DOE/OR/20722-100
REV. 1

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-81OR20722

ST. LOUIS AIRPORT SITE ANNUAL SITE ENVIRONMENTAL REPORT

St. Louis, Missouri

Calendar Year 1985

April 1986
Revised September 1986

Bechtel National, Inc.
Advanced Technology

DOE/OR/20722-100
Rev. 1

ST. LOUIS AIRPORT SITE

ANNUAL SITE ENVIRONMENTAL REPORT

CALENDAR YEAR 1985

APRIL 1986

REVISED SEPTEMBER 1986

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

Bechtel National, Inc.

Advanced Technology

P. O. Box 350

Oak Ridge, Tennessee

Bechtel Job No. 14501

ABSTRACT

During 1985, the environmental monitoring program was continued at the St. Louis Airport Site (SLAPS) in St. Louis County, Missouri. The ditches north and south of the site have been designated for cleanup as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a United States Department of Energy (DOE) program to identify, decontaminate, or otherwise control sites where low-level radioactive contamination remains from the early years of the nation's atomic energy program. The site is not currently controlled or regulated by the U.S. Department of Energy (DOE) or the Nuclear Regulatory Commission (NRC), although radiological monitoring of the site has been authorized by the DOE. The environmental monitoring program is conducted by Bechtel National, Inc., Project Management Contractor for FUSRAP.

The monitoring program at the SLAPS measures radon gas concentrations in air; external gamma radiation dose rates; and uranium, thorium, and radium concentrations in surface water, groundwater, and sediment. Potential radiation doses to the public are also calculated. Because the site is not controlled or regulated by the DOE, the DOE Derived Concentration Guides (DCGs) are not applicable to SLAPS, but are included only as a basis for comparison. The DOE DCGs and the DOE radiation protection standard have been revised (Appendix B).

During 1985, annual average radon levels in air at the SLAPS were below the DCG for uncontrolled areas. External gamma monitoring in 1985 showed measured annual gamma dose rates ranging from 3 to 2087 mrem/yr, with the highest value occurring in an area known to be contaminated. The calculated maximum dose at the site boundary, assuming limited occupancy, would be 6 mrem/yr. Average annual concentrations of thorium-230, radium-226, and total uranium in surface waters remained below the DOE DCG. The on-site groundwater

measurements showed that average annual concentrations of thorium-230, radium-226, and total uranium were within the DOE DCGs. Although there are no DCGs for sediments, all concentrations of total uranium, thorium-230, and radium-226 were below the FUSRAP Guidelines.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This report presents the findings of the environmental monitoring conducted at the St. Louis Airport Site (SLAPS) during calendar year 1985. Drainage ditches at the SLAPS have been designated for remedial action under the Department of Energy (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP), one of four remedial action programs by the direction of the DOE Division of Facility and Site Decommissioning Projects (DFSDP). The SLAPS property has not yet been designated for consideration for remedial action under FUSRAP. However, routine radiological monitoring of the site has been authorized by the DOE to be conducted by Bechtel National, Inc. (BNI), Project Management Contractor for FUSRAP. As part of this monitoring, BNI began sampling Coldwater Creek in March 1983. The on-site well monitoring program, which BNI began performing in October 1983, is a continuation of the the program formerly conducted by Oak Ridge National Laboratory. In October 1984 BNI began measuring radon and external gamma radiation levels.

1.1 LOCATION AND DESCRIPTION

The SLAPS is a 191-ha (21.7-acre) site located in St. Louis County, Missouri, approximately 24 km (15 mi) from downtown St. Louis. SLAPS lies immediately north of the Lambert-St. Louis International Airport and is bounded by the Norfolk and Western Railroad and Banshee Road on the south, Coldwater Creek on the west, and McDonnell Boulevard on the north and east. Figure 1-1 shows the location of the SLAPS, and Figure 1-2 is a photograph of the site.

Currently, the preferred alternative for the disposition of low-level radioactive waste at the SLAPS is to consolidate and contain the wastes in a monitored, engineered containment facility for long-term management at the site (Ref. 1). The wastes include those buried at the SLAPS, material in the storage pile at the Hazelwood Interim Storage Site (HISS), material excavated during

