6163 U-004-408 .10

TRANSMITTAL OF FINAL COMMENT RESPONSES ON THE OPERABLE UNIT 2 REMEDIAL INVESTIGATION

11/10/94

DOE-0184-95
DOE-FN EPAS
~~30~~ 24
RESPONSES

Department of Energy
Fernald Environmental Management Project
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6163

NOV 10 1994

DOE-0184-95

Mr. James A. Saric, Remedial Project Manager
U.S. Environmental Protection Agency
Region V - 5HRE-8J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Mr. Thomas P. Schneider
Ohio Environmental Protection Agency
40 South Main Street
Dayton, Ohio 45402-2086

Dear Mr. Saric and Mr. Schneider:

TRANSMITTAL OF FINAL COMMENT RESPONSES ON THE OPERABLE UNIT 2 REMEDIAL INVESTIGATION

This letter transmits the Operable Unit 2 (OU2) final comment responses and actions on the OU2 Remedial Investigation (RI) Report for your review and approval. The report has been revised according to the comments received from the United States Environmental Protection Agency dated October 5, 1994.

The RI comment responses contain complete responses to the comments received, including any tables or text which required modifications. The enclosed, changed pages contain underlined and strikeout text to delineate modifications made to the report as a result of the October 5, 1994 comment letter.

If you have any questions, please contact Rod Warner of my staff at (513) 648-3156.

Sincerely,

Wayne Pasko

for Jack R. Craig
Fernald Remedial Action
Project Manager

FN:Hall

Enclosure: As Stated

Recycled and Recyclable

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COMMENT/RESPONSE DOCUMENT
FOR OPERABLE UNIT 2 REMEDIAL INVESTIGATION

1. Commenting Organization: U.S. EPA Commentor: Saric
Section #: 4.0 Page #: NA Line #: NA Code:
Original Comment #: 8 (Original General Comment #5)
Comment: The original comment requests that additional information be provided in each subunit summary section. Additional revision or clarification is required for the following three subunits:

a) Lime Sludge Ponds: The summary should also mention that channelized drainage exists at the northern edge of the lime sludge ponds as noted on Page 4-128, Line 38, of the June 1994 operable unit (OU) 2 remedial investigation (RI) report.

b) Inactive Flyash Pile: Page 4-249, Line 29, should be deleted from the summary text of the June 1994 OU2 RI report.

c) Active Flyash Pile: The conclusion regarding the detection of metals and organic contamination in shallow groundwater was deleted from the revised text. the revised text should include this conclusion.

d) Also, the text should be revised to state that thorium, a radionuclide, was detected above background in perched groundwater.

e) Finally, the conclusion regarding the conceptual model should be moved from Section 4.0 to Section 6.0.

Response: Agreed, the text will be modified.
Action: The following text was modified on:

a) page 4-170, line 24, the following sentence was added to end of the paragraph:

"<u>The only drainage in the subunit battery limits is a channelized ditch at the north edge of the battery limits</u>."

b) page 4-249, line 29, sixth bulleted item was deleted.

c) page 4-397, line 35, replace fifth bulleted item with the following text:

"<u>Metals and organic compounds detected in flyash and soil samples were not detected in shallow groundwater. This suggests that these constituents detected in shallow groundwater are a result of upgradient contamination in the South Field</u>."

d) page 4-398, line 8, the following changes were made:

"...235/236, ~~and~~ uranium-238<u>, and thorium-232.</u>"

e) page 4-398, line 10, the following text was modified:

"• Based on the ~~conceptual~~ perched groundwater flow directions determined from groundwater elevation contouring ~~model of flow and constituent transport~~ in the area of the Active Flyash Pile and South Field, and contaminants detected, perched groundwater quality near the Active Flyash Pile seems to be impacted by the South Field and not the Active Flyash Pile."

2. Commenting Organization: U.S. EPA Commentor: Saric
Section #: A.2 Page #: NA Line #: NA Code:
Original Comment #: 9 (Original General Comment #12)

Comment: The original comment requested that the U.S. Department of Energy (U.S. DOE) compare modeled groundwater concentrations with actual measured concentrations in the Great Miami Aquifer (GMA) so that an evaluation of the model calibration could be performed. U.S. DOE performed the comparison on a single well, adjusted the desorption coefficient (K_d) value, and modeled a groundwater concentration deviating (on the low side) from observed concentrations by a factor of five. The issue of groundwater model calibration has not been fully addressed. It appears that the groundwater model calibration is not complete both in terms of the number of cells calibrated and the calibration targets used. These issues need to be further addressed.

