Supplemental Remedial Investigation
and Supplemental Feasibility Study
for the FMC Plant Operable Unit

REMEDIAL INVESTIGATION UPDATE MEMORANDUM FOR THE FMC PLANT OPERABLE UNIT

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PREFACE

The December 2004 RI Update Memorandum has been prepared to address comments submitted by EPA Region 10 on the June 2004 edition of the RI Update Memorandum. EPA's comments, which included comments made by the Shoshone-Bannock Tribes and the Idaho Department of Environmental Quality, were provided to FMC on November 4, 2004.

Attachment 1, a CD-ROM, identifies revisions made to the June 2004 RI Update Memorandum using the redline/strikethrough convention. A redline/strikethrough version was not prepared where revisions were extensive (e.g., several tables in Section 6 and Appendix C).

Appendix D, which presents geotechnical data on soils used in constructing caps for an number of closed waste management units, was provided in hard copy format in the June 2004 RI Update Memorandum. Appendix D is presented in electronic format (PDF file on CD) in the December 2004 edition to reduce the size of the document.

Appendices E, F, G, H, and I were not present in the June 2004 edition. Appendix E contains EPA's November 2004 comments on the June 2004 RI Update Memorandum and FMC's response to each comment. Appendices F, G, and H provide information in support of anticipated data collection methods for the future supplemental remedial investigation of the FMC Plant OU. Appendix I is a reproduction of information that was previously submitted to EPA on the use of treated water for dust suppression on roads within the FMC facility.

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ACRONYMS/ABBREVIATIONS

AOC	(1) administrative order on consent; (2) area of concern
ARAR	applicable, relevant or appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BAPCO	Bannock Paving Company
BCF	bioconcentration factor
BHHRA	Baseline Human Health Risk Assessment
C	Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeters
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
d/yr	days per year
DO	dissolved oxygen
DQO	data quality objective
E&E	Ecology and Environment, Inc.
ED	exposure duration
EE	exposure estimate
EF	exposure frequency
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FEDS	FMC Environmental Data System
FIP	Federal Implementation Plan
FS	feasibility study
ft	feet
FTIR	Fourier transform infra-red
g	gram
GAA	generator accumulation area
gm/cc	grams per cubic centimeter
HEAST	Health Effects Assessment Summary Tables
HHRA	human-health risk assessment
HQ	hazard quotient
IDEQ	Idaho Department of Environmental Quality
IOI	Idaho Optimization Initiative

IRIS	Integrated Risk Information System
kg	kilogram
kg/L	kilograms per liter
kph	kilometers per hour
km	kilometer
L/kg	liters per kilogram
LDR	land disposal restriction
LEC	level of ecological concern
LOAEL	lowest observed adverse effect level
$\mu g/m^3$	micrograms per cubic meter
m^3	cubic meter
MCL	maximum contaminant level
mg/cm^2	milligrams per square centimeter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MRL	minimum risk level
m/s	meters per second
NCEA	National Center for Environmental Assessment
NFA	no further action
NOAEL	no observed adverse effects level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
p	precipitation
PCB	polychlorinated biphenyl
pCi	picoCuries
PEF	particulate emission factor
PPRTV	peer-review toxicity values
PRG	preliminary remediation goal
QA	quality assurance
RA	remedial action
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act

RD	remedial design
RI	remedial investigation
ROD	record of decision
ROPC	radionuclides of potential concern
RU	remediation unit
RU-1, RU-2, etc.	Remediation Unit 1, Remediation Unit 2, etc.
s	second
SEP	supplemental environmental project
SFS	supplemental feasibility study
SMWU	solid waste management unit
SOW	statement of work
SPM	Scoping and Planning Memorandum
SRI	supplemental remedial investigation
SSL	soil screening level
SUF	site use factor
TB	toxicity benchmark
TCLP	toxicity characteristics leaching procedure
TIP	Technology Innovation Program
TPH	total petroleum hydrocarbons
TRV	toxicity reference value
95% UCL	95% upper confidence level
UF	uncertainty factor
VKT	vehicle kilometers traveled
VOC	volatile organic compound
WMU	waste management units
yr	year

Executive Summary

FMC discontinued manufacturing operations at its elemental phosphorus production facility in Pocatello, Idaho in December 2001. FMC has initiated activities to decommission the facility and is participating in the Idaho Optimization Initiative (IOI) to identify new commercial and/or industrial uses for the site. This RI Report Update Memorandum for the FMC Plant Operable Unit (OU) is part of a supplemental remedial investigation and feasibility study (SRI/SFS) process that updates environmental information for the FMC Plant OU and will support site redevelopment. The evaluation of existing data, and the identified data gaps, is based on the assumption that FMC will no longer operate the facility. Another key assumption is that portions of the site will be redeveloped for commercial/industrial reuse, and other areas will not be redeveloped because they will be capped or covered to prevent future releases of contaminants.

This Memorandum consolidates the extensive environmental characterization data obtained during the EMF Site remedial investigation of the FMC facility during 1992 – 1994 with subsequent groundwater, soil, and waste management unit characterization data. Current conditions at the former working areas of the plant and at over 100 solid and hazardous waste management units have been evaluated to update the assessment of potential hazardous substance source areas. These potential source areas are grouped into 23 Remediation Units (RU).

This Memorandum also presents the results of an ecological assessment regarding the potential risks associated with exposures in the undeveloped portions of FMC Plant OU. Various factors negate the potential for ecological exposures in the developed portions of the FMC Plant OU.

This evaluation of potential source areas, release mechanisms from these source areas, and potential routes of exposure provides an updated understanding of site conditions that may pose risks to future workers and ecological receptors at the site. Screening criteria to identify site conditions that might pose a risk to future site workers, including workers engaged in construction and utility installation, and ecological receptors have been updated in accordance with EPA guidelines.

Each RU was evaluated using EPA's Data Quality Objectives process to determine if available site characterization data were sufficient to identify:

- Areas where sufficient data are available to support selection of a remedial action;
- Areas that require additional site characterization data before they can be further evaluated in the supplemental feasibility study process or excluded from further action; and
- Areas where no further action is required.

None of the RUs can be eliminated from further action at this time, although the actions being taken to close hazardous waste management units subject to RCRA Interim Status standards (RU 22a) and to remediate the Calciner Ponds (RU 14) under a Consent Order with the State of Idaho can be excluded from the CERCLA RI/FS process, consistent with EPA's One Cleanup Program initiative.

Sufficient data are available for a number of RUs, and these should proceed to evaluation of remedial action alternatives in the supplemental feasibility study. There have been no

substantive changes in site conditions at the Old Phossy Ponds (RU 22b), the Calciner Solids Stockpile Area (RU 22c) and the Railroad Swale (RU 22c) since the EMF Site RI/FS was completed. The conclusion of the 1998 EMF Site ROD that remedial action is needed at these areas therefore continues to be supported.

Additional site characterization data are needed at the remaining RUs. However, these data needs are spatially focused and include:

- Delineating the lateral extent of a RCRA-engineered cap to prevent exposure to soils containing elemental phosphorus associated with historic spills and leaks from process equipment at the former elemental phosphorus production, storage, and handling areas in RU 1 and RU 2;
- Measuring gamma radiation levels where slag has been used as construction fill;
- Sampling several sites in RUs 4, 5, and 20 where fuel oils and solvents were managed to determine the need for potential "hotspot" removal; and
- Collecting additional soil samples at RUs 3, 4, 5, 6, 9, 11, and 13 to compare inorganic constituents with screening criteria at a greater statistical confidence level than can be supported with the existing data.

No further site characterization data are needed to evaluate potential risks to ecological receptors in the undeveloped western and southern portions of the FMC Plant OU. While there are minor exceedences of target risk thresholds for several avian and plant species with respect to fluoride, there is only a marginal likelihood that an adverse effect on population size or community composition of species in the area will occur.

A supplemental remedial investigation to address the data needs identified in this Memorandum will be implemented and can be completed in a timeframe that supports future commercial/industrial redevelopment of the site.

Section 1
Introduction

This RI Update Memorandum has been developed to fulfill the requirements of Tasks 1.2 through 1.5 of the Statement of Work (SOW) for the Supplemental Remedial Investigation and Supplemental Feasibility Study (SRI/SFS) for the FMC Plant Operable Unit (OU) (SOW, 2003). As such, the objectives of the RI Update Memorandum are to:

- Present an updated Conceptual Site Model (CSM) for the FMC Plant OU. Development of the updated CSM and a description of potential sources, release mechanisms, exposure pathways, migration routes, and potential receptors, are presented in Section 2.
- Present a compilation of available data describing the nature and extent of contamination for exposure pathways and former working areas relevant to the updated CSM. This compilation is presented in Section 3.
- Present a proposed Risk-Based Concentration (RBC) for elemental phosphorus. The proposed RBC is presented in Section 4.
- Present an assessment of potential ecological risks within undeveloped areas of the FMC Plant OU for three chemicals of concern (cadmium, fluoride, and zinc) that were quantitatively evaluated in the Ecological Risk Assessment (E&E, 1995), as well as for vanadium and chromium. This assessment is presented in Section 5.
- Compare site characterization data with RBCs, including the proposed RBC for elemental phosphorus, as a preliminary screen to identify areas of the FMC Plant OU that potentially require additional characterization. This comparison is presented in Section 6.
- Identify and document the rationale for excluding any areas of the FMC Plant OU from further evaluation in the Supplemental RI/FS. These areas and the rationale for exclusion are summarized in Section 7.1.
- Identify and provide characterization data for areas where adequate data exist to proceed with an evaluation of remedial action alternatives under the Supplemental Feasibility Study for the FMC Plant OU. These areas are summarized in Section 7.2.
- Identify areas for which data gaps exist and identify data needs for these areas to be addressed in a future Supplemental RI Work Plan. These areas are summarized in Section 7.3.

Section 2
Conceptual Site Model

A conceptual site model (CSM) for potential human exposure to contaminants from the Eastern Michaud Flats Site was presented in Sections 1.3 of the Baseline Human Health Risk Assessment (BHHRA) (Ecology & Environment 1996) and in Section 6.1 of the EMF Site Record of Decision (ROD) (EPA 1998). The EMF Site CSM identified current and/or potential future exposure pathways through which current and potential future site workers (FMC and Simplot employees and contractors) and nearby residents could be exposed to site-related contamination. The CSM for the EMF Site is reproduced in Figure 2-1. The FMC Plant OU consists of the Pocatello plant site and the FMC properties north of the plant site shown in Figure 2-2.

The FMC and Simplot facilities were operational when EPA selected a remedy for the EMF Site in 1998. The ROD assumed that the most likely future land use at each facility was continued industrial use, with each company operating its facility and controlling exposures to hazardous substances, pollutants, and contaminants in accordance with environmental requirements applicable to ongoing manufacturing operations. However, the ROD also evaluated the potential exposure of a hypothetical future site worker to assess the risks that the plant area could pose in the future, if it were to be converted to a different commercial or industrial use under different management.

FMC ceased production of elemental phosphorus from phosphate ore at the facility in December 2001. FMC has initiated activities to decommission the facility and is participating in the Idaho Optimization Initiative (IOI). The IOI was created by Governor Kempthorne to form a committee of local governmental representatives including the Shoshone-Bannock Tribes and interested citizens dedicated to identify new commercial or industrial redevelopment uses for the site. Consideration has been given to uses in the following areas: intermodal distribution / warehousing, high tech design / assembly, power generation, biobased products and/or bioenergy, and broad-based industrial parks. The site's assets, such as existing rail spurs, roads, and water and sewage services, and location, such as proximity to high-voltage power distribution lines, Interstate 86, Union Pacific Railroad tracks, Pocatello Regional Airport, and interstate gas pipeline, are ideal for industrial reuse.

However, redevelopment of some areas within the FMC Plant OU is constrained by several factors:

- As required under RCRA, FMC has recorded deed restrictions that prohibit intrusion into the cover, and within a 10-foot area beyond the cover, of two hazardous waste management units that have been closed in accordance with RCRA Closure Plans. FMC will record similar deed restrictions for an additional group of hazardous waste management units when the final cap is placed on these units in 2004 and 2005. FMC will also record similar deed restrictions at the closed Calciner Scrubber Wastewater Ponds, which are being remediated under an Administrative Order with the Idaho Department of Environmental Quality (IDEQ). Consequently, these capped areas would not be available as sites for construction of new facilities.
- The EMF ROD selected capping as the preferred remedy for the “Old Phossy Waste Ponds” and the “Old Calciner Pond Solids Storage Area” of the FMC Plant OU to

reduce the potential for precipitation infiltration and exposure to contaminated soils and waste materials. The EMF ROD also required FMC to extend the lining of the Railroad Swale at least 830 feet or replace it. Consequently, these capped areas also would not be available as sites for construction of new facilities. FMC anticipates land use restrictions to prevent intrusion through any cap/liner at the Railroad Swale will be implemented if capping is the selected remedy for RU 22c. These restrictions are appropriate and consistent with FMC's remediation vision for RU 22c.

- The EMF ROD selected groundwater monitoring and contingent groundwater extraction for hydraulic control to address impacted groundwater within FMC properties. The EMF ROD requires FMC to implement land use restrictions that a) prevent ingestion of groundwater containing site-related constituents above MCLs or risk-based concentrations, b) prevent future residential use of the FMC plant area, and c) require that future office buildings be constructed using radon control methods specified in an EPA guidance document titled "Radon Prevention in the Design and Construction of Schools and Other Large Buildings" (EPA 1994a). Consequently, redevelopment planning for the FMC Plant OU assumes that these land and groundwater use restrictions will be applicable.

Figure 2-3 depicts areas within the FMC Plant OU that are subject to these land and groundwater use constraints. This figure also depicts additional areas of the FMC Plant OU that are subject to supplemental investigation under the SRI/SFS process. The resulting ROD Amendment for the FMC Plant OU may determine that additional areas should be subject to additional land use controls.

In light of the cessation of phosphate ore processing and the potential for site redevelopment within the constraints noted above, the CSM is herein updated to identify potential exposure pathways under both current conditions and potential future commercial/industrial use of the FMC Plant OU. The updated CSM describes potential sources of hazardous substances within the FMC Plant OU, potential release mechanisms from these sources, and potential pathways by which current and future receptors could be exposed to such releases. The updated CSM serves as a framework for developing the scope of a supplemental remedial investigation (SRI) and supplemental feasibility study (SFS) of remedial action alternatives for the FMC Plant OU.

Section 2.1 discusses regulatory guidance for developing a CSM. The operational history of each former working area is evaluated in Section 2.2 to determine if there are site-related constituents and potential pathways of exposure to these constituents that were not evaluated during the RI. Areas of the FMC facility listed in Table J-1 of FMC's RCRA Part B Permit Application (as amended September 2002) (FMC 2002a) have been reviewed to identify former working areas. This section also discusses changes in facility operations since development of the original CSM that affect the scope of the updated CSM.

The updated CSM is presented in Section 2.3. The updated CSM includes consideration of areas already evaluated during the EMF Site RI/FS and 1998 ROD, but focuses on former working areas of the plant that were excluded from the EMF Site RI/FS and June 1998 ROD.

2.1 Factors Influencing the Updated CSM

This section discusses EPA guidelines for developing a CSM (Section 2.1.1). It also describes land use controls for certain hazardous waste management units required under RCRA (Section 2.1.2), and land and groundwater use restrictions identified in the EMF Site Record of Decision (ROD).

The agency coordination committee (comprised of EPA, IDEQ, Tribal representatives) commented on an October 2003 draft schematic of the updated CSM. The comments concerned the identification of potential sources, release mechanisms, exposure media, and exposure pathways. Section 2.3 describes how each comment was addressed in preparing the updated CSM.

2.1.1 CSM Guidance

EPA guidance (EPA 2002) for developing a CSM for a site with an anticipated non-residential land use is summarized in Figures 2-4 through 2-7. EPA recommends that a CSM be described in schematic format, such as that shown in Figure 2-8.

EPA recommends that reasonably anticipated future land use be identified as the first step of the CSM development process. As noted earlier, State and local agencies are engaged under the IOI committee to identify potential future commercial or industrial land use for part(s) of the FMC Plant OU. As stated in Section 10.2.3 of the EMF Site Record of Decision (ROD) (Land Use Restrictions), *"FMC shall also implement legally enforceable land use controls that run with the land in the form of deed restrictions to eliminate the possibility for future residential use of the FMC Plant Area."* Consequently, the updated CSM will assume a future commercial and/or industrial land use for the FMC Plant OU.

EPA also recommends that a CSM for a commercial or industrial site focus on two types of worker receptors — Outdoor Workers and Indoor Workers — unless anticipated future site activities are expected to result in substantial exposures to members of the public and/or children visiting the site. It is unlikely that future site activities would result in substantial exposures to members of the public (as might occur if the site were redeveloped as a retail business area) and/or to children (as might occur is the site were redeveloped as a school or day-care facility). Consequently, the updated CSM will identify potential exposure pathways for outdoor and indoor workers.

EPA recommends that a CSM identify potential future site activities that may contribute to exposure. Examples of activities that might occur during potential industrial redevelopment of the FMC Plant OU would include construction activities, utility installation, outdoor maintenance work and landscaping, indoor activities (e.g. manufacturing operations and office work), and monitoring and maintenance activities associated with RCRA post-closure (CERCLA/IDEQ post-remedial action) care of closed (remediated) waste management units.

As noted in Figure 2-6a, EPA recognizes six generic potential exposure pathways through which commercial/industrial site indoor and/or outdoor workers might be exposed to contaminated surface and subsurface soils. EPA also identifies six generic exposure pathways through which construction workers might be exposed to contaminated surface and subsurface soils, as noted in Figure 2-6b. EPA recommends that site managers evaluate site conditions to determine if there are pertinent exposure pathways other than the six generic pathways. Section 2.2.4 discusses how these guidelines were addressed to identify potential exposure pathways in the updated CSM.

As noted in Figure 2-7, EPA indicates that in the absence of site-specific information to the contrary, site assessments should assume that an individual receptor will have random exposure to surface soils at both residential and non-residential sites. EPA recommends that site assessment sampling plans develop a reliable estimate of the arithmetic mean of constituent concentrations for surface soils within the area that the receptor could be exposed. EPA also recommends that the depth over which soils are sampled should reflect the type of exposures expected. Activities typical for non-residential site uses (e.g., landscaping and other outdoor maintenance activities) may result in direct contact exposure for certain receptors to contaminants in shallow subsurface soils at depths of up to two feet. If available evidence indicates that contaminated subsurface soils will be disturbed and brought to the surface (e.g., as the result of redevelopment activities), EPA recommends that site managers characterize subsurface contamination with a sufficient number of samples to develop a 95% upper confidence level (UCL95) value as a conservative estimate of the mean.

EPA also recommends that CSM development for all soil screening evaluations include the identification of ground water use. Section 10.2.3 (Land Use Restrictions) of the EMF Site ROD states *"FMC shall implement legally enforceable land use controls that will run with the land (i.e., deed restrictions, limited access, well restrictions and or well head protection) to prevent ingestion of ground water with COCs above MCLs or RBCs. These controls will remain in place as long as ground water exceeds MCLs or RBCs."* Consequently, the updated CSM will reflect that these land use controls remain in place to prevent the ingestion of contaminated groundwater within the FMC Plant OU in the manner indicated in the EMF Site ROD.

2.1.2 Guidance Specific to Landfills.

The February 2004 Scoping and Planning Memorandum for the Supplemental RI and Supplemental FS for the FMC OU (SPM) (FMC 2004) notes that the EPA guidance entitled *"Presumptive Remedy for CERCLA Municipal Landfill Sites"* (EPA, 1993) will be utilized as guidance for investigation and/or remedy selection at RUs 17 (Recyclable Material Landfill), 18 (Plant Landfill) and possibly, portions of 19 (Slag Pile with buried former plant landfill and other possible buried miscellaneous wastes/debris). The objective of this directive is to streamline the remedial investigation and assessment of remedial action objectives for municipal waste landfills based on the presumption of a containment remedy. Figure 2-9 presents relevant passages from this directive, including objectives, the components of the presumptive remedy, role of the conceptual site model, and characterization of potential contaminant release/transport mechanisms, affected media, receptors, and exposure pathways. The potential applicability of the EPA directive on updating the CSM is discussed further in Section 2.3.

2.1.3 One Cleanup Program Considerations

Recognizing that CERCLA remedial action and RCRA corrective action involve similar investigations and have similar objectives, EPA has established a policy to make these two programs equivalent. This policy, known as the One Cleanup Program Initiative, is further discussed in the SOW for the SRI/SFS for the FMC Plant OU.

The FMC facility contains hazardous waste management units (WMUs) regulated under the Resource Conservation and Recovery Act (RCRA) that are in the process of RCRA closure or post-closure. As of February 2004, FMC has certified completion of closure of five of the RCRA WMUs — Ponds 8S (WMU #7) and 9E (WMU #9); Wastewater Treatment Unit (WMU #12); Anderson Filter Media Wash Station (WMU #13); Drum Storage Unit (WMU #1) — in

accordance with RCRA closure plans. FMC has completed the initial phase of closure activities at all the remaining RCRA WMUs in accordance with closure plans approved by EPA Region 10. FMC expects to certify completion of closure of Pond 15S (WMU #3), the Phase IV Ponds (WMU #8), Pond 16S (WMU #10), and Pond 8E (WMU #11) later in 2004. FMC anticipates certifying completion of closure of Pond 17 (WMU #14) and Pond 18 (WMU #15) by 2005. FMC submitted documentation to EPA that the 8S Recovery Process (WMU #4) was closed in 1993 in the manner described in the closure plan and requested EPA approval of the closure plan; FMC will certify closure of this unit following EPA approval of the closure plan. FMC will conduct RCRA closure at the Slag Pit Wastewater Collection Sump (WMU #5) after EPA has approved the closure plan for that unit. Post-closure activities at the Slag Pit Wastewater Collection Sump will be coordinated with CERCLA remediation of the slag pit area.

Certain RCRA less-than 90-day hazardous waste generator accumulation areas (GAAs) are in operation to support facility decommissioning and demolition activities. As required by the RCRA hazardous waste management standards, these GAAs are designed and operated to prevent releases and will be closed by waste removal and equipment decontamination. Potential releases from the GAAs are encompassed within the scope of the Supplemental RI/FS, but closure, including any necessary decontamination, will be addressed pursuant to RCRA requirements.

FMC signed a consent order with IDEQ on July 8, 2002 to implement remedial action for the calciner ponds (RU#14), located on State-jurisdiction land in the eastern portion of the FMC facility. A Remedial Action Plan for the calciner ponds was approved by IDEQ in December 2003 in accordance with the IDEQ consent order. As of February 2004, FMC has completed dewatering and installation of the initial fill and temporary cover at Calciner Ponds 1C, 3C, and 4C. Completion of the remedial action (capping) at the Calciner Ponds is scheduled to be completed by the end of the 2005 construction season. The timing of the final cap is dependent on meeting acceptable settlement rates for the initial fills at Ponds 1C, 3C, and 4C.

2.2 Evaluation of Former Working Areas

Section 2.2 presents an evaluation of former working areas within the FMC Plant OU to identify additional potential sources, release mechanisms, receptors, and exposure pathways. Former manufacturing process areas, feedstock and byproduct storage areas, and waste management areas of the FMC Plant OU are outlined in Figure 2-2 ["RU-1"] and listed in Table 2-1. These "former working areas" encompass all potential source areas that may have released hazardous substances within the FMC Plant OU. These former working areas were also clustered into preliminary Remediation Units (RU) in the SPM (FMC 2004).

Solid Waste Management Units (SWMUs) identified in FMC's current RCRA Part B Permit Application (as amended through September 2002) are cross-referenced with each preliminary Remediation Unit in Table 2-1. SWMUs are units from which releases of hazardous constituents that have the potential to be a threat to human health or the environment have occurred or have the potential to occur.

The operational histories of former working areas and related SWMUs are summarized in Appendix A. This appendix also summarizes findings from the EMF Site RI[1] and subsequent reports concerning the nature and extent of contamination associated with former working areas or SWMUs and other areas of the FMC Plant OU[2]. Further information on operational histories and previous investigation findings are presented in Section 3 of this RI Report Update. These operational histories and previous studies were reviewed to determine:

- Are there additional potential sources or further understanding of source characteristics or release mechanisms that should be reflected in the updated CSM? How do the issues reported by the public concerning former working areas[3] affect the identification of potential sources or influence the evaluation of site conditions?
- Are there new classes of potential receptors or potential exposure pathways that were not evaluated during the EMF Site RI or are there significant changes in the nature of potential exposure pathways? How should these receptors, pathways, or changes in pathway characteristics be addressed in the updated CSM?
- Are there site-related constituents that were not evaluated during the EMF Site RI? How should these constituents be addressed in the updated CSM?
- How should closures of RCRA waste management units, remediation of the Calciner Ponds, and decommissioning of manufacturing process units be reflected in the updated CSM?

The results of these evaluations are presented in the following sections.

2.2.1 Update: Potential Sources

This section identifies potential sources that were not described in the original conceptual site model for the EMF Site and changes in the characteristics of several potential sources that were included in the original CSM.

Residual Elemental Phosphorus (P4) from Former Spills and Process Leaks at P4 Production, Storage, and Handling Areas: A release of P4 to subsurface soils was detected in 1999 during excavation within the Furnace Building associated with installation of the Slag Ladling System. This release appeared to be attributable to leakage from the #3 Furnace P4 Sump. Subsequent review of notifications of spills and releases of process materials that

[1] The scope of the investigation included analysis of approximately 1,500 groundwater samples; potential source and soil samples from 200 locations; 3,600 air quality samples; 250 surface water and sediment samples; and aquatic and terrestrial ecology sampling. Groundwater flow was determined through quarterly measurements of groundwater elevations at over 100 wells. Characterization of groundwater flow was supplemented by a groundwater flow modeling study. An atmospheric dispersion modeling study was performed using emission inventories for 119 point, area, and line sources at the facilities (75 of which were within the FMC facility area, including emissions from the then-active Bannock Paving area).

[2] The information sources reviewed in Appendix A include: EMF Site Remedial Investigation Report; FMC's RCRA Part B Permit Application (FMC 2002a); FMC's 2/27/98 response to EPA's 1/22/98 CERCLA Section 104/RCRA Section 3007 information request (FMC 1998); FMC's 2/19/99 response to EPA's 10/23/98 and 1/12/99 information requests (FMC 1999); and FMC's 9/17/02 response to EPA's 7/8/02 RCRA Section 3008 information request (FMC 2002b).

[3] These issues are recorded in Section 3.2 of the SPM (FMC 2004).

contained, or may have contained P4 suggest that P4 may be present in subsurface soils beneath other parts of the Furnace Building - Phos Dock - Secondary Condenser area.

The presence of P4 in soils beneath the Furnace Building, the history of spills and releases of process materials containing, or potentially containing P4, and the potential for similar P4 releases to surrounding soils from other manufacturing process units related to P4 production, handling, and storage led FMC to designate the Furnace Building, Phos Dock,[4] Secondary Condenser Area as Area of Concern (AOC) #1 in its September 2001 amendment to Section J (Corrective Action) of its RCRA Part B Permit Application. AOC #1 corresponds to RU#1.

Consequently, residual P4 from former spills and process leaks at P4 production, storage, and handling areas is identified as an additional potential source in the updated CSM. SWMUs in RU#1 and other RUs at which P4 was produced, stored, or handled are listed in Table 2-2.

The CSM in the EMF ROD recognized that phossy water and precipitator slurry containing P4 were managed in ponds over the course of plant operations. RU#22a (RCRA Waste Management Units) and RU#22b (CERCLA Remedial Design / Remedial Action) include SWMUs (e.g., Pond 8S, SWMU 7) in which phossy water and precipitator slurry were managed.

Particulate Emission Reductions: Subsequent to publication of the ROD, EPA issued a Federal Implementation Plan (FIP) under the Clean Air Act that required reductions in particulate emissions from the FMC facility. Concurrently, FMC completed 13 Supplemental Environmental Projects (SEPs) during 1999-2001 pursuant to the FMC RCRA Consent Decree (entered July 13, 1999) that collectively reduced particulate emissions from on-going facility operations by approximately 80%. These emission controls met the reduction requirements established by the FIP. Moreover, emissions from these sources as well as other sources evaluated during the RI were subsequently eliminated upon cessation of elemental phosphorus manufacturing operations in December 2001. Consequently, FMC plant emissions associated with stacks and vents and operating areas are not identified as sources in the updated CSM. However, the updated CSM recognizes surface soils impacted by deposition from previous emissions from the FMC and J.R. Simplot facilities as a potential secondary source.

Elimination of Point-Source Discharge: FMC terminated the IWW discharge to the Portneuf River in August 2002 and, at FMC's request, EPA subsequently terminated the associated NPDES permit. This was the only point-source discharge associated with the FMC Plant OU. Consequently, the point-source discharge from the IWW Ditch is no longer identified as a potential source in the updated CSM for the FMC Plant OU. The IWW pond and ditch have been backfilled with silica in 2004. The sediments in IWW ditch and pond were left in place when these features were backfilled.

Carbon Monoxide Flare Pit: The CO flare pit was taken out of service after the Excess CO Combustor was installed. The pit was originally lined with silica, and the pit lining material was excavated prior to backfilling the pit.

Potential Buried Transformers at RU#12: As noted in Section 3.2 of the SPM (FMC 2004), EPA received public input that two transformers containing PCB oil were allegedly buried west of the Slag Pit. The specific public comment was *"2 transformers [15' X 15'] full of PCB oil*

[4] EPA identified the area surrounding product collection sumps at the Phos Dock as AOC #2 in its March 2002 RCRA Facility Assessment. Because this area is within the larger area identified by FMC as Remediation Unit #1 (or AOC #1), FMC believes it is redundant to designate the Phos Dock area as an AOC.

buried w of slag pit behind – on flat ground btw furnace bg and mobile shop, probably under the road now; used to store electrodes there, under overhead slurry lines – near fuel island." The location cited in the public comment corresponds to the northern portion of RU#12 (Former RP&S Area and Mobile Maintenance Shop). FMC is unaware of any transformers having been buried at this area. Burial of such used equipment would have been unlikely, given the recycling value of a used transformer (i.e., copper wire content, steel casing). Moreover, historic plant practice was to rewind the coils of large transformers and place them back in service. However, FMC agreed to investigate the potential presence of buried transformers in this area as an element of the RI Report Update. Pending further research into this issue during preparation of the RI Report Update, the updated CSM will assume that buried transformers containing PCBs may be present beneath a portion of RU#12, and that the transformers represent a potential source of PCBs.

Areas Operated With and Without Sustained Hydraulic Head: The original CSM did not distinguish among sources based on whether the source was operated with, or without, a sustained hydraulic head. The EMF Site RI found that unlined waste management units (e.g., Pond 8S) that operated with a sustained applied hydraulic head impacted both underlying soils to depths of up to 90 feet and groundwater in the upper aquifer. However, the RI also found that potential source areas that operated without a sustained applied hydraulic head did not significantly impact underlying soils (except where locally mixed through mechanical action) and that these sources did not contribute to contamination of the uppermost aquifer. This distinction between sources has been introduced to the updated CSM in order to clarify the nature and extent of impacted exposure media.

Free liquids may have been present in wastes managed at certain unlined units that did not operate with a sustained hydraulic head. These areas were the landfills within RU 17, 18 and 19, the Disposal Area behind the Laboratory and the Chemical Lab Seepage Pit in RU 5, and the Calciner Solids Stockpiles in RU 16. Free liquids, if present, may have seeped into underlying soils. Deep soil borings were completed at the Active Landfill (RU 18), the Chemical Laboratory Seepage Pit (RU 5), and the Calciner Solids Stockpile (RU 16) during the EMF RI. Although samples from these borings indicate some contaminant migration in the soils, there was no indication of groundwater contamination emanating from these sites using FMC's existing well network.

Petroleum fuels were stored and used at RU 20, and potential releases from these hydrocarbon storage facilities have not been fully investigated. At this time, the CSM recognizes that the operation of fuel storage facilities may have impacted soils and groundwater.

Feedstock Stockpiles: The sites of former unlined stockpiles of coke (SWMU 105) in RU#7 and nodules (SWMU 106) in RU#9 are new potential sources in the updated CSM.

2.2.2 Update: Potential Release Mechanisms

This section identifies a release mechanism (process spills containing P4) that was not described in the original conceptual site model for the EMF Site. It also describes modifications to release mechanisms identified in the original EMF CSM.

Subsurface Excavation: Subsurface excavation of areas containing residual P4 from historic process spills and leakage of P4 from manufacturing process units during excavation for utility

line installation or facility construction is identified as a release mechanism associated with P4 production, storage, and handling areas.

Direct Contact: Direct contact is identified as a release mechanism associated with contaminated surface soils and exposed industrial feedstocks, by-products, and wastes.

Erosion/Storm Water Runoff: Erosion/storm water runoff is identified as a release mechanism associated with contaminated surface soils and exposed industrial feedstocks, by-products, and wastes.

Infiltration/Percolation: The original EMF CSM identified infiltration/percolation as a release mechanism associated with ponds and other waste management units, without classifying units with respect to whether they were operated with or without a sustained hydraulic head. The updated CSM recognizes infiltration/percolation as a release mechanism associated with sources that operated with a sustained hydraulic head. Pursuant to the RI findings noted earlier, the updated CSM does not identify infiltration/percolation as a release mechanism associated with sources that operated without a sustained hydraulic head with the exception of unlined units within RUs 4, 5, 16, 17, 18, and 19 where wastes containing free liquids may have been managed. In addition, the updated CSM recognizes infiltration/percolation as a potential release mechanism where petroleum fuels were stored in RU 20.

Use of Byproduct as Fill: The use of slag (a by-product from manufacturing elemental phosphorus) as fill was previously identified in the EMF Site CSM for the FMC plant area. The updated CSM continues to identify the potential use of byproduct as fill as a potential release mechanism.

Surface Water Discharge: The original CSM identified surface water discharge as a release mechanism associated with the IWW Ditch. As noted earlier, FMC terminated the IWW discharge to the Portneuf River in August 2002. Consequently, the updated CSM deletes this surface water discharge as a release mechanism. The EMF RI Report demonstrated that there was no discharge of storm water runoff to surface water because runoff was contained within the FMC plant area. This finding remains applicable.

Air Emissions: The original CSM identified air emissions as a release mechanism from three groups of FMC potential sources. As noted earlier, particulate emissions were substantially reduced subsequent to the ROD and were largely eliminated upon cessation of manufacturing operations in December 2001. Moreover, gaseous emissions of phosphine and hydrogen cyanide from surface impoundments used to manage hazardous wastes have been effectively mitigated under the RCRA closure plans for these units. The updated CSM does not identify air emissions as a primary release mechanism. However, particulate emissions are identified in the updated CSM as a secondary release mechanism associated with activities (e.g., excavation, vehicle traffic on unpaved roads) that have the potential to generate fugitive dust emissions from impacted soils.

2.2.3 Update: Potential Exposure Media

This section updates the description of environmental media that could be impacted by potential releases from sources within the FMC Plant OU.

Soil: Soil quality may have been impacted through the following historical and/or current release mechanisms:

- Infiltration/percolation of constituents from a) unlined waste management units that operated with a sustained hydraulic head; b) unlined waste management units at which wastes containing free liquids were managed; and c) petroleum storage facilities, could have impacted subsurface soils
- Deposition (fallout) of constituents from former emissions at the FMC and Simplot facilities;
- Process spills and leakage from former P4 production, storage, and handling areas;
- Storage of feedstocks, byproducts, or waste materials in unlined stockpiles;
- Use of feedstocks, byproducts, or waste materials as fill (including use of materials in roadbed); and
- Spills of solvent and/or petroleum hydrocarbons at limited areas of RU 5, 12, 20, and 22b.[5]

Air: Air quality may be impacted through the following release mechanisms:

- Generation of fugitive dusts by wind;
- Generation of fugitive dusts by vehicle traffic on unpaved roads containing feedstocks, byproducts, or waste materials;
- Generation of fugitive dusts from excavation of impacted soils;
- Oxidation of P4 during excavation soils containing over 1,000 mg/kg P4, resulting in a potential fire or evolution of smoke (P2O5);
- Radon emanation from feedstocks, byproducts, or waste materials containing radium-226;[6]
- Intrusion of organic vapors into buildings overlying the limited areas of RU 5, 12, 20 and 22b at which solvent wastes may be present[7]; and
- Air emissions from the adjacent J.R. Simplot Co. facility.

Groundwater: Groundwater quality may have been impacted through the following release mechanisms:

- Infiltration/percolation of constituents from unlined waste management units that operated with a sustained hydraulic head, and in the case of the J.R. Simplot Co. gypstack, continues to operate with a sustained hydraulic head

Surface Water and Sediment: There are no surface water bodies within the FMC Plant OU. However, the Portneuf River and Batiste Springs Channel are within the adjacent Off-Plant OU.

[5] The potential presence of solvent and petroleum hydrocarbon contamination is believed to be restricted to RU 5, 12, 20, and 22b as discussed in Section 6.

[6] The EMF ROD requires that future office buildings be constructed using radon control methods specified in an EPA guidance document titled "Radon Prevention in the Design and Construction of Schools and Other Large Buildings" (EPA 1994a)

[7] The potential presence of solvent and petroleum hydrocarbon contamination is restricted to RU 5, 12, 20, and 22b as discussed in Section 6.

Surface water and sediment quality within these bodies could be impacted through the following release mechanisms:

- Discharge of impacted groundwater to the Portneuf River in the vicinity of Batiste Springs.

2.2.4 Update: Potential Receptors and Routes of Exposure

This section updates the identification of potential receptors and routes of exposure that could be affected by potential releases from sources within the FMC Plant OU.

Potential Receptors:

- Commercial/Industrial Worker. The indoor office worker could be exposed to dust generated from erosion of surface soils. The outdoor worker[8] could be exposed to the upper two feet of soil.
- Utility Worker. The utility worker engaged in excavations for utility line installation could be exposed to the upper 10 feet of soil.
- Construction Worker. The construction worker engaged in excavations for facility construction could be exposed to the upper 10 feet of soil.
- Off-Site Resident. The off-site resident at the site boundary could be exposed to fugitive dusts from traffic on unpaved roads generated by site construction activities and wind generated fugitive dusts.

Potential Routes of Exposure:

- Incidental ingestion of constituents in soils by outdoor and indoor workers.
- Dermal absorption of constituents in soils by outdoor workers.
- External exposure[9] to gamma radiation associated with decay of uranium-238 and its daughters in soils, byproducts, and waste materials by outdoor workers.
- Exposure of utility or construction workers to fire or inhalation of smoke (P2O5) in the event that P4 in sufficient concentration (i.e., 1,000 mg/kg) is exposed to air as a result of excavation of subsoils containing P4.
- Inhalation of fugitive dusts by outdoor workers and nearby residents.

[8] Periodic monitoring and maintenance activities will be performed under the post-closure care plans for RCRA hazardous waste management units (e.g., Pond 16S) and the post-remedial action plans for areas remediated under the IDEQ Consent Order and the final CERCLA ROD for the FMC Plant OU. Potential exposure pathways for workers engaged in these activities, such as collection of groundwater quality monitoring samples and maintenance of final caps at closed impoundments, will be subject to unit-specific health and safety procedures developed under RCRA, IDEQ, and CERCLA standards, and are not applicable to the Commercial/Industrial Worker exposure scenario.

[9] This pathway was recognized in EMF Site CSM and is retained in the updated CSM.

- Inhalation of radon and its decay resulting from radon intrusion into indoor air by indoor workers.[10]
- Inhalation of organic vapors intruding into indoor air by indoor workers at limited portions of RU 5, 12, 20, and 22b.[11]

Inhalation of radon and its decay resulting from radon intrusion into indoor air by indoor workers will be prevented through institutional controls specified in the EMF ROD for the FMC Operable Unit. Ingestion of groundwater exceeding MCLs and RBCs will be prevented by institutional controls specified in the EMF ROD for the FMC Operable Unit.

Receptors and routes of exposure (i.e., incidental ingestion, dermal contact, and consumption of fish) associated with surface water and sediment impacted by the discharge of impacted groundwater are addressed by the Off-Plant Operable Unit in the EMF ROD.

2.2.5 Update: Site-Related Constituents

This section updates the identification of site-related constituents associated with potential releases from sources within the FMC Plant OU. The Constituents of Potential Concern (COPCs) evaluated in the EMF ROD are reprinted in Table 2-3.

Elemental Phosphorus and its oxidation products: P4 and P2O5 were recognized as site-related constituents in the 1998 EMF ROD. As noted in the ROD, "Quantitative evaluation of potential risks from phosphorus and its oxidation products [e.g., P2O5] were unavailable due to the lack of a standard EPA method for measurement of these constituents in air, and lack of information of the toxicological effects from inhaling low levels of these substances over a prolonged period of time." (EPA 1998, page 48-49) As noted earlier, the presence of P4 beneath the Furnace Building, the history of spills and releases of process materials containing, or potentially containing, P4, and the potential for similar P4 releases to surrounding soils from other manufacturing process units related to P4 production, handling, and storage confirms that elemental phosphorus and its oxidation products are site-related constituents. Given the cessation of the P4 manufacturing process, it is inappropriate to evaluate P4 as an airborne constituent (as indicated in the excerpt from the EMF ROD noted above). Rather, P4 and its oxidation products should be evaluated as potential soil-based constituents. At low concentrations, exposure to P4 and its oxidation products can occur via incidental soil ingestion and inhalation of fugitive dusts; however, if present at concentrations above 1,000 mg/kg, P4 can ignite if exposed to air in sufficient quantity.

2.3 Updated Conceptual Site Model

The results of the evaluations reported in Sections 2.1 and 2.2 are used in updating the conceptual site model for the FMC Plant OU in Section 2.3. The updated CSM reflects the recent changes at the FMC facility as well as the potential future industrial or commercial redevelopment of the FMC facility. In light of the cessation of phosphate ore processing at the FMC facility and its potential future industrial or commercial redevelopment, the updated CSM

[10] The EMF ROD requires that future office buildings be constructed using radon control methods specified in an EPA guidance document titled "Radon Prevention in the Design and Construction of Schools and Other Large Buildings" (EPA 1994a)

[11] The potential presence of solvent and petroleum hydrocarbon contamination is believed to be restricted to RU 5, 12, 20, and 22b as discussed in Section 6.

for the FMC Plant OU will be used as a framework to develop the scope of a supplemental remedial investigation and feasibility study of remedial action alternatives for the FMC Plant OU.

EPA provided two sets of comments from the agency coordination committee on an October 2003 draft schematic of the updated CSM. These comments, which are reprinted in Table 2-4, concern the identification of potential sources, release mechanisms, exposure media, and exposure pathways. Table 2-4 outlines how these have been addressed in the updated CSM.

The updated CSM illustrates how contaminants from source areas may be transported to other media and identifies which media are of principal concern with respect to potential current and future receptors and exposure pathways. The updated CSM reflects a future commercial/industrial land use for the FMC Plant OU, with institutional land use controls in place that prevent residential uses of the site as well as preventing consumption of contaminated groundwater, as required by the EMF ROD for the FMC OU.

Figure 2-10 illustrates the updated CSM for potential human exposure within the FMC OU. Individuals potentially exposed to FMC OU-related contaminants include current and potential future site workers and nearby residents. The principal current and/or potential future exposure pathways are:

- Dermal contact with, and incidental ingestion of, contaminated soils, byproducts, and waste materials;
- External radiation exposure from contaminated soils, byproducts, and waste materials;
- Inhalation of fugitive dusts generated during excavation of contaminated soils, byproducts, and waste materials;
- Fire or smoke if P4 is exposed to air as a result of excavation of subsoils containing P4 at a concentration above 1,000 mg/kg;
- Incidental ingestion of P4 and inhalation of fugitive dusts assumed to contain phosphoric acid are potential exposure pathways for soils containing less than 1,000 mg/kg P4;
- Inhalation of radon, and exposure to radon-decay products, in indoor air;[12]
- Inhalation of organic vapors intruding into indoor air by indoor workers at limited portions[13] of RU 20; and
- Inhalation by off-site residents of fugitive dusts generated by wind and traffic on unpaved roads during site construction activities.

[12] The EMF ROD requires that require that future office buildings be constructed using radon control methods specified in an EPA guidance document titled "Radon Prevention in the Design and Construction of Schools and Other Large Buildings" (FMC 1994a)

[13] The potential presence of solvent and petroleum hydrocarbon contamination is restricted to RU 20, as discussed in Section 3.

Potential Sources

The updated CSM identifies potential sources of hazardous substances within the FMC Plant OU, potential release mechanisms from these sources, and potential current and future exposure pathways to such releases. It also identifies potential sources beyond the boundary of the FMC Plant OU that may contribute to potential exposure within the FMC Plant OU.

The updated CSM is based on information obtained during the EMF Site RI and FS for the FMC Subarea (FMC 1997) and evaluation of site conditions since completion of the EMF Site RI and FS for the FMC Subarea. The EMF Site RI found that unlined waste management units that operated with a sustained applied hydraulic head contributed releases to groundwater in the upper aquifer. The RI also found that potential source areas that operated without a sustained applied hydraulic head did not contribute to contamination of the uppermost aquifer. These findings have been used in updating release mechanisms and potential exposure media associated with each type of waste management unit, except as noted below:

- Free liquids may have been present in wastes managed at certain unlined units that did not operate with a sustained hydraulic head. These areas were the landfills within RU 17, 18 and 19, the Disposal Area behind the Laboratory and the Chemical Lab Seepage Pit in RU 5, and the Calciner Solids Stockpiles in RU 16. Free liquids, if present, may have seeped into underlying soils. Deep soil borings were completed at the Active Landfill (RU 18), the Chemical Laboratory Seepage Pit (RU 5), and the Calciner Solids Stockpile (RU 16) during the EMF RI. Although samples from these borings indicate some contaminant migration in the soils, there was no indication of groundwater contamination emanating from these sites using FMC's existing well network.
- Petroleum fuels were stored and used at RU 20, and potential releases from these hydrocarbon storage facilities have not been fully investigated. At this time, the CSM recognizes that the operation of the fuel storage facilities may have impacted soils and groundwater.

The updated CSM also reflects an initial consideration of former working areas of the plant[14] that were excluded from the RI, FS, and ROD. The updated CSM includes the following additional potential sources: Area of Concern #1 (comprised by the Furnace Building, Phos Dock, and Secondary Condenser area); the Slag Pit (prior to installation of slag ladling); former shale ore handling areas; former nodule and nodule fines handling areas; and the former coke storage area. Contamination of surface soils by deposition of former emissions from the FMC and Simplot facilities is recognized as a secondary source.

The operational history and features of former working areas will be further evaluated as the specific objectives of the Supplemental RI/FS are further developed. The updated CSM will be revised if this evaluation identifies additional potential sources, release mechanisms, or exposure pathways.

[14] Areas of the FMC facility listed in Table J-1 of FMC's RCRA Part B Permit Application (as amended September 2002) have been reviewed to identify former working areas included in this CSM.

Potential Release Mechanisms

Potential release mechanisms that could result in exposure to FMC OU-related contaminants are:

- The use of by-product (i.e., slag) from the manufacturing process as fill;
- Direct contact with contaminated surface soils and industrial feedstocks, by-products, and wastes that are stored on the ground surface;
- Excavation that exposes residual P4 at a concentration above 1,000 mg/kg from historic process spills containing P4 and leakage of P4 from manufacturing process units during excavation for utility line installation or facility construction;
- Erosion/storm water runoff of contaminated surface soils and industrial feedstocks, by-products, and wastes that are stored on the ground surface;
- Infiltration and percolation into soils and groundwater from a) unlined waste management units that operated with a sustained applied hydraulic head; b) unlined waste management units at which wastes containing free liquids were managed; and c) petroleum storage facilities within RU 20;
- Generation of fugitive dusts by traffic on unpaved roads during site construction activities; and
- Fugitive dust generated by wind and excavation-related activities.

Exposure Medium - Air

Emissions from the active Simplot facility might affect air quality within the FMC Plant OU.[15] FMC facility air emissions related to operations ceased in December 2001 other than minor sources (e.g., steam boilers) related to decommissioning activities. Fugitive dusts generated by traffic on unpaved roads during site construction activities might be inhaled by off-site residents.

Exposure Medium - Soils

The updated CSM recognizes the potential for releases to surface soils from feedstocks, by-products, and wastes in areas without a sustained applied hydraulic head. As determined by the EMF Site RI, in the absence of a sustained hydraulic head, such sources have had little effect on subsurface native soils, and essentially no effect below a depth of five feet. Areas to which a sustained hydraulic head has been applied, such as the former unlined ponds, have had the potential to impact both underlying soils and groundwater in the uppermost aquifer.

With the exception of Cell B of Pond 18 and the Calciner Ponds 2C and 5C, all areas of sustained hydraulic head at the FMC Plant OU have been dewatered, backfilled, and covered with either a temporary cover or (in the case of Ponds 8S and 9E), a final cover. During remedial construction and pending installation of caps, worker (and construction worker) exposure to contaminated surface and subsurface soils within the FMC Plant OU is currently

[15] It is assumed that by compliance with the Clean Air Act, these emissions will not impact the FMC Plant OU. Consequently, these ongoing emissions will not be considered in a quantitative manner. Characterization of these releases and the associated development of remedial action objectives and evaluation of remedial action alternatives are not within the scope of the supplemental RI/FS for the FMC OU.

minimized by administrative controls. Physical barriers and facility security systems prevent trespassers from accessing contaminated surface soils.

The EMF Site RI found that certain fluoride emissions from the Simplot facility have the potential to impact surface soils in the off-plant area (part of which is in what is now defined as the FMC Plant OU). As noted earlier, FMC facility air emissions related to operations ceased in December 2001 other than minor sources (e.g., steam boilers) used for decommissioning activities. Consequently, the CSM recognizes deposition of historic emissions from the FMC facility onto surface soils within the FMC Plant OU as a previous, and discontinued, release mechanism.

Exposure Medium - Groundwater

The updated CSM recognizes sources that operated with a sustained hydraulic head at both the FMC facility and the Simplot facility have released contaminants to groundwater in the uppermost aquifer. In accordance with the EMF Site ROD, FMC shall implement legally enforceable land use controls that will run with the land (i.e., deed restrictions, limited access, well restrictions and/or well head protection) to prevent ingestion of groundwater with constituents of concern above MCLs or RBCs. These controls will remain in place as long as the groundwater exceeds MCLs or RBCs, and they apply to all groundwater within the FMC and Simplot property boundaries. Because of this, groundwater as a future exposure medium can be effectively ruled out in the updated CSM.

The EMF Site RI found that groundwater in the uppermost aquifer within the EMF site study area has been impacted by releases from former unlined waste management units at the FMC facility (former unlined ponds 1E through 6E, 00S through 9S, former unlined calciner ponds, and the Slag Pit wastewater collection sump) and by the gypsum stack and the former east overflow pond at the adjacent J.R. Simplot facility. Groundwater impacted by the gypsum stack is present in the eastern (Joint Fenceline) area of the FMC facility.

The EMF Site RI also identified low levels of site-related contaminants in the deeper aquifer in very limited areas of the FMC Plant OU, and at very low concentrations (below MCLs, and only slightly elevated above background levels). The American Falls Lake Beds were delineated beneath the FMC plant area as well as the old pond area (See Sections 3.3, 4.4, and Appendix K of the EMF RI Report).

Vertical gradients were evaluated during the EMF RI and in subsequent groundwater monitoring events. Monitoring well pairs located near the Simplot and FMC production wells displayed upward vertical gradients while the production wells were pumping, with the exception of slight downward gradient in the Shallow/Deep well pair 125/126 near FMC's production well FMC-3. These wells are located in a portion of the FMC Plant OU that has no indication of impacted groundwater quality. The localized and minor downward gradients were directly a result of deep groundwater extraction and would not induce the downward migration of contamination to the deeper aquifer because the shallow groundwater in area is not impacted. Overall, there was no inducement of downward gradient from these production wells that could have affected the deep aquifer within the FMC Plant OU. Sections 3.3 and 4.4 provide further information.

The EMF RI investigated the future scenario where all groundwater pumping ceased at Simplot and FMC. There was no change in the shallow groundwater flow patterns. Capture zones in the deeper aquifer were eliminated and larger volumes of deep groundwater were available for

discharge to the river and springs. FMC's groundwater monitoring data collected since the plant shut down in December 2001 support these conclusions.

Because deeper groundwater was not significantly impacted by FMC sources, and because the deeper aquifer has a significantly greater flux of water, downgradient water quality should improve as a result of decreased pumping from the deeper aquifer. This is because the residual contaminants in the shallow aquifer will be diluted by a much greater flux of clean, deep groundwater in the region near the Portneuf River and Batiste Springs.

Ongoing RCRA Interim Status detection monitoring by FMC at lined hazardous waste management units within the FMC facility has found no impact on groundwater from these waste management units. The EMF Site RI found the extent of groundwater impact to be limited to properties owned by FMC and the J.R. Simplot Company, with the exception of intervening railroad and highway right-of-ways. The EMF Site RI also found that groundwater flowing from portions of the FMC facility merges with groundwater flowing from portions of the Simplot facility within the joint fenceline area of the two facilities. The EMF Site RI did not attempt to attribute or allocate release sources in characterizing the nature and extent of groundwater impact within the joint fenceline area and in the properties owned by FMC and Simplot north of Highway 30.

Receptors and Routes of Exposure

A work force of approximately 10 FMC employees and up to 100 contract personnel (during the construction season) are engaged at the FMC facility in conducting the closure of RCRA waste management units and the calciner ponds, conducting decommissioning and asset removal activities, and identifying opportunities for future commercial or industrial reuse of the facility. These activities are expected to continue through 2005/2006, after which only a minimal work force[16] will remain at the site pending commercial/industrial reuse.

Under current (i.e., 2004 and 2005) conditions, individuals who may experience exposure at the FMC Plant OU are limited to plant workers. Current workers could be exposed to contamination through incidental contact with, and ingestion of soils, and external exposure to gamma radiation from byproducts and waste materials remaining at the site. Current workers could also be exposed to emissions from the adjacent Simplot facility.