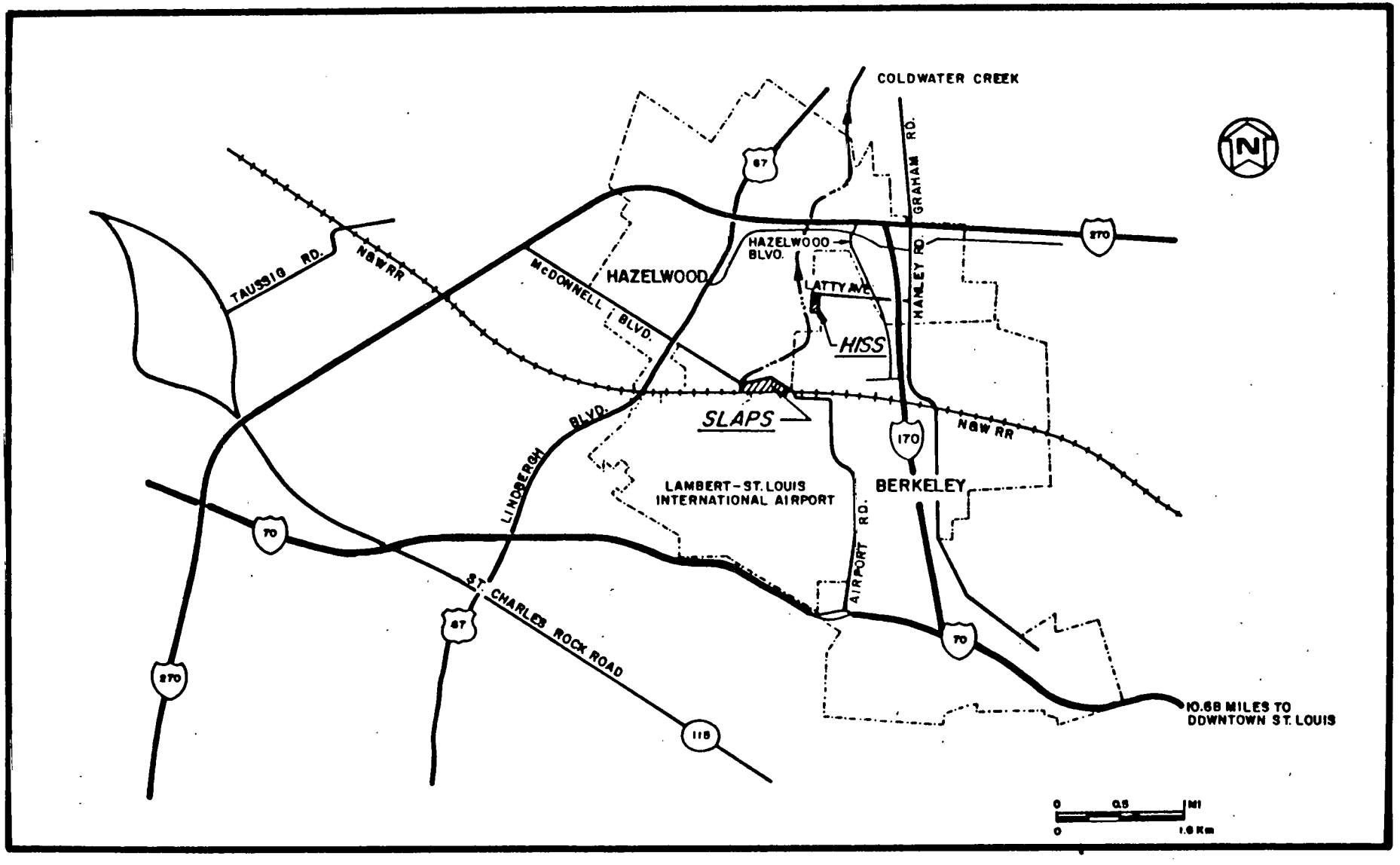


FIGURE 1-1 LOCATION OF THE SLAPS

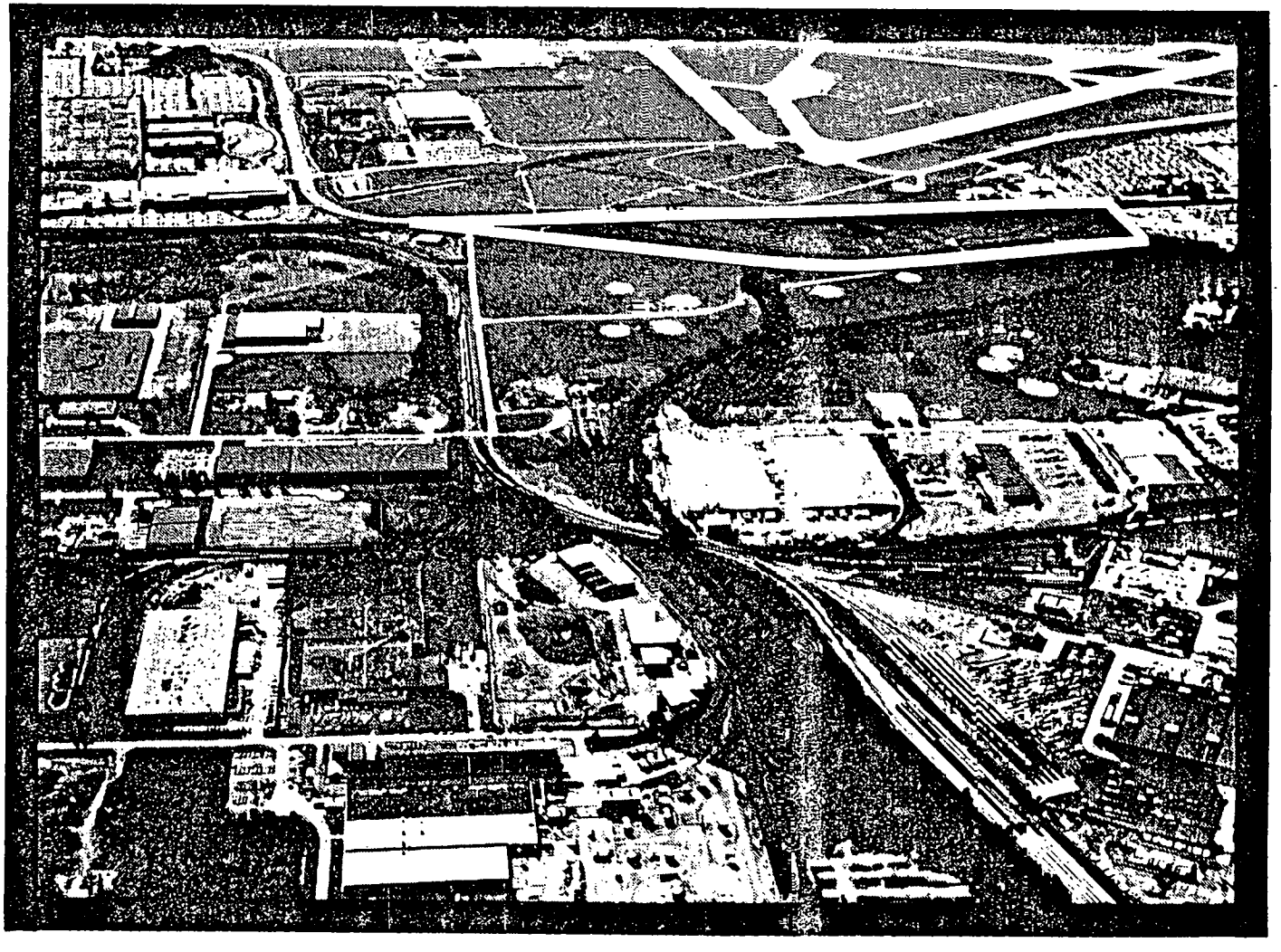


FIGURE 1-2 AERIAL VIEW OF SLAPS AND ITS VICINITY

cleanup of the HISS vicinity properties, and contaminated material to be removed from along McDonnell Boulevard immediately north and east of SLAPS.

Data required to evaluate the feasibility of long-term management of wastes at the SLAPS include hydrogeological, radiological, and chemical characterizations of the site; groundwater monitoring; and radiological characterization of vicinity properties (including ditches north of the site along McDonnell Boulevard and in Coldwater Creek).

Construction activities accomplished during 1985 were in response to erosion problems along Coldwater Creek (Ref. 2). These activities included: access road construction, vehicle decontamination facility construction, excavation of the west slope of the site abutting Coldwater Creek, storage pile construction, and gabion wall construction along the east side of Coldwater Creek.

The SLAPS is located in the upper half of the Coldwater Creek watershed. Coldwater Creek originates about 5.8 km (3.6 mi) south of SLAPS at a small spring-fed lake in Overland, Missouri, and discharges to the Missouri River approximately 6.4 km (4 mi) upstream of its confluence with the Mississippi River. Passing through the culverts under the Lambert-St. Louis International Airport, the flow in Coldwater Creek is influenced by stormwater runoff from the upstream areas of residential, commercial, industrial, and airport land (Ref. 3). Runoff leaves the SLAPS by evaporation, seepage into the groundwater system, or through surface drainage to Coldwater Creek. Surface drainage from the site is intercepted by drainage channels along the northern and southern boundaries of the site and flows into Coldwater Creek. There are no facilities on Coldwater Creek that withdraw water for human consumption. The closest water treatment facility is on the Mississippi River, approximately 12.8 km (8 mi) downstream of the confluence of Coldwater Creek and the Missouri River (Ref. 4).

Groundwater at the SLAPS, in the paleozoic limestones, is of very poor quality (Ref. 4). It typically contains more than 1000 ppm of dissolved solids and is classified as saline. In addition, yields from wells in these rocks are very low with reported specific yields being less than 7.6 liters/min/m (2 gal/min/ft) of drawdown. Groundwater is not generally used for any purpose in the area around the airport site. The nearest well is about 2.4 km (1.5 mi) north of the site. There are no records of any producing wells within a 1.6-km (1-mi) radius of the site. The water needs of the area are met by treated Mississippi River water.

The climate of the SLAPS is classified as a modified continental climate. The average annual daily temperature ranges from 7.4 to 18.6°C (45.4 to 65.5°F). The highest average monthly temperature is 31.6°C (89°F) (July) and the lowest is -6.7°C (19.9°F) (January). Normal annual precipitation is slightly over 87.5 cm (35 in.). The average annual snowfall is 65.75 cm (26.3 in.).

Prevailing winds tend to be from the south, the northwest, and west-northwest. Average wind speeds range from 12.2 to 18.9 km/h (7.6 to 11.8 mph). Figure 1-3 shows the distribution of wind direction and speed for the SLAPS vicinity (Ref. 5).

There are no sizeable residential population centers within 1.6 km (1 mi) of the site. The nearest population center comprises 75 to 100 people residing about 0.5 mi due west of the site in an industrially zoned area of Hazelwood. The next nearest population center (about 1500 people) is northwest of the site and located along Chapel Ridge Drive about 1.6 km (1 mi) from the site; however, most of Hazelwood's population is north of Interstate 270, more than 2.4 km (1.5 mi) north of the site (Ref. 4).

Land uses immediately adjacent to the site are varied (Figure 1-4, Ref. 4). More than two-thirds of the land within 0.8 km (0.5 mi) of the site is related to transportation uses - primarily Lambert-St.

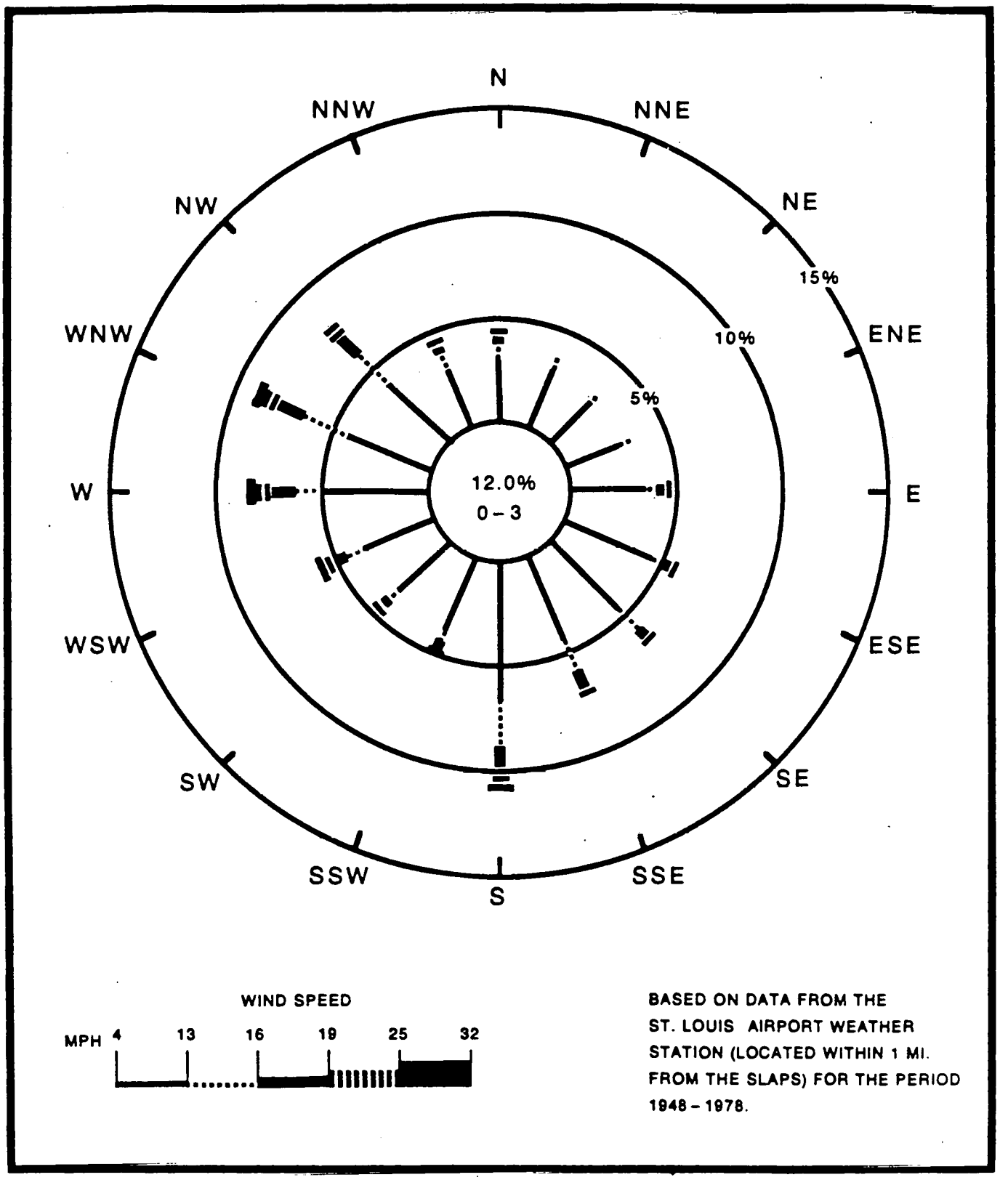
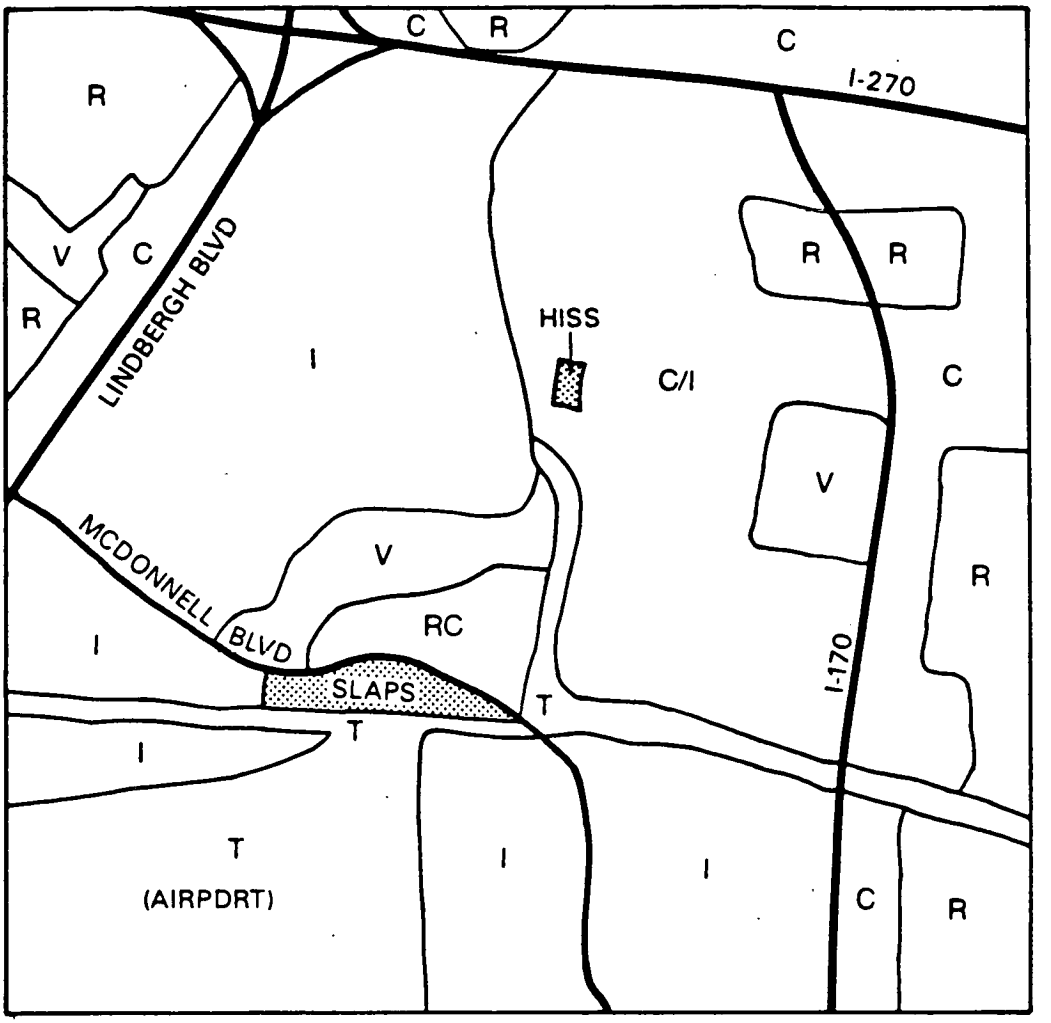