Response: Calibration of the Great Miami Aquifer fate and transport model is a two step process. The first step is the calibration of the hydraulics of the aquifer. This part of calibration is discussed in the OU5 RI report. The second step involves calibration of the model against chemical specific data. This second step of calibration has been carried out by OU2 and OU5. The OU5 calibration was more extensive and will be reported in the OU5 RI Report. The OU2 calibration involved calibration against one target well and general trend match against the uranium-238 plume in the Great Miami Aquifer. For uranium-238, CRU5's calibration of SWIFT and CRU2's calibration resulted in identical set of parameters.

Action: No action in the OU2 RI Report.

3. Commenting Organization: U.S. EPA Commentor: Saric
Section #: 4.2.4 Page #: 4-71 Line #: 22 and 23 Code:
Original Comment #: 14 (Original Specific Comment #4)

Comment: According to Table 4-1A of the June 1994 OU2 RI report, the total uranium background concentration for the GMA is 2.0 micrograms per liter (μg/L). Well 2027 is upgradient of the solid waste landfill, and Wells 2951, 2037, and 2947 are downgradient. According to Table 4-13, Well 2037 has a total uranium concentration of 4.5 μg/L. These facts support the conclusion that the upper GMA has been impacted by total uranium from the solid waste landfill within the OU limits. U.S. DOE should therefore revise its conclusion that the upper GMA has not been impacted by the solid waste landfill.

Response: Monitoring Well 2027 is an upgradient monitoring well that is potentially affected by the Waste Pit Area. All of the monitoring wells downgradient of the Solid Waste Landfill had lower concentrations of uranium than well 2027. Downgradient concentrations were close to background, and the slight elevation of concentrations in wells 2037 and 2052 are considered to be related to contamination detected in well 2027, not related to the Solid Waste Landfill.

At this time, DOE feels that the upgradient contamination is the cause of the slightly elevated uranium concentrations in wells 2037 and 2052, and that no significant impact has been observed on the Great Miami Aquifer from the Solid Waste Landfill. Uranium contamination has been documented in the Great Miami Aquifer emanating from the Waste Pit Area, and Operable Unit 5 is responsible for remedial actions related to the Great Miami Aquifer in this area.

Action: Well 2027 will be correctly placed under the upgradient category in Table 4-13.

4. Commenting Organization: U.S. EPA Commentor: Saric
Section #: A.2.8.2.1 Page #: A-2-135 Line #: NA Code:
Original Comment #: 20 (Original Specific Comment #82)

Comment: The original comment requests a discussion and justification of why lead, radium-226, and radium-228 are not included in the groundwater fate and transport modeling. This comment has not been addressed. U.S. DOE should address this issue.

Response: Table A.-14 provides the footnotes why lead, radium-226, and radium-228 will not be included for groundwater fate and transport modeling from the surface water pathway. Lead was not included for further modeling because RAGs Part B screening concentrations could not be calculated. Radium-226 and radium-228 screened out in the second screening step for surface water pathway which uses dilution in the full SWIFT cell.

Action: Insert the following sentence line 32, page A-2-127 (section A.2.8.2.1):

"Note that tables A.2-47 and A.2-48 provides CPC loading to the Great Miami Aquifer from surface water pathway for the CPCs passing all the screening steps and require detail modeling (see Table A.1-14).

5. Commenting Organization: U.S. EPA Commentor: Saric
Section #: 4.3.2 Page #: 4-127 Line #: 23 and 24 Code:
Original Comment #: 31 (New Specific Comment #11)

Comment: U.S. DOE's discussion of the lime sludge ponds still does not include lime sludge as a potential source of subsurface contamination and instead identifies other sources. U.S. DOE should clearly state that the lime sludge is also a potential source of subsurface contamination.

Response: Agreed. The Lime Sludge Ponds may be a potential source to subsurface soils.

Action: The following text was added to page 4-127, line 30:

"The Lime Sludge Pond is also a potential source to the subsurface soils."

6. Commenting Organization: U.S. EPA Commentor: Saric
Section #: 6.2.1 Page #: 6-5 Line #: NA Code:
Original Comment #: 49

Comment: The original comment requests that the off-property farmer be added to Table 6-1. Table 6-1 still omits the off-property farmer. The off-property farmer should be added to Table 6-1.

Response: The off-property farmer was added to Table 6-1; however, a typing error placed it in the wrong section. The table will be corrected.

Action: Table 6-1 was revised. See changed Table 6-1.

7. Commenting Organization: U.S. EPA Commentor: Saric
Section #: B.3.2.4.3 Page #: B-3-134 Line #: NA Code:
Original Comment #: 62 (New Specific Comment #14)
Comment: The revised text erroneously cites thorium-228 instead of thorium-232, as stated in the original comment. The text should be corrected to cite thorium-232.
Response: Agreed.
Action: The following text was modified on page B-3-47, line 10:

change "thorium-228" to "thorium-232."

