect drinking water sources. To meet this goal, the EPA developed National Primary and Secondary Drinking Water Standards. These standards are applied to drinking water supplies "at the tap." Since Mound withdraws well water for use as drinking water, the Plant is subject to the requirements of the Act.

In Ohio, the SDWA is administered by the Ohio EPA. In accordance with Ohio EPA requirements, the Plant's drinking water system is routinely tested for various compounds. These analyses must be performed by a state-certified laboratory. For 1995, the analyses were performed by National Environmental Testing, Inc. (NET); no violations of standards for bacteria, metals, nitrate, sulfate or synthetic and organic chemicals occurred.

Under the Ohio EPA's SDWA authority, Mound is also required to maintain a minimum chlorination level of 0.2 mg/L free chlorine (or 1.0 mg/L combined chlorine) in the Plant's potable water system. This standard applies throughout the distribution system. Though Mound currently meets the standard, there have been isolated results indicating atypical chlorine levels at specific locations. Low chlorine levels are a concern because they could foster bacteria growth. Continued bacterial testing of the Plant's drinking water system, however, has identified no bacteria problem. High chlorine levels, on the other hand, do not present a safe drinking water concern, but rather could be an NPDES compliance issue.

A request to exempt the site from the chlorination standard was filed with the State of Ohio in 1990. The state has not acted on the exemption because the site did not meet current standards for backflow prevention and cross-connection control (Ohio Administrative Code 3745-95). Construction to eliminate all cross-connections between potable and other water systems such as the service and fire water systems was completed in 1995.

Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) of 1976, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, established a "cradle to grave" tracking system for hazardous wastes. The Acts led to the implementation of registration and/or permit requirements for all facilities that transport, generate, treat, store, and/or dispose of hazardous wastes. For the Mound Plant, the Ohio EPA administers this program.

Mound has "interim status" as a RCRA treatment and storage facility. "Interim status" provides for the continued use of these facilities while Mound awaits a formal permit from the Ohio EPA. Mound has been seeking a permit for a number of years; the most recent permit application was submitted in October of 1995. The OEPA issued a "draft" RCRA permit for Mound in December 1995. The "draft" permit served as a recommendation to the Ohio Hazardous Waste Facility Board (HWFB) to issue a final permit. Mound is currently awaiting action from the board.

Mound has several units subject to RCRA and HSWA. During the summer of 1995, Mound determined that two of the storage units (both used for storage of energetic materials) and three of the thermal treatment units were no longer essential for Mound's mission. At that time, Mound approached the Ohio EPA and proposed that the operations, collectively known as the "Burn Area", undergo RCRA closure. As a consequence of this decision, Mound revised the RCRA permit application to only address the two remaining storage units. These two units accommodate hazardous wastes and radioactive wastes that are also regulated by RCRA (i.e. mixed wastes).

Hazardous wastes. Hazardous wastes stored onsite are managed pursuant to RCRA regulations with regard to waste characterization, labeling, storage container integrity, facility performance criteria, and availability of protective and emergency response equipment. These wastes are shipped offsite for approved treatment and/or disposal.

In 1995, the amount of hazardous waste shipped offsite was 91,180 pounds. In 1995, the amount of non-hazardous waste shipped offsite was 138,612 pounds.

Mixed wastes. Wastes regulated by RCRA, but that are also radioactive, are referred to as mixed wastes or RCRA mixed wastes. These wastes present a unique compliance issue because treatment or disposal options have not been available. For this reason, Mound continues to store mixed wastes in accordance with the Mound Site Treatment Plan.

Suspect wastes. It is the policy of DOE that RCRA hazardous wastes originating in Radioactive Material Management Areas (RMMAs) be treated as "suspect" wastes, (i.e., suspected of being radioactive). This precaution is necessary to ensure that hazardous waste management facilities do not receive radioactive wastes unless they are equipped and licensed to do so. As a result of this policy, in place since May of 1991, Mound is required to implement procedures that assure waste sent to commercial Treatment/Storage/Disposal Facilities is not radioactive. In 1995, Mound submitted for approval the documents describing Mound's waste certification program. These documents were reviewed by DOE and conditionally approved in the first quarter of 1996. The procedures have also helped minimize the volume of suspect wastes generated.

Nonhazardous solid wastes. Nonhazardous solid wastes generated at Mound are disposed of in a nearby sanitary landfill that is licensed and permitted. The volume of materials requiring landfill disposal has been significantly reduced in recent years as a result of Mound's recycling programs for paper, aluminum cans, glass, and scrap metal.

Toxic Substances Control Act (TSCA)

The goal of the Toxic Substances Control Act (TSCA) of 1976 is to protect human health and the environment from unreasonable risks associated with toxic chemical substances. The Act gave the U. S. EPA authority to govern the manufacture and use of chemicals deemed to present significant toxicity risks. Mound does not generate TSCA waste streams on a regular basis.

However, efforts continue at Mound to remove TSCA wastes associated with past practices. The two primary areas comprising this category of Plant wastes are polychlorinated biphenyl's (PCBs) and asbestos.

PCB's. PCB-contaminated materials that are not suspected of being radioactive are stored onsite pending their shipment to an EPA-approved facility for disposal. "Suspect" PCB wastes (those wastes originating in RMMAs) are retained onsite for waste characterization. Radioactively contaminated PCB wastes are also retained onsite. Disposal options are currently being explored for PCB contaminated mixed waste.

Asbestos. The use of asbestos in pipes, panels, and as an additive to diallyl phthalate in parts production, has been discontinued at Mound. Residual asbestos is handled, packaged, and shipped offsite to an approved disposal facility in compliance with TSCA regulations. Asbestos removal projects continued in 1995 in connection with building renovation activities. All such projects are carefully monitored by the Industrial Hygiene Section to ensure compliance with TSCA and Mound's Safety and Hygiene Manual.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Federal Facilities Agreement (FFA)

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, also known as Superfund, is the federal government's primary environmental restoration legislation. Through CERCLA, the U. S. EPA identifies sites where hazardous substance contamination may present a risk to human health and/or the environment. Those sites presenting a human health or environmental risk are then placed on the National Priorities List (NPL) and subjected to a four-stage remediation process.

Mound was added to the NPL in November of 1989 because of volatile organic compound (VOC) contamination in the groundwater. A Federal Facilities Agreement (FFA) between the DOE and the U.S. EPA followed in October of 1990. The FFA defined the responsibilities of each party for the completion of CERCLA-related activities.

The FFA became a tri-party agreement on July 15, 1993, when the Ohio EPA became a signatory. The addition of the Ohio EPA did not change the general purpose of the agreement, but rather provided a mechanism for the full participation of the Ohio EPA in the CERCLA process at Mound.

Preliminary CERCLA assessment of contamination at Mound identified approximately 125 locations of actual or suspected releases. These locations were grouped into "Operable Units" (OUs) based on waste type and/or geographical proximity. Originally, Mound established nine OUs. As CERCLA activities at Mound progressed, changes to the number and composition of the OUs were warranted. In 1995 the Mound CERCLA program was reorganized to streamline and speed-up the cleanup process. The new concept termed "MOUND 2000" is a DOE proposal to accelerate the cleanup of the plant site in order to release the land for economic development

much sooner than originally planned. The MOUND 2000 process consolidates the nine former Operable Units (OUs) into three OUs. Additionally, MOUND 2000 breaks the site down into 19 "Release Blocks", A through S, containing more than 400 individual "Potential Release Sites" (PRSs). The MOUND 2000 process starts with a core team, one member from DOE, U.S. EPA, and Ohio EPA to review the status of each PRS. The team puts together a concise information package on the PRS that is the basis for decision making. The core team then decides to either (1) clean-up the site, (2) make no further assessment, or (3) reassess the site before going further. The core team decision is then presented to the Mound stakeholders. If there is a consensus to clean-up the PRS, the MOUND 2000 process calls for a Removal Action (a rapid response to the clean-up). The MOUND 2000 process thus allows for accelerated clean-up of the site by focusing on PRSs and streamlining decision making. The end result is a multi-year and mutimillion dollar savings that will allow the DOE to exit the site without leaving behind environmental concerns. A brief description of CERCLA activities for 1995 can be found in Section 3.9 of this report.

Offsite characterization projects are continuing. Mound is implementing an offsite testing program which involves six types of studies to be performed throughout a 20-mile radius of the site. These study areas focus on hydrogeology, soil, residential wells and cisterns, surface water, and sediment, and ecological assessments. The soil, residential water, ecological and hydrogeology investigations are complete. Results from these investigations are in the CERCLA Public Reading Room. The surface water and sediment investigations are scheduled to be completed in 1996.

Also in 1995, the Agency for Toxic Substances and Disease Registry, ATSDR, continued its evaluation of Mound. It is a requirement of CERCLA that the ATSDR evaluate each site listed on the NPL. The Agency examines health data to seek out abnormal rates or types of illnesses. If any such problems are suspected, the Agency attempts to determine if a correlation exists between the illness and the site.

Initial ATSDR findings for the Mound Plant were published in October of 1993 as an ATSDR "Health Consultation." The consultation report indicated that plutonium-238 levels in the Mound environment are not a public health hazard. For other constituents of concern, insufficient data were available to draw public health conclusions. Therefore, a key recommendation of the report was the pursuit of additional testing. ATSDR performed soil and air sampling during 1994. None of the measurements indicates there is a public health hazard anywhere in the area. The final report is expected to be published during 1996.

In addition to the activities described above, the Act established a list of CERCLA-regulated materials. Release of these materials to the environment is subject to certain reporting requirements. No releases of reportable quantities of CERCLA-regulated materials occurred at Mound in 1995.

Emergency Planning and Community Right-to-Know Act (SARA Title III)

The reauthorization of CERCLA came in 1986 in the form of the Superfund Amendments and Reauthorization Act (SARA). The Emergency Planning and Community Right-to-Know portion of that legislation is found in Title III of the Act. SARA Title III, Section 312, requires that sites handling "extremely hazardous" and "hazardous" substances notify regional emergency planning agencies. In compliance with the Act, Mound annually reports hazardous chemical inventory data to the State Emergency Response Commission, the Miami Valley Regional Planning Commission, and the City of Miamisburg Fire Department. The inventory information is accompanied by maps showing the specific locations of the chemicals. For 1995, Mound reported using and/or storing three "extremely hazardous" and seven "hazardous" chemicals. A listing of those chemicals is presented in Section 5.3 of this report.

SARA Title III, Section 313 mandates an annual submission of a Toxic Chemical Release Inventory report. In 1995 Mound did not manufacture, process, or otherwise use toxic chemicals in quantities subject to the Section 313 reporting requirements. Private businesses located onsite are responsible for submitting their own EPCRA documentation.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) of 1969 was established to ensure that consideration is given to the potential environmental impact of federal actions prior to the irretrievable commitment of resources. DOE has formalized its approach to NEPA by enacting regulations, 10 CFR 1021. Mound has also formalized its approach by developing internal NEPA guidance documents.

The Mound Plant Decontamination and Decommissioning Environmental Assessment and the Glass Melter Thermal Treatment Unit Environmental Assessment were approved and issued a Finding of No Significant Impact (FONSI) in 1995. Numerous checklists and other NEPA-related documents were prepared for planned activities at Mound in 1995.

Endangered Species Act (ESA)

Provisions of the Endangered Species Act (ESA) of 1973, as amended, prohibit federal departments such as the DOE from carrying out projects that would destroy or modify a habitat deemed critical to the survival of an endangered or threatened species.

EG&G Mound has performed a number of surveys for threatened or endangered species. Two potential ESA compliance issues have been noted. First, an endangered plant species, the Inland rush (*Juncus interior*), and an endangered bird species, the Dark-eyed junco (*Junco hyemalis*), have been observed onsite. Both species are listed on the State of Ohio Endangered Species list. Because only one individual of inland rush was located, it is not considered a viable breeding population at the Mound facility. The dark-eyed junco, despite being a common winter visitor to Ohio, is not known to breed in southwestern Ohio. Secondly, it has been determined that the

plant site is in the habitat range of the federally endangered species of Indiana Bat (*Myotis sodalis*). Consultation with the U.S. Fish and Wildlife Service and the Dayton Museum of Natural History, indicate that the Mound site does not provide a suitable habitat for the Indiana bat. Indiana bats have never been observed onsite.

Neither the solitary sitings of the rush and the junco, nor the potential habitat for the Indiana bat, are expected to affect ongoing or future activities at the site.

Federal Facility Compliance Act (FFCAct)

The Federal Facility Compliance Act (FFCAct) was signed into law on October 6, 1992. The FFCA required that all DOE facilities prepare an inventory of mixed wastes and mixed waste treatment capabilities. In accordance with the Act, EG&G Mound prepared a Conceptual Site Treatment Plan, which was submitted to the Ohio EPA in October of 1993. Following discussions with the Ohio EPA and public stakeholders, EG&G Mound revised the Conceptual Site Treatment Plan and submitted a Draft Site Treatment Plan to the Ohio EPA in August, 1994. The final Site Treatment Plan was submitted to DOE in March, 1995 and a Director's Findings and Orders was signed on October 4, 1995. The DF&O establishes schedules for and names treatment technologies for Mound's mixed waste.

As required by the Site Treatment Plan (STP), in 1995 Mound completed characterization of the following mixed waste streams: lead-acid batteries, newly identified wastes, lead loaded gloves, kerosene/PCBs, lead shapes, waste oils, waste oils with PCBs, absorbed oil, and transuranic (TRU) corrosives. Characterization of scintillation cocktail waste and sorting and surveying of lab packed mixed wastes was ongoing at the end of 1995.

Executive Order 11988, "Floodplain Management"

The main plant site at Mound is not located in a floodplain. Recent investigations indicate that lower plant areas around the production wells may be in the 100-year floodplain. This finding does not significantly affect operations at Mound.

Executive Order 11990, "Protection of Wetlands"

Ecological assessments conducted during CERCLA activities for the site have identified small regions within and around the Mound site that are considered wetlands. Environmental restoration activities at the Mound site are not expected to have any impact on these small isolated wetland areas.

2.2 Other Key Environmental Compliance Issues

Major External Environmental Audits in 1995

U.S. EPA NESHAPs inspection. The U.S. EPA conducted a site inspection in August, 1995 to verify compliance with NESHAPs requirements. The inspection focused on stack monitoring and associated stack sample analysis and documentation. All areas were judged to be satisfactory.

Ohio EPA inspection. The annual unannounced RCRA inspection of Mound by the Ohio EPA was conducted in May of 1995. The inspection focused on RCRA compliance issues. As a result of the inspection, the Ohio EPA found Mound to be in compliance with Ohio's hazardous waste rules and regulations.

Ohio EPA NPDES Permit Compliance Evaluation Inspection. On March 22, 1995 the Ohio EPA conducted an NPDES Permit compliance evaluation. All areas which were rated were judged to be satisfactory.

DOE/NVO. An audit team from the Nevada Operations Office of DOE (DOE/NVO) evaluated Mound's Waste Management Program for the handling and certification of specific waste streams destined for disposal at the Nevada Test Site. The audit resulted in Mound receiving continued approval to ship previously reviewed waste streams, and new approvals for shipments of backlog classified, solidified tritium and bulk wastes.

Integrated Environmental Management Project (IEMP). The IEMP was initiated by EG&G in November of 1995. Comprehensive environmental assessments for all facilities on site were conducted in the first quarter of 1996. The assessments focused on regulatory compliance and best management practices. A final 12 volume Environmental Appraisal Report was submitted by EG&G to DOE in March of 1996. The project established an environmental baseline database with regards to regulatory compliance and a mechanism for tracking corrective actions and improvement initiatives. The IEMP report will serve to assist DOE and EG&G during contract transition and will be of value for future economic development activities at the site.

Continuing Litigation

A class action lawsuit was filed against the Monsanto Research Corporation (MRC) and EG&G Mound (EG&G) on December 5, 1991. The lawsuit asserts that MRC and EG&G, Mound's former and current contractor, respectively, "engaged in a continuous course of negligent...and unlawful conduct resulting in...repeated discharges of both radioactive and nonradioactive hazardous substances...into the environment surrounding the facility." The lawsuit further asserts that these actions were "concealed from the plaintiffs." EG&G and Monsanto continue to vigorously defend the litigation.

Release data for Mound have been published each year in publicly distributed documents such as this report. The release data demonstrate the efforts taken by the Plant to operate within all

applicable regulatory requirements and guidelines. Any individual who desires more information about operations at the Plant is encouraged to contact Mound's Public Relations Office.

2.3 Summary of Permits

Mound operates in compliance with 24 state air permits. Nine additional sources of air emissions are on registration status with the State of Ohio. Liquid effluent releases from the site are governed by an NPDES permit. Additionally, Mound operates in compliance with two permits governing water treatment processes. In the area of waste management, the Plant filed a RCRA permit application for two hazardous waste storage units. A draft permit by the Ohio EPA was received in December, 1995 and negotiations are currently underway with the State Hazardous Facility Board regarding terms and conditions for the final permit.

3.0 ENVIRONMENTAL PROGRAM INFORMATION

The principal objective of the monitoring programs in place at Mound is to ensure that any threat to human health or the environment is promptly detected and mitigated. It is also Mound policy that meeting this goal be viewed as a minimum standard of practice; better performance should always be pursued. The philosophy is evident in the extent and scope of Mound's effluent and environmental monitoring programs. It is also supported by Mound's commitment to successful programs in the areas of:

- ALARA (As Low As Reasonably Achievable),
- Regulatory compliance,
- Waste minimization and pollution prevention,
- Environmental training, and
- Environmental restoration.

3.1 Environmental Monitoring Program

The environmental monitoring program at Mound is designed to provide data on surface water, groundwater, sediments, food and produce, and air all of which may provide a pathway for migration of hazardous materials from the plant to the public. The monitoring program includes a plant effluent (air and water) monitoring network, an extensive environmental surveillance program as well as meteorological monitoring. The programs are discussed below.

3.2 Effluent Monitoring

Air Emissions

All applicable stacks at Mound are sampled continuously for tritium and/or particulate radionuclides. These samples are collected to demonstrate Plant compliance with the NESHAPs for radionuclides regulations and to provide early warning of abnormal emissions so that timely corrective actions can be undertaken. An outline of the stack radionuclide sampling program is shown in Table 3-1. The Mound Plant also releases very small quantities of nonradiological constituents into the atmosphere. Annual non-radiological emission rates are calculated using a material balance approach. The releases are governed by State of Ohio EPA permits and regulations.

Liquid Releases

Mound's liquid discharges are also sampled continuously at their discharge points. Plant liquid effluents include process wastewater, sewage water, and storm water. With liquid releases the key concern involves nonradiological parameters. Extensive sampling and analysis is required of the Plant to demonstrate compliance with Mound's NPDES permit. Mound also samples a number of locations prior to discharge to ensure that any unexpected constituents are quickly detected. An outline of the liquid effluent sampling program is also shown in Table 3-1.

Table 3-1. Effluent Monitoring at Mound

	Parameter Measured[a]	No. of Sampling Locations	Collection Frequency
Air Emissions			
	HT, HTO	7	Daily
	^{238}Pu	7	Daily
	$^{239,240}Pu$	7	Daily
	$^{233,234}U$	2	Daily
	^{238}U	2	Daily
Liquid Effluents			
	Flow rate	6	Daily 2/month as pumped
	HTO	3	Daily
	Pu	3	Daily
	U	3	Daily
	pH	6	Daily Weekly Bimonthly Monthly
	Chlorine	2	Daily Weekly
	Suspended solids	3	2/week Weekly
	COD	1	Weekly
	$CBOD_5$	1	2/week
	Fecal coliform	1	Weekly
	E. coli	1	Monthly
	Ammonia	1	2/month
	Oil and Grease	2	Monthly Quarterly

[a] HTO - Tritium oxide
HT = Elemental tritium
Pu = Plutonium
U = Uranium
$CBOD_5$ = Five day carbonaceous biochemical oxygen demand
COD = Chemical oxygen demand

Table 3-1 (continued)

	Parameter Measured[a]	No. of Sampling Locations	Collection Frequency
Liquid Effluents			
	Free cyanide	1	Monthly
	Total cyanide	1	2/month
	Cadmium	3	Weekly 2/month Monthly
	Chromium	3	Monthly 2/month
	Copper	3	Weekly 2/month Monthly
	Lead	2	Monthly
	Mercury	1	2/year
	Nickel	3	Weekly 2/month Monthly
	Zinc	3	Weekly 2/month Monthly
	VOCs	1	Quarterly
	Total toxic organics	1	Quarterly
	Pentachlorophenol	1	Monthly
	Bis (2-ethylhexyl) phthalate	1	Monthly
	Toxicity testing		
	Ceriodaphnia dubia		
	acute	1	Monthly
	chronic	1	Quarterly
	Pimephales promelas		
	acute	1	Monthly
	chronic	1	Quarterly

[a] HTO - Tritium oxide
HT = Elemental tritium
Pu = Plutonium
VOC = Volatile Organic Compounds
U = Uranium
$CBOD_5$ = Five day carbonaceous biochemical oxygen demand
COD = Chemical oxygen demand

3.3 Environmental Surveillance

Mound maintains an extensive environmental surveillance program designed to evaluate potential impacts from plant effluents on human health and the environment. Mound's environmental surveillance program involves sample collection and analysis of ambient air, regional water sources, sediments, onsite and offsite groundwater, vegetation, fish, and produce. An outline of the program is shown in Table 3-2.

Radionuclides of Concern

The principal radionuclides of concern at Mound are tritium and plutonium-238; no other radionuclides contribute significantly to the dose estimates for the Plant (see Appendix 1). Small quantities of other radionuclides, however, are (or have been) used at Mound. In cases where there is a strong probability of detecting such radionuclides in the environment, they have been added to the appropriate sampling schedule. The primary example in this case is uranium. Because U-234 is a decay product of Pu-238, U-234 is a part of Mound's routine environmental monitoring program. Mound analyzes drinking water and river water samples to monitor the ingrowth of U-234. No significant concentrations have been encountered. Additionally, radioisotopes of thorium have been used at Mound during some operations. To ensure no significant dose impact from thorium is occurring, especially during decontamination and decommissioning activities, periodic monitoring is being performed. These data show that thorium concentrations are at or very near environmental levels. Additional data tables have been included to show thorium concentrations in well water.

Rationale

Environmental surveillance practices at Mound focus on those environmental media that are most likely to contain the radionuclide(s) of concern. Environmental surveillance at Mound includes the following:

Ambient Air

Mound maintains a network of ambient air surveillance stations to monitor the impact of airborne radiological emissions on the local and regional environments. The network includes both onsite and offsite stations. The number and placement of offsite stations is based on the population distribution and the prevailing winds.

Surface Water and Sediment

The Great Miami River and other regional surface water locations are sampled routinely by Mound for radionuclides. Since Pu-238 in river water tends to accumulate in sediments, sediment samples are collected from these locations and analyzed for plutonium isotopes.

Aquatic Biota

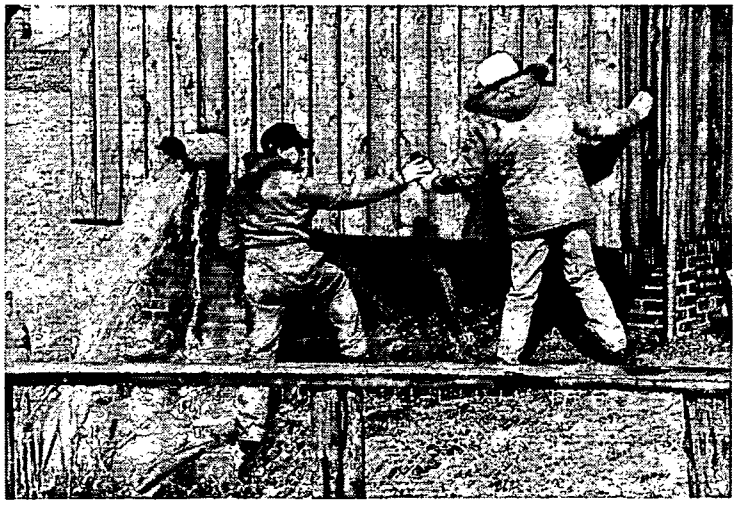
Aquatic organisms are used as test species to determine any detrimental impact Mound's liquid effluents may have on the Great Miami River. The tests provide information which is used to demonstrate compliance with the NPDES permit. Additionally, since Pu-238 in river water tends to accumulate in sediments, Mound collects fish samples from bottom-feeding fish such as carp for radioanalysis.

Foodstuffs and Vegetation

Various locally grown foodstuffs and vegetables are collected and analyzed to determine whether radionuclides of Mound origin are contributing a potential dose via the ingestion exposure pathway. Grass is sampled for Pu-238 and tritium because grass can take up these radionuclides from both air and soil. Root crops such as potatoes are analyzed since the roots may come into long-term contact with subsurface plutonium. Tomato samples, conversely, are of use due to their high water content; the high water content makes them excellent indicators of tritium uptake.

Groundwater

Mound has an extensive groundwater monitoring network designed to provide information on the impact of Mound operations on the local and regional groundwater. Groundwater samples are collected and analyzed from onsite and offsite monitoring wells, onsite and offsite production wells, private wells and specific regional community water supplies.



Sampling community groundwater supply

Environmental Levels

To evaluate Mound's impact on the environment, it is necessary to establish background or baseline levels of contaminants in a variety of media. Mound accomplishes this task by collecting samples at points where discharges from the Plant are not observable. These locations are usually in a direction opposite prevailing winds and at a distance too great to be impacted by the Plant. Concentrations measured at these reference locations are referred to as "environmental levels" in this report.

Table 3-2. Environmental Surveillance at Mound

Environmental Medium	Parameter Measured[a]	No. of Sampling Locations[b]	Collection Frequency
Onsite			
Ambient Air	HTO	7	Weekly
	^{238}Pu, $^{239,240}Pu$	7	Weekly
	Particulates	7	Weekly
Drinking water	HTO	3	Weekly
	^{238}Pu, $^{239,240}Pu$	3	Monthly
	$^{233,234}U$, ^{238}U	3	Monthly
	VOCs	5	Quarterly
Monitoring wells	HTO	c	semi-annually
	VOCs	c	semi-annually
Offsite			
Ambient Air	HTO	15	Weekly
	^{238}Pu, $^{239,240}Pu$	15	Weekly
	Particulates	15	Weekly
River water	Biotoxicity	3	Monthly (acute)
			Quarterly (chronic)
	HTO	6	Weekly
	^{238}Pu, $^{239,240}Pu$	6	Monthly
	$^{233,234}U$, ^{238}U	6	Monthly
River sediment	^{238}Pu, $^{239,240}Pu$	6	Quarterly
Pond water	HTO	7	Quarterly
	^{238}Pu, $^{239,240}Pu$	7	Quarterly
Pond sediment	^{238}Pu, $^{239,240}Pu$	7	Quarterly

[a] HTO = Tritium oxide
Pu = Plutonium
U = Uranium
VOC = Volatile Organic Compound
[b] Includes background location when applicable
[c] Number of sampling locations varies. Locations for 1995 are specified in Chapter 6.

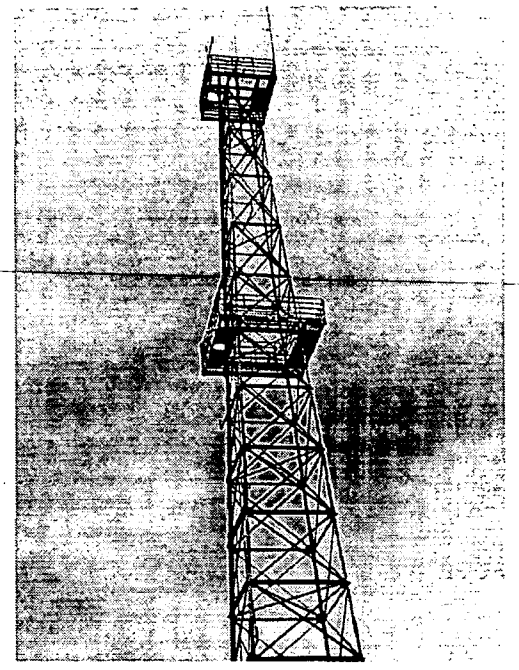
Table 3-2 (continued)

Environmental Medium	Parameter Measured[a]	No. of Sampling Locations[b]	Collection Frequency
Drinking water	HTO	c	Monthly
	^{238}Pu, $^{239,240}Pu$	c	Monthly
	$^{233,234}U$, ^{238}U	c	Monthly
Monitoring wells	HTO	c	semi-annually
	VOCs	c	semi-annually
Vegetation	HTO	7	Quarterly
	^{238}Pu, $^{239,240}Pu$	7	Quarterly
Produce	HTO	7	Quarterly
	^{238}Pu, $^{239,240}Pu$	7	Quarterly
Fish	^{238}Pu, $^{239,240}Pu$	2	Quarterly

[a] HTO = Tritium oxide
Pu = Plutonium
U = Uranium
VOC = Volatile Organic Compound
[b] Includes background location when applicable
[c] Number of sampling locations varies. Locations for 1995 are specified in Chapter 6.

3.4 Meteorological Monitoring

Meteorological monitoring at Mound provides information on weather conditions that can be used to forecast atmospheric dispersion following planned or unplanned releases of airborne material. Atmospheric dispersion is a function of wind speed, wind direction and atmospheric stability. Atmospheric stability determinations are made by estimating the amount of atmospheric turbulence in the lateral wind direction using a bidirectional wind vane. The parameters which characterize dispersion (wind speed, wind direction and atmospheric stability) are closely monitored at Mound with the aid of two meteorological towers.



Mound 50 meter meteorological tower

3.5 Effluent Treatment and Waste Management

Effluent Treatment

Air. High efficiency particulate air (HEPA) filters remove particulate radionuclides from process air emissions. Air effluents are filtered first at their point of origin (e.g., a glove box), and again just before reaching the release point (i.e., the stack or vent). The filtering system in place at each stack is composed of two banks of HEPA filters connected in series. Each filter bank has a nominal collection efficiency of 99.95% for 0.2-micron particles.

Tritium is not trapped by HEPA filters. A chemical process is used to recover tritium from waste gas streams.

Liquids. An onsite sanitary waste treatment plant manages all domestic sewage generated at Mound. An activated sludge process operated in the extended aeration mode provides the necessary treatment. The installation of a continuous backwash sandfilter in 1986 essentially upgraded the plant to tertiary treatment. The influent and effluent at the sewage treatment plant are monitored for radioactivity to ensure that radionuclides are not inadvertently discharged to the environment. All wastewater, after appropriate treatment and monitoring, is discharged from the Plant to the Great Miami River. Digested sludge from the sewage treatment plant is managed as Low Specific Activity (LSA) waste.

Waste Management

Hazardous wastes. Mound has "interim status" as a RCRA treatment and disposal facility. "Interim status" provides for the continued use of RCRA facilities while awaiting a formal permit. The operations at Mound subject to RCRA are three hazardous waste storage units and three hazardous waste treatment units. The storage units accommodate hazardous wastes, wastes that are both hazardous and radioactive, and energetic materials wastes. The thermal treatment units, which ceased operations in 1995, were used for open burning of explosives, and explosives retorting. Mound currently does not treat hazardous waste onsite.

Radioactive wastes. Mound currently has two disposal options for low-level radioactive wastes. The waste can be shipped to the Nevada Test Site (NTS) or to Envirocare, a commercial disposal facility. In 1995, Mound shipped 1,733 m^3 (61,200 ft^3) of low-level waste to NTS and 1,182 m^3 (41,760 ft^3) of low-level waste to Envirocare.

Nonhazardous, nonradioactive wastes. Solid wastes are disposed of according to a recycling and reclamation program whenever possible. White paper and scrap metal are sold for reclamation. General refuse is transported to a sanitary landfill approved by the county and the state.

3.6 Environmental Permits

Operations at Mound are routinely measured against the compliance requirements of state air and state water permits. Additionally, Mound's hazardous waste program operates under interim status with the state's RCRA program. Table 3-3 lists Mound's environmental permits.

3.7 Environmental Training

All Mound personnel received hazardous waste management training in 1995. Staff members with environment, safety, and health (ES&H) responsibilities received more intensive training based on their areas of responsibility. EG&G Mound environmental professionals attended numerous courses and professional society meetings in 1995.

3.8 Waste Minimization and Pollution Prevention (WM/PP)

Mound has established a Waste Minimization/Pollution Prevention Program to reduce the volume and toxicity of Mound's hazardous, radioactive, and solid waste streams. These goals are accomplished at Mound by preventing waste generation, by recycling and reclamation, and by a variety of treatment techniques.

In 1995 Mound completed eight Pollution Prevention Opportunity Assessments (PPOAs), and submitted two required annual reports, all on schedule. Four balers were obtained for recycling of paper from the site, one of which was installed and placed in service. Recycling of glass from the site was initiated, and process changes were instituted to increase the amount of white paper being recycled rather than discarded as waste.

Table 3-3. Environmental Permits Issued to Mound

Operation	Permit Type	Permit No.	Valid Through	Issuing Agency
10 Standby power Diesel Generators	air	857091196	1998	Ohio EPA
4 SW/R Fumehoods	air	P012,14,015,028	permanent	Ohio EPA
WD and Drum Repackaging	air	857091196P029	8/25/98	Ohio EPA
Paint Spray Booth	air	857091196K001	11/26/98	Ohio EPA
Wastewater Discharge (NPDES)	water	1IO00005*ED[b]	4/1/97	Ohio EPA
Bd-51 PAN Process	air	85709119P024	12/17/96	Ohio EPA
E-Building	air	85709119P008	10/22/96	Ohio EPA
W-Building	air	85709119P011	11/19/96	Ohio EPA
Clay Extrusion System	air	85091196P009	2/11/97	Ohio EPA
Clay Extrusion System (Diesel Generator)	air	85709119B007	3/25/97	Ohio EPA
Bd-51 (Material Deposition)	air	857091196P020 (Registration)	permanent	Ohio EPA
ULR[a] (Diesel Generator)	air	857091196B008 (Registration)	permanent	Ohio EPA
Gas Dispensing Facility	air	857091196G001 (Registration)	permanent	Ohio EPA
Open Burning (Fire Training)	air	letter permit	permanent	Ohio EPA
Power House Boiler 1 and Boiler 2	air	857091196B001 857091196B006 (Registration)	permanent permanent	Ohio EPA
Aggregate Storage Pile	air	857091196F002	2/17/98	Ohio EPA
Fuel Oil Storage	air	857091196T005	2/17/98	Ohio EPA
R/SW HEFS Stack	air	857091196F001	1/24/97	Ohio EPA
Hazardous Waste Operations		N/A	interim status[c]	Ohio EPA

[a] ULR = Underground Line Removal.
[b] Effective 12/1/94 due to permit modification.
[c] The Mound Plant is operating under interim status. The most recent permit application was submitted on August 16, 1994.

3.9 Environmental Restoration (ER)

Mound was added to the National Priorities List (NPL) in 1989. A Federal Facilities Agreement between DOE and the U. S. EPA followed in October of 1990. The FFA defines the responsibilities of each party for the completion of CERCLA-related activities. The bipartite FFA has been renegotiated to include the Ohio EPA as a signatory. The revised Agreement was signed by the three parties on July 15, 1993.

Preliminary CERCLA (Superfund) assessments of contamination at Mound identified approximately 125 locations of actual or suspected releases. These locations were grouped into nine "Operable Units", or OUs, based on waste type and/or geographical proximity. In 1995 the CERCLA program at Mound was reorganized to increase the efficiency of the environmental restoration effort with the original nine OUs consolidated to six OUs. The CERCLA program at Mound is currently functioning under the "MOUND 2000" concept. Key changes from the original CERCLA program include consolidation of the original Operable Units from six to three operable units and redefining the site in terms of Release Blocks that contain "Potential Release Sites (PRSs). The site is currently divided into Release Blocks A through S representing over 400 PRSs. Figure 3-2 shows the Mound Plant release block boundaries.

Highlights of the CERCLA program during 1995 are discussed below.