FIGURE 1-3 ANNUAL WIND ROSE FOR THE SLAPS, 1985



BASED ON AERIAL PHOTOGRAPHS, SITE VISITS AND USGS TOPOGRAPHIC MAP 1:24000 SCALE, FLORISSANT, MO (PHOTO REVISED 1982)

R RESIDENTIAL	C/I MIXED COMMERCIAL AND INDUSTRIAL
C COMMERCIAL	V VACANT
T TRANSPORTATION	RC RECREATIONAL
I INDUSTRIAL	

0 0.5 MILES

N

FIGURE 1-4 LAND USES IN THE VICINITY OF THE SLAPS

Louis International Airport. Land uses immediately adjacent to the site are dedicated to transportation, commercial, and recreational uses.

1.2 SITE HISTORY

In 1946, the Manhattan Engineer District (MED), a predecessor of the Atomic Energy Commission (AEC) and DOE, acquired the 191-ha (21.7-acre) tract now known as the SLAPS to store residues resulting from the processing of uranium ores at a facility in St. Louis.

The uranium processing (under a contract with the MED) continued through 1953; the resulting radioactive residues accumulated on the SLAPS. These materials included pitchblende raffinate residues, radium-bearing residues, barium sulfate cake, Colorado raffinate residues, and contaminated scrap (Ref. 6). Most of the residues were stored in bulk on open ground. Some contaminated materials and scrap were buried at the western end and in other parts of the site. To limit direct radiation exposure to the public, the site was fenced to prevent casual entry.

In 1966 and 1967, most of the stored residues were sold and removed from the site. On-site structures were razed, buried on the site, and covered with 0.3 to 1m (1 to 3 ft) of clean fill. Although these activities reduced the surface dose rates to acceptable levels, buried deposits of uranium-238, radium-226, and thorium-230 remained on the site (Ref. 1).

In 1973, the tract was transferred by quitclaim deed from the AEC to the City of St. Louis. The 1985 Energy and Water Development Appropriations Act (Public Law 98-360) authorized DOE to acquire the property from the city for use as a permanent disposal site for the waste already on-site, contaminated soil in the ditches surrounding the site, and the waste from the HISS, approximately 1.6 km (1 mi) to the north (Ref. 6). It is anticipated ownership will revert to DOE in fiscal year 1986.

From 1976 through 1978, the Oak Ridge National Laboratory conducted a radiological investigation of the SLAPS (Ref. 7). This survey indicated the presence of elevated concentrations of uranium-238 and radium-226 in drainage ditches north and south of McDonnell Boulevard. In 1981, the drainage ditches were designated for remedial action under the FUSRAP, which is a program to identify, clean up, or otherwise control sites where low-level radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program.

In 1982, BNI performed radiological characterizations of the ditches on either side of McDonnell Boulevard and portions of Coldwater Creek (Ref. 8). Neither of these surveys included measuring thorium-230 in soil.

Since the SLAPS characterization studies have not been completed, the volume of waste on the site and vicinity properties can not be determined accurately. An estimate based on historical data and construction projections indicates that 190,000 m^3 (250,000 yd^3) of waste will be collected as a result of remedial action (Ref. 1).

2.0 SUMMARY OF MONITORING RESULTS

During 1985, the environmental monitoring program at SLAPS continued to sample air, water, and sediments, and measure external gamma radiation. Since SLAPS is not controlled or regulated by the DOE or NRC, no specific guidelines for radionuclides are applicable to the site (Ref. 9). However, for comparative purposes, the DOE guides are presented to show how the monitoring results would compare if the site were owned by DOE. The guides, in the form of Derived Concentration Guides, represent the concentrations of individual types of radioactive materials, called radionuclides, in air or water that would limit radiation dose to 100 mrem/yr. The revised DOE Derived Concentration Guides for radioactive materials and the revised DOE radiation protection standard (Ref. 10) are provided in Appendix B. A discussion of the revisions is also included in Appendix B. Radiation doses were calculated to determine dose levels that can be compared to the radiation protection standard.

Annual average radon concentrations ranged from 4×10^{-10} to 1.2×10^{-9} uCi/ml (0.4 to 1.2 pCi/l). For comparison, the DOE Derived Concentration Guide is 3×10^{-9} uCi/ml (3 pCi/l). The average background level was 5×10^{-10} uCi/ml (0.5 pCi/l). Radon concentrations for the last 2 years, 1984 and 1985, have remained relatively constant.

Average external gamma dose rates recorded at the SLAPS boundary ranged from 3 to 2087 mrem/yr with the highest value occurring in an area of known contamination. These rates may be compared to the external dose rate from naturally occurring background radiation in the vicinity of the SLAPS, which was measured at 99 mrem/yr. The maximum dose at the site boundary, assuming a limited occupancy factor, would be 6 mrem/yr (see Subsection 3.5.1).

In surface waters, the average concentration of total uranium, radium-226, and thorium-230 did not exceed 3.4×10^{-9}, 2×10^{-10}, and 3×10^{-10} uCi/ml (3.4, 0.2, and 0.3 pCi/l), respectively. For

comparison, the DOE Derived Concentration Guides for these radionuclides are 6×10^{-7}, 1×10^{-7}, and 3×10^{-7} uCi/ml (600, 100, and 300 pCi/l), respectively.

Based on an annual average, the highest average concentration in groundwater for uranium was 4.73×10^{-6} (4735 pCi/l) measured in a well emplaced in an area of known contamination. For radium-226, the highest average concentration was 3×10^{-10} uCi/ml (0.3 pCi/l), and 2.3×10^{-9} uCi/ml (2.3 pCi/l) for thorium-230. The Derived Concentration Guides for groundwater are the same as those for surface water.

In sediments collected downstream from the site, the highest concentration, based on an annual average, was 7.6 pCi/g for total uranium, 1.9 pCi/g for radium-226, and 43.6 pCi/g for thorium-230. While there are no limits for sediments, these levels are below the DOE FUSRAP guidelines (Ref.11).

Radiological doses received by a maximally exposed individual were calculated. Two exposure pathways were quantified: ingestion of contaminated surface or groundwater and exposure to external gamma radiation. The individual is one who is assumed, when all potential routes of exposure are considered, to receive the greatest dose. This individual is assumed to obtain his domestic water from Coldwater Creek and routinely walk along the northern site boundary.

The dose to a maximally exposed individual from ingestion of groundwater would result in a 50-yr dose commitment to the bone surface (the organ receiving the largest dose) of less than 1 mrem.

External radiation from radiological materials at the SLAPS contributed less than 6 mrem to the dose received by the maximally exposed individual. For comparative purposes, this value would be less than 6 percent of the DOE radiation protection standard. The total dose to the maximally exposed individual would be 6.03 mrem.

3.0 DATA COLLECTION, ANALYSIS, AND EVALUATION

This section provides the results of 1985 environmental monitoring at the SLAPS (Ref. 12). A description is also given of the sampling, monitoring, and analytical procedures used. Since SLAPS is not controlled or regulated by DOE, no specific guidelines or limits for radionuclides are applicable to the site. However, for comparative purposes, DOE Derived Concentration Guides (DCGs) are provided to show how the monitoring results would compare if the site were owned by DOE. Radiation doses were calculated to determine hypothetical exposure levels, which were compared to the DOE radiation protection standard. DOE DCGs for radionuclides of concern at SLAPS are included in Appendix B. Appendix B also contains a discussion of the revised radiation protection standard and associated DCGs.