Worker exposure to contaminated surface and subsurface soils at the FMC facility is currently minimized by administrative controls. Physical barriers and facility security systems prevent trespassers from currently accessing contaminated surface soils.

Consideration is being given to heavy and light industrial and manufacturing uses on the plant site, including warehouses for a distribution facility, a power generation plant, or light industrial, manufacturing and commercial uses on portions of the FMC property. The updated CSM assumes that the potential sources, release mechanisms, and exposure pathways applicable to

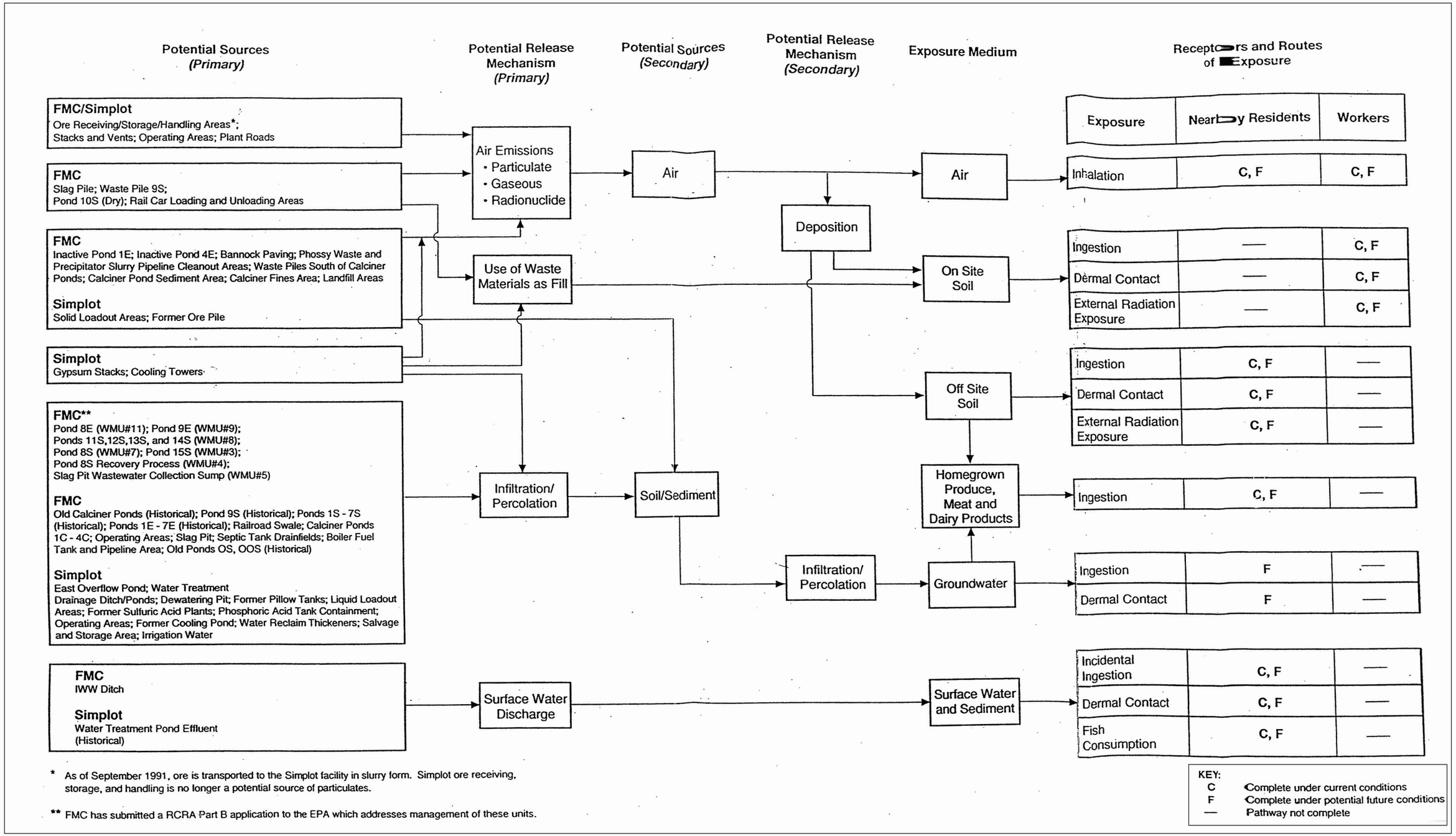
[16] Periodic monitoring and maintenance activities will be performed under the post-closure care plans for RCRA hazardous waste management units (e.g., Pond 16S) and the post-remedial action plans for areas remediated under the IDEQ Consent Order and the final CERCLA ROD for the FMC Plant OU. Potential exposure pathways for workers engaged in these activities, such as collection of groundwater quality monitoring samples and maintenance of final caps at closed impoundments, will be subject to unit-specific health and safety procedures developed under RCRA, IDEQ, and CERCLA standards, and are not applicable to the Commercial/Industrial Worker exposure scenario.

current workers are similarly applicable to future workers associated with potential industrial reuse of all, or portions of, the FMC facility.

The updated CSM identifies four types of future receptors: Commercial/Industrial Worker (subdivided into an Indoor Worker and an Outdoor Worker[17]); Utility Installation Worker; Construction Worker; and Off-site Resident.[18]

There is no current residential use of land within the FMC Plant OU and residential use of land within the FMC Plant OU would be inconsistent with industrial reuse. Moreover, FMC has filed land use restrictions with Power County that preclude residential uses of the FMC Plant OU, with the exception of the parcel formerly owned by the Union Pacific Railroad containing the closed Batiste Spring pumphouse. The FMC plant obtains its drinking water from wells within the deep aquifer, which currently meets MCLs. Future potential users of the FMC Plant OU would be required to obtain drinking water from wells within the deep aquifer or from the Pocatello municipal water supply system.

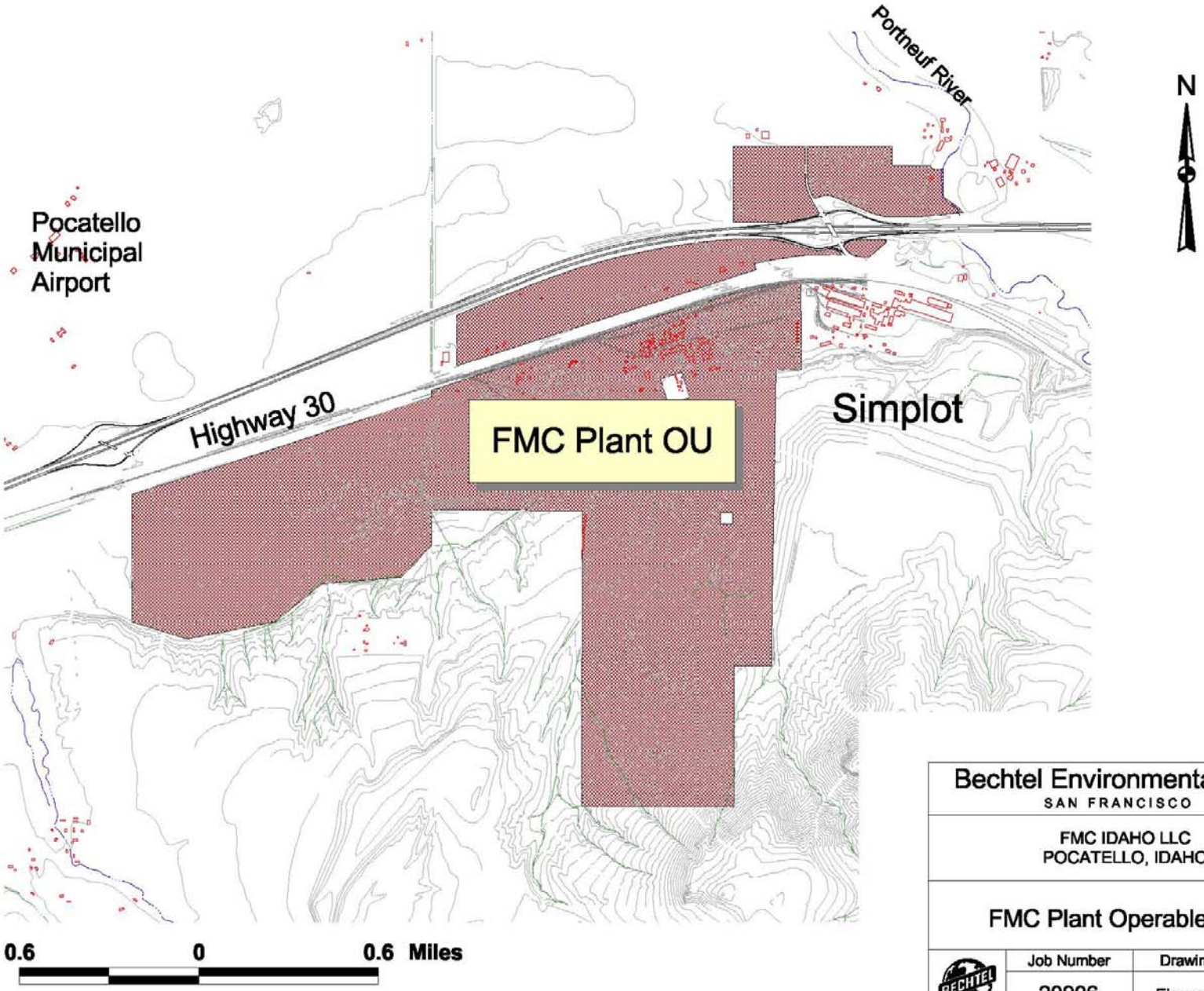
[17] A commercial/industrial worker may divide his/her time between indoor and outdoor activities.
[18] The Off-Site Resident might inhale fugitive dusts generated by traffic on unpaved roads during site construction activities and wind generated fugitive dusts for the remainder of the exposure duration.



* As of September 1991, ore is transported to the Simplot facility in slurry form. Simplot ore receiving, storage, and handling is no longer a potential source of particulates.

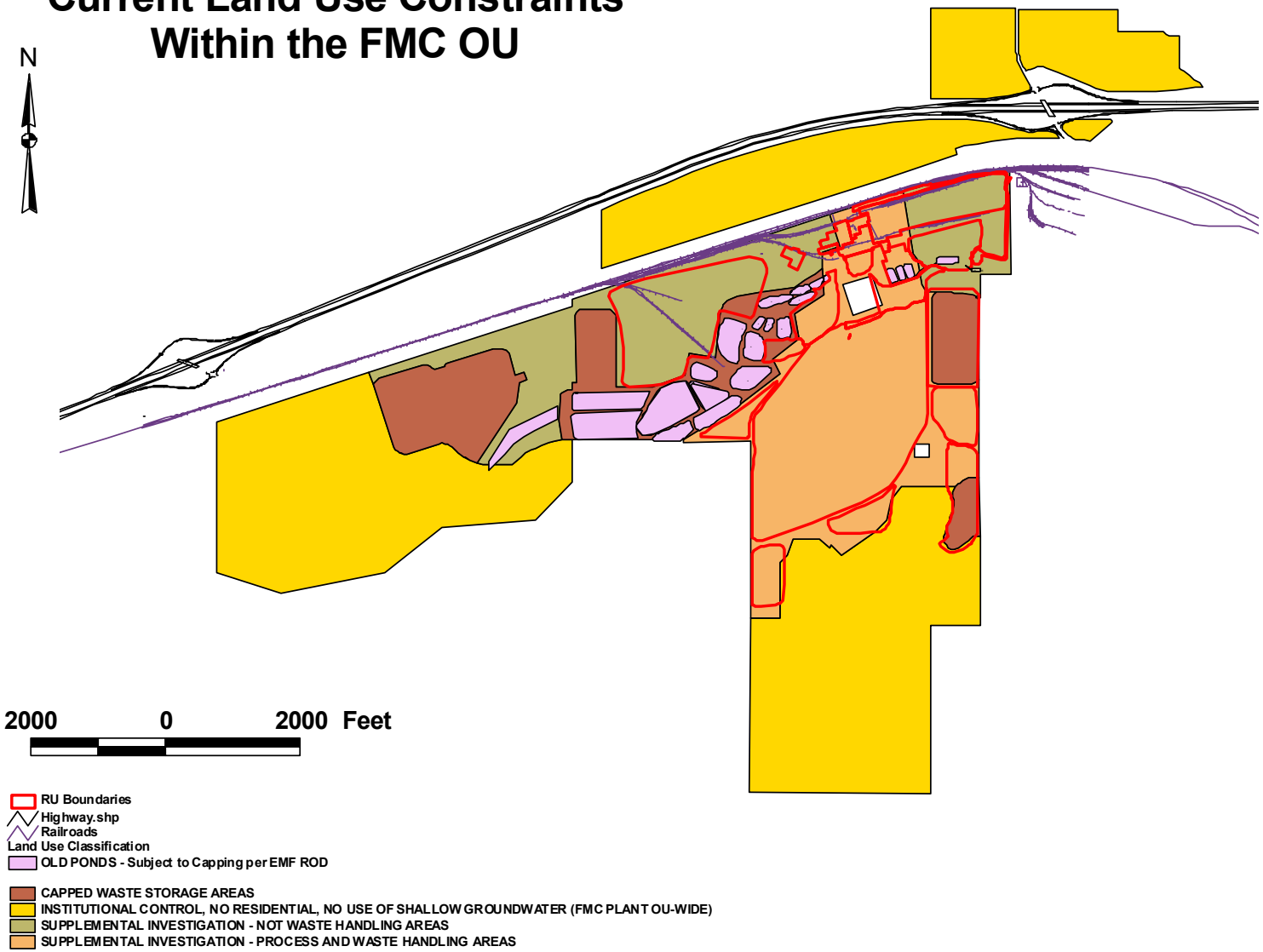
** FMC has submitted a RCRA Part B application to the EPA which addresses management of these units.

Figure 2-1
Conceptual Site Model from the EMF Site Record of Decision



Bechtel Environmental, Inc. SAN FRANCISCO			
FMC IDAHO LLC POCATELLO, IDAHO			
FMC Plant Operable Unit			
BECHTEL	Job Number	Drawing No.	Rev.
	20906	Figure 2-2	

Figure 2-3
Current Land Use Constraints Within the FMC OU



"The process of developing a CSM — a comprehensive representation of a site that illustrates contaminant distributions in three dimensions, along with release mechanisms, exposure pathways, migration routes, and potential receptors — is similar for non-residential and residential soil screening evaluations. The key differences in developing a CSM for a site with anticipated non-residential future land use are:

- **Identification of Land Use.** Identifying the reasonably anticipated future land use for an NPL site is critical to the development of the CSM. It is the first step toward identifying the future site receptors and activities that determine the key exposure pathways of concern. Future land use may also influence the selection of a screening approach by a site manager. Future industrial or commercial sites may be evaluated using any of the three screening approaches (generic, simple site-specific, or detailed site-specific modeling); sites with other non-residential future land uses (e.g., agriculture, recreation) are appropriately addressed using a detailed site-specific modeling approach.
- **Receptors for Non-Residential Uses.** When developing CSMs for commercial or industrial sites, the focus should be on worker receptors, unless anticipated future site activities are expected to result in substantial exposures to members of the public and/or children visiting the site (see Section 4.1.3). CSMs for commercial or industrial sites should include long-term receptors (e.g., indoor workers and outdoor workers) and, if appropriate, short-term, high intensity receptors (e.g., construction workers). For sites with future agricultural or recreational uses, CSMs should address a wider range of potential receptors (e.g., farm workers and children/adults exposed to contamination through consumption of agricultural products or children/adults engaged in recreational activities).
- **Activities for Non-Residential Uses.** In order to identify the exposure pathways pertinent to future exposures, site managers should consider the potential future site activities that may contribute to exposure. Examples of activities likely to occur at commercial/industrial sites include: outdoor maintenance work and landscaping, indoor commercial activities (e.g. wholesale or retail sales) and office work.

A key part of CSM development for all soil screening evaluations is the identification of ground water use. Site managers should consult EPA's policy on ground water classification (presented in Section 4.2.3) and should coordinate with state or local authorities responsible for ground water use and classification to determine whether the aquifer beneath or adjacent to the site is a potential source of drinking water. The migration to ground water pathway is applicable to all potentially potable aquifers, regardless of current or future land use." (EPA 2002, page 4-7)

"Normally, under the generic and simple site-specific screening methodologies, the receptors for the commercial/industrial scenario are limited to workers. EPA does not warrant evaluation of exposures to members of the public under a non-residential land use scenario for two reasons. First, because public access is generally restricted at industrial sites, workers are the sole on-site receptor. Second, even though the public usually has access to commercial sites (e.g., as customers), SSLs [soil screening levels] that are protective of workers, who have a much higher exposure potential because they spend substantially more time at a site, will also be protective of customers." (EPA 2002, page 4-3)

Figure 2-4
EPA Guidance for Developing a Conceptual Site Model for a Site with Anticipated Non-Residential Future Land Use

"As shown in Exhibit 4-1, two potential worker receptors are addressed under the commercial/industrial scenario. They are characterized by the intensity and location of their activities, and by the frequency and duration of their exposures.

Outdoor Worker. This is a long-term receptor exposed during the work day who is a full time employee of the company operating on-site and who spends most of the workday conducting maintenance activities outdoors. The activities for this receptor (e.g., moderate digging, landscaping) typically involve on-site exposures to surface and shallow subsurface soils (at depths of zero to two feet). The outdoor worker is expected to have an elevated soil ingestion rate (100 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal absorption of contaminants from soil, inhalation of fugitive dust, inhalation of volatiles outdoors, and ingestion of ground water contaminated by leachate. The outdoor worker is expected to be the most highly exposed receptor in the outdoor environment under commercial/industrial conditions. Thus, SSLs for this receptor are protective of other reasonably anticipated outdoor activities at commercial/industrial facilities.

Indoor Worker. This receptor spends most, if not all, of the workday indoors. Thus, an indoor worker has no direct contact with outdoor soils. This worker may, however, be exposed to contaminants through ingestion of contaminated soils that have been incorporated into indoor dust, ingestion of contaminated ground water, and the inhalation of contaminants present in indoor air as the result of vapor intrusion. SSLs calculated for this receptor are expected to be protective of both workers engaged in low intensity activities such as office work and those engaged in more strenuous activity (e.g., factory or warehouse workers).

The commercial/industrial scenario does not include exposures during construction activities. However, EPA recognizes that construction is likely to occur at many NPL sites and that it may lead to significant short-term exposures."

(EPA 2002, page 4-3 and 4-4)

Figure 2-5a
EPA Guidance for Identifying Receptors for a Commercial/Industrial Land Use

"Construction is likely to occur as part of the redevelopment process at many NPL sites, regardless of the anticipated future land use. Although construction is typically of relatively short duration (a year or less), it may lead to significant exposures to construction workers and off-site residents as a result of soil-disturbing activities that include excavation and vehicle traffic on unpaved roads. To help address this potential concern, EPA has developed a construction soil screening scenario that site managers can use to develop construction SSLs [soil screening levels]."

"The construction scenario assumes that one or more residential or commercial buildings will be erected on a site and that construction will occur within areas of residual soil contamination. Because the activities associated with such a project are likely to result in significant direct contact soil exposures (i.e., ingestion and dermal absorption) to construction workers and are likely to increase emissions of both volatiles and particulate matter from contaminated soils during the construction period, EPA recommends that site managers evaluate the construction exposure scenario whenever major construction is anticipated at a site. However, EPA realizes that developing SSLs based on a construction scenario may be difficult, especially if there is considerable uncertainty surrounding the details of future construction. In such cases, site managers can evaluate several plausible construction scenarios representing a range of activities, areal extents, and durations. The results of these evaluations can provide valuable information to help guide and focus future construction activities."

"The construction soil screening scenario evaluates exposures to construction workers present throughout a construction project, as well as exposures to nearby off-site residents. These receptors are potentially subject to higher contaminant exposures via increased volatile and fugitive dust emissions during construction activities.

- Construction Worker. This is a short-term adult receptor who is exposed to soil contaminants during the work day for the duration of a single construction project (typically a year or less). If multiple non-concurrent construction projects are anticipated, it is assumed that different workers will be employed for each project. The activities for this receptor typically involve substantial on-site exposures to surface and subsurface soils. The construction worker is expected to have a very high soil ingestion rate and is assumed to be exposed to contaminants via the following direct and indirect pathways: incidental soil ingestion, dermal absorption, inhalation of volatiles outdoors, and inhalation of fugitive dust.
- Off-site Resident. This receptor is similar to the one evaluated in the residential soil screening scenario but is located at the site boundary. The off-site resident is exposed to contaminants both during and after construction, for a total of 30 years. This receptor has no direct contact with on-site soils. Under this framework, the only exposure pathway evaluated for this receptor is the inhalation of fugitive dust, which is likely to be exacerbated during construction as a result of dust generated by truck traffic on unpaved roads."

(EPA 2002, pages 5-1, 5-2 and 5-5)

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Figure 2-5b
EPA Guidance for Identifying Receptors for the Construction Scenario

"Six exposure pathways are included in the commercial/industrial soil screening scenario. These pathways, as well as the relevant receptors for each pathway, are listed below:

Surface soil pathways:

- Incidental direct ingestion — indoor worker and outdoor worker.
- Dermal absorption — outdoor worker.
- Inhalation of fugitive dusts — outdoor worker.

Subsurface soil pathways:

- Inhalation of volatiles resulting from vapor intrusion into indoor air — indoor worker.
- Inhalation of volatiles migrating from soil to outdoor air — outdoor worker.
- Ingestion of contaminated ground water caused by migration of chemicals through soil to an underlying potable aquifer — indoor worker and outdoor worker.

Site managers should consider these pathways and make thoughtful determinations about whether receptors are likely to be exposed via each pathway.

It is important to carefully consider each of the possible pathways as part of the screening process, even though a site manager may quickly decide that one or more specific pathways are not relevant for a site. If, based on an analysis of reasonably anticipated future site activities, the site manager identifies pertinent exposure pathways other than those listed above, these additional pathways should be addressed using a detailed site-specific modeling approach."

(EPA 2002, page 4-8)

Figure 2-6a
EPA Guidance for Commercial/Industrial Exposure Pathways

Summary of the Construction Scenario Exposure Framework for Soil Screening		
	Receptors	
	Construction Worker	Off-site Resident*
Exposure Characteristics	• Exposed during construction activities only • Potentially high ingestion and inhalation exposures to surface and subsurface soil contaminants • Short-term (subchronic) exposure	• Resides at the site boundary • Exposed both during and post-construction • Potentially high inhalation exposures to contaminants in fugitive dust • Long-term (chronic) exposure
Pathways of Concern[1]	• Ingestion (surface and subsurface soil) • Dermal contact (surface and subsurface soil) • Inhalation of volatiles outdoors (subsurface soil) • Inhalation of fugitive dust due to traffic on unpaved roads (surface soil)[2]	• Inhalation of fugitive dust due to traffic on unpaved roads during construction activities and wind erosion (surface soil)

[1] The inhalation of volatiles is not included as a pathway of concern for off-site residents because SSLs developed for this pathway for the construction worker (short-term) and for the on-site worker receptor under the commercial/industrial scenario (long-term) were shown to be protective for this receptor.

[2] Analyses of the inhalation of fugitive dust pathway suggest that the most significant contribution to exposure comes from disturbance of surface soil by traffic on unpaved roads. Therefore, the framework for simple site-specific soil screening evaluation for this pathway focuses on surface soil. If a site manager determines that excavation of subsurface soil or other earth-moving activities may lead to significant exposure to fugitive dust, it may be appropriate to use a more detailed site-specific modeling approach to develop a construction SSL for this pathway. Appendix E provides guidance on conducting such modeling.

* Screening levels for on-site commercial/industrial worker are likely more conservative.

Source: Reproduced from portion of Exhibit 5-1 in EPA 2002, page 5-3.

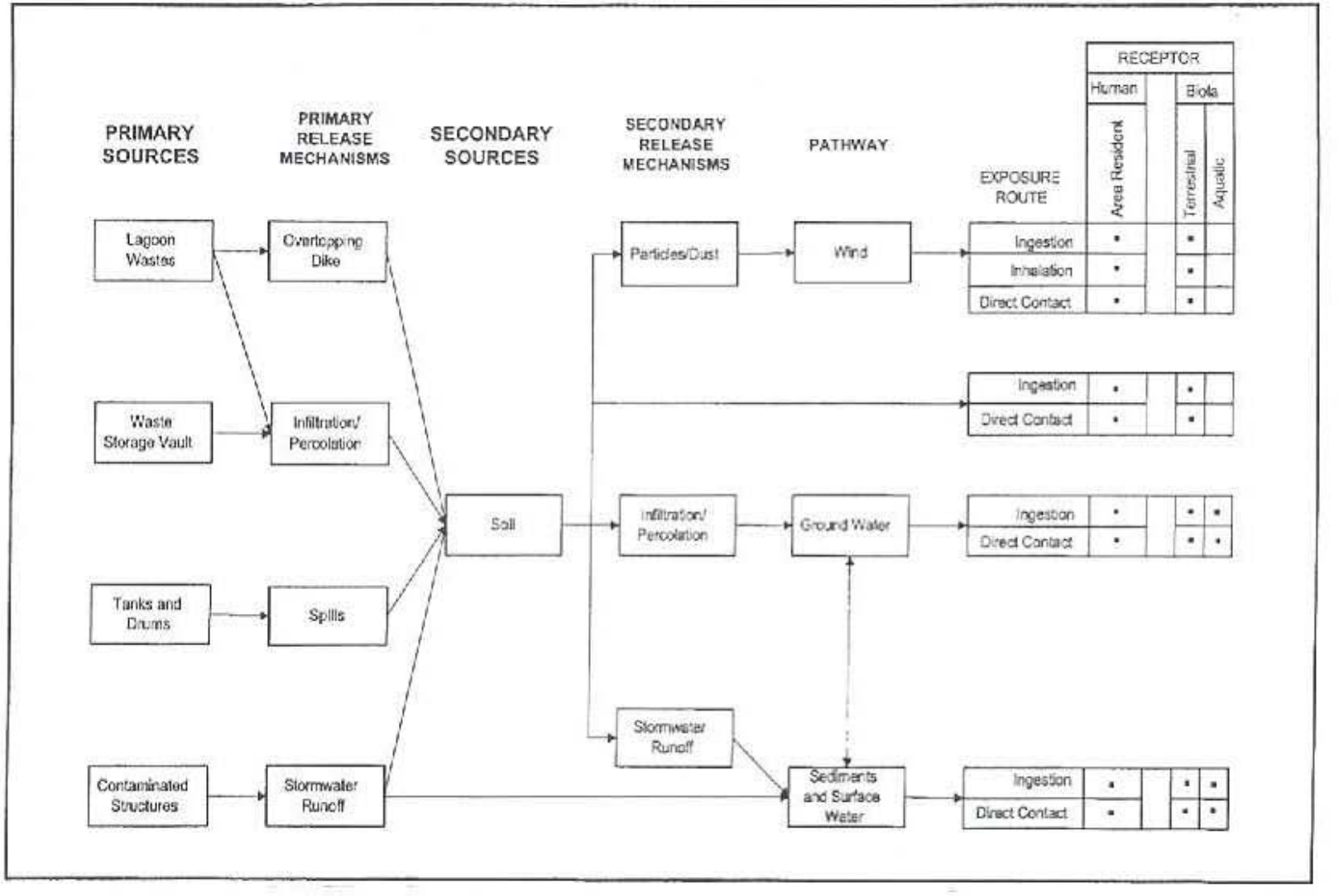
Figure 2-6b
EPA Guidance for Construction Scenario Exposure Pathways

"Regarding Step 3, EPA recommends that site managers develop a sampling plan for surface soil that will provide a reliable estimate of the arithmetic mean of contaminant concentrations. Section 2.3.2 of the 1996 *SSG* describes such a sampling plan utilizing composite samples. Guidance on developing other sampling plans using discrete samples can be found in *Guidance for Choosing a Sampling Design for Environmental Data Collection* (U.S. EPA 2000a). Although there may be differences in the activities and exposures likely to occur under non-residential and residential use scenarios, EPA is not recommending specific changes to the surface soil sampling approach when performing non-residential soil screening evaluations. Unless there is site-specific evidence to the contrary, an individual receptor is assumed to have random exposure to surface soils at both residential and non-residential sites."

"However, as in the 1996 *SSG*, EPA emphasizes that the depth over which soils are sampled should reflect the type of exposures expected. Activities typical for non-residential site uses (e.g., landscaping and other outdoor maintenance activities) may result in direct contact exposure for certain receptors to contaminants in shallow subsurface soils at depths of up to two feet. EPA expects that site managers will characterize contaminant levels in the top two feet of the soil column by taking shallow subsurface borings where appropriate. The specific locations of such borings should be determined by the likelihood of direct contact with these subsurface soils and by the likelihood that soil contamination is present at that depth. Given that these deeper soils are not characterized to the same extent as the top two centimeters of soil, the maximum measured contaminant concentration in the borings in a given exposure area should be compared directly with the SSLs, as described in Section 2.3, Step 6. Alternatively, if available evidence indicates that contaminated subsurface soils will be disturbed and brought to the surface (e.g., as the result of redevelopment activities), site managers will need to characterize subsurface contamination more thoroughly and should collect a sufficient number of samples to develop a UCL_{95} value for use in the soil screening evaluation."

(EPA 2002, page 4-6)

Figure 2-7
EPA Guidance for Assessment of Appropriate Soil Intervals



Source: Data Quality Objective Process for Hazardous Waste Site Investigations. EPA QA/G-4HW EPA/600/R-00/007, January 2000.

Figure 2-8
EPA Guidance for a Schematic Illustration of a Conceptual Site Model

Containment as a Presumptive Remedy (page 2)

Waste in CERCLA landfills usually is present in large volumes and is a heterogeneous mixture of municipal waste frequently co-disposed with industrial and/or hazardous waste. Because treatment usually is impracticable, EPA generally considers containment to be the appropriate response action, or the "presumptive remedy," for the source areas of municipal landfill sites. The presumptive remedy for CERCLA municipal landfill sites relates primarily to containment of the landfill mass and collection and/or treatment of landfill gas. In addition, measures to control landfill leachate, affected ground water at the perimeter of the landfill, and/or upgradient ground-water that is causing saturation of the landfill mass may be implemented as part of the presumptive remedy.

Highlight 1: Components of the Presumptive Remedy: Source Containments (page 3)

- Landfill cap;
- Source area ground-water control to contain plume;
- Leachate collection and treatment;
- Landfill gas collection and treatment; and/or
- Institutional controls to supplement engineering controls.

Characterizing the Site (page 4)

The use of existing data is especially important in conducting a streamlined RI/FS for municipal landfills. Characterization of a landfill's contents is not necessary or appropriate for selecting a response action for these sites except in limited cases; rather, existing data are used to determine whether the containment presumption is appropriate. Subsequent sampling efforts should focus on characterizing areas where contaminant migration is suspected, such as leachate discharge areas or areas where surface water runoff has caused erosion. It is important to note that the decision to characterize hotspots should also be based on existing information, such as reliable anecdotal information, documentation, and/or physical evidence.

Defining Site Dynamics (page 4 – 5)

The collected data are used to develop a conceptual site model, which is the key component of a streamlined RI/FS. The conceptual site model is an effective tool for defining the site dynamics, streamlining the risk evaluation, and developing the response action. Highlight 2 presents a generic conceptual site model for municipal landfills. The model is developed before any RI field activities are conducted, and its purpose is to aid in understanding and describing the site and to present hypotheses regarding:

- The suspected sources and types of contaminants present;
- Contaminant release and transport mechanisms;
- Rate of contaminant release and transport (where possible);
- Affected media;
- Known and potential routes of migration; and
- Known and potential human and environmental receptors.

After the data are evaluated and a site visit is completed, the contaminant release and transport mechanisms relevant to the site should be determined. The key element in developing the conceptual site model is to identify those aspects of the model that require more information to make a decision about response measures. Because containment of the landfill's contents is the presumed response action, the conceptual site model will be of most use in identifying areas beyond the landfill source itself that will require further study, thereby focusing site characterization away from the source area and on areas of potential contaminant migration (e.g., ground water or contaminated sediments).

(figure continues)

Figure 2-9
Excerpts from EPA Presumptive Remedy for CERCLA Municipal Landfill Sites

Streamlined Risk Evaluation of the Landfill Source (page 6) A quantitative risk assessment also is not necessary to evaluate whether the containment remedy addresses all pathways and contaminants of concern associated with the source. Rather, all potential exposure pathways can be identified using the conceptual site model and compared to the pathways addressed by the containment presumptive remedy. Highlight 3 illustrates that the containment remedy addresses all exposure pathways associated with the source at municipal landfill sites.
Response Action Objectives • Preventing direct contact with landfill contents; • Minimizing infiltration and resulting contaminant leaching to groundwater; • Controlling surface water runoff and erosion; • Collecting and treating contaminated groundwater and leachate to contain the contaminant plume and prevent further migration from source area; and Controlling and treating landfill gas
Highlight 3: Source Contaminant Exposure Pathways Addressed by Presumptive Remedy 1. Direct contact with soil and/or debris prevented by landfill cap; 2. Exposure to contaminated groundwater within the landfill area prevented by ground-water control; 3. Exposure to contaminated leachate prevented by leachate collection and treatment; and 4. Exposure to landfill gas addressed by gas collection and treatment, as appropriate.

Source: All passages reprinted verbatim from EPA 1993.

Figure 2-9 (Cont'd)

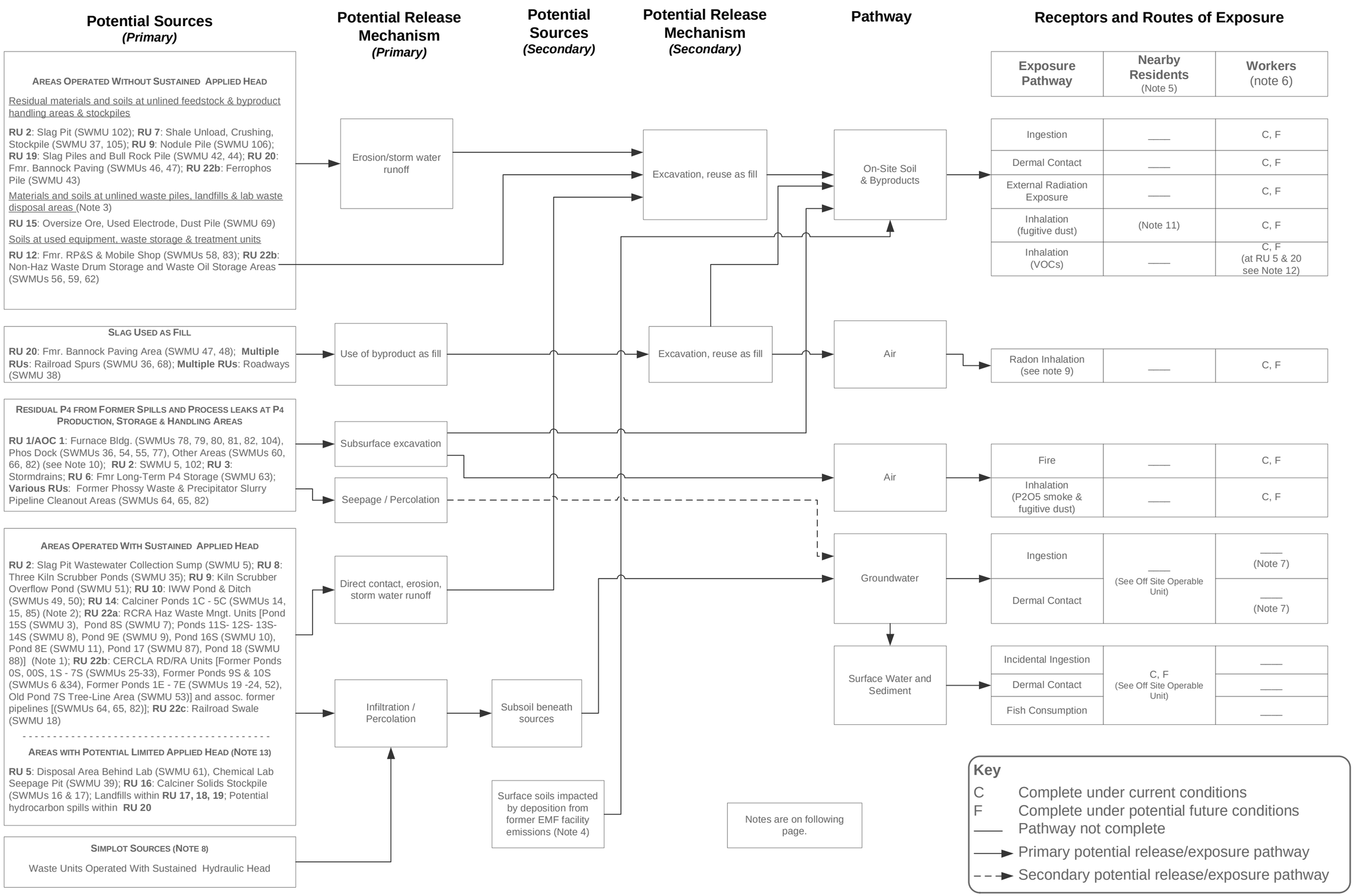


Figure 2-10: Conceptual Site Model for Potential Human Exposure to Contaminants at the FMC Operable Unit

Note 1 - These waste management units are in the process of closure pursuant to RCRA standards.

Note 2 - Remediation of the Calciner Ponds 1C-5C and the underlying Old Calciner Ponds is being conducted under a Consent Order with the IDEQ.

Note 3 - Railcars within Slag Pile included in RU 19. Alledged buried transformers included within RU 12.

Note 4 - Includes potential deposition resulting from former emissions from the FMC and Simplot facilities.

Note 5 - Based on the ROD definition of off-site areas (i.e., properties not owned by FMC or Simplot).

Note 6 - Administrative controls protect current workers from exposure.

Note 7 - Exposure precluded through administrative controls and land use restrictions.

Note 8 - Potential sources at the Simplot facility are subject to the Simplot CERCLA RD/RA Consent Decree and applicable Clean Air Act standards. Evaluation of these sources, including development of remedial action objectives, is not within the scope of the supplemental RI/FS for the FMC OU.

Note 9 - Future office buildings are to be constructed using radon control methods, per EMF ROD.

Note 10 - RU1 SWMUs 13, 73, 74, and 76 did not manage P4-containing materials. These SWMUs have been "clean closed" and are not included.

Note 11 - Off-Site Resident might inhale fugitive dusts generated by vehicle traffic on unpaved roads during site construction activities.

Note 12 - The presence of "hotspots" of volatile organic compounds at limited portions of RU 4 (SWMU 61: Disposal Area Behind Laboratory), RU 5 (SWMU 39: Chem Lab Seepage Pit) and RU 20 (Former Bannock Paving Area) are subject to further evaluation.

Note 13 - These areas did not operate with a sustained hydraulic head in a manner similar to a pond. However, free liquids may have been present in the waste materials managed or disposed at the area. If present, these free liquids may have seeped into underlying soils and groundwater.

Table 2-1

PRELIMINARY REMEDIATION UNITS AND ASSOCIATED SOLID WASTE MANAGEMENT UNITS

FMC Idaho LLC - Remediation Units and Associated Solid Waste Management Units								
Remediation Unit/SWMU Cluster	Number	Associated SWMUs (listed through 3/31/01)						**SWMUs added 9/02**
Furnace Building, Phos Dock and Secondary Condenser (AOC #1) (see footnote A)	1	**1a. Associated with Furnace Building Area**	(13) Anderson Filter Media (AFM) Washing Unit	**1b. Associated with Phos Dock Area**	(36) Rail Car Loading and Unloading Areas	**1c. Associated with Other Areas**	(60) Secondary Condenser and Old Fluid Bed Drier Unit	(104) #3 P4 Sump
			(73) Satellite Storage Areas for Spent Anderson Filter Media		(54) Phosphorus Loading Dock Area (Paved)		(66) Boiler Fuel Tank and Pipeline Area	AOC #1 (= RU #1)
			(74) East AFM Bin Area		(55) Paved Area between Phosphorus Loading Dock and Furnace Building		(68) Railroad Spurs	
			(75) Precipitator Dust Slurry Pots		(77) Phosphorus Loading Dock, Anderson Scrubber Blowdown Sump, and North Solid Tank (GAU)			
			(76) Medusa Scrubber Blowdown Collection Tank		(90) V-3800 tank and Associated Piping			
			(78) Washdown Collection Sumps -- Furnace Building Area					
			(79) Northeast Collection Sump - Furnace Building Area					
			(80) Southeast Collection Sump -- Furnace Building Area			**1d. Several Areas**	(38) Surface Roads	
			(81) Furnace Washdown Collection Tank (V-3600) (GAU)				(41) Stacks and Vents	
			(86) V-3700 tank and Associated Piping				(82) Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry)	
			(91) NOSAP Intercept Tank (Tank T-8010)					
Slag Pit	2	(5) Slag Pit Wastewater Collection Sump (Slag Pit Sump)		(82) Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry)				(102) Former Slag Pit (prior to Slag ladling))
Rec Stores, Paint Shop, P4 Decon	3	(66) Boiler Fuel Tank and Pipeline Area (former)		(72) Former Satellite Storage Area for Waste Paint Solvents		(92) P4 Maintenance Cleaning Facility		
Off Blgs & Training Cen	4	(40) Septic Tank Areas		(39) Chemical Laboratory Seepage Pit				(99) Drum Storage Area at Training Center
Laboratory & Old Drainfield	5	(1) Drum Storage Unit		(39) Chemical Laboratory Seepage Pit		(70) Satellite Storage Area for Spent Laboratory Solvents		
		(61) Disposal Area Behind Laboratory						
Former Long Term P4 Storage	6	(63) Long-Term Elemental Phosphorus Storage Tanks						(101) Railcar Loading Overflow Tank
Shale Unload, Crushing Stockpiles	7	(37) Shale Ore Handling Areas						(105) Coke Unloading Building
Calciner Area	8	(12) Wastewater Treatment Unit (Scrubber Blowdown)		(35) Three Kiln Scrubber Ponds				(103) New Horizontal Flare Pit
		(41) Stacks and Vents		(67) Flare Pit for Calciner Carbon Monoxide				
Silica Stockpiles	9	(51) Kiln Scrubber Overflow Pond						(106) Nodule Pile
IWW Pond & Ditch	10	(49) Industrial Wastewater Basin		(50) Industrial Wastewater Ditch				
Equip Area S of Calciners	11	(38) Surface Roads						
Former RP&S Area and Mobile Shop	12	(57) Transformer Salvage Area		(58) Former PCB Storage Shed		(64) Phossy Waste Pipeline Cleanout Areas and Intervals		
		(65) Precipitator Slurry Pipeline Cleanout Areas and Intervals		(71) Satellite Storage Areas for Waste Degreasing Solvents		(82) Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry)		
		(83) High-Pressure Steam Cleaning Station		(84) Used Oil Collection Tank				
Pond 8S Recovery Process & Metal Scrap Prep Area	13	(4) 8S Recovery Process		(64) Phossy Waste Pipeline Cleanout Areas and Intervals		(65) Precipitator Slurry Pipeline Cleanout Areas and Intervals		(107) Portable Storage Tanker for Used Oil
		(82) Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry)						
Calciner Ponds (1C - 5C)	14	(14) Original Calciner Pond (Including Old Pond 1C and Old Pond 2C)		(15) Calciner Ponds 1C (new), 2C (new), 3C, 4C		(85) Solar Drying Area (Pond 5C)		
Oversize Ore, broken electrode, baghouse dust	15	(69) Baghouse Reclaim Dust Pile						
Calciner Solids Stockpile	16	(16) Calciner Pond 1C Sediment Area South of Calciner Ponds		(17) Old Calciner Ponds Fines Area South of Calciner Ponds				
Recyclable material landfill	17	(89) Roadway Landfill (also referred to as Construction Debris and/or Recycle Landfill)						
Plant landfill	18	(45) Landfill (new) (also referred to as Solid Waste Landfill)						
Slag piles and bull rock pile	19	(42) Slag Pile Storage Areas		(44) Landfill (old)				
Former Bannock Paving area incl railspurs	20	(46) Rail Car Loading and Unloading Areas - Bannock Paving Company		(47) Bannock Paving Company Areas		(48) Surface Roads - Bannock Paving Company		
Other on-plant railspurs	21	(69) Railroad Spurs						
RCRA Waste Management Units	22a	(3) Phossy Waste Surface Impoundment (Pond 15S)		(7) Phossy Waste Surface Impoundment (Pond 8S)		(8) Phase IV Ponds--Phossy Water Clarifier Surface Impoundments (Ponds 11S, 12S, 13S, 14S)		(100) Pond Closure Surge Tank
		(9) Precipitator Slurry Drying Surface Impoundment (Pond 9E)		(10) Phossy Water Surface Impoundment (Pond 16S)		(11) Precipitator Slurry Surface Impoundment (Pond 8E)		
		(82) Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry)		(87) Pond 17		(88) Pond 18		
CERCLA Remedial Design/Remedial Action	22b	(6) Area 9S (Furnace Off-Gas Solids)		(19) Pond 1E		(20) Pond 2E		
		(21) Pond 3E		(22) Pond 4E		(23) Pond 5E		
		(24) Pond 6E		(25) Pond 0S		(26) Pond 00S		
		(27) Pond 1S		(28) Pond 2S		(29) Pond 3S		
		(30) Pond 4S		(31) Pond 5S		(32) Pond 6S		
		(33) Pond 7S		(34) Pond 10S (Including Precipitator Dust Pile atop Pond 10S)		(43) Ferrophos Pile Storage Areas		
		(52) Pond 7E		(53) Old Pond 7S Tree-Line Area		(56) Drum Storage Area for other Nonhazardous Wastes		
		(59) Waste Oil Storage Area		(62) Area West of Mobile Shop		(64) Phosphorus Waste Pipeline Cleanout Areas and Intervals		
		(65) Precipitator Slurry Pipeline Cleanout Areas and Intervals		(82) Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry)				
	22c	(18) Railroad Swale (Rainwater Collection Point)						
Miscellaneous Roadways	23 (also within other RUs)	(38) Surface Roads - FMC, not coincident with other RUs						
Unassigned	na	(2) West Andersen Filter Media (AFM) Bin Area (former)						

A - RU #1 includes AOC #2 (Area around the collection sumps at Phos Dock) identified by EPA in March 2002.

Table 2-2
SWMUs Associated with Elemental Phosphorus Production, Storage, and Handling

RU	SWMU No.	SWMU Name	SWMU Description	Potential for Soil Impact from SWMU*
1	54	Phosphorus Loading Dock Area	Phosphorus loading dock area where elemental phosphorus is handled. Per FMC Pocatello RCRA Consent Decree (1999) Attachment A, Point of Generation (POG) upgrades implemented in 1999.	Potential not rated by EPA prior to RCRA POG Upgrades.
1	55	Area between Phosphorus Loading Dock and Furnace Building	Area between the phosphorus-loading dock and furnace building where elemental phosphorus is loaded into rail cars. Secondary containment upgrades implemented per POG Upgrades required by FMC Pocatello RCRA Consent Decree (1999) Attachment A. Includes below-grade P4 product launders used to convey P4 from the furnace building to the Phos Dock.	Potential not rated by EPA prior to RCRA POG Upgrades.
1	60	Secondary Condenser and Old Fluid Bed Drier Unit	Secondary condenser used to remove elemental phosphorus from furnace exhaust gases; built north of former fluid bed drier unit used in early 1980s to dry and oxidize precipitator slurry.	Potential not rated by EPA. Leak from secondary condenser sump is suspected.
1	75	Former Precipitator Dust Slurry Pots	Precipitator dust was slurried in closed steel 800-gallon-to 1040-gallon capacity tanks (pots) with secondary containment; two pots at each of 4 furnaces. Operated from the 1950s. Secondary containment upgrades of slurry lines to V-3700 and V-3600 completed in 1999 pursuant to FMC Pocatello RCRA Consent Decree (1999) Attachment A POG upgrades. Pots used in operation of the NOSAP precipitator slurry treatment process. Pots taken out of service in 2001. Residual wastes removed in 2001. All furnace pots have been decontaminated and removed.	Low. Potential spills or leaks from pots (when in operation) would have been contained by concrete floor of Furnace Building prior to RCRA POG Upgrades.
1	77	Phosphorus Loading Dock, Anderson Scrubber Blowdown Sump, and North Solid Tank	Anderson Scrubber Blowdown Sump converted from a <90-day GAA to process vessel as part of FMC Pocatello RCRA Consent Decree (1999) Attachment A POG upgrades. North Solids tank (operated as a <90-day GAA) was removed in 1999 pursuant to installation of Tank V-3800 under the FMC Pocatello RCRA Consent Decree (1999) Attachment A POG upgrades.	Low, prior to RCRA POG Upgrades.

(table continues)

Table 2-2 (Continued)

RU	SWMU No.	SWMU Name	SWMU Description	Potential for Soil Impact from SWMU*
1	78	Former Washdown Collection Sumps - Furnace Building Area	Seven concrete sumps (flow-through process tanks) and connecting launders in Furnace Building used to collect phossy wastewater generated from furnace washdown. Sumps had pumps to transfer wastewater to Tank V-3600 in southeast corner of building. Newly operational in 1991. If one sump should overflow due to pump problems, wastewater would drain into an adjacent sump. Operators routinely monitored sump operation. Per FMC Pocatello RCRA Consent Decree (1999) Attachment A POG secondary containment upgrades implemented in 1999. Sumps taken out of service in 2001. Residual wastes removed and unit decontaminated in 2002.	Moderate, prior to RCRA POG Upgrades.
1	79	Former Northeast Collection Sump - Furnace Building Area	6X6X7-foot stainless steel-lined sump used for collection of phossy wastewater, which is pumped to Tank V-3600. Located in northeast area of the Furnace Building area. Operational since 1979. Wastewater is pumped to the phosphorus loading dock for further use in the process. If the sump were to overflow, wastewater would flow to one of the furnace washdown sumps. Per FMC Pocatello RCRA Consent Decree (1999) Attachment A POG secondary containment upgrades implemented in 1999. Sump taken out of service in 2001. Residual wastes removed and unit decontaminated in 2002.	Moderate, prior to RCRA POG Upgrades.
1	80	Former Southeast Collection Sump - Furnace Building Area	10,000-gallon capacity sump used for collection of nonhazardous storm water runoff and tapping floor washwater from east side of No. 1 Furnace, which is pumped to Tank V-3600. Prior to 1992, used for collection of phossy wastewater. Secondary containment pad and delumper added to SE sump in 1999 as part of POG upgrades per FMC Pocatello RCRA Consent Decree (1999) Attachment A. Located in southeast area of the furnace building area. Earliest operation unknown. Sump taken out of service in 2001. Residual wastes removed and unit decontaminated in 2002.	Moderate, prior to RCRA POG Upgrades.

(table continues)

Table 2-2 (Continued)

RU	SWMU No.	SWMU Name	SWMU Description	Potential for Soil Impact from SWMU*
1	81	Former Furnace Washdown Collection Tank (V-3600)	Stainless steel tank (V-3600) with 46,000-gallon capacity in southeast corner of the Furnace Building area. Replaced the slag pit collection sump in 1991. Tank is equipped with level controls, alarms, and secondary containment. Per FMC Pocatello RCRA Consent Decree (1999) Attachment A POG piping upgrades implemented in 1999. Unit taken out of service in 2001. Residual wastes removed and unit decontaminated in 2002.	Low.
1	82	Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry)	Phossy wastewater and precipitator slurry waste pumped from points of generation at Furnace Building area and phosphorus loading dock to various WMUs via piping system. Clean-out taps located in various locations where pipelines bend or change direction. Earliest operation unknown. Piping upgraded to welded joints and located above-grade in 12/97.	Moderate, prior to upgrade to welded joints and above-grade placement.
1	86	Former V-3700 Tank and Associated Piping	7,000-gallon stainless steel tank in southwest corner of the Furnace Building. Tank is equipped with level controls, alarms, and secondary containment pursuant to RCRA 40 CFR 265 Subpart J standards. Used as part of NOSAP process to treat precipitator slurry pursuant to RCRA Pond Management Plan. Unit taken out of service in 2001. Residual wastes removed and unit decontaminated in 2001.	Tank placed into service subsequent to EPA assessment. Unit designed, operated and closed in accordance with RCRA GAA standards for tank systems.
1	90	V-3800 Tank and Associated Piping	90-day generator accumulation area at the Phos Dock. Installed in 1999 as replacement for North Solids Tank and Anderson Scrubber Blowdown Sump (SWMU # 77) under FMC Pocatello RCRA Consent Decree (1999) Attachment A POG upgrades. Tank is equipped with level controls, alarms, and secondary containment pursuant to 40 CFR 265 Subpart J standards.	Tank placed into service subsequent to EPA assessment. Unit designed, operated and closed in accordance with RCRA GAA standards for tank systems.
1	91	Former NOSAP Intercept Tank (Tank T-8010)	5,000-gallon stainless steel tank installed in 2000 to treat off-spec NOSAP slurry from Tank V-3700 to NOSAP standards. Tank was equipped with level controls, alarms, and secondary containment pursuant to 40 CFR 264 Subpart J standards. Unit taken out of service in 2001. Residual wastes removed and unit decontaminated in 2001.	Tank placed into service subsequent to EPA assessment. Unit designed, operated and closed in accordance with RCRA GAA standards for tank systems.

