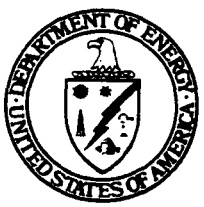
MLM-2608

Annual Environmental Monitoring Report: Calendar Year 1978

Billy M. Farmer and Daniel G. Carfagno

April 25, 1979



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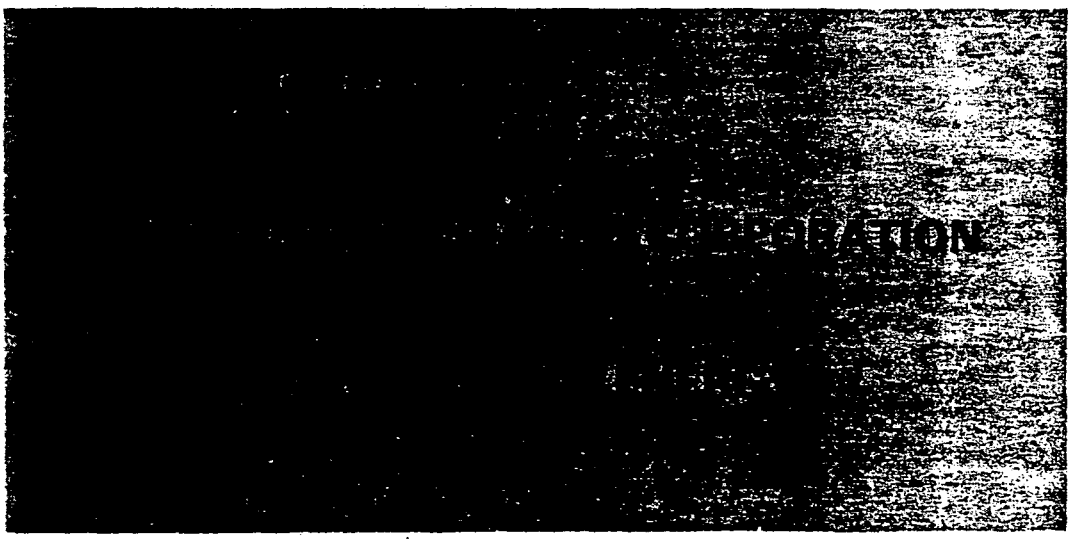

MLM-2608
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Issued: April 25, 1979

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-OP00053

Foreword

This report was prepared by the Environmental Assessment and Planning Section of the Safety and Environmental Technology Function in the Administrative Services Department at Mound Facility. Sample analyses and data reduction were performed by the Environmental Laboratory Group of the Environmental Assessment and Planning Section. Particulate samples offsite are 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.

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Contents

Introduction

Mound Facility is situated on 180 acres of land in Miamisburg, Ohio. This location is approximately 16 km (10 mi) southwest of Dayton. The predominant geographical feature in the five-county region surrounding the Facility is the Great Miami River which flows from northeast to southwest through Miamisburg. This river valley area is generally highly industrialized. The remainder of the region is predominantly agricultural with some light industry and scattered residential communities. The location and population of these communities are shown in Figure 1. Figure 2 shows the population distribution around Mound Facility. Drinking water for the area is obtained from a buried valley aquifer which 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 area in agricultural use is devoted to pasturing livestock [1].

Weather conditions in the area are moderate. The average annual precipitation is approximately 91 cm (36 in.) and is evenly distributed throughout the year. Winds are predominantly from the south or west except during the summer months when a higher frequency is recorded from out of the southwest. The wind speed averages about 16 km/hr (10 mi/hr) annually [2]. Figure 3 shows the wind rose compiled at Wright Patterson AFB which is located approximately 13 miles northeast from Mound.

Mound Facility began operations in 1949. Its mission currently includes research, development, engineering, production, and surveillance of components for the Department of Energy (DOE) weapon programs; separation, purification, and sale of stable isotopes of the noble gases; and fabrication of radioisotopic heat sources fueled with plutonium-238 for thermoelectric generators. The radionuclides of primary concern currently being handled include plutonium-238 and tritium.

Radionuclides in particulate form are removed from process air effluents from nuclear operations facilities by high efficiency particulate air (HEPA) filters. The air effluents are filtered first at the points of origin, i.e., glove boxes, and 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 with a collection efficiency of 99.9%. Radionuclides are removed from liquid effluents such as process waste liquids by chemical processing. Solid radioactive wastes are packaged and shipped offsite for burial at approved burial sites. Airborne and liquid wastes generated in the processing of explosive materials are collected and disposed of according to the Army Materiel 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

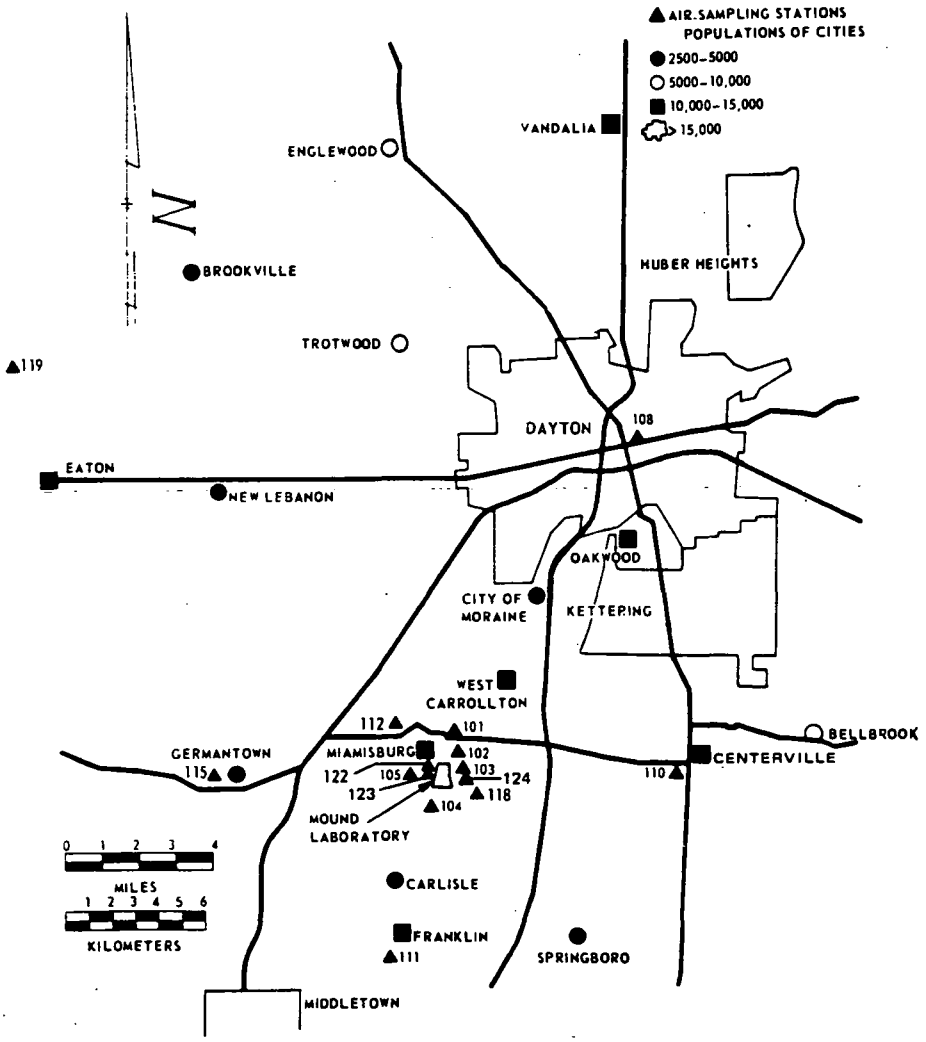

FIGURE 1 - Offsite air sampling locations.