Data are presented in summary tables which include minimum and maximum values recorded, number of data points collected, and average value. The average values listed in the individual tables are the arithmetic average of the sum of the measurements for each location. Individual sources of error (e.g., analytical error or sampling error) were not estimated. The "less than" notation (<) is used to denote sample analysis results that are below the limit of sensitivity of the analytical method based on a statistical analysis of parameters. In computing the averages, where values are less than the limit of sensitivity of the analytical method, values are considered as being equal to the limit of sensitivity and the "average" value is reported without the notation "less than."

During 1985, the routine environmental monitoring program for SLAPS and the off-site ditches includes radon gas monitoring, external gamma radiation measurements, surface water and sediment sampling of Coldwater Creek, and groundwater sampling of monitoring wells within the site boundary (which is a fenced and posted area).

3.1 RADON GAS SAMPLING

Eight radon gas detectors are maintained on-site and at site boundary locations at the SLAPS, which includes two quality control detectors. The locations of the radon monitors are shown in Figure 3-1.

Sample locations are spaced along the site boundary to ensure adequate detection capability under most atmospheric conditions.

The radon gas monitors are Terradex Type-F Track-Etch detectors. Detectors are obtained from the Terradex Corporation, placed at the sample locations, collected and exchanged quarterly by site personnel, and then returned to Terradex for analysis.

Table 3-1 reports the concentrations of radon gas in the air recorded at six locations. The annual average concentrations ranged from 0.4×10^{-10} to 1.2×10^{-9} uCi/ml (0.4 to 1.2 pCi/l). For comparative purposes, the DOE DCG for radon released to uncontrolled areas is 3×10^{-9} uCi/ml (3 pCi/l).

Radon levels were consistent from 1984 to 1985. Annual averages in 1984 (fourth quarter only) for the five locations measured ranged from 1×10^{-10} to 6×10^{-10} uCi/ml (0.1 to 0.6 pCi/l).

Based on measured radon concentrations at the SLAPS, the radon source on-site has minimal or no effect on area radon concentrations.

3.2 EXTERNAL GAMMA DOSE RATES

External gamma dose rates were measured at the six monitoring locations that correspond to the radon (Terradex) detector locations shown in Figure 3-1.

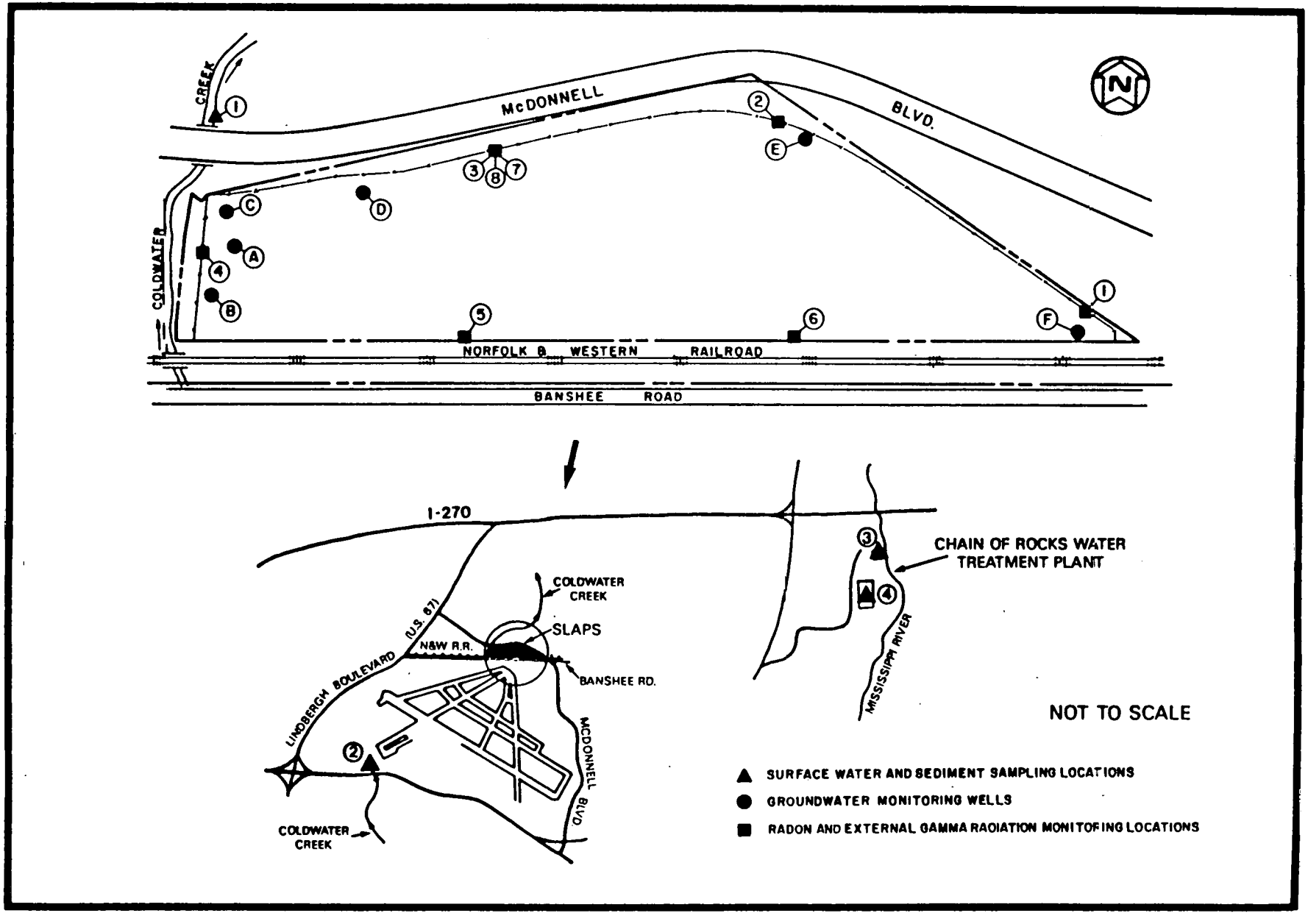


FIGURE 3-1 LOCATION OF THE SLAPS ENVIRONMENTAL MONITORING STATIONS

TABLE 3-1

RADON CONCENTRATIONS FOR SLAPS, 1985[a]

Sampling Location[b]	No. of Measurements	Radon Concentration (n x 10^9) uCi/ml[c,d] Minimum	Maximum	Average
1	4	0.2	1.0	0.5
2	4	0.2	2.5	1.2
3	3[e]	0.5	1.3	0.8
4	4	0.3	0.6	0.4
5	3[f]	0.6	1.0	0.8
6	4	0.3	0.6	0.5
7[g]	4	0.4	0.8	0.5
8[g]	3[f]	0.5	1.3	1.0
Background[h]	4	0.3	0.5	0.5

[a]Background has been subtracted.

[b]Sampling locations are shown in Figure 3-1.

[c]The DOE DCG is 3 x 10^{-9} uCi/ml (3 pCi/l); however, this value is included for comparison only. The site is not regulated by DOE.

[d]Multiply n (the listed concentration) by 10^9 to obtain uCi/ml.

[e]Detector was lost for the first quarter.

[f]Detectors not installed until 4/11/85.

[g]Locations 7 and 8 are quality control locations for Location 3.

[h]The background location is in Florissant, Missouri.

The external gamma dose rates are measured using lithium fluoride (LiF) thermoluminescent dosimeters (TLDs), exchanged quarterly. Each dosimeter contains five individual chips, the responses of which are averaged. Analytical services are provided by Eberline Analytical Corporation (EAC).

The results of the measurements for external gamma radiation are presented in Table 3-2. Annual dose rates ranged from 3 to 2087 mrem/yr at the sampling locations. The highest dose rate occurred at Location 2, which is above known buried waste where water has eroded the fill placed over the waste. Though SLAPS is not owned or regulated by the NRC or DOE, for comparative purposes, the DOE radiation protection standard for the external gamma radiation dose is 100 mrem/yr.

External dose rates were higher in 1985, primarily due to the situation described above.

3.3 WATER SAMPLING

During 1985, sampling was performed to determine the concentrations of uranium, radium, and thorium in surface water and groundwater at both off-site and on-site locations (Figure 3-1). The results of analyses for uranium, radium-226, and thorium-230 at all sampling locations are presented in Tables 3-3 and 3-4.

3.3.1 Surface Water

Surface water samples were collected quarterly from four off-site locations. Water samples were taken from Coldwater Creek approximately 15 m (50 ft) downstream of the ditch that runs along McDonnell Boulevard (Location 1) and at the intersection of the creek and Interstate 70 (Location 2). Location 2 is upstream of SLAPS and provides the background concentrations. Locations 3 and 4 are at the Chain of Rocks Water Treatment Plant downstream of where Coldwater Creek discharges into the Missouri River, which then discharges into the Mississippi River.

TABLE 3-2

EXTERNAL GAMMA DOSE RATES FOR SLAPS, 1985

Sampling Location[a]	No. of Measurements	Dose Rate (mrem/qtr)[b] Minimum	Maximum	Average	Total[c] mrem/yr
1	4	5	20	11	46
2	4	446	555	397	2087
3	4	23	35	29	116
4	4	6	24	14	57
5	3[d]	0	2	1	3
6	4	7	15	10	41
7[e]	4	19	27	23	93
8[e]	3[d]	0	9	3	12
Background[f]	4	22	30	25	99

[a]Sampling locations are shown in Figure 3-1.

[b]Background has been subtracted. Dose rate based on continuous occupancy.

[c]The quarterly average is used to obtain the total mrem/yr when missing data for the first quarter.

[d]Detectors not installed until 4/11/85.

[e]Locations 7 and 8 are quality control locations for Location 3.

[f]The background location is in Florissant, Missouri.