(table continues)

Table 2-2 (Continued)

RU	SWMU No.	SWMU Name	SWMU Description	Potential for Soil Impact from SWMU*
1	104	#3 P4 Sump	An approximately 15,250 gallon concrete sump that collected the elemental phosphorus product stream from the #3 Furnace condenser prior to refinement at the Phos Dock. An 11,000-gallon capacity stainless steel tank was installed within the sump in 1999 after excavation beneath the floor of the Furnace Building revealed that the sump had been leaking P4 into adjacent soils. Operation of the concrete sump began circa 1952 and ended in 1999.	SWMU identified subsequent to EPA assessment. Observed impact.
2	102	Former Slag Pit (prior to conversion to Slag Ladling)	SWMU 102 is an area of approximately 112,000 ft^2 adjacent to the south side of the Furnace Building in which slag from furnace tapping was cooled before removal to the Slag Pile. Phossy water spills within Furnace Building historically drained into slag pit. Operation began in 1949 and ended with the conversion to slag ladling in October 2000. Approximately 12,000 yd^3 of material were removed from the slag pit to a maximum depth of approximately 4 feet in 2000 to facilitate installation of the slag ladling system.	Potential not rated by EPA. Unlined condition suggests potential for soil impact.
3	92	P4 Maintenance Cleaning Facility	SWMU 92 is an approximately 800 sq. ft facility constructed in 1999 with secondary containment to decontaminate and prepare equipment for repairs, recycle, or discard. SWMU 92 is designed and operated as a RCRA 90-Day GAA (Containment Building Standards).	Unit placed into service subsequent to EPA assessment. Unit designed and operated in accordance with RCRA GAA standards for containment buildings.
4	99	Drum Storage Area at the Training Center	SWMU 99 is a container storage area that was placed into service in 2002 to support facility decommissioning. SWMU 99 is designed and operated as a RCRA 90-Day GAA (Container Storage Standards) and will be closed by waste removal and equipment decontamination.	Unit placed into service subsequent to EPA assessment. Unit designed and operated in accordance with RCRA GAA standards for container storage areas.
6	63	Former Long-Term Elemental Phosphorus Storage Tanks	SWMU 63 is the site of twelve former underground tanks used to store elemental phosphorus. These tanks were removed in 1994 and 1998.	Potential not rated by EPA.
8	67	Flare Pit for Calciner Carbon Monoxide	SWMU 67 was a flare pit associated with the calcining process; SWMU 67 was removed during construction of Excess Carbon Monoxide Combustor in 2000. SWMU 103 was a flare pit used to combust excess carbon monoxide gas stream from furnace operation during bypass of Excess CO Combustor.	Moderate to air (when operational). Soils beneath former flare pit were excavated during construction of Excess CO Combustor.

(table continues)

Table 2-2 (Continued)

RU	SWMU No.	SWMU Name	SWMU Description	Potential for Soil Impact from SWMU*
8	103	New Horizontal Flare Pit	SWMU 103 operated between January 2000 and December 2001. The interior base and walls of SWMU 103 were lined with slag to absorb heat; this slag layer overlies a liner system designed to RCRA MTR standards.	Unit placed into service subsequent to EPA assessment. Unit lined per RCRA MTR standards.
19	na	Railcars under the Slag Pile	As noted in Section 3.2 of the SPM (FMC 2004), EPA received public input that railcars, potentially containing P4, were present within or beneath the Slag Pile. Review of historic photographs indicates that 17 railcars were present in or before 1965 at an area that is now the thickness portion of the Slag Pile. Discussion with a former employee indicates that the railcars contain sludge from the manufacture of P4.Based on other plant operational data, sludge might contain 15% to 95% P4. Pending further research into this issue, the updated CSM will assume that railcars containing sludge from the manufacture of P4 are present beneath a portion of the Slag Pile, and that these railcars represent a potential source of P4.	Presence of railcars recognized subsequent to EPA assessment.
Mult-iple	64	Phosphorus Waste Pipeline Cleanout Areas and Intervals	SWMU 64 corresponds to cleanout taps located along the route of the pipeline used to transport phosphorus-containing water pumped from furnace washdown collection tank and phosphorus-loading dock to Ponds 11S, 12S, 13S, 14S.	Potential not rated by EPA.
“	65	Precipitator Slurry Pipeline Cleanout Areas and Intervals	SWMU 65 corresponds to cleanout taps located along the route of the pipeline used to transport precipitator slurry pumped from Furnace Building via pipelines to Pond 8E.	Potential not rated by EPA.
“	82	Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry)	SWMU 82 corresponds to the pipeline system used to transport phossy wastewater and precipitator slurry waste pumped from points of generation at Furnace Building area and phosphorus loading dock to various WMUs and associated clean-out taps where pipelines bend or change direction (date of earliest operation unknown; piping upgraded to welded joints and located above-grade in 12/97).	Moderate, prior to upgrade to welded joints and above-grade placement.

* Release potential rating from EPA’s 1994 RFA Report (EPA, 1994b).

Table 2-3
Constituents of Potential Concern Evaluated in EMF ROD

Chemical	Soil	Groundwater	Air[B]
Aluminum			X
Antimony	X		
Arsenic	X	X	X
Beryllium	X	X	
Boron	X	X	
Cadmium	X		X
Chromium			X
Crystalline Quartz			X
Fluoride	X	X	X
Gross alpha	X[A]	X[A]	
Gross beta	X[A]	X[A]	
Lead-210	X		X
Manganese	X	X	
Mercury	X	X	
Nickel	X	X	X
Nitrate		X	
Phosphorus			X
PM10			X
Polonium-210	X	[A]	X
Potassium-40	X	[A]	
Radium-226	[A]	X	
Radon	[A, C]		
Selenium	X	X	X
Silver	X		X
Tetrachloroethene		X	
Thallium	X		
Thorium-230	[A]	[A]	X
Trichloroethene		X	
Uranium-234		[A]	
Uranium-238	X	[A]	X
Vanadium	X	X	
Zinc	X	X	

[A] Individual radionuclides potentially responsible for elevated gross alpha and gross beta levels are also COPCs.
[B] Chemicals that exceeded background concentrations and lacked inhalation toxicity criteria (reference concentrations and inhalation unit risks) were retained as COPCs.
[C] Retained as a COPC mainly for evaluation of potential radon infiltration into buildings under alternate future commercial or industrial uses of the site.

Source: Table 2-3 is a reproduction of Table 14 of the EMF Site ROD (EPA 1998).

Table 2-4
Response to Agency Comments on October 2003 Draft Outline of Updated CSM

	Agency Comment	Response
Comment Set #1	1.All of the RU clusters, identified in Table 3.1 of the scoping memo do not appear to be included in the model. It is unclear if an updated CSM will be forthcoming, or if that October document is still applicable. Therefore, comments will be directed at the October document even though an updated model may be in preparation.	The figure distributed at the October 2003 meeting to illustrate the updated Conceptual Site Model was designed to fit on a single page to provide an overview of the CSM. Space was not available on this figure for a complete listing of all 107 SWMUs. The figure has been revised to include the various RUs, and the narrative explanation of the updated CSM provides additional information on the components of each RU.
	2. The P4 production, storage, and handling areas are represented as having only soil and air exposure media. It would seem appropriate that at a minimum the groundwater exposure path be identified and characterized. P4 is currently being sampled down gradient of the furnace building, and it has been detected at low concentrations.	Agreed. Groundwater has been added as a potential exposure medium for the P4 Production, Handling, and Storage Area (RU #1) in the updated CSM.
	3. Another issue that is not totally clear in the CSM is how deposition as a potential release mechanism will be investigated. At this time, deposition is described as resulting from former emissions from the FMC and Simplot facilities. This general and nebulous description does not adequately define how the final RU clusters and SWMUs will individually or collectively contribute to human health risk.	The updated CSM identifies soil impacted from former emissions from FMC and Simplot as a secondary potential source.
	4. Also, using slag as an example, if for some unforeseen circumstance slag crushing and use as a road aggregate is resumed the only potential release mechanism would not be use of byproduct as fill, and therefore would introduce the exposure pathway of air. After incorporation of the additional SWMUs, contained in Table 3-1, it is doubtful that this would be the only example where all of the potential release mechanisms and resulting exposure media have not been completely identified.	The updated CSM was revised to show fugitive emissions from slag during potential construction excavations and from vehicle traffic on roadways within FMC Plant OU that are graded with slag as potential secondary release mechanisms. Resumption of slag crushing for use as construction aggregate is speculative. Emissions associated with slag crushing and use will be evaluated in the SFS in the event that excavation and reuse of slag from the Slag Pile is identified as a potential remedial action alternative.
	5. In general, though, it is very difficult to evaluate the current CSM due to the missing SWMUs.	See above and in response to Comment #2 in Comment Set #2.
Comment Set #2	1. In general, the CSM does not appear to take into account the proposed land use change that will likely occur as a result of the facility's closure in 2001. The record of decision (ROD) proposed remedial actions that were protective under the operating scenario at the time of signing, but these actions may not be protective under future land use scenarios. Many hazardous constituents believed to exist in former operations areas and fill areas were not assessed during the remedial investigation (RI). In addition, material from these areas, that have not been characterized, may be excavated and relocated in a future construction scenario. This could expose construction workers and future site workers to unacceptable risks due to possible inhalation, ingestion, dermal contact, and external exposure to radiation. For example, fill material that was used for road construction within the facility likely contained precipitator dust. This material was not fully characterized during previous investigations. Should this material be excavated, relocated, and recycled as part of redevelopment, unacceptable risks could be posed to construction workers and future site workers or land users. The CSM must be changed to account for chemical and radiological constituents, sources, pathways, exposure routes and receptors in a future land use scenario. Exposure routes that should be included are ingestion, dermal contact, inhalation and external radiation exposure.	The comment implies that risks attributable to exposure to site sources/soils under a future, non-FMC, operating scenario have never been characterized. EPA's 1996 Human Health Baseline Risk Assessment (HHBRA) for the FMC Operable Unit evaluated two future case exposure scenarios: (1) exposure of FMC workers and contractors while FMC continued to operate the facility and impose administrative controls, and (2) exposure of site workers under a generic commercial/industrial land use scenario. For example, the HHBRA calculated risks from exposure to the Slag Pile under both scenarios. In the 1998 ROD, EPA did not select remedial actions for those portions of the plant area that would remain in operation, such as the Slag Pile, after finding that the administrative controls imposed under FMC's ongoing plant management program were acceptable in managing risks at those portions of the plant. FMC agrees that the updated CSM should identify potential exposure pathways for construction workers and future site workers. The figure illustrating the updated CSM identifies ingestion, dermal contact, external radiation exposure, inhalation to fugitive emissions, and fire and/or smoke in the case of P4, as potential exposure pathways within the FMC Plant OU associated with future construction workers and site workers. During the EMF RI characterization of potential source areas and roadways, soil samples were generally collected beneath byproduct fill (e.g., slag), in order to evaluate the vertical distribution of site-related constituents. Byproducts and waste materials (e.g., slag, ferrophos, precipitator slurry) and ore were separately characterized. EPA CSM #1 & 3 suggest that this practice has resulted in an absence of data needed to characterize surficial soils within the FMC Plant OU. This is an inappropriate conclusion. Soil boring logs from the previous investigation program record the presence and thickness of byproduct material used as fill, and the characterization data for byproduct material provide information on constituent levels that can be used for screening comparisons with RBCs. The EMF RI Report (page 4.2-130) noted one instance where precipitator slurry dusts are associated with roadbed material.

(table continues)

Table 2-4 (Continued)

	Agency Comment	Response
Comment Set #2	2. Not all of the solid waste management unit (SWMU) areas are defined in the CSM and none of the "SWMU clusters" are defined. The CSM should be refined to include these. SWMUs that were not identified include: [see list below] The CSM should account for all known SWMUs at the facility and each of the proposed SWMU clusters.	The updated CSM (Table 2-1) provides a detailed cross-reference of remediation units and SWMUs. The SWMUs listed in the comment are associated with the following Remediation Units:
	• Ferrophos Storage Pile	• RU 22b
	• Surface Roads, Bannock Paving Company	• RU 20
	• Old Pond 7S Tree Lined Area	• RU 22b
	• Chemical Laboratory Seepage Pit	• RU 5
	• Transformer Salvage Area	• RU 12
	• PCB Storage Shed	• RU 12
	• Waste Oil Storage Area	• RU 22b
	• Disposal Area Behind the Laboratory	• RU 5
	• Area West of the Mobile Shop	• RU 12
	• High Pressure Steam Cleaning Station	• RU 12
	• Old Landfill	• RU 19
	• New Landfill	• RU 18
	• Roadway Landfill	• RU 17
	• Baghouse Reclaim Dust Pile	• RU 15
	• Three Kiln Scrubber Ponds	• RU 8
	• Kiln Scrubber Overflow Pond	• RU 9
	• Secondary Condenser and Old Fluid Bed Drier Unit	• RU 1
	• Flare Pit for Calciner Carbon Monoxide	• RU 8
	• SWMUs within the Furnace Building and Process Area	• RU 1
	• Surface Roads	• Each RU includes coincident road segments; will designate RU 23 for road segments not otherwise included in other RUs.
	• Septic Tank Areas	• RU 4
	• Facility-wide wastewater piping system and sewers	• RUs 1, 12, 13, 22b
	• Areas containing construction fill	• Each RU includes coincident construction fill, which is not defined as a SWMU

(table continues)

Table 2-4 (Continued)

	Agency Comment	Response
Comment Set #2	3. Potential release mechanisms such as "byproduct as fill" and "surficial soil contamination from residuals" should be included as potential release mechanisms for all potential sources in the diagram, including "Areas with sustained hydraulic head". For example, during the RI samples were collected in the areas west of the mobile shop. This area is suspected of being over former Ponds 0S and 00S, however, the exact locations of these ponds is not known. Pond 0S and 00S are listed under "Areas with Sustained Hydraulic Head". Sample analysis revealed that precipitator dust fill likely contaminates the soil near the surface. Elevated levels of gross alpha were identified in samples collected near the surface. The existing CSM only identifies infiltration/percolation as a potential primary release mechanism. Only groundwater, surface water and sediment are identified as an exposure medium. Exposure pathways should include soil ingestion, inhalation, dermal contact and external radiation exposure for current and future site workers. Additionally, it is not clear what purpose it serves to delineate the SWMUs into areas that are delineated by the presence or absence of sustained hydraulic head.	The CSM illustration figure identifies "use of byproduct as fill", "contact", "process spills (P4)", and "infiltration/percolation" as potential primary release mechanisms for sources associated with such release mechanisms. Construction fill may be present in association with some of the sources listed under "Areas Without Sustained Hydraulic Head" (e.g., use of slag in roadbeds). It would seem redundant to list byproduct as fill, etc. as noted in the comment Evaluation of existing site characterization data in the RI Update Report will include consideration of the presence of byproduct material at each RU. As evident from inspection of recent air photos of the FMC plant area, slag is present over much of the surface area. In the case of sources that operated with a sustained hydraulic head, direct contact, erosion, and storm water runoff have been added to the CSM to acknowledge the potential for exposure to uncapped sources such as the former unlined ponds cited in the comment.
	4. Potential release of contaminants to groundwater from items allegedly buried beneath the slag pile should be addressed. For example, railcars containing high levels of radionuclide-contaminated waste could leak and contaminate groundwater to the extent that it could pose unacceptable risks under future land use scenarios.	The presence of railcars within the Slag Pile will be evaluated in response to the public comments, as noted in the Scoping and Planning Memorandum. Consideration of potential groundwater impact attributable to railcar contents will be based on the results of this initial evaluation. The RI Update Report documents findings.
	5. Utilities such as wastewater and sewer pipelines should be addressed in the CSM. These utilities may be contaminated and pose a threat to future workers at the site.	Phossy waste and precipitator slurry pipelines are already included within the scope of the SRI/SFS process, as noted earlier. The storm drain from the area north of the Furnace Building, within RU 3, will be included in the SRI/SFS scope. The SRI will investigate the potential for releases from this underground utility.
	6. The CSM should be amended to include air as a potential secondary source. Phosphorous and other volatilized compounds may be present at times.	Air is identified as an exposure medium associated with P4 production, Storage, and Handling Areas. It is unclear how air can be classified as a source.
	7. The CSM should be amended to include deposition as a potential secondary release mechanism.	Deposition (fallout) associated with former emissions from the FMC and Simplot facilities was determined by the EMF RI to have impacted surface soils. Given the substantial reductions in particulate emissions from FMC sources subsequent to the EMF RI and the cessation of FMC's manufacturing operations, deposition onto surface soils is no longer as ongoing release mechanism. The previously impacted surface soils are viewed as secondary sources. Fugitive dust emissions from these soils (due to vehicle traffic or excavation) are viewed as a secondary release mechanism.

Section 3
Site Data Compilation

Section 3 presents a compilation of available data regarding the nature and extent of contamination for potential exposure pathways within the FMC Plant OU. Data have been compiled into the FMC Environmental Data System (FEDS), a relational Access™ database developed from the following sources:

- EMF RI/FS
- FMC's RCRA and Post-RI Voluntary CERCLA Groundwater Monitoring
- Waste Management Unit Closure Confirmation Soil Samples
- Miscellaneous Studies

Figure 3-1 displays sample collection points within the FMC Plant OU. The FEDS database was provided in June 2004 in CD-ROM format. An updated version of FEDS will be submitted in January 2005 for placement behind Figure 3-1.

3.1 EMF RI/FS DATA

The scope of the remedial investigation of the EMF Superfund Site study area included analysis of approximately 1,500 groundwater samples; potential source and soil samples from 200 locations; 3,600 air quality samples; 250 surface water and sediment samples; and aquatic and terrestrial ecology sampling. Groundwater flow patterns were determined through the evaluation of quarterly measurements of groundwater elevations at over 100 wells and aquifer tests performed in 80 wells. Characterization of groundwater flow rate and direction was evaluated with a groundwater flow modeling study. An atmospheric dispersion modeling study was also performed using emission inventories for 119 point, area, and line sources at the facilities (75 of which were within the FMC facility area, including emissions from the then-active Bannock Paving Co. area of the FMC facility). Field sampling activities occurred began in 1992 and generally concluded in 1994.

The EMF RI Report was submitted to EPA Region 10, IDEQ, and the Shoshone-Bannock Tribes for review in 1995. Revision pages and additional information were submitted in August 1996 to address agency comments on the 1995 submission. EPA accepted the EMF RI Report on July 31, 1996. The final EMF RI Report is cited "Bechtel 1996" to distinguish it from the 1995 submission.

The following parts of section 3.1 provide an overview of the scope of the EMF Site remedial investigation. Findings for the EMF Site RI specific to the FMC Plant OU are presented within Section 5 (terrestrial ecology) and Section 6 (potential source, soil, and gamma radiation). Summaries of EMF Site RI findings for potential source, onsite soil, and groundwater are reproduced in Appendix A. Readers may wish to consult Bechtel 1996 for further information concerning the findings of the EMF Site RI.

EMF Site Potential Source and Facility Soil Investigations

The EMF RI examined areas for which historic data and current FMC and Simplot plant operations indicated were most likely to have been potential sources of constituent releases or where placement, spillage or leakage of raw materials, by-products or process wastes (including phosphate ore, gypsum, slag, ferrophos, precipitator dust, phossy water and other pond or impoundment contents) could have occurred. In areas to which a sustained hydraulic head was applied (e.g., gypsum stacks, ponds), samples were generally collected throughout the unsaturated soil column. In areas to which no sustained hydraulic head was applied (e.g., solid product loadout areas), samples were generally collected to depths of 10 feet or less. Soil samples from over 200 locations and more than 20 samples of industrial feedstocks, by product and co-product and waste materials were analyzed. Samples were analyzed for more than 30 constituents of the phosphate ore, and for radioactivity, volatile and semi-volatile organics, total petroleum hydrocarbons, PCBs, nitrate, potassium, sulfate, pH, and the list of analytes under the toxicity characteristics leaching procedure (TCLP).

Samples of soils and water representing unimpacted areas (natural conditions) were also analyzed for these constituents. Results from these analyses were used as representative, or background levels. Results from analyses of processing facility samples were compared with representative concentrations to assess the nature and extent of site-related constituents.

At the FMC facility, the investigation included samples of the phosphate ore, stormwater, cooling water discharged to the IWW ditch, process water discharged to active ponds, sediments and sludges that came into contact with waste streams, and soils that may have been impacted by former or present processing and waste handling operations.

EMF Site Surface Soil Investigation

The surface soil investigation was conducted to assess the possible effects of deposition of air emissions on surface soil at portions of the EMF study area located outside the processing facilities fencelines.

The surface soil investigation consisted of the sampling and analysis of surface and two foot deep samples along 16 radials extending out from the FMC and Simplot facilities in all directions to a distance of approximately three miles. Four sample locations were selected at regular intervals within the first mile, three locations within the second mile and two locations within the third mile. Twenty-seven of the 138 sampling points were on FMC properties north of Highway 30 that are within the FMC Plant OU.

More than 140 soil samples were analyzed for 30 constituents of phosphate ore, including metals, general minerals, radioactivity, and pH. Sample concentrations were compared with background soil levels and were plotted versus distance from the facilities to assess the effect of facility air emissions on surface soil. In addition, the activities of selected radioisotopes in the naturally occurring uranium-238 decay series were compared to determine if the radioisotopes were in natural secular equilibrium with uranium-238 and, in so doing, to assess the source emissions to which EMF-related effects were most likely attributable.

EMF Site Geologic and Hydrogeologic Subsurface Investigations

Geologic and hydrogeologic investigations consisted of drilling and logging 83 borings and installation and sampling of more than 130 groundwater monitoring wells adjacent to and downgradient of suspected FMC and Simplot sources of potential groundwater contamination.

Groundwater quality was evaluated by quarterly sampling over the period of the RI. Groundwater samples were analyzed for constituents of the phosphate ore and major ions. Selected samples were also analyzed for volatile and semi-volatile organics. Quarterly water level measurements were made for mapping groundwater elevations and estimating groundwater flow patterns.

In addition, slug tests were conducted in 63 wells to estimate hydraulic conductivity of individual, saturated and coarse-grained soil intervals. Aquifer pump tests were performed in four wells to provide data for calculation of hydrogeologic parameters such as transmissivity and hydraulic conductivity, and to assess lateral and vertical hydraulic interconnections. Downhole geophysical logging (gamma and temperature) was conducted in 34 wells.

A groundwater flow model was developed to support predicted local and regional groundwater budgets and flowpaths between source and discharge areas. Model output, along with water quality data, were used to estimate the fluxes of selected groundwater constituents along groundwater flowpaths.

EMF Site Surface Water and Sediment Investigations

The surface water and sediment investigation was conducted to evaluate the potential effects of FMC and Simplot activities on the Portneuf River. The investigation consisted of sampling and analysis of springs, river water, and sediments along a segment of the Portneuf River extending from approximately 6 miles upstream to approximately 5.5 miles downstream of the FMC and Simplot facilities.

Surface water samples were collected from more than 30 locations to provide samples upstream and downstream of the processing facilities, at seeps and springs that discharge to the Portneuf River, below outfalls or other anthropogenic discharges to the Portneuf River watershed. Surface water samples were collected on a quarterly basis for a year. Sediment samples were collected near the surface water sampling locations and in areas of quiet water where fine-grained sediments are most likely to have settled.

Surface water and sediment samples were analyzed for the constituents of phosphate ore as well as major ions. Results for samples collected downstream of the FMC and Simplot facilities were compared with upstream results and background groundwater and soil constituent concentrations to assess processing facility impacts on the Portneuf River. Estimates of solute fluxes at the point of groundwater discharge to the River were compared with solute flux estimates in the River upstream and downstream of the processing facilities to assess the contribution of selected constituents to the River relative to other sources.

In addition, stream flow rates were measured at selected Portneuf River locations and two spring discharges to develop a water budget for the River so that flow contributions from springs and streams along the River could be determined.

EMF Site Aquatic Ecology Investigation

Two separate investigations were conducted to assess the potential impacts of site-related constituents detected in sediment samples. The first investigation focused on the Portneuf River delta located near the river's confluence with the American Falls reservoir. Sediment samples collected from this location were analyzed for the parameters of concern. Concentrations present in the Portneuf River sediment samples were compared to concentrations measured in samples collected from upstream locations, the nearby Snake River, and to published levels of ecological concern (LEC's). The second investigation involved the collection and analysis of additional sediment samples from the Portneuf River, both upstream and downstream from the IWW ditch. Upstream samples were compared to downstream samples and to LEC's. In addition, laboratory toxicity tests were conducted to assess whether constituents present in these samples could adversely impact aquatic ecological receptors.

EMF Site Terrestrial Ecology Investigation

The terrestrial ecology investigation consisted of sampling and analysis of co-located soils, vegetation, and small mammals in the dominant native upland terrestrial ecosystem – sagebrush steppe – and in the riparian habitat bordering the Portneuf River. Sample locations ranged from 1 to 2 miles southwest of the FMC and Simplot facilities to 15 miles to the north/northeast. The samples were analyzed for cadmium, fluoride, and zinc.

Results for samples collected in areas potentially affected by the EMF facilities were compared with results for samples from reference locations. The biological availability of soil constituents was evaluated by determining tissue concentrations of constituents present in vegetation and small animals collected from the impacted area.

EMF Site Air Investigation

The air investigation consisted of an air monitoring investigation and air modeling. The air monitoring investigation consisted of sampling and analysis of ambient air at seven locations near the FMC and Simplot facilities for a period of 13 months. Over 3,600 samples of the particulate matter present in air were collected to characterize air quality. Three monitoring stations were located along or near the fenceline of the industrial operations areas of the facilities. Another three were placed several miles from the facilities near residential areas. The background sampling station was over 12 miles southwest of the facilities and in the prevailing upwind direction.

Samples were analyzed for more than 20 potential constituents of FMC and Simplot facility emissions, including particulate mass, metals, radionuclides, gaseous and particulate fluorides, and crystalline forms of silica. Meteorological data were collected at two locations for the same period.

Results for samples from locations potentially affected by the processing facilities were compared with results for samples from a background location. Sample results were also used to check air model performance.

A detailed inventory of source emissions was prepared for the FMC and Simplot processing facilities and for Bannock Paving Company, which leased property adjacent to FMC during the period of the investigation, for input into a dispersion modeling study. The inventories characterized emissions of 21 constituents from 119 point and fugitive sources. Atmospheric

dispersion models specified by EPA were used to make predictions of resulting ambient air quality in the EMF study area.

EMF Site Gamma Radiation Studies

Simplot and FMC conducted gamma radiation studies at various areas of the processing facilities to develop site-specific data relating to gamma exposure rates. Although not included in the EPA-approved RI workplan, the objective of these measurements was to characterize potential gamma radiation emitted from industrial feedstocks, by-products and wastes, and equipment shielding factors. Exposure rate measurements were obtained at over 24 locations at the Simplot facility and 63 locations at the FMC facility. Measurements were obtained using standard equipment and methods utilized in evaluating the potential need for radiation protection programs.

Exposure rates were measured under typical worker conditions (e.g., in heavy equipment cabs) or directly atop source areas (e.g., the gypsum stack and slag pile). Measurements obtained within cabs were compared to measurements obtained at the same area in the absence of the equipment to determine the shielding factor afforded by the equipment structure.

Additional measurements were obtained to characterize background exposure rates. These were collected both within the foothills of the Bannock Range south of the gypsum stack and slag pile, and in several areas of the Michaud Flats north of the industrial operations areas of the Simplot and FMC facilities.

3.2 RCRA and Post-RI CERCLA Groundwater Monitoring

RCRA Groundwater Monitoring Program

FMC measures groundwater levels and collects samples from 35 RCRA groundwater quality wells on a quarterly basis under its RCRA Interim Status Groundwater Monitoring Program. This includes monitoring groundwater elevations at wells installed at RCRA hazardous waste surface impoundments that were not in service during the RI field study period (i.e., Ponds 17 and 18). Table 3-1a lists the groundwater monitoring wells associated with each RCRA Waste Management Unit. Table 3-1b lists the current analytical parameters included in the RCRA Interim Status Groundwater Monitoring Program. Samples from a set of wells are also analyzed for elemental phosphorus on a semi-annual basis, as shown in Table 3-1c. FMC submits a RCRA Interim Status Groundwater Monitoring Assessment report annually to EPA Region 10. Post-Closure Plans for RCRA WMUs closed with waste remaining (e.g., Pond 8S) include a WMU-specific groundwater-monitoring plan.

RCRA Appendix IX Analytes

Samples collected from groundwater monitoring wells 108, 139, 143, and 156 were analyzed for the constituents listed in 40 C.F.R. Part 264 Appendix IX in November 1997, in support of preparation of FMC's RCRA Part B Permit Application . These wells were selected per agreement with the RCRA Branch at EPA Region 10. Samples from Wells 108, 139, 143, and 156 have been analyzed for dioxins and dibenzofurans, per Method 8280A (EPA 1997b), in the first quarter of 1998.

Of the 226 constituents analyzed in these samples, 211 were not detected. The non-detected constituents included all volatile organic compounds, pesticides, herbicides, PCBs, dioxins, and

dibenzofurans. With the exception of N-nitrosomorpholine, none of the semivolatile organic compounds was detected. N-nitrosomorpholine was detected at 11 µg/L in the sample collected from Well 156; the compound was not detected at a detection level of 10 µg/L in samples collected from Wells 108, 139, and 143. As noted in FMC's RCRA Part B Permit Application (Section E, page E.5-15b), this isolated detection of N-nitrosomorpholine is believed to be a false positive, since the compound was not used at the FMC facility, nor is it in commercial use within the United States.

Constituents detected among the samples from Wells 108, 139, 143, and 156 were: antimony, arsenic, barium, cadmium, chromium, cobalt, mercury, nickel, selenium, thallium, vanadium, zinc, sulfide (acid-insoluble), total cyanide, and, as previously discussed, N-nitrosomorpholine. None of the detected constituents exceeded its respective MCL or PRG.

Elemental Phosphorus

Per agreement with EPA Region 10, RCRA Branch, FMC, in conjunction with EPA, sampled the following wells in January 1998 to assess the presence of elemental phosphorus in groundwater: Wells 108, 110, 111, 112, 120, 121, 123, 134, 135, 141, 146, 151, 155, 156, 157, 158, 159, 502, 517, TW-9S, TW-11S, Swanson Road Spring, and Batiste Spring. Split samples were obtained. One set was analyzed by the U.S. Corps of Engineers for elemental phosphorus (Method 7580), total phosphorus (Method 265.4), and orthophosphate (Method 365.2). The other set of split samples was analyzed by FMC for total phosphorus, orthophosphate, and a series of constituents used in the PHREEQC Model to identify thermodynamically stable molecular species.

In the samples collected during January 1998 and March 1998, elemental phosphorus was detected at Well 108 at concentrations of 0.0013 mg/L and 0.00029 mg/L, respectively. In all other samples, elemental phosphorus was not detected above the reporting limit of 0.000025 mg/L for January 1998 and 0.00005 mg/L for March 1998. FMC continues to sample a set of RCRA monitoring wells for analysis of elemental phosphorus on a semi-annual basis, as shown in Table 3-1c.

Voluntary Post-RI CERCLA Groundwater Monitoring Program

Subsequent to the EMF RI field-sampling program, FMC continued to measure groundwater levels and collect samples from 24 wells in addition to wells sampled under the RCRA Interim Status groundwater-monitoring program on a semi-annual basis under its voluntary CERCLA Groundwater Monitoring Program. These wells are uniformly distributed on FMC properties between the area upgradient from source areas and Batiste Spring. As shown in Table 3-2a, the number of wells was reduced in recent years to 14 after it became apparent that fewer wells were needed to track well-established trends in constituent levels across the site. Table 3-2b lists the current analytical parameters included in this program. FMC also submits these data to EPA Region 10.

Calciner Pond Remedial Action Groundwater Monitoring Program

FMC has submitted a Calciner Pond Remedial Action Groundwater Monitoring Plan (FMC 2003) to IDEQ for review and approval. The objective of the monitoring program is to evaluate the effectiveness of the remedial action in preventing release of constituents from the calciner ponds to groundwater. To meet this objective, groundwater samples from the monitoring wells listed in Table 3-1 are analyzed for potassium, chloride, fluoride, arsenic, selenium, nitrate,

orthophosphate, sulfate, and total ammonia, as well as the field parameters listed in table 3-1b. Wells 136, 142, 143, 161, and 164 are already being sampled on a semi-annual frequency under FMC Voluntary CERCLA Groundwater monitoring Program. These wells will continue to be sampled at this frequency; sampling is targeted for the fall (normally November) and spring (normally May) of each year. Wells 189 and 190 were installed in the second quarter of 2003. Samples from Wells 189 and 190 will be collected on at a quarterly frequency for the first year following installation and at a semi-annual frequency after the first year.

3.3 Unit Closure Confirmation Soil Samples

Drum Storage Unit (SWMU #1)

Soil samples collected in 2003 beneath the secondary containment pad of the Drum Storage Unit after waste removal, equipment decontamination, and containment pad removal confirmed that closure objectives established in the Drum Storage Unit Closure Plan (Astaris 2000a) had been achieved. FMC forwarded these soil-sampling results to EPA Region 10.

Wastewater Treatment Unit (RCRA WMU #12; SWMU #12)

As stated in the Wastewater Treatment Unit Closure Plan, soil samples were collected from fourteen locations to assess potential subsurface contamination from the unit and the integrity of the secondary containment. Sampling locations for the soil samples were underneath and adjacent to the secondary containment area and an historical spill area to the east-northeast (the history of the spill and its subsequent cleanup was addressed in the Closure Plan). Levels of contamination were below soil cleanup criteria in soil samples collected from all fourteen sampling locations, thereby verifying that the clean closure of the WWT Unit had been completed consistent with the closure plan as amended on August 28, 2001 (Astaris 2001a). Sampling results are documented in the Closure Report for the Wastewater Treatment Unit (Astaris 2001c).

Long Term Phosphorus Storage Tanks (SWMU 63)

Seven of the 12 Long Term Phosphorus Storage Tanks (RU 6, SWMU 63) and their P4 inventory were removed in 1994 and the remaining 5 tanks and inventory were removed in 1998. Soil samples were collected during the removal process to evaluate the impact of a documented spill from overfilling a tank. The analytical results for these samples are not available within FMC's plant files. However, plant personnel recall that elemental phosphorus was either not detected or perhaps detected in the range of 1 to 10 mg/kg.

3.4 Miscellaneous Studies

Potential source and soil characterization data were obtained under a number of studies subsequent to the EMF remedial investigation. These data are relevant in updating the remedial investigation and may be useful in the evaluation of remedial action alternatives during the SFS.

LDR Treatment System Baseline Soil Samples

Soil samples were collected at 15 locations beneath and near the footprint of the LDR Treatment System (originally assigned as SWMU 92 – 98) prior to facility construction. These data were obtained to characterize baseline conditions. The sampling locations, within RU 12, are identified with a "BH" code on Figure 3-1.

Geotechnical Data for Cap Design

Geotechnical data were obtained for soils and slag used in the construction of caps at RCRA WMUs in RU 22a. These materials are anticipated to be used in constructing caps at other RUs, and these data will be useful in designing the caps.

Bannock Paving Area Spill Investigation

In 1997, the Jack B. Parsons Company, operators of the former Bannock Paving Company Area (RU 20), conducted a site investigation to determine the nature and extent of contamination associated with a reported spill of approximately 1,000 gallons of oily sludge from a railcar. A former employee reported the spill occurred as BAPCO employees were preparing a railcar for use as a storage tank, and they dumped the oil sludge from the bottom of the railcar to the ground. As part of this investigation, eight test pits were dug in the spill area, and samples of native soils were collected from the base of these test pits. In one test pit, TP-6, there was visual evidence of petroleum hydrocarbons within the slag fill. A sample was collected from the depth interval of 2 to 3 feet below the surface, and one sample was collected from the native soils at a depth of 5.5 feet. Results are summarized in Table 3-4, and the sample locations are shown in Figure 3-1.

Coke Analyses

TCLP test data were obtained from analysis of samples of coke supplied by the FMC facility in Kemmerer, Wyoming.

FTIR Data at Ponds 16S, 17, and 18

Open-path Fourier Transform Infra-Red (FTIR) Spectrometers were installed at Ponds 16S (WMU #10; SWMU 10), Pond 17 (WMU #14; SWMU 87), and Pond 18 (WMU #15; SWMU 88) in 1999 to continuously monitor phosphine and hydrogen cyanide concentrations at the berms of each pond. The FTIR systems were installed pursuant to the RCRA Consent Decree. Quarterly summaries of the FTIR data were submitted to EPA Region 10 and the Shoshone-Bannock Tribes. The FTIR systems at Ponds 16S and 17 were removed during installation of the initial fill and temporary covers at each pond. The initial fill and temporary cover was installed at Cell A of Pond 18 in 2002. Cell B of Pond 18 will be closed by waste removal at a later date. The Pond 18 FTIR system, which encompassed Cell A and Cell B of Pond 18, was removed in January 2004 after EPA agreed that the system was no longer necessary.

While these FTIR data may be useful in characterizing phosphine and hydrogen cyanide emissions from operating ponds, they do not appear to be relevant to the current status of the ponds and have not been included in the FEDS database.

EPA Radionuclide Study of P4 Thermal Process and Other Studies

EPA collected 6 samples of phosphate ore, 6 samples of calcined briquettes, one sample of silica, one sample of coke, one sample of ferrophos, and 6 samples of slag in December 1976 from the FMC facility. These samples were split. One set was analyzed at EPA's EMSL laboratory and the other set was analyzed at EPA's EERF laboratory. Both laboratories analyzed these samples for radionuclides in the uranium-238 decay series and the thorium-232 decay series. Table 3-5

presents the analytical results reported by each laboratory (EPA 1977[1]). EPA noted that the EMSL results for lead-210 were found to be in error by up to a factor of 5 too low.

For the reader's convenience, Table 3-5 includes data on radionuclide activities in potential source materials obtained by FMC in the following studies described in Section 3: the EMF RI Report (Bechtel 1996), the Pre-Start Up LDR Radionuclide Study (Astaris 2001b); and an analysis of a sample of Calciner Pond 2-C wastewater. The radiological data presented in Table 3-5 are also referenced in Appendix F of the RI Update Memo.

LDR Treatment System Development Studies

FMC performed several analytical studies in support of developing a facility to treat phossy wastes to meet RCRA Land Disposal Restriction standards and the requirements of the FMC RCRA Consent Decree. Construction of the LDR Treatment System was terminated in the fall of 2001 before the system was placed into operation.

ZIMPRO Pilot Study

Pilot tests of the ZIMPRO treatment was conducted at the US Filter Company's facility in Wisconsin during the spring and summer of 1999. Phossy wastes collected from Tanks V-3600, V-3700, and V-3800 were combined at the US Filter facility in various ratios and processed using the ZIMPRO treatment system under a variety of test conditions. The pilot tests are described in Section 4.1.3 of the FMC's LDR Waste Treatment System Submittal (FMC 2000). Section 4.1.3 includes a tabulation of analytical data for samples of untreated and treated materials.

Toluene Insolubles Study

FMC used a toluene extraction procedure in its laboratory to assay the quality of the P4 product manufactured during facility operations. Toluene insoluble solids (TI) referred to the fraction of the P4 test sample that, unlike P4, is insoluble in toluene. TI solids were essentially non-P4 furnace off-gas dusts that had not been removed from the P4 process stream by the electrostatic precipitators.

Operation of the LDR Waste Treatment System was designed to limit the rate at which metals entered the treatment system to levels protective of human health and the environment. In lieu of developing metal feed rate limits, Astaris[2] proposed to monitor the amount of P4 and TI in the slurry tanks feeding the main treatment step of the LDR Treatment System (the caustic hydrolysis reactor).

The relationship between TI and P4 and metals was examined in *Characterization and Variability Analysis of Toluene Insolubles and Selected Metals in LDR Reactor Feed Slurry* (Astaris 2000b). The phossy waste streams from the Phos Dock and precipitator slurries were sampled and analyzed over a five-month period. The 93 samples were analyzed for TI solids, P4 and eighteen metals. It was established that TI and P4 could be used as a surrogate for measuring the amounts of the individual metals that were to be fed and treated in the LDR process without endangering human health or the environment. Results showed that the TI and

[1] EPA 1977: Radiological Surveys of Idaho Phosphate Ore Processing -- The Thermal Process Plant. Office of Radiation Programs, Las Vegas Facility, Las Vegas, NV. Technical Note ORP/LV-77-3

[2] Astaris Idaho LLC, a joint venture formed by FMC and Solutia, operated the Pocatello facility from April 2000 until early 2002.

P4 could be used for this purpose for sixteen of the metals, while the remaining two metals, Co and Hg, were generally found to be present at concentrations below the detection limits of the analytical methods used in this study. The combined waste feed stream were to be further sampled during start up of the LDR Treatment System to confirm that TI and P4 can act as a surrogate for measuring the amounts of the individual metals for all eighteen metals.

The study and related statistical analyses determined that:

1) The correlation between TI and metals' concentrations was strong for Al, Sb, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, Tl, V, and Zn.
2) The relationship between TI and arsenic was found to depend on both TI and P4 concentration in the waste feed slurries.
3) Analyses for cobalt and mercury found, that for more than half of the samples, the concentration of these metals was below the detection limit of the analytical methods used. About one-fourth of the selenium and thallium samples also analyzed below the detection limit.
4) For As, Ba, Be, Cu, Mn, and Ni the concentration of metal at a given %TI was found to be higher in the Clarifier Underflow (CU) wastes from the Phos Dock than in the Precipitator Slurry (PS) wastes.
5) Combinations of the CU and PS wastes in the expected LDR feed ratio showed that for Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, V, and Zn all the combinations contained substantially less metal than the assumed concentration that was used in the Direct Inhalation Risk Assessment.
6) Combinations of the CU and PS wastes in the expected LDR feed ratio showed that for Co, Hg, and Tl some of the combinations contained higher concentrations of metal than the assumed concentration that was used in the Direct Inhalation Risk Assessment."

Pre-Start Up LDR Radionuclide Study

Samples of Tank V-3600, V-3700, and V-3800 discharges were composited in the proportion expected in the feed to the reactor system at the LDR Waste Treatment System (then under construction). The composite samples were analyzed for radionuclides in the uranium-238 decay series, as well as gross alpha and gross beta. The methods used in the study and the analytical results obtained are presented in Astaris 2000. The analytical data are included in Table 3-5.

Calciner Solids Study

During 1999 and 2000, FMC collected samples from Calciner Ponds 1C, 2C, 3C, 4C, and 5C and analyzed them for selected metals using the TCLP methodology. FMC also performed total metals and TCLP analyses on samples co-located to those collected by IDEQ in 2001. The results of these analyses are presented in Tables 3-2 through 3-4 of the Remedial Design Work Plan for the Calciner Ponds (FMC 2002).

Pond Closure Decant Treatment System

FMC developed a wastewater treatment system to treat water decanted from a series of phossy waste ponds during their closure and to support decommissioning of the plant. This system is referred to as the PCDT system. It is designed and operated to treat wastewaters to meet the

Universal Treatment Standards (UTS) identified in the RCRA Land Disposal Restrictions standards prior to the use of the treated water for dust suppression on interior roads during 2004 and 2005.

FMC provided information in support of this on-site water treatment and the use of treated water for dust control in a November 21, 2003 letter to EPA and as supplemented by a memo to EPA dated December 5, 2003 and a letter to EPA dated December 30, 2003. This letter and supplemental information, which is reproduced in Appendix I, provides:

- An estimate of the residual levels of treated water constituents in soil at those areas where water is applied, including naturally-occurring radioactive materials;
- A description of the treatment process and management of water for dust control;
- The results of bench testing to treat Pond 17 decant water to meet UTS levels;
- An evaluation of NORM constituents prepared in support of FMC's original proposal to discharge treated water to the Pocatello POTW;
- Clarification of dust control water application compared to evaporation rates by month; and
- A map showing the construction and general areas for dust control during 2004 and 2005.

As indicated in Appendix I, the application of PCDT-treated water to roads for dust control meets applicable or relevant and appropriate requirements, does not significantly add incrementally to metals or NORM already present in soils at the site, and conserves clean water that would otherwise need to be withdrawn from the aquifer.

LEGEND

MAXIMUM SAMPLE DEPTH

- 0 - 2.5
- 2.5 - 10
- Not Sampled: P4 encountered during drilling
- 10 - 50
- TO GROUNDWATER

- Potential Source Sample Location Assumed
- Potential Source Sample Location
- Potential Source Sample Location
- Shallow monitoring well
- Deep monitoring well
- Water supply well
- Production well
- Abandoned shallow monitoring well
- Abandoned deep monitoring well
- Abandoned production well
- Radiation measurement locations from 1995 survey

FORMER POND LOCATION OR POND SEDIMENT

FMC PROPERTY LINES

1. FURNACE BLDG, PHOS DOCK AND SECONDARY CONDENSER (AOC #1)
2. SLAG PIT
3. RECEIVING/STORES, OLD PAINT SHOP AND NEW P4 DECON BLDG
4. OFFICE BLDGS AND TRAINING CENTER
5. LABORATORY AND OLD DRAINFIELD
6. FORMER LONG TERM P4 STORAGE AREA
7. SHALE UNLOADING/CRUSHING AND STOCKPILES
8. CALCINER AREA
9. SILICA STOCKPILES
10. IWW POND AND DITCH
11. EQUIPMENT/SUPPLY STORAGE AREA SOUTH OF CALCINERS
12. FORMER RP&S AND MOBILE MAINTENANCE SHOP
13. POND BS RECOVERY PROCESS AND METAL SCRAP PREPARATION AREA
14. CALCINER PONDS
15. OVERSIZED ORE, BROKEN ELECTRODES AND BAGHOUSE DUST RECYCLE MATERIAL
16. CALCINER SOLIDS STOCKPILE
17. RECYCLABLE MATERIAL LANDFILL
18. PLANT LANDFILL
19. SLAG PILES AND BULLROCK PILE
20. FORMER BAPCD AREA
21. OTHER ON-SITE RAILSPURS

RCRA WASTE MANAGEMENT UNITS (SWMUs * 3, 7, 8, 9, 10, 11, 12, 13, 87, 88)

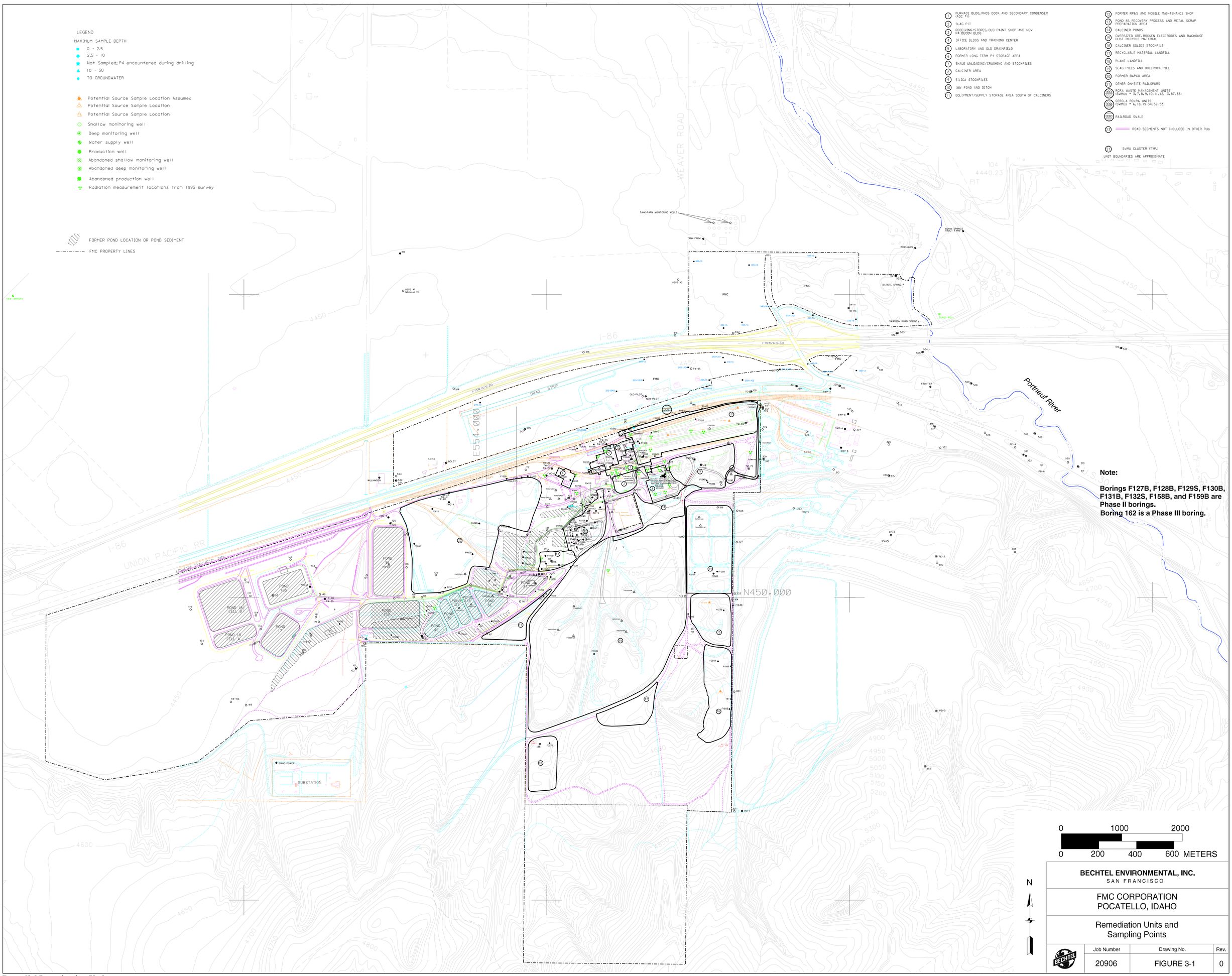
CERCLA RD/RA UNITS (SWMUs * 6, 18, 19-34, 52, 53)

RAILROAD SWALE

ROAD SEGMENTS NOT INCLUDED IN OTHER RUs

SWMU CLUSTER (TYP.)

UNIT BOUNDARIES ARE APPROXIMATE



Note:

Borings F127B, F128B, F129S, F130B, F131B, F132S, F158B, and F159B are Phase II borings.
Boring 162 is a Phase III boring.