Operable Unit 1, Area B. OU1 addresses possible volatile organic chemical contamination of the portion of the Buried Valley Aquifer which underlies the southwest corner of the original Mound Plant. OU1 covers four acres and includes an historic landfill and an overflow pond. The main concerns at this site are volatile organic compounds that may be migrating into the groundwater. It is believed that such contamination originates from the area that was formerly used for open burning and waste disposal.

The Remedial Investigation and Feasibility (RI/FS) study assessment process for OU1 was completed in 1994. The OU1 Record of Decision (ROD) was signed by the U.S. EPA and Ohio EPA in June, 1995. OU1 remedial design for the ROD remedy, groundwater pump and treat, was initiated after issuance of the ROD. The groundwater pump and treat system is scheduled to be installed and operating by the end of calendar year 1996.

Operable Unit 4, Miami-Erie Canal. OU4 addresses contamination of the old Miami-Erie Canal bed in Miamisburg. OU4 covers the canal, the north and south pond within the park, the overflow creek from the canal to the Great Miami River, and the drainage ditch from Mound's west property line to the canal. Of concern is contamination from plutonium, which was introduced into the canal from a broken waste line and historic plant runoff. Tritium is also present in the canal as a result of past plant operations. Both the plutonium and tritium have been monitored since the 1970s and have been found to present no imminent danger to human health or the environment. Sampling of the canal to confirm the levels of these radioactive elements and analyze for chemical contamination was completed in February 1993. In January of 1994 a decision was made by DOE to perform a removal action for OU4. Design and planning activities

for excavation and offsite disposal of the contaminated soil have been completed. Cleanup activities are scheduled to begin at the south end of the canal in July 1996.

Operable Unit 9, Site -Wide and Offsite. OU 9 addresses the possible environmental effects of any contamination attributable to Mound that may be found in the air, groundwater, soils, surface water, and sediments, as well as plant and animal life. OU9 has conducted investigations up to a 20-mile radius of the plant. The OU9 regional soil investigation and groundwater investigation has been completed. However, monitoring of groundwater continues.

The OU9 investigation of regional residential and municipal water has been conducted. The Residential, Municipal, and Industrial Well Investigation Report is available in the Public Reading Room. Surface water, and sediment studies are in progress.

A large-scale soil sampling study was conducted in 1994. The study involved analysis of 252 soil samples collected over a 100,000-foot (20 mile) radius of the site. The results of the study have been published in the "Operable Unit 9, Regional Soils Investigation Report", which is available in the Public Reading Room.

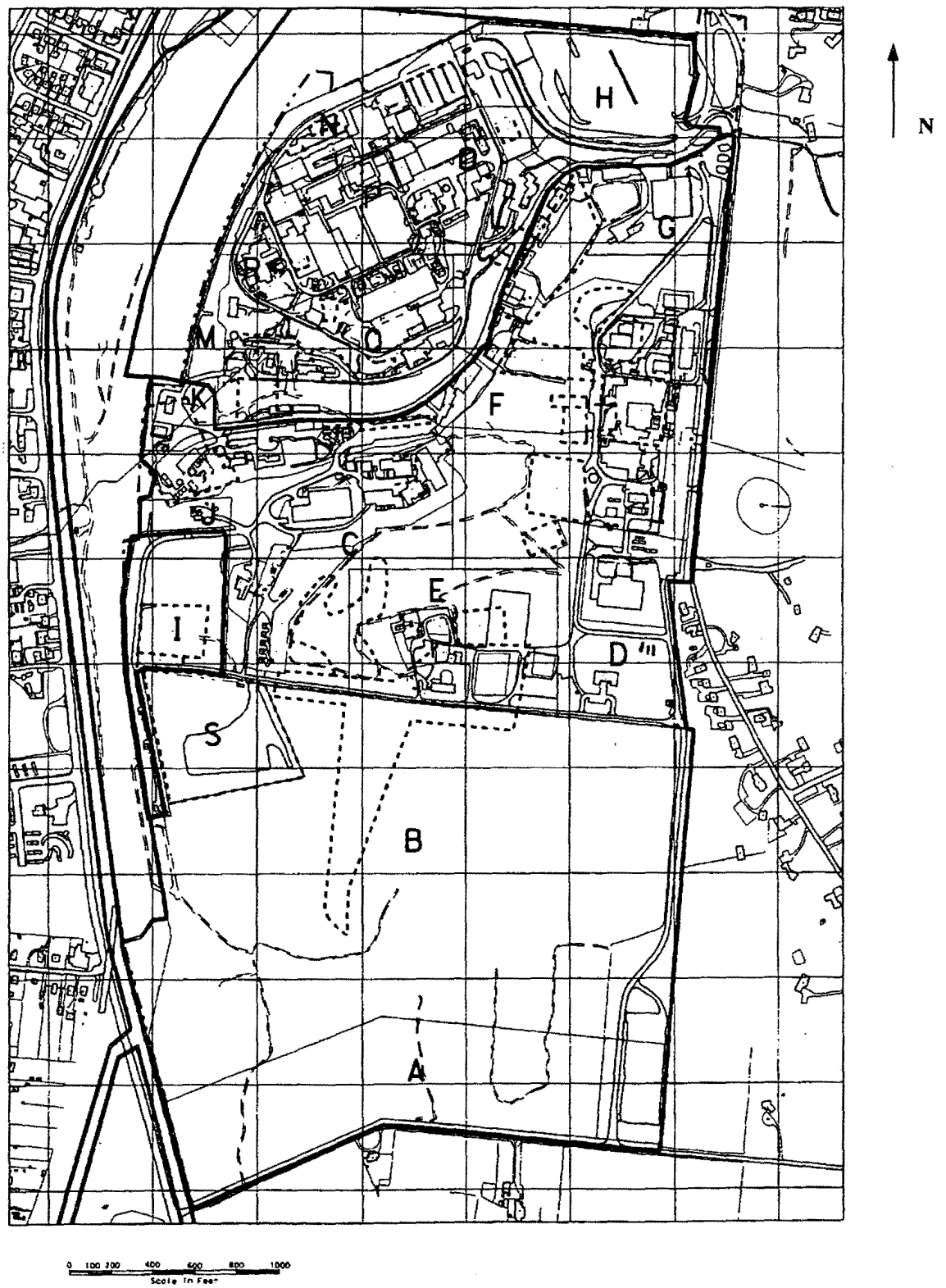
ATSDR Participation

In 1995, the Agency for Toxic Substances and Disease Registry, ATSDR, continued its evaluation of Mound. It is a requirement of CERCLA that the ATSDR evaluate each site listed on the NPL. The Agency examines health data to seek out abnormal rates or types of illnesses. If any such problems are suspected, the Agency attempts to determine if a correlation exists between the illness and the site. Initial ATSDR findings for the Mound Plant were published in October of 1993 as an ATSDR "Health Consultation." The consultation report indicated that plutonium-238 levels in the Mound environment are not a public health hazard. For other constituents of concern, insufficient data were available to draw public health conclusions.

Key recommendations of the report included:

- additional testing of surface soils, surface water, and air; and
- a continuation of the existing ban on fishing in the South Pond of the Miamisburg Community Park until data from additional testing for other constituents of concern are available.

Figure 3-1. Mound Plant Release Block Boundaries



ATSDR performed soil and air sampling during 1994. Preliminary results are consistent with monitoring performed at Mound. None of the measurements indicate there is a public health hazard anywhere in the area. The final report is expected to be published during 1996. ATSDR will continue to monitor CERCLA-related activities at Mound. ATSDR staff are frequent guest speakers at the CERCLA quarterly public meetings. They may also be contacted directly at their Atlanta, Georgia offices.

3.10 Agreement-In-Principle

The Agreement-In-Principle, or A-I-P, represents an added dimension to the environmental monitoring programs in place at DOE facilities in the State of Ohio. The A-I-P was signed by the U. S. Department of Energy and the State of Ohio in 1993. The Agreement establishes the framework under which the State will provide oversight and monitoring activities at the Mound Plant, the Fernald Environmental Management Project, and the Portsmouth Gaseous Diffusion Plant.

Under the A-I-P, the Ohio EPA reviews DOE environmental monitoring (Ohio EPA), radiological (Ohio EPA and Ohio Department of Health), and emergency management (Ohio Emergency Management Agency) and performs independent monitoring and data collection. The Ohio EPA's primary mission is to ensure that cleanup activities at these sites adequately protect human health and the environment. Additional oversight by the Ohio EPA will be applied to the emergency response and public information programs in place at each site.

4.0 RADIOLOGICAL ENVIRONMENTAL PROGRAM INFORMATION

Operations at Mound result in the discharge of radioactive effluents to the air and the Great Miami River. Release limits on these discharges have been established by the Department of Energy and the U. S. EPA. Mound monitors release levels using a network of stack and water sample collection devices. In addition, Mound operates an extensive environmental surveillance program. Data generated from those programs are presented in this Chapter.

4.1 Radionuclide Releases from Mound

1995 Data

Table 4-1 lists the quantities of radionuclides released by Mound into the air and water during 1995. The unit used to report these quantities is the curie (Ci), a unit of radioactivity equal to 3.7×10^{10} disintegrations per second. The quantities, or activities, shown in Table 4-1 were measured at the point of release. Information on the effluent monitors used to estimate release levels appears in Section 4.2 of this Chapter.

Table 4-1. Radiological Effluent Data for 1995

Radionuclide	Released to	Activity, Ci
Tritium	Air	769[a]
	Water	2.2
Plutonium-238	Air	8.7×10^{-6}
	Water	3.4×10^{-4}
Plutonium-239,240	Air	2.7×10^{-8}
	Water	7.7×10^{-6}
Radon-222	Air	2.4
Uranium-233,234	Air	3.0×10^{-9}
	Water	3.5×10^{-4}
Uranium-238	Air	1.7×10^{-9}

[a] Tritium in air consists of: Tritium oxide, 640 Ci.
Elemental tritium, 129 Ci.

5-Year Trends in Radionuclide Releases

It is Mound policy and philosophy that all releases of effluents from the Plant are ALARA, that is, As Low As Reasonably Achievable. To monitor Plant performance relative to ALARA goals, ALARA Investigation Levels (AILs) are established each year for principal radionuclides. AILs are set well below applicable regulatory standards to trigger internal investigations when exceeded.

Figures 4-1 through 4-8 illustrate 5-year trends in releases of tritium, plutonium, and uranium to the air and the Great Miami River. Mound's 1995 AILs have been included on the trend charts where applicable.

Tritium. Figure 4-1 shows releases of tritium to the atmosphere. The 1995 value, 769 Ci, represents a five year median value. The 1995 increase over the 1994 emission value was due to increased tritium processing needed to prepare tritium for shipment offsite in support of the shutdown effort. Figure 4-2 shows tritium releases to the Great Miami River. The 2.2 Ci value for 1995 represents a five year low in release rates. In 1995, tritium releases to the atmosphere and the Great Miami River did not approach their respective AILs.

Figure 4-1. Tritium Releases from Mound to the Atmosphere, 1991 - 1995

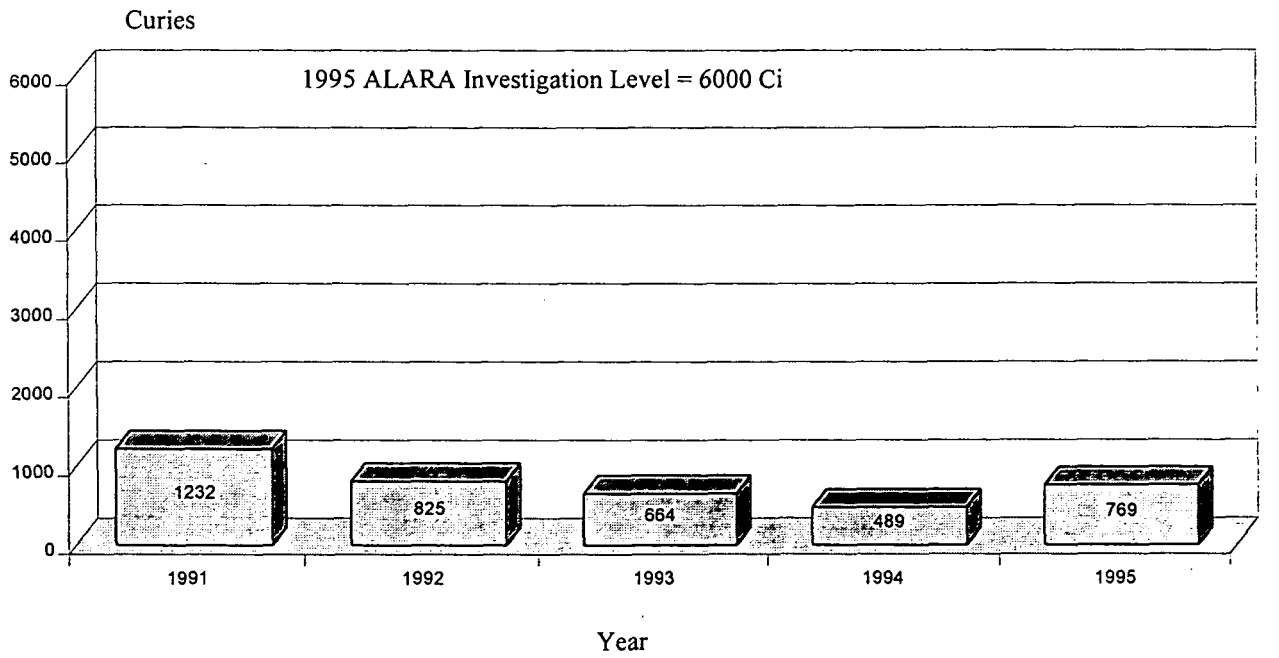
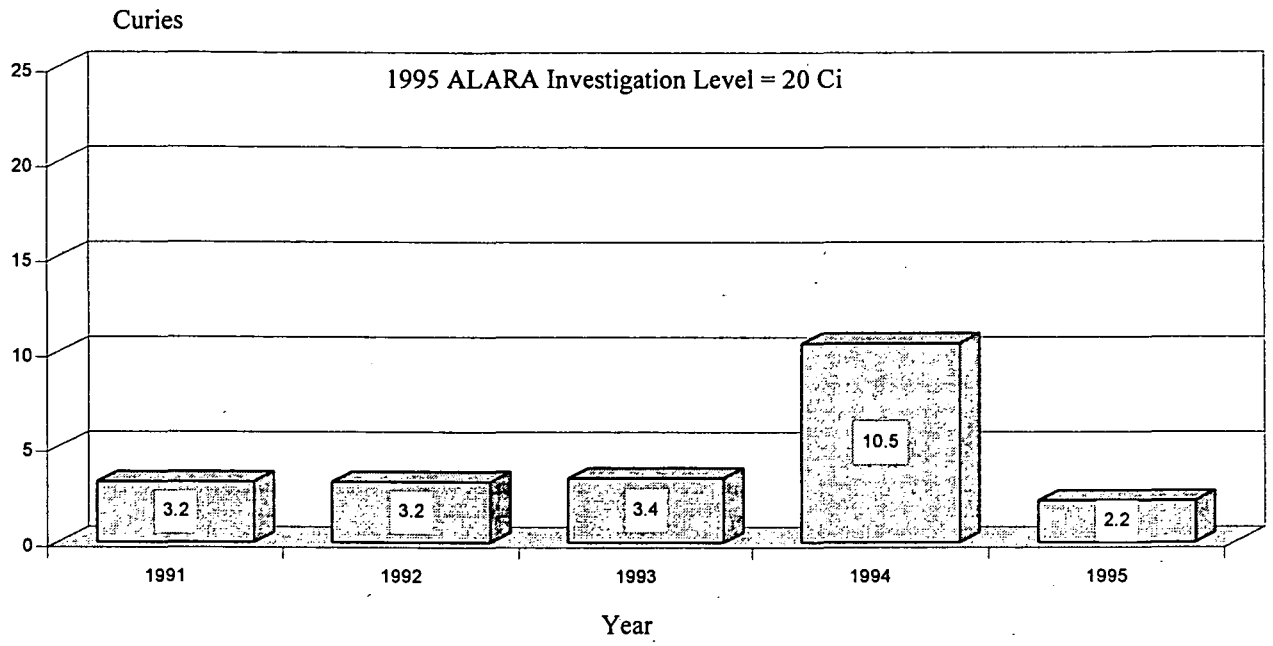


Figure 4-2. Tritium Releases from Mound to the Great Miami River, 1991 - 1995



Plutonium-238. Figures 4-3 and 4-4 show plutonium-238 releases to the atmosphere and the Great Miami River, respectively. Atmospheric release levels were lower in 1995 when compared to 1994 values; conversely, 1995 liquid release levels were higher than 1994 values.

Plutonium-239, 240. Figures 4-5 and 4-6 illustrate 5 year trends in Pu-239,240 release rates. Releases of these plutonium isotopes continue to be in the μCi and sub-μCi ranges.

Uranium. Figures 4-7 and 4-8 depict 5-year trends in uranium-233, 234 and uranium-238 release rates. Atmospheric releases of uranium are on the sub-μCi scale and as shown in Figure 4-7 uranium releases from Mound to the atmosphere in 1995 represent a five year low. Releases of uranium-233, 234 to the Great Miami River are comparable to plutonium-238 release levels for the River.

Figure 4-3. Plutonium-238 Releases from Mound to the Atmosphere, 1991 - 1995

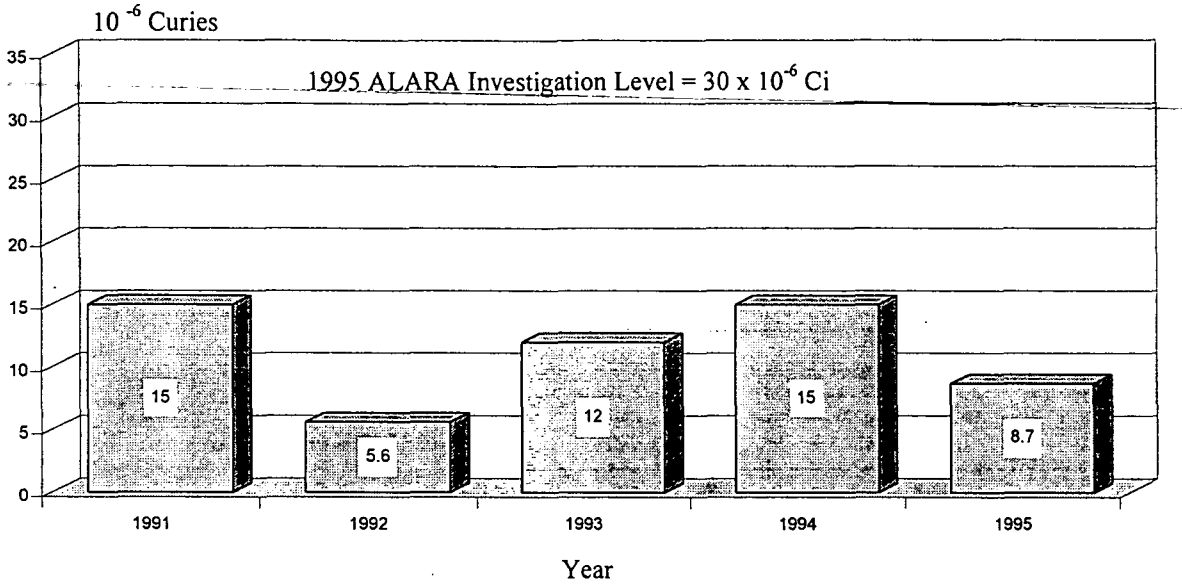


Figure 4-4. Plutonium-238 Releases from Mound to the Great Miami River, 1991 - 1995

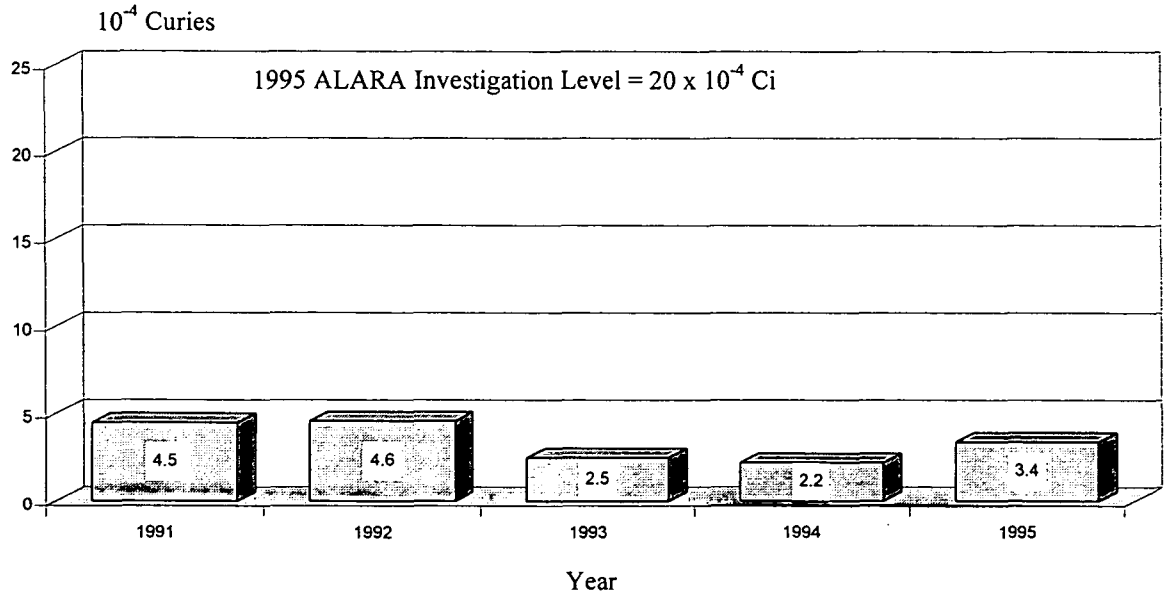


Figure 4-5. Plutonium-239,240 Releases from Mound to the Atmosphere, 1991-1995

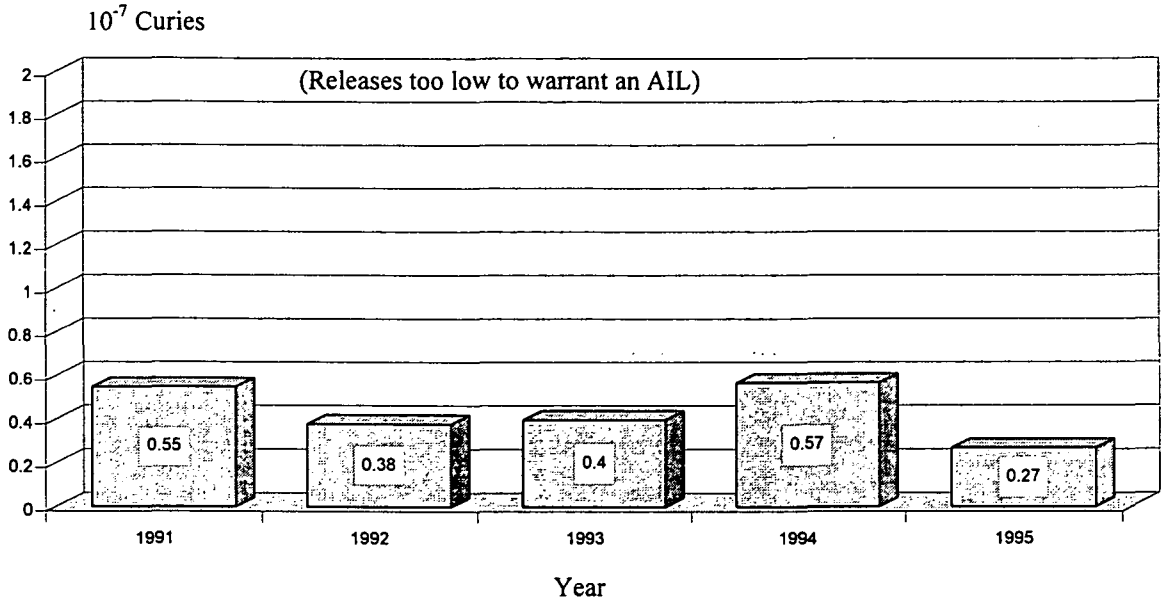


Figure 4-6. Plutonium-239,240 Releases from Mound to the Great Miami River, 1991-1995

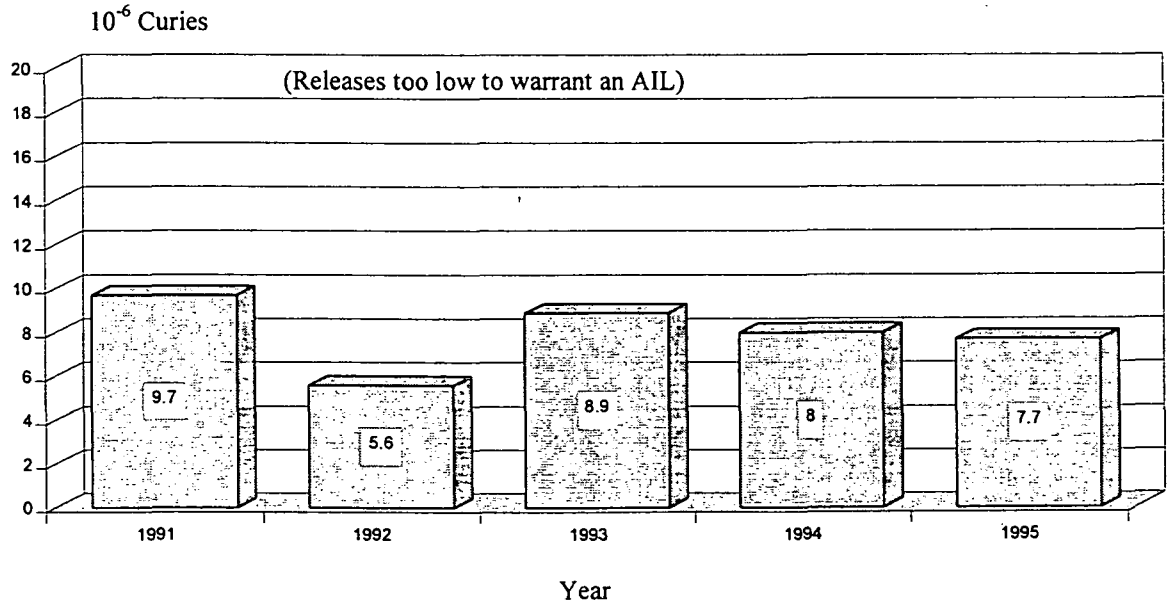


Figure 4-7. Uranium Releases from Mound to the Atmosphere, 1991-1995

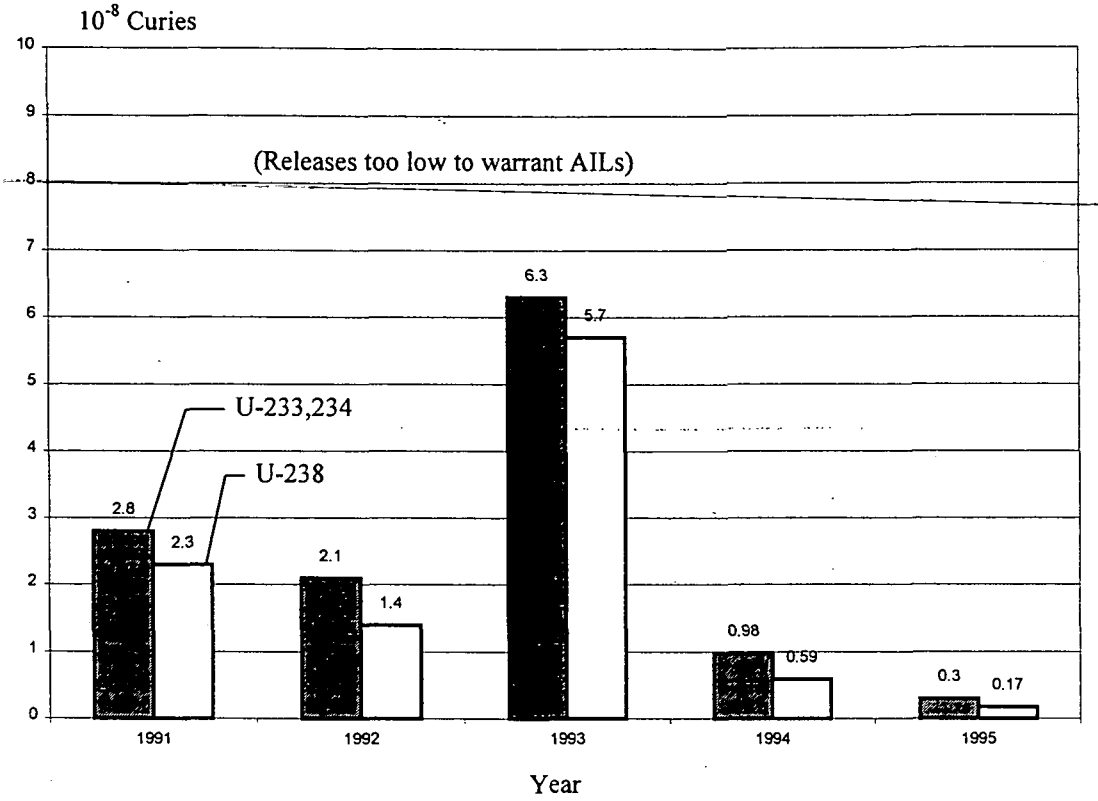
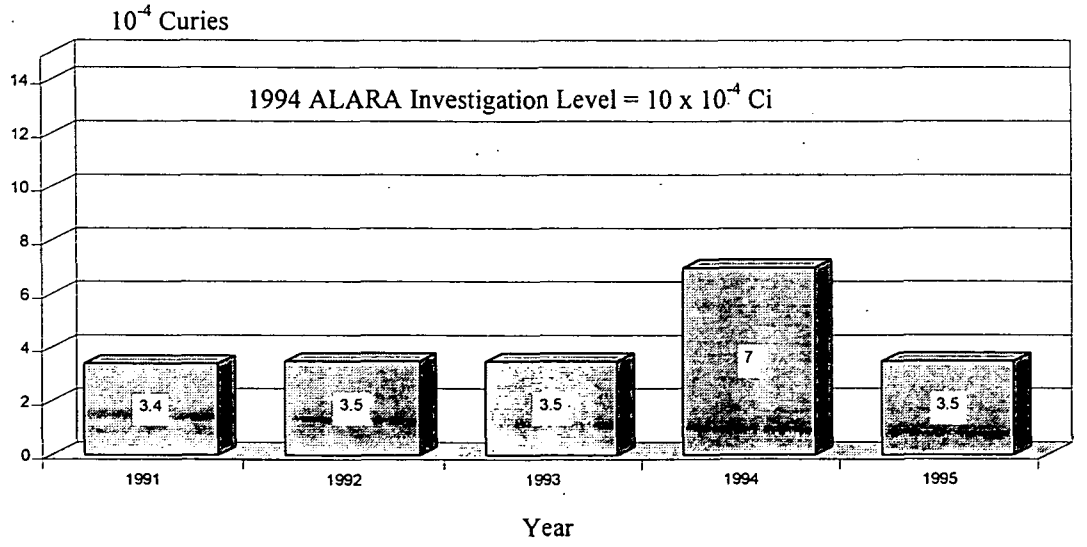


Figure 4-8. Uranium-233,234 Releases from Mound to the Great Miami River, 1991-1995



4.2 Effluent Monitoring Program

Air

Stacks through which radioactive materials are released are sampled continuously. Those areas in which a potential for unplanned releases exist are also monitored continuously.

Tritium. In operational areas where a release potential exists, room air and exhaust stacks are continuously monitored for tritium using strategically placed ionization chambers. These monitoring systems incorporate alarms and have been placed to help to locate the source if a release should occur. In most situations, an effluent removal and containment system can be relied upon to prevent or reduce the release of tritium to the atmosphere.

Plutonium and Uranium. In operational areas where a release potential exists, ventilation air passes through a minimum of two HEPA filters before being discharged to the atmosphere. Fixed continuous air samplers and continuous air monitors with alarm systems are used throughout the operational areas to detect airborne plutonium and/or uranium. These monitoring systems have been designed to ensure that prompt corrective action can be taken to reduce the number and magnitude of releases to the atmosphere.

Radon. Radon-222 from natural sources, and from past operations involving radium-226, is continually released to the atmosphere via a small roof vent. Though emission levels are negligible in comparison with natural radon emanation rates, a radon-222 release rate has been included in the 1995 effluent data (Table 4-1) in the interest of completeness. The estimated dose contribution from radon, as predicted by CAP-88, was 0.005 mrem for 1995.

Water

Sampling for radionuclides is not required by Mound's NPDES permit; however flow-proportional samples collected from NPDES Outfalls 5002, 5601, and 5602 (Figure 4-9) are analyzed for tritium, plutonium, and uranium. Samples are collected four times during Mound's four-day work week. Three 24-hour samples are collected on Tuesdays, Wednesdays, and Thursdays. One 96-hour sample is collected on Mondays. Samples are analyzed four times a week for tritium. Plutonium-238, plutonium-239, 240, and uranium-233, 234 samples are composited and analyzed every two weeks.

Average concentrations of radionuclides in effluent waters are shown in Table 4-2. These values are presented in terms of the percentage Derived Concentration Guide (DCG) they represent. DCGs for concentrations of radionuclides in water are given in DOE Order 5400.5 (DOE, 1990). These guides are based on recommendations in Publications 26 and 30 of the International Commission on Radiological Protection (ICRP 1977, 1979). The DCG for a radionuclide is defined as the concentration of that radionuclide in air or water which will give a 50-year committed effective dose equivalent of 100 mrem (1 mSv) if taken into the body by inhalation or ingestion during one year of exposure.