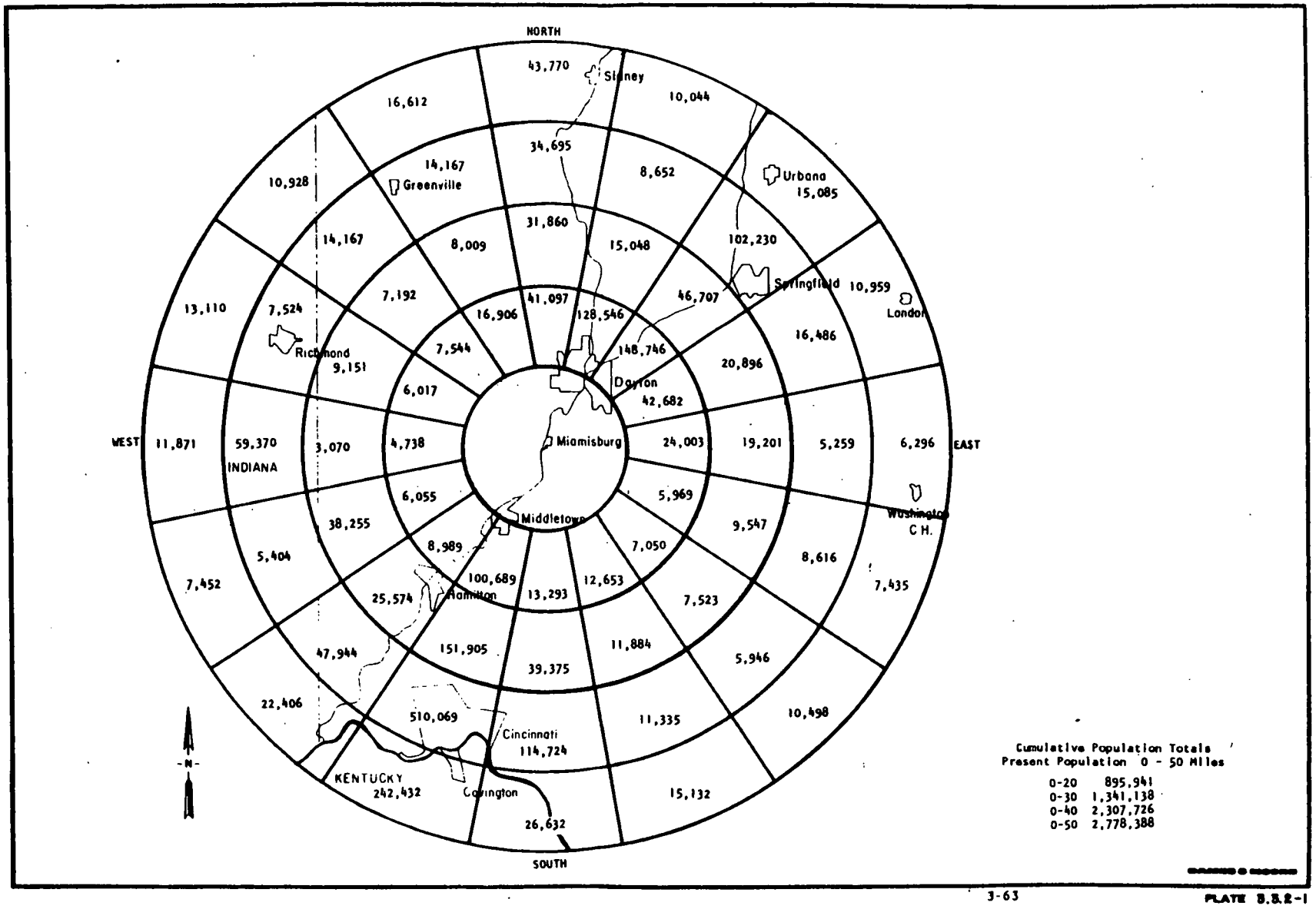

FIGURE 2 - 1970 population within 50 miles of Mound Facility.

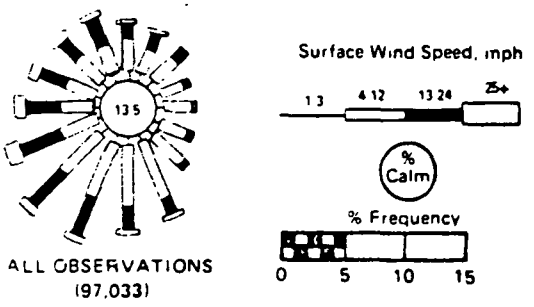

FIGURE 3 - The relative frequency and strength of winds from different directions for Wright-Patterson Air Force Base.

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 where possible.

White paper, scrap metal, and wood are sold for reclamation. General refuse was transported during 1978 to a state and county approved sanitary land fill. Waste solvents and chemicals are removed offsite by a commercial industrial-waste-disposal firm.

Conformance to regulations prescribed by DOE pertaining to the safety of employees and the public has been demonstrated during the history of Mound Facility. The fundamental objective of the Mound Facility Environmental Control Program, which has been in existence throughout the history of the Facility, is the containment of radioactive effluents to levels well within the existing standards. As part of this function, effluents are monitored and controlled at each operating step resulting in only 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.

As part of the Mound Environmental Program monitoring functions, air, water, foodstuff, and sediment samples are collected from the environment at distances up to 45 km (28 mi) from the Facility boundaries. These samples are analyzed for the specific radionuclides handled at the Facility.

A quality control program for environmental analytical procedures has been in effect for several years. There are two parts to the program: internal and external. The internal portion consists of blank and duplicate analyses for each group of samples. The blank values have been consistently small in comparison with sample values, indicating good control during analytical procedures. These blank values are the basis for detection limits as discussed below. The duplicate results for 1978 were in the range expected.

Mound Facility has again participated in DOE's Quality Assessment Program conducted by the Environmental Measurements Laboratory (EML) during CY-1978. Results of significance to the environmental monitoring program are summarized in Table 1. The air samples analyzed were simulated, consisting of filter papers spiked with a known amount of plutonium. The concentrations given for the air samples are actually pCi/filter. To compare the Mound values with the EML

values and with the means of all the laboratories participating in the program, the concentration ratios are given in the last two columns of Table 1.

Considering the experimental errors involved, the Mound results show good agreement with the EML or mean values for plutonium in air, plutonium in water, and uranium in water. There were two elevated tritium-in-water values due to instrument malfunction. This condition, however, was corrected, and current results indicate a much closer agreement with EML and the mean value.

The results of the environmental analyses for CY-1978 are provided in this report. A different approach from that used in earlier reports for deriving error estimates is included in this report. This approach yields wider error limits than counting statistics only since it includes all sources of variability including sampling, analyses, and counting statistics. Error limits are estimates of the standard error of the estimated mean at the 95% confidence level except in cases where the number of samples prohibits this type of analyses. In this case, counting statistics are provided at the 95%

Table 1 - MOUND FACILITY QUALITY ASSESSMENT PROGRAM RESULTS (FIRST THROUGH FOURTH QUARTER, 1978)

Sample Type	Sample Date	Isotope Determined	Concentration (pCi/ml)		Ratio	
			Mound	EML[a]	(Mound to EML)	(Mound to Mean)
Air	7801	Pu-238	1.21	1.16	1.04	0.96
		Pu-239	1.03	1.03	1.00	0.91
	7804	Pu-238	1.26	1.16	1.09	0.90
		Pu-239	1.07	1.03	1.03	0.90
	7807	Pu-239	0.50	0.54	0.92	0.92
	7810	Pu-239	0.61	0.53	1.15	1.02
Water	7804	Pu-239	0.0028	0.0035	0.80	0.94
		U-234	0.0108	0.0130	0.83	0.92
		U-238	0.0109	0.0130	0.84	0.96
	7807	H-3	572	367	1.56	1.63
	7810	H-3	15.9	12.6	1.26	1.14
	7810	H-3	12.6[b]	12.6	1.00	0.90

[a]Environmental Measurements Laboratory.

[b]This H-3 value was determined by the Mound Nuclear Measurements Group.

confidence level. A lower detection limit (LDL) is provided for each set of data. The LDL is composed of the average blank plus the standard error of the blank at the 95% confidence level. In some cases where the quantity of data prohibits, the use of the instrument background plus the counting error at the 95% confidence is used as the LDL.

Summary

The local environment surrounding Mound Facility was monitored for tritium and plutonium-238. The results are reported for CY-1978. The environmental parameters analyzed included air, water, foodstuffs, and sediment. The average concentrations of plutonium-238 and tritium were within the applicable stringent standards for radioactive species adopted by the U. S. DOE. Mound Facility drinking water has been brought into compliance with the new EPA standard for tritium in community drinking water systems, and Mound has undertaken a program to achieve compliance for eight private wells adjacent to the Facility site. The program has partially achieved its objective by bringing Mound wells and six of the eight affected private wells in the vicinity of Mound Facility into compliance with the U. S. EPA standard and by significantly reducing tritium concentration in the remaining wells. Data concerning nonradioactive species in air and water are also presented and compared to federal, state, and local standards where applicable. Environmental levels obtained from either monitoring or literature values have been subtracted from applicable data in this report. These levels are shown in Table 2. The resultant concentration will be referred to as the incremental concentration. The average incremental concentrations of plutonium-238 and tritium oxide in air measured at all offsite locations during CY-1978 were 0.67×10^{-17} and 0.39×10^{-11} µCi/ml, respectively. These correspond to 0.034% and 0.006% of their respective Radioactivity Concentration Guides (RCG). Details of the applicable standards are given in the Appendix.

The average concentration of plutonium-238 and the average incremental tritium measured at all locations in the Great Miami River during CY-1978 were $<0.21 \times 10^{-10}$ and 0.12×10^{-6} µCi/ml, respectively. These correspond to <0.001% and 0.01% of the respective RCG.

Radionuclide effluent data for CY-1978 are summarized in Table 3.

The average concentration of plutonium-238 and average incremental concentration of tritium found during CY-1978 in surface water and the drinking water of the area municipalities were also 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 CY-1978 since a soil inventory was completed and reported for CY-1977. Sediment sampling at several water sampling locations was conducted, however, and is reported.

Mound Facility has been granted a National Pollutant Discharge Elimination System Permit. Effluent stream analyses during 1978 indicated that several limitations, i.e., suspended solids, residual chlorine,

Table 2 - ENVIRONMENTAL CONCENTRATIONS OF RADIONUCLIDES IN VARIOUS MEDIA

Plutonium-238 in Air[a] = 0.16 ± 0.23 x 10^{-17} µCi/ml
Plutonium-238 in Surface Water[b] = 7 x 10^{-13} µCi/ml
Tritium Oxide in Air[a] = 0.45 ± 0.25 x 10^{-11} µCi/ml
Tritium in Surface and Ground Water[c] = 0.9 x 10^{-6} µCi/ml
Plutonium-238 in Foodstuffs and Vegetation[e] = <Lower detection limit
Tritium in Milk[d] = 0.33 ± 0.23 x 10^{-6} µCi/g
Tritium in Vegetables[e] = 0.58 ± 0.25 x 10^{-6} µCi/g
Tritium in Grass[e] = 1.77 ± 0.34 x 10^{-6} µCi/g

[a]Measured at offsite sampler 119
[b]Reference 4
[c]Reference 5
[d]Measured from milk at dairy supply
[e]Measured from samples >20 miles

Table 3 - EFFLUENT DATA FOR CY-1978

Radionuclide	Media	Quantity	
Tritium	air	7346	Ci
Tritium	water	32.4	Ci
Plutonium-238	air	0.014	mCi
Plutonium-238	water	4.9	mCi
Uranium-233, 234	water	1.2	mCi

and dissolved solids, were exceeded a few times. All results indicate that Mound effluent streams have no significant effect on the Great Miami River and certainly do not cause Ohio stream standards to be exceeded.

The person-rem calculated to 80 km for CY-1978 for the total population was 68 person-rem above that from natural radiation. Natural radiation would result in approximately 320,000 person-rem for the area. These data demonstrate the status of compliance with various current regulatory agency standards.