TABLE 4-13

TOTAL URANIUM IN SAMPLES COLLECTED DURING PHASE II
FROM WELLS IN THE SOLID WASTE LANDFILL
OPERABLE UNIT 2 REMEDIAL INVESTIGATION
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

1000-SERIES WELLS

Well and Location	Date	Sample		Total Uranium (μg/L)
UPGRADIENT				
1035 (north) Located upgradient outside of waste unit completed within sand lense in till	5/5/93	111554	on-site analysis	2.3
		111555	on-site analysis	2.3
		111553	off-site analysis	2.55
1947 (east) Located upgradient from waste unit	4/28/93	111650	on-site analysis	10
	7/28/93	120488	on-site analysis	11
DOWNGRADIENT				
1038 (south) located directly downgradient of waste unit completed in sand unit	5/5/93	111550	on-site analysis	5.0
		111551	on-site analysis	4.7
		111548	off-site analysis	4.11
		111549	off-site analysis	4.95
1950 (west) Located downgradient from north end of waste unit completed in sand unit within till	6/8/93	115485	on-site analysis	21
		115480	off-site analysis	7.67
1952 (south) Located directly downgradient of waste unit. Completed in till unit above sand lense	5/15/93	115469	on-site analysis	23
		115468	off-site analysis	15.8
		115471	off-site analysis	55.8

TABLE 4-13
(Continued)

2000-SERIES WELLS

Well and Location	Date	Sample		Total Uranium (μg/L)
UPGRADIENT				
2027 (southwest) Located adjacent to a waste pond near Operable Unit 1	4/23/93	111544	on-site analysis	11
		111543	off-site analysis	9.15
2949 (north) Located upgradient of waste unit	4/17/93	111490	on-site analysis	0.4
		115479	off-site analysis	0.378
2951 (west) Located upgradient of waste unit	5/1/93	111538	on-site analysis	0.8
		115478	off-site analysis	0.781
		111536	off-site analysis	1.08
DOWNGRADIENT				
~~2027 (southwest) Located adjacent to a waste pond near Operable Unit 1~~	~~4/23/93~~	~~111544~~	~~on-site analysis~~	~~11~~
		~~111543~~	~~off-site analysis~~	~~9.15~~
2037 (east) Located within waste unit	4/22/93	111541	on-site analysis	4.6
		111540	off-site analysis	4.5
2052 (northeast) Located cross-gradient and approximately 300 feet northeast from waste unit	4/29/93	111547	on-site analysis	4.7
		111546	off-site analysis	3.45
2947 (east) Located downgradient of waste unit	5/19/93	111573	on-site analysis	0.5
		115474	on-site analysis	0.5
2953 (south) Located downgradient of waste unit	6/23/93	115490	on-site analysis	1.1
		115488	off-site analysis	1.23

Comment No. 4-74, 4

contaminated prior to and after the excavation of the lime sludge ponds and then the lime sludge was
No. 30 disposed of on top of the contaminated soil. ***However, contamination or additional contamination to the soil below the lime sludge may have occurred from the leaching of the lime sludge.***

A comparison of the Phase I and Phase II subsurface soil results with the CIS profile sample results (Appendix D-16B) indicates the radionuclide parameters detected during the CIS were also detected in Phase I and Phase II and were within the same order of magnitude.

Two volatile organic compounds, acetone and toluene, were detected in surface and subsurface soil samples. These are believed to be laboratory induced contaminants since they are detected at random depths and locations. Trace levels of 2-butanone were detected in two borings. This volatile is a common lab contaminant and also believed to be a lab contaminant in this case since it was detected in soil underlying the pond in Boring No. 1963 but not in overlying material. Trace concentrations of 1,1-dichloroethane (5 μg/kg) and methylene chloride (31 μg/kg) were detected in Boring Nos. 1959 and 1958, respectively.

Eight semivolatile organics were detected in subsurface samples. All were detected two times or less except for di-n-butyl phthalate and bis(2-Ethylhexyl)phthalate. Detected concentrations of these compounds are summarized in Table 4-20. Concentrations and sample depth do not appear to be correlated and this indicates that the compound is integrated into the sludge, underlying soil, and berm materials. In contrast to the 18 organic compounds detected in surface samples, eight compounds were detected in subsurface samples. Five compounds (anthracene, phenanthrene, fluoranthene, pyrene, and n-nitrosodimetlylamine) were detected once in samples from the north edge of the north pond, the west berm, and the exploratory trench dug parallel to the K-65 trench. This indicates that these areas are a possible source for the organic compounds detected in sludge samples.
No. 31 ***Contamination increased with depth in locations 1947, 1961, 1962, and 1963. The berms were constructed prior to lime sludge disposal. If the berms were constructed of contaminated material, then it is likely that surface water ran off into the ponds from the contaminated berms, causing contamination at depth due to leaching. Also, as time went on, the levels of berm surface***
No. 5 ***contamination decreased due to this run-off.*** The Lime Sludge Pond is also a potential source to the subsurface soils.

