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FEED MATERIALS PRODUCTION CENTER ENVIRONMENTAL MONITORING ANNUAL REPORT FOR 1983

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FEED MATERIALS PRODUCTION CENTER
ENVIRONMENTAL MONITORING ANNUAL REPORT
FOR 1983

By

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SUMMARY

This report contains environmental monitoring data collected at the Feed Materials Production Center (FMPC) during 1983. These data show that the discharges of radioactive contaminants from FMPC operations were only a fraction of the Department of Energy guide levels published in DOE Order 5480.1A.[1] The resulting offsite radiation exposures were, therefore, a small fraction of the standards for uncontrolled areas.

Concentrations of environmentally important nonradioactive contaminants in water and air are also reported. Results show good compliance with applicable standards for these contaminants.

INTRODUCTION

The Feed Materials Production Center (FMPC) is an industrial facility owned by the United States Department of Energy (DOE) and operated by NLO, Inc. The facility is located on a 1050-acre site about 20 miles northwest of downtown Cincinnati, Ohio. Several rural communities are 1-3 miles away. Figure 1 is a map of the area.

The primary work at the FMPC is the production of purified uranium metal and compounds for use at other DOE sites. In regard to Uranium-235 content, the uranium may be depleted, normal, or slightly enriched. The average content is close to normal.

Uranium production may begin with ore concentrates, recycled uranium from spent reactor fuel, or with various uranium compounds. Impure starting material is

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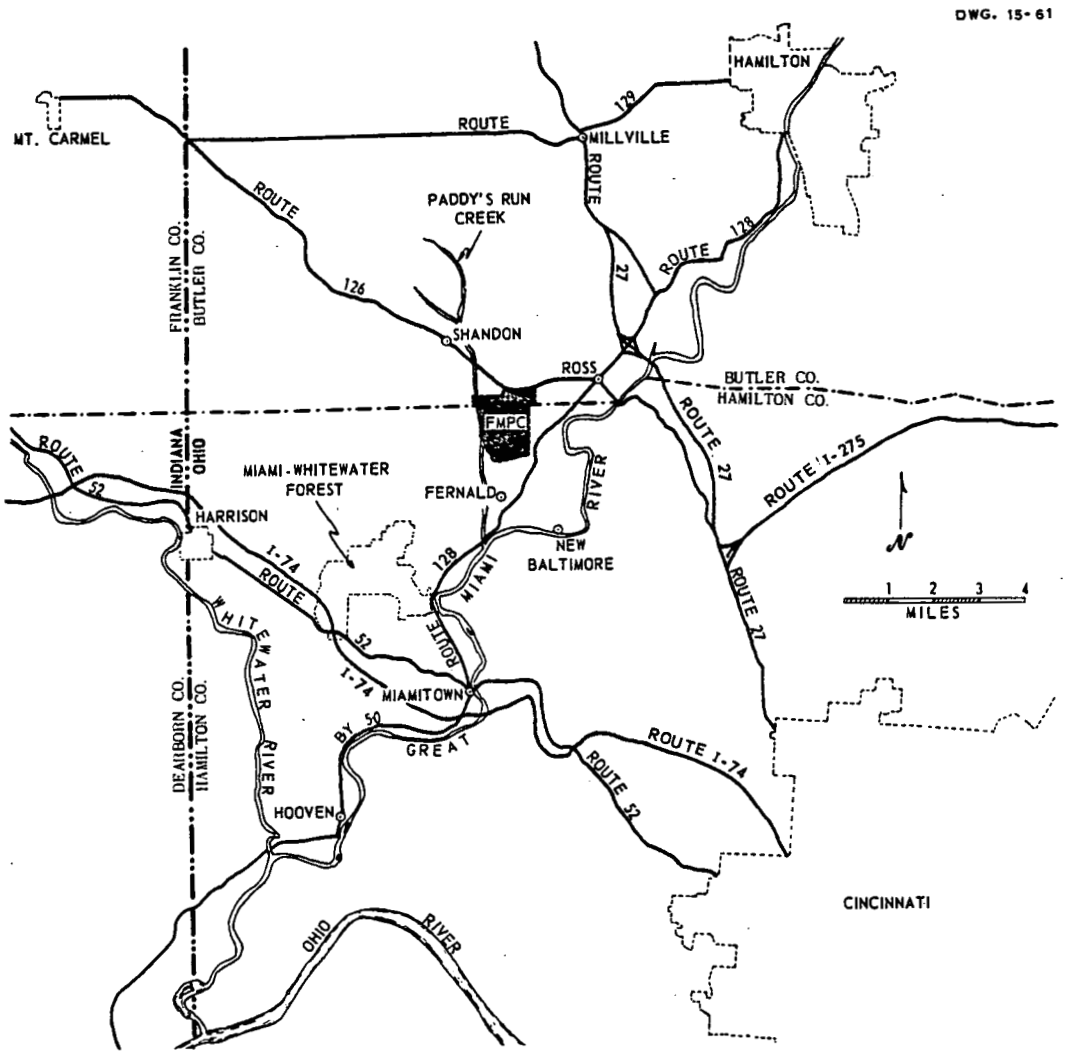


FIGURE 1 Area Map

dissolved in nitric acid and the uranium is extracted into an organic liquid and then back-extracted into dilute nitric acid to yield a solution of uranyl nitrate.

Evaporation and heating convert the nitrate solution to uranium trioxide (UO_3) powder. This compound is reduced to uranium dioxide (UO_2) with hydrogen and then converted to uranium tetrafluoride (UF_4) by reaction with anhydrous hydrogen fluoride. Uranium metal is produced by reacting UF_4 and magnesium metal in a refractory-lined reduction vessel. This primary uranium metal is then remelted with scrap uranium metal to yield a purified uranium ingot which is extruded to form rods or tubes. Sections are then cut and machined to final dimensions. These machined cores are shipped to other DOE sites for canning and final assembly into reactor fuel elements. Primary metal and metal castings of other shapes are also final products.

Periodically, small amounts of thorium are processed. No thorium processing occurred during 1983. Thorium production steps, in general, are similar to those followed in uranium production. Final products may be purified thorium nitrate solution, solid thorium compounds, or metal.

AREA FEATURES

Glacial action during the time of the Illinoian and Wisconsinan ice sheets gave the area its basic geological features. In the FMPC area, outwash from retreating glaciers filled in the wide valley of a large ancient river. Through this fill, the Miami River has cut its present course and the river bed is now located about 60 feet below the original surface level of the glacial deposits.

Underlying the FMPC is about 50 feet of clay-rich till which may be a remnant of a large glacial moraine. Beneath the till is about 150 feet of sand and gravel which fills the buried valley of the pre-glacier river. In the FMPC area, that ancient valley is about three miles wide.

On the 1050-acre FMPC site, the production facilities are oriented in a north-south direction and occupy approximately 136 acres in roughly the center of the site. The topography of the site is relatively level, being on an elevated plain at about 580 feet above sea level over most of the production area. The onsite land becomes somewhat sloping north of the production area, rising to an elevation of 700 feet at the northern edge of the site. Elevations slope downward on the western edge of the site to Paddy's Run Creek at 550 feet. Soils at the FMPC are primarily categorized as Fincastle - Xenia silt loams, with Fox-Gennessee loams along the western edge of the site and Russell-Xenia - Wynn at the northeast corner. Vegetation growing on the site is typical of that occurring in this region under similar land-use practices. Major vegetation types on the site are: grazed pasture areas on the east, north, and south sides; mowed areas on the northeast and southwest of the production area; wooded areas along the stream beds and the north and northwest portions of the site; and a scrub area east of Paddy's Run Creek.

The area east of the FMPC, in the Miami River flood plain, has fertile soil and is reported to contain some of the best farm land in the state. In the gently rolling uplands west of the flood plain, the thin soil mantle over the glacial drift is less fertile.

Although there are several small industries nearby, the major economic activities in this rural area are farming, dairying, and the raising of beef cattle. Farm crops include sweet corn, field corn, soybeans and wheat. Truck crops are widely grown and sold at local produce stands and in nearby urban markets.

The glacial till and the Miami River have provided two other important area products - groundwater and gravel. A company located about one mile from the FMPC pumps out about 20 million gallons of groundwater per day, chiefly for industries in and near Cincinnati. Pumping began just before the FMPC was built. The permeable glacial deposits, called valley-train, house the bountiful deep aquifer from which the water company and the FMPC draw supplies. The Miami River continuously provides part of the aquifer recharge.

Gravel pit operations are a familiar sight in the Miami Valley. Some operations are located along the river, with a sand dike separating gravel washwater from the river. Other operations are within the flood plain, but are several hundred feet from the river.

Upstream from the FMPC the river receives substantial amounts of industrial and municipal wastes. The cities of Dayton, Middletown, Hamilton, and Fairfield are major contributors. Little recreational use is made of the river. Downstream from the FMPC the population is sparse and industries are small and scattered. About 18 miles away, the Miami meets the Ohio River.

In 1983, total precipitation at the FMPC was 35.7 inches, measured as water. Monthly maximum and minimum values were 7.3 inches during October and 0.6 inch during September.

ENVIRONMENTAL STANDARDS

There are several sets of standards which can be applied to environmental samples collected in connection with FMPC operations. These standards have been set by DOE and the State of Ohio Environmental Protection Agency (OEPA).

DOE standards for radiation protection and environmental monitoring must be met by contract operators such as NLO, Inc.[1,2] Concentration Guides for radionuclides are established separately for air and water in work areas and in areas outside of DOE control. For environmental monitoring purposes, DOE criteria for air and water in uncontrolled areas are used as standards. At the FMPC, criteria for offsite or ambient air are applied to samples collected at the plant boundary. Criteria for offsite water are applied to stream and river samples collected downstream from the point where plant effluent is discharged, but upstream from any known use of the water as a drinking water supply.

Criteria used for nonradioactive contaminants in ambient air, the Great Miami River, and Paddy's Run are taken from standards adopted by the Ohio EPA.[3,4] In rivers and streams of the State of Ohio, water quality standards apply beyond a mixing zone permitted for industrial and municipal effluents.

