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REMOVAL SITE EVALUATION INACTIVE FLY ASH PILE/SOUTHFIELD AREA FEBRUARY 1991

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DOE-FMPC/WMCO
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REPORT

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Removal Site Evaluation

INACTIVE FLY ASH PILE/SOUTHFIELD AREA

Feed Materials Production Center

FEBRUARY, 1991

1.0 INTRODUCTION

The Inactive Fly Ash Pile/Southfield area (IFAP/SF) is located southwest of the production area and covers approximately 14 acres (figure 1). Its western boundery is defined by Paddy's Run, which parallels the area for approximately 200 ft. and comes within 10 to 15 ft. of the base of the IFAP/SF at the nearest point. The IFAP/SF is bordered on the north by access road 'B' (figure 2), and on the east by access road 'A' , which runs from the parking lot south of the production area to the Firing Range and separates the Active Fly Ash Pile to the east from the IFAP/SF to the west. Site wide institutional controls are in place to limit access to the site oveall. However, specific control measures are not in place at the IFAP/SF location demarcating areas of elevated suface contamination.

Early investigations attempted to make a distinction between the Inactive Fly Ash Pile and the Southfield. Three distinct areas of fly ash are evident (Figure 3). Fly ash is mixed with construction rubble, debris and other unidentified wastes thoughout the Southfield. Therefore, in this RSE these areas are treated as one: the IFAP/SF.

Fly ash disposal in the IFAP/SF probably terminated no later than 1968, with an estimate of 50,000 cubic yards having been disposed of in this area. The southfield has an estimated volume of 125,000 cubic yards of construction rubble, debris, and possibly other unidentified wastes. The maximum depth of the IFAP/SF is estimated to be approximately 34 ft.

Surface water runoff is generally in a southwesterly direction toward Paddy's Run (Figure 3). Currently there is an ongoing CERCLA Remedial Investigation-Feasibility Study (RI/FS) for Operable Unit 2 that is assessing environmental conditions and possible remedial actions for the IFAP/SF area.

The extent and nature of contamination was developed through review of data from the Roy F. Weston Characterization Investigation Study (C.I.S.)[1], current RI/FS information, and the FMPC annual Environmental Monitoring Reports. The existing contamination in the IFAP/SF is possibly due to contaminated fly ash, construction rubble and debris disposed of in the area.

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[1]Weston, Roy R., Inc., "Characterization Investigation Study, Vol. 3, Radiological Characterization of Surface Soils in the Waste Storage Area," 1987.

This Removal Site Evaluation (RSE) has been completed by the Department of Energy under authorities delegated by Executive Order 12580 under Section 104 of CERCLA and is consistent with Section 300.410 of the National Oil and Hazardous Substance Pollution Contingency Plan (NCP). This RSE addresses the Inactive Fly Ash Pile/Southfield area as a potential source for the exposure of the general population through the uncontrolled release of contaminants to the environment.

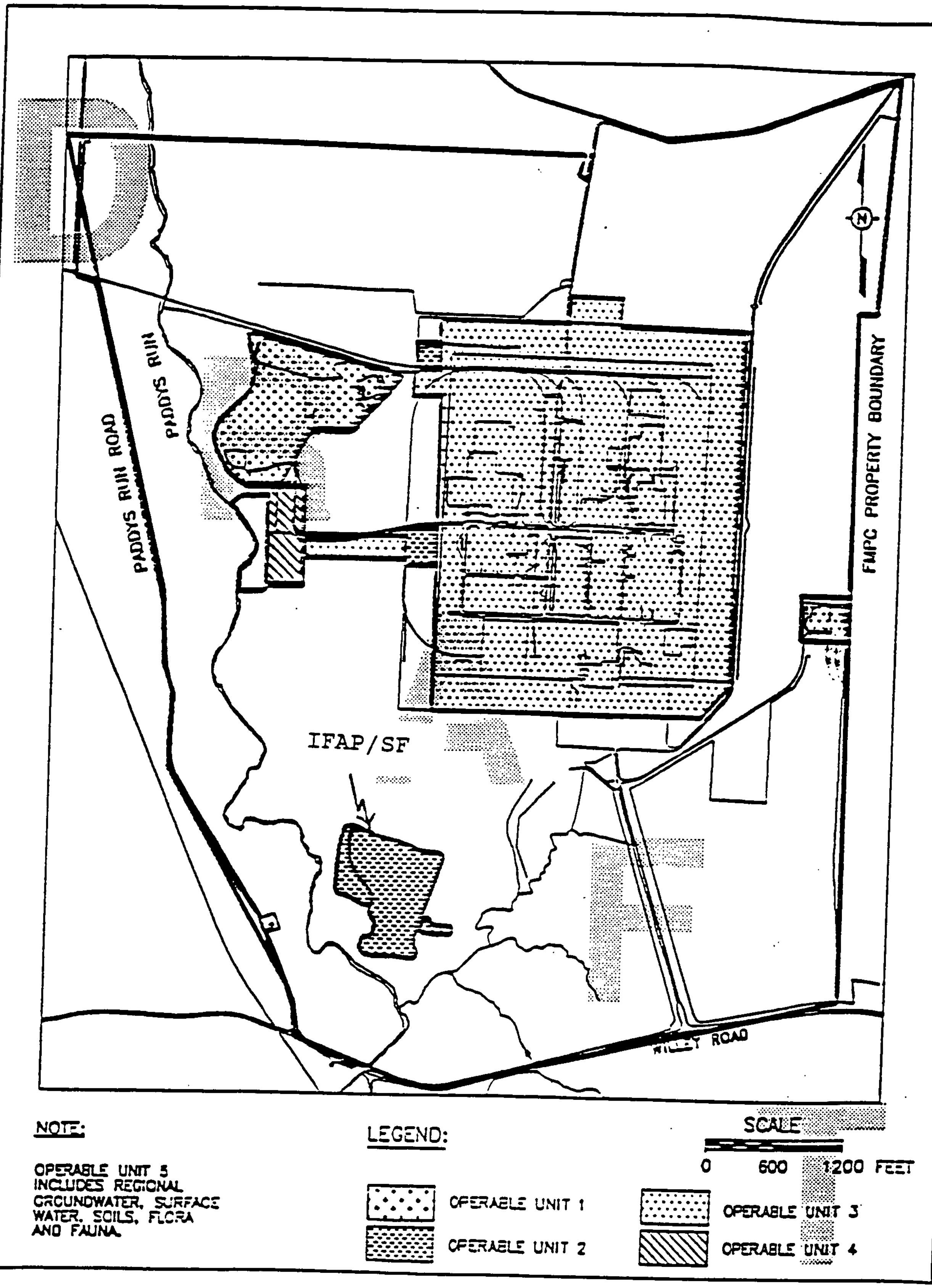

FIGURE 1 SOURCE OPERABLE UNITS

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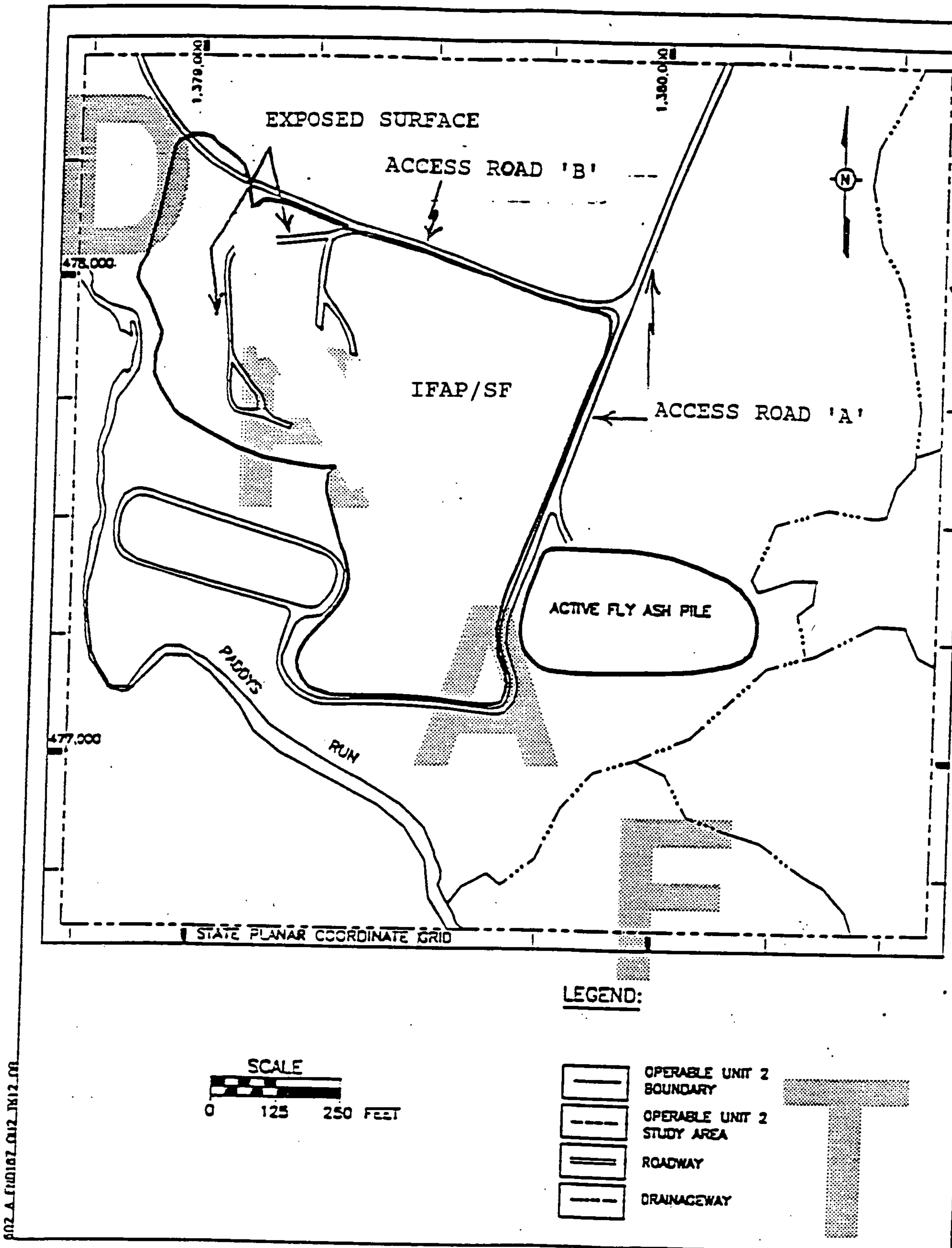