- Chloride concentrations are similar in upgradient Well 2939 (26.86 mg/L) and downgradient Well 2935 (23 mg/L) and Well 2042 (18.82 mg/L). This indicates that no impacts are present from the Lime Sludge Ponds.

- Isotopes of neptunium and plutonium were detected above background (which was 0.00 pCi/L) in water samples from all of the wells. Isotopes of uranium were detected above background (2.71 μg/L) in all three downgradient wells (2042, 2935, and 2936). The background value for total uranium (2.92 μg/L) was exceeded slightly in Well 2042 (3.39 μg/L) and Well 2935 (2.86 μg/L). These data do not indicate an impact from the waste unit upon the regional groundwater.

4.3.5 Biota

No. 4-10 ~~Impacts of the Lime Sludge Ponds upon biota will be discussed in the Operable Unit 5 Remedial Investigation Report.~~ The ecological impacts from material left after remediation will be addressed in the Site-Wide Ecological Risk Assessment that will be prepared as part of the Operable Unit 5 RI/FS.

4.3.6 Summary

The following conclusions concerning the Lime Sludge Ponds are possible:

No. 27 - *There are no perennial sources of running surface water within the battery limits of the Lime Sludge Ponds. Precipitation remains in the ponds since they are contained. the only source of surface water runoff is the steep outside berms of the south pond, and since the surface area of the berms is small and has a vegetative cover, the runoff is minimal and runs off in sheet flow.* **The only drainage in the subunit battery limits is a channelized ditch at the north edge of the battery limits.** (No. 1)

- The surface soil COCs detected above surface soil background were cesium-137, radium-226, radium-228, thorium-228, thorium-230, thorium-232, total uranium, and arsenic. (No. 4-4)

- ~~Sludge~~ Subsurface samples (including lime sludge and soil) contained trace amounts of organic compounds including six volatile ~~organic~~ and eight semivolatile organic compounds. With the exception of phenol in Phase I and bis(2-ethylhexyl)phthalate in Phase II (which are common laboratory contaminants), organic compounds ~~detected in soil~~ were not detected in samples of perched groundwater, indicating that organics have not leached from the sludge to the perched groundwater ~~these compounds are not leaching from the sludge~~. (No. 4-4, 4-22, 4-84)

- The surface soil COCs~~, arsenic, beryllium,~~ cesium-*137*, ~~neptunium,~~ radium-*226, radium-228*, thorium-*228, thorium-230, thorium-232, uranium-238* , and *total* uranium were detected above background in the subsurface samples. Other radionuclides detected above background were plutonium, strontium, and technetium. (No. 4-4, 27)

- Chemical and radiological samples indicate that the sludge, the roadway, and the berm materials have different ~~characteristics~~ constituents and concentrations and are ~~thus~~ considered distinct waste materials. (No. 4-4, 4-24)

No. 4-4, 4-24, 4-87

- Samples collected from sludge and underlying soil indicate that the underlying soil has higher ~~values~~ concentrations than the sludge for most constituents. ~~This means that future impacts of the sludge upon the soil are not likely.~~

No. 27

No. 4-4

- In perched groundwater, the surface soil COCs ~~neptunium,~~ radium-*226*, thorium-*228*, *thorium-230, thorium-232, uranium-238*, and uranium *total* were detected above background. An additional radionuclide, strontium-90, was also

No. 4-4

- The surface soil analytical results do not suggest a pattern of surface disposal at one location in the Inactive Flyash Pile with subsequent surface spreading; a more likely scenario is the disposal of waste took place throughout the Inactive Flyash Pile.

No. 4-4, 4-31, *16*

- There are indications from field observations that elevated concentrations of uranium exist in the surface water from the drainage west of the Inactive Flyash Pile, and is contributing to the recharge of the ~~aquifer~~ *Great Miami Aquifer*.

No. 4-4 4-32

- Semivolatile compounds were detected in trace concentrations in the drainage west of the Inactive Flyash Pile. Of these, four were detected in the downstream sediment sample in Paddys Run and not in the upstream sediment sample. This suggests that the Inactive Flyash Pile may be impacting Paddys Run. Furthermore, there were additional semivolatiles detected in the downstream sediment sample which were not detected in the upstream sample, giving further credence to the Inactive Flyash Pile's impact on Paddys Run.