Figure 4-9. Liquid Effluent Sampling Locations for Radionuclides

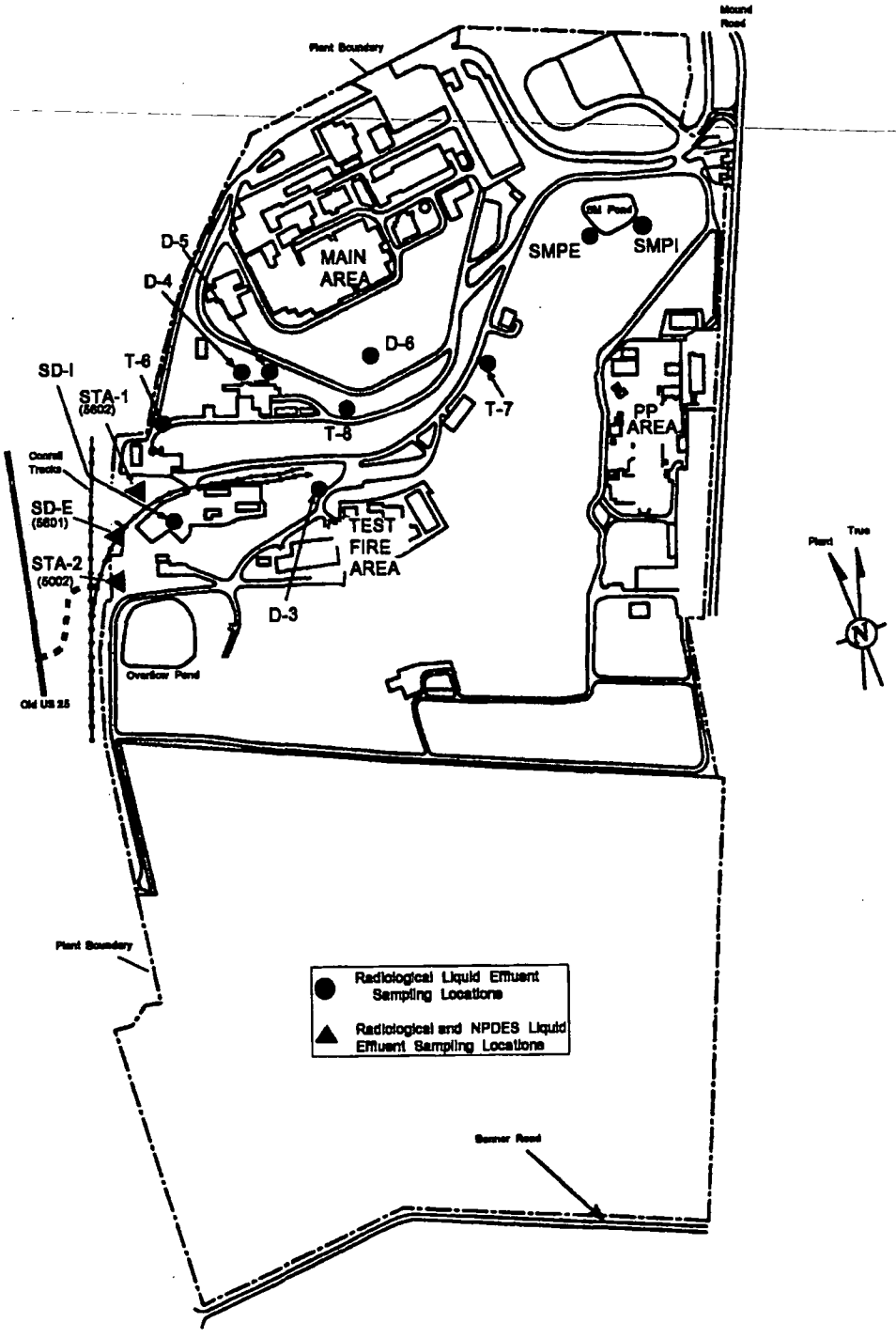


Table 4-2. Concentrations of Radionuclides in Liquid Effluent for 1995

Outfall	Radionuclide	Average Concentration (μCi/mL)	Average as a Percent of DOE DCG[a]
Outfall 5602	Tritium	4.46×10^{-6}	0.22
	Pu-238	3.08×10^{-11}	0.08
	Pu-239	5.89×10^{-12}	0.02
	U-233,234	4.35×10^{-10}	0.09
Outfall 5002	Tritium	2.03×10^{-6}	0.10
	Pu-238	4.46×10^{-10}	1.12
	Pu-239	8.93×10^{-12}	0.03
	U-233,234	3.68×10^{-10}	0.07
Outfall 5601	Tritium	2.63×10^{-6}	0.13
	Pu-238	4.00×10^{-11}	0.10
	Pu-239	4.39×10^{-12}	0.01
	U-233,234	3.19×10^{-10}	0.06

[a] DOE DCG values in water:
Tritium 2×10^{-3} μCi/mL
Pu-238 4×10^{-8} μCi/mL
Pu-239 3×10^{-8} μCi/mL
U-233,234 5×10^{-7} μCi/mL

4.3 Environmental Surveillance

In the sections that follow, tables of environmental monitoring results are presented. The tables show:

- number of samples analyzed during the year,
- minimum concentration measured,
- maximum concentration measured,
- average value with error limits, and, when appropriate, a
- comparison to a DOE or EPA standard.

Environmental Concentrations

In a number of the tables, results are presented as "incremental concentrations." The designation indicates that an average background concentration, or "environmental" concentration, has been subtracted from those values. Therefore, incremental concentrations represent estimates of Mound's contribution to the radionuclide content of an environmental sample.

Environmental or reference locations for Mound were positioned at sites where virtually no impact from Mound could be measured. The sites are in the least prevalent wind direction and/or are at substantial distances relative to Mound. Environmental levels for radionuclides in different environment media are shown in Table 4-3.

Chemist analyzing samples for radionuclides

With decreasing release rates of radionuclides, it has become increasingly difficult to observe Mound's contribution to radionuclide concentrations in the environment. For this reason, many of the tables in this Chapter report data as "below environmental levels." In those cases, it is not possible to observe an incremental concentration. In other words, the radionuclide concentration in the sample was equal to or less than the background sample.

Lower Detection Limit

All concentrations of radionuclides are determined by subtracting the instrument background and/or reagent blank from the sample count. The lower detection limit (LDL) is shown for each set of data in this Chapter. The LDL is that value at which the presence of a contaminant, above that inherent in the analytical method (including the reagent blank), can be inferred at the 95% confidence level. An LDL is calculated from the instrument background, or reagent blanks, and their respective estimated standard deviations. Much of the low level radionuclide data throughout this report show concentration values that are less than the reported lower detection limit (LDL). Most of these data are incremental concentrations, i.e., average measured concentrations less the environmental concentration. The initial measured concentration could have exceeded the LDL, but when the environmental level was subtracted from it, it fell below the LDL. Other data, such as environmental levels, are reported even if the concentration is below the LDL but exceeds the reagent blank or the instrument background level. Most of these data lie between true zero and the LDL level and provide information for comparative purposes.

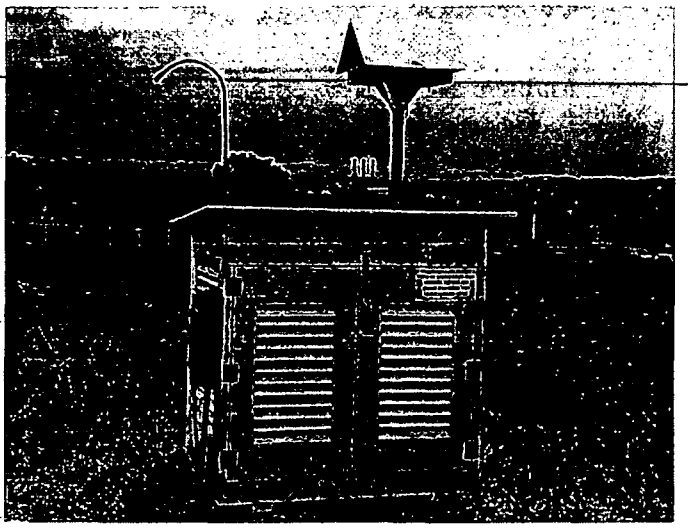
Table 4-3. Environmental Concentrations of Radionuclides in Sample Media in 1995

Radionuclide	Number of Samples	Average Concentration[a,b]	Unit of Measure
Ambient air[c]			
Tritium oxide	51	4.61 ± 2.09	10^{-12} µCi/mL
Plutonium-238	4	0.04 ± 0.14	10^{-18} µCi/mL
Plutonium-239,240	4	0.04 ± 0.11	10^{-18} µCi/mL
River water[d]			
Tritium	12	ND	
Plutonium-238	7	1.31 ± 0.68	10^{-12} µCi/mL
Plutonium-238 including suspended material	5	ND	
Plutonium-239,240	7	0.49 ± 0.87	10^{-12} µCi/mL
Plutonium-239,240 including suspended material	5	0.18 ± 3.67	10^{-12} µCi/mL
Uranium-233,234	12	0.73 ± 0.07	10^{-9} µCi/mL
Uranium-238	12	0.66 ± 0.06	10^{-9} µCi/mL
Pond water[e]			
Tritium	5	0.08 ± 0.06	10^{-6} µCi/mL
Plutonium-238	4	ND	
Plutonium-239,240	4	ND	
Sediment			
Plutonium-238 in river sediment[d]	4	2.01 ± 1.03	10^{-9} µCi/g
Plutonium-238 in pond sediment[e]	4	0.65 ± 1.20	10^{-9} µCi/g
Plutonium-239,240 in river sediment[d]	4	1.91 ± 2.13	10^{-9} µCi/g
Plutonium-239,240 in pond sediment[e]	4	1.13 ± 2.16	10^{-9} µCi/g
Vegetation[f]			
Tritium in grass	1	0.03 ± 0.03	10^{-6} µCi/g
Plutonium-238 in grass	1	0.11 ± 0.22	10^{-9} µCi/g
Plutonium-239,240 in grass	1	0.001 ± 0.09	10^{-9} µCi/g
Foodstuffs[f]			
Tritium in tomatoes	1	ND	
Plutonium-238 in root crops	1	0.05 ± 0.08	10^{-9} µCi/g
Plutonium-239,240 in root crops	1	ND	
Plutonium-238 in fish	1	ND	
Plutonium-239,240 in fish	1	ND	

[a] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.
[b] ND indicates concentrations below the reagent blanks.
[c] Measured 28 mi (45 km) northwest of Mound.
[d] Measured 20 mi (32 km) upstream of Mound on the Great Miami River.
[e] Measured 38 mi (61 km) southeast of Mound.
[f] Measured 38 mi (61 km) west of Mound.

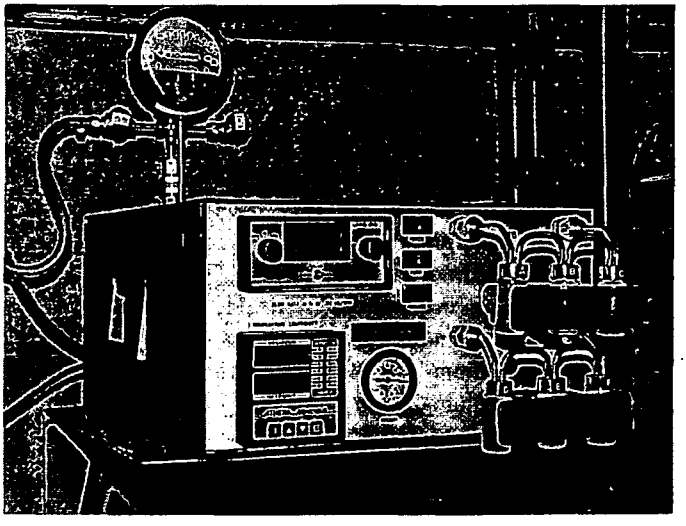
4.4 Air Sampling Program

Two types of air samples are collected at each sampling location. A particulate air sample is analyzed for plutonium-238 and plutonium-239, 240. A second air sample, collected in a bubbler apparatus, is analyzed for tritium oxide. Mound operates a network of 22 stations: seven onsite and 15 offsite. The locations of the stations are shown in Figures 4-11 and 4-12, respectively.



Mound Air Sampling Station

Tritium. The air sample for tritium analysis is collected on a continuous basis. Air is bubbled through 200 mL of ethylene glycol at a flow rate of approximately 1000 cm^3/min. Ethylene glycol is used as a trapping solution because it is not subject to loss by evaporation and will not freeze when exposed to winter sampling conditions. The glycol solutions are changed weekly and represent a sample volume of approximately 10 m^3 of air. An aliquot of each glycol solution is then analyzed weekly in a liquid scintillation counter.



Stack Effluent Tritium Bubbler Unit
(shown to illustrate a tritium bubbler)

With this technique, tritium oxide rather than elemental tritium is collected. This approach is appropriate because tritium oxide is the more radiotoxic form of tritium. The dose that would result from a given release of tritium oxide would be 25,000 times greater than the dose from the same number of curies of elemental tritium.

Comparisons of Predicted and Measured Tritium Concentrations

For 1995, tritium air concentrations predicted from modeling stack emissions with the EPA CAP-88 dispersion model were compared to air concentrations observed during routine monitoring. Since essentially all of the impact from plutonium has been observed to be from resuspension of soil, and essentially all the impact from tritium has been observed to be from stack emissions, the air concentration comparison was performed only for tritium. The predicted average concentration at each offsite air sampling location was compared with the observed incremental average concentration for 1995. Figure 4-10 shows the results of the comparison. In all cases, the predicted concentrations were higher than the observed concentrations, again illustrating conservatism in Mound's approach to estimating the potential dose impact from its radiological operations.

Plutonium. The particulate sample for isotopic plutonium analysis is collected on a 200-mm diameter fiberglass disc by a continuously operating high-volume air sampler. The air is sampled at an average rate of 1.3 x $10^6 cm^3$/min (45 ft^3/min). The disc is changed weekly and represents a sample volume of approximately 13,000 m^3 of air. Each sampler is equipped with a flow meter so location-specific flow rates can be calculated.

Plutonium analyses are performed on monthly composite samples for each onsite location and for the three offsite stations within 1000 m of Mound. The remaining samples are composited for quarterly analysis. The analytical protocol for plutonium incorporates the following basic steps: use of an internal tracer, chemical treatment, separation of plutonium with anion exchange resin, and alpha spectroscopy.

Uranium. As seen in Table 4-1, Mound includes isotopes of uranium in the release data for air. However, because the stack emissions of uranium-233,234 and uranium-238 are so low and their dose contributions are negligible, these radionuclides are not monitored at the environmental air sampling stations.

Applicable Standards

The guides for concentrations of radionuclides in air are given in DOE Order 5400.5 (DOE, 1990). These guides are based on recommendations in Publications 26 and 30 of the International Commission on Radiological Protection (ICRP 1977, 1979). The guides for radionuclide concentrations are referred to as Derived Concentration Guides, or DCGs. The DCG for a radionuclide is defined as the concentration of that radionuclide in air or water which will give a 50-year committed effective dose equivalent of 100 mrem (1 mSv) if taken into the body by inhalation or ingestion during one year of exposure. DCGs for tritium, plutonium-238 and plutonium-239,240 in air are listed in Tables 4-4, 4-5, and 4-6, respectively. The DCGs are shown for reference purposes only; strictly speaking, DCGs are to be applied to the actual point of exposure.

Figure 4-10. Predicted and Observed Concentrations of Airborne Tritium in 1995

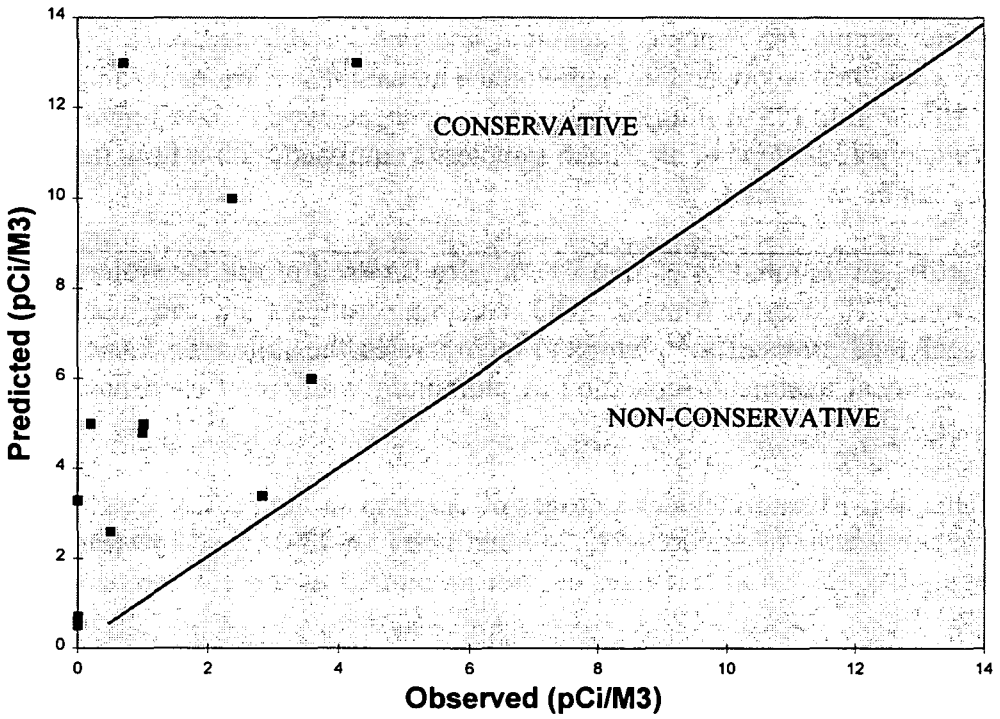


Figure 4-11. Onsite Air Sampling Locations

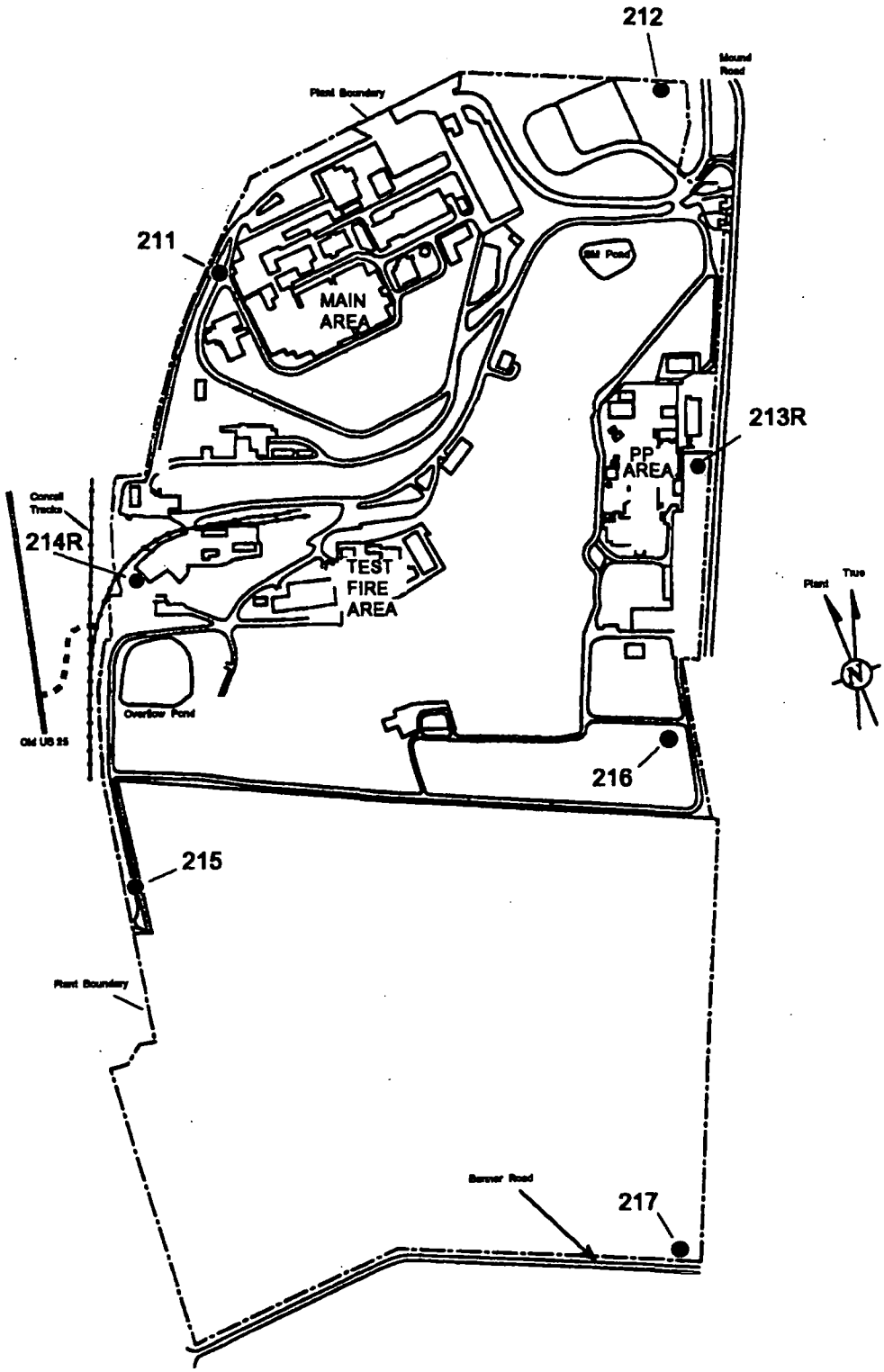
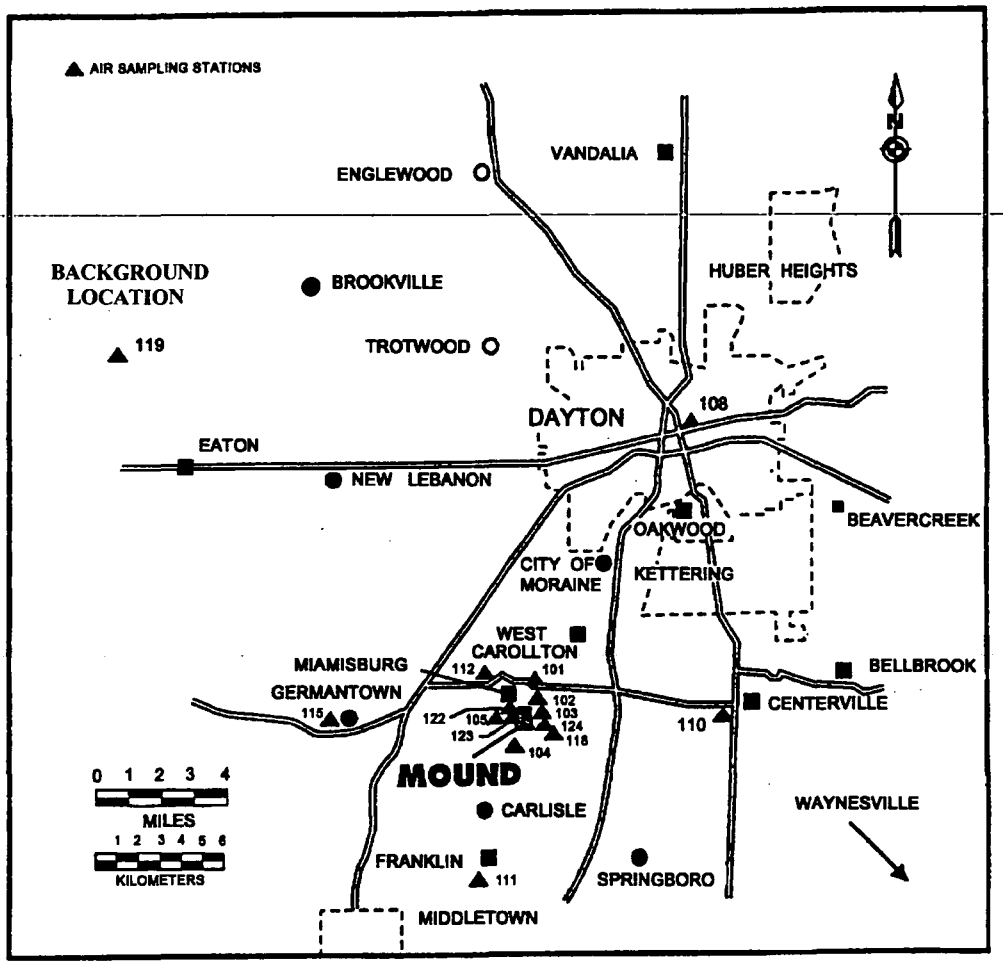


Figure 4-12. Offsite Air Sampling Locations



Results for 1995

Radionuclide concentrations measured at environmental air sampling stations in 1995 are shown in Tables 4-4, 4-5, and 4-6. The results are also presented in terms of the percentage DCG they represent. With the exception of Pu-238 results at sampling location 213R, the tables show that air concentrations of tritium and plutonium measured on and about Mound consistently averaged less than 0.05% of the DCGs established for those radionuclides.

During the last phase of the SM Building demolition elevated plutonium concentrations were observed at sampling location 213. The elevated levels were small fractions of the DOE DCG. The structure removal was completed in March of 1995.

Table 4-4. Incremental Concentrations[a] of Tritium Oxide in Air in 1995

Location*	Number of Samples	Tritium Oxide 10^{-12} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
Offsite					
101	53	e	24.87	2.83 ± 3.02	0.003
102	50	e	23.35	2.37 ± 3.01	0.002
103	52	e	17.8	0.69 ± 2.9	0.0007
104	53	e	22.0	0.5 ± 3.14	0.0005
105	51	e	19.13	1.01 ± 3.0	0.001
108	53	e	23.16	e	e
110	50	e	9.13	e	e
111	53	e	16.45	e	e
112	51	e	22.01	e	e
115	50	e	13.66	e	e
118	53	e	23.88	1.0 ± 2.94	0.001
122	34	e	21.69	0.2 ± 3.15	0.0002
123	52	e	23.62	3.57 ± 3.28	0.004
124	50	e	40.05	4.27 ± 3.32	0.004
Onsite					
211	53	e	25.08	3.35 ± 3.08	0.003
212	53	e	20.27	2.7 ± 2.71	0.003
213R	53	e	21.36	2.11 ± 2.91	0.002
214R	52	e	20.2	2.38 ± 2.9	0.002
215	53	e	20.85	0.83 ± 2.86	0.0008
216	52	e	18.38	0.43 ± 2.77	0.0004
217	52	e	15.28	0.42 ± 2.64	0.0004

[a] Average environmental level shown in Table 4-3 subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.

[c] LDL for tritium offsite in air is 18 x 10^{-12} µCi/mL. The LDL for tritium in onsite air is 23 x 10^{-12} µCi/mL. The LDL for sample 211 is 26 x 10^{-12} µCi/mL. These differences are due to different calculational methods and propagation of standard deviations due to the number of bubblers in series.

[d] DOE DCG for tritium oxide in air is 100,000 x 10^{-12} µCi/mL.

[e] Below environmental level.

R = Relocated in 1992.

* Onsite sampling locations shown on Figure 4-11.

Offsite sampling locations shown on Figure 4-12.

Table 4-5. Incremental Concentrations[a] of Plutonium-238 in Air in 1995

Location*	Number of Samples	Plutonium-238 10^{-18} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
Offsite					
101	4	0.16	0.74	0.40 ± 0.41	0.001
102	4	1.55	4.07	2.28 ± 1.90	0.008
103	4	0.61	5.31	2.48 ± 3.44	0.008
104	4	0.05	0.73	0.45 ± 0.49	0.002
105	4	0.06	11.36	3.37 ± 8.52	0.01
108	4	e	0.20	0.03 ± 0.25	0.0001
110	4	e	0.16	0.04 ± 0.23	0.0001
111	4	e	0.11	0.03 ± 0.19	0.0001
112	4	e	2.19	0.72 ± 1.63	0.002
115	4	0.05	0.35	0.20 ± 0.26	0.0007
118	4	0.12	3.20	1.51 ± 2.52	0.005
122	9[f]	e	6.79	1.26 ± 1.72	0.004
123	12	0.35	6.77	2.82 ± 1.54	0.009
124	12	0.46	20.46	6.19 ± 3.98	0.02
Onsite					
211	12	2.49	35.96	9.88 ± 6.69	0.03
211T	12	1.11	37.39	8.68 ± 6.53	0.03
212	12	0.90	11.42	4.95 ± 2.20	0.02
212T	12	e	13.22	3.21 ± 2.54	0.01
213R	12	17.04	2430.5	326.87 ± 437.34	1.1
213RT	12	14.36	1881.1	264.60 ± 340.55	0.88
214R	12	1.53	27.15	6.57 ± 4.48	0.02
214RT	12	0.31	7.75	4.54 ± 1.60	0.02
215	12	e	49.38	5.40 ± 8.84	0.02
215T	12	e	5.60	2.26 ± 1.23	0.008
216	12	e	69.95	15.33 ± 13.59	0.05
216T	12	e	107.41	13.50 ± 19.10	0.05
217	12	e	7.59	1.95 ± 1.81	0.007
217T	12	e	9.80	1.64 ± 1.81	0.005

[a] Average environmental level shown in Table 4-3 subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.

[c] LDL for monthly values is 0.86 x 10^{-18} µCi/mL, for quarterly values the LDL is 0.07 x 10^{-18} µCi/mL.

[d] DOE DCG for plutonium-238 in air is 30,000 x 10^{-18} µCi/mL.

[e] Below environmental level.

[f] Sampler 122 was not operational a portion of the year due to repair.

R = Relocated in 1992.

T = Supplemental sampling height (2m).

* Offsite sampling locations shown on Figure 4-12. Onsite sampling locations shown on Figure 4-11.

Table 4-6. Incremental Concentrations[a] of Plutonium-239,240 in Air in 1995

Location*	Number of Samples	Plutonium-239,240 10^{-18} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
Offsite					
101	4	e	0.13	0.01 ± 0.17	0.00005
102	4	e	0.37	0.13 ± 0.34	0.0007
103	4	e	0.30	0.12 ± 0.24	0.0006
104	4	e	0.68	0.23 ± 0.51	0.001
105	4	e	0.39	0.16± 0.35	0.0008
108	4	e	0.16	e	e
110	4	0.01	0.16	0.09 ± 0.15	0.0005
111	4	e	0.05	e	e
112	4	e	0.23	0.07 ± 0.22	0.0004
115	4	e	0.24	0.11 ± 0.20	0.0006
118	4	e	0.18	0.02 ± 0.26	0.0001
122	9[f]	e	1.12	e	e
123	12	e	0.44	e	e
124	12	e	1.41	0.16 ± 0.39	0.0008
Onsite					
211	12	e	0.75	0.16 ± 0.32	0.0008
211T	12	e	0.47	0.01 ± 0.25	0.00005
212	12	e	1.08	0.03 ± 0.35	0.0002
212T	12	e	0.71	0.03 ± 0.32	0.0002
213R	12	e	7.15	0.97 ± 1.32	0.005
213RT	12	e	6.86	1.58 ± 1.42	0.008
214R	12	e	3.61	0.45 ± 0.77	0.002
214RT	12	e	0.73	0.08 ± 0.32	0.0004
215	12	e	1.04	0.04 ± 0.30	0.0002
215T	12	e	0.38	e	e
216	12	e	2.77	0.37 ± 0.57	0.002
216T	12	e	1.08	e	e
217	12	e	0.80	e	e
217T	12	e	0.34	e	e

[a] Average environmental level shown in Table 4-3 subtracted from the data.
[b] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.
[c] LDL for monthly values is 0.6 x 10^{-18} µCi/mL, for quarterly values the LDL is 0.1 x 10^{-18} µCi/mL.
[d] DOE DCG for plutonium-239,240 in air is 20,000 x 10^{-18} µCi/mL.
[e] Below environmental level.
[f] Sampler 122 was not operational a portion of the year due to repair.
R = Relocated in 1992.
* Onsite sampling locations shown on Figure 4-11. Offsite sampling locations shown on Figure 4-12.

4.5 Surface Water and Sediment Sampling Program

The Great Miami River and other regional surface waters are sampled routinely by Mound for tritium, isotopes of plutonium, and isotopes of uranium. Sediment samples are also collected from these locations and analyzed for plutonium isotopes. Sampling locations are shown in Figure 4-13.

Great Miami River. River sampling locations have been selected according to guidelines published by the DOE. These locations provide samples that are representative of river water after considerable mixing with Mound effluents has occurred. Tritium samples are collected and analyzed weekly; plutonium-238, plutonium-239,240, uranium-233,234, and uranium-238 samples are collected and analyzed monthly. An additional table is presented to reflect a change in the analytical technique which was adopted in 1995. The change was made to be consistent with EPA procedures. The new tables (Tables 4-10 and 4-11) present concentrations of plutonium in water and suspended sediment in river water. Previous tables contained concentrations of plutonium in filtered water.

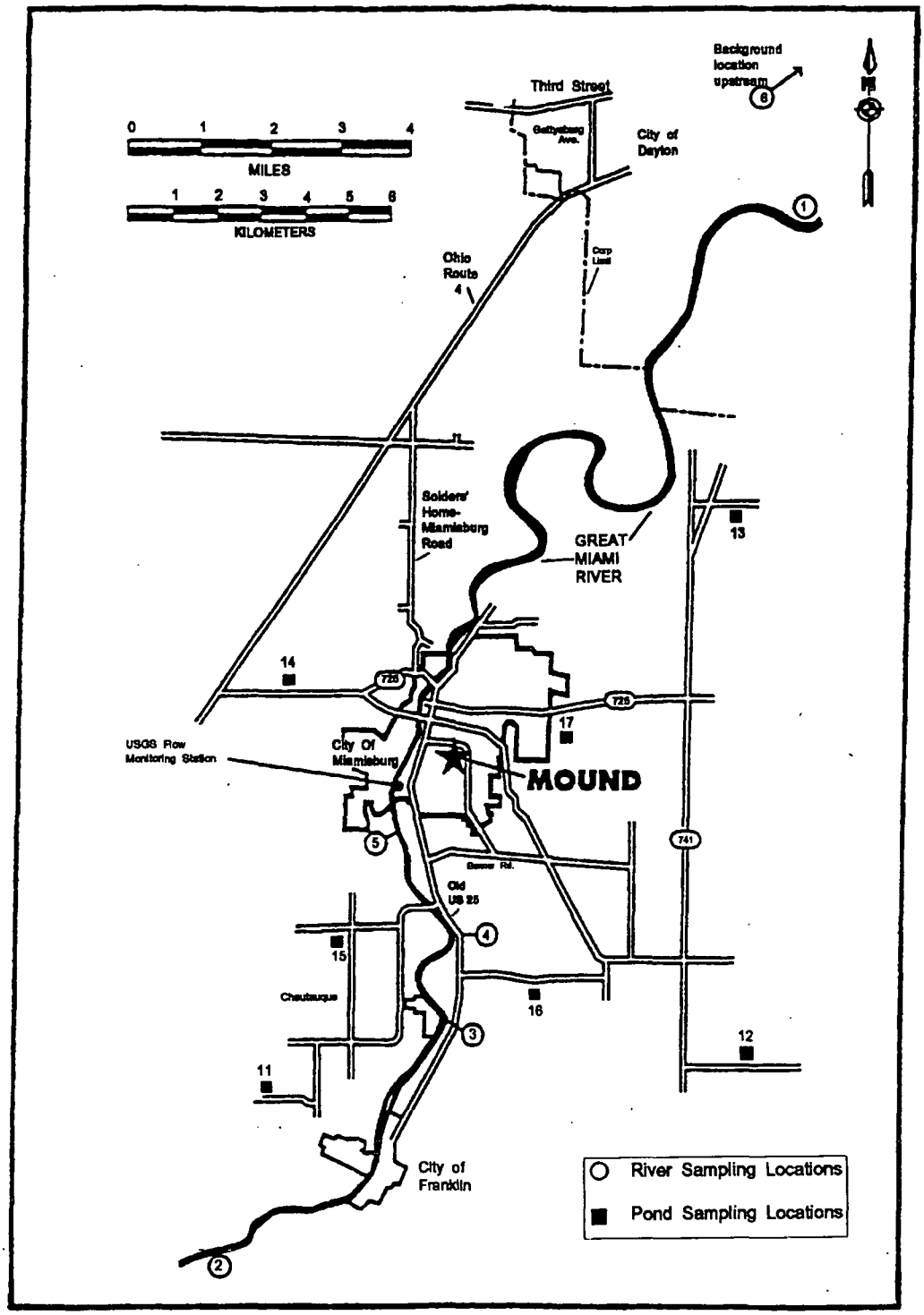
Regional surface waters. Seven ponds in various compass sectors relative to Mound are sampled quarterly. These samples are analyzed for tritium, plutonium-238, and plutonium-239,240.

River and pond sediments. Many plutonium solutions, including those in use at Mound, are relatively insoluble in water. For this reason, they are more likely to be found in sediment than in surface water. Additionally, because of the relatively long half-lives of plutonium isotopes, they may accumulate in sediments over a number of years. Therefore, Mound samples river and pond sediments on a quarterly basis. These samples are then analyzed for plutonium-238 and plutonium-239, 240.

Applicable Standards

DOE Order 5400.5 established a radiation dose limit for the general public of 100 mrem/yr (1.0 mSv) effective dose equivalent (EDE) for all exposure pathways. To ensure that the dose standard would not be exceeded, the Order also established derived concentration guides (DCGs). The DCG for a radionuclide is defined as the concentration of that radionuclide in air or water which will give a 50-year committed effective dose equivalent of 100 mrem (1 mSv) if taken into the body by inhalation or ingestion during one year of exposure.

Figure 4-13. Sampling Locations for River Water, Ponds, and Sediment



Results for 1995

River water. Radionuclide concentrations in the Great Miami River are shown in Tables 4-7 through 4-12. Many tritium, plutonium, and uranium measurements were below their respective reagent blanks or environmental levels. Averages for 1995 were on the order of one one-hundredth of a DCG or less.

Pond water. Radionuclide concentrations measured in pond water are shown in Tables 4-13 through 4-15. As observed for the river samples, many of the pond results were below environmental levels or reagent blanks.