FIGURE 2 INACTIVE FLY ASH PILE/SOUTHFIELD AREA (IFAP/SF)

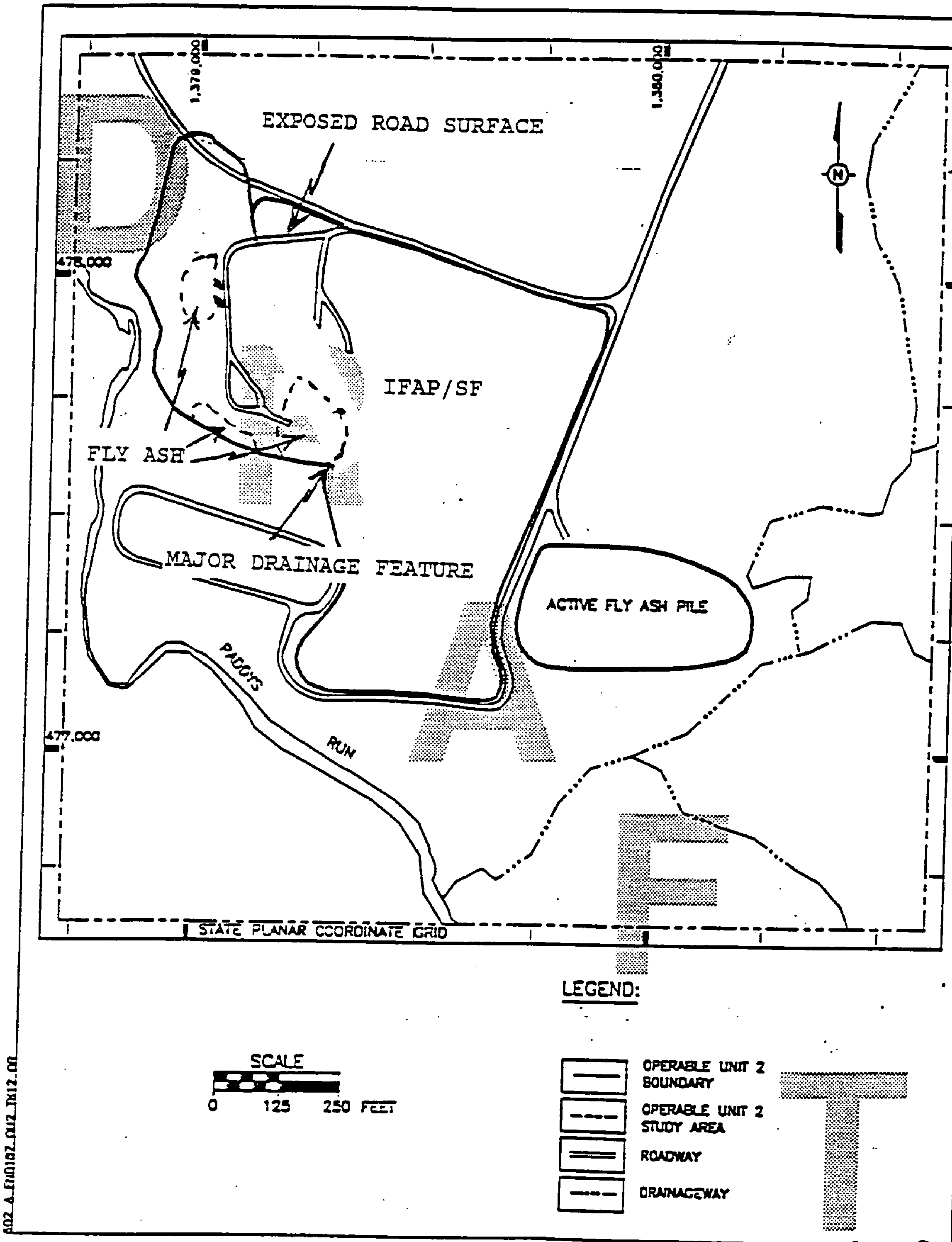

FIGURE 3 EXPOSED SURFACES

2.0 SOURCE TERM

The on-going RI/FS is providing an in-depth analysis of present and potential exposure pathways for contaminants. This RSE focuses on the nature , location, and extent of surface contamination in the Inactive Fly Ash Pile/Southfield (IFAP/SF) area. There are discrete locations with elevated concentrations of contaminants. This RSE focuses on those locations.

2.1 PHYSICAL AND VISIBLE FEATURES

Site inspection has shown that the IFAP/SF has an established vegetation cover of natural grasses, mature trees, and shrubs, which apparently stabilize the surface soils. Grass covers the flat areas with trees and shrubbery dispersed throughout. The slopes are thickly covered with trees, shrubs, and other vegetation. The only exposed surface is the access road in the center of the flat lying area (Figure 3). Since the surface area appears to be very stable, the possibility of contaminant release to the environment from wind and surface water erosion of the surface soils is negligible.

There is only one major drainage feature, which is a gully between two steep slopes of distinct fly ash and construction debris (Figure 3). The drainage appears to run toward the running track/firing range area. This feature is heavily covered with vegetation, i.e. grass, mature trees, and shrubs. There is no apparent evidence of unusual erosion in the gully or away from the gully toward the running track/firing range area.

2.2 RADIATION INSTRUMENT SURVEYS

Radiation surveys have been performed in the IFAP/SF area as part of the C.I.S. and the RI/FS. The most common instruments used for the surveys were the following:

The Field Instrument for Detecting Low-Energy Radiation (FIDLER). The FIDLER consists of a 5-inch diameter thin window (0.063 inch) sodium iodide crystal optically coupled to a quartz light pipe, which is installed in a 5-inch long probe housing. This instrument was used to detect the 63 keV and 93 keV photons from Th-234 of the U-238 decay chain (gamma rays). The FIDLER measurements are shown by contour lines on Figure 4.

The Geiger Mueller (GM). The GM is a pancake-type thin window detector. This instrument was used to measure the beta-gamma dose rate. The beta-gamma dose rates are shown by contour lines on Figure 5.

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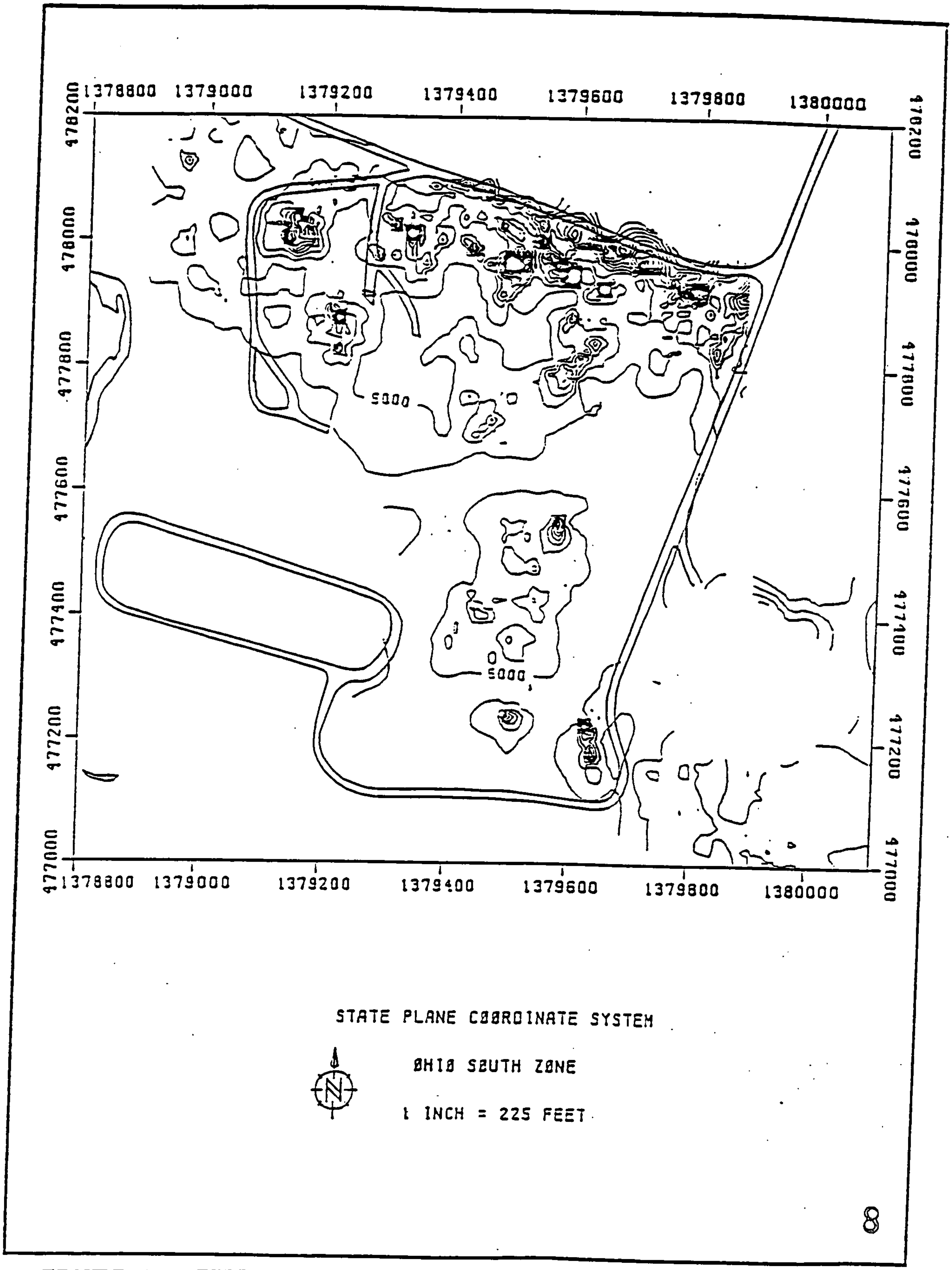