Environmental surveillance

Air - radioactive

An offsite air-sampling network consisting of 15 continuously operating air-sampling stations which are used for sampling both tritium oxide and plutonium were used

during CY-1978. Ten sampling stations are located within a 1.6 km (1 mi) radius of the Facility, and four samplers are located in or near population centers. The remaining sampler (#119) is approximately 44.8 km (28 mi) from the Facility in the least prevailing wind direction. This site 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 other locations. The samplers currently in operation are located at critical distances and directions based on a diffusion model developed for Mound Facility. 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 is a bubbler type sample for tritium oxide analysis. The particulate sample is collected on a 200-mm 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 1.3×10^6 cm^3/min (~45 ft^3/min). The Microsorban disk is changed weekly and represents a sample of approximately 13,000 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 offsite 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, electrodeposition of plutonium, and finally alpha spectrometry.

The average incremental offsite plutonium-238 air concentration for all locations was 0.67×10^{-17} µCi/ml which is 0.034% 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 4. Samples reported as less than (<) the Lower Detection Limit (LDL) are, for averaging purposes, considered to be the value of LDL when the LDL is greater than the measured environment levels. This method provides a conservative approach to low-level environmental data.

Table 5 shows concentrations of plutonium-239, 240 and plutonium-238 including environmental levels so that a ratio comparison between these two radionuclides can be made. A ratio greater than that observed at location #119 (~0.1) would indicate a concentration of plutonium-238 greater than that from atmospheric fallout and would indicate influence from Mound operations.

The gas bubbler sample is also collected on a continuous basis by bubbling air at approximately 3×10^3 cm^3/min through 200 ml of ethylene glycol. Ethylene glycol is used because this material eliminates evaporation and freezing problems associated with sample collection [6]. Any 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

Table 4 - INCREMENTAL CONCENTRATIONS OF PLUTONIUM-238 IN AIR AT OFFSITE SAMPLING LOCATIONS IN 1978

Location	Number of Samples	Range[d] (10^{-17} µCi/ml)	Average[a,c,d] (10^{-17} µCi/ml)	Percent of RCG[b]
101	4	e.l. - 0.49	0.15 ± 0.34	0.008
102	4	e.l. - 1.1	0.50 ± 0.81	0.03
103	4	0.44 - 9.7	2.9 ± 7.6	0.15
104	4	e.l. - 0.25	0.11 ± 0.26	0.006
105	4	e.l. - 0.11	e.l.	-
108	4	e.l. - 0.17	e.l.	-
110	4	e.l. - 0.04	e.l.	-
111	4	e.l. - 0.44	0.10 ± 0.32	0.005
112	4	e.l. - 0.11	e.l.	-
115	4	-	e.l.	-
118	4	e.l. - 2.9	0.79 ± 2.3	0.04
122	12	0.08 - 2.1	0.78 ± 0.51	0.04
123	12	0.13 - 25	2.8 ± 4.9	0.14
124	12	0.11 - 4.0	1.3 ± 0.73	0.07

[a]Lower Detection Limit (LDL) for ^{238}Pu in air is 0.08×10^{-17} µCi/ml. This is 0.004% of the RCG.

[b]Radioactivity Concentration Guide (RCG) = 2000×10^{-17} µCi/ml for the soluble form of ^{238}Pu for the general 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.

is 200 times more restrictive than it is for elemental tritium [7]. A sample representing ~30 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 CY-1978 for all offsite locations, not including the environmental level found at sampler #119, was 0.39×10^{-11} µCi/ml. This concentration is 0.006% of the RCG. The RCG used for comparison is the most restrictive RCG for tritium for the general population. The results are summarized in Table 6. Table 2 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

Table 5 - CONCENTRATION OF PLUTONIUM INCLUDING ENVIRONMENTAL LEVELS IN AIR AT OFFSITE SAMPLING LOCATIONS IN 1978

Location	Number of Samples	$^{239,240}Pu$ Range (10^{-17} µCi/ml)	$^{239,240}Pu$ Average[a,b] (10^{-17} µCi/ml)	^{238}Pu Average[a,b] (10^{-17} µCi/ml)	$^{238}Pu/^{239,240}Pu$
101	4	0.89 - 4.9	2.8 ± 2.6	0.31 ± 0.25	0.11
102	4	0.80 - 6.0	3.2 ± 3.5	0.66 ± 0.61	0.21
103	4	0.70 - 4.5	2.7 ± 2.5	3.0 ± 7.6	1.1
104	4	0.79 - 4.7	2.6 ± 2.6	0.27 ± 0.14	0.10
105	4	0.66 - 5.3	2.7 ± 3.1	0.15 ± 0.10	0.06
108	4	1.1 - 7.7	3.9 ± 4.5	0.14 ± 0.04	0.04
110	4	0.81 - 5.4	2.9 ± 3.0	0.11 ± 0.05	0.04
111	4	0.81 - 7.2	3.3 ± 4.4	0.26 ± 0.23	0.08
112	4	0.71 - 5.5	3.0 ± 3.3	0.12 ± 0.07	0.04
115	4	0.64 - 5.0	2.7 ± 2.9	<0.08	<0.03
118	4	0.83 - 7.2	3.6 ± 4.2	0.95 ± 2.3	0.26
119	4	0.63 - 4.4	2.2 ± 2.6	0.16 ± 0.23	0.07
122	12	0.35 - 4.4	2.2 ± 1.0	0.94 ± 0.46	0.43
123	12	0.68 - 6.0	3.0 ± 1.2	3.0 ± 4.9	1.0
124	12	0.58 - 6.0	3.0 ± 1.3	1.4 ± 0.70	0.47

[a]Lower Detection Limit (LDL) for $^{239,240}Pu$ in air for samplers 101 through 119 is 0.03×10^{-17} µCi/ml and the LDL for samplers 122 through 124 is 0.04×10^{-17} µCi/ml. The LDL for ^{238}Pu is 0.08×10^{-17} µCi/ml.

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

in Figure 4. 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 was 3.8×10^{-17} µCi/ml which is 0.054% of the RCG. The results are summarized in Table 7. Table 8 presents onsite concentrations of plutonium-239, 240 and plutonium-238 including environmental levels so that a ratio comparison between these two radionuclides can be made.

The average incremental onsite tritium oxide concentration for all locations was 0.64×10^{-11} µCi/ml which is 0.003% of the RCG. The results are summarized in Table 9.

Table 6 - INCREMENTAL CONCENTRATIONS OF TRITIUM OXIDE IN AIR AT OFFSITE SAMPLING LOCATIONS IN 1978

Location	Number of Samples	Tritium Oxide Range[d] (10^{-11} µCi/ml)	Tritium Oxide Average[a,c,d] (10^{-11} µCi/ml)	Percent of RCG[b]
101	52	e.l. - 4.03	0.44 ± 0.35	0.006
102	52	e.l. - 5.65	0.86 ± 0.44	0.012
103	52	e.l. - 8.78	0.52 ± 0.48	0.007
104	52	e.l. - 3.57	0.34 ± 0.39	0.005
105	52	e.l. - 2.81	0.20 ± 0.38	0.003
108	52	e.l. - 4.49	0.17 ± 0.39	0.002
110	52	e.l. - 2.68	0.14 ± 0.38	0.002
111	52	e.l. - 4.17	0.30 ± 0.43	0.004
112	52	e.l. - 4.12	0.29 ± 0.43	0.004
115	52	e.l. - 2.20	0.07 ± 0.37	0.001
118	52	e.l. - 1.78	0.19 ± 0.40	0.003
122	27	e.l. - 2.89	0.56 ± 0.36	0.008
123	51	e.l. - 3.56	0.73 ± 0.41	0.010
124	52	e.l. - 5.04	0.60 ± 0.43	0.009

[a]Lower Detection Limit (LDL) for tritium oxide in air is 0.12×10^{-11} µCi/ml which is 0.0017% of the RCG.

[b]Radioactivity Concentration Guide (RCG) = 7000×10^{-11} µCi/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.

The RCGs used for onsite comparisons are those applicable for exposed individuals in the population. The total amounts of plutonium-238 and tritium discharged to the atmosphere were 0.014 mCi and 7346 Ci, respectively. Comparison of these quantities to the RCG is not valid.

Air - nonradioactive

The Mound steam power supply is normally fueled with natural gas with the capability to burn fuel oil. During unusually cold weather, natural gas supply to Mound is interrupted, and fuel oil with <1% sulfur content is burned. The average sulfur content of the fuel oil burned in 1978 was approximately 0.5%. Approximately 140,000 gal of No. 2 fuel oil were burned during 1978.