SAMPLE COLLECTION AND ANALYSIS

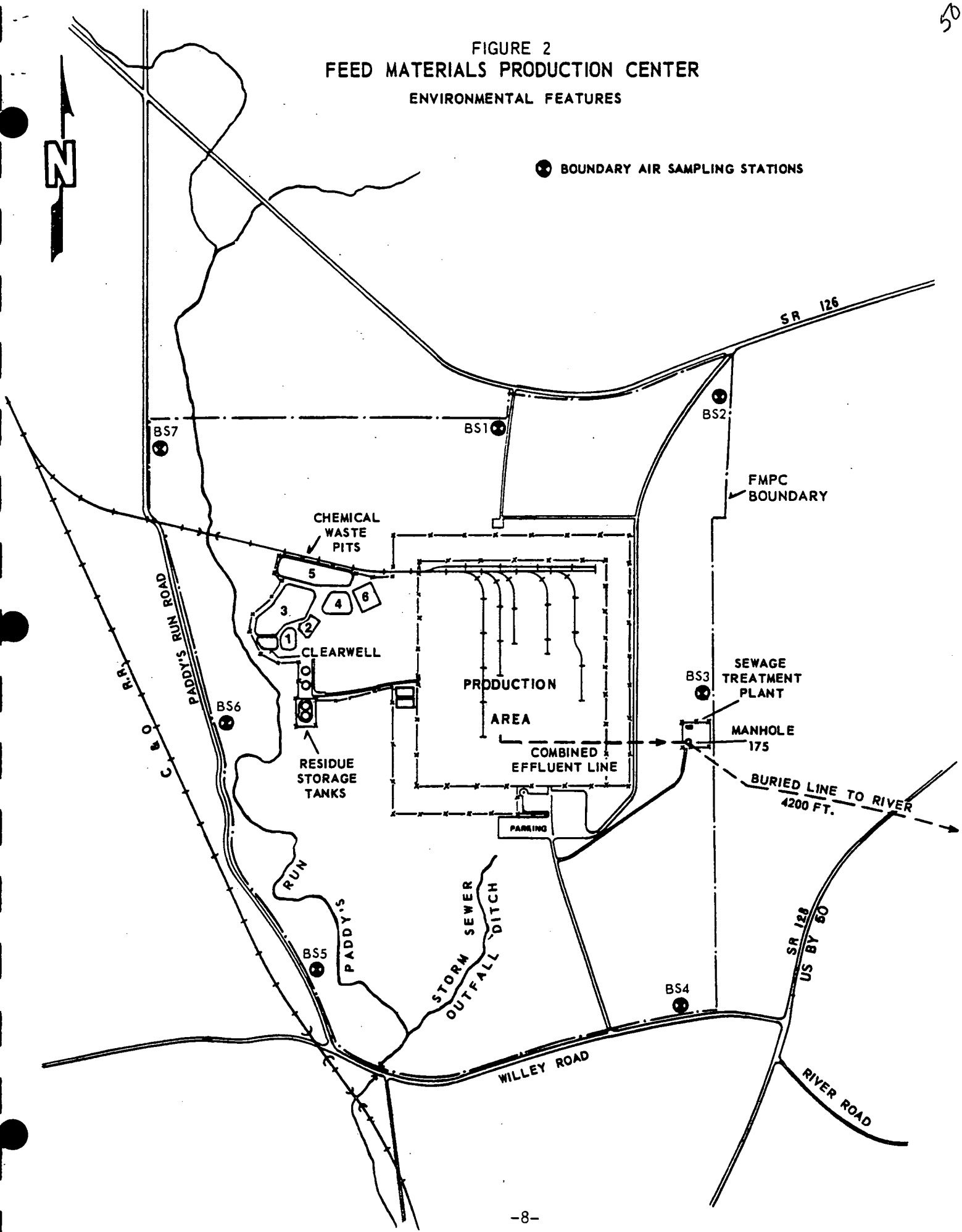
Air. Conversion of impure uranium and thorium compounds to reactor-grade feed materials involves operations which generate radioactive particulates and reaction products in an air stream. Ventilation and air cleaning systems are used to confine this air and remove airborne contaminants, including valuable material

which is returned to the production processes. The filtered or scrubbed air is exhausted to the atmosphere. Sampling of these stack exhausts is maintained on a continuous schedule to determine the operating condition of the air cleaning systems.

Samples of particulate matter in air are continuously collected at permanent sampling stations located on the project's outer boundary (see Figure 2). Seven stations were operated during 1983. At each boundary station, air is drawn at a rate of about one cubic meter per minute through an 8 inch x 10 inch filter which is changed weekly. Filters are weighed before use and then reweighed after changing to obtain the weight of collected dust. After reweighing, the filter and its collection of dust are dissolved in acid and the solutions are analyzed for uranium and beta radioactivity. Counting is done about seven days after the end of the collection period. After these analyses are completed, the remaining solution is held to provide a long-term composite for analyses of other nuclides. Frequent analyses for nuclides other than uranium are not considered necessary because of the very small amounts of these materials present and the low concentrations found in the boundary samples.

Water. Each of the individual production plants on the project has sumps and equipment for the collection and initial treatment of process waste water. Uranium and thorium may be recovered as part of the treatment. Effluents from the plants are collected at a central facility, called the General Sump, for additional treatment. The treated wastes are allowed to settle and clear or are discharged into a large pit where the solids settle to the bottom. Clear supernatant from the settling tank and clear effluent from the pit are combined with the other water streams and discharged to the Great Miami River. See Figure 3 for a diagram of the process.

FIGURE 2
FEED MATERIALS PRODUCTION CENTER
ENVIRONMENTAL FEATURES



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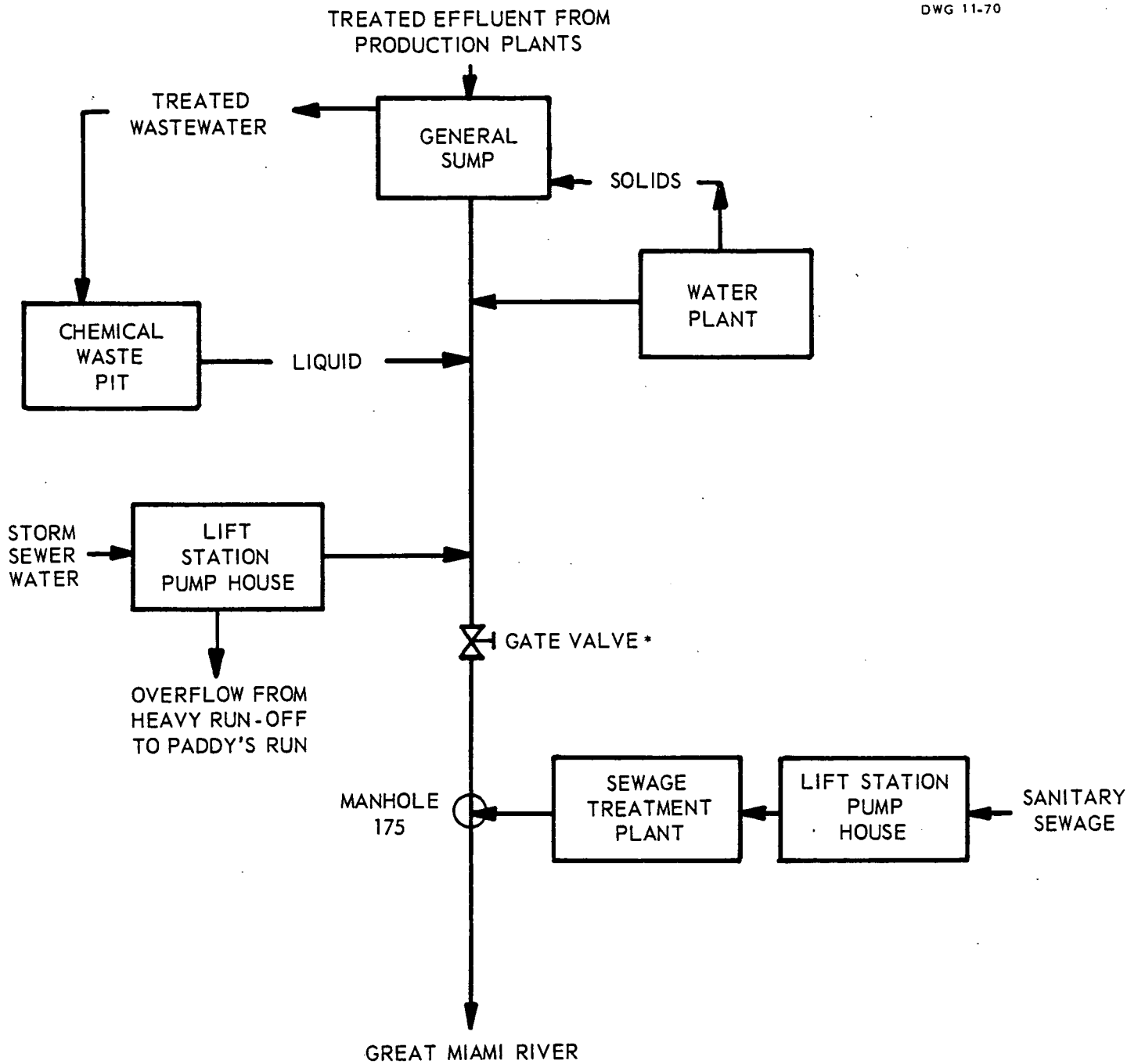


**Storm sewer water can be diverted to the Chemical Waste Pit or the General Sump by first halting the pumping from both locations and then closing the gate valve.*