FIGURE 4 FIDLER MEASUREMENT CONTOURS IN THE IFAP/SF AREA (COUNTS PER MINUTE) CONTOUR INTERVAL IS 5,000 CPM

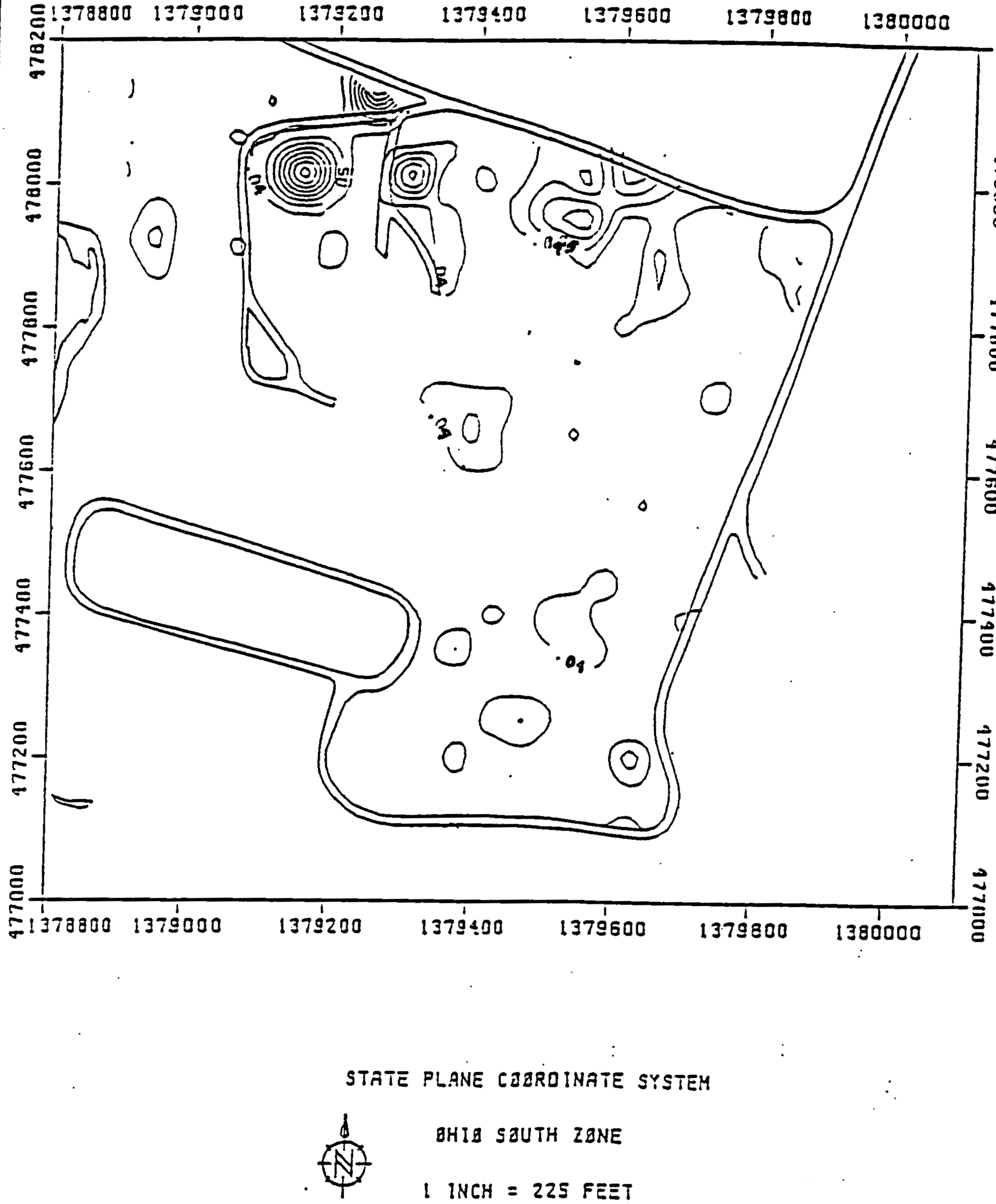

FIGURE 5 BETA GAMMA DOSE RATE CONTOURS IN THE IFAP/SF AREA (mRad/hr) CONTOUR INTERVAL IS .01 mRad/hr

Figures 4 and 5 show the areas of greatest potential concern are along the road bordering the northern boundary of the IFAP/SF and along the road leading into the area. These areas are heavily covered with native grass.

2.3 SURFACE SOIL SAMPLING

Surface soil sampling was conducted for the C.I.S. and RI/FS, which included sampling in the IFAP/SF area. The sampling procedures followed techniques outlined in the DOE Report GJ/TMC-13 UC-70[2] . These techniques included the use of "ring" samplers and stainless steel trowels to obtain surface samples down to 6 inches. Post-hole samplers and trowels were used for sampling at depths from 6 to 18 inches. The FIDLER was used to determine the location for soil sampling. Figure 6 shows the soil sampling locations. Note the correlation between the soil sampling locations and the FIDLER and GM contours in Figures 4 and 5 . The soil samples were taken from locations that were suspected to have high radionuclide concentrations. These locations are predominately along the access road bordering the northern boundary of the IFAP/SF area.

Due to the limited availability of RI/FS sediment and soil sample results, the C.I.S. data results were used for this analysis. Appendix A summarizes the radiochemistry results for surface soil concentrations from 0 to 0.16 feet in the IFAP/SF area. Averages of the radionuclide concentrations for the 15 samples analyzed are as follows:

Average Radionuclide Concentrations in Soils
From the IFAP/SF Area
(pCi/g)

Radio-nuclide	Mean Value	Standard Deviation
Ra-226	51.03	78.68
Th-228	3.36	8.58
Th-230	29.04	49.61
Th-232	3.59	9.37
U-234	1040.29	2954.56
U-235	175.4	564.64
U-238	855.68	2267.35

[2]DOE Report GJ/TMC-13 UC-70, Procedures for Sampling Radium-Contaminated Soils (1985).

