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AGENDA AND HANDOUTS FROM THE OPERABLE UNIT 2 REMEDIAL INVESTIGATION REPORT WORKSHOP MAY 10, 1994

05/10/94

DOE-FN PUBLIC
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HANDOUTS

U.S. DEPARTMENT OF ENERGY

OPERABLE UNIT 2 REMEDIAL INVESTIGATION

May 10, 1994

Alpha Building

7:00 p.m. Opening

Welcome	Gary Stegner
Introductory Remarks	Rod Warner

7:15 p.m. Findings from OU2 RI Report

Solid Block Modeling Presentation	Jim Williams/
Leading Remedial Alternatives Under Consideration	John Flinn

8:30 p.m. Question and Answer Session

After the meeting, DOE/FERMCO staff will be available to talk with Stakeholders.

(Please fill out the evaluation form and turn in before leaving. Thank You.)

Operable Unit 2 Remedial Investigation Workshop

May 10, 1994

EVALUATION

Thank you for attending the meeting to view the demonstration of Solid Block Modeling and discuss the findings from the OU2 RI Report. Please take a few moments to answer the questions below:

1. Was the demonstration of Solid Block Modeling adapted to a suitable level of knowledge for this audience?

2. Were the findings and conclusions on the OU2 RI Report discussed in an "easy to understand" fashion for this audience?

3. Was the demonstration too long? too short?

4. Did the speakers(s) explain in simple language and in enough detail the information/materials they presented?

5. Were questions adequately answered throughout the meeting?

6. Do you have any other constructive comment/criticism about tonight's meeting?

OPTIONAL

Name_____ Phone_____

DRAFT

EXECUTIVE SUMMARY

This report documents the Remedial Investigation (RI) phase of the Fernald Environmental Management Project (FEMP) Operable Unit 2 Remedial Investigation/Feasibility Study (RI/FS). The FEMP is a U.S. Department of Energy (DOE) facility located near Fernald, Ohio, which operated from 1952 to 1989 providing high purity uranium metal products to support United States defense programs. In 1989, the mission of the facility was changed to environmental restoration. Also in 1989, the facility was placed on the National Priorities List ("Superfund List"). The RI/FS for the FEMP is executed according to an Amended Consent Agreement between DOE and the U.S. Environmental Protection Agency (EPA), under authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Ohio Environmental Protection Agency (OEPA) also is participating in the FEMP RI/FS process through direct involvement in review meetings, public meetings, and technical review of project documentation.

The RI/FS is part of a process through which decisions are made to determine the specific environmental cleanup methods that will be used at a site. The Operable Unit 2 Feasibility Study (FS) will develop and compare a range of possible remedial alternatives to identify the most effective approach for meeting specific cleanup goals. Consistent with the Amended Consent Agreement, selection of the preferred cleanup alternative will be documented in a Record of Decision (ROD), which is issued by EPA after consideration of comments received from the public and other interested parties. The Operable Unit 2 RI Report provides a detailed understanding of the nature and extent of the waste materials, their present and future impacts on the surrounding environment, and the present and future risks to human health if the Operable Unit 2 wastes were not remediated. Therefore, this RI Report meets the need for the evaluation of risks due to the Operable Unit 2 wastes and provides the basis to develop and evaluate a wide range of remedial alternatives.

EPA approved the FEMP RI/FS Work Plan in May 1988. The work plan provided the overall technical approach, identified areas to be investigated, and presented the objectives and data evaluation criteria for the planned investigations. The work plan identified 27 specific areas, or units, within the FEMP for investigation. Subsequent evaluations increased the number of units to 39. It soon became apparent that for purposes of effective management, the 39 units should be categorized and grouped. The resultant groupings formed the five operable units of the FEMP. The operable units are:

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- Operable Unit 1 - Waste Pit Area
- Operable Unit 2 - Other Waste Areas
- Operable Unit 3 - Former Production Area
- Operable Unit 4 - Silos 1 through 4
- Operable Unit 5 - Environmental Media

Operable Unit 2 is comprised of five subunits: Solid Waste Landfill, Lime Sludge Ponds, Active Flyash Pile, Inactive Flyash Pile, and South Field. Large volumes of conventional industrial wastes, assumed to have small amounts of hazardous chemicals and radionuclides, were placed in these subunits during the period of production operations.

NEPA Integration

Consistent with DOE policy, the FEMP is integrating the requirements of the National Environmental Policy Act (NEPA) into the RI/FS process. On May 15, 1990, a Notice of Intent was published in the Federal Register to announce that DOE intended to prepare an Environmental Impact Statement (EIS) to evaluate the environmental impacts associated with the planned cleanup activities at the FEMP. As identified in the Notice of Intent, the FS and Proposed Plan (PP) for the earliest scheduled operable unit, (Operable Unit 4) will be issued as a FS/PP-EIS. The FS/PP-EIS will examine the environmental impacts associated with Operable Unit 4 remedial activities as well as the cumulative impacts associated with the implementation of remedial actions for all five operable units at the FEMP. An additional element of NEPA compliance is the FEMP Site-Wide Characterization Report, which supplements the Operable Unit 4 FS/PP-EIS by providing an assessment of cumulative environmental impacts associated with the existing conditions at the FEMP on a site-wide basis.

