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**Annual Environmental Monitoring
Report: Calendar Year 1981**

Billy M. Farmer and Daniel G. Carfagno

April 21, 1982

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Monsanto

MOUND FACILITY

Miamisburg, Ohio 45342

operated by

MONSANTO RESEARCH CORPORATION

a subsidiary of Monsanto Company

for the

U. S. DEPARTMENT OF ENERGY

Contract No. DE-AC04-76-DP00053

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Foreword

This report was prepared by the Environmental Assessment and Planning Section of the Administrative Services Department at Monsanto Research Corporation - Mound. Sample analyses and data reduction were performed by the Environmental Laboratory Group of the Environmental Assessment and Planning Section. Particulate samples offsite were collected by the Air Pollution Control Section of the Montgomery County Combined General Health District, which acts as the Regional Air Pollution Control Agency in this area for the Ohio Environmental Protection Agency. All other sampling was performed by EA&P personnel.

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Introduction

Monsanto Research Corporation - Mound is situated on 180 acres of land in Miamisburg, Ohio. This location is approximately 16 km (10 mi) southwest of Dayton, Ohio. The predominant geographical feature in the five-county region surrounding Mound is the Great Miami River, which flows from northeast to southwest through Miamisburg. The river valley is highly industrialized. The remainder of the region is predominantly farm land,

dotted with some light industry and small communities. The locations and populations of these communities are shown in Figure 1. Figure 2 shows the population distribution surrounding Mound. Drinking water for the area is obtained from a buried valley aquifer that generally follows the Great Miami River. The primary agricultural activity in the area is raising field crops such as corn and soybeans. Approximately 10% of the land in agricultural use is devoted to pasturing livestock [1].

FIGURE 1 - Offsite air sampling locations.

FIGURE 2 - 1970 population within 50 miles of Mound Facility.

Climate conditions in the area are moderate. The average annual precipitation is 91 cm (36 in.) and is evenly distributed throughout the year. Winds are predominantly from the south or west, except during the summer, when they are more frequently recorded from out of the southwest [2]. The annual average wind speed measured at Mound was 4.6 m/s (10.3 mi/hr) for 1981. Figure 3 shows the wind rose compiled at Mound and Table 1 shows average wind speed and percent frequency for each of 16 wind directions.

FIGURE 3 - The relative frequency of winds from different directions for Mound.

Table 1 - AVERAGE ANNUAL PERCENT FREQUENCY OF WIND DIRECTION AND AVERAGE WIND SPEED (M/S) FOR 1981

<u>Direction</u>	<u>Percent</u>	<u>Average Speed (M/S)</u>
N	4.4	4.2
NNE	4.8	4.0
NE	4.4	3.6
ENE	4.1	3.7
E	4.4	3.8
ESE	4.8	4.0
SE	6.6	4.6
SSE	9.3	5.2
S	9.5	5.0
SSW	6.9	4.9
SW	10.3	6.1
WSW	8.4	5.4
W	5.1	4.8
WNW	4.2	4.9
NW	5.9	4.8
NNW	5.4	4.7
CALM	1.5	-
Total	100	4.6

Mound began operations in 1949. Its mission currently includes 1) research, development, engineering, production, and surveillance of components for the Department of Energy (DOE) weapon programs; 2) separation, purification, and sale of stable isotopes of the noble gases; and 3) DOE programs in solar energy, fossil fuels, nuclear safeguards and waste management, heat source testing, and fusion fuel systems. The radionuclides of primary concern that result from Mound's current or past operations are plutonium-238 and tritium.

Radionuclides in particulate form are removed from process air effluents by high efficiency particulate air (HEPA) filters. The air effluents are filtered first at their points of origin (i.e., gloveboxes) and then just prior to the release point (i.e., the stack). The filtering system at the stack consists of two banks of HEPA filters in series, each bank having a collection efficiency of 99.95%. Radionuclides are removed from liquid effluents, such as process wastes, by chemical processing. Solid radioactive wastes are packaged and shipped offsite for burial at approved burial sites. Wastes generated in the processing of explosive materials are collected and disposed of according to the Army Material Command Regulation 385-100.

An onsite, sanitary waste treatment plant provides secondary treatment in accordance with U.S. Environmental Protection Agency (EPA) requirements [3], using an activated sludge process operating in the extended

aeration mode. All domestic sewage generated onsite is treated in this facility. The influent and effluent at the sewage treatment plant are also monitored for radioactivity to ensure no undetected release can occur to the environment via the sanitary sewage plant. The digested sludge from the sewage plant is shipped offsite for burial at an approved burial site. Nonradioactive solid wastes are disposed of according to a recycling and reclamation program whenever possible. White paper, scrap metal, and wood are sold for reclamation. General refuse was transported during 1981 to a sanitary landfill site approved by both the state and county. Waste solvents and chemicals are moved offsite by a commercial-industrial waste disposal firm.

Mound's compliance with regulations prescribed by DOE for the safety of its employees and the public has been demonstrated throughout the history of the facility. The fundamental objective of the Mound Environmental Control Program, an ongoing program since Mound began operations, is the containment of radioactive effluents to levels well within the existing standards. As part of this program, effluents are monitored and controlled at each operating step, resulting in no more than low-level releases of airborne or liquid wastes to the environment. Because of early detection, control techniques can be implemented, thus ensuring that concentrations are well within existing standards and meet the DOE guideline "as-low-as-reasonably-achievable" (ALARA).

As part of the Mound Environmental Program monitoring functions, air, water, vegetation, foodstuff, and sediment samples are collected from the environment at distances up to 48 km (30 mi) from Mound's boundaries. These samples are then analyzed for the specific radionuclides handled at Mound. A summary of the monitoring program is shown in Table 2.

The results of the environmental analyses for CY-1981 are provided in this report. The primary purpose of the report is to detail what impact, if any, Mound's operations have had on the adjacent environment in 1981. To meet this purpose, several calculational techniques used throughout this report should be described. The concentrations of various radionuclides reported here that result from Mound's operations are termed "incremental." The term incremental denotes a concentration value that exceeds normal environmental levels of the same radionuclide. The environmental level is that level found in the environment where Mound would have no impact. Environmental levels of radionuclides in various mediums are shown in Table 3.

To determine concentrations of radionuclides found in the environment, the instrument background and reagent blanks were subtracted from the sample count. This value was then used in averages, as opposed to using the lower detection limit (LDL), which had been the practice in past years.

For comparative purposes and for single sample evaluation, however, the lower detection limit (LDL) is shown for each set of data in this report. The LDL is the estimated standard deviation of the blanks at the 95% confidence level.

The error estimates shown with each set of data are estimates of the standard error of the estimated mean at the 95% confidence level. These values include all sources of variability including sampling, analyses, counting statistics, and the propagated error involved when subtracting the environmental levels from the actual data.

Summary

The environment locally surrounding Mound was monitored primarily for tritium and plutonium-238. The results are reported for CY-1981. The environmental medium analyzed included air, water, vegetation, foodstuffs, and sediment. The average concentrations of plutonium-238 and tritium were within the applicable standards (adopted by the U.S. DOE) for radioactive species.

Mound initiated a program in 1975 to bring Mound water wells and eight offsite wells into compliance with a proposed EPA standard for tritium in public drinking water. The new regulations reduced the federal standard for tritium by a factor of 50. Final standards were eventually promulgated for various parameters and became effective June 24, 1977. Mound's program involved an

Table 2 - MONITORING PROGRAM

	<u>Sampling Frequency</u>	<u>Parameter Measured</u>
<u>Air Surveillance</u>		
<u>Offsite</u>		
15 locations	Weekly	HTO, Pu, particulate
<u>Onsite</u>		
5 locations	Weekly	HTO, Pu, particulate
<u>Stack Emission</u>		
15 locations	Daily	HT, HTO, Pu, U
<u>Water Surveillance - Offsite</u>		
<u>River</u>		
5 locations	Daily	HTO, Pu, U
<u>Pond</u>		
8 locations	Monthly	HTO, Pu, U
<u>Municipal Drinking Water</u>		
12 locations	Quarterly	HTO, Pu
<u>Well Water</u>		
6 locations	Monthly	HTO, Pu
<u>Water Surveillance - Onsite</u>		
<u>Effluent Water</u>		
3 locations	Daily	Flow, suspended solids, BOD ₅ , fecal coliform, pH, oil & grease, COD, residual chlorine, dissolved solids, cyanide, chromium, cadmium, nickel, copper, HTO, Pu, U
<u>Silt Surveillance - Offsite</u>		
<u>River</u>		
5 locations	Quarterly	Pu
<u>Pond</u>		
8 locations	Quarterly	Pu
<u>Vegetation and Foodstuff Surveillance</u>		
<u>Vegetation</u>		
3 locations	Biannually	HTO, Pu
<u>Foodstuffs</u>		
3 locations	Annually	HTO, Pu
<u>Environmental Level Surveillance</u>		
<u>Four Media</u>		
6 locations	Quarterly	HTO, Pu

Table 3 - ENVIRONMENTAL CONCENTRATIONS OF RADIONUCLIDES IN VARIOUS MEDIUMS

Plutonium-238 in air ^a	=	0.01	± 0.03	$\times 10^{-17}$	µCi/ml
Tritium oxide in air ^a	=	0.65	± 0.24	$\times 10^{-11}$	µCi/ml
Plutonium-238 in river water ^b	=	1.9	± 3	$\times 10^{-12}$	µCi/ml
Tritium in river water ^b	=	0.21	± 0.13	$\times 10^{-6}$	µCi/ml
Plutonium-238 in surface water ^c	=	2.5	± 5.2	$\times 10^{-12}$	µCi/ml
Tritium in surface water ^c	=	0.28	± 0.15	$\times 10^{-6}$	µCi/ml
Plutonium-238 in well water ^{d,e}	=	N.D.			
Tritium in well water ^c	=	0.37	± 0.07	$\times 10^{-6}$	µCi/ml
Uranium-233, 234 in river water ^b	=	8.2	± 1.1	$\times 10^{-10}$	µCi/ml
Uranium-238 in river water ^b	=	8.2	± 1.4	$\times 10^{-10}$	µCi/ml
Plutonium-238 in river silt ^{b,e}	=	N.D.			
Plutonium-238 in surface water silt ^{c,e}	=	N.D.			
Tritium in grass ^d	=	0.38	± 0.07	$\times 10^{-6}$	µCi/g
Tritium in tomatoes ^d	=	0.58	± 0.06	$\times 10^{-6}$	µCi/g
Plutonium in grass ^{d,e}	=	N.D.			
Plutonium in potatoes ^d	=	0.00001	± 0.0003	$\times 10^{-6}$	µCi/g
Plutonium in fish ^d	=	0.000005	± 0.0001	$\times 10^{-6}$	µCi/g

^aMeasured at offsite sampler 119.