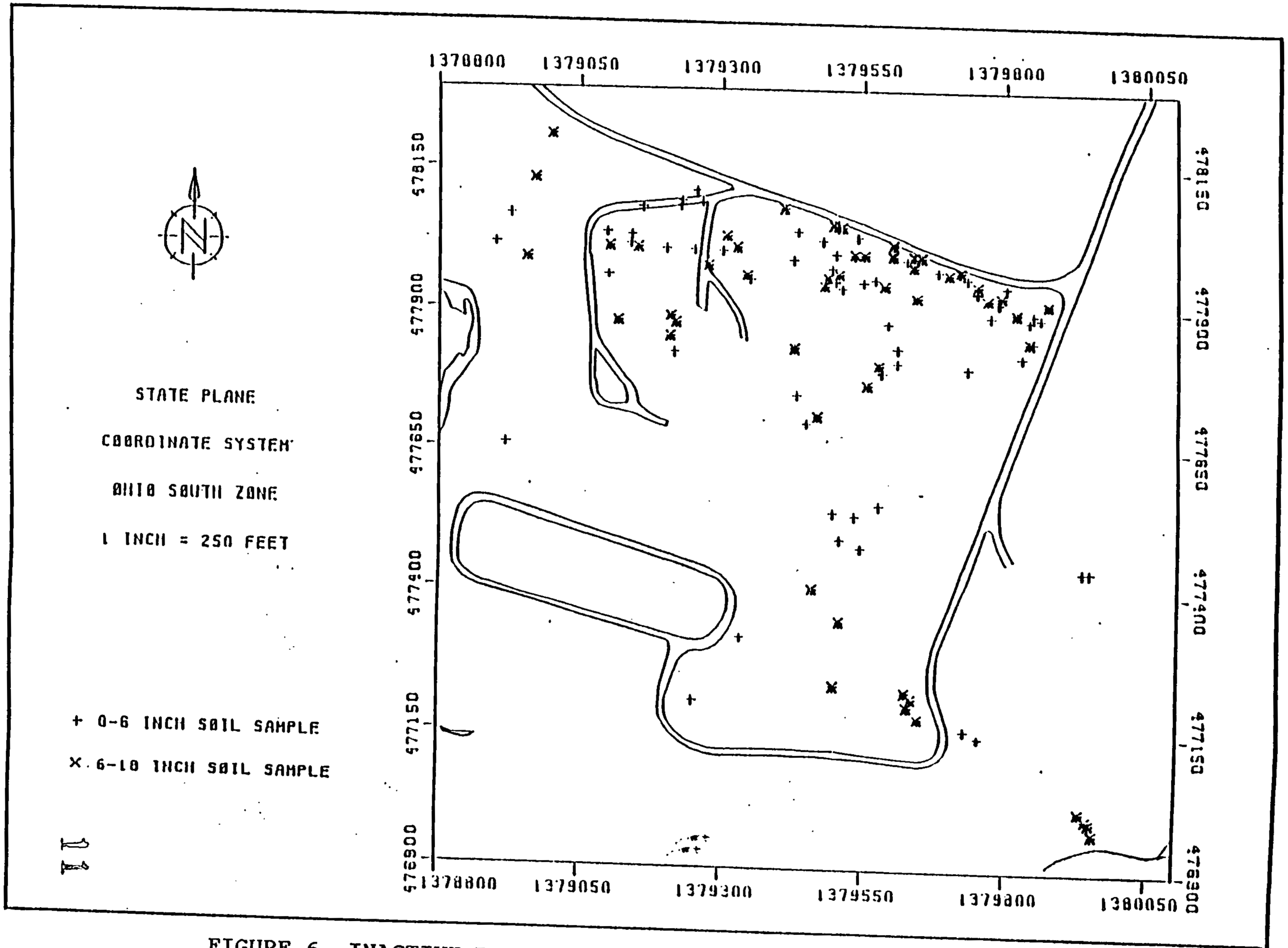

FIGURE 6 INACTIVE FLY ASH PILE/SOUTHFIELD SOIL SAMPLING LOCATIONS

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The principle contaminant is uranium. Most samples showed thorium isotopes, uranium isotopes, and Ra-226 at or slightly elevated from background levels (background values are given in Appendix B, Table B.2). The most notable values for the uranium isotopes were from samples 24-081, 24-133, 24-137, and 24-241; for thorium isotopes, 24-046, 24-133, 24-183, 24-224; for Ra-226, 24-046, 24-123, 24-133, 24-151, 24-189, and 24-224 (Appendix A). These values raised the statistical averages significantly and also the standard deviation associated with those values.

2.4 Borehole Samples

Twelve composite borehole samples from the IFAP/SF area were analyzed for HSL inorganics and HSL pesticides/PCB's (Appendix C; Tables C.4, C.5, C.6, C.7). Sample locations are shown in Figure 7.

Analysis of the HSL inorganics (Appendix C, Table C.3) show that measurable amounts of aluminum, calcium, iron, and magnesium were found in all the borehole samples. Traces of arsenic were found in all the boreholes and ranged from 3.7 to 31.17 mg/kg. Cadmium and lead were also detected in all of the boreholes. Mercury was detected in all the boreholes except number 8.

Boreholes 4, 6, 7, 8, 9, and 10 showed PCB's ranging from 250 to 880 ug/kg (Appendix C, Table C.2).

A summary of the radionuclides is presented in Appendix C, Table C.1. The U-238 concentrations range from 3.1 to 50 pCi/g. The highest uranium concentration was found in borehole 10.

The borehole samples are disussed here to show the possible extent of total contamination in the IFAP/SF. However, these contaminant concentrations are not used in the evaluation of the removal site, because they are composite concentrations below the surface and would not pose an immediate or imminent threat to human population.

2.5 Environmental Air Samples

The routine Environmental Monitoring Program at FMPC includes three particulate sampling locations in the vicinity of the IFAP/SF: Air Monitoring Stations (AMS) 4, 5, and 6 (Figure 8). Review of the meteorological data for the prevailing wind direction indicates that AMS 2 and 4 are the most likely receptors for airborne contaminants from the IFAP/SF.

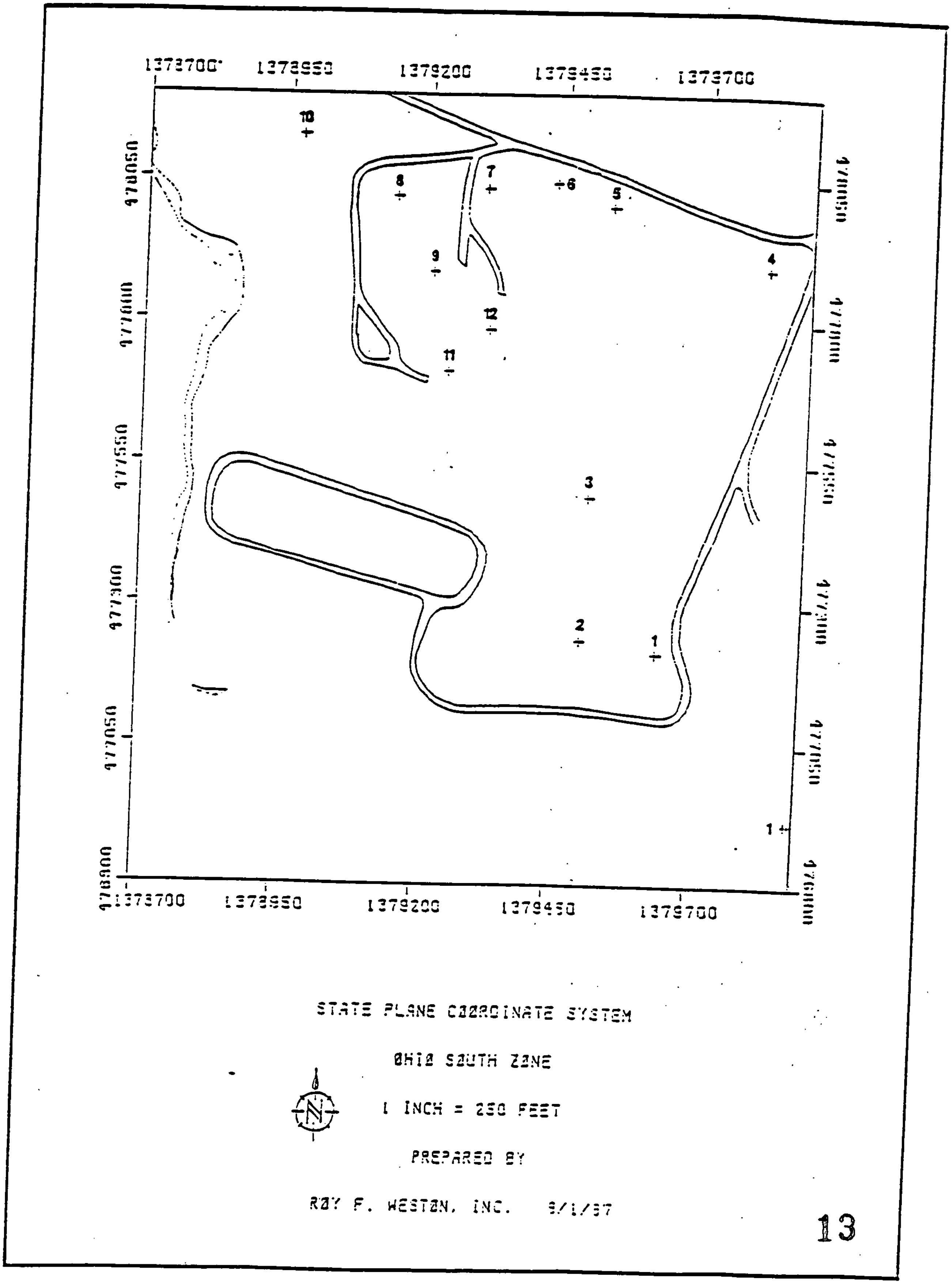

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FIGURE 7 BOREHOLE SAMPLE LOCATIONS IN THE IFAP/SF AREA

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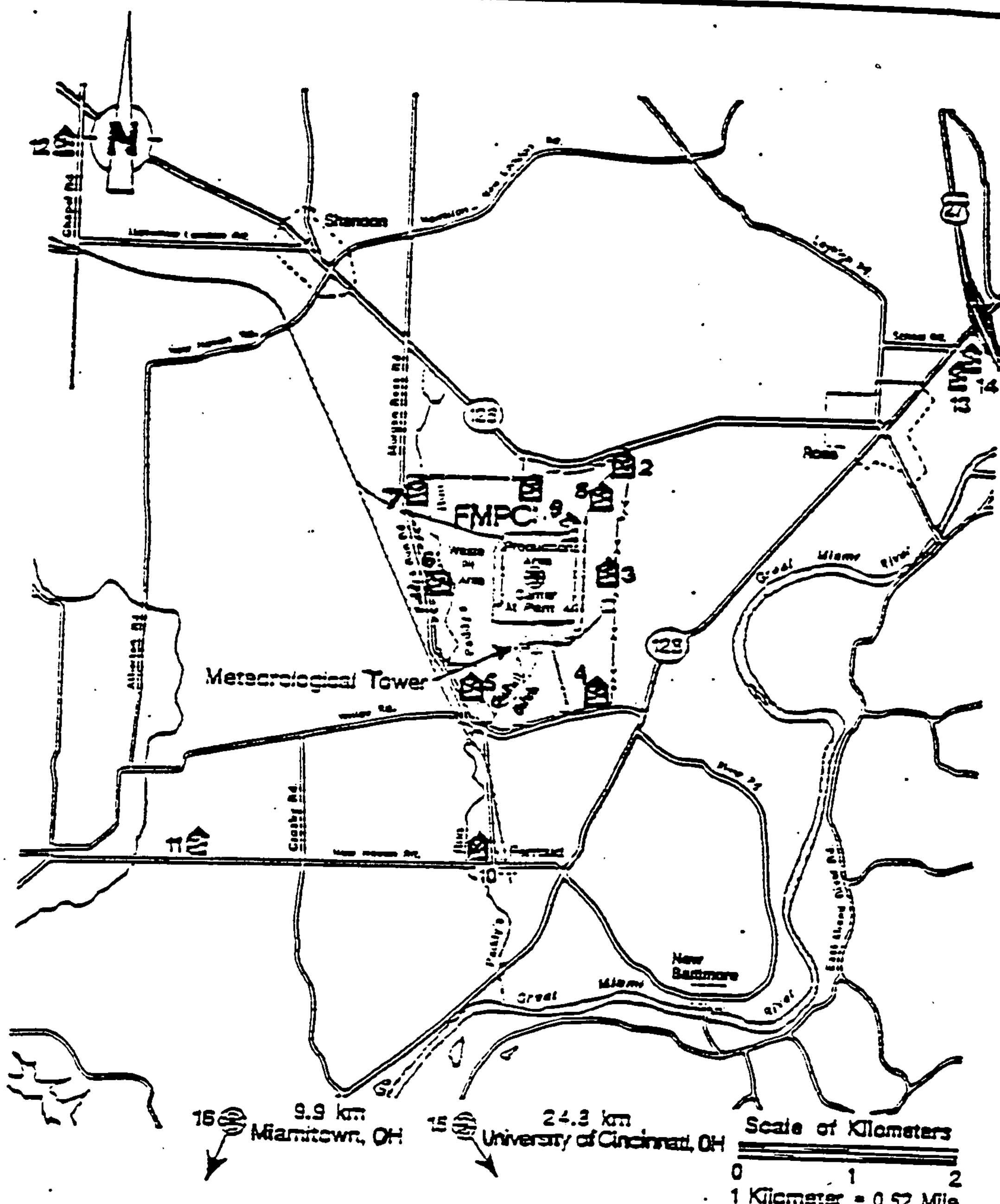