TABLE 3-3

TOTAL URANIUM, RADIUM-226, AND THORIUM-230
CONCENTRATIONS IN SLAPS SURFACE WATER SAMPLES, 1985

Sampling Location[a]	No. of Samples	Concentration[b] ($n \times 10^{9}$) uCi/ml[c] Minimum	Maximum	Average
Total Uranium				
1	4	<3.0	4.7	3.4
2	4	<3.0	<3.0	3.0
3	4	<3.0	<3.0	3.0
4	4	<3.0	<3.0	3.0
Radium-226				
1	4	0.1	0.4	0.2
2	4	<0.1	0.2	0.1
3	4	0.1	0.4	0.2
4	4	<0.1	0.2	0.1
Thorium-230				
1	4	<0.1	0.4	0.2
2	4	<0.1	<0.4	0.2
3	4	<0.1	<0.5	0.3
4	4	<0.1	<0.4	0.2

[a] Sampling locations are shown in Figure 3-1.

[b] Because the site is neither owned nor regulated by the DOE or NRC, the following DCGs are included for comparison only.

1. The DOE DCG for uranium in water is 6×10^{-7} (600 pCi/l).
2. The DOE DCG for radium-226 in water is 1×10^{-7} uCi/ml (100 pCi/l).
3. The DOE DCG for thorium-230 is 3×10^{-7} (300 pCi/l).

[c] Multiply n (the listed concentration) by 10^{9} to obtain uCi/ml.

TABLE 3-4

TOTAL URANIUM, RADIUM-226, AND THORIUM-230
CONCENTRATIONS IN SLAPS GROUNDWATER SAMPLES, 1985

Sampling Location[a]	No. of Samples	Concentration[b] ($n \times 10^9$) uCi/ml[c] Minimum	Maximum	Average
Total Uranium				
Well A	4	627	6337	2375
Well B	4	1267	6203	4735
Well C	4	21	80	36
Well D	4	247	667	474
Well E	4	87	193	114
Well F	4	73	307	177
Radium-226				
Well A	4	0.1	0.4	0.2
Well B	4	0.2	0.3	0.3
Well C	4	<0.1	0.2	0.2
Well D	4	<0.1	0.2	0.1
Well E	4	<0.1	0.2	0.2
Well F	4	<0.1	0.2	0.1
Thorium-230				
Well A	4	0.4	5.4	2.3
Well B	4	<0.1	0.7	0.3
Well C	4	<0.1	0.5	0.2
Well D	4	0.8	2.1	1.3
Well E	4	0.3	2.2	1.0
Well F	4	0.6	2.7	1.1

[a]Sampling locations are shown in Figure 3-1.
[b]Because the site is neither owned nor regulated by the DOE or NRC, the following DCGs are included for comparison only.
1. The DOE DCG for uranium in water is 6×10^{-7} (600 pCi/l).
2. The DOE DCG for radium-226 in water is 1×10^{-7} uCi/ml (100 pCi/l).
3. The DOE DCG for thorium-230 is 3×10^{-7} (300 pCi/l).

[c]Multiply n (the listed concentration) by 10^9 to obtain uCi/ml.

Samples were collected using nominal 1-liter (0.26 gal) grab samples to fill a 4-liter (1-gal) container. Eberline Analytical Corporation analyzes the samples for total uranium, radium-226, and thorium-230. Radium-226 concentrations are determined by precipitating with barium sulfate, dissolving the resulting Ba-Ra sulfate, and transferring it to an emanation tube where radon-222 is allowed to come to equilibrium. The radon-222 is then counted by alpha scintillation. Total uranium is determined by a fluormetric method. Thorium-230 is eluted in solution, electrodeposited on stainless steel discs, and counted by alpha spectrometry.

The DOE DCG for uranium of 6×10^{-7} uCi/ml (600 pCi/l) may be used as a basis of comparison for concentration levels at the locations shown in Figure 3-1. The average total uranium concentrations at these locations ranged from 3×10^{-9} to 3.4×10^{-9} uCi/ml (3.0 to 3.4 pCi/l).

The highest concentration of radium in surface water at the sampling locations was 2×10^{-10} uCi/ml (0.2 pCi/l), which compares to the DOE DCG for radium of 1×10^{-7} uCi/ml (100 pCi/l) in water.

The DOE DCG for release of thorium-230 to uncontrolled areas [3×10^{-7} uCi/ml (300 pCi/l)] may be used as a basis of comparison for concentration levels at the sampling locations. Concentrations at these locations ranged from 2×10^{-10} to 3×10^{-10} uCi/ml (0.2 to 0.3 pCi/l).

Throughout 1984 and 1985, concentrations of total uranium, radium-226, and thorium-230 in surface waters were consistent. Averages in 1984 for uranium ranged from 4×10^{-9} to 1.4×10^{-8} uCi/ml (4 to 14 pCi/l), for radium 1×10^{-10} to 2×10^{-10} uCi/ml (0.1 to 0.2 pCi/l), and for thorium 1×10^{-10} to 3.6×10^{-10} Ci/ml (0.1 to 0.36 pCi/l). The average concentrations in 1985 for total uranium ranged from 3.0×10^{-9} to 3.4×10^{-9} uCi/ml (3.0 to 3.4 pCi/l), average concentrations of radium

ranged from 1 x 10^{-10} to 2 x 10^{-10} uCi/ml (0.1 to 0.2 pCi/l), and average thorium concentrations ranged from 2 x 10^{-10} to 3 x 10^{-10} uCi/ml (0.2 to 0.3 pCi/l).

3.3.2 Groundwater

During 1985, groundwater samples were collected quarterly from six on-site wells. Groundwater samples were collected after the wells had been pumped dry or two well volumes had been removed. Samples were collected using a hand bailer. Nominal 1-liter (0.3-gal) grab samples were collected to fill a 4-liter (1-gal) container after the wells had been pumped dry or two casing volumes had been removed. Samples were analyzed by EAC for total uranium and dissolved radium-226 using the methods applied to surface water analyses.

Results of analyses for concentrations of uranium, radium, and thorium in groundwater are included in Table 3-4. The highest annual average total uranium concentration was 4.73 x 10^{-6} uCi/ml (4735 pCi/l). This sample, however, comes from a Well B, which is adjacent to or in buried radioactive materials at the site. This value can be compared to the DOE DCG for uranium, which is 6 x 10^{-7} uCi/ml (600 pCi/l). The highest annual average for radium was 3 x 10^{-10} uCi/ml (0.3 pCi/l) compared to the DOE DCG of 1 x 10^{-9} uCi/ml (100 pCi/l), and the thorium concentration was 2.3 x 10^{-9} uCi/ml (2.3 pCi/l) compared to the DOE DCG of 3 x 10^{-7} uCi/ml (300 pCi/l). The DOE DCGs are provided as a basis of comparison for concentration levels of uranium, radium, and thorium at the groundwater sampling locations.

Throughout 1984 and 1985, concentrations of total uranium, radium-226, and thorium-230 were consistent. Averages in 1984 for uranium in groundwater ranged from 4 x 10^{-8} to 5.7 x 10^{-6} uCi/ml (40 to 5700 pCi/l), for radium from 2 x 10^{-10} to 6 x 10^{-10} uCi/ml (0.2 to 0.6 pCi/l), and for thorium 2 x 10^{-10} to 9.5 x 10^{-9} uCi/ml (0.2 to 9.5 pCi/l). Averages in 1985 for

uranium ranged from 3.6×10^{-8} to 4.73×10^{-6} uCi/ml (36 to 4735 pCi/l, from 1×10^{-10} to 3×10^{-10} uCi/ml (0.1 to 0.3 pCi/l) for radium, and from 2×10^{-10} to 2.3×10^{-9} uCi/ml (0.2 to 2.3 pCi/l) for thorium.

3.4 SEDIMENT SAMPLING

During 1985, sediment samples consisting of approximately 500 g were collected off-site at surface water sampling Locations 1 and 2 (Figure 3-1). EAC analyzed the samples for uranium, radium-226, and thorium-230. The total uranium concentration was obtained by summing the results from isotopic uranium analyses. Isotopic uranium and thorium-230 were determined by alpha spectrometry, whereas the uranium and thorium-230 are leached, extracted, and electroplated on metal substrates. Radium-226 concentrations were determined by radon emanation.

SLAPS is not controlled or regulated by the NRC or DOE, and there are no specific DOE guidelines for radionuclides in sediments. However, DOE FUSRAP sites are being decontaminated to meet guidelines for radionuclides in soil. For comparative purposes, these guidelines are 5 pCi/g in the upper 15 cm (6 in.) and 15 pCi/g below 15 cm (6 in.) for radium and thorium, respectively (Ref. 11).

The analytical results for uranium (based on dry weight), radium-226, and thorium-230 are presented in Table 3-5. Quarterly analytical results for total uranium ranged from 0.1 to 13.0 pCi/g. The highest single reading, 13.0 pCi/g, and the highest annual average, 3.7 pCi/g, were both obtained from Location 1 (downstream). However, these values are believed to be anomalous because they are much higher than other sample analysis for Location 1.

The highest single reading for radium-226, 6.0 pCi/g, and the highest annual average, 2.6 pCi/g, were both obtained from Location 2 (upstream).

TABLE 3-5

TOTAL URANIUM, RADIUM-226, AND THORIUM-230
CONCENTRATIONS IN SLAPS SEDIMENT SAMPLES, 1985

Sampling Location[a]	Number of Samples	Concentration [(pCi/g (dry)] Minimum	Maximum	Average
Uranium-234				
1	4	<0.1	13.0	3.7
2	4	0.5	0.6	0.6
Uranium-235				
1	4	0.03	0.6	0.2
2	4	0.02	<1.0	0.05
Uranium-238				
1	4	<0.1	13.0	3.7
2	4	0.4	0.6	0.5
Total Uranium[b]				
1	4	0.3	26.6	7.6
2	4	1.0	2.2	1.1
Radium-226				
1	4	0.1	5.0	1.9
2	4	1.3	6.0	2.6
Thorium-230				
1	4	1.5	170.0[c]	43.6[c]
2	4	0.6	0.9	0.7

[a]Sampling locations are shown in Figure 3-1. Location 1 is downstream and Location 2 is upstream.
[b]Values for total uranium are the sum of the measurement for each isotope.
[c]The maximum value obtained for the the first quarter sample and is inconsistent with other measured values. Special followup sampling on 7/10/85 and 8/28/85 showed 1.5 and 5.6 pCi/g, respectively.