Additional sources of airborne emissions are as follows. A water-wash, paint spray booth is operated intermittently

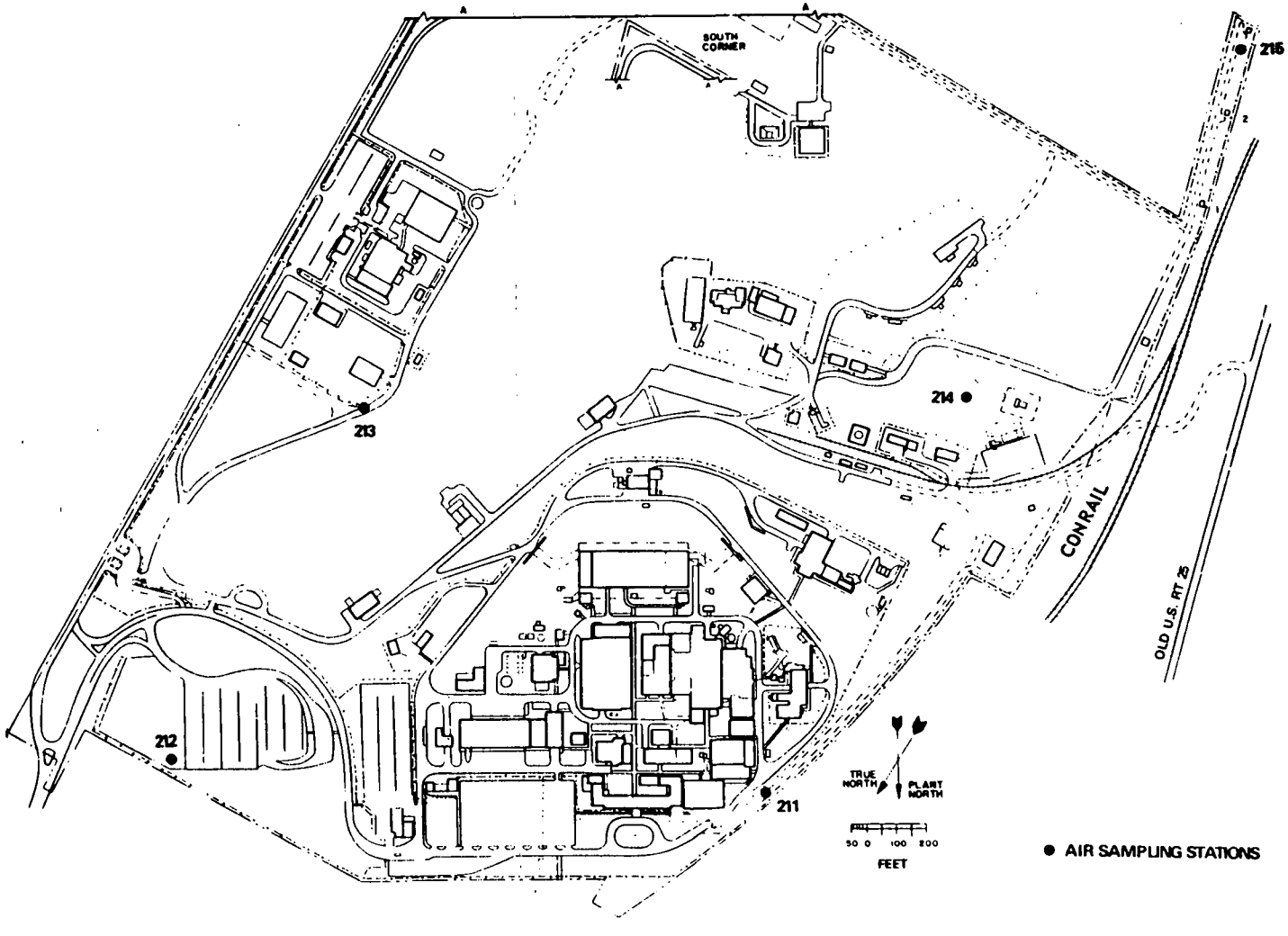

FIGURE 4 - Onsite air sampling locations.

Table 7 - INCREMENTAL CONCENTRATION OF ^{238}Pu IN AIR AT ONSITE SAMPLING LOCATIONS IN 1978

Location	Number of Samples	Range[d] (10^{-17} µCi/ml)	Average[a,c,d] (10^{-17} µCi/ml)	Percent of RCG[b]
211	12	0.32 - 3.3	2.5 ± 0.83	0.04
212	12	0.64 - 2.6	1.3 ± 0.68	0.02
213	12	2.1 - 24	11 ± 5.0	0.16
214	12	0.38 - 9.6	3.2 ± 1.8	0.05
215	12	0.20 - 3.7	1.1 ± 0.63	0.02

[a]Lower Detection Limit (LDL) for ^{238}Pu in air is 0.08 x 10^{-17} µCi/ml which is 0.001% of the RCG.

[b]Radioactivity Concentration Guide (RCG) = 7000 x 10^{-17} µCi/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 8 - CONCENTRATION OF PLUTONIUM INCLUDING ENVIRONMENTAL LEVELS IN AIR AT ONSITE SAMPLING LOCATIONS IN 1978

Location	Number of Samples	$^{239,240}Pu$ Range (10^{-17} µCi/ml)	$^{239,240}Pu$ Average[a,b] (10^{-17} µCi/ml)	^{238}Pu Average[a,b] (10^{-17} µCi/ml)	Ratio $^{238}Pu/^{239,240}Pu$
211	12	0.60 - 5.5	2.6 ± 1.1	2.7 ± 0.80	1.0
212	12	0.72 - 5.1	2.7 ± 1.1	1.5 ± 0.42	0.56
213	12	0.61 - 5.6	2.7 ± 1.1	12 ± 5.0	4.4
214	12	0.50 - 5.2	2.6 ± 1.1	3.3 ± 1.8	1.3
215	12	0.50 - 4.7	2.5 ± 1.1	1.3 ± 0.59	0.52

[a]Lower Detection Limit (LDL) for $^{239,240}Pu$ in air is 0.04 x 10^{-17} µCi/ml. The LDL for ^{238}Pu is 0.08 x 10^{-17} µCi/ml.

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

Table 9 - INCREMENTAL CONCENTRATION OF TRITIUM OXIDE IN AIR AT ONSITE SAMPLING LOCATIONS IN 1978

Location	Number of Samples	Tritium in Oxide Range[d] (10^{-11} µCi/ml)	Tritium in Oxide Average[a,c,d] (10^{-11} µCi/ml)	Percent of RCG[b]
211	52	e.l. - 3.61	0.34 ± 0.35	0.002
212	52	e.l. - 3.03	0.62 ± 0.34	0.003
213	52	e.l. - 4.12	0.90 ± 0.38	0.005
214	50	e.l. - 3.80	0.87 ± 0.46	0.004
215	52	e.l. - 3.87	0.45 ± 0.35	0.002

[a]Lower Detection Limit (LDL) for tritium oxide in air is 0.12×10^{-11} µCi/ml which is 0.0006% of the RCG.

[b]Radioactivity Concentration Guide (RCG) = $20{,}000 \times 10^{-11}$ µCi/ml for individuals in the population and 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.

in the Mound paint shop. Wastes from operations involving explosives are disposed of by open burning. A fire-test facility for qualifying containers for shipping radioactive wastes was not used during 1978. A maintenance grinding operation and a carpenter shop are also operated on an intermittent basis. Firefighter training exercises are normally held at an open outdoor facility. During 1978 no exercises of this type were held because of construction activities adjacent to this facility.

Emissions from sources registered with the Regional Air Pollution Control Agency (RAPCA) and the Ohio EPA which have applicable emission standards are summarized in Table 10. The emissions were estimated from emission factors established by the USEPA or from material balances [8]. The emission from the shipping-container fire-test facility is controlled with a forced air supply and water spray nozzles at the fuel-flame interface to an average capacity of <20%. The particulates from the grinding and carpenter shop operations are captured by cyclone air cleaners rated at 95% efficiency. Nonradioactive airborne emissions at Mound Facility 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 11 and 12. 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 offsite locations. The particulate concentration also appears to be independent of distance from Mound.

Table 10 - NONRADIOACTIVE AIRBORNE EMISSIONS 1978

Emission Source	Pollutant	Emission	Emission Standard[a]	% of Standard
Power House	Particulates	0.02 lb/10^6 Btu Input	0.20 lb/10^6 Btu Input	10
Power House	Sulfur Oxides	0.04 lb/10^6 Btu Input	1.6 lb/10^6 Btu Input	2.5
Paint Shop	Organics	0.32 lb/day	40 lb/day	0.8
Explosives	Particulates	~4 lb/yr	NA	NA

[a]Ohio EPA Air Pollution Regulations 3745-17-01 through 3745-17-13 and 3745-21-01 through 3745-21-08.

NA - not applicable.

This would suggest no influence from Mound operations. For comparison purposes, the State of Ohio - Ambient Quality Standard for airborne particulates is 60 $\mu g/m^3$.

Water - Radioactive

Water sampling locations along the bank of the Great Miami River were selected according to guidelines recommended by the U. S. EPA [9]. The locations, shown in Figure 5, provide samples which are representative of river water after suitable mixing of the effluent from Mound has occurred. Water samples are normally collected at these locations five days per week and are subjected to specific analyses for plutonium-238 and tritium.

The plutonium-238 river water analyses have been improved by a procedure developed at Mound Facility to maximize the sensitivity in detection of plutonium-238 in water. Large-volume water samples are analyzed by compositing daily samples for a semiannual analysis. The average concentration of plutonium-238 measured for all locations in the Great Miami River was $<0.21 \times 10^{-10}$ $\mu Ci/ml$ which is <0.001% of the RCG for the general population, the most restrictive standard for plutonium-238. The less than (<) indicates that the referenced environmental level (Table 2) is less than the lower detection limit. These results are summarized in Table 13.

A weekly composite of daily samples are analyzed for tritium. The average incremental concentration of tritium measured

Table 11 - 1978 WEEKLY PARTICULATE CONCENTRATION DATA[a]

Location	Number of Samples	Range ($\mu g/m^3$)	Average ($\mu g/m^3$)[b]
101	50	46 - 231	128 ± 12
102	51	26 - 251	111 ± 12
103	50	50 - 168	91 ± 8
104	52	60 - 176	114 ± 9
105	49	50 - 142	89 ± 7
108	46	58 - 356	160 ± 17
110	50	51 - 165	92 ± 8
111	52	77 - 366	152 ± 18
112	47	48 - 149	94 ± 7
115	52	49 - 236	95 ± 10
118	46	50 - 382	136 ± 21
119	51	31 - 134	70 ± 8
122	43	42 - 282	90 ± 13
123	52	51 - 224	110 ± 9
124	52	52 - 203	106 ± 9

[a]Ohio Ambient Air Quality Standard = 60 $\mu g/m^3$

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

These data are obtained by Mound's air monitoring program and are indicative only of the particulate air loading in the Dayton metropolitan area. Mound's particulate discharges presented in Table 10 make a negligible contribution to the surrounding area. In addition, Table 12 presents onsite particulate data.