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Air Monitoring Location

Distance from Center of Production Area to Sampling Locations off Map

Plant Perimeter

Production Area Perimeter

FIGURE 8 Air Monitoring Locations

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Other air monitoring stations (1-3, and 7-16) aren't considered due to the potential of the Waste Pit and Production areas contributing to the concentration of contaminants. Although the Waste Pit and Production areas may also contribute to the contaminant concentrations at AMS 4, 5, and 6, the effects would be less than at air monitoring locations closer to the Waste Pit and Production area. In fact, the variation in the isotopic concentrations (see table below) indicates probable contribution from the Waste Pit and Production areas. The average yearly concentrations is lower for AMS 4 than for 5, or 6.

Table 1
Average Airborne Concentrations During 1989
(E-18 uCi/ml)

Isotope	AMS 4	AMS 5	AMS 6
Ra-226	1.0	8.0	16.0
Th-228	<9.7	8.3	11.0
Th-230	<9.7	<8.0	<9.5
Th-232	<9.7	<8.0	<9.5
U-234	76.0	43.0	120.0
U-235	4.0	4.5	6.0
U-238	100.0	110.0	160.0

3.0 EVALUATION OF THE MAGNITUDE OF THE POTENTIAL THREAT

The source term that has been developed permits an estimate of current risks from contaminants in the Inactive Fly Ash Pile/Southfield area. Concentrations of the identified radionuclides were variable. Average air sample concentrations from the three closest sampling locations and average surface soil concentrations are used to quantify environmental, inhalation, and external exposures. Since average values for contaminant concentrations are used for the calculations in this section a degree of uncertainty must be recognized. Also, note that risks are calculated based upon a 10 year time frame of exposure in order to take into account the implementation of long term remedial actions and the subsequent modification or elimination of the source term. Even so, comparison to a 70 year lifetime value is possible by multiplying by a factor of 7, which does not affect the overall analysis of this RSE.

3.1 Environmental Exposure to Airborne Contaminants

Air sample contaminant concentrations are given in Table 1 above. Appendix D.1 shows the dose and associated risk calculations associated with those concentrations. The maximum committed effective dose equivalent (CEDE) is estimated to be

0.35 mRem/yr

with a 10 year cancer risk of

4.4E-07.

This is lower than the NESHAPS limit of

10 mRem/yr,

which has a 10 year cancer risk of

5.0E-05.

3.2 Inhalation Exposure

The inhalation exposure is based on the average soil contaminant concentrations in the IFAP/SF area. For this assessment it is assumed that there is not a vegetative cover and conditions are very dusty. The other conservative assumption is that an individual (e.g; an employee) is exposed to contaminant inhalation for 40 hours per week, 50 weeks per year. Appendix D.2 shows the dose and risk calculations associated with this exposure. The committed effective dose equivalent should be approximately

469 mRem/yr.

The cancer risk associated with that dose is

5.8E-04.

This is higher than the NESHAPS value, but it must be kept in mind that a very conservative scenario was used with no vegetation and extremely dusty conditions.

3.3 External Exposure

This exposure is another that must be considered for the general population because of the remote location of the IFAP/SF area. The assumption here is a 60 percent occupancy. The committed effective dose equivalent associated with this exposure is

657 mRem/yr

with an associated cancer risk of

8.1E-04.

Appendix D.3 shows the calculations for the results above.

4.0 ASSESSMENT ON THE NEED FOR A REMOVAL ACTION

Consistent with Section 40 CFR 300.410 of the National Contingency Plan, the Department of Energy (DOE) shall determine the appropriateness of a removal action. Eight factors to be considered in this determination are listed in 40 CFR 300.415 (b)(2). The following apply specifically to the concentrations of contaminants present in the Inactive Fly Ash Pile/Southfield area:

40 CFR 300.415 (b)(2)(i)

Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.

40 CFR 300.415 (b)(2)(iv)

High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may pose a threat of release.

40 CFR 300.415 (b)(2)(v)

Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

These factors are considered appropriate as a result of the concentration of contaminants in the soils in the Inactive Fly Ash Pile/Southfield area. There are apparent risks in this area when one considers the worse-case scenarios discussed in the previous section. However, the actual risks are minimal due to the present stable surface conditions, which abate the release of contaminants to the environment. It must be kept in mind that the scenarios presented in the previous section involved very conservative surface conditions, i.e. no vegetation cover.

5.0 APPROPRIATENESS OF A RESPONSE

If a planning period of less than six months exists prior to initiation of a response action, DOE will issue an Action Memorandum. The Action Memorandum will describe the selected response and provide supporting documentation for the decision.

If it is determined that there is a planning period greater than six months before a response is initiated, DOE will issue an Engineering Evaluation/Cost Analysis (EE/CA) Approval Memorandum. This memorandum is to be used to document the threat of public health and the environment and to evaluate viable alternative response actions. It will also serve as a decision document to be included in the Administrative Record.

The FMPC is currently on the National Priorities List and is in the RI/FS process. The final remedial action will address the means of removing or further stabilizing the contaminated soil and sediment in the Inactive Fly Ash Pile/Southfield area.

APPENDIX A

Table A
IFAP/SF Surface Soil Radiochemistry Results
(pCi/g)

Sample Number	Ra-226	Th-228	Th-230	Th-232	U-234	U-235	U-238
24-046	35.57	.30	164.00	.50	15.00	.60	16.00
24-081	18.67	.50	14.00	.20	2850.00	356.00	2940.00
24-123	184.19	.30	9.30	.20	7.20	.30	7.50
24-133	279.65	3.40	123.00	3.40	491.00	20.00	500.00
24-137	8.75	2.20	.90	2.40	254.00	40.00	216.00
24-142	4.21	4.80	1.20	5.30	99.00	4.20	94.00
24-151	49.53	.10	2.30	.10	8.50	.40	9.20
24-183	5.41	34.00	11.00	37.00	12.00	.70	11.00
24-189	48.39	.10	.20	.10	4.60	.20	6.60
24-196	33.99	.30	11.00	.30	105.00	4.40	108.00
24-212	.71	1.50	32.00	1.30	115.00	5.50	129.00
24-221	1.50	1.90	7.10	2.40	117.00	4.90	124.00
24-224	48.88	.90	59.00	.40	82.00	1.90	40.00
24-235	16.70	.10	.10	.10	44.00	1.90	42.00
24-241	29.30	.10	.50	.10	11400.00	2190.00	8600.00

APPENDIX B

Table B.1
C.I.S.
On-Site Laboratory Background Radionuclide Results
(pCi/g)

Sample I.D.	Ra-226	Th-232	U-238
45-001	.40	.60	8.9
45-002	.80	.70	7.50
45-003	.50	.80	7.90
45-004	.50	.80	5.20
45-005	.60	1.10	5.00
45-006	.60	.20	2.10
45-007	.60	1.00	8.60
45-008	.70	.90	3.20
45-009	.80	1.10	8.90
45-010	.60	.50	7.30
45-010D	.50	.60	9.30
45-011	.70	.80	5.30
45-012	.40	.80	4.40
45-013	.40	1.10	10.00
45-014	.50	1.00	8.60
45-014S	.50	.80	9.20
45-015	.50	.90	9.50
45-015S	.70	.70	4.80
Avg.	.57	.80	6.98
Standard Deviation	.13	.23	2.41

Table B.2
C.I.S.
Background Radiochemistry Results
(pCi/g)

Sample Number	Ra-226	Th-228	Th-230	Th-232	U-234	U-235	U-238
45-14S	.63	NV	.80	NV	.90	.10	.70
45-15S	.94	NV	.90	NV	.70	.10	.90

APPENDIX C

Table C.1
Radionuclide Concentrations in Borehole
Composite Samples (pCi/g)*

Borehole	Ra-226	Th-228	Th-230	Th-232	U-234	U-235	U-238
1	9.0	.10	9.60	.10	9.10	.40	19.00
2	1.20	.20	.30	.20	2.00	.09	4.90
3	.80	.10	.10	.10	8.20	.50	24.00
4	2.10	.30	.50	.10	5.80	.30	9.20
5	17.00	.80	10.00	.50	3.80	.20	5.10
6	5.00	.10	.50	.10	2.60	.10	3.10
7	.70	.70	1.10	.60	15.00	.60	16.00
8	.70	1.30	.70	1.40	14.00	.80	17.00
9	.90	1.90	.50	2.10	15.00	.80	42.00
10	4.10	2.30	11.00	2.60	48.00	2.20	50.00
11	1.50	.20	.20	.10	3.70	.20	6.60
12	.60	.20	.10	.10	6.70	.20	9.00
Avg.	3.63	.683	2.88	0.66	11.16	0.53	17.16
Standard Deviation	5.38	0.76	4.43	0.88	12.52	0.58	15.02

* Results from the "Characterization Investigation Study", Roy F. Weston, Inc., November 1987.