^bMeasured 20 mi upstream on Great Miami River.

^cMeasured 28 mi northwest of Mound.

^dMeasured 30 mi west of Mound.

^e(N.D.) Environmental level cannot be detected above reagent blanks.

extensive study of the water source for the local area, the Buried Valley Aquifer, and high-volume pumping of water from the aquifer with replacement by induced infiltration of water from the Great Miami River. All wells were brought into compliance, and high-volume pumping of water is now used periodically to control the concentrations of tritium. The final report was issued, and the project has been transferred to the routine environmental monitoring program.

Data concerning the emission of nonradioactive species into the atmosphere are also presented. All emissions were 5% or less of the applicable emission standard.

The average incremental concentrations of plutonium-238 and tritium oxide in air measured at all offsite locations during 1981 were 0.39×10^{-17} µCi/ml and 3.3×10^{-11} µCi/ml, respectively. These correspond to 0.02% and 0.05% of their respective Radioactivity Concentration

Introduction/Summary

Guides (RCG). Details of the applicable standards are given in the Appendix.

The average incremental concentration of plutonium-238 measured at all locations in the Great Miami River during 1981 was 1.56×10^{-12} $\mu\text{Ci/ml}$ which is 0.00008% of the RCG. The average concentration of tritium measured at all locations in the Great Miami River during CY-1981 was 0.13×10^{-6} $\mu\text{Ci/ml}$ which is 0.013% of the RCG.

Radionuclide effluent data for 1981 are summarized in Table 4.

The average incremental concentrations of plutonium-238 found during 1981 in surface and area drinking water were also a fraction of the DOE RCG. In addition, the average incremental concentration of tritium in surface water and the average concentration in area and municipal drinking water were a fraction of each respective DOE RCG and EPA standard.

Although there are no specific standards (RCG) for plutonium-238 and tritium in foodstuffs, the concentrations found, if compared to the water standard, are also

a small fraction of the RCG. No offsite soil sampling was conducted in 1981, since a soil inventory had been completed and reported for 1977. Sediment was sampled, however, at several offsite water sampling locations. No adverse impact to the environment could be determined from the radionuclide levels found in these sediments.

The dose commitment estimates indicate that, in all cases, the levels are at or within 1% of the DOE standard. The person-rem calculated to 80 km for the total population as a result of Mound operations during 1981 was 20 person-rem. Natural radiation would result in approximately 320,000 person-rem for the area.

Mound's National Pollutant Discharge Elimination System (NPDES) permit was renewed for 4 years on January 15, 1981. The monitoring requirements of the renewed permit have been modified to correspond to the effluent sampling as it is actually performed and eliminates the need to mathematically combine data to correspond to the permit requirements. The discharge from the sanitary sewage treatment plant

Table 4 - EFFLUENT DATA FOR CY-1981

<u>Radionuclide</u>	<u>Medium</u>	<u>Quantity</u>	
Tritium	air	4285	Ci
Tritium	water	22	Ci
Plutonium-238	air	0.008	mCi
Plutonium-238	water	1.11	mCi
Uranium-233, 234	water	0.61	mCi

Summary

has been permitted separately from the other contributors to the closed pipe (discharge 001 from previous permit). The discharge from the electroplating shop must now be monitored prior to mixing with other wastes. Effluent stream analyses during 1981 indicate that maximum permit limitations were exceeded on less than 2% of approximately 1200 analyses. Half of these exceptions were directly attributable to weather conditions and approximately 20% were related to maintenance operations. The remaining exceptions resulted from equipment malfunctions, plant operations which have subsequently been modified, or unknown causes (2 cases). These exceptions had no significantly adverse effect on the Great Miami River and certainly did not cause the Great Miami River to exceed Ohio Stream Standards.

The data contained in this summary demonstrate the status of compliance with various current regulatory agency standards and demonstrate Mound's emphasis on the as-low-as-reasonably-achievable (ALARA) concept.

Environmental surveillance

Quality assurance

The Mound Environmental Section quality control program is documented in a quality control manual published in 1981 [4]. The manual covers topics such as section audits, experimental errors and lower detection limits, sampling, and quality control sample assessment program. Of particular importance in a quality control program for environmental monitoring is

the determination of blank values. A blank value is obtained by carrying out a chemical analysis without a sample, but using deionized water, an unused filter paper, or only the reagents used in the analysis. Analyzing blanks is essential to verify the absence of laboratory contamination. The blank values are also used to calculate lower detection limits.

The principal external part of the quality control program involves Mound's participation in DOE's Quality Assessment Program. This program was conducted by the Department of Energy's Environmental Measurements Laboratory (EML), which prepared "reference" samples for analysis by DOE laboratories throughout the country. Beginning with the last quarter of 1976 and through the last quarter of 1979, a set of reference samples was made available each quarter; the reference samples contained radioisotopes of known concentrations. In 1980 and 1981 the samples were made available only twice a year, but did contain both radioactive and nonradioactive constituents of known concentration.

Mound received the samples as unknowns, analyzed the samples, and sent the results to EML. Mound received a computer printout of its own results, EML's reference concentrations, and the results of other participating laboratories within 6 weeks. Results of significance to the environmental monitoring program at Mound are summarized in Tables 5 and 6. Table 5 gives data for radioactive parameters, and Table 6, for nonradioactive parameters. The ratio of the concentration determined by Mound to the concentration determined

Summary/Quality Assurance

by EML is given in the last column of Tables 5 and 6. If Mound's experimental errors and EML's errors are taken into consideration, then a "Mound to EML" concentration ratio between 0.80 and 1.20 is generally acceptable.

In Table 5, Mound's plutonium-238 in soil values differed considerably from EML's values. These low plutonium-238 concentrations, however, are approaching Mound's estimated Lower Detection Limit of 0.001 pCi/g for a 25 g sample (Table 27). It should also be noted with soil sample 8104 that no laboratory analyzing this sample was within 20% of the EML value,

and four DOE contractor laboratories differed from EML by a factor greater than 4.3. The Mound plutonium-239 concentrations in soil at levels of 0.7 and 0.07 pCi/g agree with the EML values to within about 20%. All other radionuclide concentrations in Table 5, and the metal and anion concentrations in Table 6 determined by Mound agree with the reference EML values to within 10%.

In summary, the good results obtained by Mound in the DOE Quality Assessment Program indicate good reliability of the data generated in the routine environmental monitoring program at Mound.

Table 5 - MOUND'S DOE QUALITY ASSESSMENT
PROGRAM RESULTS FOR 1981 - RADIONUCLIDES

Sample Type	Sample No.	Isotope Determined	Concentration ^a		Concentration Ratio Mound to EML
			Mound	EML	
Air	8104	Pu-238	3.81	3.70	1.03
		Pu-239	5.68	5.60	1.01
Air	8110	Pu-239	1.29	1.30	0.99
Water	8104	H-3	24.0	24.6	0.98
Water	8110	H-3	15.6	15.6	1.00
Water	8104	Pu-239	0.005	0.0055	0.91
		U-234	0.005	0.0051	0.98
		U-238	0.005	0.0051	0.98
Water	8110	Pu-239	0.003	0.0033	0.91
		U-234	0.016	0.0175	0.91
		U-238	0.016	0.0175	0.91
Soil	8104	Pu-238	0.006	0.0014	4.3
		Pu-239	0.87	0.72	1.21
Soil	8110	Pu-238	0.001	0.0025	0.40
		Pu-239	0.061	0.077	0.79

^aAir concentrations are pCi/filter; water concentrations are pCi/ml; and soil and vegetation concentrations are pCi/g.

Table 6 - MOUND'S DOE QUALITY ASSESSMENT PROGRAM RESULTS
FOR 1981 - NONRADIOACTIVE PARAMETERS IN WATER

Sample No.	Trace Constituent	Concentration (µg/ml)		Concentration Ratio Mound to EML
		Mound	EML	
8104 (AA) ^a	Cu	1.72	1.61	1.07
	Mn	3.28	3.23	1.02
	Pb	3.25	3.23	1.01
	Zn	1.63	1.61	1.01
	Mg	4.10	3.98	1.03
	Na	8.56	9.15	0.94
8110 (AA) ^a	Cu	3.9	3.80	1.03
	Mn	7.1	7.05	1.01
	Pb	10.7	10.9	0.98
	Zn	2.5	2.71	0.92
8110 (ICAP) ^b	Al	16	16.3	0.98
	Cu	3.9	3.8	1.03
	Mn	6.8	7.05	0.96
	Pb	10.9	10.9	1.00
	V	13.0	13.6	0.96
	Zn	2.6	2.71	0.96
8110 (IC) ^c	SO ₄ ²⁻	47	47.5	0.99
	NO ₃ ⁻	18	16.3	1.10
	Cl ⁻	15.2	15.1	1.01

^aAtomic absorption values determined by Environmental Laboratories Group.

^bICAP emission spectroscopy values determined by Nuclear Operations Analytical.

^cIon chromatography values determined by Nuclear Operations Analytical.

Air - Radioactive

The offsite air-sampling network during 1981 consisted of 15 continuously operating air-sampling stations used for sampling both tritium oxide and plutonium. Ten sampling stations are located within a 1.6 km (1 mi) radius of Mound, and four samplers are located in or near population centers. The remaining sampler (#119) is approximately 44.8 km (28 mi) from Mound in the least prevailing wind direction. This sampler receives no measurable contribution from Mound operations and serves as a baseline sample for computing environmental levels.

The levels from sampler #119 are subtracted from levels detected at other locations. The samplers currently in operation are located at critical distances and directions, based on a diffusion model developed for Mound. The locations of the sampling stations are shown in Figure 1.

Two types of samples are collected at each sampling station. One is a particulate air sample for plutonium-238 analysis, and the other, from a bubbler-type sampler, is for tritium oxide analysis. The particulate sample is collected on a 200-mm

Quality Assurance/Air Radioactive

diameter Microsorban disk by a continuously operating (24 hr/day, 7 days/week) high-volume air sampler. The air is sampled at an average rate of $1.3 \times 10^6 \text{ cm}^3/\text{min}$ ($\sim 45 \text{ ft}^3/\text{min}$). The Microsorban disk is changed weekly, and represents a sample of approximately $13,000 \text{ m}^3$ of air.