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

FMC CORPORATION
POCATELLO, IDAHO

Remediation Units and Sampling Points

Job Number	Drawing No.	Rev.
20906	FIGURE 3-1	0

SFO\50509\NBS EMF DRAW\ROOT\Supplemental\RI\ FIG 3-1.DGN
05/06/04.ds

Table 3-1a
RCRA Interim Status Waste Management Unit Groundwater Monitoring Well Network

RCRA WMU	Upgradient Well	Downgradient Well
WMU #3 – Pond 15S	165	113, 115, 166
WMU #5 – Slag Pit Wastewater Collection Sump	121	108, 122, 123
WMU #7 – Pond 8S	158, 183	155, 156, 157
WMU #8 – Phase IV Ponds	167	104, 114, 131, 168
WMU #9 – Pond 9E	113, 124	126, 127, 128
WMU #10 – Pond 16S	154	147, 148, 149
WMU #11 – Pond 8E	167	104, 114, 131, 168
WMU #14 – Pond 17	173	171, 172, 180
WMU #15 – Pond 18	174, 175	154, 176, 177, 178
General Assessment		Batiste Spring

Table 3-1b
RCRA Interim Status Groundwater Monitoring Program Analytical Parameters

Parameter	Field Measurement	Laboratory Measurement
Depth to Water Level	X	
Dissolved Oxygen	X	
pH	X	
Specific Conductance	X	
Turbidity	X	
Water Temperature	X	
Potassium (total)		X
Sulfate (SO4)		X
Chloride		X
Fluoride		X
Total Ammonia (NH3+NH4 as N)		X
Nitrate (NO3 as N)		X
Orthophosphate (PO4 as P)		X
Arsenic (total)		X
Cadmium (total)		X
Selenium (total)		X

Table 3-1c
Semi-Annual Sampling for Elemental Phosphorus at RCRA Monitoring Wells

WELL NUMBER		
108	123	157
121	155	158
122	156	183

Table 3-2a
FMC Voluntary Post-RI CERCLA Groundwater Monitoring Well Network

Well Number c. 1998 – 2Q 2002 (semi-annual frequency)		Well Number 4Q 2002 – present (semi-annual frequency)	
South of Highway 30	North of Highway 30	South of Highway 30	North of Highway 30
101	502	110	515
110	515	111	524
111	523	136	525
112	524	139 (at times)	
134	525	142	
136	Old Pilot	143	
139	TW-9S	146	
140	TW-11S	161	
142	TW-12S	164	
143		189	
146		190	
151			
159			
161			
164			

Table 3-2b
FMC Voluntary Post-RI CERCLA Groundwater Monitoring Analytical Parameters

Parameter	Field Measurement	Laboratory Measurement
Depth to Water Level	X	
Dissolved Oxygen	X	
pH	X	
Specific Conductance	X	
Turbidity	X	
Water Temperature	X	
Potassium (total)		X
Sulfate (SO4)		X
Chloride		X
Fluoride		X
Total Ammonia (NH3+NH4 as N)		X
Nitrate (NO3 as N)		X
Orthophosphate (PO4 as P)		X
Arsenic (total)		X
Selenium (total)		X

Table 3-3
Calciner Pond Remedial Action Program Monitoring Wells

Monitoring Well I.D. Numbers	
Upgradient	Downgradient
142	136
161	143
164	189
	190

Table 3-4
TPH and BETX Soil Sampling Results for 1997 BAPCO Spill Investigation

Sample/Test Designation	TPH (mg/kg) Modified CA Method 8015	TRH (mg/kg) Method 418.1	BTEX (µg/kg) (SW-846 Method 8020)
TP-01	<10 Gasoline <10 Diesel <10 TPH	<10	
TP-02	<10 Gasoline <10 Diesel <10 TPH	<10	
TP-03	<10 Gasoline <10 Diesel <10 TPH	<10	
TP-04	<10 Gasoline <10 Diesel <10 TPH	<10	
TP-05	<10 Gasoline <10 Diesel <10 TPH	<10	
TP-06	<10 Gasoline <10 Diesel <10 TPH	<10	
TP-07	<10 Gasoline <10 Diesel <10 TPH	<10	
TP-08	<10 Gasoline <10 Diesel <10 TPH	<10	
TP-06 HS1	<10 Gasoline <10 Diesel <10 TPH	202	<5 MtBE 14.1 Benzene 104 Toluene 12.2 Ethylbenzene 81.8 Total Xylenes <5 Naphthalene
TP-06 CS1	<10 Gasoline <10 Diesel <10 TPH	<10	<5 MtBE <5 Benzene 12.1 Toluene <5 Ethylbenzene 23.6 Total Xylenes <5 Naphthalene

Table 3-5

Radionuclide Activities in Potential Source Materials at the FMC OU

Material	Sample	Data Source	Sample Type[a]	Sample ID	Units	Assoc. with Potassium			<- parents -- Uranium-238 Decay Series -- daughters ->																	Thorium-232 Decay Series					
						Potassium-40			Uranium-238			Uranium-234			Thorium-230			Radium-226			Lead-210			Polonium-210			Thorium-232			Radium-228		
						actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual
Phosphate Ore	FMC Ore	Bechtel 1996	PSW	FOSFPO01	pCi/g	10.9	2.46		24.2	6.92											1.7	0	U									
	Phosphate Rock (ore) [c]	EPA 1977			pCi/g				22	3.2		22	2		22	4.1		26	19		27	12		22	3		0.43	0.12		0.89	0.28	
	Phosphate Rock (ore) sample #1[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				22.3	3.35		22	3.3		21.4	0.641		24.3	0.243		27.7	0.9		21.5	3.2		0.483	0.0676		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				22	5.5		21	5.2		23	1.1		26	0.93		2.7	0.69		24	2.4		0.3	0.11		0.78	0.76	
	Phosphate Rock (ore) sample #2[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				21.0	3.05		20.6	2.99		24.1	0.723		24.0	0.24		31.8	1.9		22.8	3.3		0.516	0.0722		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				20	2.2		22	2.4		24	1.00		27	0.94		6.4	0.83		22	1.3		0.37	0.13		0.74	0.66	
	Phosphate Rock (ore) sample #3[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				22.2	3.11		21.4	2.99		22.2	0.666		21.3	0.213		29.4	1.5		25.2	3.7		0.439	0.0636		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				23	2.3		23	2.3		19	0.96		14	0.68		4.7	0.76		21	1.7		0.49	0.16		0.98	0.68	
	Phosphate Rock (ore) sample #4[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				21.8	3.15		21.7	3.15		22.8	0.648		19.4	0.194		27.7	1		19.4	1.5		0.441	0.0639		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				26	4.7		22	4.7		23	0.99		30	1		5.8	0.8		22	1.7		0.42	0.14		0.67	0.65	
	Phosphate Rock (ore) sample #5[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				21.9	3.07		21.8	3.05		22.1	0.662		21.1	0.211		15.4	1.3		21.5	1.5		0.454	0.0635		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				24	4.0		24	3.9		23	1.0		29	0.98		6.5	0.82		23	1.6		0.46	0.15		<0.65		U
	Phosphate Rock (ore) sample #6[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				20.5	2.97		20.7	3.00		22.0	0.66		20.8	0.208		31.9	1.8		22.4	0.9		0.479	0.0646		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				22	3.2		21	3.0		17	0.87		53	1.3		7.2	1		21	2.4		0.36	0.13		<0.81		U
Nodules (Calcined Briquettes)	Calcined Rock (aka nodules) [c]	EPA 1977			pCi/g				24	1.8		23	2.2		23	2		25	8.6		18	8.6		<2.65		U	0.47	0.1		0.97	0.48	
	Calcined Briquettes (aka nodules) sample #1[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.5	3.53		23.8	3.56		21.6	0.648		24.2	0.242		19.1	0.3		ND		U	0.479	0.0574		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				24	2.0		22	2.0		23	1.00		28	0.97		8.1	0.9		9.2	1.1		0.5	0.15		1.3	0.84	
	Calcined Briquettes (aka nodules) sample #2[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.0	3.22		22.3	3.12		23.0	0.689		21.8	0.218		20.5	0.3		ND		U	0.404	0.8606		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				22	1.8		22	1.7		23	0.98		20	0.82		6.5	0.85		8.5	0.88		0.52	0.15		<0.73		U
	Calcined Briquettes (aka nodules) sample #3[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				22.3	3.23		21.9	3.18		22.7	0.68		22.4	0.224		25.1	0.6		ND		U	0.575	0.0719		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				24	1.9		22	2.0		23	1.0		31	1.0		8.7	0.93		11	1.2		0.44	0.14		1.5	0.83	
	Calcined Briquettes (aka nodules) sample #4[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.6	3.3		23.2	3.25		23.8	0.713		20.3	0.203		17.4	0.6		ND		U	0.410	0.0636		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				23	1.6		23	1.5		23	0.95		25	0.91		5.2	0.77		9.3	0.86		0.49	0.14		<0.74		U
	Calcined Briquettes (aka nodules) sample #5[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.7	3.32		23.1	3.23		21.4	0.641		20.7	0.207		12.8	1.3		<2.65		U	0.465	0.0674		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				25	2.4		26	2.5		24	1.0		29	0.98		5	0.77		11	1.1		0.42	0.14		<0.78		U
	Calcined Briquettes (aka nodules) sample #6[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.9	3.7		23.0	3.56		20.9	0.627		21.6	0.216		15.2	1.5		ND		U	0.522	0.0705		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				25	2.5		23	2.3		24	1.0		32	1.0		9.7	0.9		9.0	0.89		0.42	0.13		<0.63		U
Silica	Silica [c]	EPA 1977			pCi/g				1.5	1.4		<0.86		U	1.6	0.53		1.7	0.24		0.67	0.55		2.6	0.9		0.69	0.37		<0.89		U
Coke	Coke [c]	EPA 1977			pCi/g				<0.51		U	<0.44		U	<0.23		U	0.78	0.17		2.4	0.62		<1.3		U	<0.69		U	<0.95		U
	Coke Supplement [c]	EPA 1977			pCi/g				<0.59		U	<0.95		U	<0.20		U	0.7	0.16		0.61	0.54		0.98	0.11		<0.22		U	<0.91		U
	Coke Settling Sediment Pond	Bechtel 1996	PSW	FWSCSP01	pCi/g	0.926	0.48	UJ	3.11	0	U										6.64	0	U									
Ferrophos	Ferrophosphorus [c]	EPA 1977			pCi/g				19	4.9		21	5.2		0.42	0.27		0.27	0.11		1.1	0.58		<0.57		U	0.26	0.2		0.99	0.94	
	Ferrophos	Bechtel 1996	PSW	FWSFSA01	pCi/g	2.3	0.77		4.68	1.85	UJ										1.26	0	U									
	Ferrophos	Bechtel 1996	PSW	FWSFSA02	pCi/g	0.794	0.33	UJ	9.69	1.9											1.34	0	U									
	Ferrophos	Bechtel 1996	PSW	FWSFSA03	pCi/g	2.04	0.71		12.3	2.68											1.39	0	U									
Slag	Slag [c]	EPA 1977			pCi/g				25	7		25	6.7		26	11		32	13		11	7.9		<16		U	0.59	0.29		0.96	0.46	
	Slag sample #1[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				29.4	4.41		28.4	4.25		25.5	0.764		22.8	0.228		11.6	1.0		8.27	2.86		0.648	0.081		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				25	4.2		27	4.4		29	1.4		37	1.1		2.3	0.67		8.3	1.3		0.52	0.19		<0.80		U
	Slag sample #2[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				22.2	3.1		21.2	2.96		25.8	0.774		23.2	0.232		11.1	1.7		ND		U	0.632	0.0789		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				26	2.4		27	2.4		11	0.40		40	1.2		0.86	0.61		2.4	0.50		0.20	0.055		<0.76		U
	Slag sample #3[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				21.6	2.92		21.6	2.91		26.3	0.789		24.8	0.248		6.6	0.6		23.7	5.85		0.533	0.0693		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				29	2.6		27	2.5		28	1.1		36	1.1		2.1	0.68		11	1.1		0.47	0.15		1.6	0.86	
	Slag sample #4[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				27.7	3.88		27.2	3.81		26.6	0.797		32.5	0.325		7.8	0.7	.	ND		U	0.672	0.084		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				25	2.3		29	2.4		23	0.95		37	1.1		0.69	0.62		3.3	0.45		0.66	0.16		<0.76		U
	Slag sample #5[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				18.6	2.32		19.7	2.46		28.1	0.843		32.3	0.323					ND		U	0.627	0.0783		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				24	3.3		24	3.3		33	1.5		37	1.1		1.4	0.66		11	0.95		0.73	0.22		<0.80		U
	Slag sample #6[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				20.3	2.64		20.4	2.65		27.3	0.819		33.3	0.333		16.7	2.8		ND		U	0.683	0.0854		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				28	2.0		27	2.0		31	1.2		23	0.87		4.2	0.82		8.0	0.72		0.70	0.18		<0.76		U
	FMC Slag	Bechtel 1996	PSW	FWSSSA01	pCi/g	8.48	2.09		24.4	7.22											4.66	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA02	pCi/g	7.38	2.18		28.1	7.14											4.55	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA03	pCi/g	8.09	1.85		26.3	7.52											4.52	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA04	pCi/g	9.22	1.91		22.1	6.34											3.7	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA05	pCi/g	10.9	2.16		30.7	8.90											4.35	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA06	pCi/g	9.05	2.61		26.5	8.34											4.58	0	U									
Calciner Pond Wastes	Calciner Pond 2C - Liquid	Bechtel 1996	PSL	CALPOND2	pCi/L													0.62	0.16	U									-0.5	0.40	U
	Calciner Pond 2C - Liquid (3/12/03 sample)	Hazen 2003	PSL	C351/03-1	pCi/L	44,400 [f]			<1[b]						0	0.6	U	0.9	1		8.4	4.2		18	4		0	0.6		1	1.7	U
	Water Discharged to Calciner Ponds - time composite	Bechtel 1996	PSL	FSWCPW01	pCi/L													0.34	0.11	UJ									-0.4	0.70	U
	Sediment in Calciner Ponds	Bechtel 1996	PSW	FSDCPW01	pCi/g	70.4	8.34		17.5	7.96											1.7	0	U									

Table 3-5

Radionuclide Activities in Potential Source Materials at the FMC OU

Material	Sample	Data Source	Sample Type[a]	Sample ID	Units	Assoc. with Potassium			<- parents -- Uranium-238 Decay Series -- daughters ->															Thorium-232 Decay Series					
						Potassium-40			Uranium-238			Uranium-234			Thorium-230			Radium-226			Lead-210			Polonium-210			Thorium-232			Radium-228		
						actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual
Precipitator Slurry/Phossy Wastes	Precipitator Slurry Discharged to Pond 8E - time composite	Bechtel 1996	PSL	FSWPS88E	pCi/L													103	4.48											-2.7	1.00	U
	Precipitator Slurry Discharged to Phase IV Ponds - time composite	Bechtel 1996	PSL	FSWPWSIV	pCi/L													1.9	0.56	J										-2.4	1.10	U
	Fluid Bed Dryer Prills (dried precipitator dust) [c]	EPA 1977			pCi/g				<71		U	<91		U	<24		U	13	0.65		52	1.8		440	27		<17		U	1.9	1	
	Sediments from Pond 11S	Bechtel 1996	PSW	FWSP1101	pCi/g	25.9	3.16		4.46	0	U										352	89.4										
	Sediments from Pond 12S	Bechtel 1996	PSW	FWSP1201	pCi/g	27.4	3.5		4.98	0	U										465	117										
	Sediments from Pond 15S	Bechtel 1996	PSW	FWSP5S01	pCi/g	22	3.32		3.93	4.14	UJ										204	53.8										
	Sediments from Pond 8S	Bechtel 1996	PSW	FWSP8S01	pCi/g	13.1	2.28		0.694	3.28	UJ										230	60.4										
	Sediments from Pond 9E	Bechtel 1996	PSW	FWSP9E01	pCi/g	50.7	5.78		8.36	5.32											0.782	0	U									
	Phossy Waste (V-3600/V-3700/V-3800 composite)	Astaris 2001	PSW	G-0620 115-1	pCi/g	163[f]			<3[e]						2.2	0.9		10	2		1,240	17		510	8		0.3	0.4		0	1.5	U
	Phossy Waste (V-3600/V-3700/V-3800 composite)	Astaris 2001	PSW	G-0620 115-2	pCi/g	176f			<3[e]						1.5	0.7		10	2		1,240	17		540	8		0	0.2	U	0.6	1.5	U
	Phossy Waste (V-3600/V-3700/V-3800 composite)	Astaris 2001	PSW	G-0620 118-1	pCi/g	157f			<1[e]						13	5		7.5	1.7		1,340	40		750	20		0	1.2	U	0.3	1.2	U
	Phossy Waste (V-3600/V-3700/V-3800 composite)	Astaris 2001	PSW	G-0620 118-2	pCi/g	157f			<19[e]						3.4	2.6		11	2		1,370	40		720	20		0.4	1.4	U	0	1.2	U
IWW System	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWA	pCi/L													0.89	0.15	U										-0.30	0.80	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWD	pCi/L													0.31	0.10	U										-2.90	0.30	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWE	pCi/L													0.46	0.10	U										-1.50	0.60	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWF	pCi/L													0.79	0.13	U										-0.30	0.40	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWG	pCi/L													0.18	0.08	U										6.50	0.80	
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWH	pCi/L													0.63	0.12	U										-1.10	0.40	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWN	pCi/L													0.00	0.1	U										0.00	0.30	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWP	pCi/L													0.18	0.08	U										-0.70	0.30	U
	IWW Ditch Discharge (Sept. 1992) - time composite	Bechtel 1996	PSL	FSWIWW01	pCi/L													0.72	0.17	UJ										-0.2	0.60	U
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW01	pCi/g																											
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW02	pCi/g																											
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW03	pCi/g																											
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW04	pCi/g																											
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW05	pCi/g																											
	IWW Ditch Sediments (composite)	Bechtel 1996	PSW	FSDIWW06	pCi/g																											
Railroad Swale	Water in Railroad Swale - location composite	Bechtel 1996	PSL	FWWRRS01	pCi/L													1.59	0.23											-0.3	0.50	U
	Sediment in Railroad Swale	Bechtel 1996	PSW	FSDRRS01	pCi/g																											

Notes:

Blank result cells - radionuclide not analyzed

J = Estimated value.

U = Not detected.

[a] Station location code used in EMF Site remedial investigation

[b] Uranium as U (pCi/g) calculated from total uranium; U-238 not reported, but is < U (pCi/g)

[c] As stated in EPA report Table 3, data are average results from both EMSL and EERF laboratories except for lead-210 and polonium-210 (corrected) which are average of EERF values only from Appendix C, Table C-2 of EPA report.

[e] Uranium as U (pCi/g) calculated from total uranium; U-238 not reported, but is < U (pCi/g)

[f] K-40 calculated from total potassium assuming natural abundance of K-40 is 0.0118%

[g] EPA collected 6 samples of phosphate ore, 6 samples of calcined briquettes, and 6 samples of slag in December 1976 from the FMC facility. These samples were split. One set was analyzed at EPA's EMSL laboratory and the other set was analyzed at EPA's

Astaris 2001:Pre-Start Up LDR Radionuclides Study

Bechtel 1996: EMF Site Remedial Investigation Report

EPA 1977: Radiological Surveys of Idaho Phosphate Ore Processing -- The Thermal Process Plant

Hazen 2003: Report of Analysis for Sample Calciner 2-C 03/12/2003

Section 4
RBCs for Elemental Phosphorus and Other COPCs

In the Baseline Human Health Risk Assessment (HHRA) for the EMF site (E&E, 1996) risk-based concentrations (RBCs) protective of potential future commercial/industrial workers were developed as screening criteria to assist in the identification of contaminants of potential concern (COPCs) requiring further evaluation within the assessment of the FMC Subarea. As discussed in Section 2.3.1 of the HHRA (E&E, 1996), the RBCs were developed based on methods and assumptions presented in EPA's *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals* (EPA, 1991a) and *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA, 1991b). Per these guidance documents, upperbound soil RBCs were derived for each COPC at an excess lifetime cancer target risk of $1x10^{-6}$ for carcinogens and a target hazard quotient of one for non-carcinogenic COPCs. These worker RBCs were subsequently used in the 1997 Feasibility Study (FS) Report of the FMC Subarea (FMC, 1997) to screen source material and soils for evaluation of remedial action requirements for each COPC. The original worker RBCs, presented in Table 2.3-1 of the FS Report (FMC, 1997), are presented in Table 4-1.

While elemental phosphorus (P4) was identified as a COPC in the RI (Bechtel, 1996), an RBC was not developed in the Baseline HHRA due to an absence of data to characterize the toxicity of this constituent. Since then, EPA has established a P4 toxicity reference value. Consequently, in accordance with the Statement of Work (SOW) for the SRI/FS of the FMC Plant OU (EPA, 2003a), P4 RBCs are developed in this section for use as screening levels in the SRI/FS. The P4 RBCs are derived in accordance with current EPA guidance for developing risk-based soil screening levels (SSLs) for Superfund sites (EPA, 2002). While interchangeable, it should be noted that in this section the term SSL is used instead of RBC to describe risk-based screening concentrations to be used in the SRI/FS process.

In addition to the development of P4 SSLs, the future commercial/industrial worker RBCs for inorganic COPCs presented in the HHRA and FS Report (Table 4-1) are being updated for the following reasons:

1. <u>EPA guidance for deriving future commercial/industrial worker risk-based screening levels has been updated</u>

EPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (EPA, 2002) contains revised methods and assumptions for developing risk-based SSLs applicable to Superfund sites.

2. <u>Toxicity factors have been updated</u>

Since completion of the HHRA, EPA has revised the chronic toxicity factors for several of the COPCs listed in Table 4-1 (e.g., beryllium). In addition, the hierarchy of data sources to be used to characterize COPC toxicity factors at Superfund sites has been amended (EPA, 2004a).

3. Current EPA guidance identifies additional potential receptors and exposure pathways of potential concern

Consistent with current guidance for deriving SSLs for Superfund sites (EPA, 2002), the updated CSM for the FMC Plant OU (Section 2) identifies additional receptors that could potentially be exposed to site-related contamination. Specifically, in addition to outdoor future commercial/industrial workers, the following potential receptors have also been identified:

- Indoor commercial/industrial workers
- Construction workers
- Utility workers
- Nearby off-site residents

As discussed in Section 2, each of the receptors identified above could be exposed to FMC Plant OU-related COPCs via a variety of exposure pathways. Table 4-2 summarizes the exposure pathways that are considered complete for each potential receptor. The identified pathways were developed based on recommendations within Exhibit 3-1 of EPA's SSL guidance (EPA, 2002), modified to reflect site-specific considerations at the FMC Plant OU.

With respect to the organic COPCs listed in Table 4-1, updated SSLs will be derived in the SRI Workplan for both these and other organic constituents of fuel oils and solvents that have previously been detected in soil samples obtained from the FMC Plant OU. Currently, it is envisioned that SSLs will be derived for 1,1,1-trichloroethane, aroclor 1260, chloroform, ethylbenzene, tetrachloroethene, toluene, trichloroethene and xylenes. These SSLs will serve as a basis for evaluating existing data and to support evaluation of analytical data obtained during the SRI.

With respect to the radionuclides of potential concern (ROPCs) listed in Table 4-1, updated SSLs are not derived herein because background concentrations of these constituents at the FMC Plant OU already exceed EPA's default $1x10^{-6}$ target risk threshold (per Table K-6 of the HHRA [E&E, 1996], the HHRA determined that excess lifetime cancer risks to future workers from background external gamma radiation exposure alone is $4.6x10^{-4}$). Instead, because risk evaluations of existing radionuclide-specific data characterizing the content of feedstocks and waste streams historically processed at the FMC Plant OU have found that exposure to external gamma radiation drives risk for each of the source materials of potential concern (except phossy solids), gamma radiation is identified as the principal radiation-related parameter to be considered within the SRI/SFS. Specifically, gamma radiation dose-rate measurements will be collected during the SRI as a surrogate for evaluating radiation-related risk from exposure to gamma-emitting COPCs. These data will be supplemented by a limited number of radionuclide-specific analyses of soil samples, focused in areas found to contain phossy solid fill material. The methods, assumptions and findings of the risk evaluations described above are provided in Appendix F, along with an overview of the approach that will be taken to collect radiological data during the SRI. In addition, the ability of gamma dose rate measurement instruments to adequately detect incremental dose rates relevant to an acceptable worker exposure is documented in Appendix G.

The remainder of this section is structured as follows: Section 4.1 describes the environmental fate of P4 in surface and subsurface soils, and identifies the P4-related constituents to which

future receptors could potentially be exposed. The methods and assumptions used to derive updated SSLs for chronically exposed (i.e., > 1 year) future outdoor commercial/industrial workers are presented in Section 4.2. Similarly, the methods and assumptions used to derive SSLs for chronically exposed future indoor commercial/industrial workers at the FMC Plant OU are presented in Section 4.3. By contrast, Sections 4.4 and 4.5 describe the methods and assumptions used to derive SSLs for the sub-chronic exposure (i.e., <= 1 year) of potential future FMC Plant OU construction and utility workers, respectively. Section 4.6 presents the methods and assumptions used to derive SSLs for nearby off-site residents, and to confirm that the chronic and sub-chronic SSLs developed for FMC Plant OU worker exposures are protective of these off-site receptors. Finally, Section 4.7 provides a summary of the SSLs derived for each COPC and potential receptor. The significance of these SSLs as screening criteria with the SRI/FS is also discussed.

4.1 Elemental Phosphorus

This section provides a discussion of the environmental fate of P4 in surface and subsurface soils. This information is then used to identify whether P4 or products of its environmental reactions are likely to be present within media to which future receptors at the FMC Plant OU could be exposed. The findings are incorporated into the subsequent SSL calculations for this COPC within Sections 4.2 through 4.6.

4.1.1 Environmental Fate

The primary processes for chemical transformation of white P4 (the form of phosphorus historically manufactured at the FMC Plant OU) in the environment are oxidation and hydrolysis (EPA, 2003b). In soil, white P4 oxidizes spontaneously (smokes) with oxygen in air at a concentration of approximately 1,000 mg/kg (EPA, 2003b). Under ambient conditions, this reaction produces a particulate aerosol that consists of oxides of phosphorus including phosphorus pentoxide (P_4O_{10}), and phosphorus trioxide (P_40_6) (ATSDR, 1997). These oxides react with moisture present in air (hydrolyze) to form a number of phosphorus-containing acids, such as orthophosphoric acid (H_3PO_4), pyrophosphoric acid ($H_4P_2O_7$), orthophosphorus acid (H_3PO_3), hypophosphorus acid (H_3PO_2), polyphosphoric acid of the general formula $H_{n+2}P_nO_{3n+1}$, where n=2-8, and a homologous series of linear and cyclic P_6-P_{16} polyphosphates (Spanggord et al. 1983; Tolle et al. 1988). In the absence of stoichiometric quantities of oxygen, phosphine (PH_3) may form from the reaction of unreacted P4 with atmospheric moisture (Spanggord et al. 1983).

At soil concentrations of less than 1,000 mg/kg, oxidation is still the predominant route of P4 soil loss, up to a depth that allows diffusion of oxygen (Bohn et al. 1970). While this oxidation process is not spontaneous (i.e., no smoking occurs), it is still relatively rapid. At ambient temperatures, P4 has been found to oxidize in aerobic soil within 2 days (Rodriguez et al. 1972).

In poorly oxygenated soils, a protective coating can form around P4 particles slowing the rate of oxidation (Bohn et al. 1970). In the absence of oxidation reactions in anaerobic soils, the half-life of P4 can be 10-10,000 years (Richardson, 1992; Spanggord et al., 1985). Although white P4 is relatively insoluble in water (solubility of 3 mg/L at 15 °C), P4 may be hydrolyzed in wet, anaerobic soils to form phosphine (PH_3) and lesser amounts of phosphorus acids. The rate of hydrolysis of P4 is enhanced by an increase in the pH of the water reacting with the P4 (EPA, 2003b). Since phosphine is gaseous and only slightly soluble in water, volatilization from soil pore-water is the most important process by which phosphine is lost from soil following its

formation (ATSDR, 1997). However, there are several mechanisms by which phosphine is bound in soil and made unavailable for volatilization. In a sealed tube experiment, phosphine was found to completely disappear in less than 40 days from three different types of soil with varying amounts of moisture (Hilton and Robison 1972). The disappearance was attributed to initial sorption, and the subsequent biotic and abiotic oxidation of part of the sorbed compound. The rate of adsorption increased with decreasing moisture content and increasing organic soil content (Hilton and Robison 1972). Phosphine sorption in soil can occur by both physical and chemical sorption processes, and the chemisorption process is irreversible and higher in soils with a low organic matter and high mineral content (Berck and Gunther 1970).

In pure oxygenated water, dissolved P4 is rapidly oxidized by dissolved oxygen (DO) to form various forms of soluble phosphorus acids, including $H_2PO_4^-$, HPO_4^{-2}, and PO_4^{-3}. The rate of phosphorus oxidation in water is governed by the form of the phosphorus (dissolved or suspended), DO concentration, salt concentration, metal ion concentration, pH, and temperature (EPA, 2003b). As shown in Table 4-3, the P4 oxidation rate increases with increasing concentrations of dissolved phosphorus, DO, metal ion, pH, and temperature. Under appropriate pH and Eh conditions, dissolved ions in soil pore-water can result in the transformation of the phosphorus acid oxidation products to solid metal phosphate compounds (e.g., calcium phosphate).

4.1.2 Potential Exposure to P4-Related Constituents at the FMC Plant OU

Based on the mechanisms described above, any P4 historically released to oxygenated surface (i.e., 0-2 feet) or subsurface (i.e., > 2 feet) soils at the FMC Plant OU that did not spontaneously oxidize (i.e., < 1000 mg/kg P4), was likely rapidly oxidized to form phosphorus acids and, subsequently, solid phosphates within the soil matrix. Thus, in a worst-case scenario, future workers contacting oxygenated soils at the FMC Plant OU (either through incidental soil ingestion, dermal contact, or inhalation of fugitive dust) would likely be exposed to phosphoric acid. However, for the purposes of SSL development, it is conservatively assumed that workers ingesting or coming into dermal contact with such soils are exposed to P4. In contrast, because inhaled fugitive dusts are composed of particulate sizes less than 10 microns, it is implausible that any residual P4 within such dusts would not react with atmospheric oxygen and moisture to form phosphorus acids. Thus, for the purposes of SSL development, it is assumed that worker fugitive dust exposure is to phosphoric acid.

Any historically released P4 that migrated to anaerobic subsurface soils at the FMC Plant OU has the potential to remain untransformed. Future construction and/or utility workers contacting these subsurface soils during excavation work have the potential to be exposed to P4. Assuming that the residual P4 concentration is less than the threshold at which spontaneous oxidation (smoking) may occur (1,000 mg/kg), exposure to P4 could occur through incidental ingestion and dermal contact. Similar to surface soils, due to the fine size of particulate matter inhaled as fugitive dust, it is considered implausible that any residual P4 within dusts generated from these subsurface soils would not react with atmospheric oxygen and moisture to form phosphorus acids. Thus, it is assumed that workers inhaling fugitive dusts generated during excavation work are exposed to phosphoric acid.

While phosphine may be formed by the hydrolysis of P4 present within anaerobic soils, the conditions that favor this reaction are not met within the FMC Plant OU soils under investigation. Specifically, due to the semi-arid climate of the region, FMC Plant OU soils in

RUs with no sustained hydraulic head (i.e., those areas that have the potential to be redeveloped in the future) have low moisture content, particularly at the deeper intervals that may contain residual P4. The low moisture content is not conducive to the formation of phosphine gas. Furthermore, the high mineral content of regional soils, in conjunction with the typically low organic matter content of deep subsurface soils, favor the irreversible chemisorption of any generated phosphine gas. Consequently, the potential for future workers to be exposed to phosphine gas generated from the hydrolysis of any residual P4 is considered negligible and not incorporated into the P4 SSL calculations.

Aside from the potential exposure of future workers to the chemical constituents noted above, a receptor encountering soils containing over 1,000 mg/kg of P4 also has the potential to suffer burns due to the spontaneous oxidation of P4. Therefore, since EPA's standard default SSL methods do not account for potential burning associated with spontaneous oxidation, any P4 SSL derived using EPA's standard default methods and assumptions that exceeds 1,000 mg/kg will be reduced to this concentration.

4.2 Outdoor Commercial/Industrial Worker SSLs

As defined by EPA (2002), the outdoor commercial/industrial worker is a long-term receptor exposed during the work day who is a full time employee of the company operating on-site and who spends most of the workday conducting maintenance activities outdoors. The activities for this receptor (e.g., moderate digging, landscaping) typically involve on-site exposures to surface and shallow subsurface soils (at depths of zero to two feet). Per EPA guidance (EPA, 2002), the outdoor worker is expected to be the most highly exposed receptor in the outdoor environment under commercial/industrial conditions. Thus, SSLs for this receptor are likely protective of other reasonably anticipated long-term outdoor activities at any future commercial/industrial facility operated on the FMC Plant OU.

4.2.1 Potential Exposure Pathways of Concern

Under current EPA guidance (EPA, 2002), the following exposure pathways are identified as potentially being relevant to an outdoor commercial/industrial worker:

- Incidental ingestion of soil,
- Dermal absorption of contaminants from soil,
- Inhalation of fugitive dust,
- Inhalation of volatiles outdoors, and
- Ingestion of ground water contaminated by leachate.

Per the CSM developed in Section 2 of this report, each of the first three bulleted exposure pathways are considered relevant to future commercial/industrial workers at the FMC Plant OU.

Inhalation of volatiles outdoors and ingestion of ground water contaminated by leachate are both considered implausible exposure pathways. Of the FMC Plant OU-related COPCs listed in Table 4-1, none are present in a form that could result in the generation of significant amounts of toxic vapor. Mercury vapors can be generated from elemental mercury; however, mercury within soil, ore, slag and ferrophos material present on the FMC Plant OU is predominantly present in non-volatile mineralogic forms (primarily sulfides) (ENSR, 2001). Also, while hydrolysis of P4 present in subsurface anaerobic soils can generate phosphine gas, the potential

for this to occur in areas of the FMC Plant OU with no sustained hydraulic head (i.e., those areas with the potential to be redeveloped in the future) is considered unlikely for the reasons previously provided in Section 4.1.2. Finally, worker ingestion of groundwater contaminated by leachate is not considered because, as previously documented in the updated CSM described in Section 2, FMC will record land-use restrictions to prevent future workers from being exposed to groundwater containing COPC concentrations above Maximum Contaminant Levels (MCLs) or risk-based screening levels.

No exposure pathways outside of those identified in EPA guidance (EPA, 2002) are considered plausible for potential future outdoor commercial/industrial workers at the FMC Plant OU.

4.2.2 Exposure via Soil Ingestion and Dermal Absorption

The SSL equation for combined ingestion and dermal absorption exposure to carcinogenic contaminants in soil, as presented in Equation 4-1 of EPA (2002), is as follows:

Equation 4-1

$$SSL = \frac{TR \times BW \times AT \times 365 days / year}{(EF \times ED \times 10^{-6} kg / mg) \times ((SF_o \times IR) + (SF_{ABS} \times AF \times ABS_d \times SA \times EV))}$$

Where:

SSL	=	Soil screening level (mg/kg),
TR	=	Target cancer risk (unitless),
BW	=	Body weight (kg),
AT	=	Averaging time (years),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
SF_o	=	Oral slope factor $(mg/kg\text{-}day)^{-1}$,
IR	=	Soil ingestion rate (mg/day),
SF_{ABS}	=	Dermally-adjusted cancer slope factor $(mg/kg\text{-}day)^{-1}$,
AF	=	Skin-soil adherence factor (mg/cm^2-event),
ABS_d	=	Dermal absorption fraction (unitless),
SA	=	Skin surface exposed (cm^2), and
EV	=	Event frequency (events/day).

Similarly, the screening level equation for combined ingestion and dermal absorption exposure to non-carcinogenic contaminants in soil, as presented in Equation 4-2 of EPA (2002), is as follows:

Equation 4-2

$$SSL = \frac{THQ \times BW \times AT \times 365 days / year}{(EF \times ED \times 10^{-6} kg / mg) \times ((\frac{1}{RfD_o} \times IR) + (\frac{1}{RfD_{ABS}} \times AF \times ABS_d \times SA \times EV))}$$

Where:

SSL	=	Soil screening level (mg/kg),
THQ	=	Target hazard quotient (unitless),
BW	=	Body weight (kg),
AT	=	Averaging time (years),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
RfD_o	=	Oral reference dose (mg/kg-day),
IR	=	Soil ingestion rate (mg/day),
RfD_{ABS}	=	Dermally-adjusted reference dose (mg/kg-day),
AF	=	Skin-soil adherence factor (mg/cm^2-event),
ABS_d	=	Dermal absorption fraction (unitless),
SA	=	Skin surface exposed (cm^2), and
EV	=	Event frequency (events/day).

The values used to characterize each of the non chemical-specific exposure parameters for outdoor commercial/industrial workers within Equations 4-1 and 4-2 are presented in Table 4-4. The chemical-specific oral cancer slope factors and chronic reference doses for each of the COPCs are presented in Tables 4-5 and 4-6, respectively. These values were developed in accordance with EPA's current hierarchy of data sources to be used to characterize COPC toxicity factors at Superfund sites (EPA, 2004a). Specifically, the following hierarchy was used to select cancer toxicity values:

- IRIS (EPA's Integrated Risk Information System) (EPA, 2004b)
- Provisional Peer-Reviewed Toxicity Values (PPRTVs) (EPA, 2004a)
- Other (Peer-Reviewed) Values, including:
  - ATSDR (Agency for Toxic Substances and Disease Registry) Minimal Risk Levels (ATSDR, 2004a)
  - HEAST (Health Effects Assessment Summary Tables) (EPA, 1997)

In addition to the sources listed in EPA (2004a), values available from EPA's National Center for Environmental Assessment (NCEA) were also considered (EPA, 2004c); however, cancer toxicity values were found in only the first two of the listed references.

In cases where a cancer toxicity value was available for only the inhalation route of exposure, the cancer occurred at the portal of entry. Therefore, route-to-route extrapolation to derive an oral cancer slope factor was not performed for any COPCs.

For each cancer slope factor, Table 4-5 presents information regarding the study/data on which the toxicity value is based. The EPA weight-of-evidence (for cancer) is also provided. Only those COPCs with a weight of evidence of "A", "B", or "C" (i.e., known, probable or possible human carcinogens, respectively) are listed in the table.

The same hierarchy for developing cancer slope factors was used to select chronic noncancer toxicity values:

- IRIS (EPA's Integrated Risk Information System (EPA, 2004b)
- Provisional Peer-Reviewed Toxicity Values (PPRTVs) (EPA, 2004a)

- Other (Peer-Reviewed) Values, including:
  - ATSDR (Agency for Toxic Substances and Disease Registry) Minimal Risk Levels (ATSDR, 2004a)
  - HEAST (Health Effects Assessment Summary Tables) (EPA, 1997)

In addition to the above sources, values derived by EPA's NCEA were also considered. These values were obtained from the EPA Region III Risk-Based Concentration table (EPA, 2004c).

For some COPCs, a chronic toxicity value could only be found for the oral route of exposure. If a toxicity value could be found for only the oral route of exposure, and the critical effect for the toxicity value was not a portal of entry effect (i.e., did not occur at the route of entry, but was a systemic effect), a toxicity value was derived for the inhalation exposure route by route-to-route extrapolation. An inhalation rate of 20 m^3/day and a body weight of 70 kg were assumed in the extrapolation, as follows:

Equation 4-3

$$RfC = \frac{RfDo \times BWx1000}{IR}$$

Where:

RfC	=	Inhalation reference concentration (ug/m^3),
RfD_o	=	Oral reference dose (mg/kg-day),
BW	=	Body weight (kg),
1000	=	Conversion factor (ug/mg), and
IR	=	Inhalation rate (m^3/day).

If the critical toxic effect for a chronic oral RfD was not known, an alternative chronic oral toxicity value (i.e., a value from another source on the hierarchy) with a known toxic endpoint was sought for extrapolation purposes. In the absence of an alternate chronic oral value, route-to-route extrapolation was not performed.

Due to the current absence of toxicity data for directly evaluating dermal exposures to contaminants, EPA has developed a method to extrapolate oral toxicity values for use in dermal risk assessments. This extrapolation method is necessary because most oral reference doses and cancer slope factors are based on an administered dose (e.g., in food or water) while dermal exposure equations estimate an absorbed dose. Specifically, dermal exposure equations account for the relative ability of a given contaminant to pass through the skin and into the bloodstream. The extrapolation method applies a chemical-specific gastro-intestinal absorption factor (ABS_{GI}) to the available oral toxicity values to account for the absorption efficiency of an administered dose across the gastro-intestinal tract and into the bloodstream. This modeling approach, which is incorporated into the SSL calculations, is presented in EPA's *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment* (U.S. EPA, 2004d).

The calculation of carcinogenic dermal toxicity values, from Equation 3-3 of EPA (2002), is as follows:

Equation 4-4

$$SF_{ABS} = \frac{SF_o}{ABS_{GI}}$$

Where:

SF_{ABS}	=	Dermally-adjusted cancer slope factor $(mg/kg\text{-}day)^{-1}$,
SF_o	=	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$, and
ABS_{GI}	=	Gastro-intestinal absorption fraction (unitless).

Similarly, based on Equation 3-4 of EPA (2002), the non-carcinogenic dermal toxicity values are calculated as follows:

Equation 4-5

$$RfD_{ABS} = RfD_o \times ABS_{GI}$$

Where:

RfD_{ABS}	=	Dermally-adjusted reference dose (mg/kg-day),
RfD_o	=	Oral reference dose (mg/kg-day), and
ABS_{GI}	=	Gastro-intestinal absorption fraction (unitless).

Chemical-specific oral cancer slope factors and reference doses were previously presented in Tables 4-5 and 4-6, respectively. Gastro-intestinal absorption fractions (ABS_{GI}), as recommended in EPA (2004d), are presented in Table 4-7. Chemical-specific values to characterize the dermal absorption fraction (ABS_d) parameter within Equations 4-1 and 4-2 are also provided in Table 4-7. The COPC-specific dermally-adjusted cancer slope factors (SF_{ABS}) and reference doses (RfD_{ABS}), derived via the application of Equations 4-4 and 4-5, are presented in Table 4-8.

In the SSL calculations, dermal exposure could be taken into account only for arsenic and cadmium. Although an EPA-recommended chemical-specific or default gastro-intestinal absorption factor was available for each of the COPCs (EPA, 2004d), allowing for the derivation of dermal toxicity values for all substances for which an oral toxicity value was available, a chemical-specific dermal absorption factor was only available for arsenic and cadmium. In the absence of a dermal absorption factor for a chemical, the dermal exposure route cannot be incorporated into the calculation of the SSL for that chemical. EPA does not recommend default dermal absorption factors for inorganics. For inorganics, speciation is considered critical to dermal absorption, and data are insufficient to extrapolate a default value (EPA, 2004d).

Dermal toxicity values are based on systemic toxic effects, and do not take into account the potential for direct toxicity to the skin (e.g., irritation, allergic contact dermatitis) that may be posed by dermal contact with a chemical. Direct toxic effects to the skin are considered to be portal-of-entry effects, and EPA recognizes that the dose-response relationship for these effects is likely to be independent of the systemic effects associated with the chemical (EPA, 2004d). In the absence of a dermal absorption factor for elemental phosphorus,the potential for adverse systemic effects posed by dermal absorption of elemental phosphorus could not be taken into account in the determination of the SSL. However, in addition to the potential for elemental

phosphorus to cause adverse systemic effects through dermal absorption, dermal exposure to elemental phosphorus has the potential to cause direct adverse surface effects to the skin (i.e., burning). A soil concentration less than the concentration at which elemental phosphorus may spontaneously oxidize (smoke) (i.e., <1,000 mg/kg) is considered to be protective of potential direct dermal toxicity effects to future industrial/commercial workers.

4.2.3 Exposure via Inhalation of Fugitive Dusts

While EPA (2002) evaluates the inhalation of fugitive dust exposure pathway within the derivation of SSLs for outdoor commercial/industrial workers, the Agency also notes that ingestion/dermal absorption SSLs for most metals are more conservative than the fugitive dust inhalation SSLs. In fact, EPA (2002) indicates that, with the exception of hexavalent chromium, fugitive dust SSLs do not need to be calculated for most metals; however, to ensure conservatism in the RBC update, this pathway was considered within the SSL derivation for all COPCs under this scenario.

The SSL equation for commercial/industrial worker inhalation exposure to carcinogenic contaminants in fugitive dust, as presented in Equation 4-3 of EPA (2002), is as follows:

Equation 4-6

$$SSL = \frac{TR \times AT \times 365 days / year}{URF \times 1000 ug / mg \times EF \times ED \times \frac{1}{PEF}}$$

Where:

SSL	=	Soil screening level (mg/kg),
TR	=	Target cancer risk (unitless),
AT	=	Averaging time (yr),
URF	=	Inhalation unit risk factor $(\mu g/m^3)^{-1}$,
EF	=	Exposure frequency (d/yr),
ED	=	Exposure duration (yr), and
PEF	=	Particulate emission factor (m^3/kg).

Similarly, the screening level equation for commercial/industrial worker inhalation exposure to non-carcinogenic contaminants in fugitive dust, as presented in Equation 4-4 of EPA (2002), is as follows:

Equation 4-7

$$SSL = \frac{THQ \times AT \times 365 days / year}{EF \times ED \times (\frac{1}{RfC} + \frac{1}{PEF})}$$

Where:

SSL	=	Soil screening level (mg/kg),
THQ	=	Target hazard quotient (unitless),
AT	=	Averaging time (yr),
RfC	=	Inhalation reference concentration (µg/m^3),
EF	=	Exposure frequency (d/yr),
ED	=	Exposure duration (yr), and
PEF	=	Particulate emission factor (m^3/kg).

The values used to characterize each of the non chemical-specific parameters within Equations 4-6 and 4-7 are presented in Table 4-4. The chemical-specific inhalation unit risk factors for carcinogens and chronic non-carcinogenic inhalation reference concentrations for each of the COPCs are presented in Tables 4-5 and 4-6, respectively. These toxicity factors were developed in accordance with the hierarchy of data sources and route-to-route extrapolation assumptions described in Section 4.2.2.

The particulate emission factor (PEF) within Equations 4-6 and 4-7 represents an estimate of the relationship between soil contaminant concentrations and the concentration of these contaminants in air as a consequence of particle suspension. Per Equation 4-5 of EPA (2002), the PEF is derived as follows:

Equation 4-8

$$PEF = Q / C_{wind} \times \frac{3600\,\text{sec}/hr}{0.036 \times (1-V) \times (\frac{U_m}{U_t})^3 \times F(x)}$$

Where:

PEF	=	Particulate emission factor (m^3/kg),
Q/C_{wind}	=	Inverse of the ratio of the geometric mean air concentration to the emission flux at the center of a square source (g/m^2-s per kg/m^3),
V	=	Fraction of vegetative cover (unitless),
U_m	=	Mean annual windspeed (m/s),
U_t	=	Equivalent threshold value of windspeed at 7m (m/s), and
F(x)	=	Function dependent on U_m/U_t derived using Cowherd et al. (1985) (unitless).

EPA's SSL approach to calculating the fugitive dust PEF assumes that a site's surface consists of an unlimited reservoir of highly erodible surficial sandy material. The default value provided within EPA (2002) was used to characterize the equivalent threshold value of windspeed at 7m (U_t) within Equation 4-8 (see Table 4-9). This default value is considered highly conservative with respect to the FMC Plant OU because it assumes that a relatively low windspeed is sufficient to generate fugitive dust emissions from the presumed highly erodible surface of the site. However, as described by Cowherd et al. (1985), non-homogenous surfaces impregnated with nonerodible elements (e.g., stones) are characterized as having a "limited reservoir" of erodible material. Such surfaces have relatively high threshold wind speeds (i.e., infrequent, high wind speeds are needed to generate fugitive dusts), and particulate emission rates tend to decay rapidly during an erosion event (rather than remain constant which EPA's default approach assumes). Surficial material within the RUs of the FMC Plant OU are heterogeneous

and contain a significant amount of large grain size material with low erosion potential. Therefore, both EPA's "unlimited reservoir" model and the default equivalent threshold value of windspeed at 7m (U_t) value are highly conservative, and will overstate the extent to which fugitive dusts are generated at the FMC Plant OU. For the mean annual wind speed (U_m) term, a regional-specific value for Pocatello, Idaho (4.6 m/s) was used (Cowherd et al., 1985). The F(x) function dependent upon U_m/U_t was subsequently derived using equations presented in Section 4 and Appendix B of Cowherd et al. (1985):

$$x = 0.886\ U_t/U_m$$

$$F(x) = 0.18(8x^3 + 12x)\ \exp(-x^2)$$

Because much of the developed area of the FMC Plant OU area is not vegetated, the fraction of vegetative cover (V) in Equation 4-8 was conservatively assumed to be 0. Finally, the Q/C_{wind} term was derived using Equation D-1 within EPA (2002):

Equation 4-9

$$Q/C_{wind} = A \times \exp[\frac{(\ln A_{site} - B)^2}{C}]$$

Where:

Q/C_{wind}	=	Inverse of mean concentration at center of the source (g/m-s per kg/m^2),
A, B, C	=	Constants based on air dispersion modeling for specific climate zones, and
A_{site}	=	Areal extent of the site contamination (acres).

The values used to characterize each of the constants (A, B and C) within Equation 4-9 are specific to Salt Lake City, Utah and were obtained from Exhibit D-2 of EPA (2002) (see Table 4-9). The areal extent of the re-developed site on the FMC Plant OU was assumed to be 50 acres. It is likely that any future commercial/industrial redevelopment on the FMC Plant OU will be concentrated around existing infrastructure and be limited in size. However, to ensure conservatism in the assessment, the size of the largest RU not already slated for capping (i.e., RU 20 ~ 57.1 acres) was used as the basis for selecting a 50-acre source area in calculating the particulate emission factor.

4.2.4 Summary of Outdoor Commercial/Industrial Worker SSLs

Table 4-10 presents the soil ingestion/dermal absorption and fugitive dust inhalation SSLs for carcinogenic and non-carcinogenic endpoints for each of the COPCs. The final SSL for each COPC is developed by combining the soil ingestion/dermal absorption and fugitive dust inhalation SSLs such that the incremental cancer risk and hazard quotient target thresholds of $1x10^{-6}$ and 1 are met. In the case of COPCs that exhibit both carcinogenic and non-carcinogenic effects, the health endpoint resulting in the lowest SSL from combined soil ingestion/dermal absorption and fugitive dust inhalation exposure was conservatively used to characterize the screening level for that constituent.

4.3 Indoor Commercial/Industrial Worker SSLs

In the event that part of the FMC Plant OU is commercially/industrially developed, it is likely that an office building will be constructed onsite, and indoor workers may be chronically exposed to residual contamination. Consequently, SSLs protective of a future indoor commercial/industrial worker are developed herein. Under current Agency SSL guidance (EPA, 2002), this receptor is assumed to spend most, if not all, of the workday indoors. Per EPA guidance (EPA, 2002), the SSLs calculated for this receptor are expected to be protective of both workers engaged in low intensity activities such as office work and those engaged in more strenuous activity (e.g., factory or warehouse workers).

4.3.1 Potential Exposure Pathways of Concern

While an indoor worker has no direct contact with outdoor soils, EPA guidance identifies the following potential exposure pathways:

- Ingestion of contaminated soils that have been incorporated into indoor dust,
- Ingestion of contaminated ground water, and
- Inhalation of contaminants present in indoor air as the result of vapor intrusion.

Per the CSM developed in Section 2 of this report, only the ingestion of contaminated soils that have been incorporated into indoor dust exposure pathway is relevant to a future indoor worker at the FMC Plant OU. As previously discussed in Section 4.2.1, FMC will record land-use restrictions to prevent future workers from being exposed to groundwater containing COPC concentrations above Maximum Contaminant Levels (MCLs) or SSLs. Similarly, per the ROD, any future buildings on the FMC Plant OU will be constructed with radon control measures to prevent the infiltration of this gas into the indoor environment. This measure will also effectively prevent the indoor infiltration of any other volatile contaminants.

No exposure pathways outside of those identified in EPA guidance (EPA, 2002) are considered plausible for potential future indoor commercial/industrial workers at the FMC Plant OU.

4.3.2 Exposure via Ingestion of Soils Incorporated into Indoor Dust

Under this scenario it is assumed that indoor workers incidentally ingest indoor dust comprised of surface soils that have migrated into the indoor environment. Consequently, the soil ingestion component of Equations 4-1 (carcinogens) and 4-2 (non-carcinogens) are applicable to the derivation of an SSL that is protective of indoor workers for this presumed exposure pathway. These equations were previously presented in Section 4.2.2 and are not repeated here.

Default values within EPA (2002) were used to characterize each of the non chemical-specific exposure parameters for indoor commercial/industrial workers within Equations 4-1 and 4-2, and these values are presented in Table 4-4. The chemical-specific oral cancer slope factors and chronic reference doses for each of the COPCs were previously presented in Tables 4-5 and 4-6, respectively. The basis for these toxicity factors was described in Section 4.2.2.

4.3.3 Summary of Indoor Commercial/Industrial Worker SSLs

Table 4-11 presents the soil ingestion SSLs for carcinogenic and non-carcinogenic endpoints for each of the COPCs. In the case of COPCs that exhibit both carcinogenic and non-carcinogenic

effects, the lower SSL was conservatively used to characterize the screening level for that constituent.

4.4 Construction Worker SSLs

Current EPA guidance (EPA, 2002) recognizes that construction is likely to occur as part of the redevelopment process at many NPL sites, regardless of the anticipated future land use. Although construction is typically of relatively short duration (a year or less), it may lead to significant exposures to construction workers as a result of soil-disturbing activities that include excavation and vehicle traffic on unpaved roads. EPA's approach to deriving construction worker SSLs is to assume that a short-term adult receptor is exposed to soil contaminants during the work day for the duration of a single construction project (typically a year or less). If multiple non-concurrent construction projects are anticipated, it is assumed that different workers will be employed for each project (EPA, 2002). The activities for this receptor typically involve substantial on-site exposures to surface and subsurface soils, and the construction worker is expected to have a very high soil ingestion rate.

While the exact nature of any future redevelopment of the FMC Plant OU is unknown, it is reasonable to conclude that building construction would likely be an integral part of any such effort. It is considered likely that construction workers would be most significantly exposed to any residual soil contamination to a depth of 4-6 feet (the depth at which building footers have historically been placed at the FMC Plant OU), though exposure could occur to soils as deep as 10 feet over short timeframes. Consistent with the approach outlined in EPA (2002), SSLs protective of construction workers are developed assuming that a period of six months would be required to complete the construction work.

4.4.1 Potential Exposure Pathways of Concern

Under current EPA guidance (EPA, 2002), the following exposure pathways are identified as potentially being relevant to a construction worker:

- Incidental soil ingestion,
- Dermal absorption,
- Inhalation of fugtive dust, and
- Inhalation of volatiles outdoors

Per the CSM developed in Section 2 of this report, each of the first three bulleted exposure pathways are considered relevant to potential future construction workers at the FMC Plant OU. For the reasons provided in Section 4.2.1, inhalation of volatiles outdoors is considered an implausible exposure pathway at the FMC Plant OU. No exposure pathways outside of those identified in EPA guidance (EPA, 2002) are considered plausible for potential future construction workers at the FMC Plant OU.

4.4.2 Exposure via Soil Ingestion and Dermal Absorption

The screening level equation for combined ingestion and dermal absorption exposure of construction workers to carcinogenic contaminants in soil, as presented in Equation 5-1 of EPA (2002), is as follows:

Equation 4-10

$$SSL = \frac{TR \times BW \times AT \times 365 days / year}{(EF \times ED \times 10^{-6} kg / mg) \times ((SF_o \times IR) + (SF_{ABS} \times AF \times ABS_d \times SA \times EV))}$$

Where:

TR	=	Target cancer risk (unitless),
BW	=	Body weight (kg),
AT	=	Averaging time (years),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
SF_o	=	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$,
IR	=	Soil ingestion rate (mg/day),
SF_{ABS}	=	Dermally-adjusted cancer slope factor $(mg/kg\text{-}day)^{-1}$,
AF	=	Skin-soil adherence factor (mg/cm^2-event),
ABS_d	=	Dermal absorption fraction (unitless),
SA	=	Skin surface exposed (cm^2), and
EV	=	Event frequency (events/day).

Similarly, the screening level equation for subchronic combined ingestion and dermal absorption exposure of construction workers to non-carcinogenic contaminants in soil, as presented in Equation 5-2 of EPA (2002), is as follows:

Equation 4-11

$$SSL = \frac{THQ \times BW \times AT \times 365 days / year}{(EF \times ED \times 10^{-6} kg / mg) \times ((\frac{1}{HBL_{SC}} \times IR) + (\frac{1}{HBL_{ABS}} \times AF \times ABS_d \times SA \times EV))}$$

Where:

THQ	=	Target hazard quotient (unitless),
BW	=	Body weight (kg),
AT	=	Averaging time (years),
EF	=	Exposure frequency (days/year),
ED	=	Exposure duration (years),
HBL_{SC}	=	Subchronic health-based limit (mg/kg-day),
IR	=	Soil ingestion rate (mg/day),
HBL_{ABS}	=	Dermally-adjusted subchronic health-based limit,
AF	=	Skin-soil adherence factor (mg/cm^2-event),
ABS_d	=	Dermal absorption fraction (unitless),
SA	=	Skin surface exposed (cm^2), and
EV	=	Event frequency (events/day).

The values used to characterize each of the non chemical-specific parameters within Equations 4-10 and 4-11 are presented in Table 4-4. The chemical-specific oral cancer slope factors were previously presented in Table 4-5, and the basis for these values was described in Section 4.2.2.