The Operable Unit 2 FS and PP will be coordinated with the Operable Unit 4 FS/PP-EIS for purposes of NEPA integration, and if necessary, the cumulative impact analysis presented in the Operable Unit 4 impact statement will be updated and attached to the Operable Unit 2 NEPA evaluation. The Operable Unit 2 RI Report will be incorporated by reference into the Operable Unit 2 FS and PP NEPA evaluation. This RI Report includes the characterization of Operable Unit 2 and hence, will support the necessary description of the affected environment in the Operable Unit 2 NEPA evaluation. This report also provides the baseline risk assessment that will support the evaluation of the no action alternative for Operable Unit 2.

DESCRIPTION OF OPERABLE UNIT 2

The FEMP is a 1050 acre facility located about 17 miles northwest of downtown Cincinnati near Fernald, Ohio, a small farming community. The site lies on the boundary of Hamilton and Butler counties. The primary mission of the FEMP during its 37 years as an operating production facility was to process, refine, and machine high-grade natural uranium ores into high purity uranium metal. The high purity metals were shipped to other DOE or U.S. Department of Defense facilities for use as "feed materials" in the nuclear weapons program. These uranium production activities generated large quantities of waste materials. The storage and disposal of wastes at the site and their potential for impacting human health led to the site being placed on the National Priorities List. Operable Unit 2 is comprised of five areas, or subunits, in which various conventional industrial wastes were disposed.

The FEMP is situated on an area of glacial overburden deposits; the overburden primarily is composed of till, a dense silty clay that may contain lenses of poorly sorted fine to medium grained sand and gravel, silty sand, and silt. Undisturbed glacial till has relatively low permeability. The thickness of the till varies from 0 to 50 feet on site, and the till tends to be thicker in the northern part of the site (the Solid Waste Landfill, for example is sited in thick till) and pinches out completely in the South Field area in the southern part of the site. Areas not covered with till may exhibit higher infiltration rates than those covered with glacial till.

Erratically distributed pockets of sand and gravel within the till contain zones of perched groundwater. Perched groundwater is separated from the underlying aquifer by the surrounding relatively impermeable till materials. Depth to perched groundwater at the FEMP ranges from 1 to 15 feet below ground surface. The depth may fluctuate seasonally by up to 10 feet at a given location, with the highest levels occurring in the early spring and the lowest in the late fall.

The FEMP is sited above a major aquifer system, the Great Miami Aquifer. The Great Miami Aquifer is considered a sole source aquifer and sustains numerous industrial, municipal, and private drinking water wells. The FEMP includes several areas that probably function as recharge zones to the aquifer, including Paddys Run, the Storm Sewer Outfall Ditch, and parts of the South Field.

The subunits comprising Operable Unit 2 are briefly described below.

Solid Waste Landfill

The Solid Waste Landfill is located in the northeast corner of the Waste Storage Area, and is a flat, rectangular area of about one acre. The landfill has been inactive since 1986 and is covered with a layer of soil. The operational history of the landfill is not well documented. A review of historical site aerial photographs indicates that disposal activities may have occurred as early as 1954. Available documentation and interviews indicate that the landfill was intended to be used for "nonburnable wastes"; field investigations have revealed a variety of waste materials including medical wastes, rubbish, wastes from areas other than the Production Area, and on-site construction/demolition wastes.

Lime Sludge Ponds

The North and South Lime Sludge Ponds are two unlined, rectangular ponds, each measuring approximately 125 by 225 feet, located in the southeast corner of the Waste Storage Area. The sludge is confined by earthen dikes of unknown origin. The operational history of the ponds is well understood. Wastes disposed of in the ponds originated from water plant operations, coal pile storm water runoff, and boiler plant blowdown. The South Pond is full and has been inactive since the mid-1960s, and is now overgrown with grasses and shrubs. The North Pond currently remains in use. The west side of the North Pond usually is covered with one to two feet of water, mainly depending on precipitation. The remainder of the pond is dry and sparsely covered with vegetation.

The waste from water plant operations is generated from a water softening process. About one cubic yard of waste sludge is generated each day and is pumped to Tanks 6 and 7 of the General Sump. Coal pile runoff is treated in a retention basin to settle out the solids, then pumped to Tanks 6 and 7 of the General Sump. The boiler plant blowdown consists of backflush water, generated when the boilers are backflushed to prevent scale buildup. This water is also pumped to Tanks 6 and 7 of the General Sump. Tanks 6 and 7 contain only sludges from these three sources.