FIGURE 3 Liquid Waste Streams

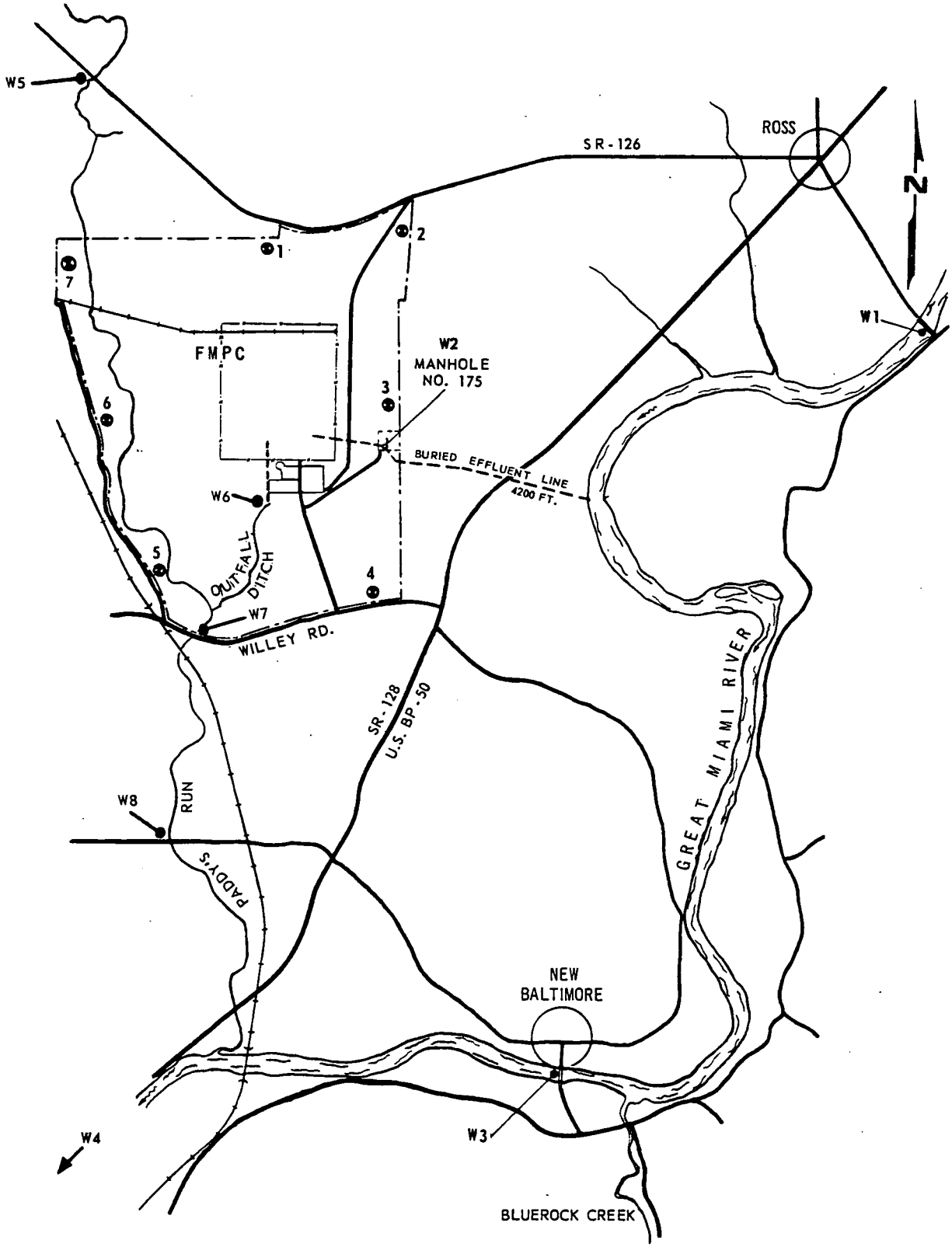
Water sampling locations are shown in Figure 4. At the final access point on the plant effluent line, W2, a Parshall Flume type water sampler continuously collects a sample which is proportional to the total flow. Twenty-four-hour samples collected daily from this point are analyzed for uranium, alpha and beta radioactivity, and pH. Analyses for chloride, fluoride and nitrate are done on one sample each week. One-month composites of the daily samples are analyzed for radium-226, radium-228, ruthenium-106, and thorium. Long-term composites are analyzed for other radionuclides of interest.

From sampling point W2 the plant effluent is discharged to the Great Miami River through a buried pipeline.

In Figure 4, the river sampling points are identified as W1, W3, and W4. At W1, upstream from the effluent discharge, a daily grab sample is collected. At point W3, downstream on the river from the effluent discharge, a daily grab sample is collected. Point W4 is at Miamitown, 4.7 miles downstream from the mouth of Paddy's Run. Grab samples are collected weekly at this point.

Paddy's Run is a small stream which flows along the site's west edge and joins the Miami River about two miles away from the FMPC boundary. During periods of heavy runoff, excess water in the storm sewer system overflows at sampling point W6 to a natural drainage ditch which discharges into Paddy's Run. Under normal conditions, all water reaching the storm sewer lift station is pumped to the line which leads to the Miami River (see Figure 3).

At least one sample per week from each of the three river sampling points is analyzed for uranium, alpha and beta radioactivity, chloride, fluoride, nitrate,



W4 is located at Miamitown, 4.7 miles from Paddy's Run.

FIGURE 4 FMPC and Surrounding Area

BOUNDARY AIR SAMPLING STATIONS.

W1-W8 - WATER SAMPLING LOCATIONS

non-filterable solids, and pH. Monthly composites from each location are analyzed for radium-226 and radium-228.

Paddy's Run sampling locations are shown in Figure 4 as W5, W7, and W8. Grab samples are collected once each week at W5 and W7. A sample is collected at W8 if there is no flow at W7. These samples are analyzed for uranium, alpha and beta radioactivity and pH weekly. Chloride, fluoride and nitrate analyses are performed on one sample each month. Radium analyses are performed on bimonthly composites of samples collected at sampling point W5 and, when available, on monthly composites of samples from location W7.

Soil and River Sediment. Once each year, soil samples are collected near the boundary sampling stations. Each sample consists of six cores, 2 cm diameter and 5 cm deep. The cores are taken about 1.5 meters apart. These samples are analyzed for uranium to observe the possible contribution from stack effluents.

Sediment samples were collected from the banks of the Miami River and analyzed for uranium to determine if material was accumulating below the site outfall. Sediment samples were also collected from the storm sewer outfall ditch and from Paddy's Run.

Quality Assurance. Quality assurance is an integral part of the overall environmental monitoring effort. Included among the various interlaboratory quality assurance practices are daily calibrations of instrumentation and routine analyses of blanks, standard solutions and spiked sample aliquots. The values obtained from these analyses have been within the ranges which indicate the analytical systems are under control and the results being obtained are reliable. Uranium

control samples provided by another onsite analytical laboratory are analyzed daily as part of the intralaboratory quality assurance activities. The values which have been obtained for these daily control samples show that the procedure used for uranium analyses produces reliable data. NLO also participates in the DOE quality assurance program which is conducted by the DOE Environmental Measurements Laboratory (EML). In this program, laboratories receive samples of various media for analysis. Results are reported to EML for comparison with established values. During 1983, water, soil, and air filter samples were analyzed for uranium. The average of the ratio of NLO results to the EML values for these analyses was 1.16.

Quality control samples provided by the U.S. Environmental Protection Agency's Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, are also analyzed as part of the quality assurance program. Samples have been analyzed for pH, non-filterable residue, nitrate nitrogen, chloride, fluoride, and sulfate. Results obtained by NLO have all been within the guidelines recommended by EPA.

MONITORING DATA

Environmental data collected during 1983 are given in the accompanying tables. Comparisons are made with the applicable standard for each significant contaminant. The most restrictive standard is applied when the solubility is unknown. Confidence limits given in the tables are derived from analytical variations or from the statistical error inherent in radioactivity determinations.

Data in Tables 1 and 2 show that average airborne radioactivity concentrations at the boundary sampling stations were no greater than 0.9% of the standard for

TABLE 1 Routinely Monitored Radioactive Contaminants in Air

Contaminant	Sampling Point (1)	Number of Samples	Maximum Concentration Found		Minimum Concentration Found		Average Concentration				Detection Level	Standard
			$\mu g/m^3$	$\mu Ci/mL$	$\mu g/m^3$	$\mu Ci/mL$	$\mu g/m^3$	$\mu Ci/mL$	% of Standard	95% Confidence Level	$\mu Ci/mL$	$\mu Ci/mL$
Uranium	BS1	53	0.295	2.0×10^{-13}	0.0009	6.3×10^{-16}	0.031	2.1×10^{-14}	0.5	$\pm 2 \times 10^{-15}$ $\mu Ci/mL$	1×10^{-16}	4×10^{-12} (2)
	BS2	53	0.145	9.8×10^{-14}	0.0002	1.6×10^{-16}	0.021	1.4×10^{-14}	0.3			
	BS3	53	0.369	2.5×10^{-13}	0.0004	2.6×10^{-16}	0.036	2.5×10^{-14}	0.6			
	BS4	53	0.130	8.8×10^{-14}	0.0006	3.9×10^{-16}	0.013	8.9×10^{-15}	0.2			
	BS5	53	0.148	1.0×10^{-13}	0.0005	3.5×10^{-16}	0.014	9.8×10^{-15}	0.2			
	BS6	53	0.068	4.6×10^{-14}	0.0011	7.5×10^{-16}	0.017	1.1×10^{-14}	0.3			
	BS7	53	0.055	3.7×10^{-14}	0.0005	3.0×10^{-16}	0.007	4.8×10^{-15}	0.1			
Gross Beta	BS1	53	NA(3)	2.3×10^{-13}	NA	1.0×10^{-14}	NA	5.6×10^{-14}	0.06	$\pm 6 \times 10^{-15}$ $\mu Ci/mL$	1×10^{-16}	1×10^{-10} (4)
	BS2	53		1.3×10^{-13}		9.8×10^{-15}		4.1×10^{-14}	0.04			
	BS3	53		2.5×10^{-13}		8.0×10^{-15}		5.7×10^{-14}	0.06			
	BS4	53		1.1×10^{-13}		9.6×10^{-15}		2.8×10^{-14}	0.03			
	BS5	53		9.1×10^{-14}		1.2×10^{-14}		3.1×10^{-14}	0.03			
	BS6	53		8.4×10^{-14}		1.3×10^{-14}		3.7×10^{-14}	0.04			
	BS7	53		3.8×10^{-13}		9.9×10^{-15}		3.2×10^{-14}	0.03			

Footnotes:

(1) See sampling locations in Figure 2.

(2) DOE Order 5480.1A, Attachment XI-1, Table II Concentration Guide for Natural Uranium based on one gram of natural uranium containing 6.77×10^{-7} Ci. Past FMPC Environmental Monitoring Annual Reports defined one curie of natural uranium as equivalent to 3,000 kg of natural uranium (or 3.33×10^{-7} Ci/g) per the guidelines presented in DOE Order 5480.1A, Attachment XI-1, Table II. In this report the definition of a curie of natural uranium will be as defined in 10CFR20[5] (or 6.77×10^{-7} Ci/g).

(3) Not applicable.

(4) DOE Order 5480.1A, Attachment XI-1, Table II, Note 3, Concentration Guide for Mixture of Unidentified Radionuclides.