The hierarchy presented below was used to characterize chemical-specific subchronic (noncancer) oral toxicity values. The hierarchy is generally in accordance with EPA guidance

for developing soil screening levels for subchronic exposures (EPA, 2002). In addition, PPRTVs (EPA, 2004a) were added to the list. To be consistent with the hierarchy for the chronic toxicity values, the PPRTV values were placed above the HEAST values in the hierarchy:

- Provisional Peer-Reviewed Toxicity Values (PPRTVs) (EPA, 2004a)
- HEAST (Health Effects Assessment Summary Tables) (EPA, 1997)
- Other (Peer-Reviewed) Values, including:
  - ATSDR (Agency for Toxic Substances and Disease Registry) Minimal Risk Levels (ATSDR, 2004a)

As for the selection of chronic noncancer toxicity values, for some COPCs a toxicity value could be found for only the oral exposure route. If the critical toxic effect for the toxicity value was not a portal of entry effect (i.e., did not occur at the route of entry, but was a systemic effect), a toxicity value was derived for the inhalation exposure route by route-to-route extrapolation. An inhalation rate of 20 m^3/day and a body weight of 70 kg were assumed in the extrapolation per Equation 4-3. If the critical toxic effect was not known, extrapolation was not performed unless an alternative toxicity value (i.e., a value from another source on the hierarchy) with a known toxic endpoint was available; the alternative value was then used for the extrapolation.

If a subchronic value was not available or could not be derived by route-to-route extrapolation, and a chronic toxicity value was available, the chronic toxicity value was conservatively used to characterize the subchronic toxicity of that constituent.

The subchronic oral toxicity values and their sources are summarized in Table 4-12. In addition, for each toxicity value, the table provides information regarding the study/data on which the toxicity value is based.

With respect to characterization of chemical-specific dermal toxicity factors, dermally-adjusted cancer slope factors (SF_{ABS}) were previously derived using Equation 4-4 (Section 4.2.2) and are summarized in Table 4-8. Dermally-adjusted subchronic health-based limits (HBL_{ABS}) are calculated as follows:

Equation 4-12

$$HBL_{ABS} = HBL_{SC} \times ABS_{GI}$$

Where:

HBL_{ABS}	=	Dermally-adjusted subchronic health-based limit (mg/kg-day),
HBL_{SC}	=	Oral subchronic health-based limit (mg/kg-day), and
ABS_{GI}	=	Gastro-intestinal absorption fraction (unitless).

As previously discussed, chemical-specific oral subchronic health-based limits (HBL_{SC}) are provided in Table 4-12. Gastro-intestinal absorption fractions, as recommended in EPA (2004d) were presented in Table 4-7. Chemical-specific values to characterize the dermal absorption fraction (ABS_d) parameter within Equations 4-10 and 4-11 were also provided in Table 4-7. The COPC-specific dermally-adjusted subchronic health-based limits (HBL_{ABS}) derived via the application of Equation 4-12 are presented in Table 4-8.

In calculating SSLs for the construction worker, the dermal exposure route could only be taken into account for arsenic and cadmium. As previously explained for the outdoor

industrial/commercial worker scenario for which chronic dermal toxicity values were derived, although subchronic dermal toxicity values could be derived for most of the COPCs, dermal absorption factors were available only for arsenic and cadmium. In the absence of a dermal absorption factor for a chemical, the dermal exposure route cannot be taken into account in the derivation of the SSL.

4.4.3 Exposure via Inhalation of Fugitive Dusts

Under a construction scenario, EPA (2002) assumes that fugitive dusts may be generated from surface soils by construction vehicle traffic on temporary unpaved roads and other construction activities (e.g., excavation soil dumping, dozing, grading, and tilling operations as well as wind erosion of soil surfaces).

Equations 4-13 and 4-14, which are based on Equations 5-3 and 5-4 of EPA (2002), were used to calculate SSLs protective of construction workers inhaling fugitive dust for carcinogens and non-carcinogens, respectively:

Equation 4-13

$$SSL = \frac{TR \times AT \times 365 days / year}{URF \times 1000 ug / mg \times EF \times ED \times \frac{1}{PEF_{SC}}}$$

Where:

SSL	=	Soil screening level (mg/kg),
TR	=	Target cancer risk (unitless),
AT	=	Averaging time (yr),
URF	=	Inhalation unit risk factor $(\mu g/m^3)^{-1}$,
EF	=	Exposure frequency (d/yr),
ED	=	Exposure duration (yr), and
PEF_{SC}	=	Subchronic particulate emission factor (m^3/kg).

Equation 4-14

$$SSL = \frac{THQ \times AT \times 365 days / year}{EF \times ED \times (\frac{1}{HBL_{SC}} + \frac{1}{PEF_{SC}})}$$

Where:

SSL	=	Soil screening level (mg/kg),
THQ	=	Target hazard quotient (unitless),
AT	=	Averaging time (yr),
HBL_{SC}	=	Subchronic health-based limit ($\mu g/m^3$),
EF	=	Exposure frequency (d/yr),
ED	=	Exposure duration (yr), and
PEF_{SC}	=	Subchronic particulate emission factor (m^3/kg).

Equations 4-13 and 4-14 are similar to the fugitive dust SSL equations for the outdoor commercial/industrial worker receptor, with the exception of the health based limit subchronic toxicity value term (HBL_{sc}) and the subchronic particulate emission factor (PEF_{SC}). The values used to characterize each of the non chemical-specific parameters for a future construction worker within Equations 4-13 and 4-14 are presented in Table 4-4. The chemical-specific inhalation unit risk factors for carcinogens were previously presented in Table 4-5. The values used to characterize the subchronic health-based limits for non-carcinogenic COPCs are presented in Table 4-12. These values were derived following the same hierarchy as employed to develop the oral subchronic health based limits, described in Section 4.4.2.

As discussed in Appendix E of EPA (2002), exposure of construction workers to unpaved road emissions occurs in the proximity of roads, whereas construction worker exposure to emissions from other construction activities are assumed to occur at the center of the emission source. The ambient air dispersion of emissions is therefore different for these two classes of fugitive emission sources. Consequently, EPA (2002) recommends that the subchronic particulate emission factor for construction worker exposure to unpaved road traffic emissions be calculated separately from the subchronic particulate emission factor for construction worker exposure to other construction activities (including wind erosion). The subchronic particulate emission factor that results in the most conservative construction worker screening level is subsequently used to characterize the construction worker SSL for each COPC.

4.4.3.1 PEF_{SC} for Fugitive Dust Emissions from Unpaved Road Traffic

The PEF_{SC} related to vehicular traffic on unpaved roads across the construction site was derived using Equation E-18 of EPA (2002):

Equation 4-15

$$PEF_{SC} = Q/C_{sr} \times \frac{1}{F_D} \times \frac{T \times L_R \times W_R \times 0.092903}{\frac{2.6 \times (s/12)^{0.8} \times (W/3)^{0.4}}{(M_{dry}/0.2)^{0.3}} \times [\frac{(365-p)}{365}] \times 281.9 \times VKT}$$

Where:

PEF_{SC}	=	Subchronic particulate emission factor for unpaved road traffic (m^3/kg),
Q/C_{sr}	=	Inverse of the ratio of the 1-hr. geometric mean air concentration to the emission flux along a straight road segment bisecting a square site (g/m^2-s per kg/m^3),
F_D	=	Dispersion correction factor (unitless),
T	=	Total time over which construction occurs (s),
L_R	=	Length of contaminated road segment (ft),
W_R	=	Width of contaminated road segment (ft),
0.092903	=	Conversion factor (m^2/ft^2),
s	=	Road surface silt content (%),
W	=	Mean vehicle weight (tons),
M_{dry}	=	Road surface material moisture content under dry, uncontrolled conditions,
p	=	Number of days with at least 0.01 inches of precipitation (days/year), and

VKT	=	Sum of fleet vehicle kilometers traveled during the exposure duration (km).

The values used to characterize each of the non-calculated parameters in Equation 4-15 (p, W_R, s, M_{dry}), along with corresponding reference sources, are provided in Table 4-13. The number of days with at least 0.01 inches of precipitation (p) was characterized using National Weather Service (NWS) data for 1990 collected at Pocatello International Airport (96 days), as presented in Appendix AE of the RI Report (Bechtel, 1996). The average width of roadways on the FMC Plant OU (25 ft) was used to characterize the width of contaminated road segment (W_R) parameter. The unpaved road surface silt content (s) was characterized by the average silt content of unpaved roads at the FMC Plant OU, as reported in Appendix AE of the RI Report (Bechtel, 1996). Finally, because site-specific measurements were not available to characterize the road surface material moisture content under dry, uncontrolled conditions (M_{dry}) term, the assumption within the Case Example (0.2) presented within Appendix E of EPA's Supplemental Soil Screening Guidance (EPA, 2002) was used to characterize this parameter.

The total time over which construction would occur during a future redevelopment project at the FMC Plant OU is conservatively assumed to be 6 months. Subsequently, in accordance with guidance within Appendix E of EPA (2002), the total time period over which vehicle traffic occurs across the construction site (T) was calculated as follows:

Equation 4-16

$$T = C_{weeks} \times C_{days} \times C_{hours} \times 3{,}600$$

Where:

T	=	Total time over which construction occurs (seconds),
C_{weeks}	=	Number of weeks of construction activity (weeks),
C_{days}	=	Days per week of construction activity (days/week),
C_{hours}	=	Hours per day of construction activity (hours/day), and
3,600	=	Conversion factor (seconds/hour).

The values used to characterize each of the parameters in Equation 4-16, along with corresponding reference sources, are provided in Table 4-13.

Per EPA (2002), the length of contaminated road segment (L_R) was calculated as follows:

Equation 4-17

$$L_R = \sqrt{A_{site} \times 43{,}560}$$

Where:

L_R	=	Length of contaminated road segment (ft),
A_{site}	=	Area of site surface contamination configured as a square (acres), and
43,560	=	Conversion factor (ft^2/acre).

The area of site surface contamination subject to future construction activities (A_{site}) is assumed to be 5 acres.

The dispersion correction factor (F_D) was calculated per Equation E-16 of EPA (2002):

Equation 4-18

$$F_D = 0.1852 + \frac{5.3537}{t_c} + \frac{-9.6318}{t_c^{\,2}}$$

Where:

F_D	=	Dispersion correction factor (unitless), and
t_c	=	Duration of construction (hours), t_c = T in units of hours.

Mean vehicle weight (W) is estimated by assuming the numbers and weights of different types of vehicles traveling across unpaved roads within the area of construction:

Equation 4-19

$$W = \frac{(N_{cars} \times W_{car}) + (N_{trucks} \times W_{truck})}{N_{cars} + N_{trucks}}$$

Where:

W	=	Mean vehicle weight (tons),
N_{cars}	=	Number of cars traveling across construction zone unpaved roads (cars/day),
W_{car}	=	Average weight of cars traveling across construction zone unpaved roads (tons/car),
N_{trucks}	=	Number of trucks traveling across construction zone unpaved roads (cars/day), and
W_{truck}	=	Average weight of trucks traveling across construction zone unpaved roads (tons/car).

The values assigned to characterize each of the parameters in Equation 4-19 are based on assumptions made within the case example provided in Appendix E of EPA (2002), and are provided in Table 4-13.

The sum of the fleet vehicle kilometers traveled during the construction project exposure duration (VKT) is estimated based on the size of the area of surface soil contamination, the configuration of the unpaved road, and the amount of traffic on the road:

Equation 4-20

$$VKT = \frac{N_{vehicles} \times L_R \times C_{weeks} \times C_{days}}{3{,}281}$$

Where:

VKT	=	Sum of fleet vehicle kilometers traveled during the exposure duration (km),
L_R	=	Length of contaminated road segment (ft),
3,281	=	Conversion factor (ft/km),
$N_{vehicles}$	=	Total number of vehicles traveling across construction zone unpaved roads (vehicles/day), $N_{vehicles} = N_{cars} + N_{trucks}$
C_{weeks}	=	Number of weeks of construction activity (weeks), and
C_{days}	=	Days per week of construction activity (days/week).

The values assigned to characterize each of the parameters in Equation 4-20 are based on assumptions made within the case example provided in Appendix E of EPA (2002), and are provided in Table 4-13.

The dispersion factor for fugitive dust emissions from unpaved road traffic (Q/C_{sr}) was derived using Equation E-19 of EPA (2002):

Equation 4-21

$$Q/C_{sr} = A \times \exp[\frac{(\ln A_{site} - B)^2}{C}]$$

Where:

Q/C_{sr}	=	Inverse of the ratio of the 1-h geometric mean air concentration to the emission flux along a straight road segment bisecting a square site (g/m^2-s per kg/m^3),
A, B, C	=	Constants based on air dispersion modeling (unitless), and
A_{site}	=	Areal extent of the site surface contamination subject to future construction (acres).

The values used to characterize each of the constants (A, B and C) within Equation 4-21 are presented in Table 4-13, and are the defaults specified in Appendix E of EPA (2002). As previously discussed, the area of site surface contamination subject to future construction activities (A_{site}) was assumed to be 5 acres.

As shown in Table 4-13, based on the values used to characterize each of the parameters within Equations 4-15 through 4-21, the subchronic particulate emission factor for unpaved road traffic is 7.44×10^5 m^3/kg. As referenced within this section and in Table 4-13, input parameters to this calculation for which site-specific data are not available were characterized using assumptions within the Case Example presented within Appendix E of EPA's Supplemental Soil Screening Guidance (EPA, 2002). These values were used because EPA typically incorporates conservative (i.e., health-protective) assumptions, representative of a reasonable maximum exposure (RME), into its analyses. Thus, although use of the EPA Case Example assumptions does add an element of uncertainty to the fugitive dust exposure component of the construction worker SSLs, the combined effect of using these values likely errs on the side of conservatism (i.e., results in SSLs that provide a higher margin of health protection).

4.4.3.2 PEF_{SC} for Fugitive Dust Emissions from Other Construction Activities

Other than emissions from unpaved road traffic, construction workers may also be exposed to fugitive dusts generated by wind erosion, excavation soil dumping, dozing, grading, tilling, and similar operations.

Per Equation E-26 of EPA (2002), the subchronic particulate emission factor associated with activities other than unpaved road traffic is calculated as follows:

Equation 4-22

$$PEF_{SC} = Q/C_{sa} \times \frac{1}{F_D} \times \frac{1}{< J'_T >}$$

Where:

PEF_{SC}	=	Subchronic particulate emission factor for construction activities other than traffic on unpaved roads (m^3/kg),
Q/C_{sa}	=	Inverse of the 1-hr. average air concentration at the center of the square emission source (g/m^2-s per kg/m^3),
F_D	=	Dispersion correction factor (unitless), and
$<J'_T>$	=	Total time-averaged particulate matter unit emission flux for construction activities other than traffic on unpaved roads (g/m^2-s).

The calculation of the dispersion correction factor (F_D) was previously presented in Equation 4-18, and the values used to characterize each of the input parameters to this equation are presented in Table 4-13.

The subchronic on-site dispersion factor for area sources (Q/C_{sa}) was derived using Equation E-15 of EPA (2002):

Equation 4-23

$$Q / C_{sa} = A \times \exp[\frac{(\ln A_{site} - B)^2}{C}]$$

Where:

Q/C_{sa}	=	Inverse of the 1-hr. average air concentration at the center of the square emission source (g/m^2-s per kg/m^3),
A, B, C	=	Constants based on air dispersion modeling (unitless), and
A_{site}	=	Areal extent of the site surface contamination subject to future construction (acres).

The values used to characterize each of the constants (A, B and C) within Equation 4-23 are presented in Table 4-14, and are the defaults specified in Appendix E of EPA (2002). As previously discussed, the area of site surface contamination subject to future construction activities (A_{site}) was assumed to be 5 acres.

The total time-averaged unit emission flux from wind erosion, excavation soil dumping, dozing, grading, and tilling operations was calculated using Equation E-25 of EPA (2002):

Equation 4-24

$$< J'_T >= \frac{M_{wind} + M_{excav} + M_{doz} + M_{grade} + M_{till}}{A_{site} \times T}$$

Where:

$<J'_T>$	=	Total time-averaged particulate matter unit emission flux or construction activities other than traffic on unpaved roads,
M_{wind}	=	Unit mass emitted from wind erosion (g),
M_{excav}	=	Unit mass emitted from excavation soil dumping (g),
M_{doz}	=	Unit mass emitted from dozing operations (g),
M_{grade}	=	Unit mass emitted from grading operations (g),
M_{till}	=	Unit mass emitted from tilling operations (g),
A_{site}	=	Areal extent of site soil contamination (acres),
4047	=	Conversion factor (m^2/acre), and
T	=	Total time over which construction occurs (seconds).

The areal extent of site soil contamination across the construction zone (A_{site}) is assumed to be 5 acres. The total time over which construction occurs (T) was previously calculated using Equation 4-16. The values of these two parameters are summarized in Table 4-14.

The unit mass emitted from wind erosion of contaminated surface soil (M_{wind}) was calculated using Equation E-20 of EPA (2002):

Equation 4-25

$$M_{wind} = 0.036 \times (1 - V) \times (\frac{U_m}{U_t})^3 \times F(x) \times A_{surf} \times 4{,}047 \times ED \times 8{,}760 hr / yr$$

Where:

M_{wind}	=	Unit mass emitted from wind erosion (g),
V	=	Fraction of vegetative cover (unitless),
U_m	=	Mean windspeed during construction (m/s),
U_t	=	Equivalent threshold value of windspeed at 7 m (m/s),
F(x)	=	Function dependent upon U_m/U_t derived from Cowherd et al. (1985) (unitless),
A_{surf}	=	Areal extent of site with surface contamination (acres),
4047	=	Conversion factor (m^2/acre), and
ED	=	Exposure duration (years).

The unit mass emitted from dumping of excavated soils was calculated using Equation E-21 from EPA (2002):

Equation 4-26

$$M_{excav} = 0.35 \times 0.0016 \times \frac{(\frac{U_m}{2.2})^{1.3}}{(\frac{M}{2})^{1.4}} \times p_{soil} \times A_{excav} \times 4{,}047 \times d_{excav} \times N_A 1 \times 10^3 g / kg$$

Where:

M_{excav}	=	Unit mass emitted from dumping of excavated soils (g),
0.35	=	PM_{10} particle size multiplier (unitless),
U_m	=	Mean windspeed during construction (m/s),
M	=	Gravimetric soil moisture content (%),
p_{soil}	=	In situ soil density (includes water) (Mg/m^3),
A_{excav}	=	Areal extent of excavation (acres),
d_{excav}	=	Average depth of excavation (m),
4047	=	Conversion factor (m^2/acre), and
N_A	=	Number of times soil is dumped (unitless).

The unit mass emitted from dozing operations was calculated using Equation E-22 from EPA (2002):

Equation 4-27

$$M_{doz} = 0.75 \times \frac{0.45(s)^{1.5}}{(M)^{1.4}} \times \frac{VKT}{S} \times 10^3 g / kg$$

Where:

M_{doz}	=	Unit mass emitted from dozing operations (g),
0.75	=	PM_{10} scaling factor (unitless),
s	=	Silt content (%),
M	=	Gravimetric soil moisture content (%),
VKT	=	Sum of dozing kilometers traveled (km), and
S	=	Average dozing speed (kph).

The unit mass emitted from grading operations was calculated using Equation E-23 from EPA (2002):

Equation 4-28

$$M_{grade} = 0.60 \times 0.0056(S)^{2.0} \times VKT \times 10^3 \, g/kg$$

Where:

M_{grade}	=	Unit mass emitted from grading operations (g),
0.60	=	PM_{10} scaling factor (unitless),
S	=	Average grading speed (kph), and
VKT	=	Sum of grading kilometers traveled (km).

Finally, the unit mass emitted from tilling operations was calculated using Equation E-24 from EPA (2002):

Equation 4-29

$$M_{till} = 1.1(s)^{0.6} \times A_{till} \times 4{,}047 m^2/acre \times 10^{-4} ha/m^2 \times 10^3 \, g/kg \times N_A$$

Where:

M_{till}	=	Unit mass emitted from tilling operations (g),
s	=	Silt content (%),
A_{till}	=	Areal extent of tilling (acres), and
N_A	=	Number of times soil is tilled (unitless).

The values used to characterize each of the parameters within Equations 4-25 through 4-29 are presented in Table 4-14. The source of value assigned to each parameter is also provided in this table.

As shown in Table 4-14, based on the values used to characterize each of the parameters within Equations 4-22 through 4-28, the subchronic particulate emission factor for construction activities other than those associated with unpaved road traffic is 6.90×10^7 m^3/kg. This value is significantly higher than the previously calculated subchronic particulate emission factor for unpaved road traffic (7.44×10^5 m^3/kg). Because the fugitive dust SSL for construction workers is proportional to the particulate emission factor, the lower PEF_{SC} associated with unpaved road traffic will result in a lower (i.e., more conservative) SSL than the PEF_{SC} for other construction activities. Therefore, SSLs relevant to a construction worker exposed to fugitive dust emissions from unpaved roads across the construction site were conservatively incorporated into the current analysis.

4.4.4 Summary of Construction Worker SSLs

Table 4-15 presents the construction worker soil ingestion/dermal absorption and fugitive dust inhalation SSLs for carcinogenic and non-carcinogenic endpoints for each of the COPCs. The final SSL for each COPC is developed by combining the soil ingestion/dermal absorption and fugitive dust inhalation SSLs such that the incremental cancer risk and hazard quotient target thresholds of $1x10^{-6}$ and 1 are met. In the case of COPCs that exhibit both carcinogenic and non-carcinogenic effects, the health endpoint resulting in the lowest SSL from combined soil ingestion/dermal absorption and fugitive dust inhalation exposure was conservatively used to characterize the screening level for that constituent.

4.5 Utility Worker SSLs

Current EPA guidance (EPA, 2002) does not identify a utility worker as a potential receptor for which SSLs should be derived. While the exact nature of any future redevelopment of the FMC Plant OU is unknown, it is likely that work will be conducted to repair or replace existing utility lines, or install new lines. Furthermore, utility repair/replacement could potentially occur in an FMC Plant OU Remedial Unit (RU) for which there is no potential for future commercial/industrial redevelopment. In such a case, the previously derived SSLs for outdoor commercial/industrial workers and construction workers would be inapplicable because these receptors would not be present within the RU. Therefore, SSLs protective of a utility worker were separately derived.

Utility workers could be exposed to residual soil contamination to a depth of 10 feet at the FMC Plant OU, which corresponds to the maximum depth at which utilities are known to have been installed at the site. To derive SSLs protective of utility workers, it is assumed that a period of 10 days would be required to complete the utility work. Similar to the approach taken to evaluate construction worker SSLs, it is assumed that under the utility worker exposure scenario, a short-term adult receptor is exposed to soil contaminants during the work day for the duration of a single project. In the event of multiple non-concurrent utility-related projects, it is assumed that different workers will be employed for each event.

4.5.1 Potential Exposure Pathways of Concern

It is assumed that a utility worker could be exposed to site-related contaminants via the same mechanisms by which a construction worker may be exposed at the FMC Plant OU (Section 4.4.1). Thus, the following exposure pathways are identified as potentially being relevant to a utility worker at the FMC Plant OU:

- Incidental soil ingestion,
- Dermal absorption, and
- Inhalation of fugtive dust.

4.5.2 Exposure via Soil Ingestion and Dermal Absorption

Under this scenario it is assumed that utility workers are exposed to FMC Plant OU surface and subsurface soils via the same mechanisms as previously described for a construction worker (Section 4.4). Therefore, Equations 4-10 and 4-11 are applicable to the derivation of SSLs that are protective of utility worker exposure to carcinogenic and non-carcinogenic COPCs,

respectively, via soil ingestion and dermal absorption. These equations were previously presented in Section 4.4.2 and are not repeated here.

With the exception of the lower exposure frequency (EF) discussed above, the assumptions made to characterize each of the non chemical-specific parameters within Equations 4-10 and 4-11 for construction workers were also applied to utility workers. These values are summarized in Table 4-4. The chemical-specific oral cancer slope factors and subchronic reference doses for each of the COPCs are presented in Tables 4-5 and 4-12, respectively. The basis for the cancer slope factors was previously described in Section 4.2.2, and the basis of the subchronic noncancer reference doses was described in Section 4.4.2.

With respect to characterization of chemical-specific dermal toxicity factors, dermally-adjusted cancer slope factors (SF_{ABS}) were previously derived using Equation 4-4 (Section 4.2.2) and are summarized in Table 4-8. Similarly, dermally-adjusted subchronic health-based limits (HBL_{ABS}) were derived using Equation 4-12 (Section 4.4.2) and are summarized in Table 4-8. As for both the outdoor industrial/commercial worker and construction worker scenarios, in calculating SSLs for the utility worker scenario, the dermal exposure pathway could only be taken into account for arsenic and cadmium.

4.5.3 Exposure via Inhalation of Fugitive Dusts

Equations 4-13 and 4-14 are applicable to the derivation of SSLs that are protective of subchronic utility worker exposure to fugitive dusts for carcinogens and non-carcinogens, respectively. These equations were previously presented in Section 4.4.3 and are not repeated here.

With the exception of the lower exposure frequency (EF), the assumptions made to characterize each of the non chemical-specific parameters within Equations 4-13 and 4-14 for construction workers were also applied to utility workers. With respect to the subchronic particulate emission factor, the factor specific to dust generated by construction-related traffic over unpaved roads was conservatively incorporated into this analysis. In reality, a utility worker would likely be exposed to dusts generated by wind and excavating, grading, tilling, and other utility work-related activities. However, as previously discussed in Section 4.4.3 and shown in Tables 4-13 and 4-14, the particulate emission factor associated with construction traffic over unpaved roads is significantly lower (i.e., more conservative) than the emission factor associated with all of the utility work-related activities combined. Therefore, to ensure conservatism in the utility worker SSLs, the particulate emission factor associated with construction-related traffic over unpaved roads was incorporated into the analysis.

With respect to the toxicity factors incorporated into Equations 4-13 and 4-14, the chemical-specific inhalation unit risk factors for carcinogens and subchronic health-based limits for non-carcinogenic COPCs are presented in Tables 4-5 and 4-12, respectively. The basis for the inhalation unit risk factors was described in Section 4.2.3, and the basis of the subchronic noncancer health-based limits was described in Section 4.4.3.

4.5.4 Summary of Utility Worker SSLs

Table 4-16 presents the utility worker soil ingestion/dermal absorption and fugitive dust inhalation SSLs for carcinogenic and non-carcinogenic endpoints for each of the COPCs. The final SSL for each COPC is developed by combining the soil ingestion/dermal absorption and fugitive dust inhalation SSLs such that the incremental cancer risk and hazard quotient target

thresholds of $1x10^{-6}$ and 1 are met. In the case of COPCs that exhibit both carcinogenic and non-carcinogenic effects, the health endpoint resulting in the lowest SSL from combined soil ingestion/dermal absorption and fugitive dust inhalation exposure was conservatively used to characterize the screening level for that constituent.

For P4, the toxicity-based SSL was found to be greater than the level at which this constituent may spontaneously oxidize (smoke). Consequently, the concentration at which spontaneous oxidation may occur (1,000 mg/kg), defined in Section 4.1, was used to characterize the P4 SSL for this receptor.

4.6 Off-Site Residential SSLs

In addition to deriving SSLs associated with subchronic exposure of construction site workers, EPA (2002) recommends that SSLs be derived for chronic exposure of off-site residents to on-site COPC releases that subsequently migrate off-site. Specifically, the off-site resident is assumed to be exposed to contaminants present in on-site releases generated both during and after construction, for a total of 30 years.

As previously discussed in Section 4.4, it is estimated that any future construction project at the FMC Plant OU would take no longer than 6 months to complete. Off-site residents could be exposed to construction-related COPC releases during this timeframe. In addition, off-site residents could be exposed for the remainder of the assumed 30 year exposure duration to COPCs released from the site by natural processes (e.g., wind erosion).

While default EPA guidance evaluates this exposure scenario by assuming that off-site residents are located at the boundary of the future on-site construction area, this assumption was not incorporated into the current analysis. Instead, because FMC owns and has deed-restricted property surrounding each of the RUs that could potentially be redeveloped, there is no potential for future residential development along the boundary of any area of the FMC Plant OU that might be subject to redevelopment. Consequently, the current analysis was performed by evaluating potential impacts at the two existing residential locations situated closest to RUs that might be redeveloped; i.e., RU-20 (Former Bannock Paving site) and RU-7 (shale handling area). Figure 4-1 depicts the location of the off-site residential properties in relation to these two RUs.

4.6.1 Potential Exposure Pathways of Concern

Under EPA guidance (EPA, 2002), the off-site residential receptor is assumed to have no direct contact with on-site soils. Instead, the only exposure pathway evaluated for this receptor is the inhalation of fugitive dusts generated by wind erosion during non-construction periods, and by work activities during periods of construction. In summary, the following exposure pathways are identified as potentially being relevant to an off-site resident:

- Inhalation of fugitive dust generated by construction-related activities, and
- Inhalation of wind generated fugitive dust during the portion of the exposure duration that construction activities are not being conducted.

Per the CSM developed in Section 2 of this report, both of the above exposure pathways are considered relevant to an off-site resident in the event of commercial/industrial redevelopment of the FMC Plant OU. No other pathways are considered within the derivation of SSLs protective of this receptor.

4.6.2 Exposure via Inhalation of Fugitive Dusts

The SSL equation for the inhalation exposure of off-site residents to carcinogenic contaminants in fugitive dust soil, as presented in Equation 5-7 of EPA (2002), is as follows:

Equation 4-30

$$SSL = \frac{TR \times AT \times 365 days / year}{URF \times 1000 ug / mg \times EF \times ED \times \frac{1}{PEF_{off}}}$$

Where:

SSL	=	Soil screening level (mg/kg),
TR	=	Target cancer risk (unitless),
AT	=	Averaging time (yr),
URF	=	Inhalation unit risk factor $(\mu g/m^3)^{-1}$,
EF	=	Exposure frequency (d/yr),
ED	=	Exposure duration (yr), and
PEF_{off}	=	Off-site particulate emission factor (m^3/kg).

Similarly, the screening level equation for chronic inhalation exposure of off-site residents to non-carcinogenic contaminants in fugitive dust, as presented in Equation 5-8 of EPA (2002), is as follows:

Equation 4-31

$$SSL = \frac{THQ \times AT \times 365 days / year}{EF \times ED \times (\frac{1}{RfC} + \frac{1}{PEF_{off}})}$$

Where:

SSL	=	Soil screening level (mg/kg),
THQ	=	Target hazard quotient (unitless),
AT	=	Averaging time (yr),
RfC	=	Inhalation reference concentration ($\mu g/m^3$),
EF	=	Exposure frequency (d/yr),
ED	=	Exposure duration (yr), and
PEF_{off}	=	Off-site particulate emission factor (m^3/kg).

The values used to characterize each of the non chemical-specific parameters within Equations 4-30 and 4-31 are presented in Table 4-4. The chemical-specific inhalation unit risk factors for carcinogens and chronic non-carcinogenic inhalation reference concentrations for each of the COPCs are presented in Tables 4-5 and 4-6, respectively. These chronic toxicity factors were developed in accordance with the hierarchy of data sources and assumptions described in Section 4.2.2.

The off-site particulate emission factor (PEF_{off}) within Equations 4-30 and 4-31 represents an estimate of the relationship between on-site soil contaminant concentrations and the concentration of these contaminants in air at off-site residential locations as a consequence of

particle suspension and dispersion. Per Equation E-29 of EPA (2002), the PEF_{off} is derived as follows:

Equation 4-32

$$PEF_{off} = Q / C_{off} \times \frac{1}{< J_T^{off} >}$$

Where:

PEF_{off}	=	Particulate emission factor (m^3/kg),
Q/C_{off}	=	Inverse of mean air concentration to the emission flux at the location of potential residential exposure (g/m^2-s per kg/m^3), and
$<J_T^{off}>$	=	Total time-averaged PM_{10} unit emission flux for the off-site receptor (g/m^2-s).

The default approach to estimating the inverse of the mean air concentration to the emission flux at the location of potential residential exposure (Q/C_{off}) assumes that the resident is situated at the boundary of the construction site. However, as previously discussed and shown in Figure 4-1, the residential receptors closest to FMC Plant OU RUs that could potentially be redeveloped are situated hundreds of meters from the boundaries to these RUs. Thus, instead of applying the default EPA (2002) approach, the SCREEN3 dispersion model was used to estimate Q/C_{off} at both residential locations. Specifically, the one-hour maximum air concentration under worst-case meteorological conditions was modeled at each residential location under an assumed unit fugitive dust emission flux (i.e., 1 g/s of a fugitive dust emissions over the 5 acre construction site). The resulting one-hour maximum air concentration under a unit flux at each residential location was converted to a unit annual average air concentration estimate by multiplying by a factor of 0.1 (EPA, 1992a). The inverse of the mean air concentration to the emission flux at the location of potential residential exposure (Q/C_{off}) was subsequently calculated as follows:

Equation 4-33

$$Q / C_{off} = \frac{EF_{unit}}{AA_{unit} / 1x10^9}$$

Where:

Q/C_{off}	=	Inverse of mean air concentration to the emission flux at the location of potential residential exposure (g/m^2-s per kg/m^3),
EF_{unit}	=	Unit PM_{10} emission flux over an assumed 5 acre construction site (g/m^2-s),
AA_{unit}	=	Annual average PM_{10} concentration at residential receptor location under a unit emission flux (ug/m^3), and
$1x10^9$	=	Conversion factor (ug/kg).

The unit PM_{10} emission flux over an assumed 5 acre construction site (EF_{unit}) and the modeled annual average PM_{10} concentrations at each residential receptor location under a unit emission flux (AA_{unit}), along with the resulting Q/C_{off} factors, are provided in Table 4-17. The EF_{unit} and AA_{unit} values resulting in the worst-case Q/C_{off} factor (344 g/m^2-s per kg/m^3) were subsequently used to conservatively derive the off-site residential SSLs for the FMC Plant OU.

The total time-averaged PM_{10} unit emission flux for the off-site receptor ($<J_T^{off}>$) was calculated in accordance with Equation E-28 of EPA (2002):

Equation 4-34

$$< J_T^{off} >= \frac{M_{road} + M_{wind} + M_{excav} + M_{doz} + M_{grade} + M_{till} + M^{pc}{}_{wind}}{A_{site} \times 4{,}047 \times ED \times 3.1536x10^7 \text{ sec}/\ yr}$$

Where:

$<J_T^{off}>$	=	Total time-averaged PM10 unit emission flux for the off-site receptor (g/m^2-s),
M_{road}	=	Unit mass emitted from unpaved roads (g),
M_{wind}	=	Unit mass emitted from wind erosion (g),
M_{excav}	=	Unit mass emitted from excavation soil dumping (g),
M_{doz}	=	Unit mass emitted from dozing operations (g),
M_{grade}	=	Unit mass emitted from grading operations (g),
M_{till}	=	Unit mass emitted from tilling operations (g),
$M^{pc}{}_{wind}$	=	Post-construction unit mass emitted from wind erosion (g),
A_{site}	=	Areal extent of site soil contamination (acres),
4047	=	Conversion factor (m^2/acre), and
ED	=	Exposure duration (years).

Values for M_{wind}, M_{excav}, M_{doz}, M_{grade}, and M_{till} were previously derived for an assumed 6 month construction project on a 5 acre site in Equations 4-25 through 4-29. These calculated values are summarized in Table 4-18.

The unit mass emitted from post-construction wind erosion of contaminated surface soil ($M^{pc}{}_{wind}$) was calculated using Equation E-20 of EPA (2002):

Equation 4-35

$$M^{pc}{}_{wind} = 0.036 \times (1 - V) \times (\frac{U_m}{U_t})^3 \times F(x) \times A_{surf} \times 4{,}047 \times ED \times 8{,}760 hr / yr$$

Where:

$M^{pc}{}_{wind}$	=	Post-construction unit mass emitted from wind erosion (g),
V	=	Fraction of vegetative cover (unitless),
U_m	=	Mean windspeed during construction (m/s),
U_t	=	Equivalent threshold value of windspeed at 7 m (m/s),
F(x)	=	Function dependent upon U_m/U_t derived from Cowherd et al. (1985) (unitless),
A_{surf}	=	Areal extent of site with surface contamination (acres),
4047	=	Conversion factor (m^2/acre), and
ED	=	Exposure duration (years).

The unit mass emitted from unpaved roads (M_{road}) was calculated using Equation E-27 from EPA (2002):

Equation 4-36

$$M_{road} = \frac{2.6 \times (s/12)^{0.8} (W/3)^{0.4}}{(M_{dry}/0.2)^{0.3}} \times [\frac{(365 - p)}{365}] \times 281.9 \times VKT$$

Where:

M_{road}	=	Unit mass emitted from unpaved roads (g),
s	=	Road surface silt content (%),
W	=	Mean vehicle weight (tons),
M_{dry}	=	Road surface material moisture content under dry, uncontrolled conditions
p	=	Number of days with at least 0.01 inches of precipitation (days/year), and
VKT	=	Sum of fleet vehicle kilometers traveled during the exposure duration (km).

The values used to characterize each of the parameters within Equations 4-35 and 4-36 are summarized in Table 4-18. The source of the value assigned to each parameter is also provided in this table.

4.6.3 Summary of Off-Site Residential SSLs

Table 4-19 presents the COPC-specific, off-site residential fugitive dust inhalation SSLs for carcinogenic and non-carcinogenic endpoints. In the case of COPCs that exhibit both carcinogenic and non-carcinogenic effects, the health endpoint resulting in the lowest SSL was conservatively used to characterize the screening level for that constituent.

For P4, the toxicity-based SSL was found to be greater than the level at which this constituent may spontaneously oxidize (smoke). However, there is no potential for off-site residents to be directly exposed to P4-containing soils on the FMC Plant OU. Consequently, the concentration at which spontaneous oxidation may occur (1,000 mg/kg) is not relevant to this receptor.

By comparing the off-site residential SSLs (Table 4-18) to those developed for a construction worker (Table 4-16), it is evident that the construction worker SSLs are consistently more conservative (i.e., lower) than the off-site residential SSLs. Therefore, use of the construction worker SSLs for screening RUs in which redevelopment could potentially occur within the SRI/FS will be protective of off-site residential receptors.

4.7 Summary

Table 4-20 summarizes the chemical-specific SSLs calculated in this section for outdoor and indoor commercial/industrial workers, construction workers, utility workers and off-site residents. These SSLs were largely derived based on conservative default assumptions contained within current EPA guidance (EPA, 2002), and can be applied as risk-based screening levels in the evaluation of the need for additional sampling and/or remedial action within select FMC Plant OU RUs throughout the SRI/FS process.

As shown by comparing the chemical-specific SSLs for each receptor, the construction worker SSLs are consistently lower (i.e., more conservative) than the screening levels for each of the other receptors. Thus, for RUs on the FMC Plant OU in which construction redevelopment could potentially occur, use of the construction worker SSLs to screen COPCs within the SRI/FS would be protective of all other potential receptors associated with foreseeable future activities in these RUs.

Similarly, the chemical-specific outdoor commercial/industrial worker SSLs are consistently lower than the corresponding screening levels for indoor commercial/industrial workers and

utility workers. Thus, for FMC RUs in which commercial/industrial redevelopment could occur (without the potential for building construction), use of the outdoor commercial/industrial worker SSLs to screen COPCs within the SRI/FS would be protective of all other potential receptors associated with foreseeable activities in these RUs.

Finally, the utility worker SSLs are applicable to screening FMC Plant OU RUs in which commercial/industrial redevelopment and construction activities are not envisioned.

Table 4-1

EPA-Calculated Worker Risk-Based Concentrations (RBCs) for the FMC Subarea[1]

Chemical	EPA Risk-Based Concentrations (RBCs) for Worker Exposure*
Antimony	359
Arsenic	1.434
Barium	61612
Beryllium	0.58
Boron	80636
Cadmium	448
Chromium	896457
Cobalt	NC
Copper	33259
Fluoride	53787
Lead	NC
Lead-210	6.24
Lithium	17929
Manganese	4475
Mercury	269
Molybdenum	4482
Nickel	17929
Polonium-210	21.22
Potassium-40	0.308
Phosphorus (total)	NC
Selenium	4482
Silver	4482
Thallium	71.72
Uranium-238	4.42
Vanadium	6275
Zinc	268937

* Values are in mg/kg or pCi/g; NC = Not calculated or not available.

1) Recreated from Table 2.3-1 of the FS Report for the FMC Subarea (FMC, 1997).

Table 4-2

Exposure Pathways Evaluated in the SSL Calculations for Each Exposure Scenario[a]

	Commercial/Industrial Scenarios				Construction-Related Scenarios					
	Outdoor Worker		Indoor Worker		Construction Worker		Utility Worker		Off-Site Resident	
Potential Exposure Pathways	**Surface Soil**	**Subsurface Soil**	**Surface Soil**	**Subsurface Soil**	**Surface Soil**	**Subsurface Soil**	**Surface Soil**	**Subsurface Soil**	**Surface Soil**	**Subsurface Soil**
Direct ingestion	X	X	X		X	X	X	X		
Dermal absorption	X	X			X	X	X	X		
Inhalation of volatiles outdoors[b]										
Inhalation of fugitive dust outdoors	X				X		X		X	
Migration of volatiles into indoor air[c]										
Ingestion of groundwater contaminated by the migration of leachate to an underlying aquifer[d]										

X = Pathway to be evaluated in the SSL calculation for this receptor.

a) Unless otherwise noted, all exposure pathways identified for evaluation in the SSL calculations are recommended by EPA (2002).

b) EPA (2002) recommends evaluating inhalation of volatiles generated from subsurface soils for the outdoor commercial/industrial and construction worker. This pathway was not evaluated in the derivation of SSLs for the FMC Plant OU due to the absence of volatile COPCs.

c) EPA (2002) recommends evaluating inhalation of volatiles generated from subsurface soils for the indoor commercial/industrial worker. This pathway was not evaluated in the derivation of SSLs for the FMC Plant OU due to the absence of volatile COPCs and the incorporation of radon control measures into future buildings constructed on the FMC Plant OU.

d) EPA (2002) recommends evaluating ingestion of contaminated groundwater for outdoor and indoor commercial/industrial workers. This pathway was not evaluated in the derivation of SSLs for the FMC Plant OU because FMC will establish land-use restrictions that prevent future workers from being exposed to groundwater containing COPC concentrations above MCLs or RBCs.

Table 4-3
Factors Affecting P4 Oxidation Rate[1]

Factor	Affect on Rate of Oxidation
Increased proportion of suspended P4	Decreased
Increased proportion of dissolved P4	Increased
Increased dissolved oxygen concentration	Increased
Increased salt concentration	Decreased
Increased metal ion concentration	Increased
Increased pH value (> 6)	Increased
Increased temperature	Increased

1) Recreated from Table 2-2 of EPA (2003b).

Table 4-4

Target Risk and Exposure Assumptions Incorporated into the SSL Calculations[a]

Parameter	Units	Outdoor Industrial/Commercial Worker	Indoor Industrial/Commercial Worker	Construction Worker	Utility Worker[b]	Off-Site Resident
Target Cancer Risk	unitless	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-6}$
Target Hazard Quotient	unitless	1	1	1	1	1
Body Weight	kg	70	70	70	70	70
Averaging Time (Non-Carcinogens)	years	25	25	1	1	30
Averaging Time (Carcinogens)	years	70	70	70	70	70
Exposure Frequency	days/yr	225	250	130	10	350
Exposure Duration	years	25	25	1	1	30
Soil Ingestion Rate	mg/day	100	50	330	330	NA
Skin-Soil Adherence Factor	mg/cm^2-event	0.2	NA	0.3	0.9	NA
Skin Surface Exposed	cm^2	3300	NA	3300	3300	NA
Event Frequency	event/day	1	NA	1	1	NA
Inhalation Rate	m^3/day	20	NA	20	20	20
Particulate Emission Factor[c]	m3/kg	3.41E+08	NA	7.44E+05	7.44E+05	2.59E+09

NA = Not applicable.

a) Unless otherwise noted, all values used to characterize exposure parameters are defaults taken from EPA (2002).

b) The default construction worker exposure assumptions are assumed to apply to a utility worker, except that a shorter exposure duration is used based on professional judgement and a higher skin-soil adherence factor is assumed per EPA (2004d).

c) The assumptions used to derive particulate emission factors are presented in Table 4-9 (outdoor commercial/industrial worker), Table 4-13 (construction and utility workers), and Table 4-18 (off-site resident).

Table 4-5

Cancer Slope Factors (CSFs) and Unit Risk Factors (URFs)

Chemical	Weight of Evidence[a]	Oral CSF (mg/kg-day)$^{-1}$	Inhalation URF ($\mu g/m^3$)$^{-1}$	Portal of Entry Effect (Y/N)[d]	Type of Cancer	Study Basis (Species / Route of Administration)	Source
Arsenic	A	1.5		N	Skin cancer	Human, epidemiological drinking water study	IRIS
			4.3×10^{-3}	Y	Lung cancer	Human (male), inhalation occupational exposure	IRIS
Beryllium	Not determined (oral)	NA					
	B1 (inhalation)		2.4×10^{-3}	Y	Lung cancer	Human, inhalation occupational exposure	IRIS
Cadmium	No evidence (oral)	NA					
	B1 (inhalation)		1.8×10^{-3}	Y	Lung, trachea, bronchus cancer	Human (white, male), inhalation occupational exposure	IRIS
Cobalt	Not determined (oral)	NA					
	B1 (inhalation)		2.8×10^{-3}		Lung cancer	Rats and mice, inhalation	PPRTV
Lead	B2	NA					IRIS
			NA				

Table 4-5 (continued)

Chemical	Weight of Evidence[a]	Oral CSF (mg/kg-day)$^{-1}$	Inhalation URF ($\mu g/m^3$)$^{-1}$	Portal of Entry Effect (Y/N)[d]	Type of Cancer	Study Basis (Species / Route of Administration)	Source
Mercuric chloride	C	NA	NA				IRIS
Nickel	A (for nickel refinery dust)	NA	2.4×10^{-4} (for nickel refinery dust)	Y	Lung and nasal cancer	Human, inhalation occupational exposure	IRIS

Abbreviations:

IRIS - EPA's Integrated Risk Information System
N - Critical effect(s) did not occur at the portal of entry
NA - not available
PPRTV - EPA's Provisional Peer-Reviewed Toxicity Values for Superfund
Y - Critical effect(s) did not occur at the portal of entry.

Footnotes:

[a] Weight of Evidence

A Known human carcinogen
B1/B2 Probable human carcinogen
C Possible human carcinogen

References:

EPA:

IRIS

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Table 4-5 (continued)

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EPA. 1995a. IRIS Toxicity Profile for Mercuric Chloride. II. Carcinogenicity Assessment for Lifetime Exposure. Revised: June, 1995. Accessed: November 15, 2004. http://www.epa.gov/iris/subst/0692.htm.

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EPA. 1998c. IRIS Toxicity Profile for Beryllium and Compounds. II. Carcinogenicity Assessment for Lifetime Exposure. Revised: April 1998. Accessed: November 15, 2004.http://www.epa.gov/iris/subst/0012.htm.

PPRTV

EPA, 2004a. Provisional Peer-Reviewed Toxicity Values for Superfund (PPRTV). Accessed: May 1, 2004. http://hhpprtv.ornl.gov

Table 4-6

Chronic Reference Doses (RfDs) and Reference Concentrations (RfCs)

Chemical	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Portal of Entry Effect (Y/N)	Confidence in RfD/RfC	Critical Effect(s)	Study Basis (Species / Route of Administration)	Uncertainty/ Modifying Factors	Note(s) on Toxicity Value	Source
Antimony	0.0004		N	Low	Decreased longevity; decreased blood glucose; altered cholesterol	Rat, drinking water	1000/1		IRIS
		0.0014							R-to-R
Arsenic	0.0003		N	Medium	Hyperpigmentation, keratosis, possible vascular complications	Human, oral	3/1		IRIS
		0.00105							R-to-R
Barium	0.07		N	Medium	No adverse effects;	Human, drinking water (community and laboratory studies);	3/1		IRIS
					Increased kidney weight	Rat, drinking water			
		0.0005	N	NA	Fetotoxicity	Rat, inhalation	1000/1		HEAST
Beryllium	0.002		Y	Low to medium	Small intestinal lesions	Dog, diet	300/1		IRIS
		0.00002	Y	Medium	Beryllium sensitization and progression to chronic beryllium disease	Human, inhalation occupational and community exposure	10/1		IRIS
Boron	0.20		N	High	Decreased fetal weight	Rat, diet	66/1		IRIS
		0.02	Y	NA	Respiratory tract irritation; bronchitis	Human, inhalation	100/1	Value is for anhydrous boron	HEAST
Cadmium	0.001		N	High	Significant proteinuria	Human, toxicokinetic model	10/1	Value is for food	IRIS
		0.0002	N	NA	NA	NA	NA	Calculated from the inhalation RfD assuming an inhalation rate of 20 m^3/day and a body weight of 70 kg.	NCEA

Table 4-6 (continued)

Chemical	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Portal of Entry Effect (Y/N)	Confidence in RfD/RfC	Critical Effect(s)	Study Basis (Species / Route of Administration)	Uncertainty/ Modifying Factors	Note(s) on Toxicity Value	Source
Chromium (III) (as soluble salts)	1.5		N	Low	No observed effects	Rat, diet	100/10		IRIS
		5.25							R-to-R
Cobalt	0.02		N	Low to medium	Increased hemoglobin; polycythemia	Human, oral therapeutic administration	10/1		PPRTV
		0.00002	Y	Medium to low	Effects on lung function	Human, occupational inhalation exposure	100/1		PPRTV
Copper	0.037		Y	NA	Gastrointestinal irritation	Human, drinking water MCL		Derived from the MCL by assuming the consumption of 2 liters of water/day and a body weight of 70 kg.	HEAST
		NA							
Fluoride	0.06		Y	High	Objectionable dental fluorosis (cosmetic effect)	Human (child), epidemiologic study	1/1	Critical effect occurred at the portal of entry, but may also be the result of systemic absorption.	IRIS
		0.21							R-to-R
Lead	NA								
		NA							
Lithium	0.02		NA	NA	NA	NA	NA		NCEA
		NA							
Manganese	0.14		N	Medium	Central nervous system effects	Human dietary intake data	1/1		IRIS
		0.00005	N	Medium	Impairment of neurobehavioral function	Human inhalation occupational exposure	1000/1		IRIS

Table 4-6 (continued)

Chemical	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Portal of Entry Effect (Y/N)	Confidence in RfD/RfC	Critical Effect(s)	Study Basis (Species / Route of Administration)	Uncertainty/ Modifying Factors	Note(s) on Toxicity Value	Source
Mercury	0.0003		N	High	Autoimmune effects	Rat, diet and subcutaneous	1000/1	Value is for mercuric chloride (as mercury)	IRIS
		0.0003	N	Medium	Hand tremor; increased memory disturbances; evidence of autonomic dysfunction	Human occupational inhalation studies	30/1	Value is for elemental mercury	IRIS
Molybdenum	0.005		N	Medium	Increased uric acid levels	Human dietary exposure study	30/1		IRIS
		0.0175							R-to-R
Nickel	0.02		N	Medium	Decreased body and organ weights	Rat, diet	300/1	Value is for soluble salts	IRIS
		0.00009	Y	NA	Respiratory effects	Rat, inhalation	30/1	Draft value	ATSDR
Phosphorus (elemental)	0.00002		N	Low	Parturition mortality; forelimb hair loss	Rat reproductive study, gavage	1000/1	Value is for white phosphorous	IRIS
		0.01	Y	Medium	Bronchiolar fibrosis	Rat, inhalation	300/1	Value is for phosphoric acid	IRIS
Selenium	0.005		N	High	Clinical selenosis	Human, epidemiological dietary study	3/1		IRIS
		0.0175							R-to-R
Silver	0.005		N	Low	Argyria (cosmetic effect)	Human, intravenous injection therapy	3/1		IRIS
		0.0175							R-to-R
Thallium	0.000068		N	Low	Increased levels of SGOT and LDH	Rat, gavage	3000/1	Calculated from the oral RfD for thallium chloride	IRIS
		0.000238							R-to-R
Uranium	0.003		N	Medium	Initial body weight loss; moderate nephrotoxicity	Rabbit, diet	1000/1	Value is for soluble salts	IRIS
		0.0105							R-to-R
Vanadium	0.007		NA	NA	NA	Rat, drinking water	100		HEAST
		NA							

Table 4-6 (continued)

Chemical	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Portal of Entry Effect (Y/N)	Confidence in RfD/RfC	Critical Effect(s)	Study Basis (Species / Route of Administration)	Uncertainty/ Modifying Factors	Note(s) on Toxicity Value	Source
Zinc	0.30		N	Medium	47 percent decrease in ESOD concentration in adult females after 10 weeks	Human, diet supplementation study	3/1		IRIS
		1.05							R-to-R

Abbreviations:

ATSDR - Agency for Toxic Substances and Disease Registry Minimal Risk Level (MRL)
ESOD - erythrocyte superoxide dismutase (an enzyme)
HEAST - EPA's Health Effects Assessment Summary Tables
IRIS - EPA's Integrated Risk Information System
LDH - lactate dehydrogenase
N - Critical effect(s) did not occur at the portal of entry.
NA - not available
NCEA - EPA-NCEA provisional value
PPRTV - EPA's Provisional Peer-Reviewed Toxicity Values for Superfund
RfC - reference concentration
RfD - reference dose
R-to-R - route-to-route extrapolation from the oral RfD, assuming an inhalation rate of 20 m3/day and a body weight of 70 kg
SGOT - serum glutamic-oxaloacetic transaminase (liver enzyme, old name, now called aspartate aminotransferase)
Y - Critical effect(s) occurred at the portal of entry.

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ATSDR:

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Table 4-6 (continued)

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EPA. 1993c. IRIS Toxicity Profile for Manganese. I.B. Reference Concentration for Chronic Inhalation Exposure. Revised: December, 1993. Accessed: November 15, 2004. http://www.epa.gov/iris/subst/0373.htm.

EPA. 1993d. IRIS Toxicity Profile for Molybdenum. I.A. Reference Dose for Chronic Oral Exposure. Revised: August, 1993. Accessed: November 15, 2004. http://www.epa.gov/iris/subst/0425.htm.