Table C.2
Organic Data Summary From Boreholes
in Inactive Fly Ash Pile/Southfield*
(ug/kg)

Borehole	Aroclor 1242	Aroclor 1254	Aroclor 1260	Acetone	Methylene Chloride
1	93.00	147.00	---	---	---
2	---	510.00	---	250.00	---
3	---	39.00	---	---	---
4	---	670.00	---	---	---
5	---	130.00	---	---	---
6	---	360.00	---	---	---
7	76.00	---	420.00	---	---
8	1.90	880.00	---	---	---
9	42.00	---	260.00	---	---
10	5.70	290.00	---	---	---
12	---	---	28.00	---	---

* Results taken from the "Characterization Investigation Study", Roy F. Weston, November 1987.

Note: --- means not detected.

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TABLE C.3

IFAP/SF INORGANIC DATA SUMMARY

rehole Number	Sample Id	Batch Number	Parameter	Concentration	Unit Of Measure
-01	FMP-PS-24-001	8705-359-0080	ALUMINUM, TOTAL	8987.91	MG/KG
			ARSENIC, TOTAL	6.00	MG/KG
			BARIUM, TOTAL	87.88	MG/KG
			CADMIUM, TOTAL	2.85	MG/KG
			CALCIUM, TOTAL	32619.92	MG/KG
			CHROMIUM, TOTAL	13.66	MG/KG
			COBALT, TOTAL	27.73	MG/KG
			COPPER, TOTAL	23.24	MG/KG
			IRON, TOTAL	16055.08	MG/KG
			LEAD, TOTAL	11.04	MG/KG
			MAGNESIUM, TOTAL	15926.62	MG/KG
			MANGANESE, TOTAL	838.02	MG/KG
			MERCURY, TOTAL	1.22	MG/KG
			NICKEL, TOTAL	48.32	MG/KG
			POTASSIUM, TOTAL	632.09	MG/KG
			VANADIUM, TOTAL	15.08	MG/KG
			ZINC, TOTAL	48.52	MG/KG
-02	FMP-PS-24-011	8705-415-0010	ALUMINUM, TOTAL	13062.21	MG/KG
			ARSENIC, TOTAL	4.10	MG/KG
			BARIUM, TOTAL	118.92	MG/KG
			CADMIUM, TOTAL	4.21	MG/KG
			CALCIUM, TOTAL	79382.49	MG/KG
			CHROMIUM, TOTAL	18.38	MG/KG
			COBALT, TOTAL	9.76	MG/KG
			COPPER, TOTAL	12.83	MG/KG
			IRON, TOTAL	21618.43	MG/KG
			LEAD, TOTAL	16.04	MG/KG
			MAGNESIUM, TOTAL	16823.27	MG/KG
			MANGANESE, TOTAL	392.57	MG/KG
			NICKEL, TOTAL	28.15	MG/KG
			POTASSIUM, TOTAL	1436.25	MG/KG
			VANADIUM, TOTAL	20.10	MG/KG
			ZINC, TOTAL	49.02	MG/KG
03	FMP-PS-24-012	8705-415-0030	ALUMINUM, TOTAL	9621.36	MG/KG
			ARSENIC, TOTAL	3.70	MG/KG
			BARIUM, TOTAL	54.74	MG/KG
			CADMIUM, TOTAL	2.89	MG/KG
			CALCIUM, TOTAL	43109.15	MG/KG

TABLE C.3

IFAP/SF INORGANIC DATA SUMMARY

ehole mber	Sample Id	Batch Number	Parameter	Concentration	Unit Of Measure
03	FMP-PS-24-012	8705-415-0030	CHROMIUM, TOTAL	18.63	MG/KG
			COPPER, TOTAL	10.74	MG/KG
			IRON, TOTAL	16897.81	MG/KG
			LEAD, TOTAL	15.35	MG/KG
			MAGNESIUM, TOTAL	18728.29	MG/KG
			MANGANESE, TOTAL	328.90	MG/KG
			MERCURY, TOTAL	.43	MG/KG
			NICKEL, TOTAL	21.89	MG/KG
			POTASSIUM, TOTAL	640.46	MG/KG
			VANADIUM, TOTAL	19.21	MG/KG
			ZINC, TOTAL	43.17	MG/KG
04	FMP-PS-24-014	8705-415-0040	ALUMINUM, TOTAL	6673.40	MG/KG
			ARSENIC, TOTAL	4.43	MG/KG
			BARIUM, TOTAL	51.07	MG/KG
			CADMIUM, TOTAL	2.12	MG/KG
			CALCIUM, TOTAL	61643.90	MG/KG
			CHROMIUM, TOTAL	9.36	MG/KG
			COPPER, TOTAL	9.57	MG/KG
			IRON, TOTAL	12797.79	MG/KG
			LEAD, TOTAL	15.98	MG/KG
			MAGNESIUM, TOTAL	30281.44	MG/KG
			MANGANESE, TOTAL	461.77	MG/KG
			MERCURY, TOTAL	.37	MG/KG
			NICKEL, TOTAL	13.19	MG/KG
			POTASSIUM, TOTAL	510.72	MG/KG
			VANADIUM, TOTAL	16.17	MG/KG
			ZINC, TOTAL	34.26	MG/KG
05	FMP-PS-24-043	8705-415-0060	ALUMINUM, TOTAL	10429.87	MG/KG
			ARSENIC, TOTAL	4.89	MG/KG
			BARIUM, TOTAL	48.37	MG/KG
			CADMIUM, TOTAL	3.07	MG/KG
			CALCIUM, TOTAL	8622.16	MG/KG
			CHROMIUM, TOTAL	14.75	MG/KG
			COPPER, TOTAL	11.27	MG/KG
			IRON, TOTAL	16397.12	MG/KG
			LEAD, TOTAL	11.22	MG/KG
			MAGNESIUM, TOTAL	2828.85	MG/KG
			MANGANESE, TOTAL	319.16	MG/KG

TABLE C.3

IFAP/SF INORGANIC DATA SUMMARY

rehole umber	Sample Id	Batch Number	Parameter	Concentration	Unit Of Measure
-05	FMP-PS-24-043	8705-415-0060	MERCURY, TOTAL	.12	MG/KG
			NICKEL, TOTAL	20.08	MG/KG
			POTASSIUM, TOTAL	348.48	MG/KG
			VANADIUM, TOTAL	16.60	MG/KG
			ZINC, TOTAL	39.76	MG/KG
-06	FMP-PS-24-017	8705-415-0050	ALUMINUM, TOTAL	8593.72	MG/KG
			ARSENIC, TOTAL	4.68	MG/KG
			BARIUM, TOTAL	90.88	MG/KG
			CADMIUM, TOTAL	3.26	MG/KG
			CALCIUM, TOTAL	32687.53	MG/KG
			CHROMIUM, TOTAL	12.43	MG/KG
			COBALT, TOTAL	14.67	MG/KG
			COPPER, TOTAL	18.74	MG/KG
			IRON, TOTAL	19422.99	MG/KG
			LEAD, TOTAL	10.35	MG/KG
			MAGNESIUM, TOTAL	19094.89	MG/KG
			MANGANESE, TOTAL	1165.66	MG/KG
			MERCURY, TOTAL	.13	MG/KG
			NICKEL, TOTAL	35.86	MG/KG
			POTASSIUM, TOTAL	468.71	MG/KG
			VANADIUM, TOTAL	18.74	MG/KG
			ZINC, TOTAL	44.22	MG/KG
07	FMP-PS-24-068	8705-426-0020	ALUMINUM, TOTAL	14636.47	MG/KG
			ARSENIC, TOTAL	7.06	MG/KG
			BARIUM, TOTAL	72.81	MG/KG
			BERYLLIUM, TOTAL	1.50	MG/KG
			CADMIUM, TOTAL	5.15	MG/KG
			CALCIUM, TOTAL	60526.34	MG/KG
			CHROMIUM, TOTAL	21.69	MG/KG
			COBALT, TOTAL	11.81	MG/KG
			COPPER, TOTAL	19.11	MG/KG
			IRON, TOTAL	23842.80	MG/KG
			LEAD, TOTAL	27.75	MG/KG
			MAGNESIUM, TOTAL	18361.10	MG/KG
			MANGANESE, TOTAL	687.36	MG/KG
			MERCURY, TOTAL	.13	MG/KG
			NICKEL, TOTAL	16.53	MG/KG
			POTASSIUM, TOTAL	1503.60	MG/KG