Plutonium-238 analyses were performed on a monthly composite for three sampling locations, #122, #123, and #124, and on quarterly composites for the other off-site locations.

The analytical scheme for plutonium-238 incorporates the following basic steps: addition of a known amount of plutonium-242 tracer, ignition to 600°C , leaching with nitric acid, separation of plutonium with anion exchange resin, electro-deposition of plutonium, and, finally, alpha spectrometry.

The average incremental offsite plutonium-238 air concentration for all locations was $0.39 \times 10^{-17} \text{ } \mu\text{Ci/ml}$ which is 0.02% of the DOE RCG. The RCG used for comparison is the guide for the soluble form of the isotope and for the general population. This is the most restrictive RCG for plutonium-238 and is applied since the solubility of the measured particles in the human body is unknown. The analytical results are summarized in Table 7.

Table 8 shows concentrations of plutonium-239, plutonium-240, and plutonium-238, including environmental levels, so that a ratio comparison between these radionuclides can be made. Ratios greater than

that observed at location #119 (~ 0.01) result from a concentration of plutonium-238 in excess of that from atmospheric fallout and are indicative of the influence of Mound operations.

The concentration of plutonium-239 in air during 1981 increased approximately by a factor of four compared to 1980. This increase is most likely due to atmospheric weapons testing by the People's Republic of China in October, 1980. Figure 4 shows the concentration of plutonium-239 for the past ten years. The pronounced peaks show the increase which is observed during the spring season each year. The magnitude of the spring time peak had been decreasing during 1979 and 1980, but a significant increase was observed in 1981.

The gas bubbler sample is also collected on a continuous basis by bubbling air at approximately $3 \times 10^3 \text{ cm}^3/\text{min}$ through 200 ml of ethylene glycol. Ethylene glycol is used because this material eliminates evaporation and freezing problems associated with sample collection [5]. Tritium (oxide) in the air is collected in the solution. Tritium oxide rather than elemental tritium is sampled and analyzed because the RCG for the oxide is 200 times more restrictive than it is for elemental tritium [6]. A sample representing $\sim 30 \text{ m}^3$ of air is collected, and an aliquot representing 1.5 m^3 is counted in a liquid scintillation spectrometer. The average incremental concentration of tritium oxide measured during 1981 for all offsite locations, not including the environmental level found at sampler #119, was $3.3 \times 10^{-11} \text{ } \mu\text{Ci/ml}$. This concentration is 0.05% of the RCG. The RCG used

Table 7 - INCREMENTAL CONCENTRATIONS OF PLUTONIUM-238
IN AIR AT OFFSITE SAMPLING LOCATIONS IN 1981

Location	Number of Samples	Range ^d (10^{-17} μ Ci/ml)	Average ^{a,c,d,e} (10^{-17} μ Ci/ml)	Percent of RCG ^b
101	4	0.02 - 0.26	0.11 ± 0.16	0.006
102	4	0.22 - 0.57	0.4 ± 0.22	0.02
103	4	0.29 - 1.43	0.7 ± 0.79	0.04
104	4	0.19 - 0.35	0.25 ± 0.09	0.01
105	4	0.07 - 0.12	0.09 ± 0.04	0.005
108	4	E.L. - 0.09	0.04 ± 0.07	0.002
110	4	E.L. - 0.22	0.09 ± 0.16	0.005
111	4	0.02 - 0.06	0.03 ± 0.04	0.002
112	4	0.03 - 0.11	0.06 ± 0.07	0.003
115	3	0.03 - 0.09	0.06 ± 0.08	0.003
118	4	0.09 - 0.34	0.22 ± 0.19	0.01
122	12	E.L. - 0.37	0.16 ± 0.09	0.008
123	12	0.12 - 10.9	1.65 ± 1.87	0.08
124	12	E.L. - 9.42	1.58 ± 1.65	0.08

^aLower Detection Limit (LDL) for ^{238}Pu in air for quarterly samples is 0.03×10^{-17} μ Ci/ml. This is 0.0015% of the RCG.

^bRadioactivity Concentration Guide (RCG) = 2000×10^{-17} μ Ci/ml for the soluble form of ^{238}Pu for the general population.

^cError limits are estimates of the standard error of the estimated means at the 95% confidence level.

^dAverage environmental level (E.L.) subtracted from data.

^eLower Detection Limit (LDL) for ^{238}Pu in air for monthly samples is 0.17×10^{-17} μ Ci/ml. This is 0.0085% of the RCG.

Table 8 - CONCENTRATION OF PLUTONIUM INCLUDING ENVIRONMENTAL LEVELS IN AIR AT OFFSITE SAMPLING LOCATIONS IN 1981

Location	Number of Samples	$^{239,240}\text{Pu}$		^{238}Pu	Ratio $^{238}\text{Pu}/^{239,240}\text{Pu}$
		Range (10^{-17} $\mu\text{Ci/ml}$)	Average ^{a,b} (10^{-17} $\mu\text{Ci/ml}$)	Average ^{a,b} (10^{-17} $\mu\text{Ci/ml}$)	
101	4	0.42 - 4.62	1.86 ± 2.97	0.12 ± 0.16	0.06
102	4	0.24 - 4.36	1.83 ± 2.78	0.47 ± 0.22	0.22
103	4	0.29 - 4.24	1.77 ± 2.72	0.71 ± 0.79	0.4
104	4	0.27 - 3.99	1.71 ± 2.53	0.26 ± 0.09	0.15
105	4	0.21 - 3.65	1.57 ± 2.31	0.1 ± 0.03	0.06
108	4	0.34 - 5.75	2.32 ± 3.73	0.05 ± 0.06	0.02
110	4	0.26 - 4.54	1.84 ± 2.97	0.1 ± 0.16	0.05
111	4	0.22 - 4.38	1.77 ± 2.84	0.04 ± 0.03	0.02
112	4	0.22 - 4.26	1.74 ± 2.75	0.07 ± 0.06	0.04
115	3	1.1 - 3.47	1.93 ± 3.21	0.07 ± 0.08	0.04
118	4	0.24 - 4.81	2.04 ± 3.07	0.23 ± 0.19	0.11
119	4	0.23 - 4.02	1.63 ± 2.62	0.01 ± 0.03	0.006
122	12	0.13 - 3.59	1.3 ± 0.77	0.17 ± 0.09	0.13
123	12	0.22 - 4.86	1.71 ± 1.01	1.66 ± 1.87	0.97
124	12	0.18 - 4.63	1.7 ± 1.01	1.59 ± 1.65	0.94

^aLower Detection Limit (LDL) for $^{239,240}\text{Pu}$ in air for samplers 101 through 119 is 0.01×10^{-17} $\mu\text{Ci/ml}$, and the LDL for samplers 122 through 124 is 0.03×10^{-17} $\mu\text{Ci/ml}$. The LDL for ^{238}Pu is 0.03×10^{-17} $\mu\text{Ci/ml}$ for samplers 101 through 119 and 0.17×10^{-17} $\mu\text{Ci/ml}$ for samplers 122 through 124.

^bError limits are estimates of the standard error of the estimated means at the 95% confidence level.

FIGURE 4 - Concentration of Pu-239 in air since 1972.

for comparison is the most restrictive RCG for tritium for the general population. The results are summarized in Table 9. Table 3 shows environmental levels for plutonium-238 and tritium in air as measured at sampler #119.

An onsite perimeter network consisting of five continuous, high-volume air samplers is used to further assess the effectiveness of stack emission control systems. The onsite sampling locations are shown in Figure 5. Particulate samples and tritium samples are collected by the onsite samplers at approximately the same flow rate as the offsite samplers and are analyzed in the same manner.

The average incremental plutonium-238 concentration measured for all locations onsite is 9.3×10^{-17} $\mu\text{Ci/ml}$ which is 0.13% of the RCG. The results are summarized in Table 10. Table 11 presents onsite concentrations of plutonium-239, plutonium-240, and plutonium-238, including

environmental levels, so that a ratio comparison between these radionuclides can be made.

The average incremental onsite tritium oxide concentration for all locations was 5.86×10^{-11} $\mu\text{Ci/ml}$ which is 0.03% of the RCG. The results are summarized in Table 12.

The RCGs used for onsite comparison are those applicable for exposed individuals in the population. The total amounts of plutonium-238 and tritium discharged to the atmosphere during 1981 were 0.008 mCi and 4285 Ci, respectively.

Air - Nonradioactive

The Mound steam power plant is normally fueled with natural gas but has the capability to burn fuel oil. During unusually cold weather, if the natural gas supply to Mound is interrupted, fuel oil with <1% sulfur content is burned. No fuel oil was burned during 1981.

Additional sources of airborne emissions are as follows. A waterwash, paint spray booth is operated intermittently in the Mound paint shop. Wastes from operations involving explosives are disposed of by open burning under a permit issued by the Regional Air Pollution Control Agency (RAPCA). A maintenance grinding operation and a carpenter shop are operated on an intermittent basis. Fire-fighter training exercises are held at an open outdoor facility under a burning permit issued by RAPCA.

Air-Radioactive/Air-Nonradioactive

Table 9 - INCREMENTAL CONCENTRATIONS OF TRITIUM
OXIDE IN AIR AT OFFSITE SAMPLING LOCATIONS IN 1981

Location	Number of Samples	Tritium Oxide		Percent of RCG ^b
		Range ^d (10 ⁻¹¹ μ Ci/ml)	Average ^{a,c,d} (10 ⁻¹¹ μ Ci/ml)	
101	50	E.L. - 36.9	7.02 $\pm$ 1.87	0.1
102	51	0.02 - 35.7	6.1 $\pm$ 1.72	0.09
103	51	E.L. - 66.6	6.17 $\pm$ 2.68	0.09
104	51	E.L. - 23.3	2.92 $\pm$ 1.25	0.04
105	51	E.L. - 12.9	2.25 $\pm$ 0.91	0.03
108	49	E.L. - 8.64	1.1 $\pm$ 0.59	0.02
110	52	E.L. - 9.14	1.19 $\pm$ 0.59	0.02
111	49	E.L. - 7.97	0.72 $\pm$ 0.63	0.01
112	51	E.L. - 9.17	1.29 $\pm$ 0.66	0.02
115	50	E.L. - 3.07	0.16 $\pm$ 0.35	0.002
118	49	E.L. - 84.6	3.12 $\pm$ 3.47	0.04
122	52	E.L. - 51.4	3.19 $\pm$ 2.04	0.05
123	51	E.L. - 77.6	5.26 $\pm$ 3.53	0.08
124	50	E.L. - 89.9	5.94 $\pm$ 4.01	0.08

^a Lower Detection Limit (LDL) for tritium oxide in air is 0.7×10^{-11} μ Ci/ml which is 0.01% of the RCG.