TABLE 2 Various Radionuclides in Air

Radionuclide	Sampling Point (1)	Concentration Found (2)		Standard (3)
		μCi/mL	% of Standard	μCi/mL
Neptunium - 237	BS1	$6.1 \pm 1.3 \times 10^{-17}$	0.061	1×10^{-13}
	BS2	$3.0 \pm 1.3 \times 10^{-17}$	0.030	
	BS3	$8.7 \pm 1.5 \times 10^{-17}$	0.087	
	BS4	$2.3 \pm 0.7 \times 10^{-17}$	0.022	
	BS5	$2.4 \pm 0.7 \times 10^{-17}$	0.024	
	BS6	$4.4 \pm 1.9 \times 10^{-18}$	0.004	
	BS7	$1.3 \pm 0.5 \times 10^{-17}$	0.013	
Plutonium - 238	BS1	$1.3 \pm 0.7 \times 10^{-17}$	0.018	7×10^{-14}
	BS2	$1.1 \pm 1.4 \times 10^{-18}$	0.015	
	BS3	$3.2 \pm 1.3 \times 10^{-17}$	0.046	
	BS4	$7.0 \pm 3.5 \times 10^{-18}$	0.010	
	BS5	$6.4 \pm 3.0 \times 10^{-18}$	0.009	
	BS6	$5.4 \pm 2.7 \times 10^{-18}$	0.008	
	BS7	$1.8 \pm 3.5 \times 10^{-19}$	<0.001	
Plutonium - 239	BS1	$4.1 \pm 0.9 \times 10^{-16}$	0.683	6×10^{-14}
	BS2	$3.2 \pm 0.9 \times 10^{-16}$	0.533	
	BS3	$5.3 \pm 1.1 \times 10^{-16}$	0.887	
	BS4	$1.7 \pm 0.3 \times 10^{-16}$	0.278	
	BS5	$1.4 \pm 0.2 \times 10^{-16}$	0.240	
	BS6	$9.9 \pm 1.7 \times 10^{-17}$	0.165	
	BS7	$2.3 \pm 0.7 \times 10^{-17}$	0.037	
Thorium - 228	BS1	$4.8 \pm 1.1 \times 10^{-17}$	0.024	2×10^{-13}
	BS2	$4.1 \pm 1.6 \times 10^{-17}$	0.021	
	BS3	$9.3 \pm 1.5 \times 10^{-17}$	0.047	
	BS4	$2.6 \pm 0.7 \times 10^{-17}$	0.013	
	BS5	$4.0 \pm 0.9 \times 10^{-17}$	0.020	
	BS6	$2.7 \pm 0.7 \times 10^{-17}$	0.014	
	BS7	$1.4 \pm 0.1 \times 10^{-17}$	0.007	
Thorium - 232	BS1	$6.1 \pm 1.3 \times 10^{-17}$	0.006	1×10^{-12}
	BS2	$3.9 \pm 1.6 \times 10^{-17}$	0.004	
	BS3	$1.4 \pm 0.2 \times 10^{-16}$	0.010	
	BS4	$5.1 \pm 1.0 \times 10^{-17}$	0.005	
	BS5	$4.3 \pm 0.9 \times 10^{-17}$	0.004	
	BS6	$1.9 \pm 0.5 \times 10^{-17}$	0.002	

Footnotes:

(1) See Sampling Locations shown in Figure 2.

(2) Concentration of a composite of 53 weekly samples.

(3) DOE Order 5480.1A, Attachment XI-1, Table II.

offsite areas. It is concluded from these data that any offsite radiation exposure resulting from FMPC airborne contaminants would be a small fraction of the standards given in reference 1. Table 1 presents data for those radioactive parameters analyzed for on a weekly basis and Table 2 presents data for parameters expected to be present in only very small concentrations and analyzed for in an annual composite of weekly samples.

The definition used for a Curie of natural uranium has been changed in the 1983 FMPC Environmental Monitoring Annual Report from the definition used in past reports, to be more consistent with non-DOE practice. In this report the activity of natural uranium is defined as 6.77×10^{-7} Ci/g per 10 CFR 20[5] guidance. According to stack monitoring data, the total amount of uranium released to the atmosphere during 1983 was 0.117 Curies. Previous annual reports used an activity of 3.33×10^{-7} Ci/g for natural uranium per DOE Order 5480.1A Attachment XI-1, Table II.[1] Based on the 10 CFR 20 definition of a Curie of natural uranium the total amounts of uranium released to the atmosphere during 1981 and 1982 were 0.230 Curies and 0.243 Curies. Throughout this report, unless otherwise specified, the term uranium refers to natural uranium with an activity of 6.77×10^{-7} Ci/g.

A commercial service was employed to monitor for radon-222 at the site boundary during 1983. Patented radon monitoring devices were deployed at the boundary stations for periods of approximately three months. Two offsite locations were also monitored to obtain information about the level of naturally-occurring radon in the general area. After exposure, the devices were returned to the commercial service for analysis. The data obtained are presented in Table 3. No independent analyses for verification of the data have been performed. The average

TABLE 3 Radon - 222 In Air

Location	Number of Samples	Concentration Range		Average Concentration		Standard (2)
		Maximum pCi/L	Minimum pCi/L	pCi/L	% of Standard	
Onsite (1)						
BS1	4	1.25	0.23	0.65	22	
BS2	4	1.09	0.60	0.77	26	
BS3	4	1.57	0.37	0.76	25	
BS4	4	0.93	0.36	0.65	22	3 pCi/L
BS5	4	1.69	0.23	1.05	35	
BS6	4	1.25	0.47	0.82	27	
BS7	4	1.99	0.48	0.91	30	
Offsite						
8 mi., ENE	4	1.25	0.36	0.77	26	
5 mi., WSW	4	0.87	0.48	0.61	20	

Footnotes:

(1) See sampling locations shown in Figure 2.

(2) DOE Order 5480.1A, Attachment XI - 1, Table II, Concentration Guide for Radon - 222.

TABLE 4 Airborne Particulates

Sampling Point (1)	Number of Samples	Concentration Range		Average Concentration			Detection Level	Standard (2)
		Maximum $\mu g/m^3$	Minimum $\mu g/m^3$	$\mu g/m^3$	% of Standard	95% Confidence Level		
BS1	53	66	13	36	48			
BS2	53	71	17	37	49			
BS3	53	70	17	38	51			
BS4	53	75	18	42	56	±5%	1 $\mu g/m^3$	75 $\mu g/m^3$
BS5	53	95	17	37	49			
BS6	53	159	17	41	55			
BS7	53	76	18	39	52			

Footnotes:

(1) See sampling locations shown in Figure 2.

(2) State of Ohio Ambient Air Quality Standard.

concentrations at the boundary stations ranged from 0.65 picoCuries per Liter (pCi/L) to 1.05 pCi/L, well under the DOE Concentration Guide of 3 pCi/L for radon in uncontrolled areas. A comparison of the average onsite data with off-site data shows no observable difference between radon levels at the FMPC site boundary and radon levels measured at locations five to eight miles distant from the site.

Particulate matter concentrations found at the boundary are given in Table 4. At all locations the average concentration of particulate matter was well below the OEPA limit for the annual geometric mean. The FMPC contribution to ambient air particulate matter cannot be assessed from these data. Except for BS-3, all boundary stations are located near roads where traffic dust is generated. Also, BS-4, BS-5, and BS-6 are located near agricultural lands, and periodic farming activities cause high dust levels.

Table 5 contains information on uranium, radium-226, radium-228, and alpha and beta radioactivity in the Great Miami River. There is no significant difference between the upstream and downstream concentrations of radium and uranium. All concentrations are well within the DOE guides for water in uncontrolled areas.

Uranium, radium-226 and radium-228 data for Paddy's Run are also given in Table 5. At the downstream sampling points the average uranium, radium-226, and radium-228 concentrations were less than 7% of the DOE guides for uncontrolled areas. Average concentrations of gross alpha and beta radioactivity were within the DOE limits for unidentified emitters.

TABLE 5 Radioactive Contaminants in Water

Contaminant	Sampling Point (1)	Number of Samples (2)	Maximum Concentration Found		Minimum Concentration Found		Average Concentration Found				Detection Level	Standard
			mg/L	μCi/mL	mg/L	μCi/mL	mg/L	μCi/mL	% of Standard	95% Confidence Limits (3)	μCi/mL	μCi/mL
Uranium	W1	52	0.005	3.4×10^{-9}	0.001	6.7×10^{-10}	0.002	1.4×10^{-9}	0.12	$\pm 1.4 \times 10^{-9}$ μCi/mL	6.7×10^{-10}	1.2×10^{-6} (5)
	W3	52	0.006	4.1×10^{-9}	0.001	6.7×10^{-10}	0.003	2.0×10^{-9}	0.17			
	W4	52	0.005	3.4×10^{-9}	0.001	6.7×10^{-10}	0.003	2.0×10^{-9}	0.17			
	W5	49	0.005	3.4×10^{-9}	<0.001	$<6.7 \times 10^{-10}$	0.002	1.4×10^{-9}	0.12			
	W7	26	0.908	6.1×10^{-7}	0.003	2.0×10^{-9}	0.112	7.6×10^{-8}	6.3			
	W8	26	0.044	3.0×10^{-8}	0.006	4.1×10^{-9}	0.013	8.8×10^{-9}	0.73			
Radium - 226	W1	12	NA (4)	4.5×10^{-10}	NA	$<4.5 \times 10^{-10}$	NA	$<4.5 \times 10^{-10}$	<1.5	$\pm 4.5 \times 10^{-10}$ μCi/mL	4.5×10^{-10}	3×10^{-8} (5)
	W3	12		4.5×10^{-10}		$<4.5 \times 10^{-10}$		$<4.5 \times 10^{-10}$	<1.5			
	W4	12		4.5×10^{-10}		$<4.5 \times 10^{-10}$		$<4.5 \times 10^{-10}$	<1.5			
	W5	6		9.0×10^{-10}		$<4.5 \times 10^{-10}$		$<4.5 \times 10^{-10}$	<1.5			
	W7	10		4.5×10^{-10}		$<4.5 \times 10^{-10}$		$<4.5 \times 10^{-10}$	<1.5			
Radium - 228	W1	12	NA	9.0×10^{-10}	NA	$<4.5 \times 10^{-10}$	NA	$<4.5 \times 10^{-10}$	<1.5	$\pm 4.5 \times 10^{-10}$ μCi/mL	4.5×10^{-10}	3×10^{-8} (5)
	W3	12		1.4×10^{-9}		$<4.5 \times 10^{-10}$		$<4.5 \times 10^{-10}$	<1.5			
	W4	12		9.0×10^{-10}		$<4.5 \times 10^{-10}$		$<4.5 \times 10^{-10}$	<1.5			
	W5	6		1.4×10^{-9}		4.5×10^{-10}		9.0×10^{-10}	3.0			
	W7	10		1.8×10^{-9}		$<4.5 \times 10^{-10}$		$<9.0 \times 10^{-10}$	<3.0			
Gross Alpha	W1	52	NA	4.5×10^{-9}	NA	$<9.0 \times 10^{-10}$	NA	$<2.3 \times 10^{-9}$	<7.7	$\pm 8.0 \times 10^{-10}$ μCi/mL	9.0×10^{-10}	3×10^{-8} (6)
	W3	52		4.5×10^{-9}		$<9.0 \times 10^{-10}$		$<2.3 \times 10^{-9}$	<7.7			
	W4	52		6.3×10^{-9}		$<9.0 \times 10^{-10}$		$<2.3 \times 10^{-9}$	<7.7			
	W5	50		5.9×10^{-9}		$<9.0 \times 10^{-10}$		$<2.3 \times 10^{-9}$	<7.7			
	W7	26		5.8×10^{-7}		2.3×10^{-9}		5.0×10^{-9} (7)	17 (7)			
	W8	26		2.3×10^{-8}		4.1×10^{-9}		7.7×10^{-9}	26			
Gross Beta	W1	52	NA	1.2×10^{-8}	NA	2.7×10^{-9}	NA	5.9×10^{-9}	20	$\pm 3.0 \times 10^{-9}$ μCi/mL	2.7×10^{-9}	3×10^{-8} (6)
	W3	52		5.1×10^{-8}		3.2×10^{-9}		9.5×10^{-9}	32			
	W4	52		3.4×10^{-8}		3.6×10^{-9}		8.6×10^{-9}	29			
	W5	50		3.2×10^{-8}		$<2.7 \times 10^{-9}$		6.3×10^{-9}	21			
	W7	26		1.3×10^{-7}		3.2×10^{-9}		1.6×10^{-8}	53			
	W8	26		8.7×10^{-8}		2.7×10^{-9}		2.1×10^{-8}	70			

Footnotes:

(1) See sampling locations shown in Figure 4.