Sludge is allowed to accumulate in the tanks for about two weeks. It is then pumped as a slurry to the North Lime Sludge Pond. The bulk of the material comprising the slurry is sludge from the water softening operations. The Lime Sludge Ponds have been operated in this manner since the early 1950s. Based on this process knowledge as well as the resulting analysis of the sludge, it appears that

the lime sludge is relatively homogenous (uniform in composition). The Lime Sludge Ponds are presently classified as Solid Waste Management Units by OEPA.

Inactive Flyash Pile

The Inactive Flyash Pile is located about 2,000 feet southwest of the former Production Area and covers approximately 2 acres. Paddys Run forms the western boundary; the South Field lies to the east. The Inactive Flyash Pile and South Field are contiguous and lack a defined physical boundary. In appearance, this subunit resembles a relatively steep hill covered with shrubs and trees. The soil covering the southern half of the Inactive Flyash Pile is of unknown origin.

The operating history of the Inactive Flyash Pile is not well understood. The bulk of the waste material in the pile is reported to be bottom ash and flyash from the facility's boiler plant operations, commonly referred to as flyash. Based on a review of historical aerial photographs, flyash appears to have been taken by truck to an existing slope near Paddys Run and dumped. The photographs indicate that flyash disposal at this subunit had ceased by the mid-1960s. Various other wastes, including building rubble, gravel, asphalt, and process waste, were also deposited at the Inactive Flyash Pile.

South Field

The South Field is an 11-acre area that lies between the Inactive Flyash Pile and the Active Flyash Pile. A physical boundary with the Inactive Flyash Pile is not distinguishable. Currently, the South Field is relatively flat and is covered with grasses, shrubs, and trees.

The operational history of the South Field is neither well documented nor understood. It is not an engineered disposal site. A review of historical aerial photographs indicates that disposal may have been initiated in 1954 and continued until the mid-1960s. Disposal appears to have taken place in a random manner. Available documentation indicates that a number of wastes were disposed in the South Field, including construction and demolition materials, flyash, soils that may have been contaminated with low levels of radioactive materials, and possibly process wastes.

Active Flyash Pile

The Active Flyash Pile is bounded to the east and north by the Storm Sewer Outfall Ditch, and is separated from the South Field to the west by an unpaved road. The Active Flyash Pile appears as a

large, steep pile of black flyash, and covers about three acres. Wind screens and silt fences have been installed to prevent wind and water erosion, and a crusting agent has been applied. A crusting agent is applied to harden the surface of the Active Flyash Pile to minimize erosion and resuspension of dust. The operational history of the subunit is well understood.

Flyash from the site's coal-fired boiler plant was disposed at the Active Flyash Pile from the mid-1960s until December 1992. Flyash presently being generated at the FEMP is disposed at an approved, off-site facility. The waste at the Active Flyash Pile is comprised of about 70 percent bottom ash and 30 percent flyash. Small quantities of unburned coal and rock are present, as is typical of boiler ashes. Previous investigations have discussed the possibility that waste oils, which theoretically could contain PCBs or uranium, might have been applied to the Active Flyash Pile as a dust control measure. However, attempts to document this possibility have not been successful.

NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at Operable Unit 2 subunits have been established through several environmental investigations. The investigations most relied on in this report are the Environmental Survey (ES), the Characterization Investigation Study (CIS), and the CERCLA Remedial Investigation. The ES and CIS primarily were focused on site-wide issues and were not intended to provide a detailed analysis of contamination related to Operable Unit 2 subunits. The ES data have not been validated; portions of the CIS data have been validated. The RI field investigations rigorously examined the nature and extent of contamination in Operable Unit 2 subunits and the potential for the spread of contamination into the various environmental media. All RI data were validated. The evaluation of the nature and extent of contamination is based primarily on RI data, and CIS data were used in a supplementary manner. ES data were used only for descriptive purposes. Neither ES nor CIS data were used in the fate and transport modeling for the baseline risk assessment.

The following sections briefly summarize the findings on the nature and extent of contamination.

Solid Waste Landfill

Trenching and boring activities in the Solid Waste Landfill have determined that cafeteria, laboratory, construction/maintenance, and manufacturing wastes were disposed in the landfill. One waste disposal cell and an evaporation pond were identified in historical photographs and trench

observations, but waste was observed in numerous other areas within the battery limits. The depth of waste is generally 10 feet with the a maximum depth is the southeastern corner of the landfill of 15 feet.

Thirteen Contaminants of Concern (COCs) have been identified for the Solid Waste Landfill that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides, 3 metals, and 3 organic compounds. The extent of COCs in the Solid Waste Landfill is distributed throughout the surface and subsurface fill materials with the maximum levels in the southeastern corner of the landfill. The COCs were also detected in the glacial till beneath the landfill and in the perched groundwater near the southeast corner of the subunit. No impact has been observed on the Great Miami Aquifer. The number of COCs detected in the surface water, sediment, and perched groundwater are fewer than those detected in the surface and subsurface soils.