Sediment. Results for river and pond sediments are listed in Tables 4-16 and 4-17 for plutonium-238 and plutonium-239,240, respectively. Maximum and average concentrations of plutonium for 1995 are comparable to concentrations observed in previous years. Since the plutonium isotopes are most likely found in sediment, the concentrations of plutonium are most likely to follow localized movement of silt in those water bodies. This movement may explain the variability in plutonium concentrations at the various river and pond locations from year to year. However, the levels have remained low and pose no significant risk.

Table 4-7. Concentrations[a] of Tritium in the Great Miami River in 1995

Location*	Number of Samples[f]	Tritium 10^{-6} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
1	37	e	0.32	0.04 ± 0.08	0.002
2	37	e	0.43	0.06 ± 0.08	0.003
3	38	e	0.29	0.03 ± 0.08	0.002
4	38	e	0.27	0.04 ± 0.08	0.002
5	38	e	0.34	0.04 ± 0.08	0.002

[a] Average environmental level below reagent blank.
[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.
[c] LDL for tritium in water is 0.6 x 10^{-6} µCi/mL.
[d] DOE DCG for tritium in water is 2,000 x 10^{-6} µCi/mL.
[e] Below reagent blank.
[f] Some weekly samples not collected due to inaccessibility or turbidity.
* Sampling locations shown on Figure 4-13.

Table 4-8. Incremental Concentrations[a] of Plutonium-238 in the Great Miami River in 1995

Location*	Number of Samples	Plutonium-238 10^{-12} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
1	7	e	0.67	e	e
2	7	e	2.34	0.80 ± 1.19	0.002
3	7	e	0.29	e	e
4	7	e	2.12	0.81 ± 1.32	0.002
5	7	e	0.99	e	e

[a] Average environmental level shown in Table 4-3 subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for plutonium-238 in river water is 3.0 x 10^{-12} µCi/mL.

[d] DOE DCG for plutonium-238 in water is 40,000 x 10^{-12} µCi/mL.

[e] Below environmental level.

* Sampling locations shown on Figure 4-13.

Table 4-9. Incremental Concentrations[a] of Plutonium-239,240 in the Great Miami River in 1995

Location*	Number of Samples	Plutonium-239,240 10^{-12} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
1	7	e	0.24	e	e
2	7	e	0.71	e	e
3	7	e	0.31	e	e
4	7	e	1.69	e	e
5	7	e	1.09	e	e

[a] Average environmental level shown in Table 4-3 subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for plutonium-239 in river water is 3.0 x 10^{-12} µCi/mL.

[d] DOE DCG for plutonium-239 in water is 30,000 x 10^{-12} µCi/mL.

[e] Below environmental level.

* Sampling locations shown on Figure 4-13.

Table 4-10. Concentrations[a] of Plutonium-238 (including suspended sediment) in the Great Miami River in 1995

Location*	Number of Samples	Plutonium-238 10^{-12} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
1	5	e	22.0	e	e
2	5	e	21.0	2.98 ± 14.42	0.007
3	5	e	6.6	e	e
4	5	e	7.95	e	e
5	5	e	4.6	e	e

[a] Average environmental level below reagent blank.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for plutonium-238 in river water (including suspended sediment) is 17.2 x 10^{-12} µCi/mL.

[d] DOE DCG for plutonium-238 in water is 40,000 x 10^{-12} µCi/mL.

[e] Below reagent blank.

* Sampling locations shown on Figure 4-13.

Table 4-11. Incremental Concentrations[a] of Plutonium-239,240 (including suspended sediment) in the Great Miami River in 1995

Location*	Number of Samples	Plutonium-239,240 10^{-12} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
1	5	e	8.72	2.81 ± 5.83	0.009
2	5	1.72	12.97	6.29 ± 8.1	0.02
3	5	e	11.47	2.35 ± 9.5	0.008
4	5	e	4.22	1.27 ± 4.73	0.004
5	5	e	7.92	2.62 ± 6.39	0.009

[a] Average environmental level shown in Table 4-3 subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for plutonium-239,240 in river water (including suspended sediment) is 9.6 x 10^{-12} µCi/mL.

[d] DOE DCG for plutonium-239,240 in water is 30,000 x 10^{-12} µCi/mL.

[e] Below reagent blank.

* Sampling locations shown on Figure 4-13.

Table 4-12. Incremental Concentrations[a] of Uranium-233,234 and Uranium-238 in the Great Miami River in 1995

Location*	Number of Samples	Uranium-233,234 10^{-9} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
1	12	e	0.24	0.08 ± 0.11	0.02
2	12	e	0.10	e	e
3	12	e	0.18	0.004 ± 0.09	0.0008
4	12	e	0.14	e	e
5	12	e	0.14	e	e

Location*	Number of Samples	Uranium-238 10^{-9} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
1	12	e	0.21	0.05 ± 0.10	0.008
2	12	e	0.07	e	e
3	12	e	0.21	0.02 ± 0.09	0.003
4	12	e	0.15	0.004 ± 0.08	0.0007
5	12	e	0.12	0.02 ± 0.08	0.003

[a] Average environmental level shown in Table 4-3 subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for uranium-233,234 is 0.05 x 10^{-9} µCi/mL. The LDL for uranium-238 is 0.03 x 10^{-9} µCi/mL.

[d] DOE DCG for uranium-233,234 in water is 500 x 10^{-9} µCi/mL. The DOE DCG for uranium-238 in water is 600 x 10^{-9} µCi/mL.

[e] Below environmental level.

* Sampling locations shown on Figure 4-13.

Table 4-13. Incremental Concentrations[a] of Tritium in Pond Water in 1995

Location*	Number of Samples	Tritium 10^{-6} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
11	5	e	0.12	e	e
12	5	e	0.11	0.02 ± 0.10	0.001
13	4	e	0.18	0.05 ± 0.15	0.003
14	5	e	0.08	e	e
15	5	e	0.07	e	e
17	5	e	0.14	0.06 ± 0.16	0.003

[a] Average environmental level shown in Table 4-3 subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for tritium in water is 0.8 x 10^{-6} µCi/mL.

[d] DOE DCG for tritium in water is 2,000 x 10^{-6} µCi/mL.

[e] Below environmental level.

* Sampling locations shown on Figure 4-13.

Table 4-14. Concentrations[a] of Plutonium-238 in Pond Water in 1995

Location*	Number of Samples	Plutonium-238 10^{-12} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
11	4	e	2.5	e	e
12	4	e	2.6	e	e
13	3	0.33	8.4	3.09 ± 8.45	0.008
14	4	e	0.65	e	e
15	4	e	22.4	e	e
17	4	e	14.55	e	e

[a] Average environmental level less than reagent blanks.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for plutonium-238 in water is 5.0 x 10^{-12} µCi/mL.

[d] DOE DCG for plutonium-238 in water is 40,000 x 10^{-12} µCi/mL.

[e] Below environmental level.

* Sampling locations shown on Figure 4-13.

Table 4-15. Concentrations[a] of Plutonium-239,240 in Pond Water in 1995

Location*	Number of Samples	Plutonium-239,240 10^{-12} µCi/mL Minimum	Maximum	Average[b,c]	Average as a percent of DOE DCG[d]
11	4	e	10.9	1.03 ± 11.26	0.003
12	4	e	3.8	e	e
13	3	0.15	12.0	5.13 ± 11.29	0.02
14	4	e	4.3	e	e
15	4	e	8.9	0.66 ± 9.78	0.002
17	4	e	6.2	0.11 ± 8.2	0.0004

[a] Average environmental level less than reagent blanks.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for plutonium-239,240 in pond water is 10.2 x 10^{-12} µCi/mL.

[d] DOE DCG for plutonium-239,240 in water is 30,000 x 10^{-12} µCi/mL.

[e] Below reagent blank.

* Sampling locations shown on Figure 4-13.

Table 4-16. Incremental Concentrations[a] of Plutonium-238 in River and Pond Sediments in 1995

River Sediment Sampling Locations

Location*	Number of Samples	Plutonium-238 10^{-9} µCi/g Minimum	Maximum	Average[b,c]
1	4	d	21.07	3.96 ± 18.23
2	4	3.46	62.35	32.21 ± 41.31
3	4	d	117.0	51.42 ± 77.72
4	4	16.43	127.9	73.49 ± 85.44
5	4	d	44.59	12.28 ± 34.54

Pond Sediment Sampling Locations

Location*	Number of Samples	Plutonium-238 10^{-9} µCi/g Minimum	Maximum	Average[b,c]
11	4	d	2.0	0.10 ± 2.4
12	4	d	24.19	5.87 ± 19.48
13	3	d	0.07	d
14	4	d	2.15	1.34 ± 2.05
15	4	d	3.83	0.96 ± 3.29
17	4	d	654.07	172.12 ± 511.65

[a] Average environmental level shown in Table 4-3 subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for plutonium-238 in river sediment is 0.8 x 10^{-9} µCi/g. The LDL for plutonium-238 in pond sediment is 1.3 x 10^{-9} µCi/g.

[d] Below environmental level.

* Sampling locations shown on Figure 4-13.

Table 4-17. Incremental Concentrations[a] of Plutonium-239,240 in River and Pond Sediments in 1995

River Sediment Sampling Locations

Location*	Number of Samples	Plutonium-239,240 10^{-9} µCi/g Minimum	Maximum	Average[b,c]
1	4	d	2.49	0.88 ± 3.36
2	4	d	d	d
3	4	d	2.44	0.21 ± 3.29
4	4	d	8.92	1.56 ± 8.14
5	4	d	2.15	0.53 ± 3.59

Pond Sediment Sampling Locations

Location*	Number of Samples	Plutonium-239,240 10^{-9} µCi/g Minimum	Maximum	Average[b,c]
11	4	0.84	5.44	2.8 ± 3.74
12	4	1.42	8.36	5.18 ± 5.86
13	3	0.91	3.26	1.99 ± 3.66
14	4	d	1.63	0.48 ± 2.91
15	4	0.03	2.65	1.38 ± 2.95
17	4	d	3.24	1.05 ± 3.91

[a] Average environmental level shown in Table 4-3 subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[c] LDL for plutonium-239 in river sediment is 0.9 x 10^{-9} µCi/g. The LDL for plutonium-239 in pond sediment is 1.9 x 10^{-9} µCi/g.

[d] Below environmental level.

* Sampling locations shown on Figure 4-13.

4.6 Produce and Vegetation

Various locally grown produce and vegetation samples are collected during the growing season. Additionally, fish are collected from the Great Miami River. The intent of this aspect of the Environmental Monitoring Program at Mound is to determine whether significant concentrations or radionuclides are present in plant and animal life.

In 1995, samples of grass, rootcrops, and tomatoes were collected from a number of regional communities. Fish were collected from the river downstream of Mound's discharge points.

Plutonium concentrations were determined by ashing the samples, then proceeding with the technique used for plutonium analyses of air samples (Section 4.4). Tritium concentrations were determined by removing and distilling the water from the sample, then analyzing the distillate using liquid scintillation spectrometry.

Result for 1995

The results for the produce, vegetation, and fish analyses are shown in Tables 4-18 through 4-20. As seen in the tables, most of the samples were below their respective environmental levels or reagent blanks. The results demonstrate that exposure to Mound's effluents via food-related pathways is negligible.

Table 4-18. Incremental Concentrations[a] of Tritium in Vegetation and Produce in 1995

Location*	Type of Sample	Number of Samples	Number of Replicates	Tritium 10^{-6} µCi/g Value[f]	Minimum	Maximum	Average[b,c]
Bellbrook	Grass	1		d			
	Tomatoes	1		0.02 ± 0.03			
Centerville	Grass	1		d			
	Tomatoes	1		e			
Franklin	Grass	1		d			
	Tomatoes	1		e			
Germantown	Grass	1		d			
	Tomatoes	1		e			
Miamisburg	Grass	3	1		d	0.05	d
	Tomatoes	1	1		e	e	e
Trotwood	Grass	1		d			
	Tomatoes	1		0.02 ± 0.03			

[a] Average environmental level shown in Table 4-3 for grass subtracted from the data. The environmental level for tomatoes was below the reagent blank and therefore not subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean or counting error at the 95 % confidence level.

[c] LDL for tritium in grass and in tomatoes is 0.2 x 10^{-6} µCi/g.

[d] Below environmental level.

[e] Below reagent blank.

[f] In cases where only one sample was taken, minimum, maximum and average values do not apply.

*Community locations shown on Figure 4-12.

Table 4-19. Incremental Concentrations[a] of Plutonium-238 in Vegetation and Produce in 1995

Location*	Type of Sample	Number of Samples	Number of Replicates	Plutonium-238 10^{-9} µCi/g Value[e]	Minimum	Maximum	Average[b,c]
Bellbrook	Grass	1		0.12 ± 0.3			
	Root crops	1		0.09 ± 0.12			
Centerville	Grass	1		0.27 ± 0.26			
	Root crops	1		0.09 ± 0.12			
Franklin	Grass	1		0.24 ± 0.26			
	Root crops	1		0.04 ± 0.12			
Germantown	Grass	1		d			
	Root crops	1		0.08 ± 0.12			
Miamisburg	Grass	3	1		d	0.3	0.08 ± 0.55
	Root crops	1	1		d	0.13	0.04 ± 1.15
Trotwood	Grass	1		d			
	Root crops	1		d			
Great Miami River	Fish	1	1	0.08 ± 0.03			

[a] Average environmental level shown in Table 4-3 subtracted from the data. The environmental level for fish was below the reagent blank and therefore was not subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean or the counting error at the 95 % confidence level.

[c] LDL for plutonium-238 in grass is 0.2×10^{-9} µCi/g. The LDL for plutonium-238 in root crops is 0.2×10^{-9} µCi/g. For plutonium-238 in fish the LDL is 0.3×10^{-9} µCi/g.

[d] Below environmental level.

[e] In cases where only one sample was taken, minimum, maximum and average values do not apply.

*Community locations shown on Figure 4-12.

Table 4-20. Incremental Concentrations[a] of Plutonium-239,240 in Vegetation and Produce in 1995

Location*	Type of Sample	Number of Samples	Number of Replicates	Plutonium-239,240 10^{-9} µCi/g Value[f]	Minimum	Maximum	Average[b,c]
Bellbrook	Grass	1		d			
	Root crops	1		0.02 ± 0.06			
Centerville	Grass	1		0.09 ± 0.13			
	Root crops	1		e			
Franklin	Grass	1		0.17 ± 0.13			
	Root crops	1		0.02 ± 0.06			
Germantown	Grass	1		d			
	Root crops	1		0.13 ± 0.08			
Miamisburg	Grass	3	1		d	0.1	0.05 ± 0.18
	Root crops	1	1		e	e	e
Trotwood	Grass	1		d			
	Root crops	1		e			
Great Miami River	Fish	1		e			

[a] Average environmental level shown in Table 4-3 subtracted from the data. The environmental level for root crops and fish were below the reagent blank and therefore was not subtracted from the data.

[b] Error limits are estimates of the standard error of the estimated mean or the counting error at the 95 % confidence level.

[c] LDL for plutonium-239,240 in grass is 0.2 x 10^{-9} µCi/g. The LDL for plutonium-239,240 in root crops is 0.1 x 10^{-9} µCi/g. LDL for plutonium-239,240 in fish is 0.6 x 10^{-9} µCi/g

[d] Below environmental level.

[e] Below reagent blank.

[f] In cases where only one sample was taken, minimum, maximum and average values do not apply.

*Community locations shown on Figure 4-12.

4.7 Offsite Dose Impacts

Dose Estimates Based on Measured Concentrations

Mound used the data presented in this report to estimate maximum doses to an offsite individual. The figure-of-merit used to calculate those doses was the committed effective dose equivalent (CEDE). CEDE calculations are required of DOE facilities. These calculations are also useful in evaluating the success of ALARA (As Low As Reasonable Achievable) policies. It is the philosophy of Mound, and the DOE complex as a whole, to ensure that all doses from radiation exposure remain ALARA.

To provide an extra degree of conservatism, dose estimates are often calculated based on maximum exposure conditions. This "maximum individual", as defined for purposes of calculating CEDEs, is a hypothetical person who remained at the site boundary 24 hours per day throughout 1995. This individual was assumed to have:

- breathed only air containing the highest average radionuclide concentrations measured at an onsite or offsite air sampling station,
- drawn all of his drinking water from the Miamisburg water supply, and
- consumed produce exhibiting the average concentrations in the samples collected from the Miamisburg area.

The radionuclides and the exposure pathways which contribute to the maximum individual's CEDEs are shown in Figure 4-14. Values for the CEDEs are shown in Table 4-21. More detailed information on the CEDE calculations, including the concentration values used, is presented in Appendix 1.

Dose Estimates for NESHAPs Compliance

The National Emission Standards for Hazardous Air Pollutants (NESHAPs) radionuclide regulations (40 CFR 61, Subpart H) limit offsite doses from airborne releases from DOE sites (excluding radon) to 10 mrem effective dose equivalent (EDE) per year. As specified by the EPA in 40 CFR 61, Subpart H, the preferred technique for demonstrating compliance with this dose standard is a modeled approach.

Maximum individual. Mound uses the EPA's computer code CAP-88 to evaluate doses for NESHAPs compliance. The 1995 input data for the CAP-88 calculations are listed in Appendix 1. Based on the CAP-88 output, the maximum EDE from all airborne releases was 0.05 mrem. This estimate represents 0.5% of the dose standard.

Figure 4-14. Exposure Pathways for Dose Calculations Based on Measured Data for 1995

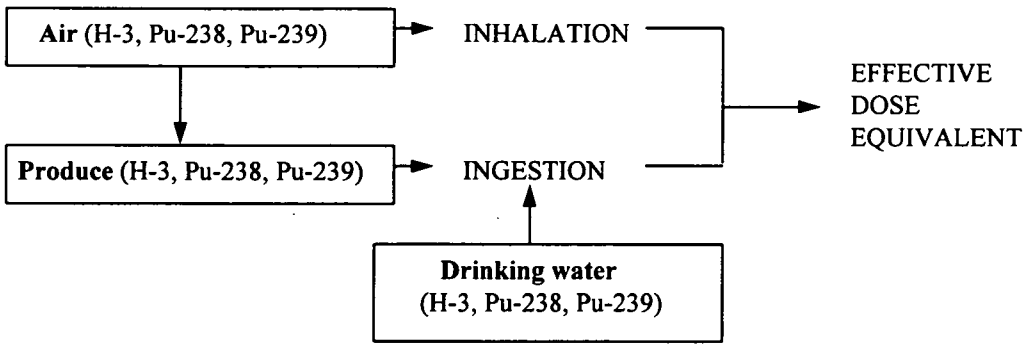


Table 4-21. Maximum Committed Effective Dose Equivalents to a Hypothetical Individual in 1995

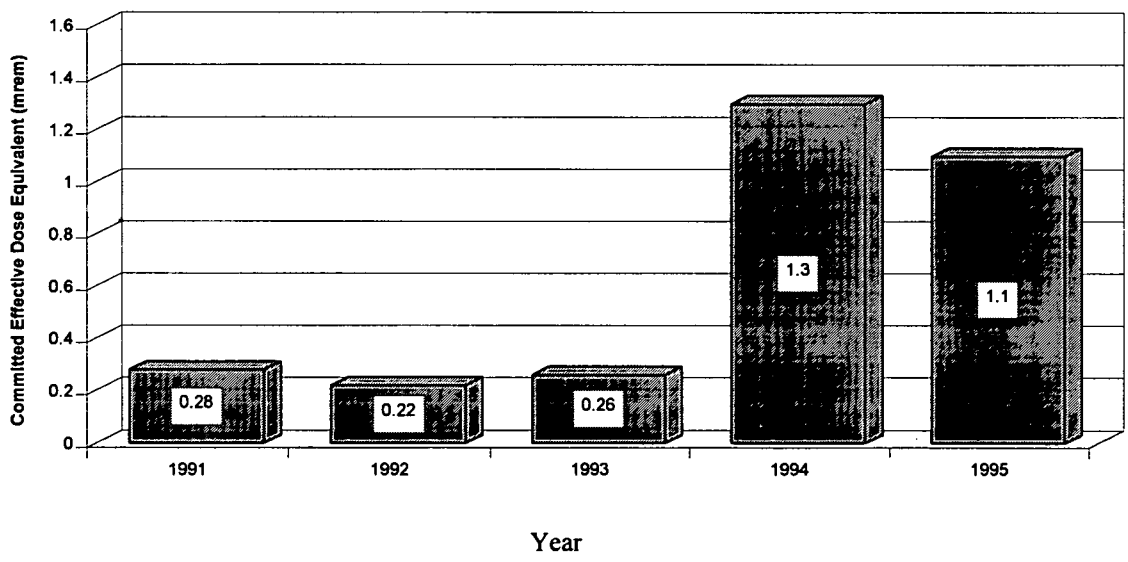
Radionuclide	Pathway	mrem	mSv
Tritium	Air	0.003	0.00003
	Water	0.009	0.00009
	Produce	ND	ND
	Total	0.01	0.0001
Plutonium-238	Air	1.04	0.0104
	Fish	0.003	0.00003
	Water	ND	ND
	Produce	0.03	0.0003
	Total	1.07	0.0107
Plutonium-239	Air	0.006	0.00006
	Fish	ND	ND
	Water	ND	ND
	Produce	0.01	0.0001
	Total	0.02	0.0002
Total		1.10	0.0110

ND = non-detect

Five Year Committed Effective Dose Equivalents to a Hypothetical Individual

Figure 4-15 presents a plot showing the 5 year trend in committed effective dose equivalent to a hypothetical individual. The increase in the committed effective dose over the last two years is primarily attributable to the D&D activities at the SM Building site.

Figure 4-15. Committed Effective Dose Equivalents to a Hypothetical Individual, 1991 - 1995



Population doses. CAP-88 also has the capability of estimating population doses from airborne releases. The population, approximately 3,035,000 persons, within a radius of 80 km (50 mi) of Mound received an estimated 2.4 person-rem from Plant operations in 1995. CAP-88 determined a person-rem value by calculating average doses to individuals in areas defined by their distance and compass sector relative to the release point. The dose for each area was then multiplied by the number of people living there. For example, an average dose of 0.001 rem x 10,000 persons in the area yields a 10 person-rem collective dose for that region. An additional dose contribution from drinking water is also added to the result for a total person-rem value.

Mound's dose contribution of 2.4 person-rem can be put in perspective by comparison with background doses. The average dose from background sources is 300 mrem (0.3 rem) per individual per year. A background collective dose can be estimated for the 80-km population by multiplying 0.3 rem x 3.035 million persons. The result, about one million person-rem, represents an estimate of the collective dose from all background sources of ionizing radiation. Mound's contribution, 2.4 person-rem, is approximately 0.00024% of that value.

5.0 NONRADIOLOGICAL ENVIRONMENTAL PROGRAM INFORMATION

The Mound Plant releases minor quantities of nonradiological constituents to the environment. These releases are governed by State of Ohio permits. Mound monitors the impact of the Plant's nonradiological airborne releases by measuring airborne particulates at seven onsite and 15 offsite locations. Nonradiological liquid releases, however, are subject to much more extensive sampling protocols. In 1995, Mound collected over 1,500 water samples to demonstrate compliance with the site's National Pollutant Discharge Elimination System (NPDES) permit.

5.1 Air Monitoring Program

The primary source of nonradiological airborne emissions at Mound is the steam power plant. The plant is normally fueled with natural gas but under certain circumstances fuel oil is used. Fuel oil with a 0.1% sulfur content is burned during unusually cold weather or if the natural gas supply to Mound is interrupted. Approximately 540,000 liters (141,971 gallons) of fuel oil and 7,850,970 m^3 (277,223,500 ft^3) of natural gas were burned during 1995.

As described in Chapter 3, Mound has both air and water permits from the Ohio EPA. A number of other sources, such as the powerhouse, are registered with the Regional Air Pollution Control Agency (RAPCA).

Nonradiological airborne emissions for 1995 are summarized in Table 5-1.

Table 5-1. Nonradiological Airborne Effluent Data for 1995

Pollutant	Emission Rate[b] (tons/yr)	Emission Threshold Limit (tons/yr)[a]	% of Standard
Total Suspended Particulates	10.0	100	10
Sulfur oxides	1.5	250	0.60
Nitrogen oxides	24	100	24
VOCs	2.0	100	2.0
Carbon monoxide	5.9	250	2.3
Lead	0.01	0.6	1.6

[a] Threshold limits defined in 40 CFR part 70 and Ohio Administrative Code 3745-77, Title V Permits
[b] Emission rates are calculated using a material balance approach.

Emission rates for sulfur oxides and nitrogen oxides in 1995 were higher than 1994 emission rates because more fuel oil was burned in 1995.

Mound evaluates particulate concentrations at seven onsite and 15 offsite locations. High-volume particulate air samples are collected weekly by flowing air through a 200-mm diameter fiberglass filter. The system operates at about 1.3 x 10^6 cm^3/min which represents a sample volume of 13,000 m^3 of air per week. By weighing the filter paper before and after use, it is possible to determine the mass of particulates retained by the filter. The mass loading and known air volume can then be used to generate concentration values (Table 5-2).

As the data in Tables 5-1 and 5-2 demonstrate, nonradioactive air emissions from Mound in 1995 did not significantly affect ambient air quality. All regulated releases were below permit limits, and comparisons of particulate concentrations measured onsite versus offsite suggest little or no influence by Mound. Particulate measurements for a few sampling locations exhibited periodic increases due to construction activities. These elevated air loadings were of short duration and did not significantly affect average values for 1995. In 1995, the arithmetic average of particulate concentrations at all sampling locations was below the 50 $\mu g/m^3$ Ohio Ambient Air Quality Standard.

5.2 Water Monitoring Program

Mound releases wastewater to offsite surface waters via three discharge systems. In 1995, Mound discharged an average of 2.54 million liters (0.675 million gallons) of water per day to the Great Miami River. U. S. Geological Survey data indicate that the 1995 flow rate in the River averaged 1,632 million gallons per day (MGD), with minimum and maximum flow rates of 258 MGD and 20,284 MGD, respectively. The average magnitude of the river flow rate is significantly greater than that of Mound's effluents. Therefore, releases from Mound can be expected to have minimal impact on river water quality.

Mound's discharges are regulated by a National Pollutant Discharge Elimination System (NPDES) permit. Mound's permit was renewed in October of 1992 and modified in December 1994. The permit will remain valid through March of 1997.

NPDES Monitoring Requirements

Mound's NPDES permit requires scheduled collection and analysis of Plant effluents at four onsite locations (Outfalls 5601, 5602, 5603, and 5002). Flow-weighted effluent limitations are further imposed for the combined discharges from Outfalls 5601 and 5602 (calculated Outfall 5001). Additional samples are required for one offsite Outfall (5604) and three Great Miami River locations (sampling locations 5801, 5901, and 5902). These locations are shown in Figure 5-1. The sampling requirements established for each outfall are listed in Table 5-3.

Although it is not required by Mound's NPDES permit, Plant effluent is also sampled for radionuclides. Average concentrations of radionuclides in effluent waters are shown in Table 4-2.

Outfall 5601. Outfall 5601 contains the effluent from Mound's sanitary sewage treatment plant. Flow-proportional, 24-hour composite samples and periodic grab samples are collected at this outfall. NPDES permit requirements for this location focus on conventional pollutants and heavy metals. Mound also analyzes the effluent quarterly for ten specific volatile organic compounds (effective December 1, 1994).

Table 5-2. 1995 Particulate Concentrations

Sampling Location[a]	Number of Samples	Particulate Concentration[b] ($\mu g/m^3$) Minimum	Maximum	Arithmetic Average[c] ($\mu g/m^3$)
Offsite				
101	53	21	65	38 ± 3
102	52	18	57	33 ± 2
103	53	13	47	26 ± 2
104	53	18	77	31 ± 3
105	53	16	128	36 ± 7
108	53	21	74	39 ± 3
110	53	18	67	31 ± 3
111	53	17	68	35 ± 3
112	53	13	42	26 ± 2
115	50	13	62	28 ± 2
118	53	11	47	25 ± 2
119[d]	53	13	44	24 ± 2
122	35	15	51	24 ± 3
123	53	19	53	32 ± 2
124	51	17	75	33 ± 3
Onsite				
211	53	15	60	33 ± 3
211T	53	18	61	34 ± 3
212	53	16	48	28 ± 2
212T	53	16	52	30 ± 2
213R	52	22	108	45 ± 5
213RT	49	17	69	35 ± 3
214R	52	16	52	31 ± 3
214RT	53	15	56	32 ± 3
215	53	13	42	24 ± 2
215T	53	11	53	30 ± 2
216	52	16	122	34 ± 5
216T	52	14	65	29 ± 3
217	52	13	54	32 ± 3
217T	53	8	61	31 ± 3

[a]Sampling locations shown in Figures 4-11 and 4-12 for onsite and offsite sampling stations, respectively.

[b] Ohio Ambient Air Quality Standard is 50 $\mu g/m^3$ (annual arithmetic mean).

[c] Values are weekly averages.

Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.

[d] Background location (approximately 28 miles NW of Mound).

Figure 5-1. NPDES Sampling Locations

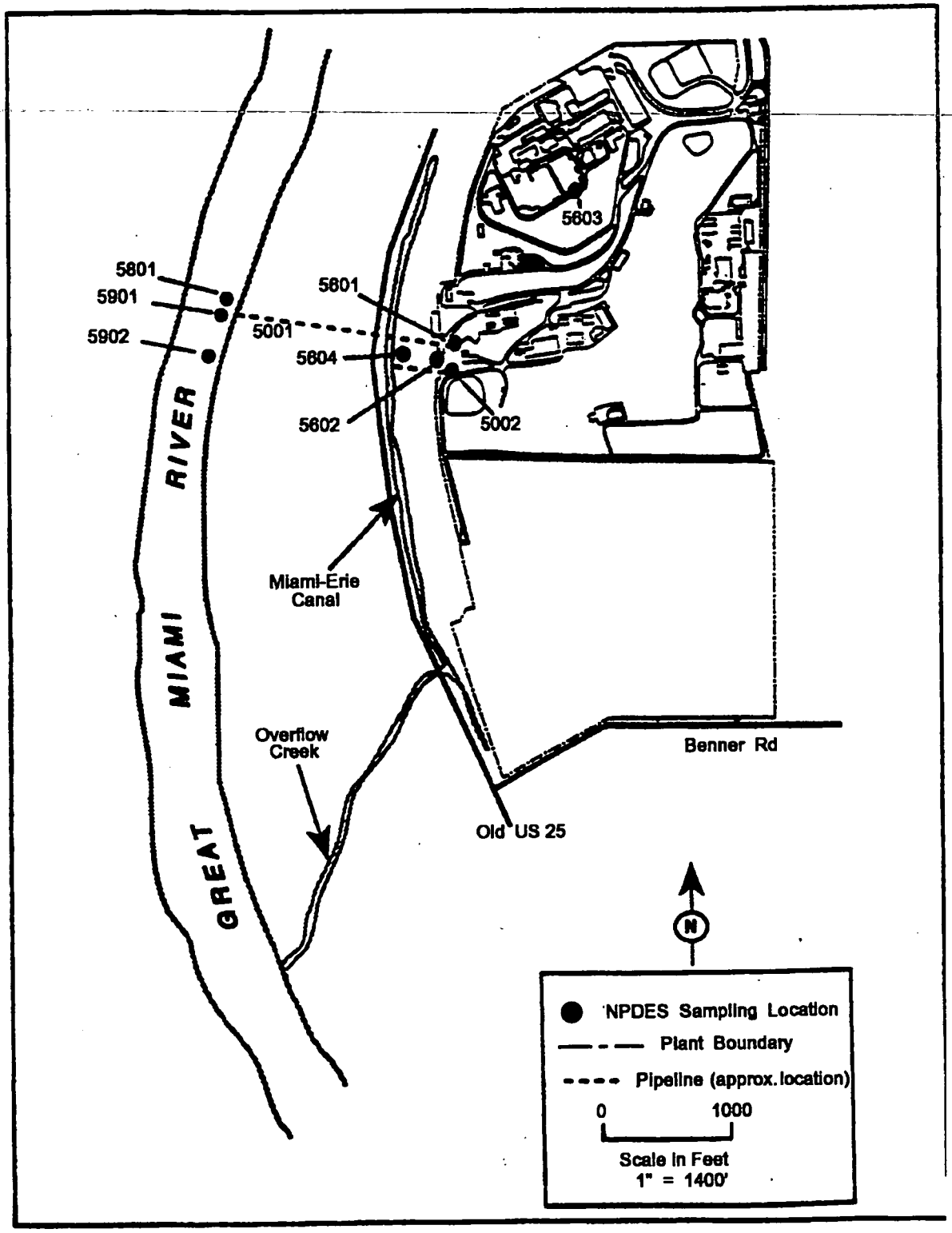


Table 5-3. National Pollutant Discharge Elimination System Data for 1995

	No. of Samples	Minimum	Maximum	Annual Average	Highest Monthly Average	NPDES Permit Limits Daily	NPDES Permit Limits Monthly Average
Outfall 5601 Parameters							
Flow Rate, (million gallons/day)	f	0.02	0.13	0.06	0.08	n/a	n/a
pH, s.u.	200	6.6	8.5	7.7	7.9	6.5-9.0	n/a
Chlorine: total[a], mg/L	104	<0.01	0.48	0.14	0.16	0.5	n/a
Suspended Solids[b], mg/L	100	<1	13.6	2.1	3.6	30	15
Fecal coliform[a], n/100mL	25	8	1700	183	710	2000	1000
Escherichia coli[a], n/100 mL	6	8	155	60	155	n/a	n/a
Ammonia, mg/L as N	26	0.03	0.41	0.15	0.35	n/a	n/a
Biochemical Oxygen Demand, mg/L	102	0.1	3.2	1.3	2.2	15	10
Oil and Grease[c], mg/L	4	<1	1.7	<1	1.7	n/a	n/a
Cadmium, µg/L	12	<10	<10	<10	<10	n/a	n/a
Chromium, µg/L	12	<15	<15	<15	<15	n/a	n/a
Copper, µg/L	12	51	132	81	132	n/a	n/a
Nickel, µg/L	12	<15	20	<15	20	n/a	n/a
Lead, µg/L	12	<15	25	<15	25	n/a	n/a
Zinc, µg/L	12	19	109	57	109	n/a	n/a
Mercury[d], µg/L	2	<0.2	<0.2	<0.2	<0.2	n/a	n/a
VOC's including acetone and methyl-ethyl-ketone[c]	4	h	h	h	h	n/a	n/a
Outfall 5602 Parameters							
Flow Rate, MGD	Cont	0.01	0.49	0.08	0.27	n/a	n/a
pH, s.u.	55	7.7	8.6	8.3	8.4	6.5-9.0	n/a
Suspended solids[b], mg/L	51	<1	15.6	2.1	6.2	45	30.0
Chemical Oxygen Demand, mg/L	51	1	156	52	90	n/a	n/a
Oil and Grease, mg/L	12	<1	1.2	<1	1.2	10	n/a

[a] Summer months only (May 1 through October 31).

[b] Limits n/a when 0.25 in. of rain occurs 3 days during the week.

[c] Quarterly samples collected in Mar., Jun., Aug., Dec.

[d] Biannual samples collected in June and December.

[e] Limit imposed October 1, 1995.

[f] = Continuous.

[g] TU = Toxicity Units.

[h] Below Minimum Detection Limits.

n/a = not applicable, no permit limits.