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Table 4-6 (continued)

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PPRTV

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Table 4-7

COPC Gastrointestinal Absorption Fractions (ABS_{GI}) and Dermal Absorption Fractions (ABS_d)

Constituent	ABS_{GI} [a]	ABS_d [b]
Antimony	1.50E-01	NV
Arsenic	1.00E+00	3.00E-02
Barium	7.00E-02	NV
Beryllium	7.00E-03	NV
Boron	1.00E+00	NV
Cadmium	2.50E-02	1.00E-03
Chromium	1.30E-02	NV
Cobalt	1.00E+00	NV
Copper	1.00E+00	NV
Fluoride	1.00E+00	NV
Lead	1.00E+00	NV
Lithium	1.00E+00	NV
Manganese	4.00E-02	NV
Mercury	7.00E-02	NV
Molybdenum	1.00E+00	NV
Nickel	4.00E-02	NV
Phosphorus (elemental)	1.00E+00	NV
Selenium	1.00E+00	NV
Silver	4.00E-02	NV
Thallium	1.00E+00	NV
Uranium	1.00E+00	NV
Vanadium	2.60E-02	NV
Zinc	1.00E+00	NV

NV = Not available

(a) Gastrointestinal absorption fractions obtained from Chapter 4 of EPA (2004d).

(b) Available dermal absorption fractions obtained from Chapter 3 of EPA (2004d).

Table 4-8

Dermally-Adjusted Toxicity Factors

Constituent	Dermally-Adjusted Cancer Slope Factors - SF_{ABS} (mg/kg-day)$^{-1}$ [a]	Dermally-Adjusted Chronic Reference Doses - RfD_{ABS} (mg/kg-day) [b]	Dermally-Adjusted Subchronic Health-Based Limits - HBL_{ABS} (mg/kg-day) [c]
Antimony	NA	6.00E-05	3.00E-05
Arsenic	1.50E+00	3.00E-04	3.00E-04
Barium	NA	4.90E-03	4.90E-03
Beryllium	NA	1.40E-05	3.50E-05
Boron	NA	2.00E-01	1.00E-02
Cadmium	NA	2.50E-05	2.50E-05
Chromium	NA	1.95E-02	1.30E-02
Cobalt	NA	2.00E-02	1.00E-02
Copper	NA	3.70E-02	3.70E-02
Fluoride	NA	6.00E-02	6.00E-02
Lead	NA	NV	NV
Lithium	NA	2.00E-02	2.00E-02
Manganese	NA	5.60E-03	5.60E-03
Mercury	NA	2.10E-05	2.10E-04
Molybdenum	NA	5.00E-03	5.00E-03
Nickel	NA	8.00E-04	8.00E-04
Phosphorus (elemental)	NA	2.00E-05	2.00E-04
Selenium	NA	5.00E-03	5.00E-03
Silver	NA	2.00E-04	2.00E-04
Thallium	NA	6.80E-05	6.80E-04
Uranium	NA	3.00E-03	2.00E-03
Vanadium	NA	1.82E-04	1.82E-04
Zinc	NA	3.00E-01	3.00E-01

NA = Not applicable.

NV= Nor available

a) Calculated using Equation 4-4.

b) Calculated using Equation 4-5.

c) Calculated using Equation 4-12.

Table 4-9

Parameter Values Used to Calculate the Particulate Emission Factor for Commercial/Industrial Worker Exposure to Wind Generated Fugitive Dust

Parameter	Units	Value	Source
Equation 4-8			
PEF - Particulate emission factor	m^3/kg	3.41E+08	Calculated per Equation 4-8
QC_{wind} - Inverse of mean concentration at center of a 50 acre square source	g/m^2-s per kg/m^3	38.63	Calculated per Equation 4-9
V - Fraction of vegetative cover	unitless	0	Site-specific, based on lack of vegetative cover on much of developed FMC OU area
U_m - Mean annual windspeed	m/s	4.6	Value for Pocatello, ID from Table 4-1 of Cowherd et al., 1985
Ut - Equivalent threshold value of wind speed at 7 m	m/s	11.32	Default value from Equation 4-5 of EPA (2002)
F(x) - Function dependent on Um/Ut derived using Cowherd et al. (1985)	unitless	0.169	Calculated from Appendix B of Cowherd et al., 1985
Equation 4-9			
QC_{wind} - Inverse of mean concentration at center of a 50 acre square source	g/m^2-s per kg/m^3	38.63	Calculated per Equation 4-9
A - constant	unitless	13.2559	Value for Salt Lake City, UT from Exhibit D-2 of EPA (2002)
B - constant	unitless	19.2978	Value for Salt Lake City, UT from Exhibit D-2 of EPA (2002)
C - constant	unitless	221.3379	Value for Salt Lake City, UT from Exhibit D-2 of EPA (2002)
A_{site}	acres	50	Assumption

Table 4-10
Summary of Outdoor Commercial/Industrial Worker Soil Screening Levels

Constituent	Soil Ingestion/Dermal Absorption Exposure Pathways (mg/kg)		Fugitive Dust Inhalation Exposure Pathway (mg/kg)		Final SSL (mg/kg)	
	Carcinogenic Endpoint	Non-Carcinogenic Endpoint	Carcinogenic Endpoint	Non-Carcinogenic Endpoint	Concentration	Endpoint
COPC						
Antimony	-	4.54E+02	-	7.74E+05	4.54E+02	Noncarcinogenic
Arsenic	1.77E+00	2.84E+02	3.60E+02	5.80E+05	1.76E+00	Carcinogenic
Barium	-	7.95E+04	-	2.76E+05	6.17E+04	Noncarcinogenic
Beryllium	-	2.27E+03	6.45E+02	1.11E+04	6.45E+02	Carcinogenic
Boron	-	2.27E+05	-	1.11E+07	2.23E+05	Noncarcinogenic
Cadmium	-	8.98E+02	8.60E+02	1.11E+05	8.60E+02	Carcinogenic
Chromium	-	1.70E+06	-	2.90E+09	1.70E+06	Noncarcinogenic
Cobalt	-	2.27E+04	5.53E+02	1.11E+04	5.53E+02	Carcinogenic
Copper	-	4.20E+04	-	-	4.20E+04	Noncarcinogenic
Fluoride	-	6.81E+04	-	1.16E+08	6.81E+04	Noncarcinogenic
Lead	-	-	-	-	8.00E+02	(a)
Lithium	-	2.27E+04	-	-	2.27E+04	Noncarcinogenic
Manganese	-	1.59E+05	-	2.76E+04	2.35E+04	Noncarcinogenic
Mercury	-	3.41E+02	-	1.66E+05	3.40E+02	Noncarcinogenic
Molybdenum	-	5.68E+03	-	9.67E+06	5.67E+03	Noncarcinogenic
Nickel	-	2.27E+04	6.45E+03	4.97E+04	6.45E+03	Carcinogenic
Phosphorus (elemental)	-	2.27E+01	-	1.75E+06	2.27E+01	Noncarcinogenic
Selenium	-	5.68E+03	-	9.67E+06	5.67E+03	Noncarcinogenic
Silver	-	5.68E+03	-	9.67E+06	5.67E+03	Noncarcinogenic
Thallium	-	7.72E+01	-	1.32E+05	7.72E+01	Noncarcinogenic
Uranium	-	3.41E+03	-	5.80E+06	3.40E+03	Noncarcinogenic
Vanadium	-	7.95E+03	-	-	7.95E+03	Noncarcinogenic
Zinc	-	3.41E+05	-	5.80E+08	3.40E+05	Noncarcinogenic

- = Not applicable.
(a) The current screening level for lead is based on the value cited by EPA's Adult Lead Methodology Workgroup (www.epa. gov/superfund/programs/lead/almfaq.htm).

Table 4-11
Summary of Indoor Commercial/Industrial Worker Soil Screening Levels

Constituent	Soil Ingestion Exposure Pathway (mg/kg)		Final SSL (mg/kg)	
	Carcinogenic Endpoint	Non-Carcinogenic Endpoint	Concentration	Endpoint
COPC				
Antimony	-	8.18E+02	8.18E+02	Noncarcinogenic
Arsenic	3.82E+00	6.13E+02	3.82E+00	Carcinogenic
Barium	-	1.43E+05	1.43E+05	Noncarcinogenic
Beryllium	-	4.09E+03	4.09E+03	Noncarcinogenic
Boron	-	4.09E+05	4.09E+05	Noncarcinogenic
Cadmium	-	2.04E+03	2.04E+03	Noncarcinogenic
Chromium	-	3.07E+06	3.07E+06	Noncarcinogenic
Cobalt	-	4.09E+04	4.09E+04	Noncarcinogenic
Copper	-	7.56E+04	7.56E+04	Noncarcinogenic
Fluoride	-	1.23E+05	1.23E+05	Noncarcinogenic
Lead	-	-	8.00E+02	(a)
Lithium	-	4.09E+04	4.09E+04	Noncarcinogenic
Manganese	-	2.86E+05	2.86E+05	Noncarcinogenic
Mercury	-	6.13E+02	6.13E+02	Noncarcinogenic
Molybdenum	-	1.02E+04	1.02E+04	Noncarcinogenic
Nickel	-	4.09E+04	4.09E+04	Noncarcinogenic
Phosphorus (elemental)	-	4.09E+01	4.09E+01	Noncarcinogenic
Selenium	-	1.02E+04	1.02E+04	Noncarcinogenic
Silver	-	1.02E+04	1.02E+04	Noncarcinogenic
Thallium	-	1.39E+02	1.39E+02	Noncarcinogenic
Uranium	-	6.13E+03	6.13E+03	Noncarcinogenic
Vanadium	-	1.43E+04	1.43E+04	Noncarcinogenic
Zinc	-	6.13E+05	6.13E+05	Noncarcinogenic

- = Not applicable.
(a) The current screening level for lead is based on the value cited by EPA's Adult Lead Methodology Workgroup (www.epa. gov/superfund/programs/lead/almfaq.htm).

Table 4-12

Subchronic Reference Doses (RfDs) and Reference Concentrations (RfCs)

Chemical	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Portal of Entry Effect (Y/N)	Confidence in RfD/RfC	Critical Effect(s)	Study Basis (Species / Route of Administration)	Uncertainty/ Modifying Factors	Note(s) on Toxicity Value	Source
Antimony	0.0002		N	Low	Decreased serum glucose	Rat, drinking water	300/1	Value is for metallic antimony	PPRTV
		0.0004	Y	Medium	Increased lung weight, lung infllammation	Rat, inhalation	100/1	Value is for metallic antimony	PPRTV
Arsenic	0.0003		N	NA	Keratosis, hyperpigmentation	Human, oral	3/1		HEAST
		0.00105							R-to-R
Barium	0.07		N	NA	Increased blood pressure	Human, drinking water	3/1		HEAST
		0.005	N	NA	Fetotoxicity	Rat, inhalation	100/1		HEAST
Beryllium	0.005		N	NA	No observed effects	Rat, drinking water	100/1		HEAST
		0.0175							R-to-R
Boron	0.01		N	NA	Developmental effects	Rat, diet	1000/1		ATSDR
		0.02	Y	NA	Respiratory tract irritation; bronchitis	Human, inhalation	100/1	Value is for anhydrous boron	HEAST
Cadmium	0.001		N	High	Significant proteinuria	Human, toxicokinetic model	10/1	The chronic oral RfD was used; value is for food	IRIS
		0.0002	N	NA	NA	NA	NA	The chronic inhalation RfD was used; Calculated from the inhalation RfD, assuming an inhalation rate of 20 m^3/day and a body weight of 70 kg.	NCEA

Table 4-12 (continued)

Chemical	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Portal of Entry Effect (Y/N)	Confidence in RfD/RfC	Critical Effect(s)	Study Basis (Species / Route of Administration)	Uncertainty/ Modifying Factors	Note(s) on Toxicity Value	Source
Chromium (III)	1.0		N	NA	No observed effects	Rat, diet	1000/1		HEAST
		3.5							R-to-R
Cobalt	0.01		N	NA	Hematological effects	Human, oral therapeutic administration	100/1		ATSDR
		0.035	N						R-to-R
Copper	0.037		Y	NA	Gastrointestinal irritation	Human, drinking water MCL	NA	Derived from the MCL by assuming the consumption of 2 liters of water/day and a body weight of 70 kg.	HEAST
		NA							
Fluoride	0.06		Y	NA	Tooth fluorosis	Human, drinking water	1/1	Critical effect occurred at the portal of entry, but may also be the result of systemic absorption.	HEAST
		0.21							R-to-R
Lead	NA								
		NA							
Lithium	0.02		NA	NA	NA	NA	NA	The chronic oral RfD was used.	NCEA
		NA							
Manganese	0.14		N	NA	Central nervous system effects	Human, diet	1/1		HEAST
		0.49							R-to-R
Mercury	0.003		N	NA	Autoimmune effects	Rat, subcutaneous	100/1	Value is for mercuric chloride	HEAST
		0.0003	N	NA	Neurotoxicity	Human, inhalation	30/1	Value is for elemental mercury	HEAST

Table 4-12 (continued)

Chemical	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Portal of Entry Effect (Y/N)	Confidence in RfD/RfC	Critical Effect(s)	Study Basis (Species / Route of Administration)	Uncertainty/ Modifying Factors	Note(s) on Toxicity Value	Source
Molybdenum	0.005		N	NA	Increased uric acid levels; pain and swelling in joints; decreased serum copper levels	Human, drinking water and diet	30/1		HEAST
		0.0175							R-to-R
Nickel	0.02		N	NA	Decreased body and organ weights	Rat, diet	300/1	Value is for soluble salts	HEAST
		0.0002	Y	NA	Respiratory effects	Rat, inhalation	30/1	Draft value	ATSDR
Phosphorus (elemental)	0.0002		N	NA	Reproductive effects	Rat (reproductive), gavage	100/1	Value is for white phosphorous	ATSDR
		0.01	Y	Medium	Bronchiolar fibrosis	Rat, inhalation	300/1	The chronic RfC was used; value is for phosphoric acid	IRIS
Selenium	0.005		N	NA	Clinical selenosis	Human, diet	3/1		HEAST
		0.0175							R-to-R
Silver	0.005		N	NA	Argyria	Human, intravenous	3/1		HEAST
		0.0175							R-to-R
Thallium	0.00068		N	NA	Iincreased SGOT levels in liver; increased serum LDH; alopecia	Rat, oral	300/1	Calculated from the oral RfD for thallium chloride	HEAST
		0.00238							R-to-R
Uranium	0.002		N	NA	Renal effects	Rabbit, drinking water	30/1	Value is for soluble salts	ATSDR
		0.0004		NA	Renal effects	Dog, inhalation	90/1	Value is for soluble salts	ATSDR
Vanadium	0.007		NA	NA	NA	Rat, drinking water	100		HEAST
		0.0105	N	NA	Renal effects	Rat, drinking water	10/1	Derived from an alternate (intermediate) oral RfD of 0.003 mg/kg/day)	RO-to-R ATSDR

Table 4-12 (continued)

Chemical	Oral RfD (mg/kg-day)	Inhalation RfC (mg/m^3)	Portal of Entry Effect (Y/N)	Confidence in RfD/RfC	Critical Effect(s)	Study Basis (Species / Route of Administration)	Uncertainty/ Modifying Factors	Note(s) on Toxicity Value	Source
Zinc	0.30		N	NA	Decreased blood enzymes	Human, dietary supplementation	3/1	Value is for metallic zinc	HEAST
		1.05							R-to-R

Abbreviations:

ATSDR - Agency for Toxic Substances and Disease Registry Minimal Risk Level (MRL)
HEAST - EPA's Health Effects Assessment Summary Tables
IRIS - EPA's Integrated Risk Information System
LDH - lactate dehydrogenase
N - Critical effect(s) did not occur at the portal of entry.
NA - not available
NCEA - EPA-NCEA provisional value
PPRTV - EPA's Provisional Peer-Reviewed Toxicity Values for Superfund
RfC - reference concentration
RfD - reference dose
R-to-R - route-to-route extrapolation from the oral RfD, assuming an inhalation rate of 20 m3/day and a body weight of 70 kg
RO-to-R - route-to-route extrapolation from an alternate oral RfD, assuming an inhalation rate of 20 m3/day and a body weight of 70 kg
SGOT - serum glutamic-oxaloacetic transaminase (liver enzyme, old name, now called aspartate aminotransferase)
Y - Critical effect(s) occurred at the portal of entry.

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Table 4-13
Parameter Values Used to Calculate the Subchronic Particulate Emission Factor for Construction Worker Exposure to Fugitive Dust Generated by Unpaved Road Traffic

Parameter	Units	Value	Source
Equation 4-15			
PEF_{SC} - Subchronic particulate emission factor for unpaved road traffic	m^3/kg	7.44E+05	Calculated per Equation 4-15
QC_{sr} - Inverse of 1-hr average air concentration along a straight road segment bisecting a square site	g/m^2-s per kg/m^3	16.40	Calculated per Equation 4-21
F_D - Dispersion correction factor	unitless	0.1903	Calculated per Equation 4-18
T - Total time over which construction occurs	s	3744000	Calculated per Equation 4-16
L_R - Surface area of contaminated road segment	ft	466.69	Calculated per Equation 4-17
W_R - Width of contaminated road segment	ft	25	Average width of roads on FMC Plant OU
0.092903 - Conversion factor	m^2/ft^2	0.092903	Conversion factor
s - Road surface silt content	%	12.89	Average of existing unpaved FMC Plant OU roadways
W - Mean vehicle weight	tons	8	Calculated per Equation 4-19
M_{dry} - Road surface material moisture content under dry, uncontrolled conditions	%	0.2	Default value from Equation E-18 of EPA (2002)
p - Number of days per year with at least 0.01 inches of precipitation	days/year	96	NWS, NOAA Data, 1990
VKT - Sum of fleet vehicle kilometers traveled during the exposure duration	km	554.74	Calculated per Equation 4-20
Equation 4-16			
T - Total time over which construction occurs	s	3744000	Calculated per Equation 4-16
C_{weeks} - Number of weeks of construction activity	weeks	26	Assumption within Appendix E Case Example (EPA, 2002)
C_{days} - Days per week of construction activity	days/week	5	Assumption within Appendix E Case Example (EPA, 2002)
C_{hours} - Hours per day of construction activity	hours/day	8	Assumption within Appendix E Case Example (EPA, 2002)
3,600 - Conversion factor	seconds/hour	3600	Conversion factor
Equation 4-17			
L_R - Surface area of contaminated road segment	ft	466.69	Calculated per Equation 4-17
A_{site} - Area of site surface contamination configured as a square	acres	5	Assumption within Appendix E Case Example (EPA, 2002)
43,560 - Conversion factor	ft^2/acre	43560	Conversion factor
Equation 4-18			
F_D - Dispersion correction factor	unitless	0.1903	Calculated per Equation 4-18
t_c - Duration of construction	hours	1040	tc = T in units of hours per Equation E-16 of EPA (2002)
Equation 4-19			
W - Mean vehicle weight	tons	8	Calculated per Equation 4-19
N_{cars} - Number of cars traveling across construction zone unpaved roads	cars/day	20	Assumption within Appendix E Case Example (EPA, 2002)
W_{car} - Average weight of cars traveling across construction zone unpaved roads	tons/car	2	Assumption within Appendix E Case Example (EPA, 2002)
N_{trucks} - Number of trucks traveling across construction zone unpaved roads	trucks/day	10	Assumption within Appendix E Case Example (EPA, 2002)
W_{trucks} - Average weight of trucks traveling across construction zone unpaved roads	tons/truck	20	Assumption within Appendix E Case Example (EPA, 2002)
Equation 4-20			
VKT - Sum of fleet vehicle kilometers traveled during the exposure duration	km	554.74	Calculated per Equation 4-20
L_R - Surface area of contaminated road segment	ft	466.69	Calculated per Equation 4-17
3,281 - Conversion factor	ft/km	3281	Conversion factor
$N_{vehicles}$ - Total number of vehicles traveling across construction zone	vehicles/day	30	Assumption within Appendix E Case Example (EPA, 2002)
C_{weeks} - Number of weeks of construction activity	weeks	26	Assumption within Appendix E Case Example (EPA, 2002)
C_{days} - Days per week of construction activity	days/week	5	Assumption within Appendix E Case Example (EPA, 2002)
Equation 4-21			
QC_{sr} - Inverse of 1-hr average air concentration along a straight road segment bisecting a square site	g/m^2-s per kg/m^3	16.40	Calculated per Equation 4-21
A - Constant	unitless	12.9351	Default value from Equation E-19 of EPA (2002)
B - Constant	unitless	5.7383	Default value from Equation E-19 of EPA (2002)
C - Constant	unitless	71.7711	Default value from Equation E-19 of EPA (2002)
A_{site} - Areal extent of site surface contamination	acres	5	Assumption within Appendix E Case Example (EPA, 2002)

Table 4-14
Parameter Values Used to Calculate the Subchronic Particulate Emission Factor for Construction Worker Exposure to Fugitive Dust Generated by Construction Activity Other than Unpaved Road Traffic

Parameter	Units	Value	Source
Equation 4-22			
PEF_{SC} - Subchronic particulate emission factor for construction activities other than traffic on unpaved roads	m^3/kg	6.90E+07	Calculated per Equation 4-22
QC_{sa} - Inverse of 1-hr average air concentration at the center of the square emission source	g/m^2-s per kg/m^3	9.44	Calculated per Equation 4-23
F_D - Dispersion correction factor	unitless	0.1903	Calculated per Equation 4-18
$<J'_T>$ - Total time-averaged particulate matter unit emission flux for construction activities other than traffic on unpaved roads	g/m^2-s	7.18E-07	Calculated per Equation 4-24
Equation 4-23			
QC_{sa} - Inverse of 1-hr average air concentration at the center of the square emission source	g/m^2-s per kg/m^3	9.44	Calculated per Equation 4-23
A - Constant	unitless	2.4538	Default value from Equation E-15 of EPA (2002)
B - Constant	unitless	17.5660	Default value from Equation E-15 of EPA (2002)
C - Constant	unitless	189.0426	Default value from Equation E-15 of EPA (2002)
A_{site} - Areal extent of site surface contamination	acres	5	Assumption within Appendix E Case Example (EPA, 2002)
Equation 4-24			
$<J'_T>$ - Total time-averaged particulate matter unit emission flux for construction activities other than traffic on unpaved roads	g/m^2-s	7.18E-07	Calculated per Equation 4-24
M_{wind} - Unit mass emitted from wind erosion	g	3.62E+04	Calculated per Equation 4-25
M_{excav} - Unit mass emitted from excavation soil dumping	g	1.62E+03	Calculated per Equation 4-26
M_{doz} - Unit mass emitted from dozing activities	g	7.37E+02	Calculated per Equation 4-27
M_{grade} - Unit mass emitted from grading activities	g	1.08E+04	Calculated per Equation 4-28
M_{till} - Unit mass emitted from tilling operations	g	5.04E+03	Calculated per Equation 4-29
A_{site} - Area of site soil contamination	acres	5	Assumption within Appendix E Case Example (EPA, 2002)
4,047 - Conversion factor	m^2/acre	4047	Conversion factor
T - Total time over which construction occurs	s	3744000	Calculated per Equation 4-16
Equation 4-25			
M_{wind} - Unit mass emitted from wind erosion	g	3.62E+04	Calculated per Equation 4-25
V - Fraction of vegetative cover	unitless	0	Default value from Equation E-20 of EPA (2002)
U_m - Mean annual windspeed	m/s	4.6	Value for Pocatello, ID from Table 4-1 of Cowherd et al., 1985
Ut - Equivalent threshold value of wind speed at 7 m	m/s	11.32	Default value from Equation E-20 of EPA (2002)
F(x) - Function dependent on Um/Ut derived using Cowherd et al. (1985)	unitless	0.169	Calculated from Appendix B of Cowherd et al., 1985
A_{surf} - Areal extent of site with surface soil contamination	m^2	5	Assumption within Appendix E Case Example (EPA, 2002)
4,047 - Conversion factor	m^2/acre	4047	Conversion factor
ED - Exposure duration	yr	0.5000	Assumption within Appendix E Case Example (EPA, 2002)
Equation 4-26			
M_{excav} - Unit mass emitted from excavation soil dumping	g	1.62E+03	Calculated per Equation 4-26
0.35 - PM_{10} particle size multiplier	unitless	0.35	Equation E-21 of EPA (2002)
U_m - Mean annual windspeed	m/s	4.6	Value for Pocatello, ID from Table 4-1 of Cowherd et al., 1985
M - Gravimetric soil moisture content	%	12	Default value from Equation E-21 of EPA (2002)
p_{soil} - In situ soil density (includes water)	Mg/m^3	1.68	Default value from Equation E-21 of EPA (2002)
A_{excav} - Areal extent of excavation	m^2	4047	Assumption within Appendix E Case Example (EPA, 2002)
d_{excav} - Average depth of excavation	m	1	Assumption within Appendix E Case Example (EPA, 2002)
N_A - Number of times soil is dumped	unitless	2	Default value from Equation E-21 of EPA (2002)
Equation 4-27			
M_{doz} - Unit mass emitted from dozing activities	g	7.37E+02	Calculated per Equation 4-27
0.75 - PM_{10} scaling factor	unitless	0.75	Equation E-22 of EPA (2002)
s - Soil silt content	%	6.9	Default value from Equation E-22 of EPA (2002)
M - Gravimetric soil moisture content	%	7.9	Default value from Equation E-22 of EPA (2002)
VKT - Sum of dozing kilometers traveled	km	24.79	Assumption within Appendix E Case Example (EPA, 2002)
S - Average dozing speed	kph	11.4	Default value from Equation E-22 of EPA (2002)
Equation 4-28			
M_{grade} - Unit mass emitted from grading activities	g	1.08E+04	Calculated per Equation 4-28
0.60 - PM_{10} scaling factor	unitless	0.6	Equation E-23 of EPA (2002)
VKT - Sum of grading kilometers traveled	km	24.79	Assumption within Appendix E Case Example (EPA, 2002)
S - Average dozing speed	kph	11.40	Default value from Equation E-23 of EPA (2002)
Equation 4-29			
M_{till} - Unit mass emitted from tilling operations	g	5.04E+03	Calculated per Equation 4-29
s - Soil silt content	%	18	Default value from Equation E-24 of EPA (2002)
A_{till} - Areal extent of tilling	acres	1	Assumption within Appendix E Case Example (EPA, 2002)
N_A - Number of times soil is tilled	unitless	2	Default value from Equation E-24 of EPA (2002)

Table 4-15
Summary of Construction Worker Soil Screening Levels

Constituent	Soil Ingestion/Dermal Absorption Exposure Pathways (mg/kg)		Fugitive Dust Inhalation Exposure Pathway (mg/kg)		Final SSL (mg/kg)	
	Carcinogenic Endpoint	Non-Carcinogenic Endpoint	Carcinogenic Endpoint	Non-Carcinogenic Endpoint	Concentration	Endpoint
COPC						
Antimony	-	1.19E+02	-	8.36E+02	1.04E+02	Noncarcinogenic
Arsenic	2.55E+01	1.64E+02	3.40E+01	2.19E+03	1.46E+01	Carcinogenic
Barium	-	4.17E+04	-	1.04E+04	8.36E+03	Noncarcinogenic
Beryllium	-	2.98E+03	6.10E+01	3.66E+04	6.10E+01	Carcinogenic
Boron	-	5.96E+03	-	4.18E+04	5.21E+03	Noncarcinogenic
Cadmium	-	5.32E+02	8.13E+01	4.18E+02	8.13E+01	Carcinogenic
Chromium	-	5.96E+05	-	7.31E+06	5.51E+05	Noncarcinogenic
Cobalt	-	5.96E+03	5.22E+01	7.31E+04	5.22E+01	Carcinogenic
Copper	-	2.20E+04	-	-	2.20E+04	Noncarcinogenic
Fluoride	-	3.57E+04	-	4.39E+05	3.30E+04	Noncarcinogenic
Lead	-	-	-	-	8.00E+02	(a)
Lithium	-	1.19E+04	-	-	1.19E+04	Noncarcinogenic
Manganese	-	8.34E+04	-	1.02E+06	7.71E+04	Noncarcinogenic
Mercury	-	1.79E+03	-	6.27E+02	4.64E+02	Noncarcinogenic
Molybdenum	-	2.98E+03	-	3.66E+04	2.75E+03	Noncarcinogenic
Nickel	-	1.19E+04	6.10E+02	4.18E+02	4.04E+02	Noncarcinogenic
Phosphorus (elemental)	-	1.19E+02	-	6.61E+03	1.17E+02	Noncarcinogenic
Selenium	-	2.98E+03	-	3.66E+04	2.75E+03	Noncarcinogenic
Silver	-	2.98E+03	-	3.66E+04	2.75E+03	Noncarcinogenic
Thallium	-	4.05E+02	-	4.97E+03	3.74E+02	Noncarcinogenic
Uranium	-	1.19E+03	-	8.36E+02	4.91E+02	Noncarcinogenic
Vanadium	-	4.17E+03	-	2.19E+04	3.50E+03	Noncarcinogenic
Zinc	-	1.79E+05	-	2.19E+06	1.65E+05	Noncarcinogenic

- = Not applicable.
(a) The current screening level for lead is based on the value cited by EPA's Adult Lead Methodology Workgroup (www.epa. gov/superfund/programs/lead/almfaq.htm).

Table 4-16
Summary of Utility Worker Soil Screening Levels

Constituent	Soil Ingestion/Dermal Absorption Exposure Pathways (mg/kg)		Fugitive Dust Inhalation Exposure Pathway (mg/kg)		Final SSL (mg/kg)	
	Carcinogenic Endpoint	Non-Carcinogenic Endpoint	Carcinogenic Endpoint	Non-Carcinogenic Endpoint	Concentration	Endpoint
COPC						
Antimony	-	1.55E+03	-	1.09E+04	1.36E+03	Noncarcinogenic
Arsenic	2.84E+02	1.83E+03	4.42E+02	2.85E+04	1.73E+02	Carcinogenic
Barium	-	5.42E+05	-	1.36E+05	1.09E+05	Noncarcinogenic
Beryllium	-	3.87E+04	7.92E+02	4.75E+05	7.92E+02	Carcinogenic
Boron	-	7.74E+04	-	5.43E+05	6.78E+04	Noncarcinogenic
Cadmium	-	5.69E+03	1.06E+03	5.43E+03	1.06E+03	Carcinogenic
Chromium	-	7.74E+06	-	9.51E+07	7.16E+06	Noncarcinogenic
Cobalt	-	7.74E+04	6.79E+02	9.51E+05	6.79E+02	Carcinogenic
Copper	-	2.86E+05	-	-	2.86E+05	Noncarcinogenic
Fluoride	-	4.65E+05	-	5.71E+06	4.30E+05	Noncarcinogenic
Lead	-	-	-	-	8.00E+02	(a)
Lithium	-	1.55E+05	-	-	1.55E+05	Noncarcinogenic
Manganese	-	1.08E+06	-	1.33E+07	1.00E+06	Noncarcinogenic
Mercury	-	2.32E+04	-	8.15E+03	6.03E+03	Noncarcinogenic
Molybdenum	-	3.87E+04	-	4.75E+05	3.58E+04	Noncarcinogenic
Nickel	-	1.55E+05	7.92E+03	5.43E+03	5.25E+03	Noncarcinogenic
Phosphorus (elemental)	-	1.55E+03	-	8.60E+04	1.00E+03	Spontaneous oxidation (b)
Selenium	-	3.87E+04	-	4.75E+05	3.58E+04	Noncarcinogenic
Silver	-	3.87E+04	-	4.75E+05	3.58E+04	Noncarcinogenic
Thallium	-	5.26E+03	-	6.47E+04	4.87E+03	Noncarcinogenic
Uranium	-	1.55E+04	-	1.09E+04	6.39E+03	Noncarcinogenic
Vanadium	-	5.42E+04	-	2.85E+05	4.55E+04	Noncarcinogenic
Zinc	-	2.32E+06	-	2.85E+07	2.15E+06	Noncarcinogenic

- = Not applicable.
(a) The current screening level for lead is based on the value cited by EPA's Adult Lead Methodology Workgroup (www.epa. gov/superfund/programs/lead/almfaq.htm).
(b) The toxicity-based SSL for elemental phosphorus is higher than the level at which P4 may spontaneously oxidize (smoke). Therefore, the SSL was amended to reflect the concentration (1,000 mg/kg) at which spontaneous oxidation may occur.

Table 4-17

SCREEN3 Dispersion Model Estimates of Fugitive Dust Concentrations at Locations of Nearest Off-Site Residents from FMC OU Remedial Units with Potential for Future Construction Activities

Source	Unit Fugitive Dust Emission Flux (EF_{unit})[a] (g/m^2-s)	Off-Site Residential Receptor Distance from Source (m)	Modeled Maximum 1 Hour Fugitive Dust Concentration at Residential Location Under Unit Flux[b] ($\mu g/m^3$)	Modeled Maximum Annual Average Fugitive Dust Concentration at Residential Location Under Unit Flux (AA_{unit})[c] ($\mu g/m^3$)	Inverse of the Average Air Concentration to the Emission Flux at the Location of Potential Residential Exposure (Q/C_{off})[d] (g/m^2-s per kg/m^3)
5 Acre Construction Site on RU 20 (Former Bannock Paving Area)	4.942E-05	275	1,438	1.44E+02	3.44E+02
5 Acre Construction Site on RU 7 (Ore Stockpile)	4.942E-05	1,150	362.7	3.63E+01	1.36E+03

a) Estimated by dividing an assumed unit emission rate of 1 g/s by the FMC OU area subject to construction (5 acres or 20,235 m^2).

b) The maximum 1-hour concentration was found to occur using model inputs of 1 m/s wind speed and F class atmospheric stability.

c) A factor of 0.1 (EPA, 1992) was used to convert the modeled maximum 1-hour concentration to a maximum annual average concentration.

d) Calculated per Equation 4-33.

Table 4-18

Parameter Values Used to Calculate the Off-Site Particulate Emission Factor for the Off-Site Residential Receptor

Parameter	Units	Value	Source
PEF_{off} - Off-site particulate emission factor	m3/kg	2.47E+09	Calculated per Equation 4-32
Q/C_{off} - Inverse of mean air concentration to the emission flux at the location of potential residential exposure	g/m^2-s per kg/m^3	3.44E+02	Calculated per Equation 4-33
$<J'_T>^{off}$ - Total time-averaged PM10 unit emission flux for the off-site receptor	g/m^2-s	1.39E-07	Calculated per Equation 4-34
Equation 4-33			
Q/C_{off} - Inverse of mean air concentration to the emission flux at the location of potential residential exposure	g/m^2-s per kg/m^3	3.44E+02	Calculated per Equation 4-33
AA_{unit} - Annual average PM_{10} at worst-case residential receptor location under a unit fugitive dust emission flux	ug/m^3	1.44E+02	Estimated using SCREEN3 dispersion model (see Table 4-17)
EF_{unit} - Unit PM_{10} emission flux over an assumed 5 acre construction site	g/m^2-s	4.94E-05	EF_{unit} = 1 g/s dividied by area of construction site (5 acres or 20,235 m^2)
Equation 4-34			
$<J'_T>^{off}$ - Total time-averaged PM10 unit emission flux for the off-site receptor	g/m^2-s	1.39E-07	Calculated per Equation 4-34
M_{wind} - Unit mass emitted from wind erosion	g	3.62E+04	Calculated per Equation 4-25
M_{excav} - Unit mass emitted from excavation soil dumping	g	1.62E+03	Calculated per Equation 4-26
M_{doz} - Unit mass emitted from dozing activities	g	7.37E+02	Calculated per Equation 4-27
M_{grade} - Unit mass emitted from grading activities	g	1.08E+04	Calculated per Equation 4-28
M_{till} - Unit mass emitted from tilling operations	g	5.04E+03	Calculated per Equation 4-29
M_{wind}^{pc} - Post-construction unit mass emitted from wind erosion	g	2.13E+06	Calculated per Equation 4-35
M_{road} - Unit mass emitted from unpaved roads	g	4.70E+05	Calculated per Equation 4-36
A_{site} - Area of site soil contamination	acres	5	Assumption within Appendix E Case Example (EPA, 2002)
4,047 - Conversion factor	m^2/acre	4047	Conversion factor
ED - Exposure duration	yr	30	Section 5 of EPA (2002)
Equation 4-35			
M_{wind}^{pc} - Unit mass emitted from wind erosion	g	2.13E+06	Calculated per Equation 4-35
V - Fraction of vegetative cover	unitless	0	Site-specific, based on lack of vegetative cover on much of developed FMC OU area
U_m - Mean annual windspeed	m/s	4.6	Value for Pocatello, ID from Table 4-1 of Cowherd et al., 1985
Ut - Equivalent threshold value of wind speed at 7 m	m/s	11.32	Default value from Equation E-20 of EPA (2002)
F(x) - Function dependent on Um/Ut derived using Cowherd et al. (1985)	unitless	0.169	Calculated from Appendix B of Cowherd et al., 1985
A_{surf} - Areal extent of site with surface soil contamination	m^2	5	Assumption within Appendix E Case Example (EPA, 2002)
4,047 - Conversion factor	m^2/acre	4047	Conversion factor
ED - Exposure duration	yr	29.5	ED = 30 years total exposure - 0.5 years of construction activity
Equation 4-36			
M_{road} - Unit mass emitted from unpaved roads	g	4.70E+05	Calculated per Equation 4-36
s - Road surface silt content	%	12.89	Average of existing unpaved FMC Plant OU roadways
W - Mean vehicle weight	tons	8	Calculated per Equation 4-19
M_{dry} - Road surface material moisture content under dry, uncontrolled conditions	%	0.2	Default value from Equation E-18 of EPA (2002)
p - Number of days per year with at least 0.01 inches of precipitation	days/year	96	NWS, NOAA Data, 1990
VKT - Sum of fleet vehicle kilometers traveled during the exposure duration	km	554.74	Calculated per Equation 4-20

Table 4-19
Summary of Off-Site Resident Soil Screening Levels

Constituent	Fugitive Dust Inhalation Exposure Pathway (mg/kg)		Final SSL (mg/kg)	
	Carcinogenic Endpoint	Non-Carcinogenic Endpoint	Concentration	Endpoint
COPC				
Antimony	-	3.61E+06	3.61E+06	Noncarcinogenic
Arsenic	1.40E+03	2.71E+06	1.40E+03	Carcinogenic
Barium	-	1.29E+06	1.29E+06	Noncarcinogenic
Beryllium	2.51E+03	5.16E+04	2.51E+03	Carcinogenic
Boron	-	5.16E+07	5.16E+07	Noncarcinogenic
Cadmium	3.34E+03	5.16E+05	3.34E+03	Carcinogenic
Chromium	-	1.35E+10	1.35E+10	Noncarcinogenic
Cobalt	2.15E+03	5.16E+04	2.15E+03	Carcinogenic
Copper	-	-	NC	-
Fluoride	-	5.42E+08	5.42E+08	Noncarcinogenic
Lead	-	-	8.00E+02	(a)
Lithium	-	-	NC	-
Manganese	-	1.29E+05	1.29E+05	Noncarcinogenic
Mercury	-	7.74E+05	7.74E+05	Noncarcinogenic
Molybdenum	-	4.52E+07	4.52E+07	Noncarcinogenic
Nickel	2.51E+04	2.32E+05	2.51E+04	Carcinogenic
Phosphorus (elemental)	-	2.58E+07	2.58E+07	Noncarcinogenic
Selenium	-	4.52E+07	4.52E+07	Noncarcinogenic
Silver	-	4.52E+07	4.52E+07	Noncarcinogenic
Thallium	-	6.14E+05	6.14E+05	Noncarcinogenic
Uranium	-	2.71E+07	2.71E+07	Noncarcinogenic
Vanadium	-	-	NC	-
Zinc	-	2.71E+09	2.71E+09	Noncarcinogenic

- = Not applicable.
NC = Not calculated due to absence of chronic inhalation toxicity factors.
(a) The current screening level for lead is based on the value cited by EPA's Adult Lead Methodology Workgroup (www.epa. gov/superfund/programs/lead/almfaq.htm).

Table 4-20
Summary of Soil Screening Levels (SSLs) Derived for Potential Receptors to COPCs on the FMC OU

Constituent	Final SSL (mg/kg)				
	Outdoor Commercial/Industrial Worker	Indoor Commercial/Industrial Worker	Construction Worker	Utility Worker	Off-Site Resident
COPC					
Antimony	4.54E+02	8.18E+02	1.04E+02	1.36E+03	3.61E+06
Arsenic	1.76E+00	3.82E+00	1.46E+01	1.73E+02	1.40E+03
Barium	6.17E+04	1.43E+05	8.36E+03	1.09E+05	1.29E+06
Beryllium	6.45E+02	4.09E+03	6.10E+01	7.92E+02	2.51E+03
Boron	2.23E+05	4.09E+05	5.21E+03	6.78E+04	5.16E+07
Cadmium	8.60E+02	2.04E+03	8.13E+01	1.06E+03	3.34E+03
Chromium	1.70E+06	3.07E+06	5.51E+05	7.16E+06	1.35E+10
Cobalt	5.53E+02	4.09E+04	5.22E+01	6.79E+02	2.15E+03
Copper	4.20E+04	7.56E+04	2.20E+04	2.86E+05	NC
Fluoride	6.81E+04	1.23E+05	3.30E+04	4.30E+05	5.42E+08
Lead	8.00E+02	8.00E+02	8.00E+02	8.00E+02	8.00E+02
Lithium	2.27E+04	4.09E+04	1.19E+04	1.55E+05	NC
Manganese	2.35E+04	2.86E+05	7.71E+04	1.00E+06	1.29E+05
Mercury	3.40E+02	6.13E+02	4.64E+02	6.03E+03	7.74E+05
Molybdenum	5.67E+03	1.02E+04	2.75E+03	3.58E+04	4.52E+07
Nickel	6.45E+03	4.09E+04	4.04E+02	5.25E+03	2.51E+04
Phosphorus (elemental)	2.27E+01	4.09E+01	1.17E+02	1.00E+03	2.58E+07
Selenium	5.67E+03	1.02E+04	2.75E+03	3.58E+04	4.52E+07
Silver	5.67E+03	1.02E+04	2.75E+03	3.58E+04	4.52E+07
Thallium	7.72E+01	1.39E+02	3.74E+02	4.87E+03	6.14E+05
Uranium	3.40E+03	6.13E+03	4.91E+02	6.39E+03	2.71E+07
Vanadium	7.95E+03	1.43E+04	3.50E+03	4.55E+04	NC
Zinc	3.40E+05	6.13E+05	1.65E+05	2.15E+06	2.71E+09

NC = Not calculated due to absence of applicable toxicity factors.

Section 5

Ecological Assessment of Undeveloped Southern and Western Portions of the FMC Plant OU

5.1 Introduction

During development of the SRI/FS SOW (EPA, 2003), EPA requested an evaluation of potential ecological risk issues related to the FMC Plant OU. As discussed in Section 5.2, during a May 2003 meeting and site visit, EPA identified specific areas of the FMC Plant OU in which potential ecological exposures could occur. Subsequently, FMC completed an analysis (FMC, 2003) that identified the relevant Remedial Investigation (RI) (Bechtel, 1996) data that could be used to assess potential risks. For the three contaminants of potential concern (COPCs), fluoride, cadmium, and zinc, quantitatively evaluated in the EMF Baseline Ecological Risk Assessment (Baseline ERA) (E&E, 1995), the RI data collected from the Bannock Hills SW sagebrush steppe Baseline ERA study area were determined to be appropriate for characterizing ecological risks within the FMC Plant OU. For two additional COPCs identified by EPA (vanadium and chromium), data from RI surface soil samples collected adjacent to the undeveloped portions of the FMC Plant OU were found to be appropriate for evaluating risks within the FMC Plant OU. A discussion of these COPC data sets is provided in Section 5.3.

The methods used in the Baseline ERA were consistent with both national (EPA, 1992) and Region 10 (EPA, 1989) ecological risk assessment guidance, as well as current EPA Region 10 ecological risk assessment guidance for Superfund sites (EPA, 1997). Consequently, no major revisions to either the Baseline ERA methodology or Conceptual Site Model (CSM), described in Section 5.4, were determined to be necessary (EPA, 2003). The evaluation of ecological risks for the FMC Plant OU therefore required only a review of current toxicological data to update the toxicity reference values (TRVs) used in the Baseline ERA, as described in Section 5.5, and an update to the relevant exposure pathways of the CSM. At the request of EPA, three additional wildlife receptors (bald eagle, pygmy rabbit, and Townsend's big-eared bat), which were not quantitatively evaluated in the Baseline ERA (E&E, 1995), were included in this assessment.

Using the methodology of the Baseline ERA, ecological risks associated with potential exposures within areas of the FMC Plant OU that represent potential wildlife habitats were evaluated. The methods used for the exposure assessment, as summarized in Section 5.6, were established in Chapter 4 of the Baseline ERA. The risk characterization and associated uncertainties relevant to undeveloped portions of the FMC Plant OU are developed in Section 5.7.

5.2 Areas of Potential Ecological Concern in the FMC Plant OU

The extent and current use of land that comprises the FMC Plant OU is shown in Figure 5-1 (amended RI Figure 4.3-18A). During a May 15, 2003 meeting and site visit held between representatives of FMC, EPA, IDEQ, and the Shoshone-Bannock Tribe, it was agreed that developed/disturbed portions of the FMC Plant OU do not provide habitat suitable for use by potential terrestrial and/or aquatic receptors (developed/disturbed areas of the FMC Plant OU are highlighted in green, blue and orange shading within Figure 5-1). This determination is supported by the fact that several areas within the developed portion of the FMC Plant OU are currently subject to high levels of traffic associated with ongoing closure activities. These areas also contain the infrastructure that would support commercial/industrial redevelopment and,

therefore, will likely remain high traffic areas for the foreseeable future. In addition, access by large mammalian species (e.g., mule deer) to disturbed/developed areas of the FMC Plant OU is restricted by migration barriers (e.g., Highway 30, Interstate 86 and the Taghee Canal to the north of the FMC Plant site, the Simplot facility to the east of the Plant site, the steep terrain within the Bannock Hills to the south of the Plant site, the wire fencing surrounding the Plant site, and the cyclone fencing surrounding the RCRA pond closure area). Also, there is a lack of readily available drinking water, and the developed/disturbed areas are limited in size compared to the home range of most of the avian species that can access these areas. Each of these factors limit the extent to which potential wildlife receptors could be exposed to hazardous substances within developed/disturbed areas of the FMC Plant OU now or in the future. During the May 15, 2003 meeting, EPA concurred that a screening level ERA of the developed areas would not be a required component of the SRI/FS conducted for the FMC Plant OU.

The undeveloped portion of the FMC Plant OU (shaded in yellow within Figure 5-1) consists of approximately 250 acres in the foothills of the Bannock Range and an additional 250 acres in the western portion of the Plant site west of the location of RCRA Ponds 17 and 18. There is additional FMC owned land located to the north of Highway 30 that is also considered to be part of the FMC Plant OU (shaded in yellow with brown lines in Figure 5-1). However, this latter undeveloped area was evaluated in the original Baseline ERA. Therefore, this evaluation of potential ecological risks in the FMC Plant OU is restricted to the undeveloped areas located to the west and south of the FMC Plant site.

5.3 Data Relevant To The Updated ERA Evaluation

In July 2003, FMC provided a detailed comparison of the cadmium, fluoride and zinc data collected at the maximally impacted sagebrush steppe sampling location evaluated in the Baseline ERA (Bannock Hills, SW) to the surface soil concentrations in RI samples collected closer to the undeveloped areas of the FMC Plant OU (FMC, 2003). Based on this assessment, summarized below, EPA concurred that the data and findings of nearby off-site analyses performed as part of the RI (Bechtel, 1996) and Baseline ERA (E&E, 1995) were appropriate for the evaluation of ecological impacts within undeveloped areas of the FMC Plant OU.

The basis for characterizing the potential ecological risks in the western and southern undisturbed portions of the FMC Plant OU using the quantitative assessment in the EMF Baseline ERA is justified by the proximity of and the data results from the maximally impacted sagebrush steppe habitat sampling location evaluated in the EMF Baseline ERA relative to the FMC Plant OU potential wildlife habitats. Figure B-2 (see Appendix B to this document) of the Baseline ERA (E&E, 1995) shows the location of both the Bannock Hills SW and Michaud Flats terrestrial sagebrush steppe habitat sampling stations used to quantitatively assess potential impacts to sagebrush steppe habitat located in the vicinity of the EMF facilities in the Baseline ERA. Specifically, data characterizing surface soil, plant (big sagebrush and thickspike wheatgrass), and whole organism deer mouse tissue concentrations were collected at these sampling stations in order to derive risk estimates for each of the three COPCs (i.e., cadmium, fluoride and zinc) identified in the Baseline ERA. Tables B-9, B-12, B-13, B-14 and B-16 (Appendix B) of the Baseline ERA (E&E, 1995) provide the cadmium, fluoride, and zinc concentrations detected in soil, unwashed sagebrush, washed sagebrush, unwashed thickspike wheatgrass and deer mouse tissue samples collected at these sampling locations for the purpose of quantitatively evaluating ecological risks. Also included in these tables are the data collected at the Ferry Butte reference location, situated several miles northeast of the FMC Plant, used to

characterize background ecological risks. As shown in the Appendix B tables and noted during the May 15, 2003 meeting with EPA, the Bannock Hills SW sampling location consistently exhibited higher COPC concentrations than the Michaud Flats location for all sampled media.

As shown in Figure 5-1, the Bannock Hills SW sampling location is in relative close proximity (within several thousand feet) of both the western and southern undeveloped areas of the FMC Plant OU. Therefore, the data collected at this sampling location should provide a reasonable approximation of potential risks within undeveloped areas of the FMC Plant OU. As verification, the surface soil COPC concentrations detected at the Bannock Hills SW sampling location were compared with surface soil concentrations in off-site RI samples collected immediately adjacent to the western and southern undeveloped areas of the FMC Plant OU (see Figure 5-1). The locations at which off-site surface soil samples were obtained during the RI, and their proximity to the undeveloped areas of the FMC Plant OU, are shown in Figure 5-1. In this figure, the specific RI surface soil samples that were collected closer to undeveloped areas of the FMC Plant OU than the Bannock Hills SW sampling plot are highlighted with a red border.

Table B-9 of the Baseline ERA (E&E, 1995) provides the cadmium, fluoride and zinc concentrations detected in the ten surface soil samples collected at the Bannock Hills SW sampling station (Appendix B). Table A-3 of the Baseline ERA (E&E, 1995) (Appendix B) summarizes the concentrations of each of these three constituents within the off-site RI surface soil samples analyzed. A direct comparison of the range of cadmium, fluoride and zinc surface soil concentrations detected at the Bannock Hills SW sampling plot versus the surface soil concentrations detected in the RI surface soil samples collected immediately adjacent to the undeveloped areas of the FMC Plant OU is provided in Table 5-1.

As shown in Table 5-1, the maximum cadmium, fluoride and zinc concentrations detected in the 10 surface soil samples collected at the Bannock Hills SW sampling station are greater than all of the concentrations of these constituents detected in the RI surface soil samples collected at locations immediately adjacent to the undeveloped areas of the FMC Plant OU. Furthermore, the average concentration of cadmium in the surface soil samples collected at the Bannock Hills SW sampling plot exceeds all but one of the RI surface soil sample concentrations. Similarly, the average concentration of fluoride in the surface soil samples collected at the Bannock Hills SW sampling station exceeds all but two of the RI surface soil sample concentrations. Finally, the average concentration of zinc in the surface soil samples collected at the Bannock Hills SW sampling station exceeds all of the surface soil concentrations in RI samples collected immediately adjacent to the undeveloped areas of the FMC Plant OU. Consequently, the data support the conclusion that the Bannock Hills SW data conservatively represent potential EMF facility-related cadmium, fluoride, and zinc concentrations within undeveloped areas of the FMC Plant OU. Furthermore, the analysis of July 2003 (FMC, 2003) illustrated that there were no maximum off-site concentrations at more distal RI surface soil sampling locations.

In summary, the findings described above confirm that, for land located in the general vicinity of the undeveloped areas of the FMC Plant OU, maximal impacts associated with the deposition of historical EMF facility emissions occurred in the area of the Bannock Hills SW sampling location. Thus, it can be concluded that characterizing the surface soil concentrations of cadmium, fluoride and zinc within the western and southern undeveloped areas of the FMC Plant OU using the Bannock Hills SW cadmium, fluoride and zinc surface soil data is conservative (i.e., health protective). By inference, it can also be concluded that the plant (sagebrush and thickspike wheatgrass) and deer mouse tissue data collected at the Bannock Hills SW sampling

plot, and used to quantitatively evaluate potential impacts to sagebrush steppe habitat in the Baseline ERA, likely conservatively characterize COPC concentrations in the these media within the undeveloped areas of the FMC Plant OU.

During the Baseline ERA, E&E (EPA's risk assessment contractor) determined that cadmium, fluoride and zinc were the chemicals of greatest potential concern because of their presence at the highest concentrations above background levels in the area surrounding the EMF facilities, and their toxicity to ecological receptors (E&E, 1995). However, based on the July 2003 summary of the data (FMC, 2003), EPA requested that vanadium and chromium be added as COPCs within this assessment, since the concentrations of these constituents in several of the RI surface soil samples collected adjacent to the undeveloped portions of the FMC Plant OU exceed both background and generic risk-based terrestrial screening levels (Table 5-2).