The media pathways considered significant for the Solid Waste Landfill as a result of the modeling include air, surface water, groundwater, and perched water. Perched water was modeled under the Solid Waste Landfill because of a potential for household use of the perched water.

Lime Sludge Ponds

Field investigations of the Lime Sludge Ponds indicate that the sludge within the subunit is homogeneous. Sampling in the berm soils and glacial till beneath the ponds has determined that the soils have higher concentrations of most constituents than the sludge. This means that future impacts from the sludge upon the soil are not likely. Elevated concentrations of uranium and thorium were detected in downgradient perched groundwater wells, but samples collected from the K-65 Trench (outside of Operable Unit 2 boundaries) detected elevated radioisotope activities. The K-65 Trench is believed to be the source of the perched groundwater contamination.

Seven COCs have been identified for the Lime Sludge Ponds that contribute greater than one percent of the total risk for a medium. These COCs consist of 4 radionuclides, 2 metals, and 1 organic compound. The extent of COCs in the Lime Sludge Ponds is limited mostly to the berm soils surrounding the ponds. Beryllium is the only COC that is believed to have originated in the lime sludge. Radionuclides and organics appear to have originated in the surface and berm soils. The COCs were also detected in the perched groundwater downgradient of the subunit, but the source of

these contaminants is believed to be the K-65 Trench. No impact has been observed on the Great Miami Aquifer.

The media pathways considered significant for the Lime Sludge Ponds as a result of the modeling include the air and groundwater pathways. No surface water pathway exists near the Lime Sludge Ponds and all surface water is contained within the subunit. Perched water was modeled under the Lime Sludge Ponds because of a potential for household use of the perched water.

Inactive Flyash Pile

Field investigations of the Inactive Flyash Pile indicate that waste other than flyash were disposed of in the subunit. Organic waste, sludge, clay tile drain pipe, wood, nails, wire, and construction debris were found in addition to flyash. Field measurements with an alpha-beta meter indicated that all materials except for flyash had elevated levels of radioactivity. The identified waste materials appear to be resting on or near the interface between the flyash and the native glacial overburden.

The occurrence of uranium contamination in the perched groundwater appears to be related to waste materials buried within or near this subunit. The perched groundwater appears to discharge through seeps into the Paddys Run drainage channel or directly into the Great Miami Aquifer through regions where the glacial overburden has been eroded. This means that a mechanism exists to transport uranium contamination vertically into the Great Miami Aquifer. Uranium contamination in the Great Miami Aquifer was not detected upgradient or from the northern part of the subunit. Uranium contamination was detected in two wells in the Great Miami Aquifer downgradient from the central part of the subunit. This suggests that a source of uranium contamination to the Great Miami Aquifer exists beneath the central part of the Inactive Flyash Pile.

Ten COCs have been identified for the Inactive Flyash Pile that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides, 3 metals, and 1 organic compound. The extent of COCs in the Inactive Flyash Pile covers most of the surface and subsurface soils and groundwater within the subunit. Radionuclides appear to be connected to non-flyash waste such as sludge, wood, and construction debris, whereas organics appear to be intermixed with the flyash, possibly from dust control spraying. Uranium is the only COC detected in the Great Miami Aquifer downgradient of the subunit.

The media pathways considered significant for the Inactive Flyash Pile as a result of the modeling include air, surface water, and groundwater pathways.

South Field

Test trenches uncovered a range of waste materials including concrete, steel pipe, sheet steel, wood, and clay tile. The results of wipe samples taken from these materials indicate that they represent a potential source of the leaching of radionuclides to groundwater.

Sixteen COCs have been identified for the South Field that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides, 3 metals, and 7 organic compounds. The extent of COCs in the South Field covers most of the surface and subsurface soils and groundwater sampled within the subunit. Radionuclides and organics were detected in higher concentrations in the northern portion of the South Field.

The media pathways considered significant for the South Field as a result of the modeling include air, surface water, and groundwater pathways.

Active Flyash Pile

The Active Flyash Pile contains only flyash from field observations and historical documentation. Interviews with former processing personnel indicated that organic compounds could have been sprayed on the flyash to reduce dust. The analytical results of the RI field investigation do not support such speculation.

Eight COCs have been identified for the Active Flyash Pile that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides and 2 metals. The extent of COCs in the Active Flyash Pile covers most of the surface soil subsurface soil within the subunit. The COCs uranium-234, uranium-235/236, and uranium-238 were detected in the Great Miami Aquifer downgradient of the subunit.

The media pathways considered significant for the Active Flyash Pile as a result of the modeling include air, surface water, and groundwater pathways.