Table 12 - 1978 WEEKLY PARTICULATE CONCENTRATION DATA ONSITE

Location	Number of Samples	Range ($\mu g/m^3$)	Average ($\mu g/m^3$)[a]
211	45	52 - 189	98 ± 9
212	44	36 - 182	86 ± 9
213	45	53 - 188	96 ± 9
214	43	38 - 215	98 ± 12
215	44	37 - 214	83 ± 11

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

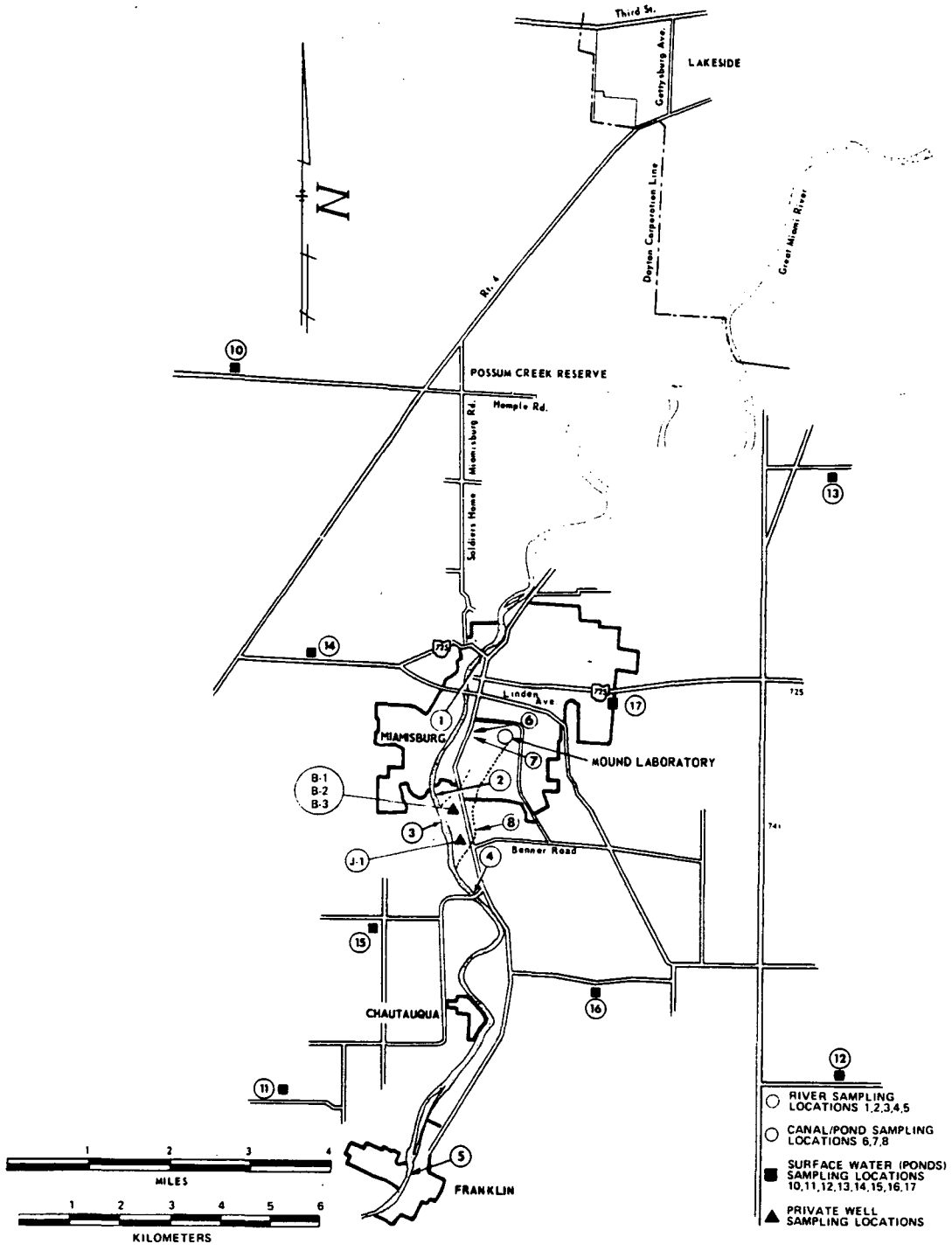

FIGURE 5 - Offsite water sampling locations.

Table 13 - CONCENTRATION OF ^{238}Pu IN THE GREAT MIAMI RIVER IN 1978

Location	Number of Samples[a]	^{238}Pu Range (10^{-10} µCi/ml)	^{238}Pu Average[b,d] (10^{-10} µCi/ml)	Percent of RCG[c]
1	2	<0.1 - 0.59	<0.36 ± 0.02	<0.0018
2	2	<0.1 - 0.18	<0.16 ± 0.04	<0.0008
3	2	<0.1 - 0.17	<0.16 ± 0.01	<0.0008
4	2	<0.1 - 0.43	<0.28 ± 0.05	<0.0014
5	2	-	<0.10	<0.0005

[a]Two composite large volume water samples for each location from water collected during CY-1978.

[b]Lower Detection Limit (LDL) for ^{238}Pu in water is 0.1×10^{-10} µCi/ml which is 0.0005% of the RCG.

[c]Radioactivity Concentration Guide (RCG) = $20,000 \times 10^{-10}$ µCi/ml for the general population and the soluble form of plutonium-238.

[d]Error limits include only counting statistics at 95% confidence level.

at all locations in the Great Miami River was 0.12×10^{-6} µCi/ml which is 0.01% of the RCG for the general population, the most restrictive standard for tritium. Referenced environmental levels (Table 2) have been subtracted. These results are summarized in Table 14.

Results of plutonium-238 and tritium analysis for one offsite sampling location on the abandoned Miami-Erie Canal shown in Figure 6 are reported in Tables 15 and 16, respectively. Results of uranium analysis from this location also are reported in Table 17. These values represent levels from the site drainage ditch which discharges into the offsite canal system prior to mixing with the Great Miami River. These values, as expected, are higher than those concentrations found in the Great Miami River where mixing and dilution occur. The total amounts of plutonium-238, tritium, and uranium-233 discharged to the Great Miami River were 4.9 mCi, 32.4 Ci, and 1.2 mCi, respectively. The concentrations were 0.13%, 1.4%, and 0.005% of the most restrictive RCG for individuals in the population. Uranium-233, 234, and 238 were monitored at the river water sampling locations during CY-1978. As can be seen by the data from Table 18, the ratio of uranium-233, 234 to uranium-238 is slightly greater than unity, which is in the range of background ratios reported [10]. This is expected as a result of secular equilibrium.

Eight additional surface water locations such as ponds in all quadrants surrounding Mound Facility as shown in Figure 5 are sampled semiannually. These samples.

Table 14 - INCREMENTAL CONCENTRATION OF TRITIUM IN THE GREAT MIAMI RIVER IN 1978

Location	Number of Samples	Tritium Range[d] (10^{-6} µCi/ml)	Tritium Average[a,c,d] (10^{-6} µCi/ml)	Percent of RCG[b]
1	41	e.l. - 1.9	e.l.	-
2	40	e.l. - 12.6	0.5 ± 0.6	0.05
3	41	e.l. - 7.5	0.1 ± 0.6	0.01
4	41	e.l. - 1.5	e.l.	-
5	41	e.l. - 0.8	e.l.	-

[a]Lower Detection Limit (LDL) for tritium in water is 0.30×10^{-6} µCi/ml which is 0.03% of the RCG.

[b]DOE Radioactivity Concentration Guide (RCG) which is compared to tritium concentration in water not used for drinking purposes = 1000×10^{-6} µCi/ml for the general population and the 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.

used for plutonium-238 determination, are also large volume water samples. The large volume of sample increases the sensitivity of the analysis. A smaller aliquot (10 ml) was taken for the tritium analysis. The average concentrations of plutonium-238 and tritium for all locations were $<0.1 \times 10^{-10}$ (LDL) and 0.6×10^{-6} µCi/ml, respectively, which are <0.0005% and 0.06% 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 2) have been subtracted from the concentrations of tritium in water; however, due to the LDL for plutonium-238 in water, no environmental levels have been subtracted. In addition, uranium-233, 234 and uranium-238 data are also reported as shown 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 1.8×10^{-6} µCi/ml which is 9% of the new standard which was 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 referenced environmental level (Table 2) for tritium in water is not subtracted from these data.

Several private wells in the vicinity of Mound Facility were analyzed semimonthly for tritium. The average concentration in these wells was 22.6×10^{-6} µCi/ml. The average concentration for 1978 exceeds the new standard by a factor of 1.1.