^b Radioactivity Concentration Guide (RCG) = 7000×10^{-11} μ Ci/ml for the general population and for soluble form of tritium.

^c Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

^d Average environmental level (E.L.) subtracted from data.

FIGURE 5 - Onsite air sampling locations.

Table 10 - INCREMENTAL CONCENTRATION OF PLUTONIUM-238
IN AIR AT ONSITE SAMPLING LOCATIONS IN 1981

Location	Number of Samples	Range ^d (10 ⁻¹⁷ μ Ci/ml)	Average ^{a,c,d} (10 ⁻¹⁷ μ Ci/ml)	Percent of RCG ^b
211	12	1.66 - 204	36.4 $\pm$ 39.2	0.52
212	12	0.07 - 3.47	1.03 $\pm$ 0.59	0.02
213	12	1.16 - 26.8	6.61 $\pm$ 5.28	0.09
214	12	0.32 - 8.81	2.07 $\pm$ 1.45	0.03
215	12	0.16 - 1.44	0.6 $\pm$ 0.29	0.009

^a Lower Detection Limit (LDL) for ²³⁸Pu in air is 0.17×10^{-17} μ Ci/ml which is 0.002% of the RCG.

^b Radioactivity Concentration Guide (RCG) = 7000×10^{-17} μ Ci/ml for the soluble form of plutonium-238 for individuals in the population.

^c Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

^d Average environmental level (E.L.) subtracted from data.

Table 11 - CONCENTRATION OF PLUTONIUM INCLUDING ENVIRONMENTAL
LEVELS IN AIR AT ONSITE SAMPLING LOCATIONS IN 1981

Location	Number of Samples	^{239,240} Pu		²³⁸ Pu	Ratio ²³⁸ Pu/ ^{239,240} Pu
		Range (10 ⁻¹⁷ μ Ci/ml)	Average ^{a,b} (10 ⁻¹⁷ μ Ci/ml)	Average ^{a,b} (10 ⁻¹⁷ μ Ci/ml)	
211	12	0.21 - 4.79	1.66 $\pm$ 0.88	36.4 $\pm$ 39.2	21.9
212	12	0.12 - 3.92	1.26 $\pm$ 0.75	1.04 $\pm$ 0.59	0.83
213	12	0.12 - 3.62	1.36 $\pm$ 0.79	6.62 $\pm$ 5.28	4.87
214	12	0.23 - 3.65	1.38 $\pm$ 0.77	2.08 $\pm$ 1.45	1.51
215	12	0.12 - 3.71	1.48 $\pm$ 0.86	0.61 $\pm$ 0.29	0.41

^a Lower Detection Limit (LDL) for ^{239,240}Pu in air is 0.03×10^{-17} μ Ci/ml. The LDL for ²³⁸Pu is 0.17×10^{-17} μ Ci/ml.

^b Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

Emissions from sources registered with the Regional Air pollution Control Agency (RAPCA) and the Ohio EPA for which applicable emission standards exist are summarized in Table 13. The emissions were

estimated from emission factors established by the U.S. EPA or from material balances [7]. The particulates from the grinding and carpenter shop operations are captured by cyclone air cleaners rated at 95%

Table 12 - INCREMENTAL CONCENTRATION OF TRITIUM OXIDE IN AIR AT ONSITE SAMPLING LOCATIONS IN 1981

Location	Number of Samples	Tritium Oxide		Percent of RCG ^b
		Range ^d (10 ⁻¹¹ μ Ci/ml)	Average ^{a,c,d} (10 ⁻¹¹ μ Ci/ml)	
211	51	E.L. - 43.4	7.18 $\pm$ 2.08	0.04
212	52	E.L. - 45.5	6.76 $\pm$ 1.96	0.03
213	49	E.L. - 72.6	7.85 $\pm$ 3.01	0.04
214	48	E.L. - 24.7	4.45 $\pm$ 1.45	0.02
215	50	E.L. - 32.9	3.04 $\pm$ 1.45	0.02

^aLower Detection Limit (LDL) for tritium oxide in air is 0.7×10^{-11} μ Ci/ml which is 0.004% of the RCG.

^bRadioactivity Concentration Guide (RCG) = $20,000 \times 10^{-11}$ μ Ci/ml for individuals in the population and soluble form of tritium.

^cError limits are estimates of the standard error of the estimated means at the 95% confidence level.

^dAverage environmental level (E.L.) subtracted from data.

Table 13 - NONRADIOACTIVE AIRBORNE EMISSIONS 1981

<u>Emission Source</u>	<u>Pollutant</u>	<u>Emission</u>	<u>Emission Standard^a</u>	<u>% of Standard</u>
Power House	Particulates	0.01 lb/10 ⁶ Btu Input	0.20 lb/10 ⁶ Btu Input	5
Power House	Sulfur Oxides	0.0006 lb/10 ⁶ Btu Input	1.6 lb/10 ⁶ Btu Input	0.04
Paint Shop	Organics	0.29 lb/day	40 lb/day	0.7
Explosives Burning	Particulates	18 lb	NA	NA
Fire Fighter Training	Particulates	475 lb	NA	NA

^aOhio EPA Air Pollution Regulations 3745-17-01 through 3745-17-13 and 3745-21-01 through 3745-21-08.

NA - not applicable.

efficiency. Nonradioactive airborne emissions at Mound were all within applicable standards and had minimal impact on ambient air quality. This is further demonstrated by the particulate concentration data summarized in Tables 14 and 15. The data presented are weekly particulate concentrations measured at Mound's offsite and onsite air-sampling sites.

The particulate concentration at onsite locations is somewhat lower than at off-site locations. The particulate concentration also appears to be independent of distance from Mound. This would suggest no influence from Mound operations. For comparison purposes, the State of Ohio - Ambient Quality Standard for airborne particulates is also given in Table 14.

Table 14 - 1981 WEEKLY PARTICULATE CONCENTRATION DATA OFFSITE^a

<u>Location</u>	<u>Number of Samples</u>	<u>Range ($\mu\text{g}/\text{m}^3$)</u>	<u>Average ($\mu\text{g}/\text{m}^3$)^b</u>
101	52	44 - 174	103 $\pm$ 10
102	51	44 - 307	95 $\pm$ 12
103	52	31 - 227	75 $\pm$ 10
104	50	7 - 220	95 $\pm$ 11
105	52	42 - 275	82 $\pm$ 10
108	51	40 - 195	111 $\pm$ 9
110	51	17 - 139	70 $\pm$ 8
111	50	51 - 191	106 $\pm$ 10
112	50	44 - 172	88 $\pm$ 7
115	37	28 - 267	89 $\pm$ 15
118	52	27 - 194	89 $\pm$ 9
119	51	6 - 472	79 $\pm$ 19
122	49	29 - 271	67 $\pm$ 10
123	50	12 - 155	90 $\pm$ 8
124	51	10 - 319	85 $\pm$ 13

^aOhio Ambient Air Quality Standard = 60 $\mu\text{g}/\text{m}^3$.

^bError limits are estimates of the standard error of the estimated means at the 95% confidence level.

These data are obtained by the Mound air monitoring program and are indicative only of the particulate air loading of the Dayton metropolitan area. Mound particulate discharges presented in Table 13 make a negligible contribution to the surrounding area. In addition, Table 15 presents onsite particulate data.

Table 15 - 1981 WEEKLY PARTICULATE CONCENTRATION DATA ONSITE

<u>Location</u>	<u>Number of Samples</u>	<u>Range ($\mu\text{g}/\text{m}^3$)</u>	<u>Average ($\mu\text{g}/\text{m}^3$)^a</u>
211	51	44 - 133	81 $\pm$ 7
212	50	37 - 147	72 $\pm$ 7
213	52	20 - 153	81 $\pm$ 8
214	52	15 - 124	59 $\pm$ 5
215	52	18 - 146	67 $\pm$ 6

^aError limits are estimates of the standard error of the estimated means at the 95% confidence level.

Water - Radioactive

Water sampling locations along the bank of the Great Miami River were selected according to guidelines recommended by the U.S. EPA [8]. The locations, shown in Figure 6, provide samples which are representative of river water after suitable mixing of the effluent from Mound has occurred. Water samples are normally collected and filtered in the field at these locations five days per week, and are subjected to specific analyses for plutonium-238 and tritium.

Large-volume water samples are analyzed by compositing daily samples for a quarterly analysis. The average incremental concentration of plutonium-238 measured for all locations in the Great Miami River was 1.56×10^{-12} $\mu\text{Ci}/\text{ml}$ which is 0.00008% of the RCG for the general population, the most restrictive standard for plutonium-238. These results are summarized in Table 16.

Weekly samples are analyzed for tritium. The average incremental concentration of tritium measured at all locations in the Great Miami River was 0.13×10^{-6} $\mu\text{Ci}/\text{ml}$ which is 0.013% of the RCG for the general population. These results are summarized in Table 17.

The total amounts of plutonium-238, tritium, and uranium-233, 234 discharged to the Great Miami River during 1981 were 1.11 mCi, 22 Ci, and 0.61 mCi, respectively. These concentrations were 0.02%, 1.3% and 0.003% of the most restrictive RCG for individuals in the population. It should be noted that a drainage control system consisting of retention basins and an overflow pond was placed in operation in 1979 to reduce plutonium levels in plant effluents. The system reduced the quantity of plutonium-238 discharged in 1981 by approximately 75% as compared to 1978.

Air-Nonradioactive/Water-Radioactive

FIGURE 6 - Offsite water sampling locations.

Table 16 - INCREMENTAL CONCENTRATION OF
PLUTONIUM-238 IN THE GREAT MIAMI RIVER in 1981

Location	Number of Samples ^a	Plutonium-238		Percent of RCG ^c
		Range ^d (10 ⁻¹² μ Ci/ml)	Average ^{b,d,e} (10 ⁻¹² μ Ci/ml)	
1	4	E.L. - 16	3.4 $\pm$ 14	0.0002
2	4	E.L. - 9.7	2.4 $\pm$ 8.4	0.0001
3	4	E.L. - 1.3	E.L.	-
4	4	E.L. - 4.8	2 $\pm$ 4.5	0.0001
5	4	E.L.	E.L.	-

^aComposite large volume water samples for each location from water collected during CY-1981.