To evaluate the potential impact of historical EMF facility releases of vanadium and chromium within undeveloped areas of the FMC Plant OU, concentrations detected in off-site RI surface soil samples collected immediately adjacent to the undeveloped areas of the FMC Plant OU are considered appropriate given the finding that concentrations of cadmium, fluoride and zinc in off-site RI surface soil samples provide a conservative representation of surface soil concentrations within undeveloped areas of the FMC Plant OU. This conclusion is supported by figures within the RI report that depict vanadium and chromium surface soil concentration isopleths. Figure 5-2 (amended RI Figure 4.3-23) shows that vanadium surface soil concentrations within much of the undeveloped areas of the FMC Plant OU are likely below the regional background level (45.4 mg/kg). As also shown in Figure 5-2, while portions of the undeveloped areas located adjacent to disturbed areas (e.g., slag pile) may exhibit higher levels, none are likely to exceed background by more than a factor of two. Similarly, as shown in Figure 5-3 (amended RI Figure 4.3-20), the undeveloped areas of the FMC Plant OU are likely to contain chromium ranging from below background (27.5 mg/kg) to approximately two-times this level at locations adjacent to disturbed areas of the FMC Plant OU. Consequently, the 95% UCL of the adjacent, offsite RI samples, several of which (e.g., Stations 225A and 225B) are located near historic fugitive sources that only affect a limited portion of the undeveloped areas, are likely to conservatively overestimate exposures across the entire undeveloped portions of the FMC Plant OU.

5.4 Conceptual Site Model (CSM)

The schematic of the original CSM, which is described in Section 2.4 of the Baseline ERA, is reproduced in Figure 5-4. As shown in this figure, the CSM included both the sagebrush steppe habitat and the Portneuf aquatic habitat, which are representative of the entire EMF area. However, the Portneuf aquatic habitat is located to the east of the FMC and Simplot facilities and is not a part of the FMC Plant OU. Consequently, because the undeveloped portions of the FMC Plant OU consist entirely of sagebrush steppe habitat, the surface water and sediment pathways will not be included in this assessment. In addition, several pathways, e.g. air emissions from the FMC facility, are no longer appropriate since the plant has ceased operations. The relevant pathways and ecological endpoints identified in the CSM, as adapted to the undeveloped portions of the FMC Plant OU, are summarized below.

5.4.1 Sources and Receiving Media

As described in Section 5.3, the COPCs defined for the FMC Plant OU include the original Baseline ERA COPCs, cadmium, fluoride, and zinc, as well as the newly added COPCs,

vanadium and chromium. Because FMC facility operations have ceased, soil is the only affected media relevant to an ecological assessment of the undisturbed portions of the FMC Plant OU (any ongoing air quality impacts associated with Simplot emissions are considered beyond the scope of the SRI/SFS of the FMC Plant OU). COPCs present in soil may be absorbed into plant matter through root uptake, deposited onto plant matter through wind-generated fugitive dusts, ingested or absorbed by soil invertebrates, and may subsequently be mobilized into the food chain with the potential for bioconcentration. Wildlife may be exposed to COPCs by ingestion of contaminated vegetation or prey, or through incidental ingestion of contaminated soil.

5.4.2 Ecological Endpoints

The representative categories of assessment endpoint species selected in the Baseline ERA for the terrestrial ecosystems of the EMF study area are reproduced in Table 5-3 (reproduced from Table 2-7 of the Baseline ERA). Measurement endpoint species were chosen in the Baseline ERA by considering the relative abundance of each species in major taxonomic groups and whether there were any regulated or rare species of concern. The measurement endpoint species and measurement endpoints used in the Baseline ERA are shown in Table 5-4 (reproduced from Table 2-9 of the Baseline ERA). For this evaluation, only the terrestrial measurement endpoint species of the sagebrush steppe habitat are appropriate for evaluating the undeveloped portions of the FMC Plant OU. The resulting list of species to be evaluated includes birds (red-tailed hawk, horned lark, sage grouse), mammals (deer mouse, mule deer, coyote), and plants (thickspike wheatgrass, sagebrush).

At the request of EPA, this assessment of the undeveloped portions of the FMC Plant OU will also include several special status species not considered in the Baseline ERA. The terrestrial measurement endpoint species to be included are: bald eagle (avian), and the mammalian species, pygmy rabbit and Townsend's Big Eared Bat.

5.5 Ecological Effects Estimate

The ecological effects assessment establishes the relevant COPC Toxicity Reference Values (TRVs) for each measurement endpoint species. EPA requested that the TRVs for the three COPCs evaluated in the Baseline ERA, i.e. fluoride, cadmium, and zinc, be reviewed to determine whether more recent toxicity data would alter the TRVs used to evaluate risk. In addition, EPA requested that risks associated with vanadium and chromium be assessed. In this section, TRVs are developed for the wildlife and terrestrial plant receptors used to assess potential ecological risks within undeveloped portions of the FMC Plant OU.

TRVs were developed for each COPC and receptor using the most recent toxicity benchmarks (TBs) available in several secondary sources (Efroymson et al., 1997; Sample et.al.,1996; Kabata-Pendias, 2000). The plant TRVs for cadmium, zinc and fluoride represent either the critical or excessive concentration in sensitive species that is the lowest tissue concentration at which toxic effects may occur. For vanadium and chromium, for which plant matter was not analyzed, plant TRVs represent the soil pore-water concentration that could result in toxic effects through plant root uptake. The mammalian and avian TBs are concentrations or doses representative of the expected ‘no observed adverse effect level’ (NOAEL) or ‘lowest observed adverse effect level’ (LOAEL) concentrations obtained during toxicity testing and are specific to a given receptor and COPC. Based on the NOAEL or LOAEL, TRVs were developed consistent with the approach used in the Baseline ERA.

5.5.1 Terrestrial Plants

As noted above, two types of TRVs were developed for terrestrial plants: TRVs relative to the COPC concentration in the plant matter itself, and TRVs relative to the soil pore-water concentration to which plant roots are exposed. Because the RI sampling effort performed for the Baseline ERA included sampling and measurement of the concentrations of cadmium, fluoride, and zinc in thickspike wheatgrass and sagebrush, TRVs for these three COPCs were obtained from Kabata-Pendias (2000) for plant tissue concentrations and are provided in Table 5-5a. Use of TRVs specific to plant tissue overcomes the difficulty of ascertaining the role of local soil geochemistry in determining the bioavailable fraction of the COPCs.

In the absence of plant tissue concentration data for chromium and vanadium, soil pore-water TRVs from Efroymson et al. (1997) were chosen as provided in Table 5-5b. Soil pore-water TRVs were selected in preference to bulk soil TRVs since, as noted in Efroymson et al. (1997), plant exposure is via soil pore-water. Additionally, as noted by Efroymson et al. (1997), elimination of soil in test systems improves the experimenter's control of exposure. This concern can be attributed to the significant role that soil geochemistry (e.g., pH, Eh, adsorptive capacity of various mineralogical components) has on controlling the ionic form and pore-water concentration of inorganic constituents. Consequently, within the alkaline soils of the study area, the pore-water TRVs are considered more representative of terrestrial plant exposure than are bulk soil TRVs.

The uncertainties associated with the use of bulk soil plant TRVs is highlighted by the fact that both the Efroymson et al. (1997) chromium and vanadium bulk soil TRVs are more than twenty-fold lower than chromium and vanadium background concentrations in the EMF study area. As stated in Efroymson et al. (1997), "…if a benchmark is exceeded by background soil concentrations, it is generally safe to assume that the benchmark is a poor measure of risk to the plant community at that site". Consequently, this ERA considered a comparison of pore-water plant TRVs to soil pore-water concentrations to be a more accurate and reliable approach to evaluating potential risks to terrestrial plants on the undeveloped portions of the FMC Plant OU.

5.5.2 Wildlife

TRVs for wildlife were developed for each COPC and receptor using the most recent toxicity benchmarks (TBs) available in Sample et al. (1996). The TBs were derived from exposure concentrations or doses that represent a NOAEL or LOAEL obtained during toxicity testing and are specific to a given COPC and the species used in the toxicity study. The TBs from which TRVs were to be developed are shown in Table 5-6.

Because TBs from the toxicity studies are only available for a few mammalian and avian species, TRVs for the measurement endpoint species were obtained by extrapolation of the TBs for the target species of the toxicity studies using the approach in the Baseline ERA. To perform the extrapolation as in the Baseline ERA, species-specific TRVs were developed by adjusting the TBs for differences in body size between test species and endpoint species, as follows (Opresko et al., 1994):

Equation 5- 1

$$TRV_E = TB_T \times \left(BW_T / BW_E\right)^{0.33}$$

where:

TRV_E = Toxicity reference value for endpoint species (mg/kg BW-day);
TB_T = Toxicity benchmark for the test species (mg/kg BW-day);
BW_E = Body weight of endpoint species (kg); and
BW_T = Body weight of test species (kg).

To avoid extrapolating across taxonomically unrelated species of wildlife, the Baseline ERA derived TRVs separately for birds and mammals. This approach was also adopted herein. The body weight for each test species and each measurement endpoint species used in the scaling is presented in Tables 5-6 and 5-7, respectively. The body weight scaling factors used for the extrapolation are presented in Table 5-8. COPC-specific TRVs for each mammalian and avian endpoint species developed by application of the body weight scaling factors and COPC-specific TBs are shown in Table 5-9.

5.6 Exposure Assessment

As noted in the Baseline ERA, while historic air deposition represents the major source of contaminants to soils and vegetation in the vicinity of the EMF facilities, the plant and mouse tissue data obtained during the RI demonstrated that COPCs were not readily mobilized in the terrestrial food chain. In addition, the COPCs, particularly cadmium and zinc, did not migrate from the surficial soils and therefore were not readily accessible to plant roots, most likely due to the adsorptive capacity and highly alkaline nature of regional soils. The low migration potential also would be expected for vanadium and chromium, although plant and mouse tissue data for these constituents were not collected during the RI. Consequently, unlike the Baseline ERA for the COPCs cadmium, fluoride and zinc, exposure concentrations for vanadium and chromium must be estimated using literature values for uptake and biotransfer factors.

This section summarizes the approach taken in the Baseline ERA to obtain exposure estimates for measurement endpoint species that may be potentially exposed to the COPCs within the undeveloped portions of the FMC Plant OU, and the extension of these methods to vanadium and chromium. The exposure scenarios and pathways are summarized and the methods used to characterize the exposure point concentrations are developed. The estimated COPC-specific exposure point concentrations are then used to develop the exposure estimates for each measurement endpoint species that will be used to characterize risk in Section 5.7.

5.6.1 Exposure Scenarios and Pathways

The exposure pathways and endpoint species identified in the CSM (see Section 5.4) established the exposure media and routes to be evaluated in the quantitative exposure assessment. Table 5-10 (which is based on Table 4-1 of the Baseline ERA) summarizes the two plant scenarios and ten wildlife scenarios to be evaluated in this assessment, including the additional special status species. The scenarios for the three additional special status species were developed for this assessment. The diet of the bat was assumed to be composed entirely of insects and that of the bald eagle was assumed to be the same as that of the red-tailed hawk. The diet of the pygmy rabbit was obtained from the literature, which indicated that shrubs represent two-thirds of the diet with one-third composed of forbs (Green and Flinders, 1980).

5.6.2 Exposure Point Concentrations (EPCs)

Table 5-11 provides the EPCs for cadmium, fluoride and zinc as determined in the Baseline ERA (E&E, 1995). In general, the 95% UCL was used to characterize the EPCs with few exceptions as listed in Table 5-11.

The specific media for which EPCs were measured to perform the Baseline ERA for cadmium, fluoride and zinc were: soil, plant matter, and deer mouse tissue. Therefore, to include vanadium and chromium in this assessment, COPC-specific EPCs for each of these media were estimated. Additionally, because the vanadium and chromium TRVs for plant toxicity were developed in terms of soil pore-water concentration, soil pore-water concentrations were estimated from measured bulk soil concentrations. Therefore, within the remainder of this subsection, vanadium and chromium EPCs are developed for the following media: soil pore-water concentrations for the terrestrial plant risk characterization, and soil, plant tissue, and deer mouse concentrations for the wildlife risk characterization.

Terrestrial Plant EPCs for Vanadium and Chromium

The soil pore-water concentrations for vanadium and chromium were derived using Equation 22 of EPA (1996) as follows:

Equation 5- 2

$$EPC_{PW} = EPC_{Soil} \Big/ \left(K_d + \left(\frac{\theta_w + \theta_a H'}{\rho_b} \right) \right)$$

where:

EPC_{PW} = Soil Pore-Water Exposure Point Concentration (mg/L);
EPC_{Soil} = Soil Exposure Point Concentration (mg/kg);
K_d = Soil-Water Partition Coefficient (L/kg);
θ_w = Water-filled soil porosity assumed to be 0.3 (Lwater/Lsoil);
θ_a = Air-filled soil porosity assumed to be 0.13 (Lair/Lsoil);
H' = Dimensionless Henry's law constant (H x 41, where 41 is a conversion factor;
H = Henry's law constant (atm-m^3/mol); and
ρ_b = dry soil bulk density assumed to be 1.5 (kg/L)

K_d values were obtained from Exhibit C-4 of EPA (2002). Although no pH dependent K_d value was available for vanadium, the chromium K_d value was estimated for a soil pH of 7.8, equivalent to the average pH value obtained from ten soil samples taken at the Bannock Hills SW Baseline ERA sampling station (E&E, 1995). Both chromium and vanadium are non-volatile constituents and do not have a Henry's law constant. The values assigned to the soil porosity parameters in the above equation are the default values provided in Equation 22 of EPA (1996). The soil EPCs necessary to estimate the pore-water concentrations were calculated as the 95% UCL of the concentrations within RI surface soils samples collected adjacent to undeveloped areas of the FMC Plant OU, which were provided in Table 5-2 and are summarized in Table 5-12. The estimated vanadium and chromium pore-water EPCs for the soil EPCs are shown in Table 5-13.

Wildlife EPCs for Vanadium and Chromium

As shown in Table 5-10, the diet of the measurement endpoint species includes seeds, forbs, shrubs, grasses, insects, and small mammals. Consistent with the Baseline ERA, seed, insect and forb EPCs for cadmium, fluoride and zinc were assumed to be equal to that of thickspike wheatgrass. With respect to vanadium and chromium, however, the estimation of plant tissue concentrations based on uptake factors does not distinguish between grasses and shrubs. Consequently, only one COPC-specific plant tissue EPC was estimated and used to characterize forb, grass, shrub and insect concentrations. A separate COPC-specific deer mouse tissue EPC was also estimated.

Plant EPCs were developed for chromium and vanadium based on EPA (1999) as follows:

Equation 5- 3

$$EPC_{Plant} = EPC_{Soil} \times BCF_r$$

where:

EPC_{Plant} = Sagebrush and Thickspike Wheatgrass Exposure Point Concentration due to root uptake (mg/kg-DW);
EPC_{Soil} = Soil Exposure Point Concentration (mg/kg); and
BCF_r = Soil-to-Plant Biotransfer Factor for Root Uptake into Aboveground Plants (unitless) [(mg/kg Plant DW)/(mg/kg soil)].

The COPC-specific EPCs for plant tissue are provided in Table 5-14 along with the BCF_r and the literature source of the BCF_r used in the estimation. Because the BCF_r is a generic number and does not take into account the geochemistry of the study area soils, the estimation of the plant tissue EPC is likely to be conservative since the alkalinity and mineralogy of the soils reduces vanadium and chromium bioavailability.

Determination of the vanadium and chromium deer mouse tissue EPC required estimating the amount of vanadium and chromium ingested by the mouse on a daily basis. As shown in Table 5-10, the deer mouse ingests seeds, foliage of grasses and shrubs, and incidentally ingests soil. Using methods described in EPA (1999), deer mouse EPCs were calculated using the following equation:

Equation 5- 4

$$EPC_{Mouse} = BCF_S \times EPC_{Soil} + BCF_F \times EPC_{Plant}$$

where:

EPC_{Mouse} = Deer Mouse Tissue Exposure Point Concentration (mg/kg-WW);
EPC_{Plant} = Sagebrush and Thickspike Wheatgrass Exposure Point Concentration (mg/kg-WW);
EPC_{Soil} = Soil Exposure Point Concentration (mg/kg);
BCF_S = Soil-to-Deer Mouse Bioconcentration Factor; and
BCF_F = Food-to-Deer Mouse Bioconcentration Factor.

The bioconcentration factors are defined as:

$$BCF_S = Ba \times P_{Soil} \times IR_{Soil}$$
$$BCF_F = Ba \times IR_F$$

where:

P_{Soil} = Incidental soil ingestion rate as percentage of diet ingestion rate;
IR_F = Deer Mouse Food Ingestion Rate (kg DW/day);
IR_{Soil} = Deer Mouse Soil Ingestion Rate (kg DW/day); and
Ba = Biotransfer Factor (day/kg WW tissue)

IR_F was obtained from Nagy (1987) and is provided in Table 5-7. IR_{Soil} was assumed to be 2% of IR_F, consistent with the Baseline ERA. A quantitative composition of the deer mouse diet was obtained from the Baseline ERA and reproduced in Table 5-15 in which the portion of the diet composed of seeds is included as forbs, consistent with the Baseline ERA. The previously calculated chromium and vanadium EPC_{Soil} and EPC_{Plant} concentrations are presented in Tables 5-12 and 5-14, respectively. The calculated deer mouse tissue concentration was converted to a dry weight basis by assuming the moisture content of animal tissue is 68% per Sample et al. (1996). The estimated vanadium and chromium EPC_{Mouse} are shown in Table 5-16 along with the referenced parameter values used in the calculation.

As a summary, the EPCs for each media for all five COPCs necessary for the exposure estimations are provided in Table 5-17.

5.6.3 Exposure Estimates (EEs)

The exposure of a receptor to a COPC consists of a dietary exposure and an exposure due to incidental ingestion of soil. The dietary exposure is estimated by multiplying each 'prey species' tissue concentration by the proportion of that prey in the diet, summing these values, multiplying by the total ingestion rate of the receptor and dividing by its body weight to obtain a total COPC mass ingested per kg body weight. However, because the species may not spend all its time in the area, the mass ingested may be adjusted by a site use factor (SUF) and the exposure duration (ED) to obtain a daily COPC ingestion rate as follows:

Equation 5- 5

$$EE_{Diet} = \frac{\sum_{1 \to n} \left[(P_1 \times T_1) + (P_2 \times T_2) + \ldots (P_n \times T_n) \times IR_F \times SUF \times ED \right]}{BW}$$

where:

EE_{Diet} = Estimated Exposure from diet (mg/kg BW-day),
P_i = Percentage of diet represented by prey item ingested,
T_i = Tissue concentration in prey item i (mg/kg dry weight);
SUF = Site use factor (unitless);
ED = Exposure duration (unitless), equal to the fraction of the year spent in the region;
IR_F = Ingestion rate of receptor (kg dry weight/day); and
BW = Body weight of receptor (kg in fresh weight).

For each of the ecological receptors, total daily ingestion rates were estimated using the relationship developed by Nagy (1987) as provided in Table 5-7. The percentage of diet represented by each prey item, the home range, assumed SUF and ED are provided in Table 5-15 and are the same for each receptor considered in the Baseline ERA. For the three special status species, data were obtained where available as referenced in the table. Similar to the Baseline ERA, SUF and ED were conservatively assumed to be one for each special status species. The home range of each of the species, although included in Table 5-15, was not considered in developing the exposure estimates.

To estimate EE_{Diet} for each receptor, the EPC for each food item was obtained from Table 5-17 where, as noted previously, the sagebrush and thickspike wheatgrass concentrations were used as the representative shrub and forb concentration, respectively, for cadmium, fluoride and zinc. Additionally, the seed (included as a component of forb ingestion) and insect concentrations of these COPCs were assumed to be equivalent to the thickspike wheatgrass concentrations. In the case of vanadium and chromium, the plant tissue concentration estimates do not distinguish between plant tissue types. Therefore, all plant matter, seeds, and insects were assumed to be of equal concentration.

Receptor exposure to COPCs from incidental ingestion of soil was assumed to be at the rate of 2% of the total wildlife ingestion rate, with the exception of the sage grouse in which soil is assumed to be 9% of its ingestion rate, based on Beyer et. al. (1994). Similar to the estimation of EE_{Diet}, EE_{Soil} was estimated by multiplying the soil EPC by the percentage of soil in the diet of each receptor, and adjusting for the SUF, ED, and BW such that:

Equation 5- 6

$$EE_{Soil} = \frac{P_{Soil} \times IR_F \times EPC_{Soil} \times SUF \times ED}{BW}$$

where:

EE_{Soil}	=Estimated Exposure from soil (mg/kg BW-day),
P_{Soil}	= Incidental soil ingestion rate as percentage of dietary ingestion rate (%),
IR_F	= Food ingestion rate of receptor (kg/day in dry weight);
EPC_{Soil}	= Soil Exposure Point Concentration (mg/kg dry weight);
SUF	= Site use factor (unitless);
ED	= Exposure duration (unitless), equal to the fraction of the year spent in the region; and
BW	= Body weight of receptor (kg in fresh weight).

The total exposure of a receptor to a COPC was calculated as the sum of the diet and soil dosages as follows:

Equation 5- 7

$$EE_{Total} = EE_{Diet} + EE_{Soil}$$

where:

EE_{Total} = Total exposure (mg/kg BW-day);
EE_{Diet} = Estimated exposure from diet (mg/kg BW-day); and
EE_{Soil} =Estimated exposure from soil ingestion (mg/kg BW-day)

It should also be noted that the Baseline ERA assumed COPC exposure from the drinking of surface water at the site to be negligible because COPC concentrations in surface water were several orders of magnitude lower than in soil, sediment, or food items. This assumption remains valid.

For each wildlife scenario shown in Table 5-15, COPC exposures to cadmium, fluoride and zinc were calculated separately, as shown in Table 5-18, for EE_{Diet} and EE_{Soil} as well as EE_{Total} for the Bannock Hills SW maximally impacted sagebrush habitat assumed to be representative of the undeveloped areas of the FMC Plant OU as well as EEs associated with the background sampling location, i.e. Ferry Butte. For chromium and vanadium, EE_{Diet} and EE_{Soil} as well as EE_{Total} were calculated separately for each wildlife scenario using RI data obtained adjacent to the FMC Plant OU, and background levels developed by EPA from off-site RI subsurface soil data (see Table 2-8 of E&E [1996]). Note that, in some wildlife such as the sage grouse, the ingestion of soil represents the predominant exposure pathway.

5.7 Risk Characterization

Potential ecological risks in the undeveloped areas of the FMC Plant OU are developed in this section by comparing the estimates of exposure to the TRVs developed in Section 5-5. The significance of the risk estimates and their uncertainties are also presented in this section to provide a framework for interpreting the results.

5.7.1 Risk Estimates

Potential ecological risks in the undeveloped areas of the FMC Plant OU were developed for each COPC and measurement endpoint species. The risks are expressed as a hazard quotient, HQ_{Total}, and are estimated by comparing the estimated exposure for all pathways (EE_{Total}) or, in the case of terrestrial Plants, either the EPC_{Plant} or EPC_{PW}, to the TRV as follows:

Equation 5- 8

$$HQ_{Total} = EE_{Total} / TRV$$

where:

HQ_{Total} = COPC and endpoint species-specific hazard quotient for all pathways;
EE_{Total} = COPC and endpoint species-specific estimated exposure for all pathways or $EPC_{Plant/PW}$ in the case of terrestrial Plants; and
TRV = COPC and endpoint species-specific toxicity reference value.

A potential risk of adverse chronic effects resulting from exposure to a specific COPC is suggested when $HQ_{Total} > 1$. An HQ_{Total} above one however does not imply that there is a likely effect since the approach used herein was developed to be conservative. In such cases, a further evaluation of the assumptions in the risk calculation is necessary to evaluate the potential for adverse effects to occur.

Terrestrial HQs

The HQs for terrestrial plants in the sagebrush steppe habitat are shown in Table 5-19 for each COPC. The HQs are shown separately for the comparison of the plant-tissue based TRVs to measured plant concentrations in the case of cadmium, fluoride and zinc, and for the comparison of pore-water plant TRVs to modeled soil pore-water concentrations in the case of chromium and vanadium. Note that the HQ for fluoride in the washed sagebrush samples is not provided. Fluoride in the detergent used to wash the sagebrush invalidated the results.

The washed plant matter concentrations are likely to be more indicative of the current conditions since FMC ceased operations nearly two years ago; although fugitive dust and ongoing Simplot facility emissions still deposit onto aboveground plant surfaces. During the period that both facilities were operating, as measured during the RI, process and fugitive emissions represented approximately 7-23% of the total COPC plant matter concentration (Section 4.6 of the RI Report). Thus, the use of the unwashed plant tissue data likely overstates plant matter concentrations and therefore adds a measure of conservatism into the current assessment. This conservatism however is not included in the exposure estimates for chromium and vanadium, since comparison of soil pore-water concentrations to pore-water TRVs only accounts for toxic effects related to plant uptake (i.e., potential deposition of vanadium and chromium onto plant surfaces was not incorporated into the EPCs). Nevertheless, given that FMC ceased operating in 2001 and that intermittent deposition of fugitive dust emissions are likely significantly less than that of historical facility emissions, the comparison of soil pore-water concentrations to pore-water TRVs is appropriate.

As was the case in the Baseline ERA, only the fluoride HQ for terrestrial plants in the Bannock Hills area was greater than one. As described in Section 5.3, the Bannock Hills area data are considered to conservatively characterize the undeveloped portions of the FMC Plant OU. There were no HQ exceedences at the Ferry Butte background reference location.

Within the Baseline ERA, the estimated fluoride risks of 1.74 for sagebrush and 1.71 for thickspike wheatgrass were considered to only marginally exceed the target risk threshold. It was thereby concluded in the Baseline ERA that the plant communities may only be marginally affected and widespread population and community level effects would be unlikely. Since the fluoride risks are the same as those in the Baseline ERA, this same conclusion is appropriate for the undeveloped portions of the FMC Plant OU.

Mammalian HQs

As shown in Table 5-20, only the vanadium HQs exceeded one for the coyote and pygmy rabbit. The estimated risks, 1.33 for the coyote and 1.32 for the pygmy rabbit, are considered marginal. No population or community level effects are likely. While the special status designation of the pygmy rabbit is of concern, its food preference for big sagebrush, which is not present at the FMC Plant OU, and its habitat preference of dense tall shrubs that include big sagebrush (Heady et. al., 2001) makes it unlikely that pygmy rabbits would be present for a sufficient amount of time in the FMC Plant OU to be affected.

It is worth noting that, unlike the Baseline ERA, the fluoride HQ for the coyote was not elevated above one due to an updated fluoride TRV. None of the background COPC levels was found to exceed an HQ of one.

Avian HQs

Similar to the Baseline ERA, the fluoride HQ exceeded one for all avian receptors, as shown in Table 5-21, but not within the Ferry Butte background reference location. No other COPC HQs exceeded one and the level of exceedence in the fluoride HQ was the same as in the Baseline ERA.

As was the case in the Baseline ERA, the estimated fluoride risks for avian receptors are considered to only marginally exceed the risk threshold. The avian communities, while marginally at risk, are unlikely to experience population or community level effects.

5.7.2 Uncertainty Assessment

The principal uncertainties of the risk assessment are summarized in this section and, where feasible, an order of magnitude assessment of the uncertainties is provided.

COPC Selection

The Baseline ERA identified cadmium, fluoride and zinc as the COPCs within the sagebrush steppe habitat. For this current assessment, vanadium and chromium were added since both were found to be present above background levels and generic, risk-based screening criteria in RI surface soil samples collected adjacent to the undeveloped areas of the FMC Plant OU. Based on the screening of other contaminants detected in the sagebrush steppe habitat (as described in Section 5.3), there is little uncertainty that COPCs, other than the five considered in this assessment, warranted quantitative evaluation.

Endpoint Selection

As is generally the case in an ERA, it is not possible to evaluate all species and communities in a specific habitat, particularly if there is insufficient toxicological information. The measurement endpoint species selected for evaluation represent the broadest and most common species of the possible range of receptors in the sagebrush steppe habitat, as well as special status species. The assessment should therefore be sufficient for regulatory decision-making.

Wildlife TRVs

Numerous uncertainties are associated with the derivation of TRVs for the measurement endpoint species. The Toxicity Benchmarks (TBs), from which the TRVs for the measurement endpoint species are developed, usually incorporate a number of assumptions, for which there are associated uncertainties. The TBs often include uncertainty factors (UFs) to account for deficiencies in the laboratory study data (e.g., to extrapolate from a short-term to a chronic exposure). Furthermore, if a study does not provide the weight of the test species, or the rate of chemical intake, assumptions are made regarding these parameters (i.e., default values are used) to calculate the TB, which is expressed in terms of a daily dose (mg/kg BW/day)

Not all sources of uncertainty are incorporated into the development of TRVs. For example, the laboratory studies used as a basis for generating TBs may not accurately represent the complexities of potential exposure under field conditions. The vehicle that was used to administer the test substance in the laboratory study (e.g., intubation) may not correspond to the medium through which wildlife species are exposed in the field (e.g., diet). The dosing of test animals by use of highly soluble salts in drinking water may overestimate dose compared to the same salt administered in food. The chemical present at the site may be in a less soluble form

than that used in the laboratory study. Additionally, toxicological studies on which TBs are based deal with a single chemical; effects of simultaneous exposure to multiple contaminants are not addressed.

It is also important to note that although separate TBs are derived for mammalian and avian species, important differences in sensitivity may still exist between members within each of these classes due to physiological differences; these differences are not typically accounted for in the development of TRVs. Furthermore, uncertainty exists in the development of TRVs for the measurement endpoint species based on the TBs for the target species of the toxicity studies.

In this assessment, TRVs were developed using the approach in the Baseline ERA in which species-specific TRVs were developed by adjusting the TBs for differences in body weight between test species and endpoint species. Such allometric scaling is common and may vary directly with body weight or with body weight to some power. In the Baseline ERA, the allometric scaling used was the ratio of body weights (test species/wildlife species) to the power of one-third. As an illustration of the scaling consider that the mammalian fluoride TB of 31.37 mg/kg/day was based on the mink, whose body weight is approximately 1 kg. Applying the Baseline ERA body weight scaling for the measurement endpoint species representing the lower- and upper-bound range in body size, [i.e., the Townsend's big-eared bat (9 g) and the mule deer (87.2 kg)], resulted in TRVs of 150.8 and 7.07 mg/kg/day for the bat and mule deer, respectively. As noted in Sample et al. (1996), smaller animals are usually more resistant to toxins because of their higher metabolism, which can increase the rate of detoxification; however, if the chemical is metabolized to a more toxic form, the smaller organism may be more sensitive.

Forgoing the body weight scaling and thereby applying the TB for the test species to all endpoint species would result in the same TRV for all species. The use of the same TRV implies a much lower tolerance in smaller species and a much higher tolerance in larger species compared to the TRVs derived using the body weight scaling. Although, as noted above, smaller animals may be more sensitive than larger animals to a given substance, this is not commonly the case. A quantitative assessment of the TRV scaling on the risk characterization is discussed later in this uncertainty section.

Plant TRVs

With respect to terrestrial plants, plant tissue-based TRVs, rather than bulk soil or soil pore-water TRVs, were used to evaluate potential effects to terrestrial plants for cadmium, fluoride, and zinc. This approach has the least uncertainty because it involves the direct comparison of the measured plant tissue concentrations in sagebrush and thickspike wheatgrass to plant tissue concentration benchmarks known to cause toxic effects. Furthermore, because soil geochemistry plays a significant role in determining the extent to which chemicals (particularly inorganics) are taken up by plants, use of bulk soil or soil pore-water based TRVs would be counter-productive since such a comparison would add a considerable degree of uncertainty.

With respect to vanadium and chromium, plant tissue data were not available. Consequently, an evaluation of the potential risk associated with vanadium and chromium in soils required the development of soil-based plant TRVs. As recommended by Efroymson et al. (1997), bulk soil TRVs were considered "a poor measure of risk to the plant community at the site" since the bulk soil TRVs for chromium and vanadium were both more than twenty-fold lower than the chromium and vanadium background concentrations. The Efroymson et al. bulk soil TRVs are most likely poor predictors of risk in the study because the geochemistry of regional soils, i.e.,

pH, Eh, as well as the adsorptive capacity of various mineralogical components reduce the bioavailability of these inorganics. Consequently, because plant exposure is via soil pore-water (Efroymson et al, 1997), using soil pore-water TRVs for vanadium and chromium reduces uncertainties and provides the most reliable and accurate basis for evaluating risk to terrestrial plants in the undeveloped portions of the FMC Plant OU.

Exposure Assessment: Plant Exposure Estimates

The washed vegetation samples obtained during the RI provide a reasonable estimate of the biologically-incorporated plant tissue concentrations of cadmium and zinc; the washed fluoride Plant samples were not useable because of the fluoride contained in the detergent used to wash the vegetation and the elevated fluoride detection limits. Based on the cadmium and zinc samples that indicated that the washed foliage concentrations were 13-22% lower than those of the unwashed samples, the estimated fluoride risks are likely to be lower than indicated by the risks associated with unwashed vegetation.

Because chromium and vanadium were not considered COPCs within the Baseline ERA, these COPCs were not analyzed in the sampled vegetation. Consequently, the pore water concentration of site soils was estimated to obtain plant exposures for these COPCs. By inclusion of soil pH, the plant exposure estimates using pore-water concentrations were considered an appropriate means to reduce uncertainty associated with the alkaline nature of site soils, particularly for chromium in which soil pH was expressly included in the soil-water partition coefficient, i.e. the K_d value.

The soil pore-water concentrations were estimated from the five RI surface soil samples collected adjacent to the undeveloped portions of the FMC Plant OU (Table 5-12). For this assessment, the 95% UCL on the arithmetic mean of these samples was used as the soil exposure point concentration (EPC). While two of the offsite samples (225-2A and 225-2B) exceeded the derived vanadium and chromium EPCs, a comparison of the locations of these two samples to land use on the FMC Plant OU (Figure 5-1) shows that both are situated in closer proximity to disturbed areas of the FMC Plant OU than the other off-site RI samples. Therefore, it is considered likely that these two samples were affected by fugitive dust emissions from historical operations (e.g., slag pile), and that the lower chromium and vanadium concentrations within other RI surface soil samples located adjacent to the undeveloped areas of the FMC Plant OU, but further away from historical fugitive sources, are more representative of concentrations within these undeveloped areas. This point is supported by the vanadium and chromium surface soil concentration isopleths, shown in Figure 5-2 and Figure 5-3, which demonstrate that the majority of the undeveloped areas of the FMC Plant OU contain surface soil concentrations below regional background levels. Despite the fact that the 95% UCL of the five RI surface soil samples for vanadium and chromium collected adjacent to the undeveloped portions of the FMC Plant OU (i.e., 76.13 and 86.4 mg/kg, respectively) are likely conservative characterizations of exposure, the maximum concentrations are used to develop the most conservative estimate of risk when combined with the non-scaled TRVs discussed in the previous sections for the purpose of the quantitative uncertainty assessment discussed below.

As shown in Table 5-12, the maximum concentrations for chromium and vanadium are 87.7 mg/kg and 95.8 mg/kg, respectively, and are less than 15% greater than the 95% UCLs. The use of the maximum off-site concentration to characterize conditions on over 500 acres of undeveloped land on the FMC Plant OU is highly conservative, especially given the fact that the

western and southern undeveloped areas are non-contiguous and lie in different directions from the sources of historical plant emissions.

Exposure Assessment: Predator Exposure Estimates

In general, the exposure estimates were developed to be conservative as described within the Baseline ERA. Because of the exceedences of a HQ of one, it is most appropriate to review the major assumptions and the degree to which uncertainty within these exposure assumptions may have contributed to the exceedences.

With respect to fluoride in the raptors, 100% of the dietary intake is assumed to be comprised of small mammals, and these receptors are also assumed to incidentally ingest an amount of soil equivalent to 2% of their dietary intake. As cited in the Baseline ERA, greater than 90% of the fluoride in mouse tissues is incorporated in bone, and bioavailability of fluoride in bone is <50% (NRC 1993). While the bioavailability in the bone suggests that the HQ may be overestimated by 25%, spike recoveries in small mammals were less than 50% thereby negating any correction to account for bone fluoride bioavailability. While no quantitative estimate of the bioavailable fraction from soil was made in the Baseline ERA, it was acknowledged that the bioavailability is likely less than 100%. Although nearly 20% of the total fluoride intake by raptors is due to incidental ingestion of soil, incorporating bioavailability of fluoride from soils will not lower the HQ to less than one.

To evaluate the uncertainty of fluoride HQs in the horned lark and sage grouse, the Baseline ERA uncertainty assessment lowered the forb concentrations (representing seed concentrations) ten-fold because of the conservative assumption equating seed concentration (and insect concentrations) to thickspike wheatgrass. However, the high frequency of J qualified plant fluoride data, poor spike recovery, and elevated detection limits were addressed in the Baseline ERA uncertainty section by doubling the fluoride plant concentrations, thereby offsetting some of the reduction of the horned lark HQ while elevating the fluoride HQ for the sage grouse. However, consideration of the bioavailable fraction of fluoride in soils would likely lower the fluoride HQs for the horned lark and the sage grouse, particularly since the sage grouse is assumed to obtain nearly 75% of its fluoride intake from incidental ingestion of soils. Nonetheless, the fluoride HQ would remain above one for both species indicating a marginal risk.

There is uncertainty associated with the vanadium and chromium dietary pathways because they are dependent on various BCFs. The use of literature-based uptake factors may be overly conservative, thereby overestimating the risks. The uncertainty in the plant ingestion pathway stems, in part, from the fact that BCFs for plant uptake are not species-specific, do not account for the effect of soil geochemistry on plant uptake (e.g., pH), and do not differentiate between various plant parts (e.g., shoots, leaves, seeds, berries). Thus, although the receptors tend to eat different types and parts of plants, prediction of the various plant tissue concentrations were conservatively assumed to be equivalent. Additionally, deposition of fugitive dust emissions (and ongoing Simplot facility emissions which are beyond the scope of the SRI/SFS of the FMC Plant OU) could potentially contribute to aboveground plant concentrations. For the prey ingestion pathways, deer mouse tissue concentrations were derived from soil vanadium and chromium concentrations rather than actual field measurements. The degree to which the deer mouse may bioconcentrate these two COPCs was conservatively estimated.

The vanadium exceedences of a HQ of one in coyote (1.33) and pygmy rabbit (1.32) likely represent an overestimate of the bioavailable fraction of vanadium in soil both in estimating plant uptake and through incidental ingestion. In the coyote, the incidental ingestion of soil accounts for more than 94% of the ingested vanadium while in the pygmy rabbit it represents more than 78%. The laboratory study on which the mammalian TRV for vanadium was based (i.e., the critical study) used a solution of sodium metavanadate (sodium vanadate; $NaVO_3$), a relatively bioavailable form of vanadium (Domingo et al., 1986) which was administered through daily intragastric dosing (gavage) that tends to minimize the interaction of the test substance with dietary components. In the site area, the potential source of vanadium is likely phosphate rock from the Phosphoria Formation that was processed at the Plant. In weathered rock, more than 60% of the vanadium is present as insoluble (residual) oxides and silicates and either soluble oxyhydroxides or vanadium-bearing phosphates (J.R. Hein, personal communication). Therefore, although it is difficult to predict the site-specific bioavailability of vanadium from soil, it is likely that a significant fraction of the vanadium will be present as chemical species that are less bioavailable (e.g., as insoluble oxides) than the relatively bioavailable sodium metavanadate that was used in the critical study. In addition, it is likely that some of the vanadium in soil may interact with dietary components, further limiting its availability through ingestion in comparison to the intragastric dosing performed in the critical study.

A reduced bioavailability of vanadium in comparison to the sodium metavanadate of the critical toxicity study has been demonstrated in a study by Boyce et al. (1996). In this study in which the bioavailability of vanadium in site soil (at an alloy production and chemical manufacturing facility) was compared with its bioavailability in the dosing media in critical studies, the bioavailability in site soil was decreased by a factor of 2.5 to 7 (Boyce et al., 1996). It is also likely that the net bioavailability of vanadium in soils at the FMC Plant OU is less than that of vanadium in the critical toxicity study (Domingo et al., 1986), tending to overestimate risk to wildlife through soil ingestion.

Additional conservative assumptions are contained within the exposure estimates. In particular, an assumed Site Use Factor (SUF) and Exposure Duration (ED) of one for most species is likely overly conservative. As mentioned above, the pygmy rabbit prefers big sagebrush, which is not present on the FMC Plant OU. Consequently, the SUF and ED should be considerably lower than one, if it were to be assumed that pygmy rabbits reside near the area, even though it is not representative of the pygmy rabbit's preferred habitat. SUF and ED should also be lowered significantly for several other species based on their home range. For example, the entire 500 acres of the undeveloped areas of the FMC Plant OU represents less than 12% of the home ranges of the raptors, coyote and bat and 56% of the home range of the sage grouse.

Quantitative Uncertainty Assessment

Two potential concerns raised by EPA during this assessment were the use of the TRV body weight scaling factor and the characterization of vanadium and chromium using the 95% UCL of the five RI surface soil samples collected adjacent to the undeveloped portions of the FMC Plant OU. Consequently, a quantitative assessment of uncertainty was undertaken by using the maximum offsite vanadium and chromium soil concentrations, along with TRVs without the body weight scaling.

The greatest impact was associated with forgoing the TRV body weight scaling. As expected based on the TRV discussions above, HQs were lowered for larger measurement endpoint

species and increased for smaller species. Within mammals, eliminating the body weight scaling reduced the vanadium HQ for the coyote from 1.33 to 0.39, despite the use of the maximum vanadium concentration. However, the vanadium HQ for the Townsend's big-eared bat and the deer mouse increased from 0.54 and 0.75 to 1.85 and 1.92, respectively. Additionally, the vanadium HQ for the pygmy rabbit increased by 13% from 1.32 to 1.49, primarily due to the higher concentration since the TRV was relatively unaffected (the body weight of the test species was very similar).

The exceedances of a HQ of one (with a maximum of 1.92) as listed above are considered marginal and unlikely to cause population or community level effects. As noted earlier, the preferred habitat of the pygmy rabbit is not present within the FMC Plant OU. As a result, the pygmy rabbit is unlikely to spend much time in the area and its exposure is expected to be significantly less than that assumed (i.e., SUF of one) in the calculation of the HQ. With regard to the Townsend's big-eared bat, the 500 acres of undeveloped land of the FMC Plant OU represents less than five percent of its home range (Table 5-15). Consequently, exposures to the Townsend's big-eared bat are also expected to be far less than that assumed (i.e., an SUF of one) in calculating the HQ. Therefore, no population or community level effects are likely.

Furthermore, as noted earlier, the vanadium HQs for the pygmy rabbit, Townsend's big-eared bat and deer mouse reflect an overestimate of the bioavailable fraction of vanadium in soil, both to plants through root uptake and directly to these receptors through incidental soil ingestion. Incidentally ingested vanadium, which represents approximately 78% of the total ingested vanadium for each of the species identified above, is likely to be significantly less bioavailable, possibly by a factor of 2.5 to 7-fold, than the relatively bioavailable form of vanadium used in the TB study (Boyce et al., 1996).

It is also worth noting that a more recent analysis of the body weight scaling factor developed by Sample and Arenal (1999) from acute toxicity data, and used to assess chronic exposures (Sample and Suter, 2002), would result in scaling factors more similar to the Baseline ERA when considering the results based on chemical class, i.e., for inorganics only. Based on data for inorganics, the mammalian scaling factor would be 0.2 thereby lowering the HQ for the Townsend's big-eared bat to less than one and the HQ of the deer mouse from 1.92 to 1.16.

Consequently, the quantitative assessment of the uncertainties associated with the body weight scaling methodology and the characterization of the vanadium and chromium exposures in the undeveloped portions of the FMC Plant OU have not resulted in any significant change in the findings of the risk assessment for mammalian species.

With respect to avian species, fluoride remained the only COPC with HQs above one despite forgoing the body weight scaling. Because TRVs were lowered for smaller avian species and increased for larger ones, risks were lowered to below one for the bald eagle, and nearly halved for the sage grouse (from 2.97 to 1.24) and the red-tailed hawk (from 2.31 to 1.29). However, the risk to the small horned lark was increased from 2.01 to 3.61, the highest projected risk. Using an inorganic scaling factor based on more recent data (Sample and Arenal, 1999) would result in risks that fall within the HQ ranges described above.

In summary, with the exception of the fluoride HQ for the horned lark, risks to avian species were generally lowered by eliminating the body weight scaling factor and hence do not effect the general findings of the risk assessment.

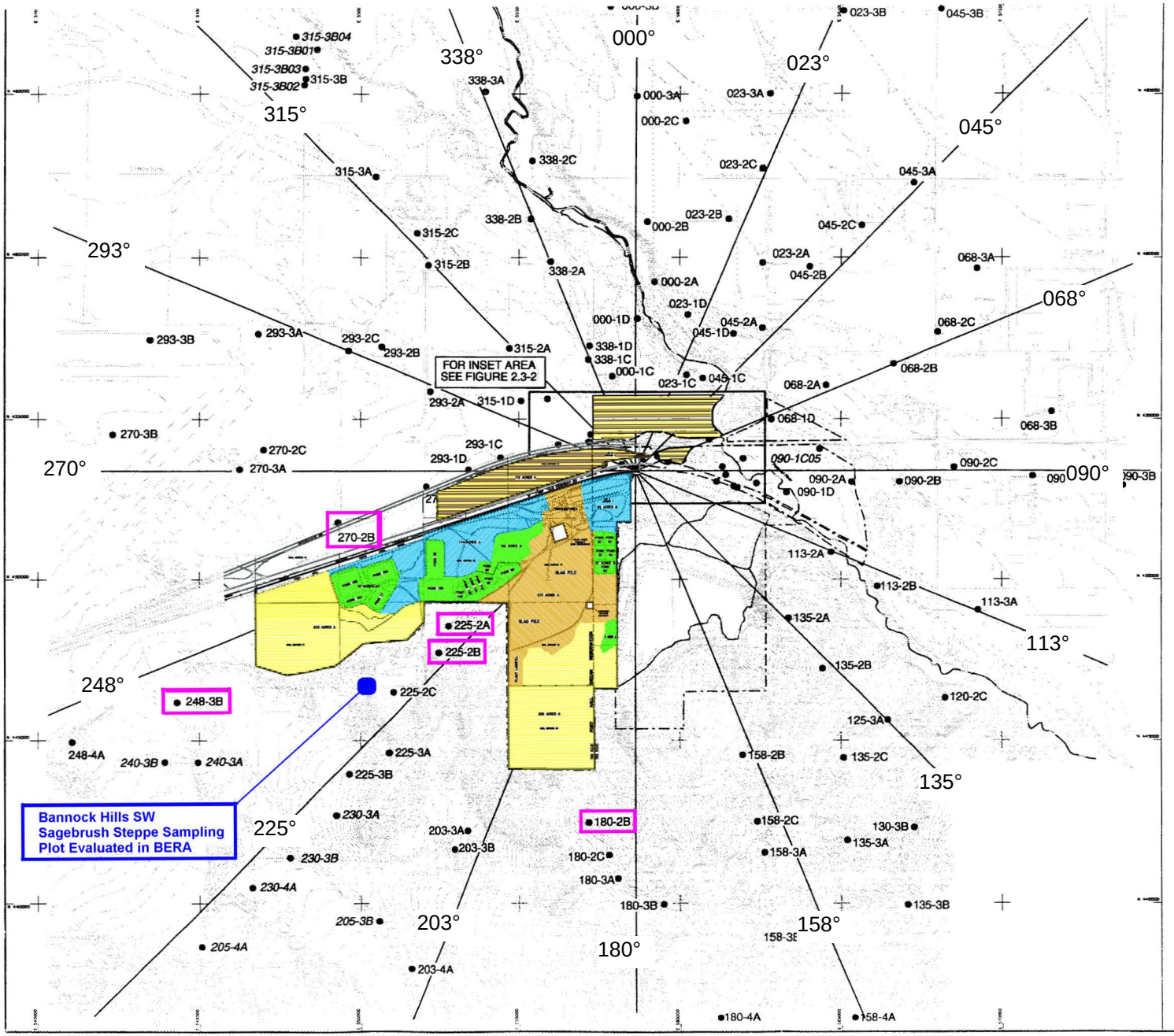
5.8 Conclusion

The conservative nature of the risk characterization is likely to have resulted in an overestimate of the potential adverse ecological effects of the COPCs. Nonetheless, despite the magnitude of the uncertainties associated with the fluoride risk estimates, marginal risks are estimated to remain for terrestrial plants as well as the sage grouse and horned lark. These risks nonetheless are likely to have only a marginal likelihood of resulting in an adverse effect on population size or community composition of species in the area since, as cited from the Baseline ERA: (1) the estimated risks of fluoride are only marginally above the threshold for toxic effects, (2) the potential avian risks were quantified for effects on individual organisms using conservative assumptions to account for uncertainty, and (3) the upland species most likely to be impacted occur commonly throughout the region. Nonetheless, the Baseline ERA noted that ongoing deposition of fluoride from facility operations has the potential to result in elevated risks and may require ongoing monitoring. However, it should be noted that since the Baseline ERA was performed FMC has ceased operations. Therefore, the only current ongoing emission source of fluoride is Simplot, which was also the largest source of airborne fluoride emissions during the time of the RI.

With respect to vanadium, the HQs minimally exceeded one (1.32 for the pygmy rabbit and 1.33 for the coyote). A reduction in the bioavailable fraction in soils to 75% for the coyote and 69% in the pygmy rabbit would lower the HQ to below a level of concern. Based on the geochemistry of soils on the FMC Plant OU, these reductions are likely conservative; the relative bioavailable fraction is likely to be lower. Additionally, the likely reduction in plant uptake due to the adsorptive capacity and alkaline nature of the soils in the area has not been incorporated into the analysis. Furthermore, the SUF for the coyote greatly overestimates risk since the coyote home range is nearly 14 times greater than the undeveloped areas of the FMC Plant OU. Similarly, the assumed SUF and ED of one is too high for pygmy rabbits because the undeveloped areas of the FMC Plant OU do not provide suitable habitat for this receptor (i.e, there is an absence of big sagebrush and tall dense shrubs).

Confidence in the results of the risk assessment is considered to be high for the COPCs, cadmium, fluoride and zinc, for which plant and small mammal tissue data were obtained during the RI. While there is more uncertainty in the estimates for vanadium and chromium, the assumptions used in the assessment were conservative. Despite the conservative nature of the assessment, only marginal exceedances of a vanadium HQ of one were determined for the coyote and pygmy rabbit receptors. Moreover, if soil bioavailability were to be considered or the SUF lowered to represent likely site usage, the vanadium HQ for the coyote and pygmy rabbit would be significantly less than one.