(2) Samples are composited for radium analyses as follows: one-month composites of daily samples from W1 and W3; one-month composites of weekly samples from W4, and all available weekly samples from W7; two-month composites of weekly samples from W5.

(3) Confidence limits are given for the average concentration.

(4) Not applicable.

(5) DOE Order 5480.1A, Attachment XI-1, Table II, Concentration Guides for natural uranium, radium - 226 and radium - 228.

(6) DOE Order 5480.1A, Attachment XI-1, Note 2, Concentration Guides for mixtures of unidentified radionuclides.

(7) Since the standard is for unidentified alpha activity, this figure is based on the difference between total gross alpha activity and uranium alpha activity.

Information given in Table 6 shows the total quantity of 11 radionuclides discharged during 1983 and the average concentrations in the plant effluent as measured at the final onsite access point, W2. The average concentrations are all below the DOE limits for water in uncontrolled areas. Analysis of the plant effluent provides basic information for assessing the adequacy of waste treatment efforts and the control of contaminant releases. It is much easier to get continuous representative samples of the effluent than of the river and radionuclides can generally be determined with greater reliability in effluent samples than by analysis of river samples after the radionuclides have undergone a large dilution.

During 1983, the average flow of plant effluent was 0.469 million gallons per day. The average river flow was 2058 million gallons per day, which means that on an average basis, each gallon of FMPC effluent mixed with 4388 gallons of river water. At this volume ratio, uranium, radium-226 and radium-228 from the FMPC would have amounted to less than 0.02% each, of the DOE Order 5480.1A limit for water in uncontrolled areas. The percentage shown for the other nuclides in Table 6 would have been similarly reduced.

Operations at the FMPC did not cause any state standard for nonradioactive contaminants to be exceeded in the Great Miami River or in Paddy's Run. The contaminants listed in Table 7 were selected for analysis and reporting because of the possibility of adding to the river concentrations greater than 1% of the applicable state standards.

There are no soil concentration standards for comparison with the results for uranium in soil listed in Table 8. Although the normal concentration for uranium

TABLE 6 Radionuclides Discharged Via Sampling Point W2 (1)

Radionuclide	Total Curies	Average Concentration Found		Standard (2)
		μCi/mL	% of Standard	μCi/mL
Cesium - 137	5.6×10^{-3}	8.6×10^{-9}	0.04	2×10^{-5}
Neptunium - 237	$<1.8 \times 10^{-4}$	$<2.8 \times 10^{-10}$	<0.009	3×10^{-6}
Plutonium - 238	5.1×10^{-6}	7.8×10^{-12}	<0.001	5×10^{-6}
Plutonium - 239	7.7×10^{-5}	1.2×10^{-10}	0.002	5×10^{-6}
Radium - 226	1.4×10^{-3}	2.2×10^{-9}	7.3	3×10^{-8}
Radium - 228	6.2×10^{-3}	9.5×10^{-9}	32	3×10^{-8}
Ruthenium - 106	3.1×10^{-4}	4.8×10^{-10}	0.005	1×10^{-5}
Strontium - 90	5.9×10^{-3}	9.1×10^{-9}	3	3×10^{-7}
Technetium - 99	2.1×10^{-1}	3.2×10^{-5}	11	3×10^{-4}
Thorium	2.3×10^{-4}	3.5×10^{-10}	0.04	1×10^{-6}
Uranium (3)	4.0×10^{-1}	6.1×10^{-7}	51	1.2×10^{-6}

Footnotes:

(1) Radionuclides in the plant effluent which is discharged to the Great Miami River through a buried pipeline. An additional 3.0×10^{-2} Curie of uranium was contained in the storm sewer overflow discharged into a ditch at sampling point W6. The ditch empties into Paddy's Run above sampling point W7.

(2) DOE Order 5480.1A, Attachment XI-1, Table II, Concentration Guides for Water in Uncontrolled Areas. These Guides are for water such as the Great Miami River and are not meant to be applied to the plant effluent. They are listed here for comparison purposes.

(3) Curies of natural uranium using the 10CFR20 definition of natural uranium activity.

TABLE 7 Non-Radioactive Contaminants in Water

Contaminant	Sampling Point (1)	Number Of Samples	Maximum Concentration Found mg/L	Minimum Concentration Found mg/L	Average Concentration			Detection Limit	Standard (2)
					mg/L	% of Standard	95% Confidence Limits		
Fluoride	W1	52	1.1	0.2	0.5	25	±15%	0.1 mg/L	2.0 mg/L
	W3	52	1.1	0.2	0.5	25			
	W4	52	0.9	0.3	0.5	25			
	W5	12	0.3	0.1	0.2	10			
	W7	12	1.1	0.1	0.4	20			
	W8	12	0.2	<0.1	0.1	5			
Nitrate Nitrogen	W1	52	10.3	2.6	6.5	30	±10%	0.3 mg/L	22 mg/L
	W3	52	11.1	3.7	6.5	30			
	W4	52	10.6	3.2	6.3	29			
	W5	12	7.5	<0.1	2.7	12			
	W7	12	6.4	1.1	3.3	15			
	W8	12	7.1	<0.1	1.8	8.2			
Chloride	W1	52	110	15	56	22	±5%	5 mg/L	250 mg/L
	W3	52	104	15	56	22			
	W4	52	105	13	54	22			
	W5	12	60	6	29	12			
	W7	13	27	8	20	8			
	W8	12	67	20	37	15			
pH (3)	W1	52	8.8	7.7	NA (4)	NA	±0.1 pH Units	NA	6.5 - 9.0
	W3	52	9.0	7.6					
	W4	52	8.9	7.7					
	W5	50	8.3	7.0					
	W7	26	8.4	7.6					
	W8	26	8.5	7.3					

Footnotes:

(1) See sampling locations shown in Figure 4.

(2) Ohio EPA Water Quality Standards, Administrative Code Chapter 3745-1.

(3) pH is reported in standard units.

(4) Not applicable.

TABLE 8 Uranium in Soil

Sampling Point (2)	Uranium Concentration (1)		Detection Level
	μCi/g	95% Confidence Level	
1	9.5×10^{-6}	±25%	3.4×10^{-7} μCi/g
2	1.3×10^{-5}		
3	5.3×10^{-5}		
4	4.7×10^{-6}		
5	6.1×10^{-6}		
6	8.8×10^{-6}		
7	2.7×10^{-6}		
8	2.0×10^{-6}		
9	2.7×10^{-6}		
10	3.3×10^{-6}		
11	1.6×10^{-5}		
12	2.5×10^{-6}		
13	2.4×10^{-6}		
14	2.5×10^{-6}		
15	2.4×10^{-6}		

Footnotes:

(1) Results on dry basis.

(2) See sampling locations shown in Figure 5.

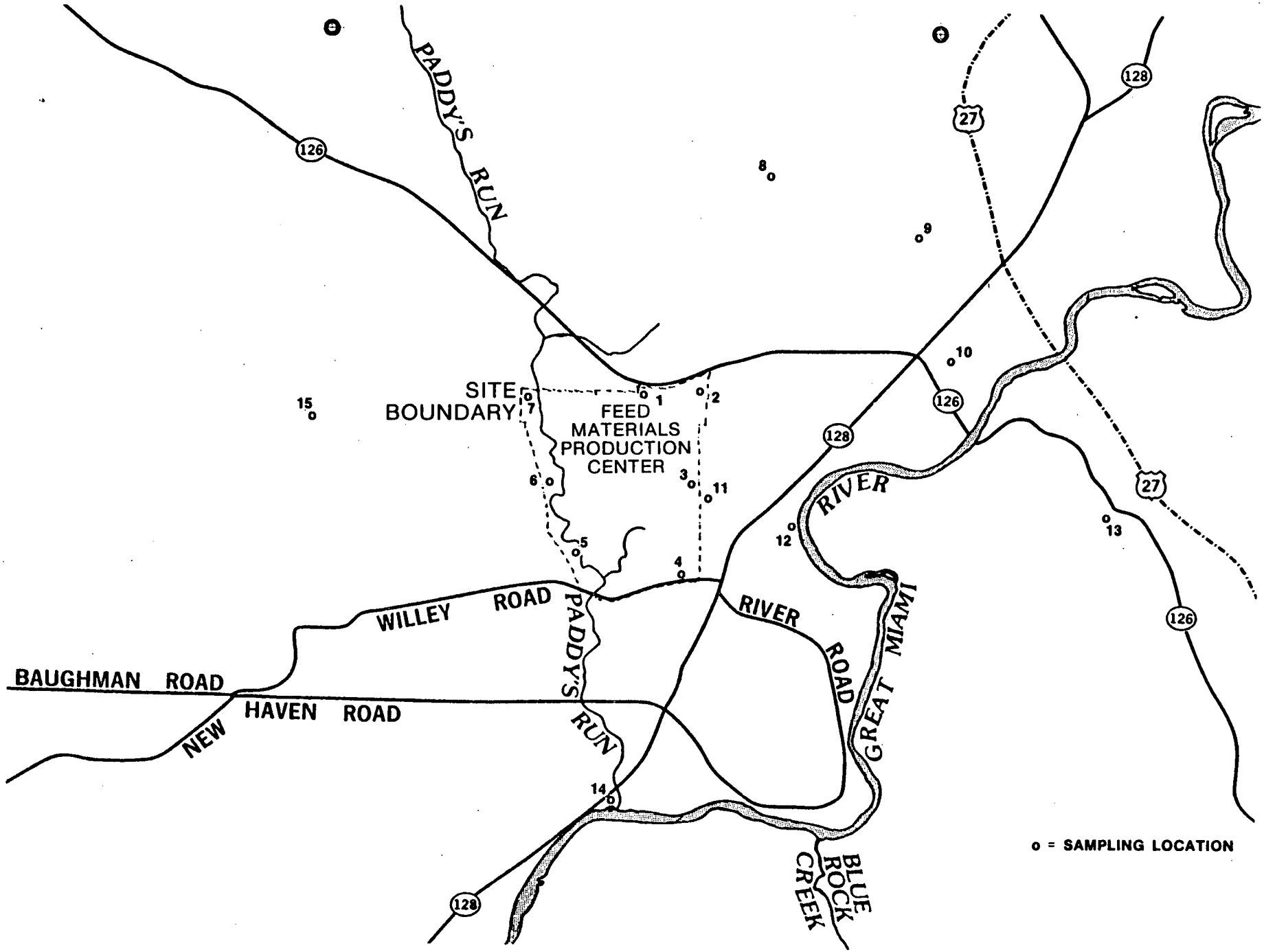


FIGURE 5 Soil Sampling Locations

in local soil is 1-4 μg/g, or 6.77×10^{-7} to 2.7×10^{-6} μCi/g, there are no hazards associated with the increased concentrations caused by FMPC operations. Penetrating radiation from uranium is slight and review of the radiation dose rates measured at the site boundaries using thermoluminescent dosimeters indicates that the exposure contribution from the increased soil concentration of uranium would be considerably less than the Radiation Protection Standard[1] for people in uncontrolled areas. Considerations of the exposures from direct radiation at the boundary stations, exposures from airborne dust, and exposures from consumption of locally grown vegetables are presented in the section on "Maximum potential dose."