Table 5-3. (continued)

	No. of Samples	Minimum	Maximum	Annual Average	Highest Monthly Average	NPDES Permit Limits Daily	NPDES Permit Limits Monthly Average
Outfall 5603 Parameters							
Flow Rate, million gallons/day	16	3925	3925	3925	3925	n/a	n/a
pH, s.u.	16	7.2	8.2	7.7	8.0	6.5-9.0	n/a
Cyanide, mg/L	16	<0.03	<0.03	<0.03	<0.03	1.0	0.65
Cadmium, µg/L	16	<10	<10	<10	<10	100	n/a
Chromium, µg/L	16	<15	<15	<15	<15	500	n/a
Copper, µg/L	16	95	260	167	245	500	n/a
Nickel, µg/L	16	<15	115	26	69	500	n/a
Zinc, µg/L	16	<15	16	<15	<15	n/a	n/a
Total toxic organics[c], mg/L	3	<0.05	<0.05	<0.05	<0.05	2.13	n/a
Outfall 5002 Parameters							
Flow Rate, MGD	[f]	0.02	2.35	0.54	0.91	n/a	n/a
pH, s.u.	53	7.9	8.8	8.2	8.4	6.5-9.0	n/a
Suspended solids[b], mg/L	50	1.7	44.6	12.1	23.9	45	30
Outfall 5001 Parameters							
Flow Rate, MGD	[f]	0.04	0.53	0.14	0.32	n/a	n/a
pH, s.u.	25	7.8	8.3	8.1	8.3	6.5-9.0	n/a
Residual chlorine[a], mg/L	27	0.02	0.30	0.13		0.38[e]	n/a
Cyanide, mg/L	12	<0.02	<0.02	<0.02	<0.02	0.083	0.023
Pentachlorophenol, µg/L	13	<10	<10	<10	<10	n/a	n/a

[a] Summer months only (May 1 through October 31).

[b] Limits n/a when 0.25 in. of rain occurs 3 days during the week.

[c] Quarterly samples collected in Mar., Jun., Aug., Dec.

[d] Biannual samples collected in June and December.

[e] Limit imposed October 1, 1995.

[f] Continuous.

[g] TU = Toxicity Units.

[h] Below Minimum Detection Limits.

n/a = not applicable.

Note: Outfall 5604 did not operate in 1995.

Table 5-3. (continued)

	No. of Samples	Minimum	Maximum	Annual Average	Highest Monthly Average	NPDES Permit Limits Daily	NPDES Permit Limits Monthly Average
Outfall 5001 Parameters (continued)							
Bis(2-ethylhexyl) phthalate, µg/L	13	<5	<5	<5	<5	n/a	n/a
Cadmium, µg/L	51	<10	<10	<10	<10	43	n/a
Chromium, µg/L	51	<15	<15	<15	<15	878	546
Copper, µg/L	51	24	120	59	94	120	n/a
Nickel, µg/L	51	<15	56	15	38	1261	760
Lead, µg/L	51	<55	49	30	79	305	191
Zinc, µg/L	51	17	119	41	55	n/a	n/a
Ceriodaphnia dubia							
acute TU[g]	6	0.30	1.6	0.9	1.6	n/a	n/a
chronic TU[g]	3	<0.1	1.34	0.9	1.34	n/a	n/a
Pimephales promelas							
acute TU[g]	6	<0.1	<0.1	<0.1	<0.1	n/a	n/a
chronic TU[g]	3	<0.1	<0.1	<0.1	<0.1	n/a	n/a
Outfall 5801 Parameters							
% affected:							
Ceriodaphnia dubia							
48 hour acute	9	0	10	2.5	10	n/a	n/a
Pimephales promelas							
96 hour acute	9	0	17	6.1	17	n/a	n/a

[a] Summer months only (May 1 through October 31).

[b] Limits n/a when 0.25 in. of rain occurs 3 days during the week.

[c] Quarterly samples collected in Mar., Jun., Aug., Dec.

[d] Biannual samples collected in June and December.

[e] Limit imposed October 1, 1995.

[f] = Continuous.

[g] TU = Toxicity Units.

[h] Below Minimum Detection Limits.

n/a = not applicable.

Table 5-3. (continued)

	No. of Samples	Minimum	Maximum	Annual Average	Highest Monthly Average	NPDES Permit Limits Daily	NPDES Permit Limits Monthly Average
Outfall 5901 Parameters							
% affected:							
Ceriodaphnia dubia							
48 hour acute	9	0	100	22.7	100	n/a	n/a
Pimephales promelas							
96 hour acute	9	0	30	6.6	30	n/a	n/a
Outfall 5902 Parameters							
% affected:							
Ceriodaphnia dubia							
7 day chronic	3	0	17.5	6	17.5	n/a	n/a
Pimephales promelas							
7 day chronic	3	0	25	11	25	n/a	n/a

[a] Summer months only (May 1 through October 31).

[b] Limits n/a when 0.25 in. of rain occurs 3 days during the week.

[c] Quarterly samples collected in Mar., Jun., Aug., Dec.

[d] Biannual samples collected in June and December.

[e] Limit imposed October 1, 1995.

[f] Continuous.

[g] TU = Toxicity Units.

[h] Below Minimum Detection Limits.

n/a = not applicable.

Outfall 5602. Outfall 5602 includes storm water runoff, single-pass cooling water, cooling tower blowdown, zeolite softener backwash, and effluent from the radioactive waste disposal facility. Flow-proportional, 24-hour composite samples and periodic grab samples are collected at this outfall. NPDES permit requirements for this location include chemical oxygen demand, suspended solids, and oil and grease content. Though not a condition of the permit, Mound also analyzes the effluent quarterly for total toxic organics (TTOs).

Outfall 5603. Outfall 5603 is associated with an electroplating facility operated onsite. Time-proportional composite samples and periodic grab samples are collected at this outfall. Because the effluent is associated with the plating shop, the parameters of concern are heavy metals and cyanide. The NPDES permit also requires quarterly TTO sampling.

Outfall 5002. Discharge 5002 contains softener backwash and most of the Plant's storm water runoff. Flow-proportional, 24-hour composite samples and periodic grab samples are collected at this outfall. NPDES permit requirements for this location focus on pH and suspended solids. Though not a condition of the permit, Mound also analyzes the effluent quarterly for total toxic organics (TTOs).

Calculated Outfall 5001. Outfall 5001 represents the combined effluents of 5601 and 5602. These discharges are combined and released to the Great Miami River via a closed pipe. Since sampling the pipe is not practical, Mound's NPDES permit imposes additional limits for this outfall based on flow-weighted calculations. The concentrations of materials present in Outfalls 5601 and 5602 are used, along with their respective flow rates, to estimate concentrations in the effluent discharged through the pipe. The limits associated with Outfall 5001 are also listed in Table 5-3.

Outfall 5604. Outfall 5604 is an abandoned well located west of the plant site. In the past, Mound has purged the well, known as Miamisburg Abandoned Well No. 2, to reduce tritium concentrations. The purged water was then directed through a closed pipe to the Great Miami River. When this activity is performed, Mound's NPDES permit requires that the flow rate and pH be recorded. The well was most recently pumped in 1991.

Sampling Locations 5801, 5901, and 5902. A requirement of Mound's NPDES permit involves toxicity testing of water samples taken from the Great Miami River. The permit specifies that monthly (for acute toxicity testing) and quarterly (for chronic toxicity testing) samples be collected from specific river locations and plant effluents (Table 5-3 and Figure 5-1). Toxicity testing consists of observing the effect of varying concentrations of sampled water on water fleas (*Ceriodaphnia dubia*) and fathead minnows (*Pimephales promelas*). The test is intended to quantify the biological effect that a particular water sample potentially has on the aquatic environment.

Toxicity test results are presented in either toxicity units or percent of organisms affected. Results are determined by the number of observed mortalities, growth or reproductive effects, or atypical behavior of the species tested. A typical value reported in toxicity units is 2 TU (toxicity units). An ND (not detected) result indicates that the above conditions were not observed in any of the test organisms.

The three sampling locations are positioned upstream, downstream, and near the Plant's point of discharge to the Great Miami River. Results from the three sampling locations are compared to identify potential impacts of the plant effluent on the Great Miami River.

Results

A total of 1,550 samples were analyzed for NPDES parameters in 1995. Key results are summarized in Tables 5-3 and 5-4. Analytical procedures were consistent with the methods specified in regulations of the Clean Water Act, 40 CFR 136. Sampling and analytical services were provided by Mound's Environmental Monitoring and Bioassay Labs and by outside contractors. All such procedures meet Mound standards for quality assurance and quality control.

A review of Mound's NPDES performance over the past five years is shown in Figure 5-2. As seen in the figure, Mound recorded a total of three NPDES permit exceedances between 1991 and 1995. During that time period, 6,832 NPDES samples were collected.

Table 5-4. Summary of Organic Components Detected in Mound Effluents in 1995

		Concentration, µg/L				
Outfall[a]	Parameter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	MDL*
5601	Bromodichloromethane	ND[b]	ND	1.5	ND	1.0
	Chloroform	ND	1.0	2.3	ND	1.0
5602		No Organics Detected Above Detection Limits				
5603	Bromoform	1.7	1.4	2.3	[c]	1.0
	Dibromochloromethane	2.2	2.5	3.0	[c]	1.0
	Bromodichloromethane	1.0	1.3	1.4	[c]	1.0
	Tetrachloroethylene	ND	ND	1.0	[c]	1.0
	Trichloroethene	ND	1.1	2.1	[c]	1.0
	1,1,1-Trichloroethane	ND	2.6	1.7	[c]	1.0

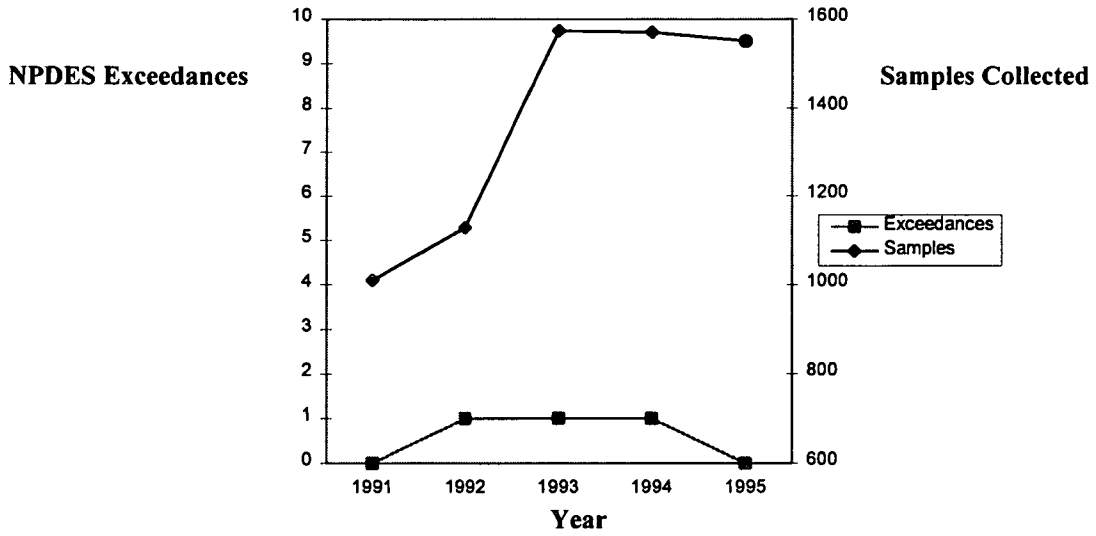
* MDL = Method Detection Limit.

[a] Sampling locations are shown on Figure 5-1.

[b] ND = None detected.

[c] Operations at Station 5603 were permanently discontinued during September.

Figure 5-2. NPDES Sample Profile for the Five-Year Period 1991 - 1995



5.3 Submissions Under SARA Title III

Title III of the Superfund Amendments and Reauthorization Act (SARA) addresses the emergency planning and community right-to-know responsibilities of facilities handling hazardous substances. Sections 311 and 312 of Title III specify reporting requirements for the use and/or storage of "extremely hazardous" and "hazardous" substances. For facilities subject to Section 311 and 312, chemical usage, storage, and location information must be submitted to regional emergency response agencies by March 1 of each year. For 1995, Mound reported using and/or storing three extremely hazardous substances and seven hazardous substances. This information, along with site maps showing usage and storage locations, was submitted to the State Emergency Response Commission, the Miami Valley Regional Planning Commission, and the City of Miamisburg Fire Department. The ten applicable substances handled by Mound are listed in Table 5-5.

Table 5-5. 1995 SARA Title III Emergency and Hazardous Chemical Data for Mound

Hazardous Substances

Diesel Fuel	Nitrogen, liquid	Ethylene glycol
No. 2 fuel oil	Helium, liquid	
Gasoline, unleaded	Argon, liquid	

Extremely Hazardous Substances

Chlorine	Sulfuric acid	Nitric acid

Section 313 of Title III specifies reporting requirements associated with the release of toxic chemicals. Mound did not manufacture, process or otherwise use any chemical above the Section 313 thresholds. No Section 313 submissions were required for Mound operations in 1995. The Ohio EPA was notified that Section 313 submissions were not required from Mound.

5.4 Environmental Occurrences

Under CERCLA and the Clean Water Act, reportable quantity (RQ) levels have been established for designated hazardous substances. If a spill or other inadvertent release to the environment exceeds the RQ, immediate notification of the appropriate federal agencies (e.g., National Response Center, EPA, or Coast Guard) is required. No such releases occurred at Mound during 1995.

6.0 GROUNDWATER MONITORING PROGRAM

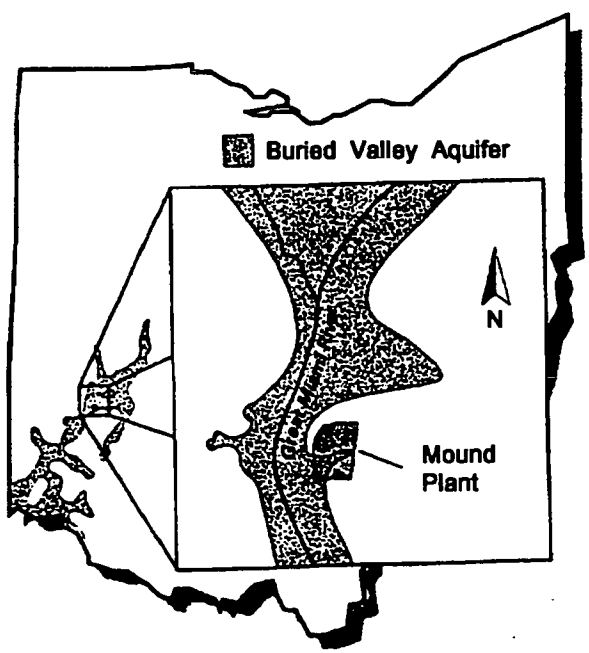
The Mound Plant site lies atop the largest of Ohio's sole-source aquifers, the Buried Valley Aquifer (BVA). The City of Miamisburg, and a number of other communities in the area, draw drinking water from the BVA. Mound also relies on the BVA for drinking and process water.

Mound has approximately 200 active groundwater monitoring sites in place onsite and offsite to characterize the impact Plant operations may have on the BVA. Included in these sites are three production wells, 126 monitoring wells, 39 piezometers, 10 capture pits, 7 residential wells, and 8 community wells. The groundwater monitoring program has been developed to meet the SDWA monitoring requirements, RCRA monitoring requirements as applicable or relevant and appropriate requirements (ARARs) for the CERCLA Program, and DOE-mandated practices.

6.1 Regional Hydrogeology

Beneath the Miami Valley region of southwest Ohio lies the Buried Valley Aquifer (BVA). The BVA was designated a sole-source aquifer by the U.S. EPA in May, 1988. This distinction indicates that the aquifer supplies all of the drinking water to the communities above it. The approximate aerial extent of the BVA is shown in Figure 6-1.

Figure 6-1. Location and Extent of the Buried Valley Aquifer



The aquifer has a north-south orientation and reaches a maximum thickness of about 46 m (150 ft) near the Great Miami River channel. Groundwater in the area generally flows south, following the downstream course of the River. Recharge by induced stream infiltration occurs, although in this region the aquifer contains extensive layers of clayish till which impede infiltration. The BVA west of the Plant site is estimated to have calculated transmissivity values ranging from 200,000 to 430,000 gallons per day per foot. The transmissivity values are based upon hydraulic characterization data obtained from a May 1993 aquifer pump test.

The BVA is somewhat overdrawn between the cities of West Carrollton and Dayton. Practices involving relocation of well fields and artificial recharge via infiltration lagoons are in use to reduce the magnitude of the reversal. Currently, there is no evidence that the gradient reversal affects regions south of West Carrollton such as Miamisburg. In Miamisburg, pumping does not influence the natural groundwater gradient except in the immediate vicinity of individual well fields.

Uses of Groundwater in the Vicinity

There are seven municipal water supplies and numerous industrial users within an 8 km (5 mi) radius of the Mound Plant. The locations of public and private water supply wells are shown in Figure 6-2. The only industrial user within 8 km (5 mi) downgradient is the O. H. Hutchings Power Generation Station. Industrial groundwater users located north (upgradient) of the site are isolated from Mound by hydraulic barriers.

The communities of Franklin and Carlisle are the first downgradient water supplies, but, due to the extremely slow rate of groundwater movement, should not be significantly affected by the Mound Plant. The City of Miamisburg owns ten wells in the BVA. At this time only the four wells located on the west side of the Great Miami River are in use. These wells are upgradient and should not be impacted by groundwater contamination from the Mound Plant. All city wells currently in service are separated from the Plant by a minimum straight-line distance of 0.8 km (0.5 mi).

In 1992, a residential well and cistern study (DOE 1993a) was conducted. A total of 216 residential wells and 14 cisterns were identified within a 2-mile radius of the Mound Plant. Results of this study are in the CERCLA Public Reading Room.

6.2 Hydrology at Mound

As seen in Figure 6-1 and 6-2, a "tongue" of the BVA extends onto the Mound Plant site. Within the limits of the property, the maximum known thickness of the aquifer is about 21 m (70 ft) at the extreme southwest corner of the site. Present usage of BVA water by Mound ranges from 19 to 32 liters per second (300 to 500 gallons per minute). Recharge to the portion of the BVA underlying Mound primarily arises from direct infiltration of river water, precipitation, and leakage from valley walls. These sources of recharge provide sufficient volumes of water to balance Mound's withdrawals.

Groundwater elevations are shown on groundwater contour maps (Figures 6-3 and Figure 6-4). The contour maps reflect the two sources of groundwater that are of concern to Mound, the perched water in the bedrock and the BVA. Groundwater levels vary from elevations near 670 ft to approximately 875 ft. Onsite groundwater levels generally increase with increasing ground surface elevations. (Ground surface elevations are shown on Insert 1-1.) The maximum groundwater level for the perched water in the bedrock beneath the main hill is 835 ft. The ground surface elevation for the main hill is approximately 880 ft.

Bedrock permeability. As a result of the dramatic changes in elevations associated with the Plant's topography, the site has a variety of groundwater regimes. Virtually impermeable bedrock underlies all but the first few feet of the hilltop and hillside areas at Mound. Although the rock itself is, for practical purposes, impermeable, small quantities of groundwater seep through joints and cracks. The upper 6 m (20 ft) of bedrock, where chemical weathering leads to enlargement of the cracks, is the most permeable. Permeability of the upper 6 m (20 ft) of bedrock is estimated to range from 40 to 400 L/day/m^2 (1 to 10 gal/day/ft^2). Below this depth, bedrock permeability generally ranges from 0 to 8 L/day/m^2.

Glacial till and outwash permeability. Hydraulic properties of the glacial tills that form a veneer over the site vary depending on the proportions of fine and course-grained materials at a given location. Values of permeability normally range from 0.0041 to 0.041 L/day/m^2 (0.0001 to 0.001 gal/day/ft^2), although values up to 2.8 L/day/m^2 (0.007 gal/day ft^2) have been measured in upper weathered zones. Below the glacial till in the lower valley is a zone of glacial outwash composed of sand and gravel. The permeability of this zone is estimated to range from 40,700 to 81,000 L/day/m^2 (1,000 to 2,000 gal/day /ft^2).

Seeps

A key issue for groundwater protection at Mound is the seepage of contaminated water to the surface of the Main Hill. At points along the Plant's north hillside, bedrock is exposed and seep lines exist. A generalized cutaway depicting this phenomenon is shown in Figure 6-5. Numerous samples have been collected from the seeps and analyzed for tritium and volatile organic compounds. Results for 1995 are discussed in Section 6.4.

Surface Water Features

There are no perennial streams on the plant site. A natural drainage area exists in the deep valley separating the two main hills, but water in this area generally has a short residence time. The basin is relatively small and the slopes are relatively steep. Therefore, runoff through site drainage features is rapid.

Figure 6-2. Production and Monitoring Well Locations

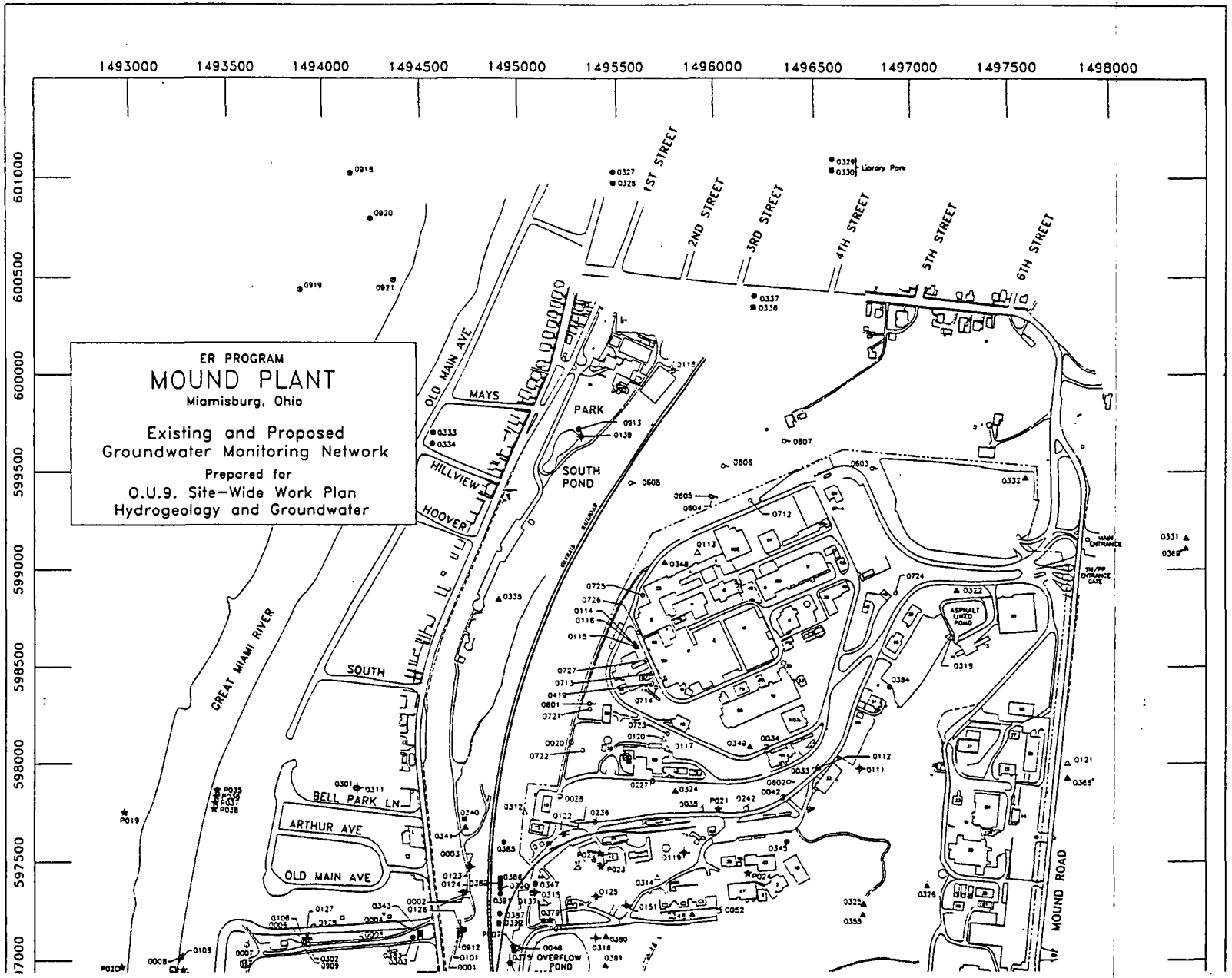


Figure 6-2. Production and Monitoring Well Locations

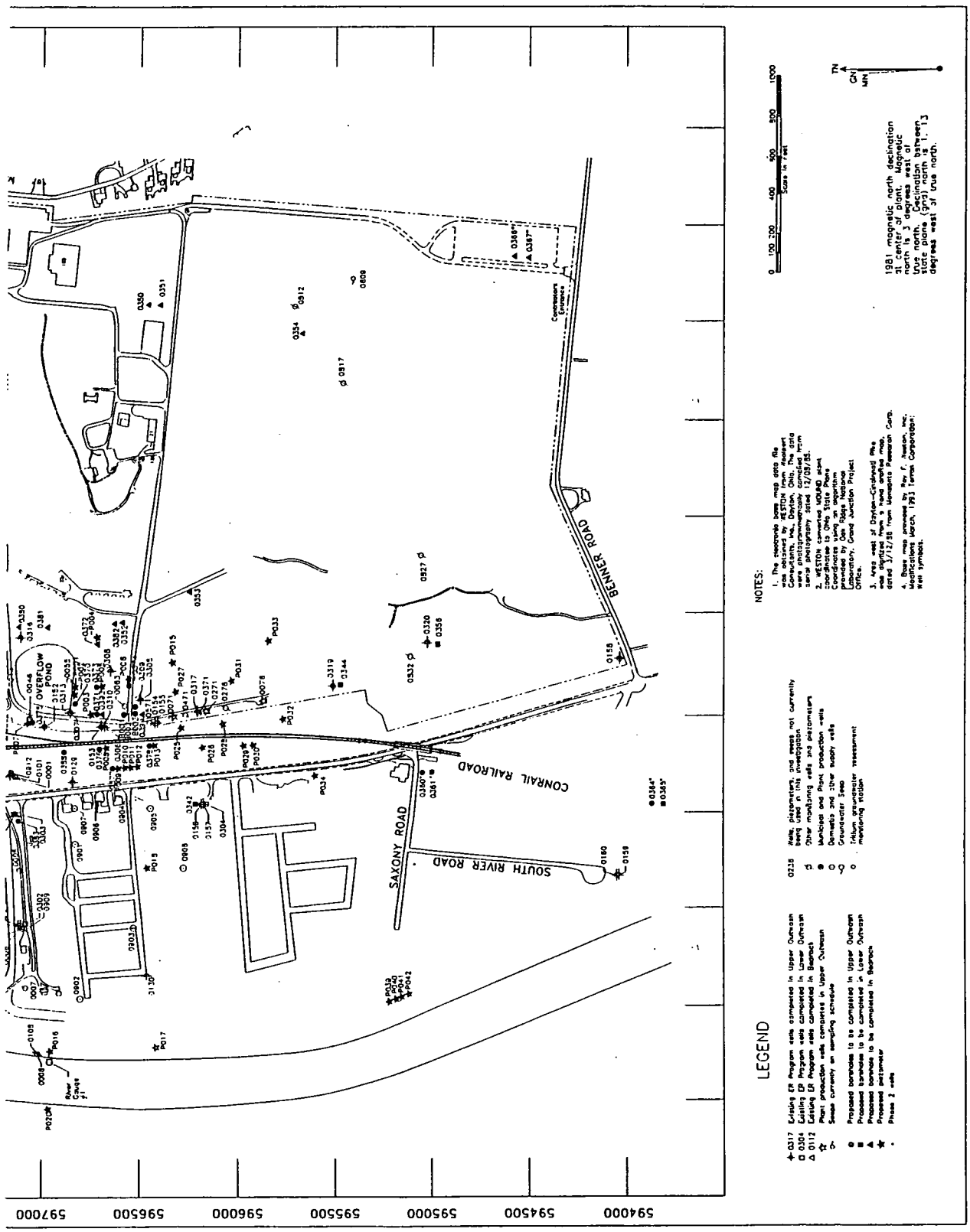


Figure 6-3. Groundwater Elevations for the Perched Water in the Bedrock

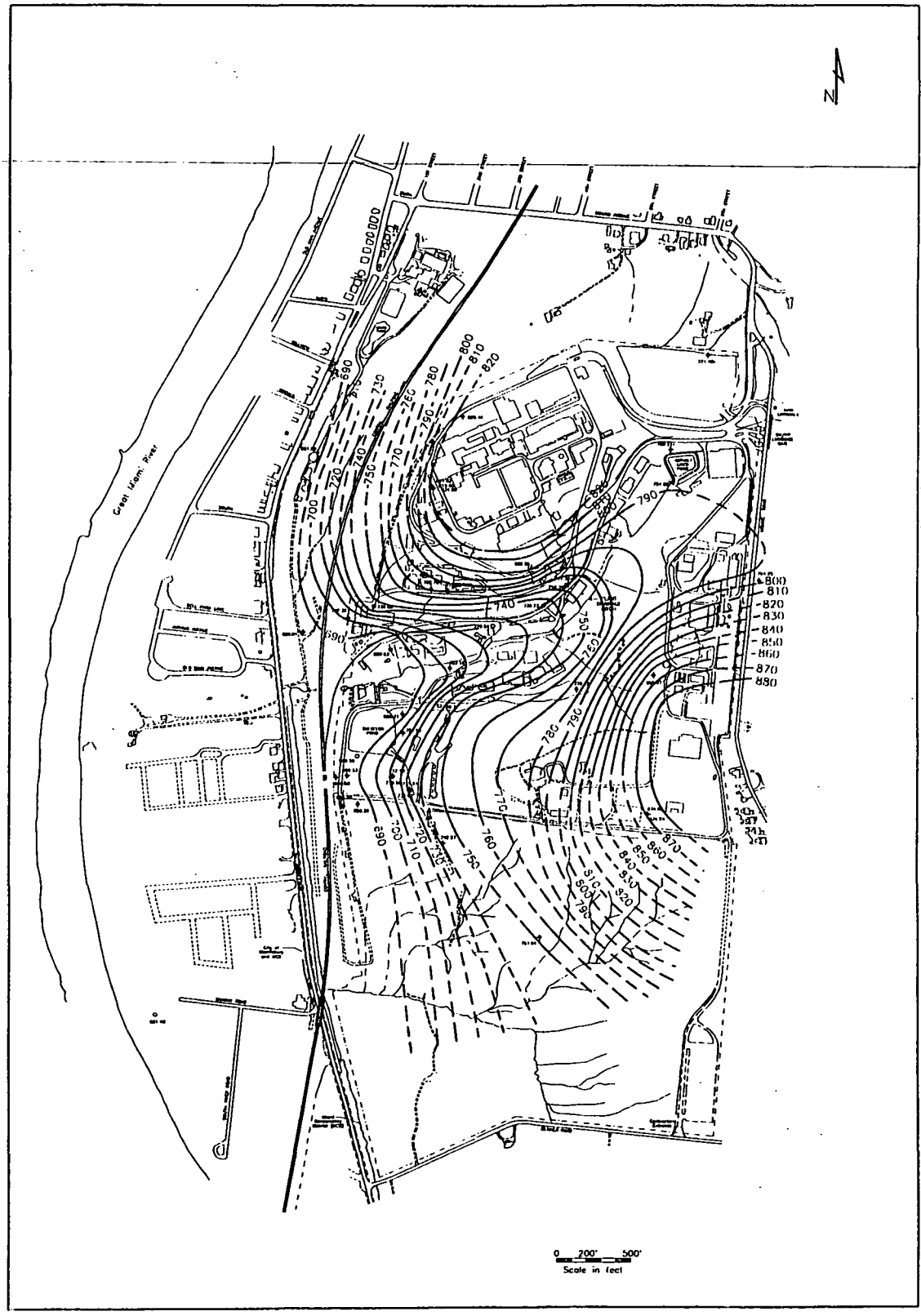


Figure 6-4. Groundwater Elevations for the Buried Valley Aquifer

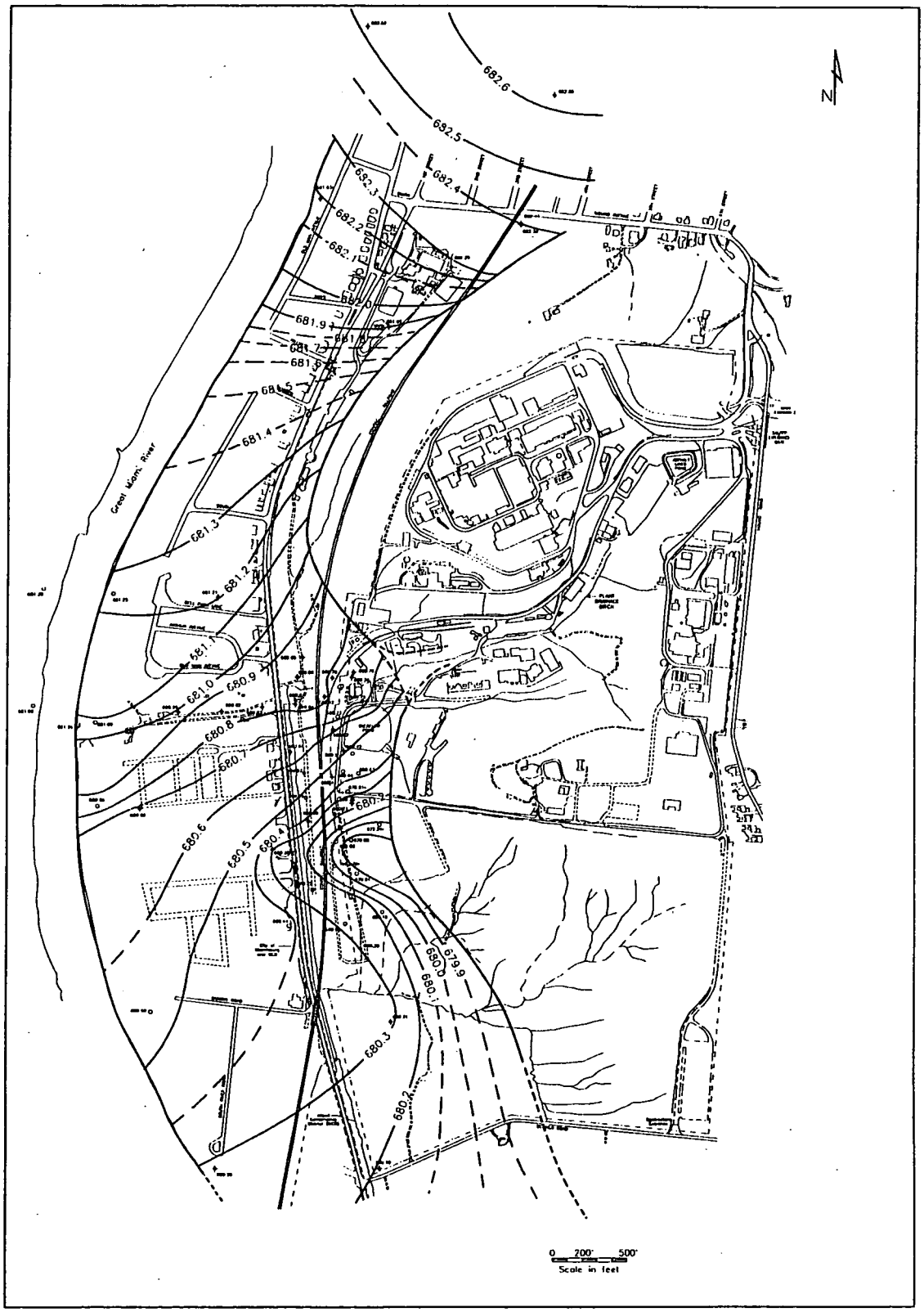
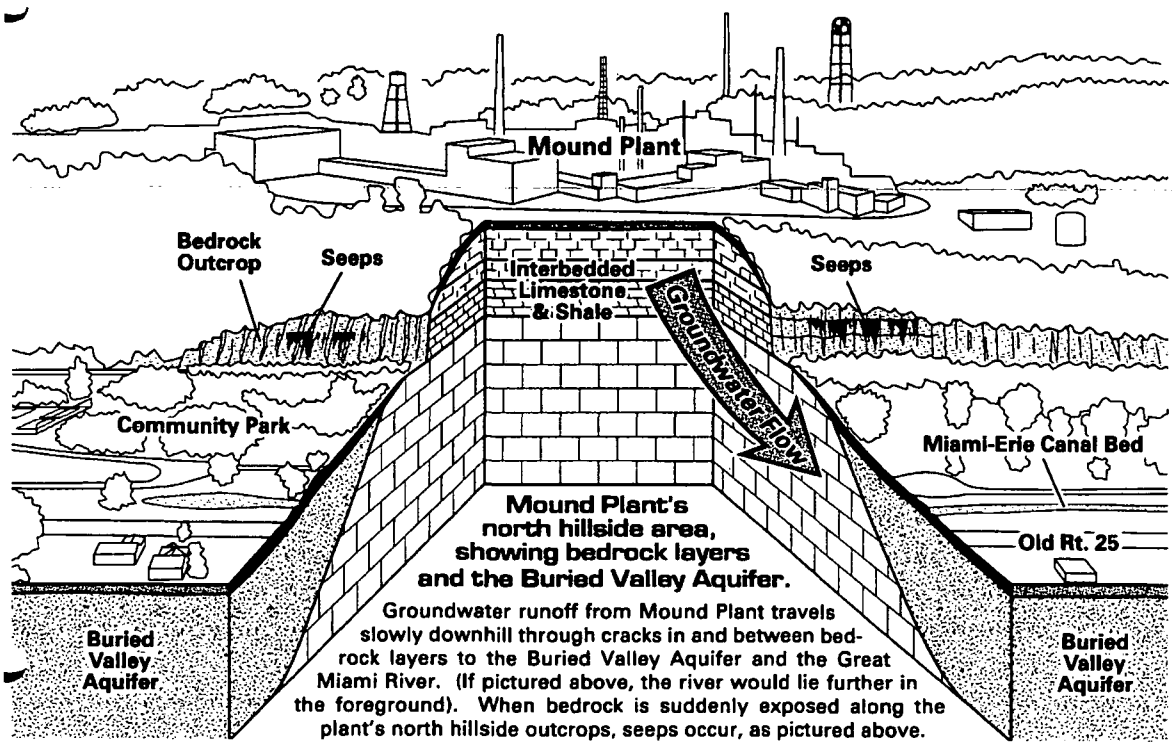


Figure 6-5. Geologic Cutaway of the Mound Plant



6.3 Offsite Groundwater Monitoring Program

The offsite groundwater monitoring program at Mound consists of routine collection of samples from production wells, private wells, regional drinking water supplies, and BVA monitoring wells. Samples are collected and analyzed primarily for radionuclides, metals, and volatile organic compounds (VOCs). Sampling and analytical procedures used to generate these results are documented in Mound's Environmental Monitoring Plan (1994) and Mound's Groundwater Protection Management Program Plan (DOE 1993b).