^bLower Detection Limit (LDL) for ²³⁸Pu in water is 0.8×10^{-12} μ Ci/ml which is 0.00004% of the RCG.

^cRadioactivity Concentration Guide (RCG) = $2,000,000 \times 10^{-12}$ μ Ci/ml for the general population and the soluble form of plutonium-238.

^dAverage environmental level (E.L.) subtracted from data.

^eError limits are estimates of the standard error of the estimated means at the 95% confidence level.

Uranium-233, 234, and 238 were also monitored at the river water sampling locations during 1981. The average incremental concentrations of uranium-233, 234, and uranium-238 were at environmental levels shown in Table 3. In addition, as shown in Table 18, the ratio of uranium-233, 234 to uranium-238 is slightly greater than unity, which is in range of background ratios reported [9]. This is expected as a result of secular equilibrium.

Seven additional surface water locations, such as ponds, in all quadrants surrounding Mound as shown in Figure 6 are sampled quarterly for plutonium and tritium

analyses. The samples used for plutonium-238 determination are also large volume water samples. The large volume of sample increases the sensitivity of the analysis for plutonium. A smaller aliquot (10 ml) is taken which is adequate for the tritium analysis. The average concentrations of plutonium-238 and tritium for all locations were 1.08×10^{-12} μ Ci/ml and 0.1×10^{-6} μ Ci/ml, respectively, which are 0.00005% and 0.01% of the respective RCG for the general population. The results of the surface water samples are summarized in Tables 19 and 20. Environmental levels (Table 3) have been subtracted from the concentration of plutonium and tritium in water.

Water-Radioactive

Table 17 - INCREMENTAL CONCENTRATION OF TRITIUM IN THE GREAT MIAMI RIVER IN 1981

Location	Number of Samples	Tritium		Percent of RCG ^b
		Range ^d (10 ⁻⁶ μ Ci/ml)	Average ^{a,c,d} (10 ⁻⁶ μ Ci/ml)	
1	43	E.L. - 1.0	0.08 $\pm$ 0.15	0.008
2	47	E.L. - 0.6	0.08 $\pm$ 0.14	0.008
3	47	E.L. - 0.7	0.09 $\pm$ 0.14	0.009
4	47	E.L. - 0.6	0.17 $\pm$ 0.14	0.017
5	47	E.L. - 1.0	0.22 $\pm$ 0.14	0.022

^aLower Detection Limit (LDL) for tritium in water is 0.4×10^{-6} μ Ci/ml which is 0.04% of the RCG.

^bDOE Radioactivity Concentration Guide (RCG) which is compared to tritium concentration in water not used for drinking purposes = 1000×10^{-6} μ Ci/ml for the general population and the soluble form of tritium.

^cError limits are estimates of the standard error of the estimated means at the 95% confidence level.

^dAverage environmental level (E.L.) subtracted from data.

During 1981, Mound concluded a previously reported program for reducing the concentration of tritium in the local area of the Buried Valley Aquifer adjacent to the site in order to comply with new EPA Interim Primary Drinking Water Regulations which became effective in June 1977 for public water systems. The background level of tritium in the aquifer had been increased by past tritium operations at Mound. In response to this situation, releasing tritium process liquid effluents to the environment was discontinued during 1970. The natural reduction of tritium in the aquifer was augmented by forced water turnover, involving high-volume pumping

of two high-capacity wells and induced infiltration of water from the Great Miami River.

The EPA drinking water regulations, promulgated in July 1976, reduced the federal standard for tritium by a factor of 50. This great reduction resulted in Mound's three wells and eight offsite wells being out of compliance. The pumping program to remove tritiated water from the aquifer brought Mound's three wells into compliance with the new tritium standard in September 1977, and five of the affected, offsite, privately owned, wells in April 1978. By December 1980, all wells were

Table 18 - INCREMENTAL CONCENTRATION OF $^{233,234}\text{U}$ AND ^{238}U IN THE GREAT MIAMI RIVER IN 1981

Location	Number of Samples ^a	$^{233,234}\text{U}$			^{238}U			Ratio ^d $^{233,234}\text{U}/^{238}\text{U}$
		Range ^d (10^{-10} $\mu\text{Ci/ml}$)	Average ^{a,b,c,e} (10^{-10} $\mu\text{Ci/ml}$)	Percent of RCG ^{f,g}	Range ^e (10^{-10} $\mu\text{Ci/ml}$)	Average ^{a,b,c,e} (10^{-10} $\mu\text{Ci/ml}$)	Percent of RCG ^{f,g}	
1	4	E.L.	E.L.	-	E.L.	E.L.	-	1.1
2	4	E.L.	E.L.	-	E.L.	E.L.	-	1.1
3	4	E.L. - 0.02	E.L.	-	E.L.	E.L.	-	1.1
4	4	E.L.	E.L.	-	E.L.	E.L.	-	1.2
5	4	E.L.	E.L.	-	E.L.	E.L.	-	1.0

^aComposite large volume water samples for each location.

^bLower Detection Limit (LDL) for $^{233,234}\text{U}$ and ^{238}U in water is 0.31×10^{-10} $\mu\text{Ci/ml}$ and 0.11×10^{-10} $\mu\text{Ci/ml}$, respectively.

^cError limits are estimates of the standard error of the estimated means at the 95% confidence level.

^dA ratio slightly greater than unity indicates naturally occurring uranium [11]. Does not have environmental levels subtracted.

^eAverage environmental level (E.L.) subtracted from data.

^fDOE Concentration Guide (RCG) for $^{233,234}\text{U} = 100,000 \times 10^{-10}$ $\mu\text{Ci/ml}$ for the general population.

^gDOE Concentration Guide (RCG) for $^{238}\text{U} = 400,000 \times 10^{-10}$ $\mu\text{Ci/ml}$ for the general population.

Table 19 - INCREMENTAL CONCENTRATION OF
PLUTONIUM-238 IN SURFACE WATER IN 1981

Location	Number of Samples ^a	Plutonium-238		Percent of RCG ^c
		Range ^d (10 ⁻¹² μ Ci/ml)	Average ^{b,d,c} (10 ⁻¹² μ Ci/ml)	
10	4	E.L.	E.L.	-
11	4	E.L.	E.L.	-
12	4	E.L. - 3.2	0.1 $\pm$ 6.7	0.000005
13	4	E.L.	E.L.	-
14	4	E.L.	E.L.	-
15	4	E.L.	E.L.	-
16	4	E.L. - 3.1	E.L.	-
17	4	E.L. - 37	8.5 $\pm$ 29	0.0004

^aComposite large volume water samples were used for each location.

^bLower Detection Limit (LDL) for ²³⁸Pu in water is 0.8×10^{-12} μ Ci/ml which is 0.00004% of the RCG.

^cRadioactivity Concentration Guide (RCG) for ²³⁸Pu in water = 2,000,000 $\times 10^{-12}$ μ Ci/ml for the general population and soluble form of plutonium-238.

^dError limits are estimates of the standard error of the estimated means at the 95% confidence level.

in compliance with the EPA standard. The average concentration of tritium in all affected offsite wells during 1981 was 11×10^{-6} μ Ci/ml or 45% below the EPA standard. Periodic pumping of the aquifer continued in 1981 and will be used to maintain the wells in compliance until data indicate that the pumping can be terminated. Additional details concerning this program have been reported by Styron and Meyer [10]. Analytical results from the private wells are summarized in Table 21.

Drinking water from communities in the surrounding area is sampled and analyzed quarterly for tritium. These communities and their relative locations are shown in Figure 1. The average concentration of

tritium for all locations was 0.6×10^{-6} μ Ci/ml which is 3% of the standard adopted by the U.S. EPA in 1977 for community drinking water systems. Data from the analyses of community drinking water samples are summarized in Table 22. The environmental level in Table 3 for tritium in water is not subtracted from these data.

Four private wells and Miamisburg city water were sampled and analyzed quarterly for plutonium-238. These samples were also large volume water samples. The average incremental plutonium-238 concentration for these locations was 8.3×10^{-12} μ Ci/ml which is 0.0004% of the applicable DOE RCG for the general population. These results are shown in Table 23.

Table 20 - INCREMENTAL CONCENTRATION OF TRITIUM IN SURFACE WATER IN 1981

Location	Number of Samples	Tritium		Percent of RGC ^c
		Range ^d (10 ⁻⁶ μ Ci/ml)	Average ^{a,b,d} (10 ⁻⁶ μ Ci/ml)	
10	16	E.L. - 0.4	0.03 $\pm$ 0.17	0.003
11	20	E.L. - 1.1	0.09 $\pm$ 0.2	0.009
12	19	E.L. - 0.2	E.L.	-
13	19	E.L. - 0.1	0.01 $\pm$ 0.16	0.001
14	21	E.L. - 0.4	0.17 $\pm$ 0.16	0.017
15	21	E.L. - 0.4	0.09 $\pm$ 0.17	0.009
16	19	E.L. - 0.2	0.07 $\pm$ 0.17	0.007
17	19	0.1 - 0.9	0.34 $\pm$ 0.17	0.034

^aLower Detection Limit (LDL) for tritium in water is 0.4×10^{-6} μ Ci/ml which is 0.04% of the RGC.

^bDOE Radioactivity Concentration Guide (RCG) which is compared to tritium concentration in water not used for drinking purposes = 1000×10^{-6} μ Ci/ml for the general population and soluble form of tritium.

^cError limits are estimates of the standard error of the estimated means at the 95% confidence level.

^dAverage environmental level (E.L.) subtracted from data.

Table 21 - TRITIUM IN PRIVATE WELLS IN 1981

Location	Number of Samples	Tritium		Percent Standard ^c
		Range ^e (10 ⁻⁶ μ Ci/ml)	Average ^{a,b,d,e} (10 ⁻⁶ μ Ci/ml)	
B-1	51	4 - 25	15 $\pm$ 1.6	75
B-2	4	9 - 14	11 $\pm$ 3.5	55
B-3	12	7.4 - 9.1	8.3 $\pm$ 0.4	42
J-1	12	4.9 - 9.1	6.5 $\pm$ 0.7	33
B-R	39	10 - 17	14 $\pm$ 0.5	70
B-II	52	8.4 - 17	14 $\pm$ 0.5	70

^aAll wells are now in compliance with the new EPA standard of 20×10^{-6} μ Ci/ml.

^bLower Detection Limit (LDL) for tritium in water is 0.4×10^{-6} μ Ci/ml which is 2% of the EPA Standard.

^cEPA Standard for tritium in community drinking water systems = 20×10^{-6} μ Ci/ml. Mound is using the EPA Standard as a guide for the private water supplies.