BASELINE RISK ASSESSMENT

The Operable Unit 2 baseline risk assessment accomplished the following for each subunit:

- Determination of the constituents of potential concern (CPCs)
- Assessment of the potential for and magnitude of constituent transport from Operable Unit 2 sources to potential points of human exposure
- Quantification of potential exposures to human receptors under current and future land use scenarios
- Characterization of the nature and magnitude of potential risks associated with Operable Unit 2, assuming there were no remedial action in the future
- Evaluation of the uncertainty associated with the risk estimations.

The Operable Unit 2 baseline risk assessment addresses only potential risks associated with waste subunits within the battery units of Operable Unit 2. It does not consider existing sources or contamination in soil, surface water, and sediment outside the boundaries of Operable Unit 2, nor does it consider groundwater contamination. These risks will be evaluated in the Operable Unit 5 RI. Risks due to groundwater in this and other operable unit risk assessments are based on estimates of future concentrations which are based on modeling. This risk assessment does not consider the potential impacts on flora and fauna (ecological risks). Evaluation of site-wide ecological risks will take place in the Operable Unit 5 RI/FS; areas likely to be remediated on the basis of human health protection will not be evaluated.

Operable Unit 2 includes five subunits for which remedial decisions must be made. In order to facilitate the decisions, risk was quantified separately for each subunit. The specific risk assessment methodology followed was consistent across all subunits, and the cumulative risk from Operable Unit 2 sources was calculated.

Potential human exposure to risk is evaluated in the context of three land use scenarios: (1) current land use having DOE ownership with both access and no access control, (2) future land use assuming federal ownership, and (3) future land use assuming private ownership. For all scenarios, it is assumed that no additional cleanup of Operable Unit 2 occurs beyond that which already has taken place.

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The postulated human receptors of incremental risk for the current land use scenario include a trespassing youth, off-property residents, and on-property groundskeeper. For the future land use scenario assuming federal ownership, the receptors are expanded trespasser and off-property farmers. For the future land use scenario assuming private ownership, the receptors are on-property farmers, homebuilders, and users of "perched" groundwater (isolated bodies of groundwater within the glacial till). Recreational users of the Great Miami River were also considered future receptors regardless of whether federal or private ownership is assumed. For the future land use scenarios, the constituent concentrations at the specific geographical and temporal points of human exposures were determined by the application of approved air dispersion, and surface water and groundwater transport computer simulation models.

Epidemiological evidence indicates that the typical human being has a risk of developing cancer of about one in three, or 3.3×10^{-1}. Federal regulations for the management of waste sites limit the allowable excess risk to any person, resulting from exposure to carcinogenic materials, to one in 10,000 or 10^{-4}. Accordingly, the baseline risk assessment presents the risks due to exposure to carcinogens in terms of incremental lifetime cancer risk (ILCR); that is the additional risk to a given person, given a lifetime of exposure to Operable Unit 2 wastes and impacted media. Hazards due to exposure to noncarcinogenic constituents also are evaluated. Noncarcinogenic risks are reported as a hazard index (HI). HIs of greater than 1.0 or "above unity" indicate a concern for potential health effects.

To ensure that the most sensitive or most exposed individuals in the population are protected, EPA guidance provides for calculation of reasonable maximum exposure (RME), which is the maximum exposure a person reasonably could receive from the waste site being evaluated. For example, in the Operable Unit 2 future land use scenario assuming private ownership, the on-property RME farmer (adult and child) builds a home on (where physically feasible) and actively farms the unremediated Operable Unit 2 waste units and is exposed to the following for each CPC:

- Inhalation of fugitive dust, volatile organic compounds, and gases
- Incidental ingestion, inhalation, and dermal contact while using groundwater (separate evaluations for Great Miami Aquifer and perched groundwater) in the home
- Consumption of foodstuffs grown on the waste site, including fruits and vegetables, and meat and milk

- Incidental ingestion, external radiation, and dermal contact with soil
- Inhalation of indoor radon

Thus, the RME receptors usually will have the highest estimated risks in a risk assessment. Risk and hazard results are also presented for a central tendency (CT) receptor, whose exposures are thought to be more typical of the average individual in the exposed population. For all subunits, future risks to off-property receptors (with the exception of the expanded trespasser, whose exposures primarily occur on site) will be the same for federal or private ownership. A summary of results from the risk assessment for each subunit is presented below. All site-related risks were calculated without accounting for (removing) the potential contribution from natural background sources.

Solid Waste Landfill

For the current land use scenario, a total carcinogenic risk to a trespassing youth is 1.6×10^{-5} due mostly to external radiation from radium-226 and thorium-228 and dermal contact with beryllium in soil. HIs are less than 1.0. Total risk to the on-property groundskeeper are within the same order of magnitude as the trespassing youth. Major contributors to risk for this receptor are the same as those to the trespassing youth. Off-property farmers have carcinogenic risks on the order of 10^{-8} and HIs of less than 1.0.