Technetium is present in trace quantities in various materials sent to the FMPC for uranium recovery and, therefore, analysis for this nuclide in sediments was instituted in 1983 in addition to the analysis for uranium routinely performed. Results of analyses for uranium and technetium-99 in sediment samples collected onsite within the controlled area of the FMPC, from Paddy's Run and a drainage ditch which receives storm water overflow, are presented in Table 9. These data show the presence of uranium and technetium-99 in trace quantities consistent with the production activities which have been carried out at this site.

The results of sediment sampling for the Great Miami River given in Table 10 do not indicate any build-up of uranium along the edge of the water where settling might be expected to occur. Most of the uranium present in the site effluent is soluble, probably existing as a carbonate complex, and remains soluble after mixing in the river. Furthermore, periodic flooding, which is severe enough to cause channel alteration and bank erosion, scours the river bed and banks and

TABLE 9 Radionulides in FMPC Onsite Sediment

Sampling Point (2)	Uranium Concentration (1)			Technetium-99 Concentration		
	μCi/g	95% Confidence Level	Detection Level	μCi/g	95% Confidence Level	Detection Level
1	1.7×10^{-6}	±25%	3.4×10^{-7} μCi/g	$<1.4 \times 10^{-7}$	±20%	1.4×10^{-7} μCi/g
2	3.2×10^{-5}					
3	1.8×10^{-4}					
4	1.3×10^{-4}			8.1×10^{-6}		
5	1.5×10^{-5}			1.4×10^{-6}		
6	1.9×10^{-4}			1.7×10^{-5}		
7	6.9×10^{-5}					

Footnotes:

(1) Results on dry basis.

(2) See sediment sampling locations shown in Figure 6.

TABLE 10 Radionulides in Miami River Sediment

Sampling Point (2)	Distance From FMPC Outfall	Uranium Concentration (1)			Technetium-99 Concentration		
		μCi/g	95% Confidence Level	Detection Level	μCi/g	95% Confidence Level	Detection Level
	Upstream						
8	3.7 miles	1.8×10^{-6}	±25%	3.4×10^{-7} μCi/g		±20%	1.4×10^{-7} μCi/g
9	1.5 miles	1.7×10^{-6}			$<1.4 \times 10^{-7}$		
	Downstream						
10	50 feet	3.1×10^{-6}	±25%	3.4×10^{-7} μCi/g	4.2×10^{-6}	±20%	1.4×10^{-7} μCi/g
11	0.8 mile	1.3×10^{-6}					
12	3.3 miles	1.6×10^{-6}			9.0×10^{-7}		
13	4.5 miles	2.7×10^{-6}					
14	4.7 miles	2.1×10^{-6}			1.1×10^{-6}		

Footnotes:

(1) Results on dry basis.

(2) See sediment sampling locations shown in Figure 6.

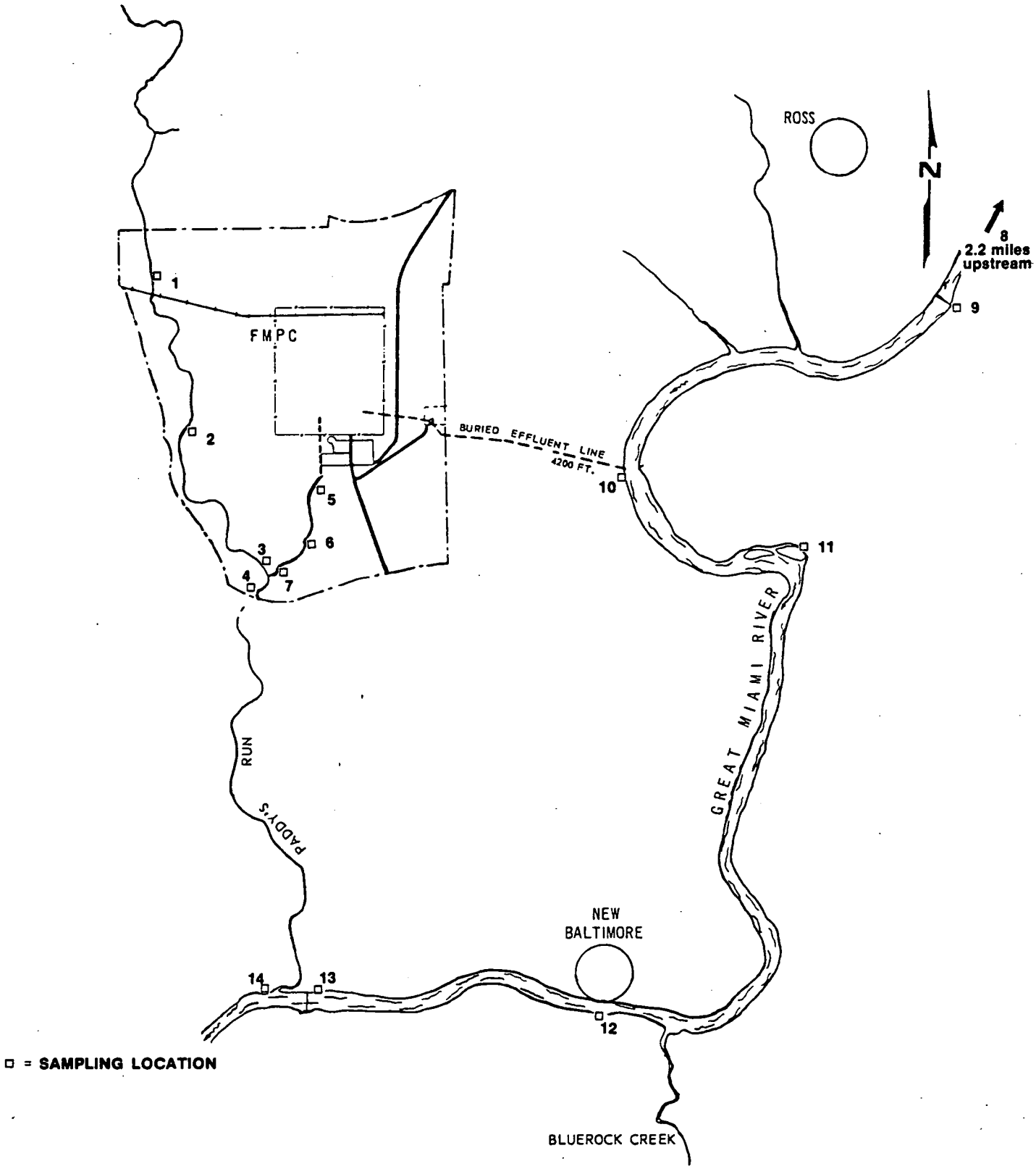


FIGURE 6 Sediment Sampling Locations

prevents any long-term sediment accumulation. Technetium-99 analysis indicates the presence of this radionuclide in sediments downstream of the FMPC river outfall.

Other monitoring efforts at the FMPC include the collection of groundwater samples on a quarterly basis from onsite production wells and test wells located in the vicinity of the site waste management area. The analytical results for these samples are shown in Table 11. While some wells contain uranium above background concentration, all are well below the DOE standard for uranium in water in uncontrolled areas.[1]

Table 12 contains data for groundwater samples obtained from existing wells located in the vicinity of the FMPC. Sampling points 12, 15, and 17 showed above-background concentrations of uranium to be present; however, concentrations were all well below the DOE standard for uranium in water in uncontrolled areas. Studies are underway to determine the cause of the above-background concentrations.

Milk samples were also routinely collected on a quarterly basis during 1983 to determine if uranium was present in milk. Samples of raw milk from both a neighboring and distant farms were submitted for uranium analysis. The neighboring farm is located adjacent to the FMPC site and the distant farm, used as a control sampling location, is located about 18 miles southeast of the site. The results are presented in Table 13 and showed no increase in uranium concentration in the local milk sample as compared with the control.

TABLE 11 Uranium in FMPC Monitoring Wells

Sampling Point (1)	Average Concentration Found				Detection Level μCi/mL	Standard μCi/mL
	mg/L	μCi/mL	% of Standard	95% Confidence Limits (3)		
P1	0.0010	6.7×10^{-10}	0.06			
P2	0.0030	2.0×10^{-9}	0.17			
P3	0.0003	2.0×10^{-10}	0.02			
T1S	0.0114	7.6×10^{-9}	0.63			
T1D	0.0006	4.0×10^{-10}	0.03			
T3	0.0032	2.1×10^{-9}	0.18			
T4	0.0066	4.4×10^{-9}	0.37	$\pm 1.4 \times 10^{-10}$ μCi/mL	6.7×10^{-11}	1.2×10^{-6}
T5	0.0047	3.1×10^{-9}	0.26			
T8S	0.0010	6.7×10^{-10}	0.06			
T8D	0.0004	2.7×10^{-10}	0.02			
T9	0.0017	1.1×10^{-9}	0.09			
T10	0.0265	1.8×10^{-8}	1.5			
T11	0.0009	6.0×10^{-10}	0.05			

Footnotes:
(1) See sampling locations shown in Figure 7.
(2) Average of quarterly sampling results.