^dError limits are estimates of the standard error of the estimated means at the 95% confidence level.

^eEnvironmental level is included in these data for comparison to the EPA Standard.

Table 22 - SUMMARY OF TRITIUM LEVELS IN
COMMUNITY DRINKING WATER IN 1981

Locations	Number of Samples	Tritium		Percent Standard ^b
		Range ^d (10 ⁻⁶ μ Ci/ml)	Average ^{a,c,d} (10 ⁻⁶ μ Ci/ml)	
Bellbrook	4	0.3 - 0.5	0.4 $\pm$ 0.2	2
Centerville	4	0.4 - 0.7	0.5 $\pm$ 0.2	2.5
Dayton	4	0.3 - 0.4	0.4 $\pm$ 0.1	2
Franklin	4	0.2 - 0.6	0.5 $\pm$ 0.3	2.5
Germantown	4	0.3 - 0.5	0.4 $\pm$ 0.2	2
Kettering	4	0.3 - 0.6	0.5 $\pm$ 0.2	2.5
Miamisburg	4	1 - 5.1	2.4 $\pm$ 2.9	12
Middletown	4	0.4 - 0.5	0.4 $\pm$ 0.1	2
Moraine	4	-	0.4	2
Springboro	4	0.4 - 0.6	0.5 $\pm$ 0.1	2.5
Waynesville	4	0.2 - 0.3	0.3 $\pm$ 0.1	1.5
West Carrollton	4	0.7 - 1.1	0.9 $\pm$ 0.3	4.5

^aLower Detection Limit (LDL) for tritium oxide is 0.4×10^{-6} μ Ci/ml which is 2% of the EPA Standard for community drinking water.

^bEPA Drinking Water Standard for tritium = 20×10^{-6} μ Ci/ml for community drinking water systems.

^cError limits are estimates of the standard error of the estimated means at the 95% confidence level.

^dEnvironmental level is included in these data for comparison to the EPA Standard.

Table 23 - INCREMENTAL CONCENTRATION OF PLUTONIUM-238 IN PRIVATE
WELLS AND MIAMISBURG MUNICIPAL DRINKING WATER IN 1981

Location	Number of Samples ^a	Plutonium-238		Percent of RCG ^c
		Range ^e (10 ⁻¹² μ Ci/ml)	Average ^{b,d,e} (10 ⁻¹² μ Ci/ml)	
Miamisburg	4	0.5 - 11	3.3 $\pm$ 8	0.0002
B-1	4	1 - 8.5	3.9 $\pm$ 12	0.0002
B-2	1	-	25	0.001
B-3	4	1 - 22	7.9 $\pm$ 16	0.0004
J-1	4	N.D. - 2.7	1.3 $\pm$ 2.2	0.00007

^aComposite large volume water samples were analyzed from each location from water collected during CY-1981.

^bLower Detection Limit (LDL) for ²³⁸Pu is 0.8×10^{-12} μ Ci/ml which is 0.00004% of the RCG.

^cApplicable DOE Radioactivity Concentration Guide (RCG) for ²³⁸Pu in water = $2,000,000 \times 10^{-12}$ μ Ci/ml for the general population and soluble form of plutonium-238.

^dError limits are estimates of the standard error of the estimated means at the 95% confidence level.

^e(N.D.) - Environmental levels could not be detected, values presented represent actual measurements above reagent blank levels.

Water - Nonradioactive

Mound's National Pollutant Discharge Elimination System (NPDES) permit was renewed effective January 15, 1981 after several years of negotiations with the Region V office of the U.S. EPA. This permit specified limitations for pollutants in the effluent streams from Mound that discharge to the Great Miami River. The renewed permit contains monitoring requirements modified from the previous permit. These new requirements correspond to the sampling as it is actually performed and eliminate the need to mathematically combine data to correspond to the permit requirements. Discharge 001 (pipe) from the old permit has been separated into two discharges 001-A and 001-B. Discharge 001-A includes only the sanitary sewage treatment plant discharge. Discharge 001-B includes storm water runoff, single-pass cooling water, zeolite softener backwash, boiler-plant blowdown, and discharge from the radioactive waste disposal facility. One new monitoring location was added to the closed pipe system, 001-C, the discharge from the electroplating shop which is routed to the sanitary sewage treatment plant. This discharge is monitored prior to mixing with other sanitary waste. Discharge 002 (ditch) monitoring requirements remained essentially unchanged in the renewed permit. Discharge 002 consists of single-pass cooling water, cooling-tower blowdown, zeolite softener backwash, and most of the storm water runoff. Two additional discharges 003 and 004, are now included in Mound's permit. These discharges are from two wells

that are periodically pumped as a part of the Potable Water Standards Project. The only requirement imposed by EPA for these two discharges is that the flow be monitored: 238 million gallons were discharged from 003; no water was discharged from 004 during 1981.

A 24-hr composite, flow proportional sample is automatically collected from discharges 001-A, 001-B, and 002. An 8-hr composite, time proportional sample is collected from discharge 001-C. Grab samples are also collected, as required by EPA, for the analysis of certain pollutants. The effluent water samples are analyzed for water quality parameters according to standard methods [11]. The results of effluent analyses for 1981 are summarized in Table 24.

A total of 1198 analyses were performed in 1981 in conjunction with the NPDES permit. From these measurements, an effluent parameter exceeded its maximum discharge limit 23 times. In addition, effluent parameters exceeded 30-day average discharge limits 11 times during 1981. Half of these exceptions were attributable directly to the weather, 11 maximum and 5 average exceptions. High suspended solids resulting from storm runoff was the primary cause of the weather-related exceptions. Maintenance operations resulted in 5 maximum and 2 average exceptions for suspended solids, fecal coliform, residual chlorine, and nickel, collectively. Equipment malfunctions caused 2 maximum exceptions. Three maximum exceptions were identified with plant operations that have subsequently been modified to minimize

Table 24 - NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM DATA FOR 1981

Table 24 - NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM DATA FOR 1981							
Parameter	Parameter Units	No. of Samples	Minimum	Maximum	Annual Average	Permit Limits	
						Maximum**	Monthly Average
<u>Discharge 001-A</u>							
Flow Rate	MGD	Cont.	0.05	0.28	0.14	***	***
Biochem. O ₂ Demand	mg/l (kg/day)	88	1.2 (0.6)	7.5 (4.7)	3.8 (1.9)	15.0 (14.2)	10.0 (4.9)
Susp. Solids	mg/l (kg/day)	100	3.0 (1.4)	28.0 (18.6)	12.1 (6.1)	30.0 (28.4)	15.0 (7.4)
Fecal Coliform	MPN/100 ml	93	< 2	4350	107	2000	1000
pH	pH units	239	6.8	8.3	-	9.0	***
<u>Discharge 001-B</u>							
Flow Rate	MGD	Cont.	0.02	0.50	0.09	***	***
Susp. Solids (Oct-Mar)	mg/l (kg/day)	43	0.8 (0.2)	74.3 (33.0)	15.2 (3.0)	30.0 (11.4)	20.0 (7.6)
Susp. Solids (Apr-Sept)	mg/l (kg/day)	48	0.7 (0.2)	48.0 (36.3)	11.7 (4.9)	50.0 (19.0)	20.0 (7.6)
Oil and Grease	mg/l	14	0.2	2.1	1.2	10.0	***
Dissolved Solids	mg/l	14	416	16700	2150	***	***
Chemical O ₂ Demand	mg/l	13	6.7	128	46	***	***
Residual Chlorine	mg/l	94	< 0.02	1.2	< 0.02	0.02	***
pH	pH units	111	7.4	8.8	-	9.0	***
<u>Discharge 001-C</u>							
Cyanide	mg/l	19	< 0.01	0.92	0.17	1.0	***
Cadmium	mg/l	16	0.02	0.15	0.06	0.1	***
Chromium	mg/l	16	0.01	0.13	0.05	0.5	***
Copper	mg/l	16	0.07	0.72	0.23	0.5	***
Nickel	mg/l	16	0.07	3.36	0.51	0.5	***
<u>Discharge 002</u>							
Flow Rate	MGD	Cont.	0.06	1.57	0.52	***	***
Susp. Solids	mg/l (kg/day)	94	1.0 (1.0)	43.7 (128)	12.5 (27.7)	30.0 (91)	15.0 (34)
Dissolved Solids	mg/l (kg/day)	24	398 (624)	2460 (4500)	900 (1730)	2000 (6065)	1500 (3412)
Oil and Grease	mg/l	13	0.3	0.9	0.5	10	***
Residual Chlorine	mg/l	90	< 0.02	< 0.02	< 0.02	0.02	***
pH	pH units	37	7.5	8.5	-	9.0	***
**pH has a minimum limit of 6.5 and a maximum limit of 9.0.							
***No limit applicable.							

their impact on the NPDES permit limits. Combinations of the above mentioned factors were involved with 4 of the average exceptions. Only 2 maximum exceptions, residual chlorine at 001-B, occurred whose cause could not be determined even after considerable investigation. After each of these exceptions was discovered, a sample was collected later that same day which indicated normal concentrations (<0.02 mg/l), thus making it impossible to trace back to the source.

In all cases, the above exceptions had no significantly adverse effect on the Great Miami River. In addition, the data in Table 24 show that Mound releases to the Great Miami River did not cause the Ohio Stream Standards to be exceeded.

Foodstuffs and vegetation -

Radioactive

Various locally grown foodstuffs and vegetation samples are collected from the surrounding area. The intent of this portion of the Environmental Monitoring Program is to determine whether there is any significant uptake and concentration of radionuclides by plant or animal life. Samples were collected in Miamisburg,

Centerville, and Bellbrook. Centerville and Bellbrook are in the prevailing wind direction from Mound at a distance of 8 km (5 mi) and 16 km (10 mi), respectively. Both communities are shown in Figure 1. Fish were collected in the Great Miami River downstream of Mound's outfall into the Great Miami River. The area from which the fish were taken can be seen in Figure 6. The plutonium-238 content of the foodstuff and vegetation samples is determined by ashing the samples, then proceeding with the same techniques used for plutonium-238 analyses of air samples (see section on Air - Radioactive). The tritium content of the foodstuff and vegetation samples is determined by distilling the water from the sample, then analyzing the distillate for tritium. The results of the foodstuff, vegetation, and fish analyses are summarized in Tables 25 and 26. The concentration is given in terms of the sample weight (wet weight) before ashing or distilling. The samples of aquatic life analyzed included only the edible, fleshy portions of fish. These analyses indicate no evidence of any significant uptake or concentration by plant or animal life of the radionuclides handled at Mound. Environmental levels for foodstuffs and vegetation have been subtracted from the data (Table 3).