- Waste materials identified in samples collected from soil borings in the subunit included localized sludge-like material, clay tile drain pipe, wood, nails, wire, construction debris, and flyash. The recovered materials from the borings, except the flyash, produced elevated field measured radioactivity by an alpha-beta meter. These elevated/readings may be due to the materials having been associated with or in contact and/or cross contaminated with process materials or waste.

No. 4-4, *27*

- The subsurface soils had the surface soil COCs arsenic, ~~beryllium, cesium, neptunium,~~ radium-*228*, thorium-*228*, *thorium-232*, ~~uranium (also a cross media groundwater COC),~~ and dibenzo(a,h)anthracene. Other radionuclides detected above background were lead-210, plutonium, ruthenium, strontium, and technetium.

No. 1

- ~~The flyash generally had lower concentrations of constituents than the fill material.~~

- Identifiable waste materials appear to be resting on or near the interface of flyash and glacial overburden near the center of the Inactive Flyash Pile.

- Flyash and fill are in contact with the Great Miami Aquifer in the western and southern portions under the Inactive Flyash Pile.

- The highest concentrations of Aroclor-1254 and total uranium were found associated with the trace of a buried drainage that existed before the Inactive Flyash Pile was developed.

No. 4-4 4-34

- The occurrence of uranium ~~in groundwater~~ in the perched groundwater ~~system~~ appears to be related to waste materials ~~buried~~ within the pile or close to it since upgradient Hydropunch™ ~~data (from Hydropunch™~~ 11047 ~~and 11010)~~ and upgradient Well 1047 data ~~do not detect uranium~~ have uranium concentrations close to background and two orders of magnitude lower than downgradient Hydropunch™ concentrations.

No. 4-35

- Seepage in the drainage to the west may be associated with the perched groundwater. The correlation can be made that the total uranium concentrations from the Hydropunch™ samples upgradient of the seepage were of the same order of magnitude as that collected

4.6.5 Biota

No. 4-10 ~~Impacts from the Active Flyash Pile are not addressed in the Operable Unit 2 RI because it is likely to be remediated. A Site-wide Ecological Risk Assessment will be prepared as part of the Operable Unit 5 RI/FS to address areas not likely to be remediated.~~ The ecological impacts from material left after remediation will be addressed in the Site-Wide Ecological Risk Assessment that will be prepared as part of the Operable Unit 5 RI/FS.

4.6.6 Active Flyash Summary

Data from environmental samples collected from soil and water media in the Active Flyash Pile indicate the following:

No. 4-4 4-50
- Flyash contains elevated concentrations of metals, radionuclides, and organic compounds when compared to background concentrations for soil. When compared to background for flyash, radium, thorium, and uranium ~~two metals, five radionuclides, and nine organic compounds~~ exceeded background levels. However, it should be noted that the FEMP flyash contains approximately 70 percent bottom ash; therefore, analytical results may be skewed higher.

No. 4-4 4-51
- ~~Flyash contains elevated concentrations of VOCs when compared to literature derived background concentrations for flyash.~~ There are no background concentrations for VOCs in flyash; however VOCs were detected in flyash samples from the Active Flyash Pile. This ~~fact~~ suggests that VOCs may have been disposed of as an additional waste material in the subunit.

No. 4-4, *8, 27*
- The surface soil COCs detected above background in subsurface soils, both source and nonsource, are arsenic, beryllium, *lead-210,* neptunium-*237*, radium-*226, radium-228*, thorium-*228 and thorium-232*~~, and uranium (also a cross media groundwater COC)~~. Other radionuclides detected above background were lead-210, strontium, and plutonium.

No. 4-4 4-118
- Concentrations of organic compounds decrease ~~with depth~~ below the flyash/soil interface, from approximately 10 to 17 feet deep ~~in the flyash pile~~. This ~~fact~~ suggests that the organic contamination is related to surface activities after the pile was approximately half-way constructed.

No. 4-4 No. 1
- ~~Metals and organic compounds detected in flyash and soil samples were not detected in shallow groundwater. This suggests that these constituents have not impacted groundwater.~~ Metals and organic compounds detected in flyash and soil samples were not detected in shallow groundwater. This suggests that these constitutents detected in shallow groundwater are a result of upgradient contamination in the South Field.

No. 4-4
- Chemical and radiological constituents detected in sediment samples are similar to those detected in surface and subsurface flyash samples. This suggests that the origin for sediment in the subunit is the flyash and that there has been an impact from the subunit on sediment. The surface soil COCs detected above background in the sediment are arsenic,

No. 27 beryllium *and* neptunium~~, and uranium (also a cross-media groundwater COC)~~. An additional radionuclide, plutonium, was also detected above background.