The highest concentration for thorium-230 was 170 pCi/g. This concentration is inconsistent with the value for the first quarter sample and is believed to be anomalous. Followup sampling showed concentrations of 1.5 and 5.6 pCi/g. The highest annual average concentration for thorium was 43.6 pCi/g. Both concentrations were recorded from Location 1.

Because only one sediment sample was taken in 1984 for uranium, radium, and thorium, and four samples were taken in 1985, the data would not provide a meaningful comparison.

3.5 RADIOLOGICAL EXPOSURE

To assess the impact of the radioactive materials stored at the SLAPS, the radiological exposure of a maximally exposed individual and to the population were evaluated. This individual is one who is assumed, when all potential routes of exposure are considered, to receive the greatest dose. An appraisal of potential pathways suggested that ingestion of water containing natural uranium, radium-226, and thorium-230 and external gamma irradiation were the principal exposure modes in both cases. Inhalation of radon and its radioactive daughters is also a pathway; however, an accurate, quantitative determination of dose is not possible because of uncertainties concerning the distribution of exposure.

For each of the pathways considered, most organs in the body receive some radiological exposure. However, depending on the method of internal deposition and the chemical characteristics of the radionuclides, some organs receive a higher exposure than others. These are called "critical organs" because the effect of the exposure is maximized in them.

Uranium, radium, and thorium taken into the body via ingestion tend to migrate and incorporate into the bone, which is the critical organ for this pathway. Conversion of measured concentrations in water to an internal dose to the bone requires several assumptions.

An intake rate must be postulated. For these calculations, the maximum water intake rate [730 ml (0.2 gal) of tap water per day] of Reference Man was used (Ref. 13). Radionuclide intakes were converted to internal doses to the bone using the methodology described in ICRP 26 and 30 (Refs. 14 and 15). All reported doses are 50-yr dose commitments. The 50-yr dose commitment is a concept which provides for the fact that an intake of a radionuclide with a long half-life (such as uranium and radium) may result in an internal exposure for many years.

Gamma radiation from external sources is assumed to irradiate the body uniformly. The total body is therefore the critical organ for external gamma exposure. Internal organs are assumed to be exposed to the same level as the entire body. Exposure to organs resulting from internal and external sources is additive.

Inhalation of radon and its radioactive daughters is also a pathway; however, an accurate, quantitative determination of dose is not possible because of uncertainties concerning the distribution of exposure.

3.5.1 Dose to Maximally Exposed Individual

To identify the individual in the vicinity of the SLAPS who would receive the highest dose from on-site radioactive materials, the combined dose from ingestion of water and exposure to external gamma radiation was calculated at various monitoring locations. From these calculations, it was determined that the highest overall dose would be received by an individual who drinks water from Coldwater Creek and walks daily along the northern site boundary. The water ingestion rate of 730 ml/day (0.2 gal/day) for Reference Man was used.

Ingestion of water from Coldwater Creek would result in the highest realistic dose to an individual. The yearly average uranium, radium-226, and thorium-230 concentrations from Location 2 were

subtracted from those measured at Location 1 to determine the impact the site had on concentrations of these radionuclides in Coldwater Creek. Ingestion of this water containing these concentrations would result in a 50-yr dose commitment of approximately 1 mrem to the critical organ which is the bone surface. No attempt was made to separately quantify the contribution of materials on the SLAPS and natural background radionuclides. This can be compared to the 620 mrem dose that would be received if water were ingested that contained uranium concentrations equal to the DOE DCG [6×10^{-7} uCi/ml (600 pCi/l)].

The area adjacent to the SLAPS is a normally unoccupied area. Dose to the maximally exposed individual was calculated assuming an individual walked the fence line twice a day, 5 days per week. It is also assumed that the individual walks at a rate of 4.8 km/h (3 mph) along the 0.8 km (0.5 mi) northern site boundary and is exposed to an average dose rate of 750 mrem/yr from Locations 1, 2, and 3. The annual dose rate to this individual would be 6 mrem.

The 6-mrem dose from external gamma radiation (see Subsection 3.2) and the 1-mrem dose from ingestion are used to calculate the total dose. However, the 1-mrem dose is multiplied by the internal organ to whole body weighting factor of 0.03 (Ref. 14). This addition results in a total dose of 6.03 mrem to the maximally exposed individual.

3.5.2 Dose to Population

The dose to the population represents the conceptual cumulative radiation dose to all residents within a 80-km (50-mi) radius of a given site. This calculated dose includes contributions from all potential pathways. For the SLAPS, these pathways are: direct exposure to gamma radiation, inhalation of radon gas, and ingestion of water containing radioactivity.

The contribution to the population dose made by gamma radiation from on-site radioactive materials is too small to be measured; gamma

radiation levels decrease rapidly as distance from the source of contamination increases. For example, if the gamma dose rate at a distance of 1 m (3 ft) from the radioactive source were 10 times that allowable, the dose rate at a distance of 6.3 m (21 ft) from the source would be indistinguishable from naturally occurring background radiation.

Similarly, radon gas is known to dissipate rapidly as distance from the radon source increases. Therefore, radon exposure does not contribute significantly to population dose.

On the basis of radionuclide concentrations measured in water leaving the site, it also appears that there is no predictable pathway by which ingestion of water could result in a significant dose to the population. As water migrates farther from the source, radionuclide concentrations are further reduced, thereby lowering potential doses to even less significant levels.

Since the contributions to population dose via all three potential exposure pathways are inconsequential, calculation of dose to the population is not warranted.

The cumulative dose to the population within a 80-km (50-mi) radius contributed by on-site radioactive materials would be indistinguishable from the dose the same population would receive from naturally occurring radioactive sources.

4.0 ACTIVITIES AND SPECIAL STUDIES

4.1 ACTIVITIES

In January 1985, significant erosion along Coldwater Creek at the western end of the site necessitated immediate control measures. In conjunction with DOE-OR and Argonne National Laboratory (ANL), BNI obtained a construction permit from the Metropolitan St. Louis Sewer District before the work was started. To obtain the permit, BNI submitted engineering plans for the work to the Metropolitan St. Louis Sewer District, which reviewed and approved them.

During the spring, a 3.6-m (12-ft) high wall of rock-filled wire baskets, known as gabions, was erected along a 93-m (310-ft) stretch of the western bank. The creek was temporarily diverted while work was in progress. The bank was excavated to accommodate the wall, and a gabion scouring blanket was laid to serve as a base on which to erect the wall and to prevent further erosion from occurring at the base of it. Every 6 m (20 ft), counterfort sections (also made of gabions) were extended into the bank to optimize the stability of the wall. Filter fabric and filter rock were placed between the gabions and the backfill behind the wall to minimize the hydrostatic pressure on the gabions and to prevent leakage of sediment between the rocks and into the creek.

4.2 SPECIAL STUDIES

During 1985, a document describing the storage capacity required for long-term management of radioactive wastes at the SLAPS was prepared. It summarized baseline conceptual designs for above- and below-grade storage at the site and possible modifications to these designs (Ref. 16).

REFERENCES

1. U. S. Department of Energy. Remedial Action Work Plan for the St. Louis Airport Disposal Site, DOE/OR-868, Oak Ridge, TN, January 1986.

2. Environmental Research Division. Potential Environmental Issues Associated with the Proposed Emergency Maintenance at the St.Louis Airport Storage Site, March 8, 1985.

3. R. F. Weston, Inc. Evaluation of Environmental Impact Associated with the Former Airport Storage Site of the Atomic Energy Commission, St. Louis County, Missouri, March 1980.

4. R. F. Weston, Inc. Environmental Impact Assessment of the Former Airport Storage Site of the Atomic Energy Commission, St. Louis County, Missouri, July 1979.

5. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Wind - Ceiling - Visibility Data at Selected Airports, Interagency Agreement DOT-FA79WAI-057, National Climatic Data Center, Asheville, NC, January 1981.

6. Bechtel National, Inc. Characterization Plan for the St. Louis Airport Disposal Site, DOE/OR/20722-87, Draft, December 1985.

7. Oak Ridge National Laboratory. Formerly Utilized MED/AEC Sites Remedial Action Program Radiological Survey of the St. Louis Airport Storage Site, DOE/E8-0005/16, Oak Ridge, TN, September 1979.

8. Bechtel National, Inc. Radiological Survey of the Ditches at the St. Louis Airport Storage Site (SLAPSS), Oak Ridge, TN, August 1983.

9. Bechtel National, Inc. St. Louis Airport Storage Site (SLAPSS) Environmental Monitoring Summary Calendar Year 1984, DOE/OR/20722-59, Oak Ridge, TN, July 1985.

10. Memorandum, R.J. Stern, Department of Energy, to Distribution. "Preparation of Annual Site Environmental Reports for Calendar Year 1985" (Attachment: DOE-Derived Concentration Guides for Drinking Water and Breathing Air Contaminated With Radionuclides by Members of the Public), February 26, 1986.

11. U.S. Department of Energy. "U.S. Department of Energy Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites," Rev. 1, July 1985.

12. Memorandum, A.J. Kuhaida, Bechtel National, Inc., to File. "Environmental Monitoring Program," CCN 35858, April 2, 1986.

13. Snyder, W. S. et al. Report on the Task Group on Reference Man, published for the International Commission on Radiological Protection, Pergamon Press, New York, NY, 1975.

14. Sowby, F. C., editor. Annals of the International Commission on Radiological Protection, Publication 26, Pergamon Press, Elmsford, NY, January 1977.

15. Sowby, F. C., editor. Annals of the International Commission on Radiological Protection, Publication 30, Pergamon Press, Elmsford, NY, July 1978.

16. Bechtel National, Inc. St. Louis Airport Storage Site (SLAPSS) Summary of Design Concepts, Oak Ridge, TN, August 1985.