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TABLE C.3

IFAP/SF INORGANIC DATA SUMMARY

ehole mber	Sample Id	Batch Number	Parameter	Concentration	Unit Of Measure
07	FMP-PS-24-068	8705-426-0020	VANADIUM, TOTAL	29.64	MG/KG
			ZINC, TOTAL	67.01	MG/KG
08	FMP-PS-24-066	8705-426-0010	ALUMINUM, TOTAL	14433.12	MG/KG
			ARSENIC, TOTAL	5.05	MG/KG
			BARIUM, TOTAL	70.08	MG/KG
			CADMIUM, TOTAL	4.85	MG/KG
			CALCIUM, TOTAL	113966.13	MG/KG
			CHROMIUM, TOTAL	19.19	MG/KG
			COBALT, TOTAL	12.72	MG/KG
			COPPER, TOTAL	18.96	MG/KG
			IRON, TOTAL	18726.04	MG/KG
			LEAD, TOTAL	32.98	MG/KG
			MAGNESIUM, TOTAL	29953.35	MG/KG
			MANGANESE, TOTAL	564.37	MG/KG
			NICKEL, TOTAL	25.90	MG/KG
			POTASSIUM, TOTAL	1387.80	MG/KG
			SODIUM, TOTAL	138.78	MG/KG
			VANADIUM, TOTAL	31.91	MG/KG
			ZINC, TOTAL	58.98	MG/KG
)9	FMP-PS-24-095	8705-426-0030	ALUMINUM, TOTAL	7406.99	MG/KG
			ARSENIC, TOTAL	5.62	MG/KG
			CADMIUM, TOTAL	3.68	MG/KG
			CALCIUM, TOTAL	187187.03	MG/KG
			CHROMIUM, TOTAL	14.11	MG/KG
			COPPER, TOTAL	10.02	MG/KG
			IRON, TOTAL	14073.69	MG/KG
			LEAD, TOTAL	15.88	MG/KG
			MAGNESIUM, TOTAL	14674.92	MG/KG
			MANGANESE, TOTAL	441.72	MG/KG
			MERCURY, TOTAL	.15	MG/KG
			NICKEL, TOTAL	10.22	MG/KG
			POTASSIUM, TOTAL	818.00	MG/KG
			VANADIUM, TOTAL	19.42	MG/KG
			ZINC, TOTAL	42.53	MG/KG
)	FMP-PS-24-097	8705-426-0050	ALUMINUM, TOTAL	6958.84	MG/KG
			ARSENIC, TOTAL	31.17	MG/KG

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TABLE C.3

IFAP/SF INORGANIC DATA SUMMARY

·ehole ımber	Sample Id	Batch Number	Parameter	Concentration	Unit Of Measure
·10	FMP-PS-24-097	8705-426-0050	BARIUM, TOTAL	205.08	MG/KG
			BERYLLIUM, TOTAL	1.43	MG/KG
			CADMIUM, TOTAL	3.82	MG/KG
			CALCIUM, TOTAL	54215.80	MG/KG
			CHROMIUM, TOTAL	15.79	MG/KG
			COPPER, TOTAL	23.45	MG/KG
			IRON, TOTAL	14807.88	MG/KG
			LEAD, TOTAL	55.95	MG/KG
			MAGNESIUM, TOTAL	8523.86	MG/KG
			MANGANESE, TOTAL	780.11	MG/KG
			MERCURY, TOTAL	.26	MG/KG
			NICKEL, TOTAL	12.20	MG/KG
			POTASSIUM, TOTAL	1076.85	MG/KG
			SODIUM, TOTAL	167.51	MG/KG
			VANADIUM, TOTAL	26.32	MG/KG
			ZINC, TOTAL	46.42	MG/KG
11	FMP-PS-24-130	8705-466-0010	ALUMINUM, TOTAL	7557.77	MG/KG
			ARSENIC, TOTAL	10.76	MG/KG
			BARIUM, TOTAL	271.04	MG/KG
			CADMIUM, TOTAL	2.43	MG/KG
			CALCIUM, TOTAL	12069.71	MG/KG
			CHROMIUM, TOTAL	12.44	MG/KG
			COPPER, TOTAL	22.45	MG/KG
			IRON, TOTAL	7281.86	MG/KG
			LEAD, TOTAL	13.78	MG/KG
			MAGNESIUM, TOTAL	3305.51	MG/KG
			MANGANESE, TOTAL	238.04	MG/KG
			MERCURY, TOTAL	.15	MG/KG
			NICKEL, TOTAL	13.25	MG/KG
			SODIUM, TOTAL	189.35	MG/KG
			VANADIUM, TOTAL	29.48	MG/KG
			ZINC, TOTAL	36.24	MG/KG
12	FMP-PS-24-167	8705-466-0020	ALUMINUM, TOTAL	8156.77	MG/KG
			ARSENIC, TOTAL	5.91	MG/KG
			BARIUM, TOTAL	78.49	MG/KG
			CADMIUM, TOTAL	3.39	MG/KG
			CALCIUM, TOTAL	74419.80	MG/KG
			CHROMIUM, TOTAL	18.32	MG/KG

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TABLE C.3

IFAP/SF INORGANIC DATA SUMMARY

ehole mber	Sample Id	Batch Number	Parameter	Concentration	Unit Of Measure
12	FMP-PS-24-167	8705-466-0020	COPPER, TOTAL	11.76	MG/KG
			IRON, TOTAL	18828.88	MG/KG
			LEAD, TOTAL	16.67	MG/KG
			MAGNESIUM, TOTAL	19299.38	MG/KG
			MANGANESE, TOTAL	832.41	MG/KG
			MERCURY, TOTAL	.14	MG/KG
			NICKEL, TOTAL	14.02	MG/KG
			POTASSIUM, TOTAL	1017.90	MG/KG
			SODIUM, TOTAL	135.72	MG/KG
			VANADIUM, TOTAL	25.56	MG/KG
			ZINC, TOTAL	49.31	MG/KG

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TABLE C.4 HSL VOLATILES

Volatiles	CAS Number	Detection Limits* Low Water[a] ug/L	Low Soil/Sediment[b] ug/Kg
1. Chloromethane	74-87-3	10	10
2. Bromomethane	74-83-9	10	10
3. Vinyl Chloride	75-01-4	10	10
4. Chloroethane	75-00-3	10	10
5. Methylene Chloride	75-09-2	5	5
6. Acetone	67-64-1	10	10
7. Carbon Disulfide	75-15-0	5	5
8. 1,1-Dichloroethene	75-35-4	5	5
9. 1,1-Dichloroethane	75-35-3	5	5
10. trans-1,2-Dichloroethene	156-60-5	5	5
11. Chloroform	67-66-3	5	5
12. 1,2-Dichloroethane	107-06-2	5	5
13. 2-Butanone	78-93-3	10	10
14. 1,1,1-Trichloroethane	71-55-6	5	5
15. Carbon Tetrachloride	56-23-5	5	5
16. Vinyl Acetate	108-05-4	10	10
17. Bromodichloromethane	75-27-4	5	5
18. 1,1,2,2-Tetrachloroethane	79-34-5	5	5
19. 1,2-Dichloropropane	78-87-5	5	5
20. trans-1,3-Dichloropropene	10061-02-6	5	5
21. Trichloroethene	79-01-6	5	5
22. Dibromochloromethane	124-48-1	5	5
23. 1,1,2-Trichloroethane	79-00-5	5	5
24. Benzene	71-43-2	5	5
25. cis-1,3-Dichloropropene	10061-01-5	5	5
26. 2-Chloroethyl Vinyl Ether	110-75-8	10	10
27. Bromoform	75-25-2	5	5
28. 2-Hexanone	591-78-6	10	10
29. 4-Methyl-2-pentanone	108-10-1	10	10
30. Tetrachloroethene	127-18-4	5	5
31. Toluene	108-88-3	5	5
32. Chlorobenzene	108-90-7	5	5
33. Ethyl Benzene	100-41-4	5	5
34. Styrene	100-42-5	5	5
35. Total Xylenes		5	5

[a]Medium Water Contract Required Detection Limits (CRDL) for Volatile HSL Compounds are 100 times the individual Low Water CRDL.

[b]Medium Soil/Sediment Contract Required Detection Limits (CRDL) for Volatile HSL Compounds are 100 times the individual Low Soil/Sediment CRDL.