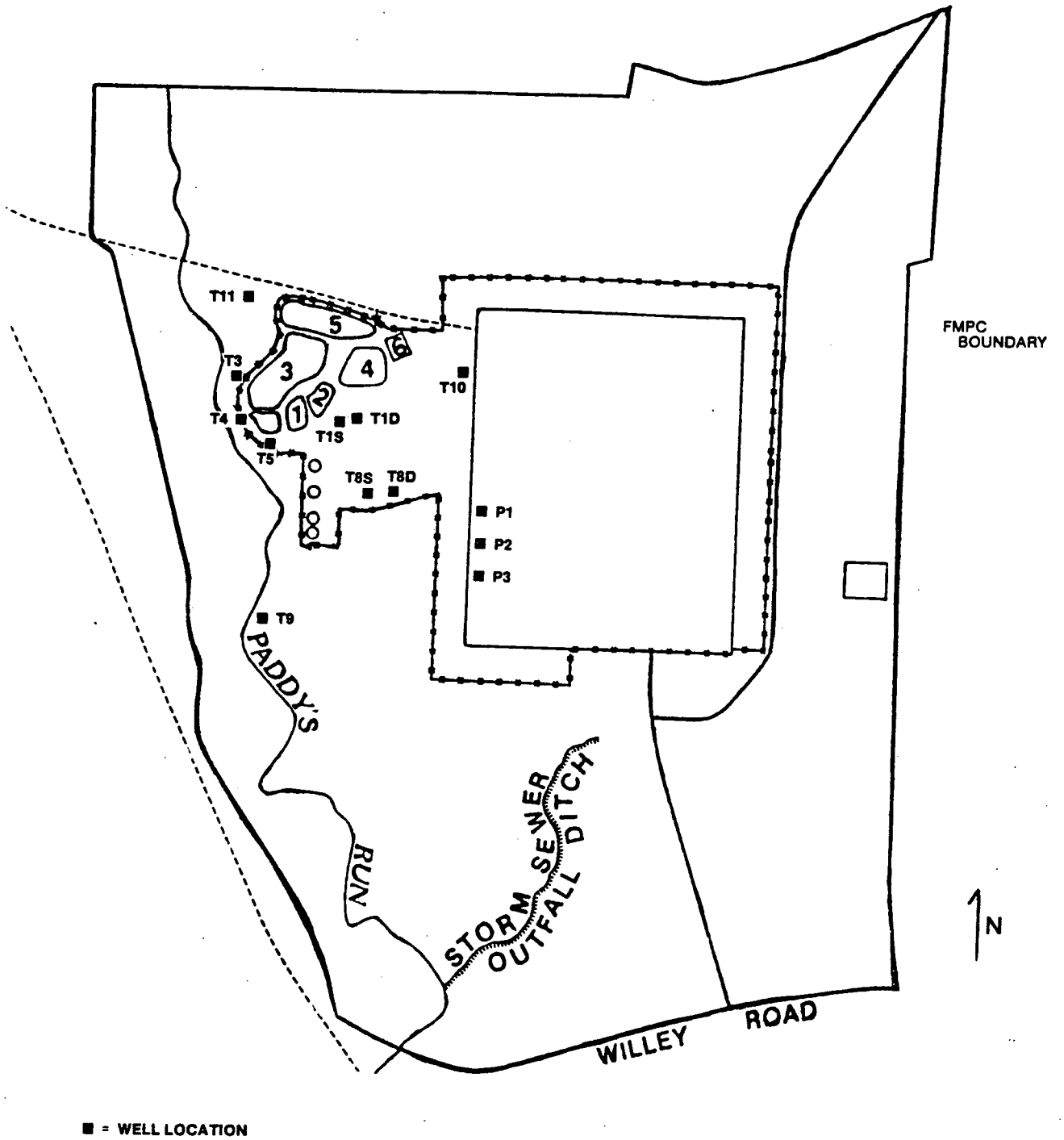


FIGURE 7 FMPC Monitoring Well Locations

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TABLE 12 Uranium in Offsite Wells

Sampling Point (1)	Number of Samples	Average Concentration Found				Detection Level μCi/mL	Standard μCi/mL
		mg/L	μCi/mL	% of Standard	95% Confidence Limits (3)		
1	4	0.0003	2.0×10^{-10}	0.02			
2	4	0.0003	2.0×10^{-10}	0.02			
3	4	0.0004	2.7×10^{-10}	0.02			
4	5	0.0018	1.2×10^{-9}	0.10			
5	5	0.0020	1.4×10^{-9}	0.12			
6	5	0.0024	1.6×10^{-9}	0.13			
7	4	0.0014	9.5×10^{-10}	0.08			
8	5	0.0008	5.4×10^{-10}	0.05			
9	5	0.0012	8.1×10^{-10}	0.07			
10	12	0.0016	1.1×10^{-9}	0.09			
11	11	0.0012	8.1×10^{-10}	0.07	$\pm 1.4 \times 10^{-10}$ μCi/mL	6.7×10^{-11}	1.2×10^{-6}
12	12	0.208	1.4×10^{-7}	11.7			
13	12	0.0006	4.1×10^{-10}	0.03			
14	12	0.0012	8.1×10^{-10}	0.07			
15	12	0.431	2.9×10^{-7}	24.2			
16	11	0.0009	6.1×10^{-10}	0.05			
17	12	0.057	3.9×10^{-8}	3.3			
18	11	0.0005	3.4×10^{-10}	0.03			
19	11	0.0002	1.4×10^{-10}	0.01			
20	11	0.0002	1.4×10^{-10}	0.01			
21	12	0.0004	2.7×10^{-10}	0.02			

Footnotes:
(1) See well sampling locations shown in Figure 8.

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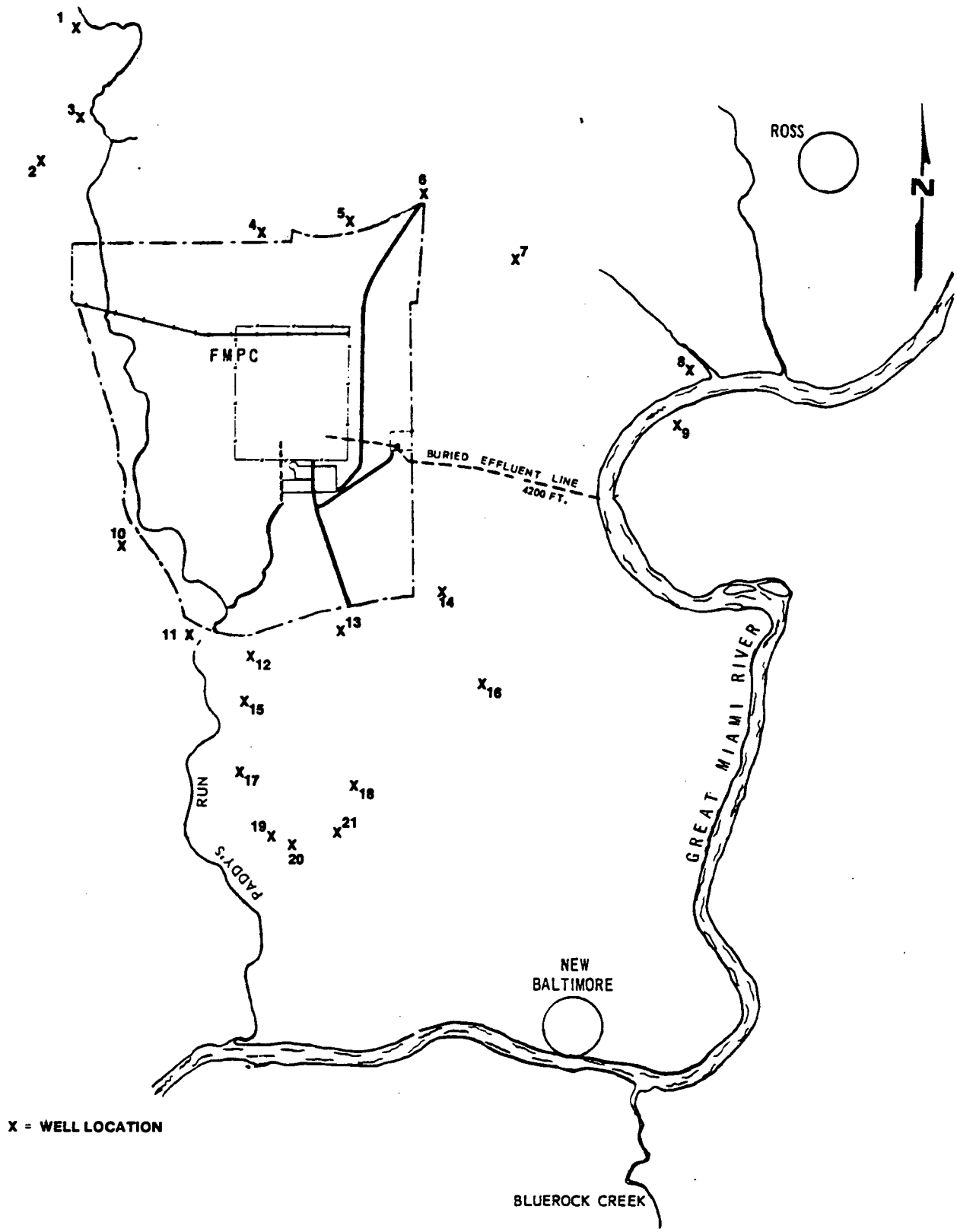

FIGURE 8 Offsite Monitoring Well Locations

TABLE 13 Uranium in Milk

Sampling Date	Uranium Concentration $\mu Ci/g$		Detection Level $\mu Ci/g$
	Local Sample	Control Sample	
1 - 83	$<6.8 \times 10^{-10}$	$<6.8 \times 10^{-10}$	6.8×10^{-10}
2 - 83	$<6.8 \times 10^{-10}$	$<6.8 \times 10^{-10}$	
5 - 83	$1.35 \pm 0.68 \times 10^{-9}$	$1.35 \pm 0.68 \times 10^{-9}$	
8 - 83	$<6.8 \times 10^{-10}$	$<6.8 \times 10^{-10}$	

NPDES PERMIT

A permit to discharge liquid effluent has been issued to the FMPC by the U.S. Environmental Protection Agency and is now administered by the Ohio EPA. The permit was issued under a national control program called the National Pollutant Discharge Elimination System (NPDES). Schedules for sampling are specified in the permit and results are reported to the U.S. EPA on a quarterly basis and to the Ohio EPA on a monthly basis. Table 14 lists parameters and shows the degree of compliance achieved during 1983 on the FMPC NPDES permit which became effective November 1, 1980. Compliance with the permit limits was excellent with only eight occurrences when permit limits for regulated parameters were exceeded.

ESTIMATION OF RADIATION DOSE

Maximum potential dose. 1983 stack discharge data (see section on "Monitoring Data") were used to calculate the dose due to airborne uranium at the maximally exposed offsite residence by means of the AIRDOS and DARTAB computer codes. A 50-year lung dose commitment of 26 mrem was calculated using this method, along with the following other 50-year dose commitments: whole body, 7.6 mrem; kidneys, 1.6 mrem; endosteal cells, 3.3 mrem.