Table 25 - INCREMENTAL PLUTONIUM-238 IN FOODSTUFFS
AND VEGETATION IN 1981

Location	Type of Sample	Number of Samples	Plutonium-238	
			Range ^{a,d} (10 ⁻⁶ μ Ci/g)	Average ^{a,b,c,d} (10 ⁻⁶ μ Ci/g)
Miamisburg	Grass ^e	8	N.D. - 0.0017	0.0007 $\pm$ 0.0005
	Potatoes	4	0.0002 - 0.0009	0.0005 $\pm$ 0.0005
Centerville	Grass ^e	8	N.D. - 0.0007	0.0001 $\pm$ 0.0003
	Potatoes	4	0.0002 - 0.001	0.0004 $\pm$ 0.0007
Bellbrook	Grass ^e	8	N.D. - 0.0006	0.0001 $\pm$ 0.0002
	Potatoes	4	E.L. - 0.0005	0.00001 $\pm$ 0.0007
Mound (outfall to river)	Fish	8	E.L. - 0.0002	0.00007 $\pm$ 0.0002

^aAverage environmental level (E.L.) subtracted from data.

^bError limits are estimates of the standard error of the estimated means at the 95% confidence level.

^cLower Detection Limit (LDL) for plutonium-238 in grass samples is 0.0006×10^{-6} μ Ci/g. LDL for plutonium-238 in potato samples is 0.0002×10^{-6} μ Ci/g. LDL for plutonium-238 in fish samples is 0.0001×10^{-6} μ Ci/g.

^dMany of these results were at the LDL level; however, the actual values were used in the averages as explained earlier in this report.

^e(N.D.) Environmental level and values cannot be detected above reagent blanks, therefore includes environmental level.

Table 26 - INCREMENTAL CONCENTRATION OF
TRITIUM IN VEGETATION IN 1981

Location	Type of Sample	Number of Samples	Tritium	
			Range ^c (10 ⁻⁶ μ Ci/g)	Average ^{a,b,c,d} (10 ⁻⁶ μ Ci/g)
Miamisburg	Grass	8	0.07 - 0.46	0.29 $\pm$ 0.11
	Tomatoes	4	1.19 - 1.5	1.35 $\pm$ 0.23
Centerville	Grass	8	0.33 - 0.74	0.53 $\pm$ 0.16
	Tomatoes	4	0.18 - 0.41	0.31 $\pm$ 0.17
Bellbrook	Grass	8	E.L. - 0.53	0.17 $\pm$ 0.16
	Tomatoes	4	E.L. - 0.4	0.16 $\pm$ 0.38

^aLDL for tritium in grass is 0.08×10^{-6} μ Ci/g.

^bLDL for tritium in tomatoes is 0.07×10^{-6} μ Ci/g.

^cAverage environmental levels have been subtracted from data.

^dError limits are estimates of the standard error of the estimated means at the 95% confidence level.

Silt - Radioactive

Silt samples were collected from the river and surface water sample locations shown in Figure 6.

The results of the silt sample analyses are found in Tables 27 and 28. No offsite soil sampling was conducted in 1981 since the soil inventory was completed and reported for 1977, and there is no evidence of other than minimal uptake of plutonium-238 by plants from soil [12].

Table 27 - INCREMENTAL CONCENTRATION OF PLUTONIUM-238 IN SILT FROM RIVER MONITORING LOCATIONS IN 1981

Location	Number of Samples	²³⁸ Pu Range ^c	²³⁸ Pu Average ^{a,b,c}
		(10 ⁻⁶ μ Ci/g)	(10 ⁻⁶ μ Ci/g)
1	4	N.D. - 0.01	0.003 $\pm$ 0.009
2	4	0.01 - 0.15	0.05 $\pm$ 0.1
3	4	0.03 - 0.1	0.07 $\pm$ 0.05
4	4	0.13 - 0.51	0.3 $\pm$ 0.31
5	4	0.008 - 0.04	0.02 $\pm$ 0.03

^a Lower Detection Limit (LDL) for ²³⁸Pu in silt is 0.001 x 10⁻⁶ μ Ci/g.

^b Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

^c (N.D.) - Environmental level and sample values cannot be detected above reagent blanks, therefore includes environmental level.

Table 28 - INCREMENTAL CONCENTRATION OF PLUTONIUM-238 IN SILT FROM SURFACE WATER MONITORING LOCATIONS IN 1981

Location	Number of Samples	²³⁸ Pu Range ^c	²³⁸ Pu Average ^{a,b,c}
		(10 ⁻⁶ μ Ci/g)	(10 ⁻⁶ μ Ci/g)
10	4	0.0002 - 0.0006	0.0004 $\pm$ 0.0003
11	4	0.0002 - 0.0006	0.0005 $\pm$ 0.0004
12	4	0.0003 - 0.0016	0.0009 $\pm$ 0.0008
13	4	N.D. - 0.0037	0.0007 $\pm$ 0.0033
14	4	N.D. - 0.0004	N.D.
15	4	0.0015 - 0.0068	0.0032 $\pm$ 0.0039
16	4	N.D. - 0.0016	0.0005 $\pm$ 0.0012

^a Lower Detection Limit (LDL) for ²³⁸Pu is 0.001 x 10⁻⁶ μ Ci/g.

^b Error limits are estimates of the standard error of the estimated means at the 95% confidence level.

^c (N.D.) - Environmental level and sample values cannot be detected above reagent blanks, therefore includes environmental level.

Evaluation of dose commitment to the public

A dose assessment was performed for radionuclides in the environment from Mound operations. These radionuclides are plutonium-238 and tritium. Tritium (oxide) is the only radionuclide at Mound for which the critical organ is the whole body. The critical organs for plutonium-238 are assumed to be the lung for insoluble material and the bone for soluble material. The solubility of plutonium-238 in the receptor is unknown; therefore, each dose evaluation for both lung and bone was based on total incremental concentration of plutonium-238 found in the environment. This approach gives a very conservative or overestimate of the dose commitment.

The term "dose commitment," as used in this report, is that cumulative dose for a period of 50 yr from 1 yr of exposure to a given radionuclide.

Plutonium-238 assumptions and methodology

The dose commitment estimates for plutonium-238 were based on environmental monitoring data for CY-1981. The estimates for maximum dose commitment to the lung at the site boundary and maximum dose commitment to the lung in individuals were based on the maximum onsite incremental average concentration of plutonium-238 in air from onsite samplers (sampler 211, Table 10), since the samplers are in

close proximity to the site boundary. The maximum dose commitment to the lung in population group(s) was based on the maximum offsite average incremental concentration of plutonium-238 in air (sampler 123, Table 7).

The estimates for maximum dose commitment to the bone at the site boundary and in individuals were also based on the maximum onsite average incremental concentration of plutonium-238 in air and the maximum offsite average concentration of plutonium-238 in drinking water (average of B-1, B-2, and B-3, Table 23). The maximum dose commitment to the bone for individuals in population group(s) was calculated using airborne concentrations of plutonium-238 and the concentration of plutonium-238 in municipal drinking water (Miamisburg drinking water, Table 23).

The terms "maximum dose commitment at the site boundary" and "maximum dose commitment to individuals" refer to the maximum dose commitment possible for individuals to receive assuming they remain at the site boundary 24 hr/day and 365 days/yr. The term "maximum dose commitment for individuals in population group(s)" refers to those individuals who reside in an area adjacent to Mound and who receive the maximum dose commitment values found in the offsite environment.

The calculational methods can be found in the Appendix. The results of the dose commitment estimate calculations are shown in Table 29.

Table 29 - DOSE COMMITMENT ESTIMATES

	Plutonium-238 (mrem/50 yr)				Tritium Oxide (mrem/50 yr)	
	<u>Lung</u>	<u>% of Applicable DOE Standard</u>	<u>Bone</u>	<u>% of Applicable DOE Standard</u>	<u>Whole Body</u>	<u>% of Applicable DOE Standard</u>
Maximum dose equivalent at the site boundary	2.32	-	15.3	-	1.42	-
Maximum dose equivalent to an individual	2.32	0.15	15.3	1.0	1.42	0.3
Maximum dose equivalent to an individual in the population group(s)	0.11	0.02	0.7	0.1	0.3	0.2

The data indicate that in all cases of dose commitment comparisons, the dose commitments are at or within 1% of the DOE standard. In addition, to provide a relative comparison of these dose commitment values, the maximum dose to the lung of an individual around Mound is 2.32 mrem/50 yr. This would be equivalent to the additional dose to an individual smoking 3.5 cigarettes/yr [13] or visiting a friend who lives in a brick house for 2.5 days [14] (as compared to a wooden house).

Tritium (oxide) assumptions and methodology

The dose commitment estimates for tritium (oxide) were also based on environmental monitoring data for 1981. The concentrations used for dose commitment estimates for tritium (oxide) were arrived at by the same method as that used for plutonium. The maximum average onsite air

incremental concentration was measured at sampler 213 (Table 12), and the maximum drinking water incremental concentration was the average measured at location B-R (Table 21). The maximum average off-site air incremental concentration was measured at sampler 101 (Table 9), and the maximum incremental concentration of drinking water for individuals in a population group was that measured in the Miamisburg drinking water. The total dose commitment for the whole body was obtained by addition of the dose commitment of tritium (oxide) in air and the dose commitment of tritium (oxide) in water. The calculational methods can be found in the Appendix. The results of the dose commitment estimate calculations are shown in Table 28.

The tritium data indicate dose commitment levels well within 1% of the DOE standards. For example, the maximum whole body dose commitment to an individual around Mound from tritium is 1.42 mrem. This value is

Dose Commitment

equivalent to the additional dose to an individual from Ohio taking a 5-day vacation in Colorado [15].

Environmental data indicate that Mound's influence does not reach 32 km (20 mi); however, 32 km will be the assumed limit for Mound's impact.

The person-rem dose commitment estimate calculations were based on tritium (oxide) data from environmental air sampling stations in two ranges: 0-8 km (0-5 mi) and 8-32 (5-20 mi). The 0-8 km range includes 10 samplers within 1.6 km (1 mi) of Mound.

The average concentration of tritium (oxide) in air was obtained by averaging ten offsite tritium air samplers less the concentration found at sampler #119. From this average concentration a dose commitment was determined and multiplied by the number of people from 0 to 8 km.