- The levels of radionuclides in surface flyash, subsurface flyash and sediment appears to vary within a narrow range. This suggests that the source for the radionuclides is the flyash.

No. 4-4, 27,1

- In the perched groundwater, the surface soil COCs detected above background were neptunium-*237* ~~and uranium (also a cross media groundwater COC)~~. Other radionuclides detected above background were plutonium-*238*, ~~and~~ strontium-*90, uranium-234, uranium-235/236,* ~~and~~ *uranium-238* and thorium-232.

No. 4-4 1

- Based on the ~~conceptual~~ perched groundwater flow directions determined from groundwater elevation contouring ~~model of flow and constituent transport~~ in the area of the Active Flyash Pile and South Field, and contaminants detected, perched groundwater quality near the Active Flyash Pile seems to be impacted by the South Field and not the Active Flyash Pile.

No. 4-4

- ~~Groundwater in the 2000 series wells has elevated concentrations of radionuclides with respect to background groundwater.~~ The surface soil COCs above background for the 2000-series wells in the Great Miami Aquifer are thorium-*232 and thorium-228.* ~~and uranium (also a cross media groundwater COC). An~~ Additional radionuclide*s radium-226, uranium-234, uranium-235/236, and uranium-238 were detected above background.* ~~plutonium, was also detected above background. The contaminant source is believed to be~~ Due to the proximity of the wells to the South Field, these contaminants are possibly due to the recharge originating in the South Field.

TABLE 6-1

GENERIC DESCRIPTION OF EXPOSURE SCENARIOS AND EXPOSURE POINT CONCENTRATIONS OPERABLE UNIT 2 BASELINE RISK ASSESSMENT

Current Land Use	Receptor	Direct Contact Medium	Route of Exposure		Exposure Point Concentration
Current with Access Controls (current use of FEMP continues, DOE ownership)	Trespassing Youth	surface soil	incidental ingestion dermal contact external radiation		surface soil within subunit
		air	inhalation	particulates, volatiles, and gases	maximum estimated on-subunit current concentration derived from air modeling
		surface water	incidental ingestion dermal contact		surface water within subunit
		sediment	incidental ingestion dermal contact external radiation		sediment within subunit
	Off-Property Resident Farmer (adult and child), homegrown produce off-property, livestock grazing off-property	air	inhalation	particulates, volatiles, and gases	maximum estimated off-property current concentrations derived from air modeling
		plants (homegrown produce)	ingestion	fruits and vegetables	maximum estimated off-property current concentrations derived from air modeling
		livestock (grazing off-property)	ingestion	milk beef	maximum estimated off-property current concentrations derived from air modeling
	Groundskeeper	air	inhalation	particulates, volatiles and gases	maximum estimated on-subunit current concentration derived from air modeling
		surface soil	incidental ingestion dermal contact external radiation		surface soil within subunit

TABLE 6-1
(Continued)

Current Land Use	Receptor		Direct Contact Medium	Route of Exposure		Exposure Point Concentration
Current with Access Controls (current use of FEMP continues, DOE ownership) (Continued)	Great Miami River Users	Recreational User	surface water	ingestion dermal contact		estimated concentrations in the Great Miami River
			fish	ingestion		estimated concentrations in the Great Miami River
		Agricultural User	plants (homegrown produce irrigated with water from Great Miami River)	ingestion	fruit and vegetables	estimated concentrations in the Great Miami River
			livestock (grazing on crops irrigated with water from Great Miami River)	ingestion	beef and milk	estimated concentrations in the Great Miami River
		Household User	surface water	inhalation ingestion dermal contact	particulates, volatiles, and gases	estimated concentrations in the Great Miami River
Current without Access Controls (current use of FEMP continues)	User of Meat and Milk Products		livestock (grazing on-property)	ingestion of milk and beef		maximum estimated on-property current concentrations derived from air modeling

TABLE 6-1
(Continued)

Future Land Use	Receptor	Direct Contact Medium	Route of Exposure		Exposure Point Concentration
Federal Ownership	Future Off-Property Farmer (adult and child), homegrown produce off-property, grazing off-property, groundwater off-property	air	inhalation	particulates, volatiles, and gases	maximum estimated off-property future concentrations derived from air modeling
		plants (homegrown produce)	ingestion	fruits and vegetables	maximum estimated off-property future concentrations derived from air modeling and groundwater modeling
		livestock (grazing at property boundary)	ingestion	milk and beef	maximum estimated off-property future concentrations derived from air modeling and groundwater modeling
		groundwater	ingestion dermal contact inhalation of volatiles released during household use		modeled groundwater concentrations at fenceline when concentration is greatest
	Expanded Trespasser (youth)	air	inhalation	particulates, volatiles, and gases	maximum estimated on-subunit air concentrations derived from air modeling
		surface soil	incidental ingestion dermal contact external radiation		surface soil within subunit
		surface water	incidental ingestion dermal contact		surface water within subunit
		sediment	ingestion dermal contact external radiation		sediment within subunit