For the future land use scenario assuming private ownership, total carcinogenic risk and hazard to the RME farmer are 1.2×10^{-3} and 1.5, respectively. The greatest contributors to risk are from radium-226, uranium-238, and thorium-228 in soils via external radiation and dermal contact with beryllium in soil. Risks exceeded the 1.0×10^{-4} level for the perched groundwater users due primarily to the estimated presence of carbazole in perched groundwater.

For the future scenario having federal ownership, the expanded trespasser has a combined carcinogenic risk of 4.4×10^{-5} due mostly to external radiation by radium-228, thorium-228, and uranium-238 and dermal contact with beryllium in soil. Total HI is less than 1.0. Total carcinogenic risk for off-property farmers range from 10^{-5} to 10^{-8}.

Risk to the recreational users of the Great Miami River is in the range of 1.0×10^{-6} to 1.0×10^{-5} due mostly to external radiation from thorium-228, radium-228, and uranium-238 in sediment. HIs are below 1.0.

The media pathways with the most significant risk for COCs are related to ingestion, inhalation, and dermal contact with soil and consumption of fruit and vegetables, milk and beef contaminated by soil. Two COCs, carbazole and technetium-99, contribute risk to the on-property resident farmer if perched groundwater is used for as a household drinking water source. Approximately 86 percent of the total risk to the on-property resident farmer is derived from four COCs: radium-228, thorium-228, uranium-238, and beryllium in soil.

Lime Sludge Ponds

For the current land use scenario, a total carcinogenic risk to a trespassing youth is 2.8×10^{-5} due primarily to exposure to surface soil containing radium-228 and thorium-228, via external radiation, and to dermal contact with beryllium and Aroclor-1254. Total risk to the current on-property groundskeeper is 4.7×10^{-5} due mostly to the presence of thorium-228 and beryllium in soil. Total HI for these receptors is less than 1.0. Carcinogenic risks to off-property residents are on the order of 10^{-7} and the combined HI is much less than 1.0.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total risk of 1.9×10^{-3} due almost entirely to the presence of radium-228, thorium-228, uranium-238, and beryllium in soil. Total HI is less than 1.0 for the farmer, but for the on-property child, the HI exceeded 1.0 due to the presence of total uranium in soil.

For the future land use scenario with federal ownership, the expanded trespasser has a total risk of less than 9.8×10^{-5} due to the same compounds as the on-property farmer HI is less than 1.0. Off-property farmers have carcinogenic risks on the order of 10^{-7} and HIs of less than 1.0. uranium in soil.

The media pathways with the most significant risk for COCs are related to ingestion, inhalation, and dermal contact of soils. No COCs were determined for perched groundwater even if perched groundwater is used for a household drinking water source. Approximately 88 percent of the risk to the on-property resident farmer is derived from four COCs in soil: radium-228, thorium-228, beryllium and Aroclor-1254.

Inactive Flyash Pile

Because of the contiguous nature of the Inactive Flyash Pile and South Field, the complexity of the geology and lithology, and the patterns of groundwater flow in the area, it was not possible to completely separate these potential groundwater sources on other than an arbitrary basis. Therefore, the groundwater modeling for these subunits included simultaneous inputs from the entire area of these combined subunits. Hence, the risk contribution of the groundwater pathway is based on the combined effects of these subunits.

For the current land use scenario, total carcinogenic risks range from slightly greater than 10^{-5} for the trespassing youth to about 10^{-8} for off-property receptors. Total risk to the trespassing youth is 3.3 x 10^{-5} due mostly to the presence of radium-228, thorium-228, and beryllium in soil. Risk to the on-property groundskeeper are on the same order of magnitude as the trespassing youth. Major contributors are the same as those for the trespassing youth. HIs for all current scenario receptors are less than 1.0.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total risk of 3.2 x 10^{-3} and HI far greater than 1.0. The major contributors of risk are thorium-228 and beryllium in soil and uranium-234 and uranium-238 in groundwater and consequently in irrigated produce, and in milk and beef from livestock that are watered with groundwater contaminated from the combined Inactive Flyash Pile/South Field source area. The most significant components of the elevated HI are due to total uranium in groundwater and consequently in irrigated produce.

For the future land use assuming federal ownership, the expanded trespasser has a total carcinogenic risk of 1.2 x 10^{-4} and HI of less than 1.0. The off-property farmer has a total carcinogenic risk of 6.6 x 10^{-5} and HI of 3.4. Major contributors of risk to the off-property farmer are uranium-234 and uranium-238 in groundwater contaminated from the combined Inactive Flyash Pile/South Field source area. The major contributors to hazard are from total uranium in groundwater and consequently in irrigated produce, and in milk and beef from cattle that are watered with contaminated groundwater from the Inactive Flyash Pile/South Field source area.