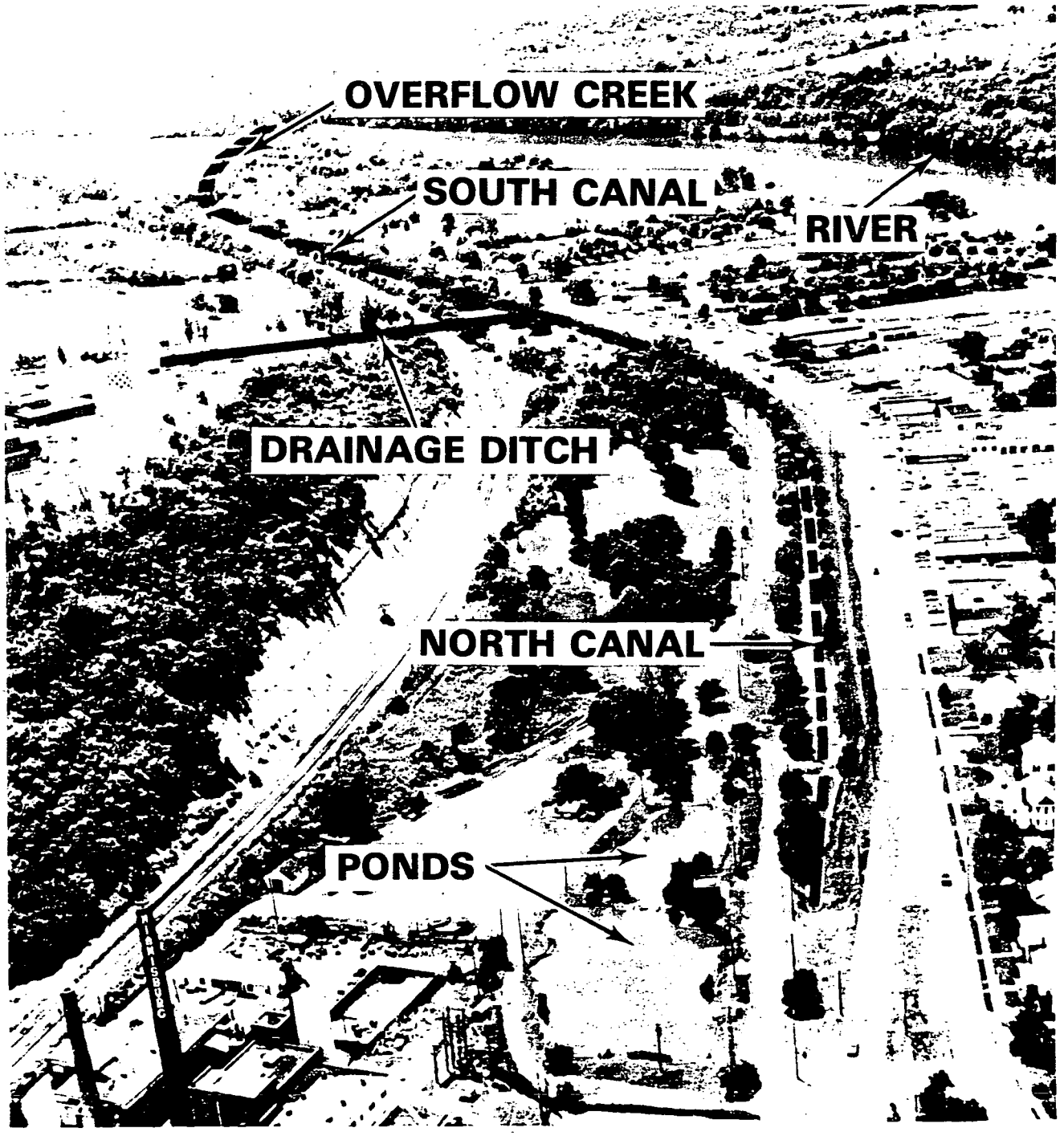

FIGURE 6 - Aerial view (from the north) of offsite abandoned canal and pond system.

Table 15 - INCREMENTAL CONCENTRATION OF ^{238}Pu IN WATER FROM CANAL/POND AREA IN 1978

Location[a]	Number of Samples[b]	^{238}Pu Range[f] (10^{-10} µCi/ml)	^{238}Pu Average[c,e,f] (10^{-10} µCi/ml)	Percent of RCG[d]
8 (South Canal)	2	11.7 - 16.8	14.3 ± 0.15	0.07

[a]Locations are shown in Figure 5.

[b]Two composite large volume water sample for each location from water collected during CY-1978.

[c]Lower Detection Limit (LDL) for ^{238}Pu in Water is 0.1 x 10^{-10} µCi/ml which is 0.0005% of the RCG.

[d]Radioactivity Concentration Guide (RCG) = 20,000 x 10^{-10} µCi/ml for the general population and soluble form of plutonium-238.

[e]Error limits include only counting statistics at 95% confidence level.

[f]Average environmental level (e.l.) subtracted from data.

Table 16 - INCREMENTAL CONCENTRATION OF TRITIUM IN WATER FROM CANAL/POND AREA IN 1978

Location[a]	Number of Samples	Tritium Range[e] (10^{-6} µCi/ml)	Tritium Average[b,d,e] (10^{-6} µCi/ml)	Percent of RCG[c]
8 (South Canal)	41	e.l. - 25	12 ± 1.4	1.2

[a]Locations are shown in Figure 5.

[b]Lower Detection Limit (LDL) for tritium in water is 0.3 x 10^{-6} µCi/ml which is 0.03% of the RCG.

[c]DOE Radioactivity Concentration Guide (RCG) which is compared to tritium concentration in water not used for drinking purposes = 1000 x 10^{-6} µCi/ml for the general population and soluble form of tritium.

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

[e]Average environmental level (e.l.) subtracted from data.

Table 17 - CONCENTRATION OF $^{233,234}U$ IN WATER FROM CANAL/POND AREA IN 1978

Location	Number of Samples[a]	$^{233,234}U$ Range (10^{-10} µCi/ml)	$^{233,234}U$ Average[b,c] (10^{-10} µCi/ml)	^{238}U Average[c] (10^{-10} µCi/ml)	Ratio $^{233,234}U/^{238}U$
8 (South Canal)	2	8.2 - 16	12 ± 0.5	9.8 ± 0.28	1.2

[a]Two composite large volume water samples for each location.

[b]Lower Detection Limit (LDL) for $^{233,234}U$ in water is 0.3×10^{-10} µCi/ml.

[c]Error limits include only counting statistics at 95% confidence level.

Table 18 - CONCENTRATION OF $^{233,234}U$ IN THE GREAT MIAMI RIVER IN 1978

Location	Number of Samples[a]	$^{233,234}U$ Range (10^{-10} µCi/ml)	$^{233,234}U$ Average[a,b,c] (10^{-10} µCi/ml)	^{238}U Average[c] (10^{-10} µCi/ml)	Ratio[d] $^{233,234}U/^{238}U$
1	2	5.9 - 6.2	6.1 ± 0.33	5.7 ± 0.32	1.1
2	2	6.3 - 6.7	6.5 ± 0.25	5.9 ± 0.24	1.1
3	2	6.0 - 6.3	6.2 ± 0.39	4.5 ± 0.33	1.4
4	2	6.2 - 6.4	6.3 ± 0.21	5.8 ± 0.20	1.1
5	2	-	6.4 ± 0.33	5.7 ± 0.31	1.1

[a]Two composite large volume water samples for each location.

[b]Lower Detection Limit (LDL) for $^{233,234}U$ in water is 0.3×10^{-10} µCi/ml.

[c]Error limits include only counting statistics at 95% confidence level.

[d]A ratio slightly greater than unity indicates naturally occurring uranium [10].

However, most recent data indicate that six of eight private wells are within the EPA Drinking Water Standard and the two remaining wells are nearing compliance. These wells are expected to be in compliance by early 1979. The present status has been achieved by a forced water turnover program involving high-volume pumping of two high-capacity wells. The high-volume pumping will be maintained until all private wells achieve compliance, and periodic pumping will be used to maintain the wells in compliance until rebound studies indicate that the program can be terminated. Additional details concerning this program have been reported by Styron and Meyer [11]. Private well analyses results are summarized in Table 23.

Four private wells and Miamisburg city water were sampled and analyzed

Table 19 - SUMMARY OF SURFACE WATER MONITORING FOR PLUTONIUM-238 IN 1978

Location	Number of Samples[a]	^{238}Pu Range (10^{-10} µCi/ml)	^{238}Pu Average[b] (10^{-10} µCi/ml)	Percent of RCG[c]
10	2	-	<0.1	<0.0005
11	2	-	<0.1	<0.0005
12	2	-	<0.1	<0.0005
13	1	-	<0.1	<0.0005
14	2	-	<0.1	<0.0005
15	2	-	<0.1	<0.0005
16	1	-	<0.1	<0.0005
17	2	-	<0.1	<0.0005

[a]Two composite large volume water samples were used for each location.

[b]Lower Detection Limit (LDL) for ^{238}Pu in water is 0.1×10^{-10} µCi/ml which is 0.0005% of the RCG.

[c]Radioactivity Concentration Guide (RCG) for ^{238}Pu in water = $20{,}000 \times 10^{-10}$ µCi/ml for the general population and soluble form of plutonium-238.

Table 20 - SUMMARY OF SURFACE WATER MONITORING FOR INCREMENTAL TRITIUM IN 1978

Location	Number of Samples	Tritium Range[d] (10^{-6} µCi/ml)	Tritium Average[a,c,d] (10^{-6} µCi/ml)	Percent of RCG[b]
10	4	e.l. - 1.2	0.5 ± 1.0	0.05
11	4	e.l. - 0.5	0.1 ± 0.5	0.01
12	4	e.l. - 1.2	0.5 ± 1.1	0.05
13	3	0.4 - 1.4	0.8 ± 1.2	0.08
14	4	e.l. - 1.4	0.5 ± 1.4	0.05
15	4	0.1 - 1.7	0.7 ± 1.1	0.07
16	4	e.l. - 2.2	0.6 ± 1.8	0.06
17	4	e.l. - 3.4	1.1 ± 2.5	0.11

[a]Lower Detection Limit (LDL) for tritium in water is 0.5×10^{-6} µCi/ml which is 0.05% of the RCG.

[b]DOE Radioactivity Concentration Guide (RCG) which is compared to tritium concentration in water not used for drinking purposes = 1000×10^{-6} µCi/ml for the general population and 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.

Table 21 - CONCENTRATION OF $^{233,234}U$ FROM SURFACE WATER LOCATION IN 1978

Location	Number of Samples[a]	$^{233,234}U$ Range (10^{-10} µCi/ml)	$^{233,234}U$ Average[b,c] (10^{-10} µCi/ml)	^{238}U Average[c] (10^{-10} µCi/ml)	Ratio[d] $^{233,234}U/^{238}U$
10	2	3.6 - 9.5	6.5 ± 0.25	7.5 ± 0.25	0.9
11	2	3.7 - 3.8	3.7 ± 0.20	3.3 ± 0.19	1.1
12	2	1.4 - 2.1	1.8 ± 0.12	1.7 ± 0.12	1.1
13	2	2.1 - 3.2	2.6 ± 0.16	2.2 ± 0.15	1.2
14	2	2.0 - 2.5	2.3 ± 0.15	1.7 ± 0.13	1.4
15	2	-	4.2 ± 0.24	4.1 ± 0.23	1.0
16	2	1.4 - 2.5	1.9 ± 0.14	1.9 ± 0.14	1.0
17	2	2.6 - 3.3	2.9 ± 0.20	2.7 ± 0.19	1.1

[a]Two composite large volume water samples for each location.