APPENDIX A
QUALITY ASSURANCE

APPENDIX A
QUALITY ASSURANCE

A comprehensive quality assurance program was maintained to ensure that the data collected were representative of actual concentrations in the environment. First, environmental data were obtained to prevent an unrealistic reliance on only a few results. Second, newly collected data were compared with both recent results and historical data for each location and each environmental medium to ensure that deviations from previous conditions were identified and evaluated. Third, samples at all locations were collected using published procedures to ensure consistency in sample collection. Fourth, the quality of the data was verified by a continuing program of analytical laboratory quality control, participation in interlaboratory crosschecks, replicate analysis, and splitting samples with other recognized laboratories. Fifth, chain-of-custody procedures maintain traceability of samples and corresponding analytical results. This program ensures that the monitoring data can be used to evaluate accurately the environmental impacts from site operations.

The majority of the routine radioanalyses for the FUSRAP Environmental Monitoring Program were performed under subcontract by the Eberline Analytical Corporation (EAC), Albuquerque, New Mexico. This laboratory maintained an internal quality assurance program that involved routine calibration of counting instruments, source and background counts, routine yield determinations of radiochemical procedures, and replicate analyses to check precision. The accuracy of radionuclide determination was ensured through the use of standards traceable to the National Bureau of Standards, when available. The laboratory also participated in the Environmental Protection Agency's (EPA) Laboratory Intercomparison Studies Program. In this program, samples of different environmental media (water, milk, air filters, soil, foodstuffs, and tissue ash) containing one or more radionuclides in known amounts were prepared and distributed to the participating laboratories. After the

samples were analyzed, the results were forwarded to EPA for comparison with known values and with the results from other laboratories. This program enabled the laboratory to regularly evaluate the accuracy of its analyses and take corrective action if needed.

Interlaboratory comparison of the TLD results was provided by participation in the International Environmental Dosimeter Project sponsored jointly by the Department of Energy, the Nuclear Regulatory Commission, and the EPA.

Assurance of the quality of dose calculations was provided in several ways. First, comparisons were made against past calculated doses and significant differences, if any, were verified. Second, all computed doses were double checked by the originator and by an independent third party who also checked all input data and assumptions used in the calculation.

APPENDIX B
ENVIRONMENTAL STANDARDS

APPENDIX B
ENVIRONMENTAL STANDARDS

The radiation protection standards and associated Derived Concentration Guides (DCG) applicable to Department of Energy (DOE) installations have been modified (Ref. 10).

The radiation protection standard has been reduced from 500 mrem/yr to 100 mrem/yr. In conjunction with this reduction, evaluation of exposure pathways and resulting dose calculations are based on realistic assumptions. Realistic assumptions may include the use of occupancy factors in determining dose due to external gamma radiation; subtraction of background concentrations of radionuclides in air, water, and soil before calculating dose; closer review of water use, using the data that most closely represents actual exposure conditions rather than maximum values as applicable; and using average consumption rates of food and water per individual rather than maximums. Utilization of realistic assumptions will result in lower calculated doses than previous years. However, these doses will more accurately reflect the exposure potential from site activities.

The associated DCGs, which provide limits for the maximum permissible radioactivity in various environmental media, have also been revised. The new DCGs reflect changes to the radiation protection standard and new uptake models. On a case-by-case basis, the DCG for a given radionuclide may have increased, decreased, or remained unchanged. The DCGs for the common radionuclides at the SLAPS are presented in Table B-1. For comparative purposes, the old and revised DCGs are presented. Conversion factors for the new reporting units are provided in Table B-2.

TABLE B-1

RADIATION PROTECTION STANDARD[a] AND
RADIOACTIVITY CONCENTRATION GUIDES FOR THE SLAPS

Radionuclide	Transport Medium	Previous Guide (Uncontrolled Areas)	New Guide
Uranium-Natural	Water	600 pCi/l	Unchanged[b]
Radium-226	Water	30 pCi/l	1×10^{-7} uCi/ml (100 pCi/l)
Radon-222	Air	3 pCi/l	Unchanged[b]
Thorium-230	Water	2,000 pCi/l	3×10^{-7} uCi/ml (300 pCi/l)

[a]The radiation protection standard was changed from 500 mrem/yr to 100 mrem/yr.

[b]The values are the same as for previous years, but are reported in different units.

TABLE B-2

CONVERSION FACTORS

1 yr	=	8760 h
1 liter	=	1000 ml
1 mrem	=	1000 uR
1 mrem/yr	=	11 uR/hr (assuming 8760 hours of exposure per year)
1 uCi	=	1,000,000 pCi
1 pCi	=	0.000001 uCi
1 pCi/l	=	10^{-9} uCi/ml
1 pCi/l	=	0.000000001 uCi/ml
1 uCi/ml	=	1,000,000,000 pCi/l
10^{-6}	=	0.000001
10^{-7}	=	0.0000001
10^{-8}	=	0.00000001
10^{-9}	=	0.000000001
10^{-10}	=	0.0000000001
7×10^{-10}	=	0.0000000007

APPENDIX C

ABBREVIATIONS

APPENDIX C
ABBREVIATIONS

cm	centimeter
cm/sec	centimeters per second
ft	foot
g	gram
gal	gallon
h	hour
ha	hectare
in.	inch
km	kilometer
km/h	kilometers per hour
m	meter
m^3	cubic meters
mg	milligram
mg/l	milligrams per liter
mi	mile
ml	milliliter
mph	miles per hour
mrem	millirem
mrem/qtr	millirem per quarter
mrem/yr	millirem per year
m.s.l.	mean sea level
uCi/ml	microcuries per milliliter
ug/l	microgram per liter
uR/h	microroentgens per hour
pCi	picocurie
pCi/g	picocuries per gram
pCi/l	picocuries per liter
wk	week
yd^3	cubic yards
yr	year

APPENDIX D

DISTRIBUTION LIST FOR THE ST. LOUIS AIRPORT SITE ANNUAL SITE ENVIRONMENTAL MONITORING REPORT

APPENDIX D
ST. LOUIS AIRPORT SITE ANNUAL
SITE ENVIRONMENTAL MONITORING REPORT
MAILING LIST

Media:

City Editor
GLOBE-DEMOCRAT
1710 North Tucker Boulevard
St. Louis, Missouri 63101

Environmental Editor
St. LOUIS POST-DISPATCH
1710 North Tucker Boulevard
St. Louis, Missouri 63101

News Editor
Suburban St. Louis Newspaper Group
7020 Chippewa Street
St. Louis, Missouri 63119

ASSOCIATED PRESS
1710 North Tucker Boulevard
St. Louis, Missouri 63101

UNITED PRESS INTERNATIONAL
900 North Tucker Boulevard, 2nd Floor
St. Louis, Missouri 63101

News Director
KDNL-TV
1215 Cole Street
St. Louis, Missouri 63106

News Director
KETC-TV
6996 Milbrook Boulevard
St. Louis, Missouri 63130

News Director
KMOX-TV
1 Memorial Drive
St. Louis, Missouri 63102

News Director
KPLR-TV
4935 Lindell
St. Louis, Missouri 63108

News Director
KSDK-TV
1111 Olive Street
St. Louis, Missouri 63105

News Director
KTVI-TV
5915 Berthold Avenue
St. Louis, Missouri 63110

News Director
Radio Station KMOX
1 Memorial Drive
St. Louis, Missouri 63102

News Director
Radio Station KEZK
7711 Carondelet Avenue
St. Louis, Missouri 63105

News Director
Radio Station WIL
300 North Tucker Boulevard
St. Louis, Missouri 63101

Federal:

Mr. Morris Kay, Administrator (5 copies)
U.S. Environmental Protection Agency
Region VII
324 East Eleventh Street
Kansas City, Missouri 64106

Mr. Darrell Sommerhauser, Superfund Section
U.S. Environmental Protection Agency
Region VII
324 East Eleventh Street
Kansas City, Missouri 64106

Mr. George DeBuchannanne, Chief
Office of Radiohydrology
U.S. Department of Interior
Geological Survey, MS 140
Reston, Virginia 22000

Mr. William Crow
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20910

Mr. James Zeregia
U.S. Army Corps of Engineers
210 Tucker Boulevard, North
St. Louis, Missouri 63101-1986

State:

Dr. Fred Brunner, Director
State of Missouri
Department of Natural Resources
Post Office Box 176
Jefferson City, Missouri 65102

Mr. Ron Kucera (5 copies)
State of Missouri
Department of Natural Resources
Post Office Box 176
Jefferson City, Missouri 65102

Mr. William Ford (5 copies)
State of Missouri
Department of Natural Resources
Post Office Box 1368
Jefferson City, Missouri 65102

Dr. David Bedan
State of Missouri
Department of Natural Resources
Post Office Box 176
Jefferson City, Missouri 65102

Mr. Roy Hengerson
Division of Environmental Quality
State of Missouri
Department of Natural Resources
Post office Box 1368
Jefferson City, Missouri 65102

Mr. John R. Crellin, Director
Bureau of Environmental Epidemiology
Division of Health
State of Missouri
Department of Social Services
Post Office Box 570
Jefferson City, Missouri 65102

Mr. D. R. Dodson
Division of Health
State of Missouri
Department of Social Services
1511 Locust Street, Third Floor
St. Louis, Missouri 63103

Mr. John W. Spell
Administrative Chief
Industrial Hygiene Section
Department of Community Health and Medical Care
801 S. Brentwood Boulevard
Clayton, Missouri 63105

Local:

Honorable Douglas Palmer
Mayor, City of Hazelwood
415 Elm Grove
Hazelwood, Missouri 63042

Mr. Ed Carlstom
City Manager
City of Hazelwood
415 Elm Grove
Hazelwood, Missouri 63042

Mr. Jose Hernandez
Division of Public Works
City of Hazelwood
415 Elm Grove
Hazelwood, Missouri 63042

Honorable Jack Quigle
Mayor, City of Berkeley
6140 North Hanley Road
Berkeley, Missouri 63134

Mr. Larry Birkla
City Manager
City of Berkeley
6140 North Hanley Road
Berkeley, Missouri 63134