Total estimated risk to future Great Miami River users are in the range of 1.0 x 10^{-6} to 1.0 x 10^{-5}. Major contributors to risk were from thorium-228, uranium-235/236, and radium-228. HIs are less than 1.0.

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Pathways contributing to risk include ingestion, inhalation, and dermal contact with soil, and ingestion of groundwater. Approximately 85 percent of the risk to the on-property resident farmer is derived from five COCs: radium- 228, thorium-228, uranium-234, uranium-238, and beryllium.

South Field

For the current land use scenario, total carcinogenic risks range from slightly greater than 10^{-5} for the trespassing youth to about 10^{-7} for off-property receptors. Major contributors of risk to the trespassing youth are mostly due to radium-228, and thorium-228, and beryllium in soil. Total estimated risk to the on-property groundskeeper is 6.5×10^{-4} due primarily to thorium-228 in soil. HIs for all current receptors are less than 1.0.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total carcinogenic risk of 3.8×10^{-3} and the resident child has a risk of 4.5×10^{-4}. The on-property RME farmer, and resident child have HIs greater than 1.0. The largest component of risk to the on-property farmers are from thorium-228, radium-228, beryllium and benzo(a)pyrene in soil, and uranium-234, uranium-238, and total uranium in groundwater and consequently in irrigated produce, and in milk and beef from livestock that is watered with groundwater contaminated from the combined Inactive Flyash Pile/South Field source area. Risks for the on-property RME farmer at the South Field are somewhat higher than for the Inactive and Active Flyash Piles because it is feasible to build a house on the South Field. Therefore, the South Field RME farmer has higher direct radiation exposures as well as exposure to indoor radon.

For the future land use assuming federal ownership, the expanded trespasser has a total carcinogenic risk of about 2.2×10^{-4} and a HI of less than 1.0. Major contributor to risk is from beryllium in soil and sediment. Off-property farmers have carcinogenic risks as great as 10^{-5} and HIs greater than 1.0. The largest component of risk to the off-property farmers is uranium-234, uranium-238, and total uranium in groundwater and consequently in irrigated produce, and in milk and beef from livestock that is watered with groundwater contaminated from the combined Inactive Flyash Pile/South Field source area.

Total estimated risk to the Great Miami River users are within a 1.0×10^{-5} to 1.0×10^{-4} range. Major contributors to risk include benzo(a)pyrene, thorium-230, and beryllium. Pathways contributing most to risk include ingestion, inhalation, and dermal contact with soil, and ingestion of

groundwater. Over 80 percent of the risk to the on-property resident farmer is derived from five COCs: radium-228, thorium-228, uranium-234, uranium-238, and beryllium.

Active Flyash Pile

For the current land use scenario, total carcinogenic risk to a trespassing youth is 6.8×10^{-5} due to the presence of radium-226, radium-228, and thorium-228 in soil. Total risk to the on-property groundskeeper is 9.2×10^{-5} due mostly from thorium-228 and beryllium in soil. Total HI for all current receptors are less than 1.0. Carcinogenic risks to off-property residents are on the order of 10^{-6}.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total carcinogenic risks of 1.9×10^{-3} due mostly to the presence of neptunium-237, radium-228, thorium-228, and arsenic in surface flyash material. Total HI is less than 1.0.

For the future land use assuming federal ownership, the expanded trespasser has a total carcinogenic risk of 2.4×10^{-4} and HI of less than 1.0. Exposure to the expanded trespasser is due mostly to beryllium in surface flyash. Off-property farmers have carcinogenic risks greater than 1.0×10^{-6} due mostly to uranium-234 and uranium-238 in groundwater contaminated from the Active Flyash Pile source area. Total HI is less than 1.0. Total estimated risks to the Great Miami River users are in the range of 1.0×10^{-5} to 1.0×10^{-4} due mostly to arsenic and beryllium in sediment.

The pathway which contributes most significant risk is dermal contact. Over 85 percent of the risk to the on-property resident farmer is derived from three COCs in soil: radium-228, thorium-228, and arsenic.

OPERABLE UNIT 2 CUMULATIVE RISK

Future land use receptors were evaluated for cumulative risk from the presence of contaminants within Operable Unit 2. It is emphasized that the risks and hazards presented are those resulting primarily from the three subunits contributing most to groundwater contamination: the Active Flyash Pile, South Field and Inactive Flyash Pile.

The greatest carcinogenic risk posed was to the RME on-property farmer which had a total risk of 3.7×10^{-3}. The major contributors to risk for the on-property receptor is from the presence of

thorium-228, radium-228 and beryllium in soil, and the estimated presence of uranium-238 in groundwater.

Total risk to the off-property farmer slightly exceeded 1.0×10^{-4} due primarily to uranium-234 and uranium-238 in groundwater, and thorium-228, thorium-230, and uranium-238 in soil.