TABLE 6-1
(Continued)

Future Land Use	Receptor		Direct Contact Medium	Route of Exposure		Exposure Point Concentration
Federal Ownership (Continued)	Great Miami River Users	Recreational User	surface water	ingestion dermal contact		estimated concentrations in the Great Miami River
			fish	ingestion		estimated concentrations in the Great Miami River
		Agricultural User	plants (homegrown produce irrigated with water from Great Miami River)	ingestion	fruit and vegetables	estimated concentrations in the Great Miami River
			livestock (grazing on crops irrigated with water from Great Miami River)	ingestion	beef and milk	estimated concentrations in the Great Miami River
		Household User	surface water	inhalation ingestion dermal contact	particulates, volatiles and gases	estimated concentrations in the Great Miami River
Without Federal Ownership	Future Off-Property Farmer (adult and child), homegrown produce off-property, grazing off-property, groundwater off-property		air	inhalation	particulates, volatiles, and gases	maximum estimated off-property future concentrations derived from air modeling
			plants (homegrown produce)	ingestion	fruits and vegetables	maximum estimated off-property future concentrations derived from air modeling and groundwater modeling
			livestock (grazing at property boundary)	ingestion	milk and beef	maximum estimated off-property future concentrations derived from air modeling and groundwater modeling
			groundwater	ingestion dermal contact inhalation of volatiles released during household use		modeled groundwater concentrations at fenceline when concentration is greatest

TABLE 6-1
(Continued)

Future Land Use	Receptor	Direct Contact Medium	Route of Exposure		Exposure Point Concentration
Without Federal Ownership (continued)	Future On-Property Resident Farmer (adult and child); homegrown produce on-subunit, livestock grazing on-property, groundwater on-property; will include RME and CT estimates	air	inhalation	particulates, volatiles, gases, and indoor radon	maximum estimated on-subunit future concentrations derived from air modeling; radon estimated from soil radium concentrations
		plants (homegrown produce)	ingestion	fruits and vegetables	maximum estimated on-subunit future concentrations derived from air modeling and groundwater modeling of the Great Miami Aquifer.
		livestock (grazing on property)	ingestion	milk and beef	maximum estimated on-subunit future concentrations derived from air modeling and groundwater modeling of Great Miami Aquifer
		groundwater	inhalation	particulates, volatiles, and gases	groundwater concentration in Great Miami Aquifer underlying subunit at time when concentration is greatest
		surface soil	ingestion dermal contact incidental ingestion dermal contact external radiation		surface soil within subunit
	Future Homebuilder	waste material/subsurface soil	external radiation incidental ingestion dermal contact		subsurface soil within subunit
		air	inhalation	particulates, volatiles, and gases	air concentrations at construction site based on modeling

TABLE 6-1
(Continued)

Future Land Use	Receptor	Direct Contact Medium	Route of Exposure		Exposure Point Concentration
Without Federal Ownership (Continued)	Future Perched Groundwater User, homegrown produce on-subunit, groundwater on-property	air	inhalation	particulates, volatiles, gases, and indoor radon	maximum estimated on-subunit future concentrations derived from air modeling; radon estimated from soil radium concentrations
		plants (home grown produce)	ingestion	fruits and vegetables	maximum estimated on-subunit future concentrations derived from air modeling and groundwater modeling of the Great Miami Aquifer
		livestock (grazing on property)	ingestion	milk and beef	maximum estimated on-subunit future concentrations derived from air modeling and groundwater modeling of the Great Miami Aquifer
		perched groundwater directly underlying subunit	ingestion dermal contact inhalation of volatiles released during house use		perched groundwater concentrations directly underlying the subunit at time when concentrations are greatest
		surface soil	incidental ingestion dermal contact external radiation		surface soil within subunit

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Model simulations were performed using SWIFT/386 on a Powerbox PC microcomputer or Silicon Graphics workstation. Simulation execution times varied between 18 and 37 hours on Powerbox PC and 8 to 15 hours on Silicon Graphics workstation and required extensive computing capacity. Output was written to a single file from which relevant data was extracted using data manipulation programs written for that purpose. Contour plots were made for selected constituents at different simulation times for CPCs exceeding screening concentration to represent CPC plumes and plume changes over time. Contour plots are presented at the time of maximum concentration on-site and at the FEMP property boundary, at the time of uranium maximum concentration on-site and at the FEMP property boundary, and at 1000 years.