Tritium in Production and Private Wells

Private wells immediately downgradient of the Plant have tritium concentrations that are above background. "Background" is established each year by collecting well water from a location unaffected by Plant operations. Those samples are collected from a well north of Mound in the municipality of Tipp City. In 1995, tritium concentrations measured at that location were less than or equal to the reagent blanks.

Because tritium is known to have migrated from the site, downgradient wells are closely monitored for tritium. Sampling results for 1995 are shown in Table 6-1. As seen in the table, the maximum tritium concentration observed was 3.91 nCi/L. This value represents 19.5% of

the EPA's drinking water standard of 20 nCi/L. Average tritium concentrations, however, ranged from 0.15 nCi/L to 2.61 nCi/L, or 0.80% to 13.1% of the drinking water standard, respectively.

Tritium in Community Drinking Water Supplies

Tritium is the most mobile of the radionuclides released from the Plant. For this reason, Mound also monitors tritium concentrations in a number of regional groundwater supplies. The results for 1995 are presented in Table 6-2. The table shows that all of the values were near or below the lower limit of detection. However, the results reflect the pattern of tritium concentrations one would expect: higher averages near the site (Miamisburg,) and lower averages at greater distances (e.g., Middletown).

Table 6-1. Tritium Concentrations in Offsite Production and Private Wells in 1995

Well ID*	Historical Designation	Number of Samples	Tritium nCi/L Minimum	Tritium nCi/L Maximum	Tritium nCi/L Average[a,b]	Average as a % of the EPA Standard[c]
0904	J-1	.8	0.36	0.6	0.5 ± 0.07	2.5
0905	Tr-1	8	d	0.35	0.15 ± 0.1	0.8
0906	B-R	7	2.04	3.53	2.61 ± 0.46	13.1
0907	B-H	7	0.98	1.35	1.18 ± 0.15	5.9
0909	MCD	10	d	0.44	0.19 ± 0.09	0.95
0912	MSBG2	21	1.34	3.91	2.37 ± 0.36	11.9

[a] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.
[b] LDL for tritium in private well water is 0.9 nCi/L.
Note: the lower detection limit (LDL) is based on the variation of background or blank data associated with the environmental parameter. In some instances, a large variation in the blank data was noted which in turn caused a marked increase in the LDL.
[c] The EPA standard for tritium in drinking water is 20 nCi/L.
[d] Below the blank value.
*Well locations shown on Figure 6-2.

Tritium in Offsite Monitoring Wells

To provide additional information on the extent of offsite tritium migration, Mound also collects groundwater samples from a number of offsite monitoring wells. The results for 1995 are shown in Table 6-3.

Offsite Monitoring Activities for Other Radionuclides

Private well waters in the immediate vicinity of the Plant are also analyzed for plutonium-238, plutonium-239,240, uranium-233,234, uranium-238, thorium-228 and thorium-232. Results for 1995 are shown in Tables 6-4, 6-5 and 6-6 for plutonium, uranium and thorium, respectively.

Averages reported in both tables demonstrate that concentrations measured in 1995 were comparable to background levels for these radionuclides. (Background levels for 1995 are also listed in the tables.)

Monitoring wells along the western boundary of the Plant were analyzed twice in 1995 for plutonium-238, plutonium-239,240, uranium-233,234, uranium-238 and americium-241. The results, shown in Tables 6-7 and 6-8, are comparable to those obtained for well J1, a well just off the western edge of the Mound plantsite. Laboratory results indicated that concentrations of americium-241 are below the minimum detectable activity (MDA).

Table 6-2. Tritium Concentrations in Community Drinking Water Supplies in 1995

Location	Number of Samples	Tritium nCi/mL Minimum	Maximum	Average[a,b]	Average as a % of the EPA of Standard[c]
Centerville	12	d	0.17	0.08 ± 0.04	0.4
Franklin	12	d	0.27	0.12 ± 0.05	0.6
Germantown	12	d	0.18	0.05 ± 0.05	0.25
Miamisburg	12	0.07	0.39	0.26 ± 0.06	1.3
Middletown	12	d	0.15	0.09 ± 0.03	0.45
Moraine	12	d	0.16	0.07 ± 0.04	0.35
Springboro	12	d	0.29	0.19 ± 0.05	0.95
W. Carrollton	12	0.01	0.32	0.10 ± 0.06	0.5

[a] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.
[b] LDL for tritium in community drinking water is 0.4 nCi/L.
[c] The EPA standard for tritium in drinking water is 20 nCi/L.
[d] Below reagent blank.

Table 6-3. Tritium Concentrations in Offsite Monitoring Wells in 1995

Well ID*	Number of Samples	Tritium nCi/L Value[c]	Minimum	Maximum	Average	% EPA Standard
0005	6		0.17	0.92	0.74 ± 0.3[a]	3.7
0101	6		2.63	5.55	3.33 ± 1.16[a]	16.65
0106	6		0.14	1.32	0.39 ± 0.48	1.95
0123	2		0.53	1.01	0.77 ± 0.17[a,b]	3.85
0124	1	1.59				7.95
0126	1	2.31				11.55
0129	1	ND				
0330	2		0.75	0.27	0.51 ± 0.17	2.55
0333	2		1.14	1.36	1.25 ± 0.08	6.25
0337	2		0.30	1.34	0.82 ± 0.37	4.10
0341	2		1.90	2.25	2.08 ± 0.12	10.38
0376	1	1.64				8.20
0377	1	1.44				7.20
0378	1	0.89				4.45
0386	2		2.17	2.24	2.21 ± 0.02	11.03
0387	2		5.15	6.99	6.07 ± 0.65	30.35
0389	2		2.20	6.37	4.29 ± 1.47	21.43
0392	2		2.62	3.71	3.17 ± 0.39	15.83
P026	1	3.25	3.25	3.25	3.25 ± 0.0	16.25

[a] LDL for tritium in monitoring wells is 0.9 nCi/L (for samples analyzed by Mound lab).
[b] LDL for tritium in monitoring wells ranged from 0.20 nCi/L and 0.48 nCi/L (for samples analyzed by contract lab).
[c] In cases where only one sample was taken, minimum, maximum and average values do not apply.
ND = nondetectable values were reported by the contract lab.
* Well locations shown on Figure 6-2.

Table 6-4. Plutonium Concentrations in Offsite Drinking Water and an Offsite Private Well in 1995

Well I.D.*	Number of Samples	Plutonium-238 10^{-12} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
Miamisburg water supply	12	e	12.0	e	e
0904	8	e	9.6	e	e

Well I.D.*	Number of Samples	Plutonium-239,240 10^{-12} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
Miamisburg water supply	12	e	1.93	e	e
0904	8	e	1.0	e	e

[a] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.
[b] LDL for plutonium-238 in well water is 13.7 x 10^{-12} µCi/mL. LDL for plutonium-239,240 in well water is 8.4 x 10^{-12} µCi/mL.
[c] Background concentration of plutonium-238 in 1995 averaged below the reagent blanks. Background concentration of plutonium-239,240 in 1995 averaged 0.08 x 10^{-12} µCi/mL.
[d] DOE DCGs correspond to doses of 100 mrem/yr. Since the EPA drinking water dose standard is 4 mrem/yr, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for plutonium-238 and 0.04 x DCG for plutonium-239,240 are 1600 x 10^{-12} µCi/mL and 1200 x 10^{-12} µCi/mL, respectively.
[e] Below reagent blank.
* Well locations are shown in Figure 6-2.

Table 6-5. Uranium Concentrations in Offsite Drinking Water and an Offsite Private Well in 1995

Well I.D.*	Number of Samples	Uranium-233,244 10^{-9} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
Miamisburg water supply	12	0.35	0.47	0.4 ± 0.02	2.0
0904	8	0.14	0.19	0.16 ± 0.02	0.8

Well I.D.*	Number of Samples	Uranium-238 10^{-9} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
Miamisburg water supply	12	0.30	0.45	0.36 ± 0.02	1.5
0904	8	0.11	0.15	0.13 ± 0.01	0.5

[a] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.
[b] LDL for uranium-233,234 is 0.04 x 10^{-9} µCi/mL. LDL for uranium-238 is 0.03 x 10^{-9} µCi/mL.
[c] Background concentrations of uranium-233,234 and uranium-238 in 1995 averaged 0.39 x 10^{-9} µCi/mL and 0.32 x 10^{-9} µCi/mL, respectively.
[d] DOE DCGs correspond to doses of 100 mrem/yr. Since the EPA drinking water dose standard is 4 mrem/yr, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for uranium-233,234 and 0.04 x DCG for uranium-238 are 20 x 10^{-9} µCi/mL and 24 x 10^{-9} µCi/mL, respectively.
* Well locations are shown in Figure 6-2.

Table 6-6. Thorium Concentrations in Offsite Drinking Water and an Offsite Private Well in 1995

Well I.D.*	Number of Samples	Thorium-228 10^{-12} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
Miamisburg water supply	5	0.9	19.5	9.17 ± 8.68	0.06
0904	4	e	16.6	5.55 ± 14.12	0.28

Well I.D.*	Number of Samples	Thorium-232 10^{-12} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
Miamisburg water supply	5	e	6.8	e	e
0904	4	1.5	6.0	3.89 ± 3.15	0.19

[a] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.
[b] LDL for thorium-228 in well water is 39.1 x 10^{-12} µCi/mL. LDL for thorium-232 in well water is 17.1 x 10^{-12} µCi/mL.
[c] Background concentration of thorium-228 in 1995 averaged 5.48 x 10^{-12} µCi/mL.
Background concentration of thorium-232 in 1995 averaged 2.5 x 10^{-12} µCi/mL.
[d] DOE DCGs correspond to doses of 100 mrem/yr. Since the EPA drinking water dose standard is 4 mrem/yr, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for thorium-228 and 0.04 x DCG for thorium-232 are 16,000 x 10^{-12} µCi/mL and 2,000 x 10^{-12} µCi/mL, respectively.
[e] Below reagent blank.
* Well locations are shown in Figure 6-2.

Table 6-7. Plutonium Concentrations in Offsite Monitoring Wells in 1995

Well ID*	Pu-238 10^{-9} µCi/mL	% of 0.04 x the DOE DCG[a]	Pu-239,240 10^{-9} µCi/mL	% of 0.04 x the DOE DCG[c]
0123	LDL[a]		LDL[b]	
0129	LDL		0.03	2.5
0330	LDL		LDL	
0333	LDL		LDL	
0337	LDL		LDL	
0376	LDL		LDL	
0377	0.09	5.63	LDL	
0378	0.02	1.25	LDL	

* Well locations shown in Figure 6-2.
LDL = Below the lower detection limit.
[a] LDL: for Pu-238 is 0.02 x 10^{-9} µCi/mL.
[b] LDL: for Pu-239,240 is 0.02 x 10^{-9} µCi/mL.
[c] DOE DCGs correspond to doses of 100 mrem/yr. Since the EPA dose standard is 4 mrem/yr, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for plutonium-238 and 0.04 x DCG for plutonium-239,240 are 1.6 x 10^{-9} µCi/mL and 1.2 x 10^{-9} µCi/mL, respectively.

Table 6-8. Uranium Concentrations in Offsite Monitoring Wells in 1995

Well ID*	U-233,234 10^{-9} µCi/mL	% of 0.04 x the DOE DCG[a]	U-238 10^{-9} µCi/mL	% of 0.04 x the DOE DCG[a]
0123	0.13	0.65	0.04	0.16
0129	0.17	0.85	0.13	0.54
0330	0.20	1.00	0.17	0.71
0333	0.46	2.30	0.40	1.67
0337	0.19	0.95	0.17	0.71
0376	0.24	1.20	0.17	0.71
0377	0.35	1.75	0.29	1.21
0378	0.20	1.20	0.15	0.63

* Well locations shown in Figure 6-2.
[a] DOE DCGs correspond to doses of 100 mrem/yr. Since the EPA dose standard is 4 mrem/yr, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for uranium-233,234 and 0.04 x DCG for uranium-238 are 20 x 10^{-9} µCi/mL and 24 x 10^{-9} µCi/mL, respectively.

VOCs in Offsite Monitoring Wells

Sixteen offsite monitoring wells were also used to evaluate concentrations of volatile organic compounds (VOCs). The wells sampled were analyzed for over 50 VOC's. Only those VOC's which were detected are discussed in this report. VOCs of concern at industrial sites are typically halogenated solvents such as 1, 1, 1-trichloroethane, trichloroethene and tetrachloroethene. Concentrations of these compounds measured in offsite monitoring wells in 1995 are presented in Table 6-9. The table also lists the MCLs for those compounds identified. Trichloroethene was the only halogenated solvent to exceed the MCL. MCLs are used by the EPA to ensure compliance with the Primary Drinking Water Standards; since the samples do not represent drinking water, the MCLs should only be used to put the observed concentrations in perspective.

Table 6-9. VOC Concentrations in Offsite Monitoring Wells in 1995

Well I.D.*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL[a]
0126	Tetrachloroethene	NS	0.55	5
0129	1,1,1-Trichloroethane	NS	0.86	200
0377	1,1,1-Trichloroethane	NS	17.0	200
0378	1,1,1-Trichloroethane	NS	34.0	200
0386	Tetrachloroethene	ND	0.37	5
	Trichloroethene	7.8	8.4	5
0387	Tetrachloroethene	ND	0.36	5
	Trichloroethene	ND	1.2	5
0389	Tetrachloroethene	ND	0.71	5
	Trichloroethene	4.5	8.0	5
0392	Tetrachloroethene	ND	0.42	5
0389[b]	Trichloroethene	2.5	NS	5
0327[b]	Tetrachloroethene	0.4	NS	5

[a] MCL = Maximum Contaminant Level (based on EPA Primary Drinking Water Standards).

ND = not detected.

NS = not sampled.

* Well locations shown on Figure 6-2.

Metals in Offsite Monitoring Wells

The offsite monitoring wells were also used to evaluate concentrations of metallic constituents. The metals of concern are those regulated under the Safe Drinking Water Act (SDWA). Concentrations of these metals measured above the detection limits in offsite monitoring wells in 1995 are presented in Table 6-10. The table also lists the primary and secondary MCLs for these metals. Several wells showed contamination at or above the MCL for particular metals. Those metals exceeding the MCL were chromium, lead, nickel, and thallium. The secondary MCLs were exceeded for aluminum, iron, and manganese. However, as previously noted, MCLs are not truly applicable to these samples. MCLs are used by the EPA to ensure compliance with the Primary Drinking Water Standards. Secondary MCLs are defined as the maximum advisable limits for certain contaminants. Since the samples do not represent drinking water, the MCLs should only be used to put the observed concentrations in perspective.

Table 6-10. Metal Concentrations in Offsite Monitoring Wells in 1995

Well ID*	Compound	µg/L		
		2nd Quarter	4th Quarter	MCL[a]
0123	Aluminum	29.3	9.5	50 - 200[b,c]
	Chromium	20.9	0.72	100
	Iron	159	11.7	300[b]
	Lead	1.9	2.2	15[d]
	Manganese	420	346	50[b]
0126	Aluminum	NS	20.6	50 - 200[b,c]
	Barium	NS	135	2,000
	Chromium	NS	7.8	100
	Iron	NS	257	300[b]
0330	Aluminum	NS	35.4	50 - 200[b,c]
	Barium	NS	243	2,000
	Iron	NS	2,640	300[b]
	Manganese	NS	69.7	50[b]
0333	Arsenic	NS	27	50
	Barium	NS	188	2,000
	Iron	NS	2,350	300[b]
	Lead	NS	2.6	15[d]
	Manganese	NS	154	50[b]
0337	Iron	NS	106	300[b]
	Lead	NS	1.9	15[d]
	Nickel	NS	38.4	100

[a] Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).
[b] Secondary Maximum Contaminant Level.
[c] The MCL for aluminum is a range; Final MCL values have not been established for Mound.
[d] EPA Action Level.
ND = not detected.
NS = not sampled.
* Well locations shown on Figure 6-2.

Table 6-10. (continued)

Well ID*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL[a]
0341	Aluminum	36.8	12.6	50 - 200[b,c]
	Chromium	8.4	7.5	100
	Iron	645	639	300[b]
	Lead	1.7	5.2	15[d]
	Manganese	83	78.1	50[b]
	Nickel	72.1	65.5	100
0376	Chromium	NS	302	100
	Iron	NS	5,940	300[b]
	Manganese	NS	46.3	50[b]
	Nickel	NS	301	100
0377	Aluminum	NS	25.2	50 - 200[b,c]
	Arsenic	NS	6.8	50
	Chromium	NS	1,840	100
	Iron	NS	56,700	300[b]
	Lead	NS	25	15[d]
	Manganese	NS	624	50[b]
	Nickel	NS	1,250	100
0378	Aluminum	NS	39.8	50 - 200[b,c]
	Chromium	NS	310	100
	Iron	NS	16,300	300[b]
	Manganese	NS	274	50[b]
	Nickel	NS	552	100
0386	Aluminum	36.2	3.8	50 - 200[b,c]
	Chromium	127	35.9	100
	Iron	2920	1,170	300[b]
	Manganese	48	26.9	50[b]
	Nickel	156	159	100
0387	Aluminum	37.7	10.9	50 - 200[b,c]
	Iron	105	83.4	300[b]
	Nickel	28.1	39.6	100
0389	Aluminum	ND	32.4	50 - 200[b,c]
	Barium	95.4	83.7	2,000
	Chromium	ND	14.4	100
	Iron	18.2	145	300[b]

[a] Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).
[b] Secondary Maximum Contaminant Level.
[c] The MCL for aluminum is a range; Final MCL values have not been established for Mound.
[d] EPA Action Level.
ND = not detected.
NS = not sampled.
* Well locations shown on Figure 6-2.

Table 6-10. (continued)

Well ID*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL[a]
0392	Aluminum	5430	47,300	50 - 200[b,c]
	Arsenic	4.8	12.8	50
	Barium	78.6	279	2,000
	Beryllium	0.37	3	4
	Cadmium	2.2	ND	5
	Chromium	4040	1,920	100
	Iron	28900	117,000	300[b]
	Lead	12.7	87	15[d]
	Manganese	712	1,490	50[b]
	Nickel	1280	532	100
	Thallium	2.5	ND	2
	Zinc	808	942	5,000[b]
P026	Aluminum	NS	120	50 - 200[b,c]
	Barium	NS	192	2,000
	Iron	NS	2,380	300[b]
	Lead	NS	3.3	15[d]
	Manganese	NS	94.9	50[b]

[a] Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).
[b] Secondary Maximum Contaminant Level.
[c] The MCL for aluminum is a range; Final MCL values have not been established for Mound.
[d] EPA Action Level.
ND = not detected.
NS = not sampled.
* Well locations shown on Figure 6-2.

6.4 Onsite Groundwater Monitoring Program

The onsite groundwater monitoring program at Mound consists of routine collection of samples from production wells and BVA monitoring wells. Samples are collected and analyzed primarily for radionuclides and VOCs. Sampling and analytical procedures used to generate these results are documented in Mound's Environmental Monitoring Plan (1994) and Mound's Groundwater Protection Management Program Plan (DOE 1993b).

Tritium in Mound's Production Wells

There are three production wells onsite which provide drinking water and process water for the Mound Plant. Tritium concentration in those wells are evaluated on a monthly basis. The results for 1995 are summarized in Table 6-11. As seen in the table, minor levels of tritium are associated with the wells. However, the maximum concentration observed, 2.3 nCi of tritium per liter of water, represents 11.5% of the drinking water standard.

Table 6-11. Tritium Concentrations in Onsite Production Wells in 1995

Well I.D.*	Historic Designation	Number of Samples	Tritium nCi/L Minimum	Maximum	Average[a,b]	Average as a % of EPA Standard[c]
0071	No. 1	46	0.6	1.9	1.1 ± 0.1	5.5
0271	No. 2	46	0.5	2.3	1.3 ± 0.1	6.5
0076	No. 3	24[d]	0.8	1.5	1.0 ± 0.1	5.0

[a] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.

[b] LDL for tritium in onsite well water is 0.5 nCi/L.

[c] The EPA standard for tritium in drinking water is 20 nCi/L.

[d] Well 0076 was temporarily out of service for maintenance and was not sampled during this time.

* Well locations shown on Figure 6-2.

Tritium in the BVA

Mound maintains an extensive network of onsite Buried Valley Aquifer (BVA) monitoring wells (Figure 6-2). Samples from a number of these wells are collected and analyzed for tritium. The results for 1995 are listed in Table 6-12. Data from Table 6-12 and from previous years demonstrate that some degree of tritium contamination is present in the aquifer. The maximum concentration observed in 1995 was 23.13 nCi/L at Well 0324. Well 0324 was the only monitoring well sampled that exceeded the drinking water standard of 20 nCi/L.

Tritium in the Seeps

Tritium has been recognized as a persistent contaminant in the Main Hill seeps since 1986 (DOE 1987). Since then, tritium has been the focus of extensive sampling activities in that area. Table 6-13 shows concentrations of tritium in seep samples for 1995. (Seep locations are shown on Figure 6-6). The highest tritium concentrations are clearly associated with Seep 601. This result is consistent with observations in previous years.

Remediation of the seeps is being addressed through Mound's CERCLA Program. The seeps were formerly part of Operable Unit 2 (which has been replaced by Mound 2000) and are now being individually addressed as potential release sites.

Table 6-12. Tritium Concentrations in Onsite Monitoring Wells in 1995

Well I.D.*	Number of Samples	Tritium nCi/L Value[a]	Minimum	Maximum	Average[b]	% of EPA Standard
0112	1	2.95				14.75
0119	1	2.43				12.15
0125	1	ND				
0137	2		1.74	3.54	2.64 ± 0.64	13.20
0152	1	4.83				24.15
0312	2		6.32	7.47	6.89 ± 0.41	34.46
0313	2		2.96	4.73	3.84 ± 0.63	19.22
0315	2		3.0	3.95	3.48 ± 0.34	17.38
0324	1	23.13				115.65
0346	1	4.73				23.65
0347	2		1.22	2.57	1.90 ± 0.48	9.48
0402	1	1.12				5.60
0410	2		4.28	5.24	4.76 ± 0.34	23.80
0411	2		LDL	1.24	0.62 ± 0.44	3.10
P015	2		2.42	4.43	3.43 ± 0.71	17.13
P022	1	ND				
P023	2		0.78	1.04	0.91 ± 0.09	4.55
P027	2		1.73	3.75	2.74 ± 0.71	13.70
P031	1	0.86				4.30

[a] In cases where only one sample was taken, minimum, maximum and average values do not apply.

ND = not detected.

* Well locations shown on Figure 6-2.

[b] LDL for tritium in monitoring wells = 0.3 nCi/L.

Table 6-13. Tritium Concentrations in Seeps in 1995

Seep I.D.*	Historic Designation	Number of Samples	Tritium nCi/L Minimum	Maximum	Average
0601	S001	221	55.2	245.5	112 ± 24.8
0605	S005	7	9.4	80.0	47.1 ± 22.5
0606	S005	5	6.3	57.4	33.1 ± 16.9
0607	S007	213	12.9	81.0	35.8 ± 10.6

* Seep locations are shown on Figure 6-6.

Tritium in the Capture Pits

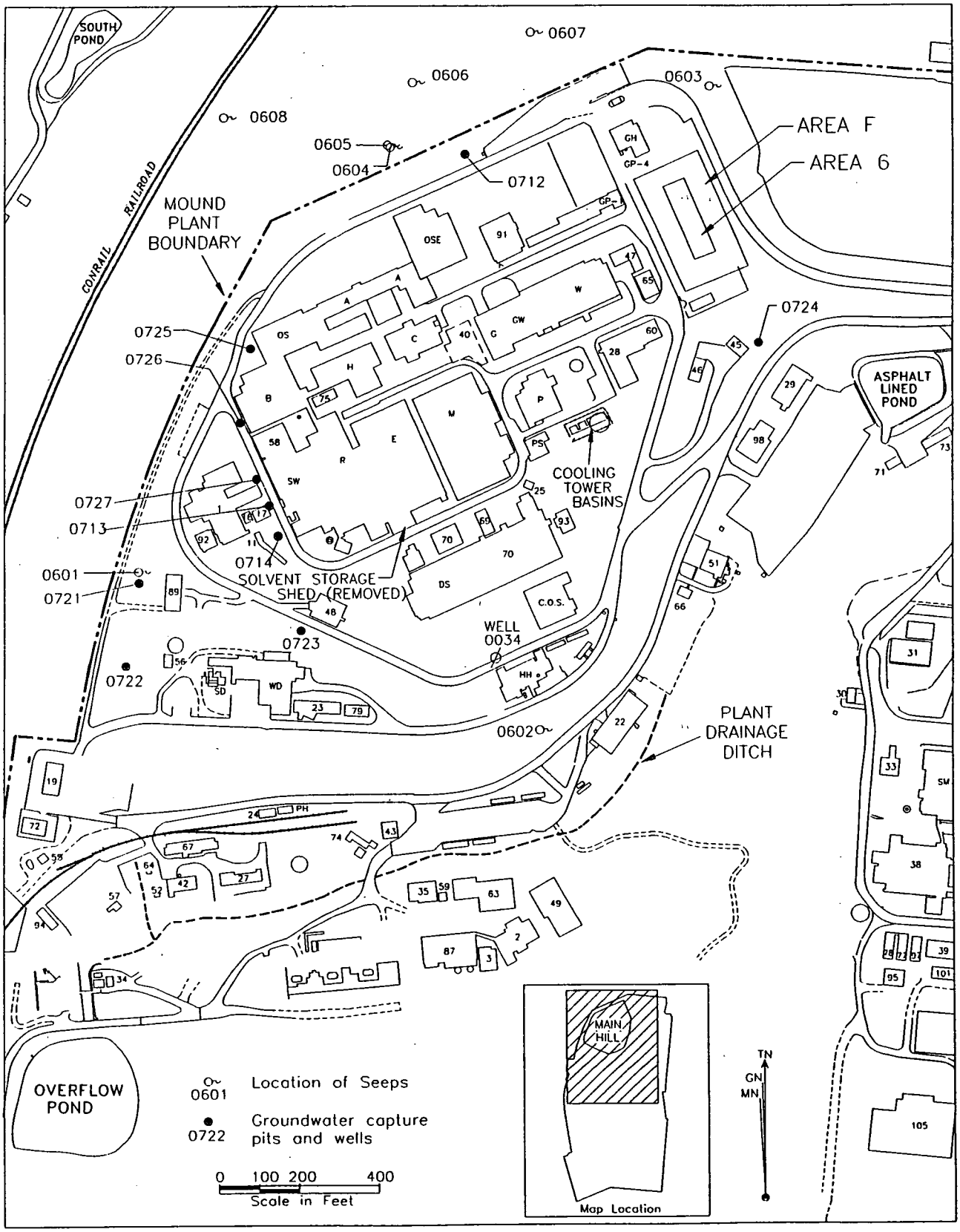
A number of groundwater collection devices, or "capture pits", are used on the Main Hill to isolate and monitor contamination in perched groundwater. These devices have been designed to collect pockets of shallow groundwater which may have been contaminated as a result of past operational practices. In 1995, numerous samples were collected from the pits and analyzed for tritium. The results are shown in Table 6-14. The locations of the sampling points for the capture pits are shown on Figure 6-6.

Table 6-14. Tritium Concentrations in the Capture Pits in 1995

Capture Pit I.D.*	Historic Designation	Number of Samples	Tritium nCi/L Minimum	Maximum	Average
0712	P012	31	0.6	3.6	1.8 ± 0.7
0714	P014	41	153.2	590.5	278.2 ± 72.0
0725	W005	29	0.8	12.6	3.9 ± 3.2
0726	W006	31	2.9	665.6	130.5 ± 161.4
0727	W007	30	8.5	972.9	535.5 ± 339.7

* Capture pit locations are shown on Figure 6-6.

Figure 6-6. Seep and Capture Pit Locations



Onsite Monitoring Activities for Other Radionuclides

Samples collected from the Plant's three production wells are also analyzed for plutonium-238, plutonium-239,240, uranium-233,234, uranium-238, thorium-228 and thorium-232. Results for 1995 are shown in Tables 6-15, 6-16 and 6-17 for plutonium, uranium and thorium, respectively. Values reported in the tables demonstrate that average concentrations measured in 1995 were comparable to background levels for these radionuclides (background levels for 1995 are also listed in the tables).

Table 6-15. Plutonium Concentrations in Onsite Production Wells in 1995

Well I.D.*	Historic Designation	Number of Samples	Plutonium-238 10^{-12} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
0071	No. 1	12	e	12.5	e	e
0271	No. 2	12	e	9.2	0.28 ± 3.75	0.02
0076	No. 3	6[f]	0.5	2.03	1.17 ± 0.58	0.07

Well I.D.*	Historic Designation	Number of Samples	Plutonium-239,240 10^{-12} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
0071	No. 1	12	e	19.6	2.22 ± 3.65	0.2
0271	No. 2	12	e	16.85	0.04 ± 4.38	0.003
0076	No. 3	6[f]	e	2.43	0.31 ± 2.01	0.03

[a] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[b] LDL for plutonium-238 in drinking water is 13.7 x 10^{-12} µCi/mL. LDL for plutonium-239,240 in well water is 8.4 x 10^{-12} µCi/mL.

[c] Background concentration of plutonium-238 in 1995 averaged below reagent blanks. Background concentration of plutonium-239,240 in 1995 averaged 0.08 x 10^{-12} µCi/mL.

[d] DOE DCGs correspond to doses of 100 mrem/yr. Since the EPA dose standard is 4 mrem/yr, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for plutonium-238 and 0.04 x DCG for plutonium-239,240 are 1600 x 10^{-12} µCi/mL and 1200 x 10^{-12} µCi/mL, respectively.

[e] Below reagent blank.

[f] Well 0076 was temporarily out of service for maintenance and was not sampled during this time.

* Well locations are shown in Figure 6-2.

Table 6-16. Uranium Concentrations in Onsite Production Wells in 1995

Well I.D.*	Historic Designation	Number of Samples	Uranium-233,234 10^{-9} µCi/mL Minimum	Maximum	Average[a,b]	Average as a % of 0.04 x the DOE DCG[c]
0071	No. 1	12	0.17	0.23	0.2 ± 0.01	1.0
0271	No. 2	12	0.18	0.22	0.2 ± 0.01	1.0
0076	No. 3	6[f]	0.19	0.24	0.21 ± 0.02	1.1

Well I.D.*	Historic Designation	Number of Samples	Uranium-238 10^{-9} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
0071	No. 1	12	0.15	0.22	0.18 ± 0.01	0.8
0271	No. 2	12	0.14	0.19	0.17 ± 0.01	0.7
0076	No. 3	6[f]	0.16	0.24	0.19 ± 0.03	0.8

[a] Error limits are estimates of the standard error of the estimated mean at the 95 % confidence level.

[b] LDL for uranium-233,234 is 0.04 x 10^{-9} µCi/mL. LDL for uranium-238 is 0.03 x 10^{-9} µCi/mL.

[c] Background concentrations of uranium-233,244 in 1995 averaged 0.39 x 10^{-9} µCi/mL
Background concentrations of uranium-238 in 1995 averaged 0.32 x 10^{-9} µCi/mL

[d] DOE DCGs correspond to doses of 100 mrem/yr. Since the EPA dose standard is 4 mrem/yr, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for uranium-233,234 and 0.04 x DCG for uranium-238 are 20 x 10^{-9} µCi/mL and 24 x 10^{-9} µCi/mL, respectively.

[f] Well 0076 was temporarily out of service for maintenance and was not sampled during this time.

* Well locations are shown in Figure 6-2.

Table 6-17. Thorium Concentrations in Onsite Production Wells in 1995

Well I.D.*	Historic Designation	Number of Samples	Thorium-228 10^{-12} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x DOE DCG[d]
0071	No. 1	5	e	22.6	3.37 ± 14.01	0.02
0271	No. 2	5	e	13.4	4.21 ± 7.63	0.03

Well I.D.*	Historic Designation	Number of Samples	Thorium-232 10^{-12} µCi/mL Minimum	Maximum	Average[a,b,c]	Average as a % of 0.04 x the DOE DCG[d]
0071	No. 1	5	e	7.5	3.24 ± 4.93	0.16
0271	No. 2	5	e	4.5	2.19 ± 2.34	0.11

[a] Error limits are estimates of the standard error of the estimated mean at the 95% confidence level.

[b] LDL for thorium-228 in drinking water is 39.1 x 10^{-12} µCi/mL. LDL for thorium-232 in well water is 17.1 x 10^{-12} µCi/mL.

[c] Background concentration of thorium-228 in 1995 averaged 5.48 x 10^{-12} µCi/mL. Background concentration of thorium-232 in 1995 averaged 2.5 x 10^{-12} µCi/mL.

[d] DOE DCGs correspond to doses of 100 mrem/yr. Since the EPA dose standard is 4 mrem/yr, the averages have been reported as percentages of 0.04 x DCGs. 0.04 x the DCG for thorium-228 and 0.04 x DCG for thorium-232 are 16,000 x 10^{-12} µCi/mL and 2,000 x 10^{-12} µCi/mL, respectively.