[b]Lower Detection Limit (LDL) for $^{233,234}U$ in water is 0.3×10^{-10} µCi/ml.

[c]Error limits include only counting statistics at 95% confidence level.

[d]A ratio slightly greater than unity indicates naturally occurring uranium [10].

semiannually for plutonium-238. These samples were also large volume water samples. The average plutonium-238 concentration for these locations was $<0.1 \times 10^{-10}$ (LDL) µCi/ml which is <0.0005% of the applicable DOE RCG for the general population. These results are shown in Table 24.

Water - Nonradioactive

Mound Facility has a discharge permit under the National Pollutant Discharge Elimination System (NPDES) issued by Region V of the U. S. EPA. The permit specifies limitations for pollutants in the two effluent streams from Mound that discharge to the Great Miami River. The discharge from outfall number 001 includes the discharge from the sanitary waste treatment plant, radioactive waste disposal facility, single-pass cooling water, zeolite softener backwash, and some storm water runoff. The discharge from outfall number 002 consists of single-pass cooling water, cooling-tower blowdown, boiler-plant blowdown, zeolite softener backwash, and most of the storm-water runoff. A 24-hr composite sample of each effluent stream is collected automatically. The volume of samples collected is proportional to the flow in the stream. The composite effluent water samples are analyzed for water quality parameters according to standard methods [12]. The results of effluent stream analyses for 1978 are summarized in Tables 25 and 26. There were eleven suspended solids, four residual chlorine, and one dissolved solids exceptions during 1978. Three of the suspended solids exceptions were caused by the sanitary waste treatment plant operation; one was apparently from a minor upset which was

Table 22 - SUMMARY OF TRITIUM LEVELS IN COMMUNITY DRINKING WATER IN 1978

Locations	Number of Samples	Tritium Range[d] (10^{-6} µCi/ml)	Tritium Average[a,c,d] (10^{-6} µCi/ml)	Percent Standard[b]
Bellbrook	7	0.3 - 2.8	1.1 ± 0.7	5.5
Centerville	6	0.6 - 1.6	1.2 ± 0.3	6.0
Dayton	7	0.3 - 0.8	0.5 ± 0.2	2.5
Franklin	7	0.9 - 1.5	1.2 ± 0.2	6.0
Germantown	8	0.5 - 3.7	1.2 ± 0.9	6.0
Kettering	7	0.8 - 3.7	1.6 ± 1.0	8.0
Miamisburg	7	1.5 - 8.8	5.1 ± 2.7	26
Middletown	7	0.6 - 5.0	1.5 ± 1.5	7.5
Moraine	7	0.7 - 6.6	2.1 ± 2.0	11
Springboro	7	1.2 - 3.3	1.9 ± 0.7	9.5
Waynesville	8	0.6 - 2.6	1.2 ± 0.7	6.0
West Carrollton	7	2.0 - 4.0	3.0 ± 0.7	15

[a] Lower Detection Limit (LDL) for tritium oxide is 0.2 x 10^{-6} µCi/ml which is 1.0% of the EPA Standard for community drinking water.

[b] EPA Drinking Water Standard for tritium = 20 x 10^{-6} µCi/ml for community drinking water systems.

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

[d] Environmental level is included in these data for comparison to the EPA standard.

quickly corrected, and the others were from hydraulic overloading caused by a water-line break. The remaining suspended solids exceptions were detected in the effluent artery of discharge 001 which includes storm runoff and powerhouse discharges. The residual chlorine exceptions occurred at the sanitary waste treatment plant and involved chlorination of the plant effluent prior to discharge from the site. The dissolved solids exception occurred in discharge 002. The source of dissolved solids is the zeolite water softening operation which discharges large quantities of dissolved solids during recharging operations. These waterborne effluents had no significant effect on the River since the river flow, even under low-flow conditions, was approximately 350 times the maximum flow discharge from Mound during 1978. These data show that the Mound releases to the 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

Table 23 - TRITIUM IN PRIVATE WELLS IN 1978

Location	Number of Samples	Tritium Range[e] (10^{-6} µCi/ml)	Tritium Average[a,b,d,e] (10^{-6} µCi/ml)	Percent Standard[c]
B-1	19	12.7 - 48.7	24.2 ± 4.7	121
B-2	19	16.5 - 31.6	21.1 ± 1.9	106
B-3	19	15.3 - 25.3	20.0 ± 1.3	100
J-1	18	17.9 - 32.1	25.0 ± 1.7	125

[a]All wells are approaching compliance with the new EPA standard of 20 x 10^{-6} µCi/ml.

[b]Lower Detection Limit (LDL) for tritium in water is 0.4 x 10^{-6} µCi/ml which is 0.04% of the EPA Standard.

[c]EPA Standard for tritium in community drinking water systems = 20 x 10^{-6} µCi/ml. Mound is using the EPA Standard as a guide for the private water supplies.

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

[e]Environmental level is included in these data for comparison to the EPA Standard.

Table 24 - PLUTONIUM-238 IN PRIVATE WELLS AND MIAMISBURG MUNICIPAL DRINKING WATER IN 1978

Location	Number of Samples[a]	^{238}Pu Range (10^{-10} µCi/ml)	^{238}Pu Average[b,d] (10^{-10} µCi/ml)	Percent of RCG[c]
Miamisburg	2	-	<0.1	<0.0005
B-1	2	<0.1 - 0.14	<0.12 ± 0.01	<0.0006
B-2	2	-	<0.1	<0.0005
B-3	2	-	<0.1	<0.0005
J-1	2	-	<0.1	<0.0005

[a]Two composite large volume water samples were analyzed from each location from water collected during CY-1978.

[b]Lower Detection Limit (LDL) for ^{238}Pu is 0.1 x 10^{-10} µCi/ml which is 0.0005% of the RCG.

[c]Applicable DOE Radioactivity Concentration Guide (RCG) for ^{238}Pu in water = 20,000 x 10^{-10} µCi/ml for the general population and soluble form of ^{238}Pu.

[d]Error limits include only counting statistics at 95% confidence level.

Table 25 - 1978 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT DATA FOR STATION 001

Parameter		No. Samples	Minimum	Maximum	Average
Flow, MGD[a]	Reported	Cont.	0.03	0.31	0.12
	Permit			0.92	0.53
BOD_5	Reported	84	0.5	9.9	3.5
	Permit			15	10.0
Suspended Solids	Reported	214	2.0	80.7	11
	Permit			15	10
Dissolved Oxygen	Reported	154	5.8	12.2	8.6
	Permit				>5
Residual Chlorine	Reported	124	ND[b]	2.5	0.15
	Permit			0.5	
Oil and Grease	Reported	84	ND	8.8	1.3
	Permit			10	
pH	Reported	150	6.2	9.0	
	Permit		6.0	9.0	
Organic Carbon	Reported	15	2	12	7.6

[a]MGD - million gallons per day. All other values are in milligrams per liter.

[b]ND - none detectable.

portion of the Environmental Monitoring Program is to determine whether there is any uptake and concentration of radionuclides by plant or animal life. Where possible, sampling sites are chosen at maximum deposition locations predicted on the basis of the diffusion model developed for Mound Facility [13]. Field crops and vegetables are collected on the basis of this diffusion model. Milk is collected from individual farms closest to the Facility. Aquatic life is trapped from the Miami River generally downstream of Miamisburg and from adjacent waterways, depending upon availability of fish.

Grass samples are collected in the vicinity of the surface water locations shown in Figure 5. The plutonium-238 content of the foodstuff and vegetation samples, including milk, is determined by ashing the samples and then proceeding with the same techniques used for plutonium-238 analyses of air samples (see section on Air - Radioactive). Milk samples are analyzed for tritium oxide by distilling the water fraction from an aliquot. The distillate is then analyzed for tritium by liquid scintillation spectrometry in the same manner as the water samples (see section on Water - Radioactive). The

Table 26 - 1978 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT DATA FOR STATION 002

Parameter		No. Samples	Minimum	Maximum	Average
Flow, MGD[a]	Reported	Cont.	0.01	1.5	0.35
	Permit				0.53
Suspended Solids	Reported	220	1.5	19.3	10.2
	Permit			20.0	15
Dissolved Oxygen	Reported	138	6.4	14.2	9.2
	Permit				>5.0
Residual Chlorine	Reported	120	ND[b]	0.05	0.02
	Permit			0.05	
Oil and Grease	Reported	65	ND	6.0	1.0
	Permit			10.0	
pH	Reported	142	7.8	8.8	
	Permit		6.0	9.0	
Dissolved Solids	Reported	65	105		
	Permit			2277	1061

[a]MGD - million gallons per day. All other values are in milligrams per liter, except pH.

[b]ND - none detectable.

results of the foodstuff and vegetation analyses are summarized in Tables 27 and 28. The concentration is given in terms of the sample weight (wet weight) before ashing. The vegetables analyzed were turnips and tomatoes. The samples of aquatic life analyzed included only the edible fleshy portions of fish. No evidence has been found that there is any significant uptake or concentration by plant or animal life of the radionuclides handled at Mound Facility. Environmental levels for foodstuffs and vegetation have been subtracted from the data (Table 2).

Silt - radioactive

Silt samples were collected from the surface water sample locations shown in Figure 5. These samples were obtained by filtration of sediment (silt) from the water that was collected from these locations.

The results of the silt sample analyses are found in Tables 29, 30, and 31. No offsite soil sampling was conducted in CY-1978 since the soil inventory was completed and reported for CY-1977 and

Table 27 - INCREMENTAL PLUTONIUM-238 IN FOODSTUFFS AND VEGETATION IN 1978

Type of Sample	Number of Samples	^{238}Pu Range[f] (10^{-10} µCi/g)	Average[a,b,c,d,e,f] (10^{-10} µCi/g)
Milk	1	-	<2.6
Vegetables	1	-	<4.4
Grass	23	<9.0 - 47	<17 ± 6.0
Aquatic Life	2	-	<19

[a]Lower Detection Limit (LDL) for ^{238}Pu in milk is 2.6×10^{-10} µCi/g.