A.2.8.2.1 Source Loading to the Great Miami Aquifer

Constituent loading to the Great Miami Aquifer came from:

- The leaching of CPCs from the soil matrix into the dissolved phase and then migrating to the Great Miami Aquifer through the vadose zone
- The infiltration of contaminated surface water from Operable Unit 2 subunits to the Storm Sewer Outfall Ditch and Paddys Run and then to the Great Miami Aquifer
- Percolation of perched water beneath the subunits through the vadose zone to the underlying Great Miami Aquifer
- Lateral migration of perched water beneath the subunits and then infiltrating through an area where glacial overburden is not present (subsurface seeps).
- Infiltration of contaminated seep water to the Great Miami Aquifer

Loading from perched water, waste leachate, and seeps to the Great Miami Aquifer was modeled using ODAST and results are presented in Section A.2.7. Appendix A.1 describes modeling of CPCs through the surface water pathway. CPCs that follow the surface water pathway to the Great Miami
No. 4 Aquifer were first screened to remove constituents that pose insignificant risk. Note that Tables A.2-47 and A.2-48 provides CPC loading to the Great Miami Aquifer from surface water pathway for the CPCs passing all the screening steps and require detail modeling (see Table A.1-14). If theoretical Great Miami Aquifer concentrations were below the screening concentrations then the constituent was screened out and was not modeled in the aquifer. All CPCs were screened out from the surface water pathway for the Solid Waste Landfill and the surface water pathway is not

applicable for the Lime Sludge Ponds. Table A.2-47 provides a summary of surface water runoff loading to the Great Miami Aquifer from the Inactive Flyash Pile, and South Field, while Table A.2-48 provides a summary of

7.38 x 10^{-5}~~-3~~. This is largely due to the uptake of radium-226 and technetium-99 and benzo(a)pyrene, dibenzo(a,h) anthracene, and indeno(1,2,3-cd)pyrene. ~~PAHs~~ by livestock additional CPCs contributed greater than 1.0 x 10^{-6}, but made up less than two percent of the total medium risks. Total HI from beef and milk ~~hazard~~ for both the farmer and the child was below 1.0, ~~but the~~ child. ~~had a hazard of 2.9 due to the estimated uptake of uranium total by livestock.~~

CT estimates of risk for the future on-property resident farmer associated with exposures to surface soil, groundwater, homegrown produce, and beef and milk are given in Tables B.3.2-23, B.3.2-24,
NO. B-77 B.3.2-25, and B.3.2-26, respectively (Attachment B III). Total risk from soil was ~~2.1~~9.3 x 10^{-4}, ~~due~~
No. 62,7 *due predominantly to external radiation from radium-226 and thorium-2*~~38~~ 32 ~~due mostly to external~~
NO. B-230 radiation from thorium-228. Total risk from groundwater is ~~7.8~~6.6 x 10^{-5}, homegrown produce is ~~1.1~~9.9 x 10^{-5}, and beef and milk is ~~8.3 x 10^{-6}~~ 9.4 x 10^{-6}. The greatest proportion of these risks *from groundwater* was due to the presence of technetium-99, benzo(a)pyrene, and dibenzo(a,h)anthracene in dust and uranium-234, and uranium-238 in ~~groundwater~~ *drinking water* and ~~its subsequent~~ uptake into irrigated plants and by watered livestock. Total HI for ~~groundwater~~ produce was ~~11~~ 2.2 due to total uranium and total HI for ~~produce was 1.3 also due to total uranium.~~ groundwater was 8.3 also due to uranium-total.

B.3.2.4.4 Future On-Property (South Field) Homebuilder

Risks were calculated for a future homebuilder ingesting, inhaling, or coming into dermal contact with surface and subsurface soil within the South Field. The risk of external radiation resulting from exposure to subsurface soil was also determined.

The risks and hazards for an on-property homebuilder exposed to contaminated subsurface soils while building a home on the South Field are given in Table B.3.2-27 (Attachment B III). The total risk
NO. B-78, due to all CPCs by all routes of exposure was ~~2.2 x 10^{-6}~~ 1.1 x 10^{-5}. The major contribution to total
NO. B-230 risk is from radium-226 (2.6 x 10^{-6}), thorium-232 (2.1 x 10^{-6}), and thorium-228 (1.6 x 10^{-6}) via
No. 63 external radiation. ***Arsenic contributed 1.0 x 10^{-6} ILCR due to dermal contact.*** HI did not exceed 1.0 for any individual CPC.