The average tritium (oxide) concentration from the four other offsite samplers (less the concentration at sampler 119) were used to obtain the person-rem from 8 to 32 km. Eight area segments from 8 to 32 km were obtained by letting each sampler represent one segment concentration and the average of two adjacent samplers would represent another segment. These segment concentrations were then multiplied by their respective population. By using the four samplers and this averaging technique, a more realistic person-rem value could be obtained.

The person-rem from tritium (oxide) in community water was based on average concentrations of tritium (oxide) in various community water supplies, less appropriate environmental levels, and weighing these concentrations with respective populations.

The calculations for the air and water dose commitment estimates are shown in the Appendix.

It is estimated that the total population from 0 to 32 km is receiving 20 person-rem from Mound's emissions. The remaining population from 32 km to 80 km (20 to 50 mi) is not receiving any dose commitment from tritium (oxide) emissions. Thus, the dose commitment from Mound's emission is 20 person-rem for the 0-80 km range.

For comparison, the person-rem values from natural radiation, including cosmic rays and terrestrial radiation, would be approximately 320,000 person-rem for the 0 to 80 km (50 mi) range [16]. The dose commitment from natural background tritium alone is 80 person-rem for the 0 to 80 km range.

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Appendix

Applicable standards

RADIOACTIVE STANDARDS

In conformance with DOE Order 5480.1, Chapter XI, "Requirements for Radiation Protection," offsite sample results are compared with RCG's established for the general population. These RCG's are derived by dividing the RCG's for an uncontrolled area by three.

Onsite sample results are compared with the uncontrolled area RCG's which are applicable for individuals in the population.

The RCG values (in microcuries per milliliter - $\mu\text{Ci/ml}$) used for comparison purposes for the various types of samples in this report are listed below. In all cases, these are the most restrictive RCG's.

Plutonium-238 (Soluble Form)

Air

General Population 2×10^{-14} $\mu\text{Ci/ml}$
Uncontrolled Area 7×10^{-14} $\mu\text{Ci/ml}$
(Individuals in
the Population)

Water

General Population 2×10^{-6} $\mu\text{Ci/ml}$
Uncontrolled Area 5×10^{-6} $\mu\text{Ci/ml}$
(Individuals in
the Population)

Tritium (Soluble Form)

Air

General Population 7×10^{-8} $\mu\text{Ci/ml}$
Uncontrolled Area 2×10^{-7} $\mu\text{Ci/ml}$
(Individuals in
the Population)

Water (DOE RCG is compared to water not used for drinking purposes)

General Population 1×10^{-3} $\mu\text{Ci/ml}$
Uncontrolled Area 3×10^{-3} $\mu\text{Ci/ml}$
(Individuals in
the Population)

As of June 24, 1977, community drinking water quality is regulated by the EPA National Interim Primary Drinking Water Regulations for Radionuclides. The new standard = 20×10^{-6} $\mu\text{Ci/ml}$ (20,000 pCi/l).

Foodstuffs There are no RCG values specified for foodstuffs. However, to give some perspective, the foodstuff values can be compared to the RCG values for plutonium and tritium in water.

Soil There are no guidelines established for radioactive species in soil. (The U.S. EPA has guidelines under consideration.)

NONRADIOACTIVE STANDARDS

Water Region V of the U.S. EPA has issued a discharge permit under NPDES regulations covering Mound liquid effluent streams. The discharge limitations for each effluent stream are as follows:

<u>Discharge 001-A</u>	<u>7-day Average</u>	<u>30-day Average</u>
BOD ₅ mg/l (kg/day)	15 (14.2)	10 (4.9)
Suspended Solids mg/l (kg/day)	30 (28.4)	15 (7.4)
Fecal Coliform N/100 ml	2000	1000
pH	6.5 - 9.0	-

<u>Discharge 001-B</u>	<u>Daily Maximum</u>	<u>Daily Average</u>
Suspended Solids mg/l (kg/day)		
(Oct-Mar)	30 (11.4)	20 (7.6)
(Apr-Sept)	50 (19)	20 (7.6)
Oil and Grease mg/l	10	-
COD	Monitor Only	
Dissolved Solids	Monitor Only	
Residual Chlorine mg/l	0.02	
pH	6.5 - 9	

<u>Discharge 001-C</u>	<u>Daily Maximum</u>
Cyanide mg/l	1.0
Chromium - Total mg/l	0.5
Cadmium mg/l	0.1
Nickel mg/l	0.5
Copper mg/l	0.5

<u>Discharge 002</u>	<u>Daily Maximum</u>	<u>Daily Average</u>
Suspended Solids mg/l (kg/day)	30 (91)	15 (34)
Dissolved Solids mg/l (kg/day)	2000 (6065)	1500 (3412)
Oil and Grease mg/l	10	-
Residual Chlorine	0.02	-
pH	6.5 - 9	

The Ohio EPA has established Water Quality Standards (3745-1-01-3745-1-09). The standards listed below are excerpted from these regulations. These standards are

stream standards and apply to a stream beyond a suitable mixing zone permitted for discharges. They should not be compared with effluent concentrations.

<u>Constituent</u>	<u>Average Concentration (mg/liter)</u>
Dissolved Oxygen	5.0
pH	6-9
Fecal Coliform	200 per 100 ml
Dissolved Solids	1500
Ammonia	1.5
Arsenic	0.05
Barium	0.8
Cadmium	0.005
Chloride	250
Chromium (hexavalent)	0.05
Cyanide (free)	0.005
Fluoride	1.3
Foaming Agents (MBAS)	0.5
Iron	1
Lead	0.04
Manganese	1
Mercury	0.0005
Oil and Grease	5
Phenols	0.01
Selenium	0.005
Silver	0.001
Copper	0.005 - 0.075*
Zinc	0.075 - 0.5*

*Dependent on CaCO₃ hardness.

Dose commitment calculations

PLUTONIUM-238 CALCULATIONAL METHODS

These dose commitment to the lung resulting from inhalation of airborne plutonium-238 was calculated by:

$$D(t) = \frac{51.1 \text{ CI}_{a1} t_{a1} f f_r \sum E F (RBE) \eta}{\lambda_m} (1 - e^{-\lambda t_2})$$

Appendix

where

$D(t)$ = 50-yr dose commitment delivered to the lung in 365 days of continuous exposure to plutonium-238 in air, rem/50 yr

C = average airborne concentration, $\mu\text{Ci/ml}$

I_a = average air intake
= 2×10^7 ml/day [1]

t_1 = time exposed, 365 days

t_2 = duration of dose, 50 yr

f_a = fraction of inhaled material reaching organ of interest
= 0.7 (max.) for the pulmonary region [2]

f_r = fraction of pulmonary deposition undergoing long-term retention = 0.6 for actinide (class Y) [2]

$\Sigma\text{EF(RBE)}\eta$ = effective energy deposition per disintegration = 57 [1]

λ = effective decay rate, 0.0014 day^{-1} for actinides (class Y) from the pulmonary region [3]

m = lung mass, 1000 g [1]

The dose commitment to bone resulting from inhalation of airborne plutonium-238 was calculated by:

$$D(t) = \frac{51.1CI_a f_a t_1 \Sigma\text{EF(RBE)}\eta}{\lambda m} (1 - e^{-\lambda t_2})$$

where

f_a = 0.2 [1]

EF(RBE) = 280 [1]

m = 7×10^3 g [1]
= $3 \times 10^{-5} \text{ day}^{-1}$ [1]

The dose commitment to bone resulting from ingestion of plutonium-238 in water was calculated by:

$$D(t) = \frac{51.1CI_w f_a t_1 \Sigma\text{EF(RBE)}}{\lambda m} (1 - e^{-\lambda t_2})$$

where

I_w = average quantity of water intake,
 2200 cm^3 [1]

f_a = 2.4×10^{-5} [1]

TRITIUM OXIDE CALCULATIONAL METHODS

The dose commitment to the whole body resulting from exposures to tritium (oxide) in air was calculated by:

$$D(t)a = \frac{\bar{C}_a}{R_a} \times S$$

where

$D(t)a$ = dose commitment, mrem/50 yr

$\bar{C}_a$ = average concentration of tritium (oxide) in air

R_a = RCG for tritium (oxide) in air [4]

S = Radiation protection standard in mrem/50 yr [4]

The dose commitment to the whole body resulting from uptake of tritium (oxide) in water was calculated by:

$$D(t)w = \frac{\bar{C}_w}{R_w} \times S$$

where

$D(t)w$ = dose equivalent in mrem/50 yr

$\bar{C}_w$ = average concentration

R_w = RCG for tritium (oxide) in water [4]

S = radiation protection standard in mrem/50 yr [4]

These dose commitment values were divided by 1.7 in order to reflect the quality factor of one as recommended by the International Commission on Radiological Protection [5] and the National Council on Radiation Protection Measurements [6].

PERSON-REM CALCULATIONS

The equations used for this calculation were:

$$\bar{D}(t)a = \frac{\bar{C}_a}{R_a} \times S$$

where

$\bar{D}(t)a$ = dose commitment from tritium (oxide) in air

$\bar{C}_a$ = average tritium (oxide) concentration in air

R_a = RCG for tritium (oxide) in air [4]

S = radiation protection standard for tritium (oxide) in air in mrem/50 yr [4]

$$\bar{D}(t)w = \frac{\bar{C}_w}{R_w} \times S$$

where

$\bar{D}(t)w$ = dose commitment from tritium (oxide) in water

$\bar{C}_w$ = average tritium (oxide) concentration in water

R_w = RCG for tritium (oxide) in water [4]

S = radiation protection standard for tritium (oxide) in water, mrem/50 yr [4]

These dose commitment values were divided by 1.7 in order to reflect the quality factor of one as recommended by the International Commission on Radiological Protection [5] and the National Council on Radiation Protection and Measurements [6].

The total person-rem from 0 to 32 km is obtained by:

$$\sum_0^{32} R = \left(D(t)a \sum_0^8 P \right) + \sum_0^8 \bar{D}(t)a \sum_8^{32} P + \sum_0^{32} \left(\bar{D}(t)wP \right)$$

where

$\sum_0^{32} R$ = person-rem within 32 km

$\bar{D}(t)a \sum_0^8 P$ = average dose commitment x population from 0-8 km

$\sum_0^8 \bar{D}(t)a \sum_8^{32} P$ = summation of dose commitments x the respective populations within eight direction segments from Mound from 8-32 km

$\sum_0^{32} \left(\bar{D}(t)wP \right)$ = summation of dose commitments x respective population from 0-32 km

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