Mr. Vijay K. Bhasin, P.E., Director
Division of Public Works
City of Berkeley
6140 North Hanley Road
Berkeley, Missouri 63134

Honorable Vincent C. Schoemehl
Mayor, City of St. Louis
Tucker and Market Streets
St. Louis, Missouri 63103

Mr. Robert H. Dierker, Jr.
Assistant City Counselor
City of St. Louis
314 City Hall
St. Louis, Missouri 63103

Dr. William B. Hope, Jr.
Health Commissioner
City of St. Louis
Department of Health and Hospitals
Division of Health
P.O. Box 14702
St. Louis, Missouri 63178-4702

Honorable Robert Feigenbaum
Redacted - Privacy Act

Mr. Leonard L. Griggs, Jr.
Director of Airports
Lambert-St. Louis International Airport
Post Office Box 10036
St. Louis, Missouri 63145

Mr. Gene McNary
County Executive
County Government Center
Clayton, Missouri 63105

Mr. Blaine Rhoades
County Health Department
801 South Brentwood Boulevard
Clayton, Missouri 63150

Honorable E. W. Abram
Mayor, City of Bridgeton
11955 Natural Bridge Road
Bridgeton, Missouri 63044

Congressional:

Honorable Thomas Eagleton
U.S. Senate
1209 Dirksen Office Building
Washington, D.C. 20510

Mr. Gene Bickel
Senator Eagleton's Office
320 Jackson Street
Jefferson City, Missouri 65101

Mr. Mark Van Matre
Senator Eagleton's Office
815 Olive Street, Room 224
St. Louis, Missouri 63101

Honorable John Danforth
U.S. Senate
460 Russell Office Building
Washington, D.C. 20510

Ms. Clair Elsberry
Senator Danforth's Office
1223 Jefferson Street
Jefferson City, Missouri 65101

Mr. Rod McDonald
Senator Danforth's Office
815 Oliver Street, Room 228
St. Louis, Missouri 63101

Honorable Robert Young
U.S. House of Representatives
1317 Longworth Building
Washington, D.C. 20515

Mr. Gary Olmstead
Congressman Young's Office
4105 Cypress Road
St. Ann, Missouri 63074

Honorable William Clay
U.S. House of Representatives
2264 Rayburn Office Building
Washington, D.C. 20515

Honorable Harold Volkmer
U.S. House of Representatives
1007 Longworth Building
Washington, D.C. 20515

Mr. L. J. Peery, Science Consultant
Senate Research Staff
Senate Post office
State Capital
Jefferson City, Missouri 65101

Honorable Edwin L. Dirck
Missouri State Senate
State Capital
Jefferson City, Missouri 65101

Honorable Fred Dyer
Missouri State Senator
1025 Sherbrook
St. Charles, Missouri 63301

Honorable Neil Molloy
Missouri House of Representatives
State Capital
Jefferson City, Missouri 65101

Honorable James Russell
Missouri House of Representatives
District 75
State Capital
Jefferson City, Missouri 65101

Honorable Judith O'Connor
Missouri House of Representatives
District 76
State Capital
Jefferson City, Missouri 65101

Honorable George Dames
Member, Missouri House of Representatives
Route #3, Box 82
O'Fallon, Missouri 63366

Honorable Joan Tobin
Member, Missouri House of Representatives
39 Rue Grand
Lake St. Loius, Missouri 63367

Honorable Thomas Barklage
Member, Missouri House of Representatives
1 Johns Drive
St. Charles, Missouri 63301

Library:

Reference Librarian
St. Louis County Library
1640 Lindbergh Boulevard
St. Louis, Missouri 63131

Miscellaneous:

Mr. Park Owen (2 copies)
Remedial Action Program Information Center
Oak Ridge National Laboratory
Martin Marietta Energy Systems, Inc.
Post Office Box X
Oak Ridge, Tennessee 37831

Distribution (27 copies)
Office of Scientific and Technical Information
U.S. Department of Energy
Post office Box 62
Oak Ridge, Tennessee 37831

Mr. J. P. Corley
Battelle Pacific Northwest Laboratories
Post Office Box 999
Richland, Washington 99352

Ms. Pam Merry-Libby (3 copies)
Division of Environmental Impact Studies
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Ms. Meredith Bollmeier
Redacted - Privacy Act
Redacted - Privacy Act

Mrs. Kay Drey
Redacted - Privacy Act
Redacted - Privacy Act

Ms. Pat Hicks
Public Relations Director
Mallinckrodt, Inc.
Post Office Box 5840
St. Louis, Missouri 63134

Mr. E. Dean Jarboe
Futura Coatings
9200 Latty Avenue
Hazelwood, Missouri 63042

Mr. Lenore Loeb
First Vice President
League of Women Voters of Missouri
2138 Woodson Road
St. Louis, Missouri 63114

Mr. George Rifakes
Cotter Corporation
Post Office Box 767
Chicago, Illinois 60690

Mr. J. L. Tuepker
Vice President for Production
St. Louis County Water Company
535 N. New Ballas Road
St. Louis, Missouri 63141

Mr. Robert M. Wester, President
R. M. Wester and Associates, Inc.
3317 Highway 94 North
St. Charles, Missouri 63301

DOE-Headquarters:

Mr. David S. Devane, Director, Press Services
Office of Communications
CP-22, Room 8G-082, HQ, FORSTL

Mr. John R. Barber (10 copies)
Office of Environmental Audit and Compliance
EH-24, Room 7A-075, HQ, FORSTL

Mr. William R. Voigt, Jr., Director
Office of Remedial Action and Waste Technology
NE-20, Room E-435, HQ, GTN

Mr. John E. Baublitz, Acting Deputy Director
Office of Remedial Action and Waste Technology
NE-20, Room E-420, HQ, GTN

Mr. Edward G. Delaney, Director
Division of Facility and Site Decommissioning
NE-23, Room E-423, HQ, GTN

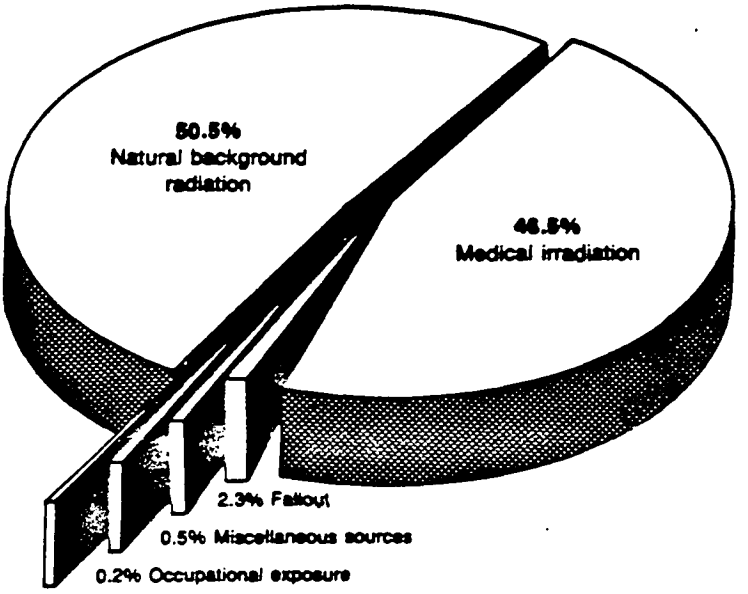
Ms. Gale Turi
Office of Facility and Site Decommissioning
NE-23, Room E-428, HQ, GTN

DOE-ORO:

J. W. Range, M-4 (3 copies)
G. W. Benedict, CE-50
S. W. Ahrends, CE-53
L. F. Campbell, CE-53
J. F. Wing, CE-53
B. G. Bowles, CE-53
S. K. Oldham, CE-53
R. L. Egli, SE-30
D. B. Howard, SE-33
B. J. Davis, SE-33 (5 copies)

Radiation in the Environment

Radiation is a natural part of our environment. When our planet was formed, radiation was present—and radiation surrounds it still. Natural radiation showers down from the distant reaches of the cosmos and continuously radiates from the rocks, soil, and water on the Earth itself.



Source: National Academy of Sciences, 1980; National Council of Radiation Protection and Measurement

During the last century, mankind has discovered radiation, how to use it, and how to control it. As a result, some manmade radiation has been added to the natural amounts present in our environment.

Many materials—both natural and manmade—that we come in contact with in our everyday lives are radioactive. These materials are composed of atoms that are unstable. The unstable atoms release particles or waves as they change into more stable forms. These particles and waves are collectively referred to as *radiation*, and a quantity of the unstable atoms is referred to as *radioactivity*.

Types of Ionizing Radiation

Radiation that has enough energy to disturb the electrical balance in the atoms of substances it passes through is called *ionizing radiation*. There are three basic forms of ionizing radiation.

Alpha

Alpha particles are the largest and slowest moving type of radiation. They are easily stopped by a sheet of paper or the skin. Alpha particles can only move through the air a few inches before being stopped by air molecules. However, alpha radiation is dangerous to sensitive tissue inside the body.

Beta

Beta particles are much smaller and faster moving than alpha particles. Beta particles pass through paper and can travel in the air for about 10 feet. However, they may be stopped by thin shielding such as a sheet of aluminum foil.

Gamma

Gamma radiation is a type of electromagnetic wave that travels at the speed of light. It takes a thick wall of steel, lead, or concrete to stop gamma rays. X rays and cosmic rays are similar to gamma radiation. X rays are produced by manmade devices; cosmic rays reach Earth from outer space.

References

Effect of Ionizing Radiation on Human Health, The. Arthur C. Upton. New York University Medical Center. Atomic Industrial Forum, 1984.

Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980. Committee on the Biological Effects of Ionizing Radiations. National Academy Press, 1984.

Radiation Exposure from Consumer Products and Miscellaneous Sources: Report Number 56. National Council on Radiation Protection and Measurements, 1977.

Radiation in Medicine and Industry. A.P. Jacobson and G.P. Sakolosky, 1980.

Radioactivity in Consumer Products. U.S. Nuclear Regulatory Commission, 1978.