The Great Miami River is not used as a source of drinking water, but calculations of 50-year dose commitments were made assuming an individual took water from a location downstream from the FMPC discharge point. A daily intake of 2.2 Liters per day was assumed. This intake, for a full year, would result in a 50-year dose commitment of 0.8 mrem to the bone, 0.4 mrem to the endosteal tissue, and 0.5 mrem to the total body.

TABLE 14 NPDES Summary

Location	Parameter	Daily Maximum Limit (1)		Daily Average Limit (1)		Compliance With Permit Limits, %
		mg/L	kg/day	mg/L	kg/day	
Manhole - 175	Suspended Solids	60	— (2)	20	—	99
	Nitrate (N)	—	3180	—	1590	100
	Ammonia (N)	—	43	—	28	100
	Oil & Grease	15	—	—	—	97
	Residual Chlorine	0.10	—	—	—	100
	pH (Std. pH units)	6.5 - 10	—	—	—	100
General Sump & Clearwell Combined	Suspended Solids	—	12.8	—	6.2	100
	Chromium (+6)	—	0.008	—	0.004	94
	Chromium (total)	—	0.102	—	0.050	100
	Iron	—	0.85	—	0.41	100
	Nickel	—	0.256	—	0.124	100
	Copper	—	0.051	—	0.025	100
Storm Sewer Lift Station	Suspended solids	100	—	30	—	98
	Oil & Grease	15	—	—	—	100
Sewage Treatment Plant	BOD, 5-day	40	10.0	20	5.0	100
	Suspended Solids	40	10.0	20	5.0	100
	Fecal, coliform (No. per 100 mL)	2000	—	1000	—	100
Storm Sewer Outfall	Suspended solids	100	—	30	—	100
	Oil & Grease	15	—	—	—	100

Footnotes:

(1) Permit limits are in units of mg/L or kg/day except pH and Fecal coliform bacteria.

(2) Not applicable.

Throughout 1983, gamma radiation at the seven boundary sampling stations was measured with thermoluminescent dosimeters which were changed and processed every three months (see Table 15). The maximum annual average, 0.018 mR/hr, was measured at BS-6. If 0.010 mR/hr is used as the natural background, 0.008 mR/hr at BS-6 was due to FMPC operations. This results in a maximum potential annual exposure at the boundary of 0.07 R. This exposure is equivalent to about 14% of the DOE Order 5480.1 dose limit for individuals at points of maximum exposure (i.e., at the site fenceline).

The maximum average fenceline radon-222 concentration was 1.05 pCi/L, measured at boundary station BS-5. This concentration includes naturally occurring radon plus that from FMPC operations. If the local concentration of radon from natural sources is taken as 0.69 pCi/L (average concentration of offsite sampling locations listed in Table 3), a maximum average of 0.36 pCi/L could be attributed to the FMPC. Intake of radon at a concentration of 0.36 pCi/L for a full year would result in a 50-year dose commitment of 7 mrems to the lung.[6]

The maximum dose to an individual due to direct radiation from FMPC operations was calculated from the dose rate data in Table 15. An annual whole body dose of 10 mrem was obtained for the nearest residence to BS-6, assuming an occupancy factor of 80%.

River water is not used as a drinking water supply but it is possible for the residents to have an additional uranium intake if they consume a significant quantity of locally grown vegetables. The average incremental concentration of uranium found in vegetables grown near the FMPC during 1983 was 0.004 micrograms per gram wet weight. Assuming that a resident would consume an average of one

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TABLE 15 Radiation Dose Rates at Site Boundary

Location (1)	Dose Rate, mR/hr	
	Range (2)	Average
BS1	0.011 - 0.012	0.011
BS2	0.012 - 0.013	0.012
BS3	0.011 - 0.013	0.012
BS4	0.010 - 0.013	0.011
BS5	0.011 - 0.013	0.012
BS6	0.017 - 0.020	0.018
BS7	0.012 - 0.014	0.013

Footnotes:

(1) See Figure 2.

(2) Continuous monitoring dosimeters were processed quarterly.

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half pound per day of fresh or home-canned vegetables an annual ingestion of 0.33 mg would result. The following 50-year dose commitments were calculated[6] for this intake: total body, 0.38 mrem; bone, 0.87 mrem; kidney, 0.19 mrem; G.I. tract, 0.04 mrem; endosteal, 0.37 mrem.

Maximum dose to a population group. The community of Ross, Ohio, is located about 2.5 miles from the center of the production area. Because of distance and wind direction frequency, boundary station BS-3 is the sampling location which would give the best indication of contaminants moving toward Ross. Starting with the average concentrations found at BS-3, diffusion equation calculations[7] give an average uranium concentration at Ross of 2.02×10^{-15} μCi/mL. Considering uranium and other nuclides, and assuming a time occupancy factor of 80%, the following 50-year dose commitments were calculated for this population group: lung, 3.74 mrem; kidney, 0.10 mrem; bone, 0.32 mrem; total body, 0.27 mrem. Each of these doses is less than 0.8% of the applicable DOE radiation protection standard for the general population.

80-km man-rem dose. The total population within an 80-km radius of the FMPC is 2.5 million (see Table 16). The total 50-year whole body dose commitment due to airborne uranium and other nuclides for this group is 60 person-rem.[6,7] For this same population group, whole body dose due to natural radiation is 200,000 person-rem per year.[8]

Summary of exposure data. Radiation exposures to the public due to FMPC activities were only a small fraction of the DOE radiation protection standards. A summary of pertinent exposure data is given in Table 17.

TABLE 16 Population Distribution within 80 - km (50 mi) of the FMPC

Compass Sector	Estimated Population (1)			
	0 - 8 km (0 - 5 mi)	8 - 16 km (5 - 10 mi)	16 - 32 km (10 - 20 mi)	32 - 80 km (20 - 50 mi)
N	445	3,395	6,743	29,597
NNE	221	18,959	12,805	148,079
NE	489	32,001	36,705	557,783
ENE	2,489	25,760	29,830	55,078
E	512	40,770	70,762	85,240
ESE	713	54,533	150,630	107,365
SE	1,606	36,467	247,846	118,490
SSE	985	28,932	207,202	51,946
S	669	19,214	53,673	39,116
SSW	390	4,217	10,614	21,987
SW	185	2,957	13,066	16,574
WSW	440	4,961	3,930	19,199
W	519	1,765	3,292	31,629
WNW	157	1,361	5,211	21,605
NW	511	1,433	1,802	37,945
NNW	519	1,134	21,042	71,493
Totals	10,850	277,859	875,153	1,413,126

Total in all sectors: 2,576,988

Footnote:

(1) Based on "Report of Findings, Population Studies for DOE Feed Materials Production Center, Near Fernald, Ohio, for NLO, Inc.", May 18, 1981.

TABLE 17 Summary of 1983 Exposure Data

Type of Exposure	Dose Estimate	% of Standard	Radiation Protection Standard (1)
"Maximum potential" dose due to direct radiation from FMPC operations.	0.07 Rem	14	0.5 Rem
"Maximum individual" whole-body dose due to direct radiation from FMPC operations.	0.01 Rem	2.3	0.5 Rem
"Population group" 50 - year whole-body dose commitment from airborne uranium and other nuclides.	0.00027 Rem	0.16	0.17 Rem
"80 - km" 50 - year whole-body dose commitment from airborne uranium and other nuclides.	60 person - Rem	—	—

Footnote:

(1) DOE Order 5480.1A, Chapter XI, Exposure of Individuals and Population Groups in Uncontrolled Areas.

OTHER ENVIRONMENTAL CONTROLS

Sewage Plant Effluent. Effluent from the FMPC Sewage Treatment Plant is combined with other effluents at Manhole-175 (see Figure 4). Prior to discharge from the Sewage Treatment Plant, however, the effluent is carefully monitored and sampled to determine efficiency of operation and compliance with all applicable standards. Table 14 shows that the Sewage Treatment Plant was in 100% compliance with its NPDES limits.

Steam Plant Emissions. The steam generation plant at the FMPC utilizes two boilers with a total design capacity of 150,000 lbs of steam per hour. Electrostatic precipitators keep the particulate discharge below the Ohio EPA particulate limit of 0.13 pounds per million BTU input.

Sulfur dioxide emission limits for stationary facilities have been adopted by the Ohio Environmental Protection Agency. Under these rules, the limit for FMPC steam plant is 2.0 pounds of sulfur dioxide per million BTU input from each boiler. This limit is equivalent to the use of coal containing 1.3% sulfur. Coal containing only 1% sulfur, or less, is purchased in order to meet the State's SO_2 emission requirement.

Particulates from industrial processes. Maximum rates of emissions of particulates from industrial processes are prescribed in State of Ohio EPA Regulation 3745-17-11, "Restriction of emission of particulate matter from industrial processes." Through the use of many dust collectors, scrubbers, electrostatic precipitators, and other types of air cleaning equipment, particulate emissions from FMPC process operations are far below the established limits. No problems are anticipated in remaining in compliance with the state standard.

Incinerator operations. The FMPC solid waste incinerator is used for the destruction of combustible trash, paper, wood, etc. The incinerator was specified to meet state emission standards of 0.10 pound of particulate matter per 100 pounds of combustible refuse charged. An incinerator operating permit has been issued by the State of Ohio for the solid waste incinerator. A liquid waste incinerator has been constructed for the destruction of non-hazardous waste oils. An operating permit has been applied for to run this device, which includes a bag-house-collector to minimize stack emissions.

REFERENCES

(1) U.S. Department of Energy, Order 5480.1A, "Environmental Protection, Safety and Health Protection Program for DOE Operations," as noted in Chapter XI, Requirements for Radiation Protection, August 13, 1981.

(2) U.S. Department of Energy, Order 5484.1, "Environmental Protection, Safety and Health Protection Information Reporting Requirements," February 24, 1981.

(3) Ohio Environmental Protection Agency, "Ambient Air Quality Standards."

(4) Ohio Environmental Protection Agency, "Water Quality Standards Administrative Code Chapter 3745-1," effective February 14, 1978.

(5) Code of Federal Regulations, Title 10, Part 20, Chapter 1, "Standards for Protection Against Radiation," January 1, 1983, pp. 230-269.

(6) Dunning, D. E., S. R. Bernard, P. J. Walsh, G. G. Killough, J. C. Pleasant, Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel - Cycle Facilities, Vol. II, U.S. NRC Report NUREG/CR-0150-V.2 (U.S. DOE Report ORNL/NUREG/TM-190/V.2), November, 1979.

(7) Slade, D. H., editor, Meteorology and Atomic Energy - 1968, U.S. Air Resources Laboratories (also referred to as USAEC Report TID-24190), July, 1968.

(8) Oakley, D. T., Natural Radiation Exposure in the United States, USEPA Report ORP/SID-72-1, June, 1972.

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