[e] Below reagent blank.

* Well locations are shown in Figure 6-2.

VOC Monitoring Activities

Production wells. The Plant's drinking water supply is provided by three production wells. These wells have exhibited VOC contamination in the form of halogenated solvents. Each well sample was analyzed for over 50 VOCs. Only those VOCs detected are discussed in this report. The four halogenated solvents typically present in trace concentrations are 1, 1, 1-trichloroethane, cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene. Results for 1995 are shown in Table 6-18. The data show the production wells to be consistently below the MCL standard for VOC contamination. (Compliance with the SDWA regulations is determined by a running annual average.)

Table 6-18. VOC Concentrations in Onsite Production Wells in 1995

Well I.D.*	Compound	Number of Samples	µg/L Minimum	Maximum	Average	MCL[a]
0071	1,1,1-Trichloroethane	5	0.7	1.6	1.0 ± 0.3	200
	cis-1,2-Dichloroethene	5	0.9	3.1	1.6 ± 0.7	70
	Trichloroethene	5	2.3	2.9	2.6 ± 0.2	5
	Tetrachloroethene	5	0.8	1.2	1.0 ± 0.1	5
0271	1,1,1-Trichloroethane	13	0.8	2.7	1.7 ± 0.7	200
	cis-1,2-Dichloroethene	13	ND	1.2	0.6 ± 0.5	70
	Trichloroethene	13	0.8	3.3	2.3 ± 1.0	5
	Tetrachloroethene	13	ND	1.8	1.1 ± 0.7	5
0076	1,1,1-Trichloroethane	9	0.7	1.2	1.0 ± 0.2	200
	cis-1,2-Dichloroethene	9	ND	0.6	0.3 ± 0.3	70
	Trichloroethene	9	1.4	2.1	1.8 ± 0.2	5
	Tetrachloroethene	9	ND	0.6	0.5 ± 0.2	5

[a] MCL = Maximum Contaminant Level (based on EPA Drinking Water Standards).
ND = Not detected.
* Well locations shown on Figure 6-2.

BVA. Within the Mound Plant, numerous monitoring wells in the upper and lower units of the BVA have been sampled routinely since 1988. Results confirm the presence of VOC contamination in the aquifer. Based on routine sampling of the BVA monitoring network, the contamination appears to be greatest in the upper unit of the BVA along the western Plant boundary, immediately southwest of the Main Hill. Generally, within the boundaries of the plant, the contamination tends to decrease from west to east and from north to south.

The results for 1995 are shown in Table 6-19. Vinyl chloride, trichloroethene, cis 1,2-dichloroethene and tetrachloroethene are the principal contaminants which exceed the MCL for drinking water. MCLs are used as guidelines to help put observed concentrations in perspective.

Table 6-19. VOC Concentrations in Onsite Monitoring Wells in 1995

Well ID*	Compound	µg/L		
		2nd Quarter	4th Quarter	MCL[a]
0119	Vinyl chloride	NS	1.0	2
0137	Trichloroethene	1.4	2.4	5
	Tetrachloroethene	ND	0.34	5
0312	cis-1,2-Dichloroethane	4.9	7.4	70
	Trichloroethene	10	36	5
0315	Trichloroethene	5.7	3.6	5
	Carbon Tetrachloride	3.6	6.7	5
0324	cis-1,2-Dichloroethane	NS	2.0	70
	Trichloroethene	NS	2.3	5
0347	cis-1,2-Dichloroethane	1.1	ND	70
	Trichloroethene	7.2	6.4	5
	Carbon Tetrachloride	4.8	4.4	5

[a] MCL = Maximum Contaminant Level (based on EPA Primary Drinking Water Standards).
* Well Locations shown on Figure 6-2.
NS = not sampled.
ND = not detected.

Table 6-19. (continued)

Well ID*	Compound	µg/L 2nd Quarter	4th Quarter	MCL[a]
0410	cis-1,2-Dichloroethane	150	240	70
	trans-1,2-Dichloroethane	ND	2.2	100
	Trichloroethene	22	29	5
	Tetrachloroethene	13	17	5
	Vinyl chloride	13	22	2
	Chloroform	3.4	5.2	80
	Dichlorodifluoromethane	ND	3.1	-
	Trichlorofluoromethane	ND	6.1	-
0411	cis-1,2-Dichloroethane	2.7	2.6	70
	Trichloroethene	14	16	5
P015	cis-1,2-Dichloroethane	140	130	70
	trans-1,2-Dichloroethane	1.3	1.6	100
	Trichloroethene	33	49	5
	Tetrachloroethene	10	12	5
	Carbon Tetrachloride	ND	1.3	5
	Vinyl chloride	7	9.1	2
	Chloroform	ND	3.0	80
	Dichlorodifluoromethane	ND	1.9	-
	Trichlorofluoromethane	ND	5.3	-
	Toluene	2.6	ND	1000
P027	cis-1,2-Dichloroethane	2.6	1.7	70
	Trichloroethene	5.8	7.2	5
	Tetrachloroethene	2.0	3.4	5
P031	Trichloroethene	NS	2.8	5
	Tetrachloroethene	NS	2.3	5

[a] MCL = Maximum Contaminant Level (based on EPA Primary Drinking Water Standards).
* Well Locations shown on Figure 6-2.
NS = not sampled.
ND = not detected.

Seeps. Samples collected from the Main Hill in 1988 first confirmed the presence of VOCs in Seeps 0601, 0602, 0605, and 0607 (EG&G Mound, 1991). (The seep locations are shown on Figure 6-6.) The results for 1995 are shown on Table 6-20. The primary contaminants are 1,2-cis-dichloroethene and trichloroethene. In 1995, tetrachloroethene was seen only in Seep 0601. The tetrachloroethene concentration measured at seep 0601 was above the 5 µg/L drinking water standard. The MCL is used only for comparison since seep water is unlikely to serve as a drinking water source. Therefore, a relatively low degree of risk is associated with the VOC contamination present in the seeps.

Table 6-20. VOC Concentrations in Seeps in 1995

Seep I.D.*	Compound	No. of Samples	µg/L Minimum	Maximum	Average	MCL[a]
0601	cis-1,2-Dichloroethene	9	ND	0.8	0.4 ± 0.3	70
	Trichloroethene	9	4.0	6.5	5.2 ± 0.7	5
	Tetrachloroethene	9	5.6	20.3	14.6 ± 4.0	5
0607	cis-1,2-Dichloroethene	9	0.8	2.5	1.6 ± 0.5	70
	Trichloroethene	9	1.7	4.2	3.1 ± 0.7	5

[a] MCL = Maximum Contaminant Level (based on EPA Drinking Water Standard).
* Seep locations are shown on Figure 6-6.
ND = Not detected.

Monitoring Activities for Metals

Metals in Onsite Monitoring Wells. The onsite monitoring wells are also used to evaluate concentrations of metallic constituents. The metals of concern are those regulated under the Safe Drinking Water Act (SDWA). Concentrations of these metals measured above the detection limit in onsite monitoring wells in 1995 are presented in Table 6-21. The table also lists the primary and secondary MCL for these metals. However, MCLs are not truly applicable to these samples. MCLs are used by the EPA to ensure compliance with the Primary Drinking Water Standards. Secondary MCLs are defined as the maximum advisable limits for certain contaminants in water. Since the samples do not represent drinking water, the MCLs should only be used to put the observed concentrations in perspective.

Several wells show contamination at or above the MCL for particular metals. Those metals exceeding the primary MCL were antimony, chromium, lead and nickel. The secondary MCLs were exceeded by aluminum, chloride, iron and manganese. More information on these results can be reviewed in the CERCLA *Operable Unit 9, Hydrogeologic Investigation: Groundwater Sweeps Report, Technical Memorandum,* January 1995.

6.5 Five-Year Trends for Wells of Interest

As seen in Sections 6.1 through 6.4 of this chapter, a large volume of groundwater monitoring data is generated each year for the Mound Plant. It is important that the data be reviewed for evidence of long-term trends, especially in cases where there is some history of elevated concentrations of contaminants. In this section, five-year trends are presented for certain indicator parameters measured in wells of interest.

Trend Data for Offsite Drinking Water

A primary environmental consideration for the Mound Plant is to ensure that area drinking water supplies are not adversely affected by Plant operations. The most mobile of the constituents released to groundwater by Mound is tritium. For this reason, tritium is an excellent indicator of offsite migration. Detailed information regarding tritium levels in offsite wells was presented in Section 6.3.

Among the wells listed in those sections, two drinking water sources can be considered key receptor wells. First, the drinking water supply of the City of Miamisburg is of interest due to the proximity of the City's well fields to the Plant. And second, Well 0904, a private well, is useful as an indicator because it reflects potential impact to small drinking water systems.

Five-year trends for tritium concentrations in the two wells described above are shown in Figure 6-7. As seen in the figure, tritium levels in the wells have exhibited little change during the period 1991 through 1995. All of the values shown on the graph are significantly below the drinking water standard of 20 nCi/L for tritium.

Table 6-21. Metal Concentrations in Onsite Monitoring Wells in 1995

Well ID*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL[a]
0112	Aluminum	NS	241	50 - 200[b,c]
	Iron	NS	421	300[b]
	Lead	NS	1.7	15[d]
	Manganese	NS	38.8	50[b]
0119	Aluminum	NS	30.1	50 - 200[b,c]
	Cadmium	NS	133,000	5
	Iron	NS	1,220	300[b]
	Lead	NS	6.7	15[d]
	Manganese	NS	37.6	50[b]
0125	Aluminum	NS	375	50 - 200[b,c]
	Chromium	NS	7.9	100
	Iron	NS	370	300[b]
	Manganese	NS	29.1	50[b]
0137	Aluminum	228	151	50 - 200[b,c]
	Cadmium	7.0	ND	5
	Chromium	16.8	11.4	100
	Iron	68900	73,700	300[b]
	Lead	15.7	53.4	15[d]
	Manganese	319	386	50[b]
	Zinc	35.2	22.5	5,000[b]
0312	Aluminum	3110	2,340	50 - 200[b,c]
	Arsenic	8.2	12.4	50
	Beryllium	0.18	2.2	4
	Cadmium	4.1	ND	5
	Chromium	13300	44,800	100
	Iron	64400	174,000	300[b]
	Lead	7.9	18.4	15[d]
	Manganese	2340	1,620	50[b]
	Nickel	11600	8,780	100
	Zinc	74.9	68.2	5,000[b]
0315	Barium	198	165	2,000
	Chromium	206	42.5	100
	Iron	2870	592	300[b]
	Lead	2.0	ND	15[d]
	Manganese	54.8	10.7	50[b]
	Nickel	84.3	91.4	100
0324	Aluminum	NS	45.9	50 - 200[b,c]
	Iron	NS	310	300[b]
	Manganese	NS	634	50[b]

[a] Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).
[b] Secondary Maximum Contaminant Level.
[c] The MCL for aluminum is a range; Final MCL values have not been established for Mound.
[d] EPA Action Level.
ND = not detected.
NS = not sampled.
* Well locations shown on Figure 6-2.

Table 6-21. (continued)

Well ID*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL[a]
0346	Aluminum	NS	38.3	50 - 200[b,c]
	Iron	NS	1,160	300[b]
	Manganese	NS	32.1	50[b]
	Zinc	NS	22	5,000[b]
0347	Aluminum	20.8	11	50 - 200[b,c]
	Barium	159	144	2,000
	Chromium	6.2	34.8	100
	Iron	88.1	447	300[b]
	Lead	2.4	ND	15[d]
	Manganese	5.0	5.2	50[b]
	Nickel	17	21.6	100
0402	Aluminum	NS	107,000	50 - 200[b,c]
	Antimony	NS	6.9	6
	Barium	NS	603	2,000
	Beryllium	NS	6.2	4
	Cadmium	NS	4.1	5
	Chromium	NS	1550	100
	Iron	NS	445,000	300[b]
	Lead	NS	34	15[d]
	Manganese	NS	7,430	50[b]
	Mercury	NS	0.33	2
	Nickel	NS	618	100
	Zinc	NS	885	5,000[b]
0410	Aluminum	61600	84,500	50 - 200[b,c]
	Antimony	1.2	24.6	6
	Arsenic	9.9	ND	50
	Barium	522	615	2,000
	Beryllium	4.2	5.4	4
	Cadmium	16.7	ND	5
	Chromium	619	439	100
	Iron	227000	502,000	300[b]
	Lead	92.4	ND	15[d]
	Manganese	5720	7,550	50[b]
	Mercury	0.35	0.3	2
	Nickel	305	389	100
	Zinc	668	890	5,000[b]

[a] Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).
[b] Secondary Maximum Contaminant Level.
[c] The MCL for aluminum is a range; Final MCL values have not been established for Mound.
[d] EPA Action Level.
ND = not detected.
NS = not sampled.
* Well locations shown on Figure 6-2.

Table 6-21. (continued)

Well ID*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL[a]
0411	Aluminum	22300	24,300	50 - 200[b,c]
	Arsenic	4.9	9.5	50
	Barium	126	93.4	2,000
	Beryllium	1.2	1.4	4
	Cadmium	3.3	ND	5
	Chromium	1450	2,190	100
	Iron	54100	58,300	300[b]
	Lead	14.9	8	15[d]
	Manganese	1070	833	50[b]
	Nickel	117	214	100
	Zinc	92.1	97.1	5,000[b]
P015	Aluminum	16000	59,000	50 - 200[b,c]
	Arsenic	13.4	24.9	50
	Barium	230	395	2,000
	Beryllium	1.1	3.7	4
	Cadmium	4.6	ND	5
	Chromium	35.8	73.7	100
	Iron	43400	232,000	300[b]
	Lead	44.8	215	15[d]
	Manganese	707	2,870	50[b]
	Mercury	ND	0.4	2
	Nickel	40.8	108	100
	Thallium	2.1	ND	2
	Zinc	370	701	5,000[b]
P022	Aluminum	NS	30,100	50 - 200[b,c]
	Arsenic	NS	8.6	50
	Barium	NS	175	2,000
	Beryllium	NS	2	4
	Cadmium	NS	199	5
	Chromium	NS	113	100
	Iron	NS	57,800	300[b]
	Lead	NS	27.2	15[d]
	Manganese	NS	915	50[b]
	Nickel	NS	69.5	100
	Selenium	NS	24	2
	Zinc	NS	126	5,000[b]

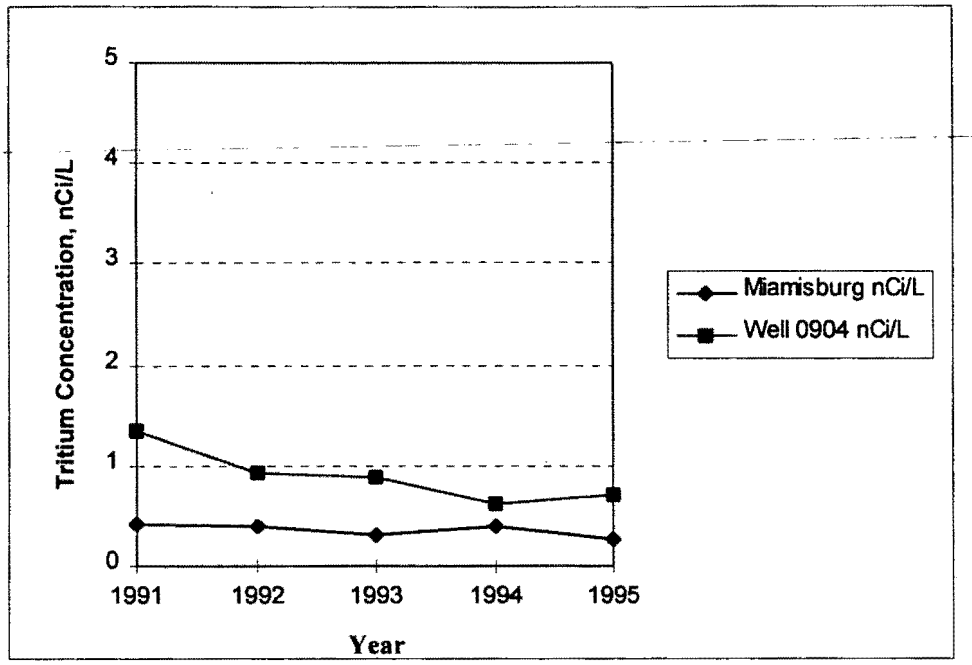
[a] Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).
[b] Secondary Maximum Contaminant Level.
[c] The MCL for aluminum is a range; Final MCL values have not been established for Mound.
[d] EPA Action Level.
ND = not detected.
NS = not sampled.
* Well locations shown on Figure 6-2.

Table 6-21. (continued)

Well ID*	Compound	µg/L 2nd Quarter	µg/L 4th Quarter	MCL[a]
P023	Aluminum	3230	46,600	50 - 200[b,c]
	Arsenic	1.6	27.7	50
	Barium	54.6	179	2,000
	Beryllium	ND	2.7	4
	Cadmium	2160	4,450	5
	Chromium	19.2	146	100
	Iron	33900	215,000	300[b]
	Lead	104	245	15[d]
	Manganese	921	2,520	50[b]
	Nickel	19.6	120	100
	Silver	ND	10.3	100
	Zinc	139	354	5,000[b]
P027	Aluminum	23800	17,900	50 - 200[b,c]
	Arsenic	3.9	9	50
	Barium	208.6	163	2,000
	Beryllium	1.4	1.37	4
	Cadmium	4.7	ND	5
	Chromium	35.3	21	100
	Iron	67500	42,500	300[b]
	Lead	26.6	28.8	15[d]
	Manganese	1330	1,080	50[b]
	Nickel	62.7	41.2	100
	Zinc	236	156	5,000[b]
P031	Aluminum	NS	107,000	50 - 200[b,c]
	Antimony	NS	8.8	6
	Arsenic	NS	15.3	50
	Barium	NS	474	2,000
	Beryllium	NS	5.8	4
	Chromium	NS	134	100
	Iron	NS	348,000	300[b]
	Lead	NS	119	15[d]
	Manganese	NS	4,000	50[b]
	Mercury	NS	0.2	2
	Nickel	NS	210	100
	Zinc	MS	850	5,000[b]

[a] Maximum Contaminant Level (based on EPA Primary and Secondary Drinking Water Standards).
[b] Secondary Maximum Contaminant Level.
[c] The MCL for aluminum is a range; Final MCL values have not been established for Mound.
[d] EPA Action Level.
ND = not detected.
NS = not sampled.
* Well locations shown on Figure 6-2.

Figure 6-7. Annual Average Tritium Concentrations in Offsite Drinking Water, 1991 - 1995



(Drinking water standard for tritium = 20 nCi/L)

Trend Data for Onsite Production Wells and Seeps

As previously described in this chapter, tritium and certain volatile organic compounds (VOCs) have been observed in the groundwater system underlying the plant site. As discussed in Section 6.4, VOCs of concern include trichloroethene, tetrachloroethene, and 1,2-dichloroethene. Trichloroethene serves as an "indicator" VOC.

An appropriate onsite indicator well is Production Well No. 3 (also referred to as Well 0076) because it serves as the primary source of drinking water for the Plant. Another important monitoring point for the evaluation of groundwater conditions is associated with the seep sites. Data collected to date suggest that Seep 0601 is an appropriate location for the observation of long-term trends.

Five-year trend data for Mound Production Well No. 3 are shown in Figures 6-8 and 6-9 for tritium and trichloroethene, respectively. Similarly, Figures 6-10 and 6-11 present five-year trend data for tritium and trichloroethene at Seep 0601.

Figure 6-8 indicates that tritium levels in Mound Well No. 3 are well below the applicable drinking water standard (20 nCi/L) and are not significantly different from the values reported for offsite drinking water systems.

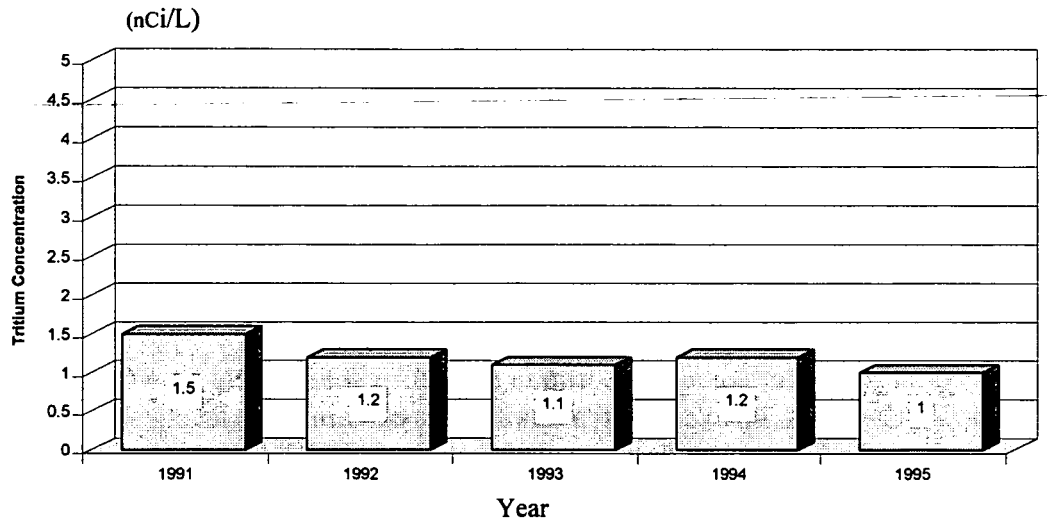
Slightly elevated concentrations of trichloroethene have been observed in Well No. 3 (Figure 6-9). However, observed concentrations have remained below the applicable MCL.

Figure 6-10 presents tritium concentration data for Seep 0601. Data for the period 1991-1995 show the yearly average for tritium concentrations ranging from approximately 100 nCi/L to 350 nCi/L. From the figure, it can be noted that average concentrations have both increased and decreased over the five-year period shown. The increase in 1994 is attributable to a water main break beneath SW-Building. SW-Building is the primary tritium facility onsite.

As seen in Figure 6-11, Seep 0601 is also characterized by elevated levels of trichloroethene. Additionally, though not shown in the figure, over the past few years tetrachloroethene has also emerged as a key contributor to VOC contamination in this seep.

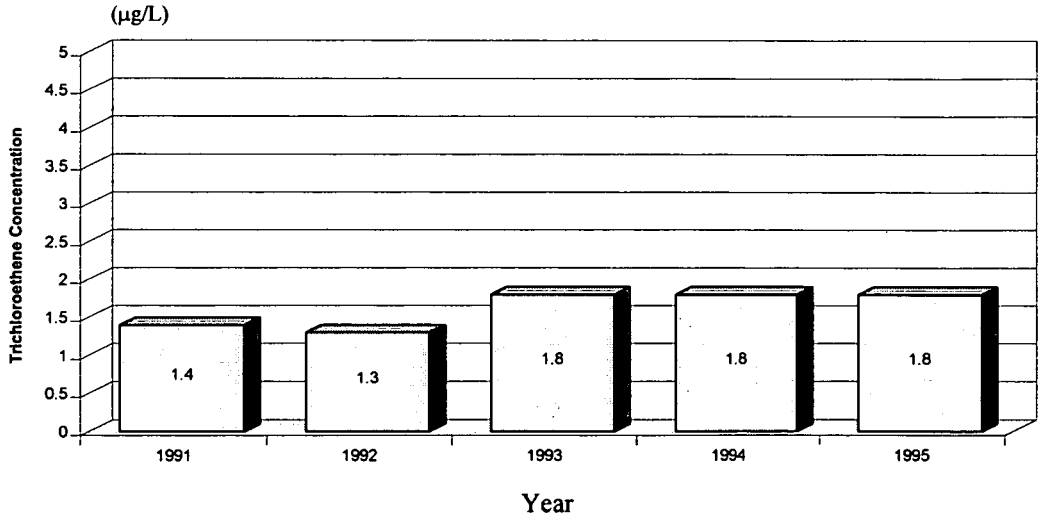
Because Mound seep sites are not sources of drinking water, tritium levels above the drinking water standard, or VOC values in excess of a maximum contaminant level, should not be interpreted as indicative of a human health concern. Mound's CERCLA Program will evaluate the risks associated with contamination in the seeps and will identify remediation actions which may be appropriate.

Figure 6-8. Annual Average Tritium Concentration in Production Well 0076, 1991 - 1995



(Drinking water standard for tritium = 20 nCi/L)

Figure 6-9. Annual Average Indicator Trichloroethene Concentration in Production Well 0076, 1991 - 1995



(MCL for trichloroethene = 5 µg/L)

Figure 6-10. Annual Average Tritium Concentration for Seep 0601, 1991 - 1995

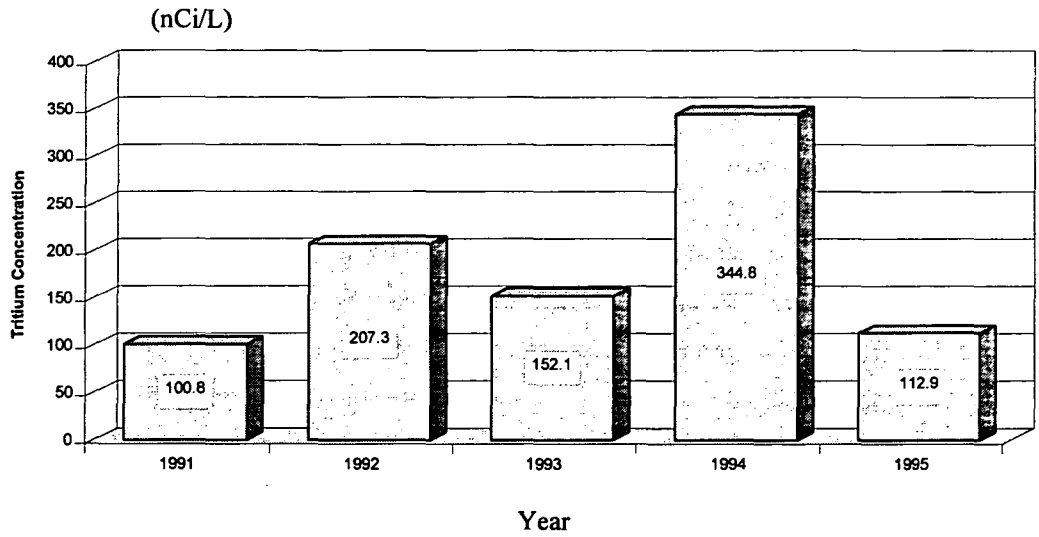
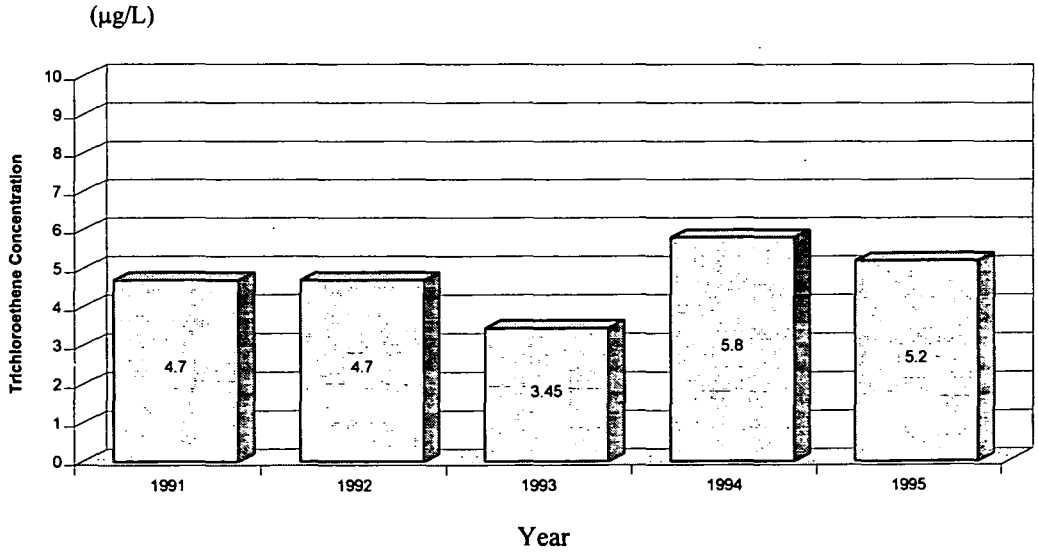


Figure 6-11. Annual Average Indicator VOC Concentration for Seep 0601, 1991 - 1995



7.0 QUALITY ASSURANCE PROGRAMS FOR ENVIRONMENTAL DATA

Mound participates in quality assurance (QA) exercises sponsored by the DOE and the EPA. Such exercises provide objective evaluations of the validity of the environmental data generated by Mound. In this Chapter, QA programs involving radiological and nonradiological analyses of a variety of environmental media are described. In addition to these external QA programs, Mound performs internal QA studies that make use of reagent blanks, internal standards, and duplicate samples.

QA Program

Twice each year, DOE's Environmental Measurements Laboratory (EML) conducts environmental sampling exercises for DOE sites. Each participating lab is given a number of samples to analyze for radiological constituents. The radionuclides are present as contaminants on air filters, or in soil, vegetation, or water. A laboratory's performance is evaluated by comparing their results with EML's reference values.

The concentrations reported by Mound for the March and September 1995 studies are shown in Table 7-1. The reference values established by EML are also shown in the table. A useful method of evaluating Mound's performance is to examine the ratio of Mound's result to the EML reference concentration for each environmental medium. This information is shown in Figure 7-1.

In 1995, EG&G Mound performed analyses on four environmental media. As evidenced by Table 7-1 and Figure 7-1, Mound's results compared favorably with DOE (EML) results with an overall average ratio of 0.98.

Additionally, the USEPA Analytical Sciences Branch (CRD-LV), formerly known as the Nuclear Radiation Assessment Division (EMSL-LV) sent samples containing known radioactive constituents in water for analysis as part of their Performance Evaluation Studies Program. Mound's performance is evaluated by comparing Mound's results with CRD-LV reference values.

The concentrations reported by Mound are shown in Table 7-2. The reference value established by CRD-LV are also shown in the table along with the ratio of Mound's results to the CRD-LV reference value. Figure 7-2 shows a plot of the ratio of Mound's results to the CRD-LV reference value. Mound's results compared favorably with CRD-LV results with an overall average ratio of 0.96.

Table 7-1. Mound DOE Quality Assessment Program Results for 1995: Radionuclides in Environmental Samples

Sample Type	Radionuclide	Mound Result[a]	EML Reference Concentration	Ratio Mound/EML
Air filters, pCi/filter				
March	Pu-238	3.38	3.30	1.02
	Pu-239	1.81	1.68	1.08
	U-234	1.84	1.59	1.15
	U-238	1.11	0.81	1.37
September	Pu-238	2.43	2.59	0.94
	Pu-239	2.43	2.51	0.97
	Total U	2.92	2.89	1.01
Vegetation, pCi/kg				
March	Pu-238	2.19	2.41	0.91
	Pu-239	29.19	30.27	0.96
September	Pu-239	24.06	26.49	0.91
Soil, pCi/kg				
March	Pu-238	937.94	864.96	1.08
	Pu-239	188.13	182.72	1.03
	U-234	694.67	819.01	0.85
	U-238	681.16	854.15	0.80
		654.13	854.15	0.77
September	Pu-238	446.0	473.03	0.94
	Pu-239	136.23	139.75	0.97
	Total U	1473.14	1573.15	0.94
Water, pCi/L				
March	H-3	1210.94	1629.91	0.74
	Pu-239	19.27	15.97	1.21
	U-234	9.46	10.08	0.94
September	Pu-238	35.95	38.11	0.94
	Pu-239	7.03	7.35	0.96
	Total U	18.11	16.87	1.07

Figure 7-1. Mound's Performance in the DOE Quality Assessment Program in 1995

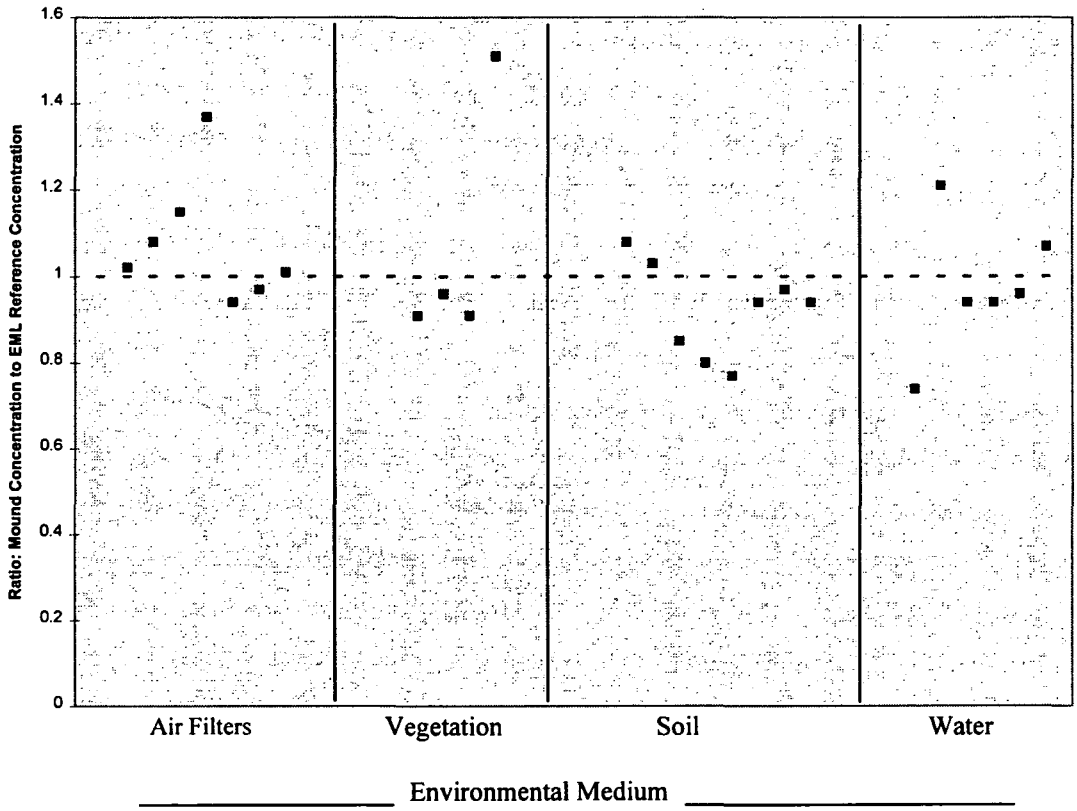
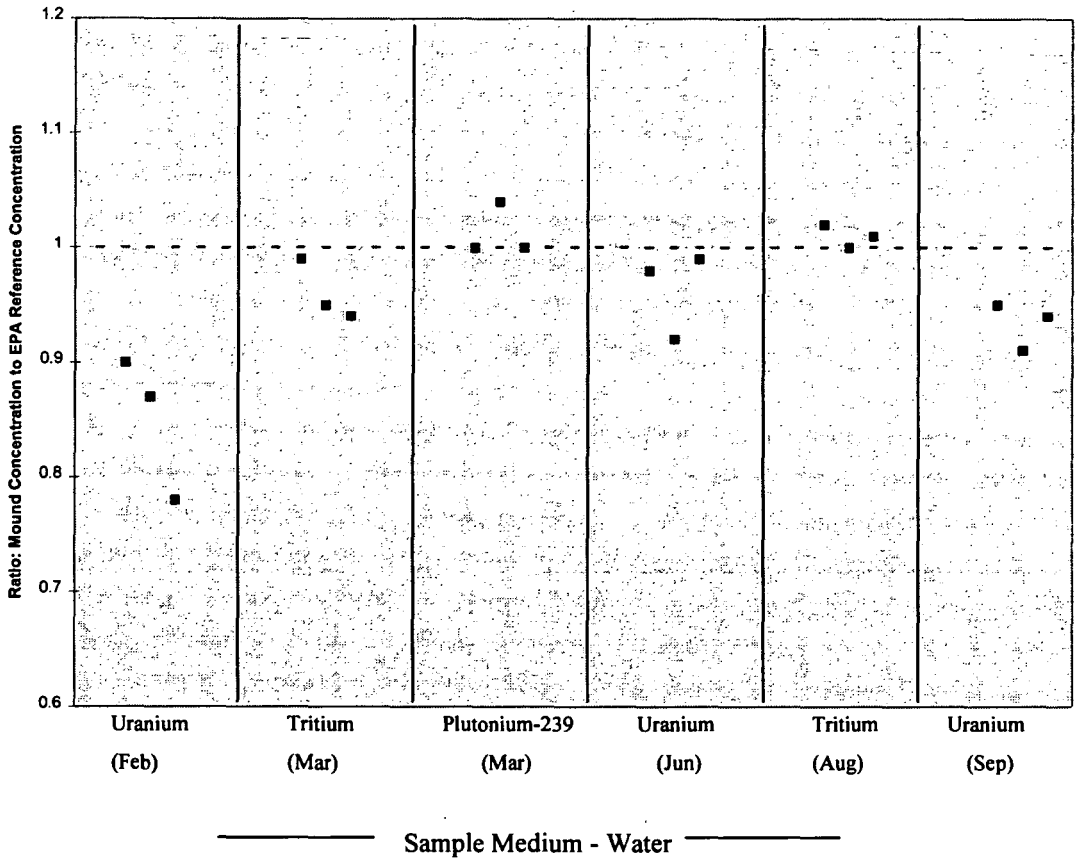


Table 7-2. Mound U.S. EPA Quality Assessment Program Results for 1995: Radionuclides in Water Samples

Sample Type	Radionuclide	Mound Results[a]	CRD-LV[b] Reference Concentration	Ratio Mound/EPA
Water, pCi/L				
February	Uranium (natural)	23.0	25.5	0.90
		23.3		0.87
		20.0		0.78
March	Tritium	7,380	7,435	0.99
		7,100		0.95
		6,960		0.94
March	Plutonium-239	11.1	11.1	1.0
		11.5		1.04
		11.1		1.0
June	Uranium (natural)	14.9	15.2	0.98
		14.0		0.92
		15.0		0.99
August	Tritium	4,985	4,872	1.02
		4,878		1.0
		4,918		1.01
September	Uranium (natural)	29.1	30.5	0.95
		27.7		0.91
		28.8		0.94

[a] The Mound error is the two-sigma error based on counting statistics or replicate analysis.
[b] Characterization Research Division - Las Vegas

Figure 7-2. Mound's Performance in the U.S.EPA Quality Assessment Program in 1995



NPDES QA Program

National Pollutant Discharge Elimination System (NPDES) permits are used by the EPA to regulate discharges of liquid effluents. The permits limit the concentrations of certain wastewater constituents to protect the receiving body of water. To ensure that a facility does not exceed those limits, the NPDES permit imposes strict requirements for effluent characterization. The EPA requires that laboratories performing analyses for NPDES parameters participate in QA exercises. These exercises assure EPA that the laboratories are producing reliable and accurate data.