Total HIs exceed 1.0 for both the on- and off-property farmers due primarily to the estimated presence of total uranium in groundwater.

Total risk to the expanded trespasser was 6.6×10^{-5} due primarily to beryllium and thorium-228 in soil which contributed 64.5 percent and 15.5 percent, respectively. Total HI for this receptor was below 1.0.

Approximately 68 percent of the total risk to the on-property farmer is attributed from four COCs in soil and groundwater: thorium-228, radium-226, beryllium, and uranium-238.

Risk Assessment Uncertainty

Every quantitative risk assessment is subject to sources of uncertainty. To ensure that risk is not underestimated and that human health is protected, CERCLA guidance and the conventions followed in this report address areas of uncertainty through application of conservative (i.e., protective) assumptions. The greatest uncertainty associated with the Operable Unit 2 baseline risk assessment is due to the assumptions made to estimate constituent concentrations at the spatial and temporal points of human exposure. Specifically, the exposure point concentrations in groundwater, air, produce, and beef and milk for human receptors in the future are the most conservatively estimated. All risk and hazard estimates for future on-property residents are subject to uncertainty, and hence conservatism, because the future site ownership and access controls are unknown. Taken together and interactively, the uncertainties identified with site data, exposure parameters, fate and transport, toxicity assessment, and risk characterization are judged to be high, having the potential to overestimate risk by two orders of magnitude or more.

One way to evaluate the degree of conservatism in the risk assessment methodology is to follow the risk estimation protocol, substituting natural background concentrations for the contaminants that were found, in place of the values actually measured at the waste site. This was done for the Operable

Unit 2 land use and human exposure scenarios. The use of background constituent levels in the Operable Unit 2 risk assessment results in a carcinogenic risk for the on-property RME residents of greater than 1.0×10^{-4}. Major contributors to total background risk are from thorium-228, radium-228, and beryllium in surface soil.

Conclusions

This RI presents a detailed understanding of the nature and extent of the contamination of the individual subunits that comprise Operable Unit 2. The contaminant data are used for two major purposes: (1) after the application of rigorous validation and statistical procedures, the data are used to drive the contaminant fate and transport models used in the risk assessment, and (2) the types and quantities of contaminants are used in the FS in the screening of appropriate cleanup technologies and the development of specific remedial alternatives. The data collected for the Operable Unit 2 RI are completely adequate for both purposes and no data gaps have been identified.

The Operable Unit 2 baseline risk assessment utilizes a data set in which every data element has been validated for its intended usability. The fate and transport models are approved by EPA and calibrated to the specific site conditions. The risk assessment rigorously follows CERCLA guidance, the approved Risk Assessment Work Plan Addendum, and specific guidance to the FEMP from EPA Region V.

This report concludes that none of the Operable Unit 2 subunits presents a risk to current off-property receptors above allowable levels. Risk to the trespassing youth and the on-property groundskeeper would be greater than the lower risk threshold (10^{-6}) but are within the same range as the risk due to background levels calculated to test the conservatism (over estimate) of the risk assessment methodology.

The risk assessment shows that in the future assuming federal ownership, in the absence of remediation, the Lime Sludge Ponds present an unacceptable risk for both the on-property receptors and the expanded trespasser.

The risk assessment shows that in the future, in the absence of remediation, the Active Flyash Pile, Inactive Flyash Pile, South Field, and Solid Waste Landfill will present greater than allowable risk to both on- and off-property receptors.

Remedial Action Objectives

The development of the following general remedial action objectives (RAOs) is based only on the results of the baseline risk assessment. The Operable Unit 2 FS will include a consideration of the ARARs for each subunit, and ARARs have the potential to significantly affect the remedial action objectives. For the Operable Unit 2 subunits requiring remedial action, feasible remedial action alternatives will be developed and evaluated in the FS Report to be issued for Operable Unit 2.

The remediation of existing contamination in the Great Miami Aquifer is not considered here because remediation of the aquifer is within the scope of the Operable Unit 5 remedial actions. During remediation of Operable Unit 2, contaminated perched water will be controlled to prevent the recontamination of the areas being cleaned up. The treatment or disposal of the perched water will be coordinated with the remedial actions for Operable Unit 5. Also, during the remediation of Operable Unit 2, storm water will be controlled to prevent the spread of contaminants. The treatment or disposal of the storm water will be coordinated with the remedial actions for Operable Unit 5.

The RAOs for all subunits in Operable Unit 2 are to prevent the release or migration of contaminants from waste materials and contaminated soils that could potentially (1) affect future groundwater users (perched and aquifer) on the site, (2) be harmful as sources of external radiation, (3) prevent the availability of harmful waste materials or contaminated soils for inhalation or ingestion by on-property resident farmers, and (4) prevent the availability of harmful waste materials or contaminated soils for plant uptake, disposition on plants, or ingestion by animals raised for meat and milk products.