[b]Lower Detection Limit (LDL) for ^{238}Pu in vegetables is 4.4×10^{-10} µCi/g.

[c]Lower Detection Limit (LDL) for ^{238}Pu in grass is 9.0×10^{-10} µCi/g.

[d]Lower Detection Limit (LDL) for ^{238}Pu in aquatic life is 19×10^{-10} µCi/g.

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

[f]Average environmental level (e.l.) have been subtracted from the data.

Table 28 - INCREMENTAL TRITIUM IN FOODSTUFFS AND VEGETATION IN 1978

Type of Sample	Number of Samples	Tritium[d] Range (10^{-6} µCi/g)	Tritium[a,b,c,d,e] Average (10^{-6} µCi/g)
Milk	2	0.02 - 0.14	0.08 ± 0.32
Vegetables	3	0.2 - 0.78	0.4 ± 0.38
Grass	26	e.l. - 3.8	0.4 ± 0.41

[a]LDL for tritium in milk = 0.2×10^{-6} µCi/g.

[b]LDL for tritium in vegetables = 0.2×10^{-6} µCi/g.

[c]LDL for tritium in grass = 0.14×10^{-6} µCi/g.

[d]Average environmental levels (e.l.) have been subtracted from data.

[e]Error limits include only counting statistics at 95% confidence level.

Table 29 - PLUTONIUM-238 IN SILT FROM RIVER MONITORING LOCATIONS IN 1978

Location	Number of Samples	^{238}Pu Range (10^{-6} µCi/g)	^{238}Pu Average[a,b] (10^{-6} µCi/g)
1	2	1.4 - 63	32 ± 0.44
2	2	5.3 - 36	20 ± 0.26
3	2	7.6 - 11	9.2 ± 0.19
4	2	3.8 - 37	20 ± 0.25
5	2	1.0 - 2.8	1.9 ± 0.15

[a]Lower Detection Limit (LDL) for ^{238}Pu in silt is 0.1 x 10^{-6} µCi/g.

[b]Error limits include only counting statistics at 95% confidence level.

Table 30 - PLUTONIUM-238 IN SILT FROM SURFACE WATER MONITORING LOCATIONS IN 1978

Location	Number of Samples	^{238}Pu Range (10^{-6} µCi/g)	^{238}Pu Average[a,b] (10^{-6} µCi/g)
10	2	-	0.3 ± 0.04
11	2	<0.2 - 0.7	<0.4 ± 0.05
12	2	<0.2 - 0.4	<0.3 ± 0.03
13	2	0.2 - 0.9	0.6 ± 0.09
14	2	-	<0.2
15	2	-	<0.2
16	2	0.6 - 0.7	0.6 ± 0.08
17	2	0.5 - 1.3	0.9 ± 0.04

[a]Lower Detection Limit (LDL) for ^{238}Pu is 0.2 x 10^{-6} µCi/g.

[b]Error limits include only counting statistics at 95% confidence level.

Table 31 - PLUTONIUM-238 IN SILT FROM CANAL/POND AREA SILT IN 1978

Location[a]	Number of Samples	^{238}Pu Range (10^{-6} µCi/g)	^{238}Pu Average[b,c] (10^{-6} µCi/g)
8 (South Canal)	2	299 - 443	371 ± 1.4

[a]Locations are shown in Figure 5.

[b]Lower Detection Limit (LDL) for ^{238}Pu in silt is 0.1 x 10^{-6} µCi/g.

[c]Error limits include only counting statistics at 95% confidence level.

there is no evidence of other than minimal uptake of plutonium-238 by plants from soil [14].

Evaluation of dose commitment to the public

A dose assessment was performed for radionuclides in the environment from Mound Facility operations. These radionuclides are plutonium-238 and tritium. Tritium (oxide) is the only radionuclide at Mound Facility 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 were based on total concentration of plutonium-238 found in the environment. This approach gives a very conservative estimate of dose equivalents.

Plutonium-238 assumptions and methodology

The dose equivalent estimates for plutonium-238 were based on environmental monitoring data for CY-1978. The estimates for maximum dose equivalent to the lung at the site boundary and maximum dose equivalent to the lung in individuals were based on the maximum onsite incremental average concentration of plutonium-238 in air from onsite samplers (sampler 213, Table 7) since the samplers are in close proximity to the site boundary. The maximum dose equivalent to the lung in population group(s) was based on the maximum offsite average incremental concentration of plutonium-238 in air (sampler 103, Table 4).

The estimates for maximum dose equivalent 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, B-3, Table 24). The maximum dose equivalent to the bone for individuals in population group(s) was based on the maximum offsite average incremental concentration of plutonium-238 in air and maximum offsite average concentration of plutonium-238 in water (Miamisburg drinking water, Table 24). The total dose equivalent for bone was obtained by the addition of the dose equivalent of plutonium in air and the dose equivalent of plutonium in water.

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

The calculational methods can be found in the Appendix.

Tritium (oxide) assumptions and methodology

The dose equivalent estimates for tritium (oxide) were also based on environmental monitoring data for CY-1978. The concentrations used for dose equivalent 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 9), and the maximum drinking water incremental concentration was the average of B-1, B-2, and B-3. The maximum average offsite air incremental concentration was measured at sampler 102 (Table 6), and the maximum incremental concentration of drinking water for individuals in a population group was 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 estimate calculations are shown in Table 32.

The methodology for 80 km (50 mi) person-rem dose commitment estimates has changed for CY-1978. Environmental monitoring and data analyses have been improved to allow the use of sampler #119 to determine environmental levels of tritium in air. This means that the calculations to determine concentrations of tritium will include only one distance range, 0 to 32 km (20 mi).

Environmental data indicate that Mound's influence does not reach 32 km (20 mi); however, for conservatism, 32 km (20 mi) will be the assumed limit for Mound's impact. This, coupled with the assumption of 360° atmospheric diffusion to 32 km (20 mi), provides a high degree of conservatism.

The person-rem dose commitment estimate calculations were based on average

Table 32 - DOSE COMMITMENT ESTIMATES

	Plutonium-238 (mrem/50 yr)		Tritium Oxide (mrem/50 yr)
	Lung	Bone	Whole Body
Maximum dose equivalent at the site boundary	0.70	4.69	2.06
Maximum dose equivalent to an individual	0.70	4.69	2.06
Maximum dose equivalent to an individual in the population group(s)	0.19	1.25	0.43

tritium (oxide) data from environmental air sampling stations and average tritium (oxide) data in community drinking water.

The average concentration of tritium (oxide) in air was obtained by averaging all 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 32 km (20 mi).

The person-rem from tritium (oxide) in community water was based upon average concentrations of tritium (oxide) in various community water supplies and weighting 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 (20 mi) is receiving an additional 68 person-rem from Mound's emissions. The remaining population from 32 km to 80 km (20 to 50 mi) is not receiving dose from tritium (oxide) emissions.

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 [15]. 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 Manual Chapter 0524, "Standards 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 - μCi/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} μCi/ml
Uncontrolled Area (Individuals in the Population	7×10^{-14} μCi/ml

Water

General Population	2×10^{-6} μCi/ml
Uncontrolled Area (Individuals in the Population)	5×10^{-6} μCi/ml

Tritium (Soluble Form)

Air

General Population	7×10^{-8} μCi/ml
Uncontrolled Area (Individuals in the Population)	2×10^{-7} μCi/ml

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

General Population	1×10^{-3} μCi/ml
Uncontrolled Area (Individuals in the Population)	3×10^{-3} μCi/ml

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} μCi/ml (20,000 pCi/l).

Foodstuffs There are no RCG values specified for foodstuffs.

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 USEPA has issued a discharge permit under NPDES regulations covering both Mound Facility liquid effluent streams. The discharge limitations for each effluent stream are as follows:

Outfall Number 001	Daily Average	Daily Maximum
Flow (10^6 gal/day)	0.53	0.92
BOD_5 (mg/liter)	10	15
Suspended Solids (mg/liter)	10	15
Dissolved Oxygen (mg/liter)	5	-
Residual Chlorine (mg/liter)	-	0.5
Oil and Grease (mg/liter)	-	10
pH	6-9	-

Outfall Number 002	Daily Average	Daily Maximum
Flow (10^6 gal/day)	0.53	-
Suspended Solids (mg/liter)	15	20
Dissolved Oxygen (mg/liter		
October-April	8	-
May-September	5	-
Residual Chlorine (mg/liter)	-	0.05
Oil and Grease (mg/liter)	-	10
Dissolved Solids (mg/liter)	1500	2000
pH	6-9	-

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.

Constituent	Average Concentration (mg/liter)
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 $CaCo_3$ hardness.

Dose commitment calculations

PLUTONIUM-238 CALCULATIONAL METHODS

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

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

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, μCi/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]

$\Sigma EF(RBE)\eta$ = 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:

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

where

f_a = 0.2 [1]

$\Sigma EF(RBE)\eta$ = 284 [1]

m = 7×10^3 g [1]

= 3×10^{-5} day^{-1} [1]

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

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

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:

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

where

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

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

Ra = 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:

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

where

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

$\bar{C}w$ = average concentration

Rw = 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:

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

where

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

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

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

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

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

where

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

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

Rw = 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.

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

$$\sum_{0}^{32} R = \left(\left(\bar{D}(t)\, a \sum_{0}^{32} P\right) + \sum_{0}^{32} \left(\bar{D}(t)\, wP\right)\right)$$

where

$\sum_{0}^{32} R$ = person-rem within 32 km

$\bar{D}(t)\, a \sum_{0}^{32} P$ = average dose commitment x population from 0-32 km (895,941)

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

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