TABLE C.5 HSL SEMI-VOLATILES

Semi-Volatiles	CAS Number	Detection Limits[b] Low Water[c] ug/L	Low Soil/Sediment[d] ug/Kg
36. Phenol	108-95-2	10	330
37. bis(2-Chloroethyl) ether	111-44-4	10	330
38. 2-Chlorophenol	95-57-8	10	330
39. 1,3-Dichlorobenzene	541-73-1	10	330
40. 1,4-Dichlorobenzene	106-46-7	10	330
41. Benzyl Alcohol	100-51-6	10	330
42. 1,2-Dichlorobenzene	95-50-1	10	330
43. 2-Methylphenol	95-48-7	10	330
44. bis(2-Chloroisopropyl) ether	39638-32-9	10	330
45. 4-Methylphenol	106-44-5	10	330
46. N-Nitroso-Dipropylamine	621-64-7	10	330
47. Hexachloroethane	67-72-1	10	330
48. Nitrobenzene	98-95-3	10	330
49. Isophorone	78-59-1	10	330
50. 2-Nitrophenol	88-75-5	10	330
51. 2,4-Dimethylphenol	105-67-9	10	330
52. Benzoic Acid	65-85-0	50	1600
53. bis(2-Chloroethoxy) methane	111-91-1	10	330
54. 2,4-Dichlorophenol	120-83-2	10	330
55. 1,2,4-Trichlorobenzene	120-82-1	10	330
56. Naphthalene	91-20-3	10	330
57. 4-Chloroaniline	106-47-8	10	330
58. Hexachlorobutadiene	87-68-3	10	330
59. 4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
60. 2-Methylnaphthalene	91-57-6	10	330
61. Hexachlorocyclopentadiene	77-47-4	10	330
62. 2,4,6-Trichlorophenol	88-06-2	10	330
63. 2,4,5-Trichlorophenol	95-95-4	50	1600
64. 2-Chloronaphthalene	91-58-7	10	330
65. 2-Nitroaniline	88-74-4	50	1600
66. Dimethyl Phthalate	131-11-3	10	330
67. Acenaphthylene	208-96-8	10	330
68. 3-Nitroaniline	99-09-2	50	1600
69. Acenaphthene	83-32-9	10	330
70. 2,4-Dinitrophenol	51-28-5	50	1600
71. 4-Nitrophenol	100-02-7	50	1600
72. Dibenzofuran	132-64-9	10	330
73. 2,4-Dinitrotoluene	121-14-2	10	330
74. 2,6-Dinitrotoluene	606-20-2	10	330
75. Diethylphthalate	84-66-2	10	330
76. 4-Chlorophenyl Phenyl ether	7005-72-3	10	330
77. Fluorene	86-73-7	10	330
78. 4-Nitroaniline	100-01-6	50	1600
79. 4,6-Dinitro-2-methylphenol	534-52-1	50	1600
80. N-Nitrosodiphenylamine	86-30-6	10	330
81. 4-Bromophenyl Phenyl ether	101-55-3	10	330
82. Hexachlorobenzene	118-74-1	10	330
83. Pentachlorophenol	87-86-5	50	1600
84. Phenanthrene	85-01-8	10	330
85. Anthracene	120-12-7	10	330
86. Di-n-butylphthalate	84-74-2	10	330
87. Fluoranthene	206-44-0	10	330
88. Pyrene	129-00-0	10	330
89. Butyl Benzyl Phthalate	85-68-7	10	330
90. 3,3'-Dichlorobenzidine	91-94-1	20	660
91. Benzo(a)anthracene	56-55-3	10	330
92. bis(2-ethylhexyl)phthalate	117-81-7	10	330
93. Chrysene	218-01-9	10	330
94. Di-n-octyl Phthalate	117-84-0	10	330
95. Benzo(b)fluoranthene	205-99-2	10	330
96. Benzo(k)fluoranthene	207-08-9	10	330
97. Benzo(a)pyrene	50-32-8	10	330
98. Indeno(1,2,3-cd)pyrene	193-39-5	10	330
99. Dibenz(a,h)anthracene	53-70-3	10	330
100. Benzo(g,h,i)perylene	191-24-2	10	330

[c] Medium Water Contract Required Detection Limits (CRDL) for Semi-Volatile HSL Compounds are 100 times the individual Low Water CRDL.

[d] Medium Soil/Sediment Contract Required Detection Limits (CRDL) for Semi-Volatile HSL Compounds are 60 times the individual Low Soil/Sediment CRDL.

TABLE C.6 HSL PESTICIDES

Pesticides	CAS Number	Detection Limits* Low Water[e] ug/L	Low Soil/Sediment[f] ug/Kg
101. alpha-BHC	319-84-6	0.05	8.0
102. beta-BHC	319-85-7	0.05	8.0
103. delta-BHC	319-86-8	0.05	8.0
104. gamma-BHC (Lindane)	58-89-9	0.05	8.0
105. Heptachlor	76-44-8	0.05	8.0
106. Aldrin	309-00-2	0.05	8.0
107. Heptachlor Epoxide	1024-57-3	0.05	8.0
108. Endosulfan I	959-98-8	0.05	8.0
109. Dieldrin	60-57-1	0.10	16.0
110. 4,4'-DDE	72-55-9	0.10	16.0
111. Endrin	72-20-8	0.10	16.0
112. Endosulfan II	33213-65-9	0.10	16.0
113. 4,4'-DDD	72-54-8	0.10	16.0
114. Endosulfan Sulfate	1031-07-8	0.10	16.0
115. 4,4'-DDT	50-29-3	0.10	16.0
116. Endrin Ketone	53494-70-5	0.10	16.0
117. Methoxychlor	72-43-5	0.5	80.0
118. Chlordane	57-74-9	0.5	80.0
119. Toxaphene	8001-35-2	1.0	160.0
120. AROCLOR-1016	12674-11-2	0.5	80.0
121. AROCLOR-1221	11104-28-2	0.5	80.0
122. AROCLOR-1232	11141-16-5	0.5	80.0
123. AROCLOR-1242	53469-21-9	0.5	80.0
124. AROCLOR-1248	12672-29-6	0.5	80.0
125. AROCLOR-1254	11097-69-1	1.0	160.0
126. AROCLOR-1260	11096-82-5	1.0	160.0

[e]Medium Water Contract Required Detection Limits (CRDL) for Pesticide HSL Compounds are 100 times the individual Low Water CRDL.

[f]Medium Soil/Sediment Contract Required Detection Limits (CRDL) for Pesticide HSL compounds are 15 times the individual Low Soil/Sediment CRDL.

*Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, as required by the contract, will be higher.

TABLE C.7 HSL INORGANICS

Analyte	Contract Required Detection Limit (ug/L)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	5
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

APPENDIX D

D.1 Environmental Exposure to Airborne Contaminants

Average concentrations of the principle radionuclides at air sample locations AMS 4, 5, and 6 are compared below to concentrations in DOE Order 5400.5, which are modelled to estimate an annual maximum committed effective dose equivalent (CEDE) of 100 mREm/yr. The derived CEDE's are as shown.

Isotope	Avg. Airborne Concentrations (uCi/ml)	5400.5 DCG (uCi/ml)	CEDE (mRem/yr)
Ra-226	8.3E-18	1.0E-12	8.3E-04
Th-228	< 9.7E-18	4.0E-14	< 2.4E-02
Th-230	< 9.1E-18	5.0E-14	< 1.8E-02
Th-232	< 9.1E-18	1.0E-14	< 9.1E-02
U-234	7.9E-17	9.0E-14	8.8E-02
U-235	4.8E-18	1.0E-13	4.8E-03
U-238	1.2E-16	1.0E-13	1.2E-01
			< 3.5E-01

The calculated risk coefficient for all cancer incidence (including non-fatal cancer) is 125E-06 per Rem. If one uses the above combined CEDE value of .33 mRem/yr, the 10 year cancer risk becomes

(0.35 mRem/yr) x (10 yr) x (1.25E-07/mRem) < 4.4E-07.

D.2 Inhalation Exposure

The 1989 Environmental Monitoring Report gave environmental air sample concentration averages for airborne dust at approximately 35 ug/m^3 ; this estimate is based upon relatively dusty conditions. Using a RES RAD default value of 200 ug/m^3 , airborne concentrations can be estimated by the following equation:

$$(X \text{ pCi/g soil}) \times (200 \text{ ug/m}^3) \times (10^{-6} \text{ g/ug}) \times (10^{-6}\text{m}^3\text{/ml}) \times (10^{-6}\text{uCi/pCi}) = \text{uCi/ml airborne}$$

or:

$$(X \text{ pCi/g soil}) \times (2 \times 10^{-16}) = \text{uCi/ml airborne}$$

Based upon average soil sample concentrations for the Inactive Fly Ash Pile/Southfield the following values are obtained:

Isotope	Soil (pCi/g)	Airborne (uCi/ml)
Ra-226	51.0	1.0E-14
Th-228	3.4	6.8E-16
Th-230	29.0	5.8E-15
Th-232	3.6	7.2E-16
U-234	1040.3	2.1E-13
U-235	175.4	3.5E-14
U-238	856.2	1.7E-13

These concentrations can be compared to DOE values in DOE Order 5400.5, which gives the following derived CEDE's:

Isotopes	Estimated Airborne (uCi/ml)	5400.5 DCG (uCi/ml)	CEDE (mRem/yr)
Ra-226	1.0E-13	1.0E-12	10.0
Th-228	6.8E-16	4.0E-14	1.7
Th-230	5.8E-15	5.0E-14	11.6
Th-232	7.2E-16	1.0E-14	7.2
U-234	2.1E-13	9.0E-14	233.0
U-235	3.5E-14	1.0E-13	35.0
U-238	1.7E-13	1.0E-13	170.0
			468.5

Using the same risk basis as in C.1, the following value for a 10 year cancer risk is obtained:

$$(469 \text{ mRem}) \times (10 \text{ yr}) \times (1.25 \times 10^{-7}/\text{mRem}) < 5.8\text{E-}04.$$

D.3 External Exposure

To assess this exposure path, the RES RAD model is used with a 60 percent occupancy factor. Using the RES RAD dose conversion factors (DCF), and assuming a soil density of 1.8 g/cm^3, will give the following:

Isotope	Avg. Soil Concent. (pCi/g)	Volume Concent. (pCi/cm^3)	DCF mRem/yr per (pCi/cm^3)	CEDE (mem/yr)
Ra-226	51.0	91.4	8.6	472.0
Th-228	3.4	6.1	7.4	26.8
Th-230	29.0	52.3	1.0E-03	0.032
Th-232	3.6	6.5	6.0E-04	0.023
U-234	1040.0	1872.0	7.0E-04	0.78
U-235	175.0	315.0	4.9E-01	92.6
U-238	856.0	154.0	7.0E-02	64.4
				656.6

Based upon the estimate of 657 mRem/yr, and the prior method, the cancer risk becomes;

$$(657 \text{ mRem/yr}) \times (10 \text{ yrs}) \times (1.25 \times 10^{-7}/\text{mRem}) = 8.1\text{E-}04.$$