In 1995, as in previous years, Mound participated in the NPDES QA exercise. In this program, a contractor laboratory, ManTech Environmental Technology, Inc., prepares water samples for

analysis. Laboratories, including Mound, analyze these samples and then submit the results to the contractor. The contractor evaluates the data based on limits for acceptability.
Mound's performance for 1995 is shown in Table 7-3. Of the 15 parameters analyzed, Mound was rated "acceptable" on all 15 parameters.

Table 7-3 also shows an evaluation of the contract laboratory used to perform biomonitoring studies for EG&G Mound. The lab's performance for the 1995 QA exercise resulted in "acceptable" ratings for all 8 measurements.

Table 7-3. Mound's Performance in the NPDES Quality Assurance Program for 1995

Parameters	Mound Value	EPA Value	Acceptance Limits	Warning Limits	Mound Performance Evaluation
Trace Metals, µg/L					
Cadmium	225	210	181 - 240	188 - 232	Acceptable
Chromium	343	361	312 - 409	324 - 396	Acceptable
Copper	885	890	792 - 980	816 - 957	Acceptable
Lead	503	500	438 - 561	453 - 545	Acceptable
Mercury[a]	1.62	1.76	1.26 - 2.30	1.39 - 2.17	Acceptable
Nickel	790	780	701 - 860	721 - 840	Acceptable
Zinc	980	967	848 - 1080	877 - 1050	Acceptable
Miscellaneous Analytes, mg/L					
Total Suspended Solids	20.3	23	15.2 - 24.1	16.3 - 23.0	Acceptable
Oil & Grease	14.5	16.4	9.27 - 20.8	10.7 - 19.3	Acceptable
Total Cyanide	0.860	0.740	0.547 - 0.911	0.593 - 0.865	Acceptable
Total Residual Chlorine	0.190	0.160	0.074 - 0.257	0.098 - 0.233	Acceptable
Ammonia as Nitrogen	3.90	3.90	3.07 - 4.70	3.26 - 4.50	Acceptable
Demands, mg/L					
CBOD[b]	10.39	8.87	3.72 - 14.0	5.13 - 12.60	Acceptable
COD[c]	14.0	15.9	6.15 - 23.6	8.35 - 21.4	Acceptable
pH (standard units)	9.10	9.0	8.61 - 9.35	8.70 - 9.26	Acceptable

[a] Mercury analysis performed for EG&G Mound by a contract laboratory.
[b] CBOD = Carbonaceous biochemical oxygen demand.
[c] COD = Chemical oxygen demand.

Table 7-3 (continued)

Parameters	Contract Lab Value[a]	EPA Value	Acceptance Limits	Warning Limits	Contract Lab Performance Evaluation
Biomonitoring Results, % of sample affected					
Pimephales promelas (Fathead minnows)					
Acute Toxicity in MHSF[b]:					
LC_{50}[c]	63.7	46.2	22.4 - 70.0	N/A	Acceptable
Chronic Toxicity:					
Survival in MHSF					
NOEC[d]	25	25	12.5 - 50	N/A	Acceptable
Growth effects in MHSF					
IC[e]	46.2	39.9	9.91 - 69.8	N/A	Acceptable
NOEC[d]	25	25	12.5 - 50	N/A	Acceptable
Ceriodaphnia dubia (Water fleas)					
Acute Toxicity in DMW[f]:					
LC_{50}[c]	55.5	41.9	18.8 - 65.1	N/A	Acceptable
Chronic Toxicity:					
Survival in DMW					
NOEC[d]	25.0	25.0	12.5 - 50.0	N/A	Acceptable
Growth effects in DMW					
IC[e]	30.1	27.2	3.87 - 50.5	N/A	Acceptable
NOEC	25.0	25.0	12.5 - 50.0	N/A	Acceptable

[a] Biomonitoring studies are performed for EG&G Mound by a contract laboratory.
[b] MHSF = moderately hard synthetic freshwater.
[c] LC_{50} = lethal concentration to 50 % of the population.
[d] NOEC = no observable effect concentration.
[e] IC = inhibition concentration.
[f] DMW = diluted mineral water.
N/A = Not Applicable.

APG QA Program As a companion to the EPA program described above, Mound participates in another QA exercise for NPDES parameters. In this study, water samples prepared by Analytical Products Group, Inc. (APG) are analyzed in a round-robin fashion by participating laboratories. The studies are conducted two times per year. For each parameter of interest, APG determines the average value reported by all participants. The figure-of-merit used to evaluate a laboratory is the standard deviation of a result from the average for that parameter. In this fashion, a laboratories performance is rated relative to the performance of all other laboratories.

Limits of acceptability are associated with the APG studies. There are "warning" and "not acceptable limits" for performance. Those limits have been set at 1.96 and 2.58 standard deviations from the average, respectively.

Mound participated in both APG studies for 1995. The results are shown in Figures 7-3a and 7-3b for trace metals and miscellaneous parameters, respectively. Figure 7-3a demonstrates Mound's performance for trace metal analysis in 1995. Mound's performance for the trace metal analysis , Figure 7-3a, was excellent, with no unacceptable values. Mound's performance for the miscellaneous analytes, Figure 7-3b, also generated zero unacceptable results.

Mound Internal QA Program

In addition to the external programs described above, Mound performs a number of internal QA operations. Blank samples are analyzed to verify the absence of excessive instrument contamination or background. The standard deviation of the blank is then used to calculate the lower limit of detection. A quality-based approach to these data is imperative because many of the environmental samples analyzed at Mound have contaminant concentrations at or below the lower detection limit.

Mound also routinely uses duplicate sample analysis and internal standard techniques to evaluate analytical precision. Deviation from an expected value results in a comprehensive review of the analytical protocol.

Figure 7-3a. Mound's Performance in the APG Proficiency Environmental Testing Program for 1995: Trace Metal Analysis

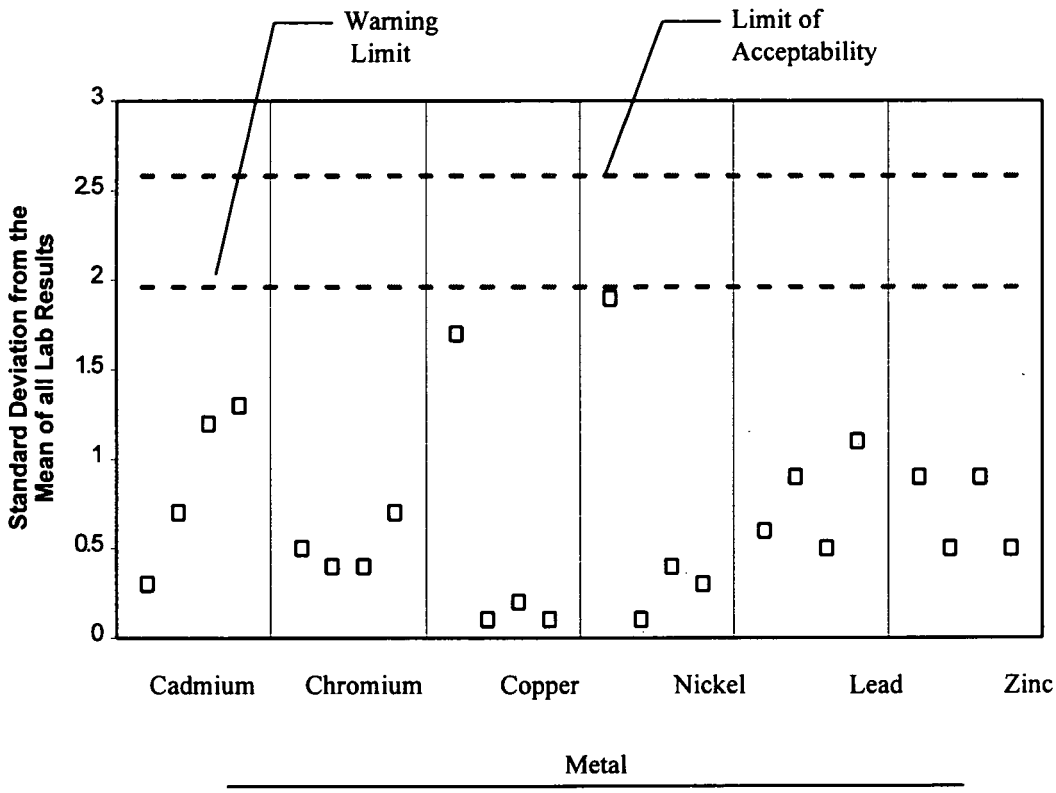
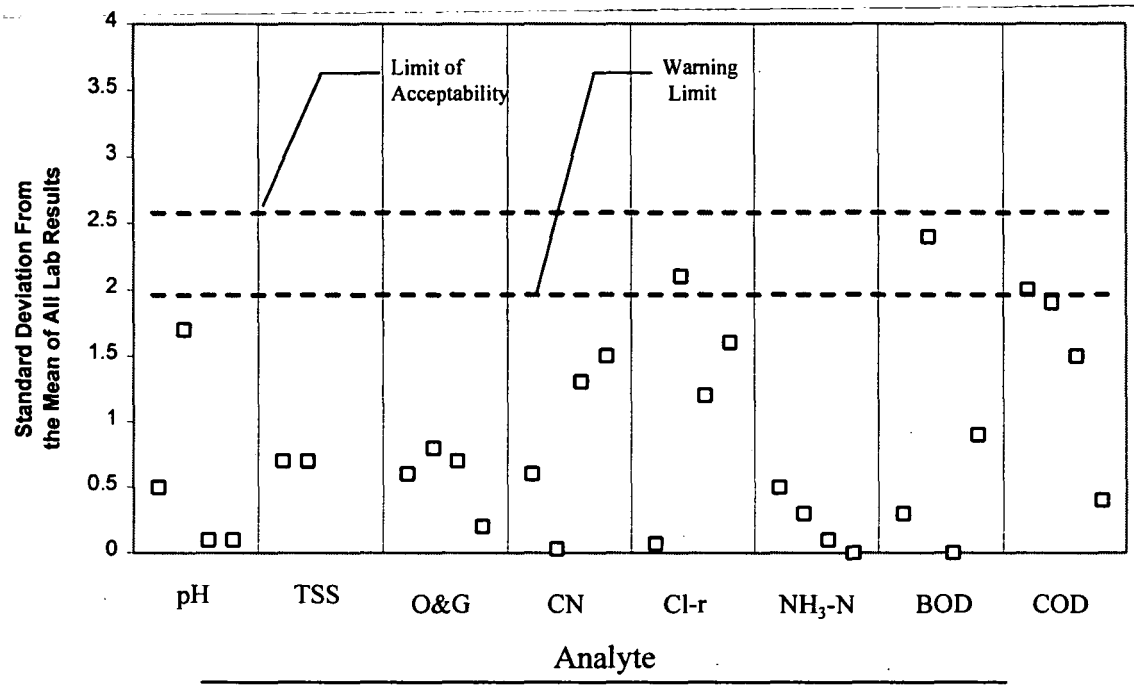


Figure 7-3b. Mound's Performance in the APG Proficiency Environmental Testing Program for 1995: Miscellaneous Parameters



LEGEND	
TSS = Total Suspended Solids	NH_3-N = Ammonia as Nitrogen
O&G = Oil and Grease	BOD = Biochemical Oxygen Demand
CN = Cyanide	COD = Chemical Oxygen Demand
Cl-r = Residual Chlorine	

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40 CFR 141-143. *National Primary Drinking Water Regulations Implementation and National Secondary Drinking Water Regulations.*

OAC 3745-17-10. *Restrictions on Particulate Emissions from Fuel Burning Equipment.*

OAC 3745-77. *Title V Permits.*

OAC 3745-18-63. *Montgomery County Emission Limits.*

OAC 3745-95. *Backflow Prevention and Cross-Connection Control.*

APPENDIX 1

A.1 Exposure Routes

Members of the public receive radiation doses via various exposure pathways. For radionuclides discharged to the atmosphere, a person may inhale or be immersed in airborne radionuclides. Other routes of airborne exposure include ground deposition of radionuclides and consumption of food products that were contaminated by airborne releases. For radionuclides released to water, a person may consume contaminated water or fish. The other potential water-based exposure pathways (e.g., swimming and boating) generally do not add significantly to the dose.

A.2 Dose Calculations Based on Measured Data

For DOE reporting requirements, doses are presented as 50-year committed effective dose equivalents (CEDEs). The CEDE is the total dose equivalent that will be received by an individual over a 50-year time period as a result of one year of exposure to ionizing radiation. The total CEDE reported is the sum of the CEDEs from the air, water, and food-related pathways.

Each year, Mound personnel calculate CEDEs for tritium, plutonium-238, plutonium-239. (Other radionuclides released by Mound were present in concentrations that were too small to affect overall dose.) The CEDEs for tritium and plutonium are evaluated using environmental monitoring data measured on and near the plant site. A CEDE for a given radionuclide is calculated as shown below. Specific input values for 1995 are shown in Table A-1.

$$CEDE = \sum_{1}^{p} C_r \bullet I_a \bullet DCF$$

where CEDE = total committed effective dose equivalent, mrem.

$\sum_{1}^{p}$ = summation over the exposure pathways 1 through p.

C_r = maximum average concentration of the radionuclide.

I_a = annual intake of the environmental medium.

DCF = dose conversion factor for the radionuclide and intake type.

The CEDE for all radionuclides are then summed to provide a single value for reporting purposes.

Table A-1. Factors Used to Calculate 1995 CEDEs

Radionuclide	Maximum Average Concentration	Location	Dose Conversion Factor, mrem/μCi
Tritium			
Air	4.27×10^{-12} μCi/mL	124	6.3×10^{-2} (b)
Drinking water	0.2×10^{-6} μCi/mL	Miamisburg	6.3×10^{-2}
Produce	ND	Miamisburg	ND
Plutonium-238			
Air	326.87×10^{-18} μCi/mL	213R	3.8×10^{5} (a)
Drinking water	ND	Miamisburg	ND
Produce	0.06×10^{-9} μCi/g	Miamisburg	1.9×10^{3} (a)
Fish	0.08×10^{-9} μCi/mL	Great Miami River	1.9×10^{3} (a)
Plutonium-239			
Air	1.58×10^{-18} μCi/mL	213T	4.2×10^{5}
Drinking water	ND	Miamisburg	ND
Produce	0.03×10^{-9} μCi/g	Miamisburg	2.2×10^{3}
Fish	ND	Great Miami River	ND

ND = not detected (either below the environmental level or reagent blank).

Annual Intake Values

Air	8400 m^3	Produce	260 kg
Well water	730 L	Fish	21 kg

(a) Plutonium releases from Mound are believed to be insoluble (Class Y). However, to provide a reasonable degree of conservatism in the dose estimates, the Pu-238 and Pu-239 dose factors are averages of Class W and Class Y values.
(b) The dose factor is multiplied by a factor of 1.5 to include absorption of tritium through the skin.

A-3. Dose Calculations for NESHAPs Compliance

To demonstrate compliance with the requirements of the National Emission Standards for Hazardous Air Pollutants (NESHAPs, 40 CFR 61, Subpart H), Mound performs additional dose calculations each year for all airborne releases. As preferred by the EPA in 40 CFR 61, Subpart H, Mound uses the computer code The Clean Air Act Assessment Package (CAP-88) to calculate those doses.

The CAP-88 computer model is a set of computer programs, databases, and associated utility programs for estimation of dose and risk from radionuclide emissions to air. CAP-88 was developed by the U.S. EPA to demonstrate compliance with the National Emission Standards for Hazardous Air Pollutants for radionuclides other than radon at DOE facilities under 40 CFR Part 61, Subpart H. The assessment package is managed by the Office of Radiation Programs, U.S. EPA, Las Vegas, NV.

Whenever available, Mound uses site-specific data as input to the code. Meteorological data measured onsite are used to evaluate transport and dispersion. Stack specific release rates are used in an aggregated form below (Table A-2). This approach makes it possible to combine stacks with similar physical attributes. Table A-2 lists the relevant stack information used for the 1995 CAP-88 runs.

Table A-2. 1995 CAP-88 Input Data

Stack IDs	Assumed Stack Height (meters)	Assumed Stack Diameter (meters)	Exit Velocity (meters/sec)	Radionuclide(s)	1995 Release Rate (Ci/yr)
HH	34	1.7	1.6	H-3	3.2×10^{1}
NCDPF/SW1C	44	0.8	16.8	H-3	3.19×10^{1}
				Pu-238	5.1×10^{-9}
				Pu-239	6.62×10^{-10}
				U-234	4.03×10^{-10}
				U-238	1.97×10^{-10}
HEFS	46	1.9	13.5	H-3	6.81×10^{2}
				Pu-238	3.8×10^{-8}
				Pu-239	9.37×10^{-10}
				U-234	2.43×10^{-9}
				U-238	1.29×10^{-9}
SMPP/ T West/ T East	60	2.0	10.3	H-3	2.43×10^{1}
				Pu-238	8.35×10^{-6}
				Pu-239	2.28×10^{-8}
				U-234	1.98×10^{-10}
				U-238	2.37×10^{-10}
WDALR/ WDAHR/ WDSS	12	0.6	7.0	H-3	2.3×10^{-2}
				Pu-238	3.29×10^{-7}
				Pu-239	2.39×10^{-9}

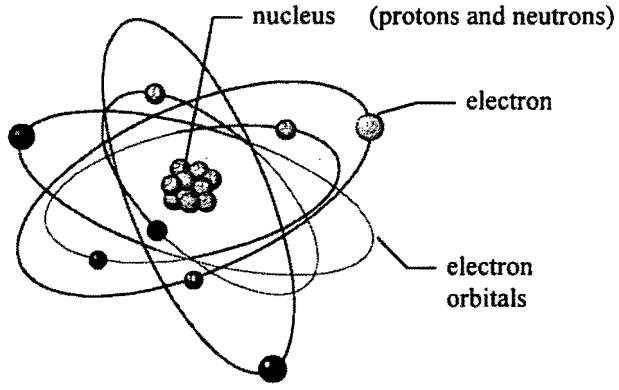
APPENDIX 2

The Atom

All substances are composed of atoms. Atoms are exceedingly small with an average diameter of only about 0.000,000,001 inch. To put this in perspective, approximately 100,000 atoms lying side by side in a straight line touching one another would span the thickness of a sheet of thin paper. Atoms are composed of three basic parts (particles):

- electrons,
- protons , and
- neutrons

Atom Model



Protons and neutrons compose the part of an atom called the nucleus. The protons have a positive electrical charge while the neutrons have no electrical charge. Protons and neutrons are nearly identical in mass and are considerably more massive than electrons (approximately 1,800 times as massive). Therefore the nucleus contains nearly all of the mass of the atom. The electrons, which carry a negative electrical charge, orbit the nucleus. The number of protons (positive charges) in the nucleus is equivalent to the number of electrons (negative charges) in the orbits, thus creating an atom that is electrically neutral (no net charge).

The atomic number is an identifying characteristic of an element and equals the number of protons in the atomic nucleus of an atom. Each element has an associated atomic number that serves as an identifier. For example, hydrogen has an atomic number of one corresponding to one proton in the nucleus (the hydrogen atom also has an electron that orbits the nucleus thus keeping the atom electrically neutral). Plutonium, a much more massive atom, has an atomic number of 94 corresponding to 94 protons in the nucleus and 94 electrons orbiting the nucleus to maintain electrical neutrality.

The sum of the protons and neutrons in an atom's nucleus is called the mass number. Although the number of protons in the nucleus will always be the same for any given element, the number of neutrons in the nucleus can vary. For example, most hydrogen atoms have a nucleus composed of a single proton with no neutrons giving it a mass number of 1. Hydrogen atoms with mass number two are known as deuterium and have both a proton and a neutron in the nucleus. Tritium, a form of hydrogen important to the Mound site, has a nucleus composed of one proton and two neutrons. As can be seen from this example, all three forms of hydrogen have exactly one proton in the nucleus, but have differing numbers of neutrons. Chemically, these

three forms of hydrogen all behave in a similar manner. These forms of hydrogen all having the same atomic number but different mass numbers are known as isotopes.

The radionuclides that are of concern at Mound are:

- plutonium - 238 (94 protons + 144 neutrons = mass number 238)
- plutonium - 239 (94 protons + 145 neutrons = mass number 239)
- plutonium - 240 (94 protons + 146 neutrons = mass number 240)

- uranium - 233 (92 protons + 141 neutrons = mass number 233)
- uranium - 234 (92 protons + 142 neutrons = mass number 234)
- uranium - 235 (92 protons + 143 neutrons = mass number 235)
- uranium - 238 (92 protons + 146 neutrons = mass number 238)

- thorium - 228 (90 protons + 138 neutrons = mass number 228)
- thorium - 232 (90 protons + 142 neutrons = mass number 232)

- hydrogen - 3 (tritium) (one proton + two neutrons = mass number 3)

Radioactivity and Radiation

The atomic nucleus is held together by exceedingly strong forces of attraction which act indiscriminately between its protons and neutrons, protons and protons, neutrons and neutrons. Certain isotopes, because of their own physical makeup, are unstable. This instability is due to an unbalanced ratio between the number of protons and the number of neutrons. This instability in the nucleus causes the atom to change spontaneously to a more stable, less energetic state. This spontaneous change is called radioactivity and the atom is said to decay or disintegrate. Radiation is the energy associated with the radioactivity. Radiation is generally one of the following three types:

- alpha
- beta
- gamma

When a radioactive atom decays, its nucleus changes and the resultant atom may no longer be the same kind of atom; it can transform into an element of different atomic number. As noted above, the radioactive decay is brought about by instability in the nucleus and therefore, by the process of radioactive decay, the atom strives to achieve a more stable configuration. The ultimate stable configuration is generally not reached in decay transformation. In fact, the new element, called a "daughter" resulting from the radioactive decay may be more unstable than the "parent." Ultimately the original radionuclide will be transformed into a stable element through a series of transformations. The decay sequence from radioactive parent to radioactive daughter is called a radioactive decay chain. The time required for one-half of all the atoms of a radionuclide to

decay is called its "half-life." The half-life is an average value for any very large number of atoms. It does not accurately apply to a small number of atoms.

Each atom essentially takes its own time to decay and there is no predicting when its instability will cause it to do so. Radionuclides with short half-lifes such as Iodine 131 (used in medical radiotherapy) decay away rapidly and may not pose as much of an environmental concern as a long lived (long half-life) radionuclide like plutonium-239 which may remain in the environment for many thousands of years before decaying away.

As noted above there are three primary types of radiation:

- alpha
- beta
- gamma

Alpha particles result when the unstable nucleus of a radionuclide ejects a particle consisting of two protons and two neutrons. The resulting particle has a net positive charge and will therefore react with any atoms that are nearby (i.e. with the negative electronic charges of the orbital electrons or the positive electronic charge of the protons in the nucleus). These interactions cause the alpha particle to give up some of the original energy it contained when ejected from the nucleus. In fact there are enough atoms within the thickness of an ordinary sheet of paper to react with and bring to rest most alpha particles. The alpha particle will therefore not penetrate solid material to any significant depth. If, however, an alpha particle is released inside the human body (by means such as inhaling radioactive particles) the emitted alpha particle will be brought to rest rapidly within a small volume of human tissue. Thus all of the energy of the alpha particle is released within a small volume of tissue and cellular damage can occur. Isotopes of plutonium and uranium are examples of radionuclides used by Mound that decay by emitting alpha particles.

Beta particles result when the unstable nucleus of a radionuclide ejects a particle consisting of a negatively charged electron. As with alpha particles, the charged beta particle interacts with any atoms that are nearby thus losing some of its initial energy. However because beta particles have only half the charge of an alpha particle and are ejected from the nucleus with a much greater velocity, most can penetrate solids more readily than alpha particles. When compared to an alpha particle, beta particles give up their initial energy over a longer distance. This results in less localized damage to tissue that may interact with a beta particle. Tritium is an example of a radionuclide used by Mound that decays by emitting a beta particle.

Gamma rays, unlike alpha and beta particles, are not discrete physical particles. Instead a gamma ray is a package of energy that behaves as though it were a particle. Gamma rays are exactly the same in nature as visible light, heat waves, radio waves, radar rays and x-rays. They have very short wavelengths like those of most x-rays and are in fact indistinguishable from such x-rays. The penetrating power of x-rays is well known and since gamma radiation is very much like the radiation of x-rays the penetrating power of gamma radiation is also very high. Gamma rays can pass through the human body giving up small amounts of energy along the way. Many

radionuclides emit both alpha and gamma or beta and gamma radiation upon decay. Isotopes of plutonium are examples of radionuclides used by Mound that decay by emitting both alpha and gamma radiation.

Units of Measurement

Radiation intensity is typically measured in terms of "activity." Activity corresponds to the number of atomic nuclei of any particular radionuclide that decay over a specified time interval. A "curie" (Ci) is a unit typically used to define activity. One curie is equal to the amount of radioactive material that decays at a rate of 37 billion atoms per second. This disintegration rate is almost exactly the rate at which one gram of radium-226 decays. As noted earlier, each radioactive isotope follows its own specific decay schedule in accordance with its half-life. As a result, for a given quantity of material (e.g. one gram), different radionuclides will vary in the quantity of nuclei that will disintegrate over a given time period. Therefore equal masses of different radionuclides have varying activity levels that are dependent on each radionuclide's half-life. As an example, one gram of radium-226 (radium-226 has a half-life of 1,622 years) is equivalent to one curie of activity. It would take about 1.5 million grams of uranium-238 (half-life 4.5 billion years) to have an activity of one curie. In other words it would take 1.5 million grams of uranium-238 to yield 37 billion disintegrations per second. As can be seen from the example, radionuclides that decay rapidly (short half-lives) have relatively high activity levels compared to radionuclides that have very long half-lives.

It should be noted that a curie is only related to the number of disintegrations that occur in a given time frame and does not indicate the biological damage that the radionuclide could cause if it comes into contact with a person. That is to say that one curie of tritium is not equivalent to one curie of plutonium-238 in terms of the biological effect on living tissue. The activity levels of radionuclides in the environment due to Mound operations are typically very small fractions of a curie. A convenient way to express these very small curie fractions is introducing two additional units; the microcurie (μCi) one millionth of a curie, and the picocurie (pCi) one trillionth of a curie. These units occur throughout the Mound Annual Site Environmental Report.

Radiation Dose

Radiation exposure to humans is described in terms of a "dose." Dose is a measure of the amount of radiation delivered to the body. As noted in the previous section, for a given activity level, different radionuclides will vary in their ability to cause biological damage (e.g., at a given activity level, alpha radiation is more damaging than beta). A "dose equivalent" is a means of comparing the dose resulting from exposure to various radionuclides. The Roentgen Equivalent Man (rem) is the unit used to express the dose equivalent. A rem is defined as the dose, measured in terms of a specific amount of energy, which produces the biological equivalent to that produced by the same amount of x-ray energy. The rem allows for a direct comparison of the potential damage that may be caused by exposure to various radionuclides. The higher the rem value, the greater the potential for biological damage.

Dose can be viewed in several different ways and is typically reported with respect to either a specific organ, an effective dose, a committed effective dose, or a whole body dose. Each dose measure will be discussed below.

The ***organ dose*** is the estimated dose received by a specific organ due to exposure to radiation. Certain radionuclides may tend to accumulate within specific organs of the body. Critical organs can be identified based on the chemistry of the radionuclide, the amount of radiation, the sensitivity of the organ to radiation, and the importance of the organ to the body.

The ***effective dose*** estimates the health risk that a radiation dose poses to an individual. The effective dose is calculated by summing the weighted organ dose for each organ. The weighted organ dose is simply the original calculated organ dose multiplied by an importance factor that takes into account the relative risk to the exposed organ.

Some radionuclides assimilated into the body can remain in the body for long periods of time. When particulate material, (e.g. dust) contaminated with plutonium is breathed, the plutonium is deposited in the lung tissue. The plutonium will remain in the body indefinitely (the original quantity will be reduced over time due to radioactive decay and biological factors). The plutonium is continually emitting alpha and gamma radiation while in the lungs. The individual is therefore exposed to this radiation for the remainder of their life.

The ***committed effective dose equivalent*** indicates the total dose over the individual's projected remaining lifetime (assumed to be 50 years) that results from an intake during one year. The committed effective dose equivalent (CEDE) expresses the dose of internal radiation received when an individual has ingested or inhaled a radionuclide that will remain inside the body for months or years. It is also expressed in rem, mrem (1000 mrem = 1 rem), or Sieverts.

Dose Due to Exposure to Background Radiation Sources

Every day our bodies absorb ionizing radiation. Most of it comes from natural sources. Consumer products and medical procedures that use radiation are other common sources of ionizing radiation.

Natural Sources. Natural radiation comes from two sources: cosmic and terrestrial. Cosmic radiation results when energetic particles from outer space, traveling at nearly the speed of light, collide with nuclei in our atmosphere, creating showers of radioactive particles that fall to earth. The average annual dose equivalent received from cosmic radiation is 26 mrem for an individual living at sea level. Because cosmic radiation dissipates as it travels through the atmosphere, individuals living at lower altitudes receive less dose from this source than those living at higher altitudes.

Terrestrial radiation results when radionuclides that are a natural part of the earth's rocks and soils emit ionizing radiation. Because the concentrations of these radionuclides vary geographically, an individual's exposure depends on his location. The average annual dose equivalent from terrestrial radiation for an individual living in the U. S. is 28 mrem.

Besides absorbing radiation from external radionuclides, we can also absorb radiation internally when we ingest radionuclides along with the food, milk, and water we ingest or along with the air we inhale. Once in our bodies, radionuclides follow the same metabolic paths as nonradioactive forms of the same elements. The length of time a particular radionuclide remains and emits radiation depends on whether the body eliminates it quickly or stores it for a long period, and on how long it takes for the radionuclide to decay into a nonradioactive form. The principal source of internal exposure in the U. S. is believed to be radon. Inhalation of radon contributes about 200 mrem to the average annual dose equivalent from internal radiation. Other radionuclides present in the body contribute approximately 39 mrem.

Consumer Products. Many familiar consumer products emit ionizing radiation. Some must emit radiation to perform their functions, e. g., smoke detectors and airport x-ray baggage inspection systems. Other products, e.g., TV sets, emit radiation only incidentally to performing their functions. The average annual effective dose equivalent to an individual from consumer products ranges from 6 to 12 mrem.

Medical Uses. Radiation is a tool for diagnosing and treating disease. The average annual dose equivalent for an individual in the U. S. from diagnostic radiation is 53 mrem. Individuals undergoing radiation therapeutic procedures may receive much higher doses.

On average the annual radiation dose due to background radiation to a person living in the United States is about 300 millirem. The total contribution to this dose due to operations at the Mound Plant is 1.1 mrem, or a very small fraction of the dose received from background.

Effects of Radiation

The harmful effects of radiation are considered to be due to ionization of atoms in the molecules of the chemical constituents of a cell. The three principal types of radiation, (alpha, beta and gamma) all have the ability to ionize atoms by disrupting their orbital electrons. An atom which has been ionized has been stripped of one or more of its outer shell electrons causing the atom to lose its electrical neutrality (i.e. the atom ends up with more positive charge than negative charge). As a result of this atomic ionization some of the molecules of the cell constituents are broken up and cannot function properly. If only a few atoms in the cell are ionized the cell can repair the damage relatively easily but if a large number of ionizations occur the cell may be unable to repair the damage and will die. Therefore if the radiation is weak there will be relatively few cellular atomic ionizations, and the resulting effects may be insignificant. However, if the radiation is intense with a correspondingly high number of cellular atomic ionizations, the damage to the cells may be great and beyond the ability of repair.

The effects of radiation on humans can be divided into two categories, somatic and genetic. Somatic effects develop in the individual that is directly exposed to the ionizing radiation. Genetic effects on the other hand are passed on to the offspring of the directly exposed individual.

Somatic Effects. Somatic effects are known to occur at high radiation levels. For example, survivors of the Hiroshima and Nagasaki atomic bombings developed clouding in the lens of the eye. High radiation doses are also known to cause low fertility rate and reduced numbers of white cells in the blood. Prolonged exposure to low levels of radiation can produce gradual somatic effects over time. It is essentially impossible to determine if a resulting illness is due to prolonged exposure to low-level radiation or some other factor that could bring about the illness. The most likely somatic effect of low-level radiation is thought to be a small increase in the risk of developing cancer.

Genetic Effects. The human cell contains 46 chromosomes which in turn contain the genes that pass on genetic information from generation to generation. Radiation can cause the chromosomes of a human cell to become structurally altered. The genes of the chromosome are altered and the gene is said to be "mutated". These mutated genes are passed on to the next generation where they will likely have no effect on the offspring. If these genes meet a similar gene during reproduction then they would become a characteristic of the offspring.

Radiation Environment at Mound

Mound's dose contribution for 1995 was well within all applicable guidelines, limits, and regulatory standards. These guidelines, limits and standards are levels which present very low risk to individuals around Mound. Mound, like all DOE sites, strives to keep worker and public doses as low as reasonably achievable.

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