Figure 5-1



LAND USAGE

- Undeveloped area of the FMC OU included in the CERCLA ERA
- Undisturbed/undeveloped areas of the FMC OU
- Disturbed and/or developed areas of the FMC OU
- RI surface soil samples located adjacent to undeveloped areas of the FMC OU

Legend:

- 315-3B — Phase I soil sample location and designation
- 315-3B01 — Phase II soil sample location and designation
- EMF Property Lines

000° = 000 degree RI surface soil sample transect

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Surface Soil Sample Locations

Job Number	Drawing No.	Rev.
21372	FIGURE 4.3-18A	

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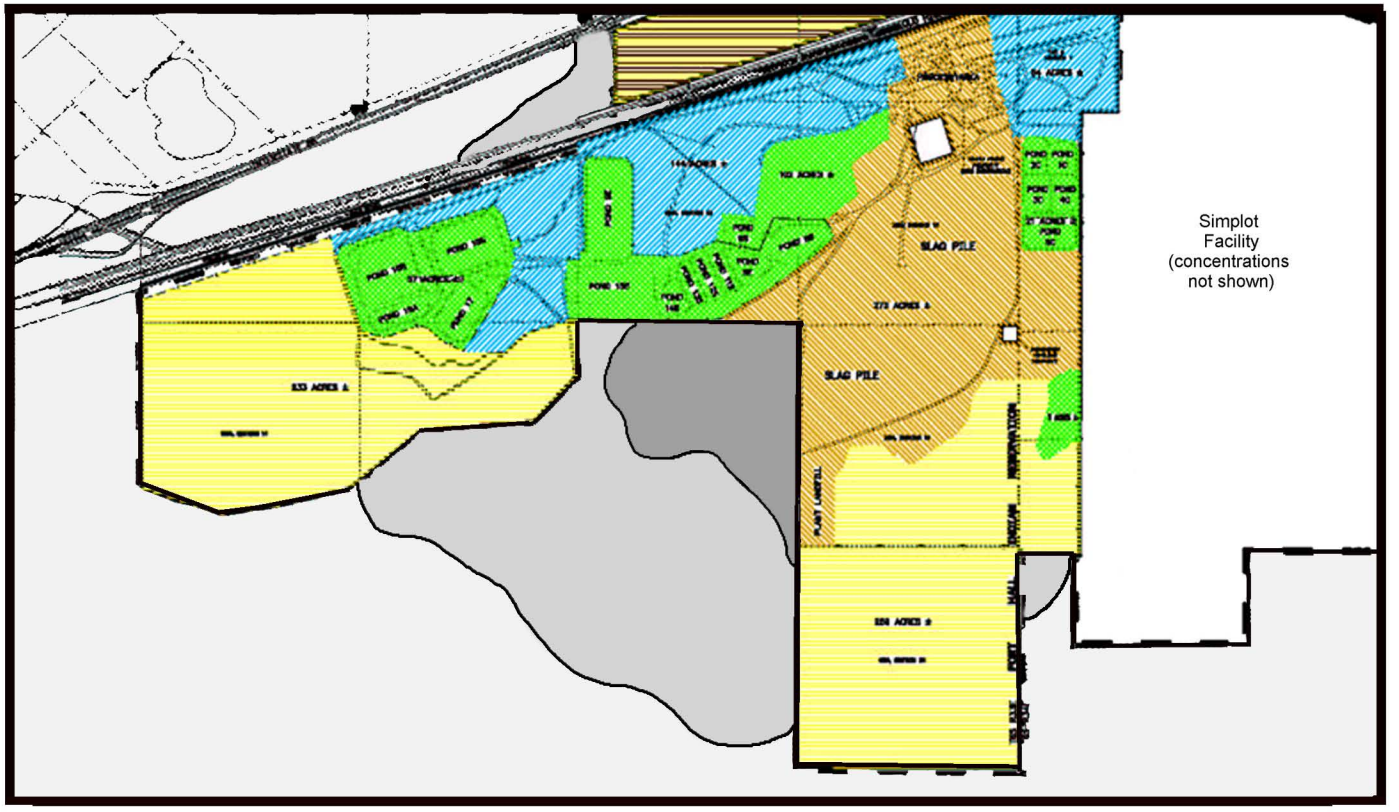
Figure 5-2

Vanadium Concentrations in Surface Soils



LAND USAGE

- Undeveloped area of the FMC OU included in the CERCLA ERA
- Undisturbed/undeveloped areas of the FMC OU
- Disturbed and/or developed areas of the FMC OU

Key to Vanadium (mg/kg)

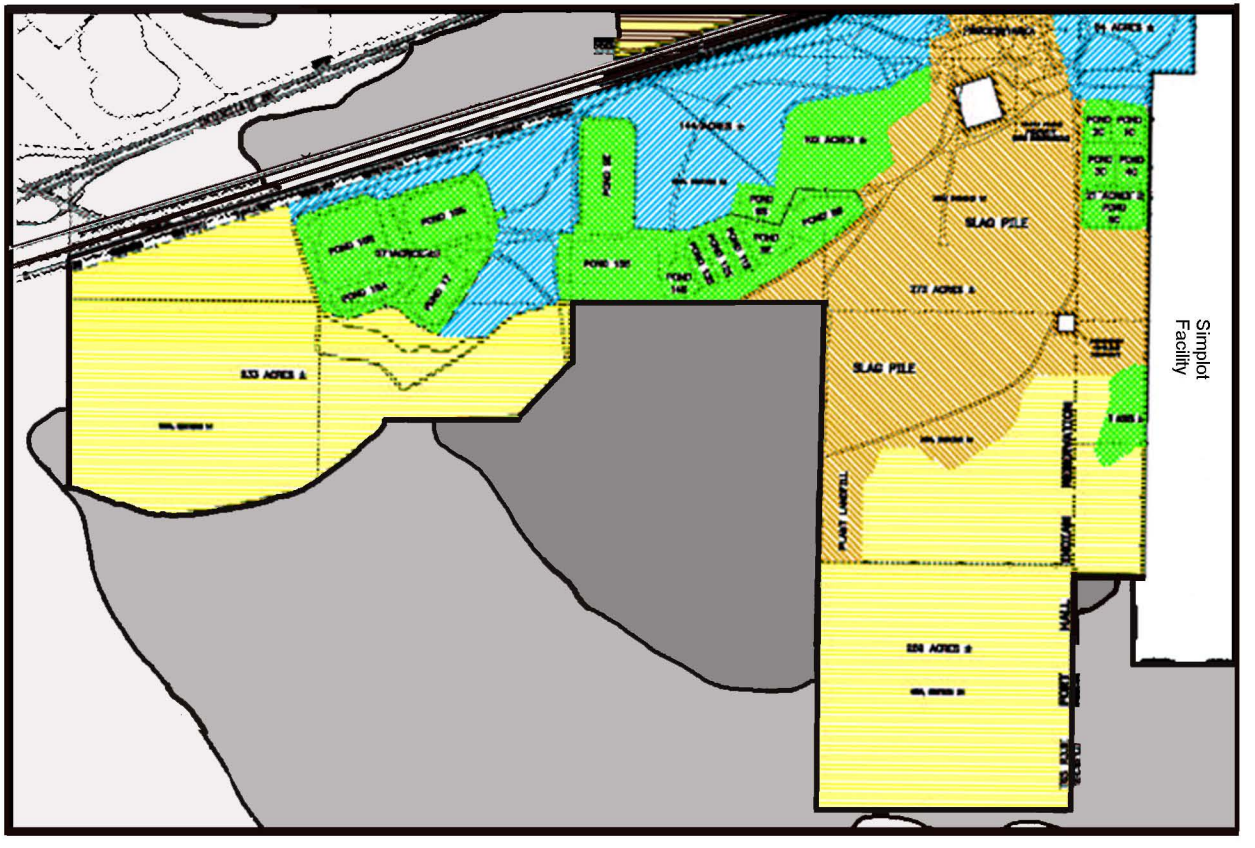
- 90 to <180
- 45.4 to <90
- <45.4 (Background)

N

Regional background concentration = 45.4 mg/kg

Figure 5-3

Chromium Concentrations in Surface Soils



LAND USAGE

- Undeveloped area of the FMC OU included in the CERCLA ERA
- Undisturbed/undeveloped areas of the FMC OU
- Disturbed and/or developed areas of the FMC OU

Key to Chromium (mg/kg)

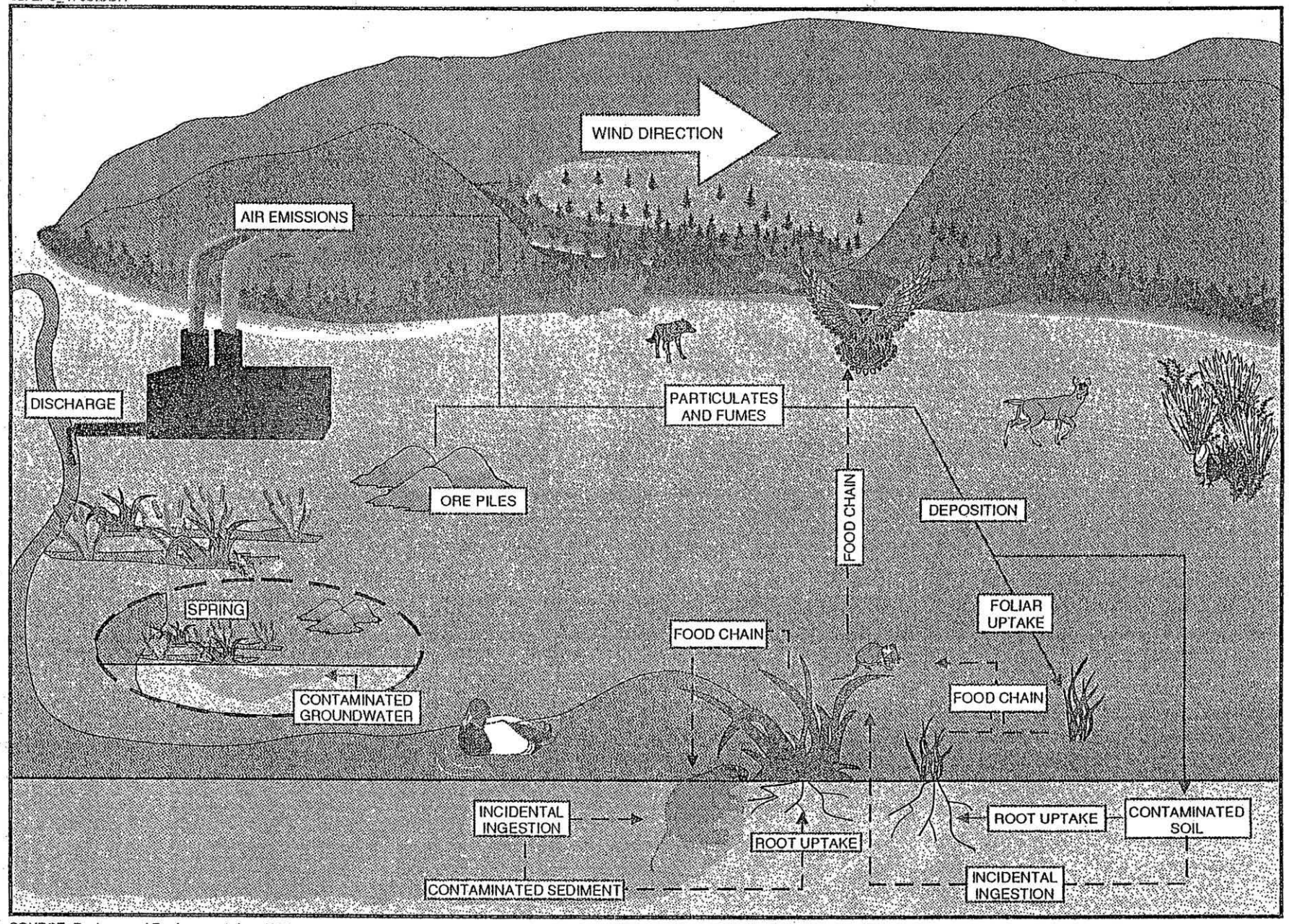
- 55 to <90
- 27.5 to <55
- <27.5 (Background)

N

Regional background concentration = 27.5 mg/kg

Figure 5-4
Potential Exposure Pathways For Ecological Receptors at the EMF Site (Figure 2-2 of the Baseline ERA)

02: ZP3_4709.CDR



SOURCE: Ecology and Environment, Inc. 1995

Table 5-1
Comparison of Surface Soil Concentrations at the Bannock Hills SW Sagebrush Steppe Sampling Plot to Concentrations in Off-site RI Surface Soil Samples Located Adjacent to Undeveloped Portions of the FMC Site

	Cadmium		Fluoride		Zinc	
	Detected Concentration* (mg/kg)	Mean Conc. (mg/kg)	Detected Concentration* (mg/kg)	Mean Conc. (mg/kg)	Detected Concentration* (mg/kg)	Mean Conc. (mg/kg)
EMF ERA (Terrestrial Investigations)						
Bannock Hills SW (Sagebrush Steppe)	18.6 – 34.1	27.2	1100 - 1840	1454	183 - 342	256
EMF RI Offsite Surface Soil Samples						
270-2B	1.3	-	530	-	79.9	-
248-3B	3.8	-	463	-	61.9	-
225-2A	26.2	-	1590	-	204	-
225-2B	28.1	-	1680	-	209	-
180-2B	2.9	-	433	-	75.8	-

*The range of concentrations is shown for all ten samples collected at the Bannock Hills SW Sagebrush Steppe sampling plot.

Table 5-2
Comparison of Surface Soil Concentrations in Off-site RI Surface Soil Samples Located Adjacent to Undeveloped Portions of the FMC Site to Background and Terrestrial Risk-Based Screening Levels

	Chromium (mg/kg)	Vanadium (mg/kg)
EMF Background Levels (ERA Table A-4 and A-1)		
Background	27.5	45.4
Background range	4.9 – 166	19.3 - 220
Risk-Based Screening Levels (1)		
Screening Level	5	2
EMF RI Offsite Surface Soil Samples		
270-2B	**21.9**	**31.5**
248-3B	**22**	**35.5**
225-2A	**79.5**	**95.8**
225-2B	**87.7**	**91.7**
180-2B	**14.3**	**26.1**

(1) Lowest risk-based screening levels from Efroymson et al. (1997). Chromium value from EPA (2000)

Off-site surface soil concentration exceeds background
Off-site surface soil concentration exceeds risk-based screening level but not background level
Off-site surface soil concentration exceeds background and risk-based screening level

Table 5-3
Sagebrush Steppe and Riparian Habitats Assessment Endpoint Species (Table 2-7 of the Baseline ERA)

SAGEBRUSH STEPPE AND RIPARIAN HABITATS ASSESSMENT ENDPOINT SPECIES				
Assessment Endpoint Species/Functional Group	**Ecological Relevance**	**Regulatory or Social Significance**	**Susceptibility to COPCs**	**Measurability or Predictability**
Native upland shrubs and grasses	Provide nesting sites, food, and cover for wildlife.	Potential importance as rangeland for grazing livestock. Habitat for game animals and other wildlife.	Vulnerable to exposure through root uptake and foliar deposition.	Levels of COPCs in soil and plant tissue were measured and can be related to published toxicity benchmarks for crops or native plants.
Riparian shrubs	Provide nesting sites, food, and cover for wildlife.	Habitat for game animals and other wildlife.	Vulnerable to exposure through root uptake and foliar deposition.	Levels of COPCs in soil and plant tissue were measured and can be related to published toxicity benchmarks for crops or native plants.
Small mammals	Base of food chain for raptors and carnivores. Occur in wide range of habitats, including disturbed areas.	Small mammals are important as a community because of significance as a food item for other species. The pygmy rabbit is a federal C2 species.	Susceptible to direct exposure due to burrowing habits, soil ingestion, consumption of contaminated food.	Levels of contaminants in soil and food items were measured and can be related to toxicity benchmarks derived from the literature.
Upland game birds	Important breeding wildlife in sagebrush steppe.	Game animals.	May ingest contaminated soil or food items.	Levels of contaminants in soil and food items were measured and can be related to toxicity benchmarks derived from the literature.

(From Table 2-7 of E&E 1995.)

Table 5-3
Sagebrush Steppe and Riparian Habitats Assessment Endpoint Species
(Table 2-7 of the Baseline ERA)

SAGEBRUSH STEPPE AND RIPARIAN HABITATS ASSESSMENT ENDPOINT SPECIES				
Assessment Endpoint Species/Functional Group	**Ecological Relevance**	**Regulatory or Social Significance**	**Susceptibility to COPCs**	**Measurability or Predictability**
Large herbivorous mammals	Significant consumers of vegetation in terms of biomass and abundance.	Game animals.	May ingest contaminated soil or forage.	Levels of contaminants in soil and food items were measured and can be related to toxicity benchmarks derived from the literature.
Raptors	Top avian predator in terrestrial food chain.	Of recreational and aesthetic importance. Several species of raptors are state species of special concern. Federally protected under the Migratory Bird Treaty Act and Eagle Protection Act.	Could be exposed through consumption of contaminated food items.	Levels of contaminants in soil and food items were measured and can be related to toxicity benchmarks derived from the literature.
Mammalian carnivores	Top mammalian predator in terrestrial food chain.	Of recreational and aesthetic importance. The wolverine is a federal C2 species.	Could be exposed through consumption of contaminated food items.	Levels of contaminants in soil and food items were measured and can be related to toxicity benchmarks derived from the literature.
Songbirds	Common breeding wildlife in riparian and upland habitats.	Federally protected under the Migratory Bird Treaty Act. Songbirds are classified as protected nongame wildlife species under Idaho law.	May ingest contaminated food or soil.	Levels of contaminants in soil and food items were measured and can be related to toxicity benchmarks derived from the literature.

(From Table 2-7 of E&E 1995.)

Table 5-4
Sagebrush Steppe and Riparian Habitats Measurement Endpoint Species
(Table 2-9 of the Baseline ERA)

SAGEBRUSH STEPPE AND RIPARIAN HABITATS MEASUREMENT ENDPOINT SPECIES			
Measurement Endpoint Species	Relevance to Assessment Endpoints	Responsiveness and Diagnostic Attributes	East of Measurement
Thickspike wheatgrass, sagebrush	Dominant species of native shrubs and grasses in the sagebrush steppe habitat.	Rooting plants are in direct contact with contaminated soil and can be sensitive indicators of toxic metal contamination.	Published toxicological information is available for similar species of grasses and shrubs. Levels of COPCs in tissues were measured.
Russian olive	Common species of shrub in the riparian habitat.	Rooting plants are in direct contact with contaminated soil and can be sensitive indicators of toxic metal contamination.	Published toxicological information is available for similar species of shrubs. Tissue levels of COPCs were measured.
Deer mouse	Most common small mammal in study area.	Representative of exposure for small mammals. Prolific breeding and short life span allow for rapid response to COPCs.	Extensive toxicological database available for related species of rodents. Tissue levels of COPCs were measured.
Sage grouse	Important upland game bird.	Feeds mainly on sagebrush foliage.	Can predict dietary intake from measured soil and plant tissue concentrations.
Mule deer	Common large herbivorous mammal.	Migratory animal winters in the sagebrush steppe. Ungulates are sensitive to the effects of fluoride, possibly because of the long period of time food is held in their digestive tracts.	Can predict dietary intake from measured soil and plant tissue concentrations.

(From Table 2-9 of E&E 1995.)

Table 5-4
Sagebrush Steppe and Riparian Habitats Measurement Endpoint Species
(Table 2-9 of the Baseline ERA)

SAGEBRUSH STEPPE AND RIPARIAN HABITATS MEASUREMENT ENDPOINT SPECIES			
Measurement Endpoint Species	**Relevance to Assessment Endpoints**	**Responsiveness and Diagnostic Attributes**	**East of Measurement**
Red-tailed hawk	Common raptor.	Consumption of small vertebrates as primary food item and year-round presence in study area are representative of worst-case exposure for raptors.	Can predict dietary intake from measured mouse tissue concentrations.
Coyote	Common carnivore.	Consumption of small vertebrates as primary food item and year-round presence in study area are representative of worst-case exposure for terrestrial carnivores.	Cam predict dietary intake from measured mouse tissue concentration.
Cedar waxwing	Common songbird of the riparian habitat.	Feeds mainly on fruits.	Can predict dietary intake from measured soil and plant tissue concentrations.
Horned lark	Common songbird of the sagebrush steppe habitat.	Feeds mainly on seeds; present in the study area year-round.	Can predict dietary intake from measured soil and plant tissue concentrations.

(From Table 2-9 of E&E 1995.)

Table 5-5a
Toxicity Reference Values for Plant Tissues (mg/kg DW)

Chemical	Deficient	Sufficient of Normal	Critical Concentration in Sensitive Species	Excessive or Toxic	Selected TRV
Cadmium	-	0.05 - 0.2	5 - 10	5 - 30	5
Fluoride	-	5 - 30	-	50 - 500	50
Zinc	10 - 20	27 - 150	150 - 200	100 - 400	150

Source: Kabata-Pendias and Pendias (2000)

Table 5-5b
Soil Solution Toxicity Reference Values for Plants (mg/L) [(a)]

Chemical	Recommended Toxicological Benchmark	Level of Confidence
Chromium	0.05	Moderate
Vanadium	0.2	Low

[a)] Based on soil solution phytotoxicity screening benchmarks cited in Efroymson, R.A., et al. (1997).

Table 5-6
Derivation of Test Species Toxicity Benchmarks (TBs)

Chemical	Test Species	Form	Exposure Duration and Exposure Route	Endpoint and Concentration		Critical Effects(s)	Test Species TB[1] (mg/kg/day)	Test Species Body Weight[2] (kg)	Study Reference[3]
Cadmium	Mallard duck	cadmium chloride	90 days; diet	NOAEL	15.2 ppm	Reproduction	1.45	1.153	White and Finley, 1978
	Rat	cadmium chloride	age 6 weeks through mating and gestation; oral gavage	NOAEL	1 mg/kg/day	Reproduction	1.0	0.303	Sutou et al., 1980
Fluoride	Screech owl	sodium fluoride	5-6 months; diet	NOAEL	56.5 ppm	Reproduction	7.8	0.181	Pattee et al., 1988
	Mink	sodium fluoride	382 days; diet	NOAEL	229 ppm	Reproduction	31.37	1.0	Aulerich et al., 1987
Zinc	White leghorn hen	zinc sulfate	44 weeks; diet	NOAEL	228 ppm	Reproduction	14.5	1.935	Stahl et al., 1990
	Rat	zinc oxide	days 1-16 of gestation; diet	NOAEL	2000 ppm	Reproduction	160	0.35	Schlicker and Cox, 1968
Chromium	Black duck	chromium potassium sulfate	10 months; diet	NOAEL	10 ppm	Reproduction	1	1.25	Haseltine et al., 1985
	Rat	chromic oxide	90 days and 2 years; diet	NOAEL	50,000 ppm	Reproduction; longevity	2737	0.35	Ivankovic and Preussman, 1975
Vanadium	Mallard duck	vanadyl sulfate	12 weeks; diet	NOAEL	110 ppm	Mortality; body weight; blood chemistry	11.4	1.17	White and Dieter, 1978
	Rat	sodium metavanadate	60 days prior to gestation through lactation; oral intubation	LOAEL	2.1 mg/kg/day	Reproduction	0.21[(4)]	0.26	Domingo et al., 1986

Footnotes:
1 Derived by Sample et al., 1996
2 Body weight used to calculate the toxicity benchmark dose.
3 Source of critical study as cited in Sample et al., 1996.

4 Includes an uncertainty factor of 0.1 to convert the LOAEL to a NOAEL

References:

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Table 5-7
Avian and Mammalian Ingestion Rates and Body Weights

Species	Food Ingestion Rate (kg DW/day)	Reference	Body Weight (kg)	Reference
Mammals				
Deer mouse	0.0035	Nagy, 1987[1]	0.021	Millar, 1989
Mule deer	2.253	Nagy, 1987[1]	87.175	Burt and Grossenheider, 1952
Coyote	0.5873	Nagy, 1987[1]	13.6	Godin, 1977
Pygmy rabbit	0.032	Nagy, 1987[1]	0.246	Nowak, 1997
Townsend's big-eared bat	0.0014	Nagy, 1987[1]	0.009	Fitzgerald et al., 1994
Birds				
Sage grouse	0.1047	Nagy, 1987[1]	2.468	Dunning, 1993
Red-tailed hawk	0.0603	Nagy, 1987[1]	1.056	EPA, 1993
Horned lark	0.0074	Nagy, 1987[1]	0.0311	Dunning, 1993
Bald eagle	0.119	Nagy, 1987[1]	3.0	EPA, 1993

Footnote:

[1] Food ingestion rate (F) is based on the body weight (BW) of the organism in grams:

Rodents: $F = 0.621(BW)^{0.564}$

Herbivores: $F = 0.577(BW)^{0.727}$

Placental mammals: $F = 0.235(BW)^{0.822}$

Nonpasserine birds: $F = 0.648(BW)^{0.651}$

Passerine birds: $F = 0.398(BW)^{0.850}$

Table 5-8
BODY SIZE SCALING FACTORS FOR SELECTED SPECIES

Test Species		Endpoint Species		
Species	Body Weight (BW_t) (kg)	Species	Body Weight (BW_t) (kg)	Scaling Factor[1] $(BW_t)/(BW_w)^{1/3}$
Cadmium				
Rat	0.303	Deer mouse	0.021	2.43
Rat	0.303	Mule deer	87.175	0.15
Rat	0.303	Coyote	13.6	0.28
Rat	0.303	Pygmy rabbit	0.246	1.07
Rat	0.303	Townsend's big-eared bat	0.009	3.23
Mallard duck	1.153	Sage grouse	2.468	0.78
Mallard duck	1.153	Red-tailed hawk	1.056	1.03
Mallard duck	1.153	Horned lark	0.0311	3.33
Mallard duck	1.153	Bald eagle	3.0	0.73
Fluoride				
Mink	1.0	Deer mouse	0.021	3.62
Mink	1.0	Mule deer	87.175	0.23
Mink	1.0	Coyote	13.6	0.42
Mink	1.0	Pygmy rabbit	0.246	1.60
Mink	1.0	Townsend's big-eared bat	0.009	4.81
Screech owl	0.181	Sage grouse	2.468	0.42
Screech owl	0.181	Red-tailed hawk	1.056	0.56
Screech owl	0.181	Horned lark	0.0311	1.80
Screech owl	0.181	Bald eagle	3.0	0.39
Zinc				
Rat	0.35	Deer mouse	0.021	2.55
Rat	0.35	Mule deer	87.175	0.16
Rat	0.35	Coyote	13.6	0.30
Rat	0.35	Pygmy rabbit	0.246	1.12
Rat	0.35	Townsend's big-eared bat	0.009	3.39
White leghorn hen	1.935	Sage grouse	2.468	0.92
White leghorn hen	1.935	Red-tailed hawk	1.056	1.22
White leghorn hen	1.935	Horned lark	0.0311	3.96
White leghorn hen	1.935	Bald eagle	3.0	0.86
Chromium				
Rat	0.35	Deer mouse	0.021	2.55
Rat	0.35	Mule deer	87.175	0.16
Rat	0.35	Coyote	13.6	0.30
Rat	0.35	Pygmy rabbit	0.246	1.12
Rat	0.35	Townsend's big-eared bat	0.009	3.39
Black duck	1.25	Sage grouse	2.468	0.80
Black duck	1.25	Red-tailed hawk	1.056	1.06
Black duck	1.25	Horned lark	0.0311	3.43
Black duck	1.25	Bald eagle	3.0	0.75

Table 5-8
BODY SIZE SCALING FACTORS FOR SELECTED SPECIES

Test Species		Endpoint Species		
Species	**Body Weight (BW_t) (kg)**	**Species**	**Body Weight (BW_t) (kg)**	**Scaling Factor[1] $(BW_t)/(BW_w)^{1/3}$**
Vanadium				
Rat	0.26	Deer mouse	0.021	2.31
Rat	0.26	Mule deer	87.175	0.14
Rat	0.26	Coyote	13.6	0.27
Rat	0.26	Pygmy rabbit	0.246	1.02
Rat	0.26	Townsend's big-eared bat	0.009	3.07
Mallard duck	1.17	Sage grouse	2.468	0.78
Mallard duck	1.17	Red-tailed hawk	1.056	1.03
Mallard duck	1.17	Horned lark	0.0311	3.35
Mallard duck	1.17	Bald eagle	3.0	0.73

[1] From Opresko et al., 1994

Table 5-9
TOXICITY REFERENCE VALUES FOR WILDLIFE

Chemical	Test Species	Test Species TB (mg/kg/day)	Endpoint Species	Estimated Wildlife TRV (mg/kg/day)
Cadmium				
	Rat	1.0	Deer mouse	2.43
			Mule deer	0.15
			Coyote	0.28
			Pygmy rabbit	1.07
			Townsend's big-eared bat	3.23
	Mallard duck	1.45	Sage grouse	1.13
			Red-tailed hawk	1.49
			Horned lark	4.83
			Bald eagle	1.05
Fluoride				
	Mink	31.37	Deer mouse	113.70
			Mule deer	7.07
			Coyote	13.14
			Pygmy rabbit	50.07
			Townsend's big-eared bat	150.81
	Screech owl	7.8	Sage grouse	3.26
			Red-tailed hawk	4.33
			Horned lark	14.03
			Bald eagle	3.06
Zinc				
	Rat	160.0	Deer mouse	408.70
			Mule deer	25.43
			Coyote	47.24
			Pygmy rabbit	179.96
			Townsend's big-eared bat	542.08
	White leghorn hen	14.5	Sage grouse	13.37
			Red-tailed hawk	17.74
			Horned lark	57.46
			Bald eagle	12.53
Chromium				
	Rat	2737.0	Deer mouse	6991.30
			Mule deer	435.01
			Coyote	808.07
			Pygmy rabbit	3078.36
			Townsend's big-eared bat	9272.92
	Black duck	1	Sage grouse	0.80
			Red-tailed hawk	1.06
			Horned lark	3.43
			Bald eagle	0.75

Table 5-10
Sagebrush Steppe Habitat Exposure Scenarios

Assessment Endpoint Species/Functional Group	Measurement Endpoint Species	Exposure Media	Potentially Important Exposure Routes
Shrubs	Big sagebrush	Soil	Root uptake
		Air	Foliar uptake
Grasses	Thickspike Wheatgrass	Soil	Root uptake
		Air	Foliar uptake
Mammalian carnivores	Coyote	Soil	Incidental ingestion
		Small mammals	Dietary
Upland game birds	Sagegrouse	Soil	Incidental ingestion
		Sagebrush foliage and forbs	Dietary
Raptors	Red-tailed hawk	Soil	Incidental ingestion
		Small mammals	Dietary
	Bald Eagle	Soil	Incidental ingestion
		Small mammals	Dietary
Songbirds	Horned Lark	Soil	Incidental ingestion
		Seeds of grasses and shrubs	Dietary
Small Mammals	Deer mouse	Soil	Incidental ingestion
		Seeds, foliage of grasses and shrubs	Dietary
	Pygmy Rabbit	Soil	Incidental ingestion
		Sagebrush foliage and forbs	Dietary
	Townsend's Big-Eared Bat	Soil	Incidental ingestion
		Insects	Dietary
Large herbivorous Mammals	Mule deer	Soil	Incidental ingestion
		Foliage of grasses and shrubs	Dietary

Based on Table 4-1 of the 1996 Baseline ERA.

Table 5-11
RI COPC Exposure Point Concentrations within the Sagebrush Steppe Habitat of the Undeveloped Areas of the FMC OU (mg/kg) [(a)]

Exposure Medium	Location	COPC		
		Cadmium	Fluoride	Zinc
Surface Soil	Background	0.81	381	59.2
	Undeveloped Areas of the FMC OU	30.1	1585	283.00
Sagebrush (unwashed)	Background	0.35	12.1	33.90
	Undeveloped Areas of the FMC OU	1.06	85.7	33.60
Thickspike Wheatgrass (stems and leaves)	Background	0.27	12.2	9.05
	Undeveloped Areas of the FMC OU	0.65	86.9	13.40
Deer Mouse (whole body)	Background	0.21	6.8	42.4
	Undeveloped Areas of the FMC OU	0.77	144	41.4

NA = Not applicable

[(a)] Cd, F and Zn EPCs characterized by data collected at the Ferry Butte (background) and Bannock Hills SW (adjacent to undeveloped areas of the FMC OU) CERCLA ERA sampling stations (see Table 4-3 of CERCLA ERA) relied on 95% UCL with the following exceptions:

Cadmium	Sagebrush (unwashed); background location – Non-outlier maximum concentration
	Thickspike wheatgrass; background location – Average of detected concentrations
Fluoride	Thickspike wheatgrass; background location – One-half detection limit
	Thickspike wheatgrass; undeveloped areas of FMC OU – Third quartile (75th
	Deer mouse (whole body); background location – One-half detection limit
Zinc	Sagebrush (unwashed); background location – 95% UCL of lognormal distribution

Table 5-12
Estimation of Chromium and Vanadium Surface Soil Exposure Point Concentrations (EPCs) in Undeveloped Areas of the FMC OU

Sample Location	Soil Concentration (mg/kg)	
	Chromium	Vanadium
EMF Background Levels (CERCLA ERA Tables A-4)		
Background	27.5	45.4
EMF RI Offsite Surface Soil Samples Taken Adjacent to Undeveloped Areas of the FMC OU		
270-2B	21.9	31.5
248-3B	22	35.5
225-2A	79.5	95.8
225-2B	87.7	91.7
180-2B	14.3	26.1
EPC (95% UCL on mean)	76.13	86.40

Table 5-13

Estimation of Chromium and Vanadium Soil Pore-Water Concentrations in Undeveloped Areas of the FMC OU [a]

Constituent	Soil-Water Partition Coefficient (Kd) - (L/kg) [b]	Surface Soil EPC on FMC OU (mg/kg)	EMF Study Area Background Soil Concentration (mg/kg) [c]	Soil Pore-Water EPC on FMC OU (mg/L)	Background Concentration in Soil Pore-Water (mg/L)
Chromium	4.30E+06	76.13	27.5	1.77E-05	6.40E-06
Vanadium	1.00E+03	86.40	45.4	8.64E-02	4.54E-02

a) Soil pore-water concentrations derived using Equation 22 of EPA (1996).

b) Chromium K_d value for soil pH = 7.8 from Exhibit C-4 of EPA (2002). Non soil pH dependent vanadium K_d value from Exhibit C-4 of EPA (2002).

c) Calculated as the 95th percentile of off-site RI sub-surface soil concentrations, per Table 2-8 of E&E (1996).

Table 5-14
Estimation of Chromium and Vanadium Plant (Sagebrush and Thickspike Wheatgrass) Exposure Point Concentrations (EPCs) in Undeveloped Areas of the FMC OU

Constituent	Soil-to-Plant Biotransfer Factor for Root Uptake into Aboveground Plants (BCF_r) - (unitless)		Surface Soil EPC on FMC OU (mg/kg)	EMF Study Area Background Soil Concentration (mg/kg)	Aboveground Plant EPC on FMC OU (mg/kg DW) [a]	Background Concentration in Aboveground Plants (mg/kg DW) [a]
Chromium	7.50E-03	EPA (1999)	76.13	27.5	5.71E-01	2.06E-01
Vanadium	5.50E-03	Baes et al. (1984)	86.40	45.4	4.75E-01	2.50E-01

[a] Plant concentrations derived using the equation presented in Table B-3-3 of EPA 1999, on a dry-weight basis.

Table 5-15
Exposure Parameters for Wildlife in Sagebrush Steppe Habitat (a)

Assessment Endpoint Species/Functional Group	Measurement Endpoint Species	Percent of Diet					Home Range (acres)	Site Use Factor	Exposure Duration	Ingestion Rate (kg/day)	Body Weight (kg)
		Shrubs	Forbs	Insects	Small Mammals	Soil					
Upland game birds	Sage grouse	74	26	0	0	9	890	1	1	0.105	2.468
Raptors	Red-tailed hawk	0	0	0	100	2	4374	1	1	0.060	1.056
	Bald eagle	0	0	0	100	2	9266	1	1	0.119	3.000 (b)
Songbirds	Horned lark	0	80	20	0	2	2	1	1	0.0074	0.0311
Small Mammals	Deer mouse	21.5	42.8	35.7	0	2	0.32	1	1	0.0035	0.0210
	Pygmy rabbit (c)	67.7	32.3	0	0	2	6.7 (d)	1	1	0.0316	0.2460 (e)
Large Mammalian herbivores	Mule deer	75	25	0	0	2	90	1	0.5	2.253	87.175
Mammalian carnivores	Coyote	0	0	0	100	2	6968	1	1	0.587	13.600
Mammalian insectivore	Townsend's big-eared bat	0	0	100	0	2	12177	1	1	0.0014	0.0090 (f)

(a) Unless otherwise noted, all values taken from Table 4-5 of the Ecological Risk Assessment, Eastern Michaud Flats, Pocatello, Idaho (E&E, 1995).
(b) EPA, 1993
(c) Percent diet of pygmy rabbit from Green and Flinders, 1980
(d) Washington Department of Fish and Wildlife, 1995.
(e) Nowak, 1997
(f) Fitzgerald et al., 1994

Table 5-16

Estimation of Chromium and Vanadium Concentrations in Deer Mouse within Undeveloped Areas of the FMC OU[a]

Constituent	Biotransfer Factor (Ba) - day/kg WW tissue [b]	Deer Mouse Food Ingestion Rate (kg DW/day)	Food-to-Deer Mouse Bioconcentration Factor (BCF)	FMC OU Deer Mouse Tissue Concentration due to Food Ingestion (mg/kg WW)	Background Deer Mouse Tissue Concentration due to Food Ingestion (mg/kg WW)	Deer Mouse Soil Ingestion Rate (kg/day)	Soil-to-Deer Mouse Bioconcentration Factor (BCF)	FMC OU Deer Mouse Tissue Concentration due to Soil Ingestion (mg/kg WW)	Background Deer Mouse Tissue Concentration due to Soil Ingestion (mg/kg WW)	FMC OU Deer Mouse Tissue Concentration (mg/kg DW)[c]	Background Deer Mouse Tissue Concentration (mg/kg DW)[c]
Chromium	5.50E-03	3.46E-03	1.90E-05	1.09E-05	3.92E-06	6.92E-05	3.80E-07	2.90E-05	1.05E-05	1.24E-04	4.49E-05
Vanadium	2.30E-03	3.46E-03	7.95E-06	3.78E-06	1.99E-06	6.92E-05	1.59E-07	1.37E-05	7.22E-06	5.48E-05	2.88E-05

a) Deer mouse concentrations calculated using methods described in EPA (1999).
b) Ba values from Baes et al. (1984).
c) Dry weight mouse tissue concentration derived assuming a 68% moisture content (Sample et al. 1997).

Table 5-17
Summary of COPC Exposure Point Concentrations within the Sagebrush Steppe Habitat of the Undeveloped Areas of the FMC OU (mg/kg) (a)

Exposure Medium	Location	COPC				
		Cadmium	Fluoride	Zinc	Chromium	Vanadium
Surface Soil	Background	0.81	381	59.2	27.5	45.4
	Undeveloped Areas of the FMC OU	30.1	1585	283	76.13	86.40
Soil Pore Water	Background	NA	NA	NA	6.40E-06	0.05
	Undeveloped Areas of the FMC OU	NA	NA	NA	1.77E-05	0.09
Sagebrush (unwashed)	Background	0.35	12.1	33.9	0.21	0.25
	Undeveloped Areas of the FMC OU	1.06	85.7	33.6	0.57	0.48
Thickspike Wheatgrass (stems and leaves)	Background	0.27	12.2	9.05	0.21	0.25
	Undeveloped Areas of the FMC OU	0.65	86.9	13.4	0.57	0.48
Deer Mouse (whole body)	Background	0.21	6.8	42.4	4.49E-05	2.88E-05
	Undeveloped Areas of the FMC OU	0.77	144	41.4	1.24E-04	5.48E-05

NA = Not applicable

(a) Cd, F and Zn EPCs characterized by data collected at the Ferry Butte (background) and Bannock Hills SW (adjacent to undeveloped areas of the FMC OU) CERCLA ERA sampling stations (see Table 4-3 of CERCAL ERA). Cr and V EPCs characterized by calculations presented in Tables 5-1, 5-2, 5-3 and 5-4.

Table 5-18
Estimated Exposure of Wildlife to COPCs in Sagebrush Steppe Habitat

Measurement Endpoint Species	COPC	Location	EEdiet (mg/kg-day)	EEsoil (mg/kg-day)	EEtotal (mg/kg-day)
Sage Grouse	Cadmium	Ferry Butte (Background)	0.014	0.003	0.017
		Bannock Hills SW	0.040	0.115	0.155
	Fluoride	Ferry Butte (Background)	0.514	1.455	1.969
		Bannock Hills SW	3.649	6.052	9.702
	Zinc	Ferry Butte (Background)	1.164	0.226	1.390
		Bannock Hills SW	1.203	1.081	2.283
	Chromium	Background	0.009	0.105	0.114
		Adjacent to FMC OU	0.024	0.291	0.315
	Vanadium	Background	0.011	0.173	0.184
		Adjacent to FMC OU	0.020	0.330	0.350
Red-tailed hawk	Cadmium	Ferry Butte (Background)	0.012	0.001	0.013
		Bannock Hills SW	0.044	0.034	0.078
	Fluoride	Ferry Butte (Background)	0.388	0.435	0.823
		Bannock Hills SW	8.216	1.809	10.025
	Zinc	Ferry Butte (Background)	2.419	0.068	2.487
		Bannock Hills SW	2.362	0.323	2.685
	Chromium	Background	2.565E-06	0.031	0.031
		Adjacent to FMC OU	7.099E-06	0.087	0.087
	Vanadium	Background	1.642E-06	0.052	0.052
		Adjacent to FMC OU	3.124E-06	0.099	0.099
Bald eagle	Cadmium	Ferry Butte (Background)	0.008	0.001	0.009
		Bannock Hills SW	0.031	0.024	0.054
	Fluoride	Ferry Butte (Background)	0.270	0.302	0.572
		Bannock Hills SW	5.707	1.256	6.964
	Zinc	Ferry Butte (Background)	1.680	0.047	1.727
		Bannock Hills SW	1.641	0.224	1.865
	Chromium	Background	1.781E-06	0.022	0.022
		Adjacent to FMC OU	4.931E-06	0.060	0.060
	Vanadium	Background	1.140E-06	0.036	0.036
		Adjacent to FMC OU	2.170E-06	0.068	0.068
Horned lark	Cadmium	Ferry Butte (Background)	0.064	0.004	0.068
		Bannock Hills SW	0.154	0.143	0.298
	Fluoride	Ferry Butte (Background)	2.900	1.811	4.711
		Bannock Hills SW	20.653	7.534	28.187
	Zinc	Ferry Butte (Background)	2.151	0.281	2.432
		Bannock Hills SW	3.185	1.345	4.530
	Chromium	Background	0.049	0.131	0.180
		Adjacent to FMC OU	0.136	0.362	0.498
	Vanadium	Background	0.059	0.216	0.275
		Adjacent to FMC OU	0.113	0.411	0.524
Deer Mouse	Cadmium	Ferry Butte (Background)	0.047	0.003	0.050
		Bannock Hills SW	0.122	0.099	0.221
	Fluoride	Ferry Butte (Background)	2.005	1.255	3.260
		Bannock Hills SW	14.267	5.220	19.487
	Zinc	Ferry Butte (Background)	2.370	0.195	2.565
		Bannock Hills SW	2.922	0.932	3.854
	Chromium	Background	0.034	0.091	0.125
		Adjacent to FMC OU	0.094	0.251	0.345
	Vanadium	Background	0.041	0.150	0.191
		Adjacent to FMC OU	0.078	0.285	0.363

Table 5-18 (cont.)
Estimated Exposure of Wildlife to COPCs in Sagebrush Steppe Habitat

Measurement Endpoint Species	COPC	Location	EEdiet (mg/kg-day)	EEsoil (mg/kg-day)	EEtotal (mg/kg-day)
Pygmy rabbit	Cadmium	Ferry Butte (Background)	0.042	0.002	0.044
		Bannock Hills SW	0.119	0.077	0.196
	Fluoride	Ferry Butte (Background)	1.557	0.978	2.536
		Bannock Hills SW	11.051	4.069	15.120
	Zinc	Ferry Butte (Background)	3.321	0.152	3.473
		Bannock Hills SW	3.475	0.727	4.202
	Chromium	Background	0.026	0.071	0.097
		Adjacent to FMC OU	0.073	0.195	0.269
	Vanadium	Background	0.032	0.117	0.149
		Adjacent to FMC OU	0.061	0.222	0.283
Mule deer	Cadmium	Ferry Butte (Background)	0.004	2.094E-04	0.004
		Bannock Hills SW	0.012	0.008	0.020
	Fluoride	Ferry Butte (Background)	0.157	0.098	0.255
		Bannock Hills SW	1.112	0.410	1.521
	Zinc	Ferry Butte (Background)	0.358	0.015	0.373
		Bannock Hills SW	0.369	0.073	0.442
	Chromium	Background	0.003	0.007	0.010
		Adjacent to FMC OU	0.007	0.020	0.027
	Vanadium	Background	0.003	0.012	0.015
		Adjacent to FMC OU	0.006	0.022	0.028
Coyote	Cadmium	Ferry Butte (Background)	0.009	0.001	0.010
		Bannock Hills SW	0.033	0.026	0.059
	Fluoride	Ferry Butte (Background)	0.294	0.329	0.623
		Bannock Hills SW	6.218	1.369	7.587
	Zinc	Ferry Butte (Background)	1.831	0.051	1.882
		Bannock Hills SW	1.788	0.244	2.032
	Chromium	Background	1.94E-06	0.024	0.024
		Adjacent to FMC OU	5.37E-06	0.066	0.066
	Vanadium	Background	1.24E-06	0.039	0.039
		Adjacent to FMC OU	2.36E-06	0.075	0.075
Townsend's big-eared bat	Cadmium	Ferry Butte (Background)	0.043	0.003	0.045
		Bannock Hills SW	0.103	0.096	0.199
	Fluoride	Ferry Butte (Background)	1.939	1.211	3.150
		Bannock Hills SW	13.811	5.038	18.849
	Zinc	Ferry Butte (Background)	1.438	0.188	1.627
		Bannock Hills SW	2.130	0.900	3.029
	Chromium	Background	0.033	0.087	0.120
		Adjacent to FMC OU	0.091	0.242	0.333
	Vanadium	Background	0.040	0.144	0.184
		Adjacent to FMC OU	0.076	0.275	0.350

Table 5-19
Hazard Quotients for Plants in Sagebrush Steppe Habitat

Measurement Endpoint Species	Chemical	Location	EE (mg/kg)	TRV (mg/kg)	HQ
Sagebrush (washed)	Cadmium	Ferry Butte (background)	0.34	5	0.07
		Bannock Hills SW	0.86	5	0.17
	Fluoride	Ferry Butte (background)	NA	50	NA
		Bannock Hills SW	NA	50	NA
	Zinc	Ferry Butte (background)	28	150	0.19
		Bannock Hills SW	28	150	0.19
Sagebrush (unwashed)	Cadmium	Ferry Butte (background)	0.35	5	0.07
		Bannock Hills SW	1.06	5	0.21
	Fluoride	Ferry Butte (background)	12.1	50	0.24
		Bannock Hills SW	85.7	50	1.71
	Zinc	Ferry Butte (background)	33.9	150	0.23
		Bannock Hills SW	33.6	150	0.22
Thickspike Wheatgrass	Cadmium	Ferry Butte (background)	0.27	5	0.05
		Bannock Hills SW	0.65	5	0.13
	Fluoride	Ferry Butte (background)	12.2	50	0.24
		Bannock Hills SW	86.9	50	1.74
	Zinc	Ferry Butte (background)	9.05	150	0.06
		Bannock Hills SW	13.4	150	0.09
Measurement Endpoint Species	**Chemical**	**Location**	**EE (mg/L)**	**TRV (mg/L)**	**HQ**
Sagebrush and Thickspike Wheatgrass	Chromium	Background	6.40E-06	0.05	0.00
		Undeveloped Areas of FMC OU	1.77E-05	0.05	0.00
	Vanadium	Background	0.05	0.2	0.23
		Undeveloped Areas of FMC OU	0.09	0.2	0.43

Table 5-20
Hazard Quotients for Mammals in Sagebrush Steppe Habitat

Measurement Endpoint Species	Chemical	Location	EE*total* (mg/kg-day)	TRV (mg/kg-day)	HQ
Coyote	Cadmium	Ferry Butte (background)	0.01	0.28	0.03
		Bannock Hills SW	0.06	0.28	0.21
	Fluoride	Ferry Butte (background)	0.62	13.14	0.05
		Bannock Hills SW	7.59	13.14	0.58
	Zinc	Ferry Butte (background)	1.88	47.24	0.04
		Bannock Hills SW	2.03	47.24	0.04
	Chromium	Background	0.02	808.07	0.00
		Adjacent to FMC OU	0.07	808.07	0.00
	Vanadium	Background	0.04	0.06	0.70
		Adjacent to FMC OU	0.07	0.06	1.33
Deer Mouse	Cadmium	Ferry Butte (background)	0.05	2.43	0.02
		Bannock Hills SW	0.22	2.43	0.09
	Fluoride	Ferry Butte (background)	3.26	113.70	0.03
		Bannock Hills SW	19.49	113.70	0.17
	Zinc	Ferry Butte (background)	2.56	408.70	0.01
		Bannock Hills SW	3.85	408.70	0.01
	Chromium	Background	0.12	6991.30	0.00
		Adjacent to FMC OU	0.34	6991.30	0.00
	Vanadium	Background	0.19	0.49	0.39
		Adjacent to FMC OU	0.36	0.49	0.75
Mule Deer	Cadmium	Ferry Butte (background)	0.00	0.15	0.03
		Bannock Hills SW	0.02	0.15	0.13
	Fluoride	Ferry Butte (background)	0.26	7.07	0.04
		Bannock Hills SW	1.52	7.07	0.22
	Zinc	Ferry Butte (background)	0.37	25.43	0.01
		Bannock Hills SW	0.44	25.43	0.02
	Chromium	Background	0.01	435.01	0.00
		Adjacent to FMC OU	0.03	435.01	0.00
	Vanadium	Background	0.01	0.03	0.49
		Adjacent to FMC OU	0.03	0.03	0.94
Pygmy Rabbit	Cadmium	Ferry Butte (background)	0.04	1.07	0.04
		Bannock Hills SW	0.20	1.07	0.18
	Fluoride	Ferry Butte (background)	2.54	50.07	0.05
		Bannock Hills SW	15.12	50.07	0.30
	Zinc	Ferry Butte (background)	3.47	179.96	0.02
		Bannock Hills SW	4.20	179.96	0.02
	Chromium	Background	0.10	3078.36	0.00
		Adjacent to FMC OU	0.27	3078.36	0.00
	Vanadium	Background	0.15	0.21	0.69
		Adjacent to FMC OU	0.28	0.21	1.32
Townsend's Big Eared Bat	Cadmium	Ferry Butte (background)	0.05	3.23	0.01
		Bannock Hills SW	0.20	3.23	0.06
	Fluoride	Ferry Butte (background)	3.15	151	0.02
		Bannock Hills SW	18.85	151	0.12
	Zinc	Ferry Butte (background)	1.63	542	0.00
		Bannock Hills SW	3.03	542	0.01
	Chromium	Background	0.12	9273	0.00
		Adjacent to FMC OU	0.33	9273	0.00
	Vanadium	Background	0.18	0.64	0.29
		Adjacent to FMC OU	0.35	0.64	0.54

Table 5-21
Hazard Quotients for Birds in Sagebrush Steppe Habitat

Measurement Endpoint Species	Chemical	Location	EE*total* (mg/kg-day)	TRV (mg/kg-day)	HQ
Horned Lark	Cadmium	Ferry Butte (background)	0.07	4.83	0.01
		Bannock Hills SW	0.30	4.83	0.06
	Fluoride	Ferry Butte (background)	4.71	14.03	0.34
		Bannock Hills SW	28.19	14.03	2.01
	Zinc	Ferry Butte (background)	2.43	57.46	0.04
		Bannock Hills SW	4.53	57.46	0.08
	Chromium	Background	0.18	3.43	0.05
		Adjacent to FMC OU	0.50	3.43	0.15
	Vanadium	Background	0.28	38.20	0.01
		Adjacent to FMC OU	0.52	38.20	0.01
Red-tailed hawk	Cadmium	Ferry Butte (background)	0.01	1.49	0.01
		Bannock Hills SW	0.08	1.49	0.05
	Fluoride	Ferry Butte (background)	0.82	4.33	0.19
		Bannock Hills SW	10.03	4.33	2.31
	Zinc	Ferry Butte (background)	2.49	17.74	0.14
		Bannock Hills SW	2.69	17.74	0.15
	Chromium	Background	0.03	1.06	0.03
		Adjacent to FMC OU	0.09	1.06	0.08
	Vanadium	Background	0.05	11.80	0.00
		Adjacent to FMC OU	0.10	11.80	0.01
Sage Grouse	Cadmium	Ferry Butte (background)	0.02	1.13	0.02
		Bannock Hills SW	0.16	1.13	0.14
	Fluoride	Ferry Butte (background)	1.97	3.26	0.60
		Bannock Hills SW	9.70	3.26	2.97
	Zinc	Ferry Butte (background)	1.39	13.37	0.10
		Bannock Hills SW	2.28	13.37	0.17
	Chromium	Background	0.11	0.80	0.14
		Adjacent to FMC OU	0.31	0.80	0.40
	Vanadium	Background	0.18	8.89	0.02
		Adjacent to FMC OU	0.35	8.89	0.04
Bald Eagle	Cadmium	Ferry Butte (background)	0.01	1.05	0.01
		Bannock Hills SW	0.05	1.05	0.05
	Fluoride	Ferry Butte (background)	0.57	3.06	0.19
		Bannock Hills SW	6.96	3.06	2.28
	Zinc	Ferry Butte (background)	1.73	12.53	0.14
		Bannock Hills SW	1.87	12.53	0.15
	Chromium	Background	0.02	0.75	0.03
		Adjacent to FMC OU	0.06	0.75	0.08
	Vanadium	Background	0.04	8.33	0.00
		Adjacent to FMC OU	0.07	8.33	0.01

Section 6
Application of DQO Process to Remediation Units

This section presents a comparison of the expanded set of available site characterization data with the RBCs presented in Section 4 (along with the RBC developed for P4) as a screen to identify areas potentially requiring additional characterization.

This section also includes a comparison of site characterization data with representative levels of constituents in soils. The term "representative levels" was used during the EMF RI to acknowledge that soils in the EMF Study Area have been affected by anthropogenic activities not related to the EMF facilities, and that background concentrations in the study area should not be considered pristine, unaffected background levels. Representative levels were determined by EPA's risk assessment contractor, E&E, during the EMF RI. The derivation of these levels was documented in the Baseline Human Health Risk Assessment for the EMF Site (E&E, 1997).

Constituents of Concern (COCs) and Constituents of Potential Concern (COPCs) within each RU are identified in Table 6-1. COCs are constituents confirmed to be present in a RU based on sampling results and/or process knowledge. The presence or absence of COPCs within specific RUs has not been confirmed. For RUs with a remediation vision that includes a cap/cover, investigation of COPCs is not identified as a data gap because the envisioned remedial action will meet RAOs for the COPCs as well as COCs present within these RUs. For RUs with a remediation vision of no further action anticipated to be necessary, the SRI scope will include sampling for COPCs. Details of each investigation will be provided in the SRI Work Plan.

EPA selected remedies for the Calciner Solids Storage Area (RU 16), the Old Phossy Ponds (RU 22b), and the Railroad Swale (RU 22c) in the 1998 ROD. EPA subsequently elected to reconsider the 1998 ROD; consequently, implementation of these remedies was stayed pending EPA's further review.[1] FMC believes that these areas continue to warrant remedial action. As a result, these areas were evaluated to determine if there have been any significant changes since the EMF remedial investigation that would bring into question the appropriateness of the remedies selected in the 1998 ROD, and if so, whether additional characterization is appropriate prior to reevaluating these areas for remedial action during the SFS process.

EPA's Data Quality Objectives (DQO) process (EPA 2000) was used to evaluate each RU. At some of the RUs, FMC anticipates implementing a presumptive remedy of containment, and the DQO procedure was reformatted to follow EPA's Technical Areas for Presumptive Remedies of

CERCLA Municipal Landfills (EPA 1995) for landfill-like units or similar wastes. At RU 16 and RU 22b, FMC anticipates implementing the remedy selected for that area in the 1998 ROD.

FMC also anticipates implementing the 1998 ROD remedy selected for groundwater. Groundwater impacts, flow patterns, flow rates, source areas, and fate and transport were characterized during the EMF RI. Subsequent monitoring has supported the conclusions drawn in the EMF RI (Sections 3.3, 4.4 and 5). FMC will continue the voluntary CERCLA groundwater monitoring and the RCRA groundwater monitoring at the FMC Plant OU throughout the SRI/SFS process. The EMF RI findings, coupled with ongoing groundwater

[1] Further review of potential remedial action technologies is available in Treatment Technologies for Historical Ponds Containing Elemental Phosphorus – Summary and Evaluation (EPA 2003). This document is also referred to as the EPA TIP Report.

monitoring and additional source characterization during the SRI, as described below, will provide sufficient information to support the RD/RA.

The remainder of this section focuses on characterizing soil and solid media in the exposure pathways and at the 0-10' depths that may be encountered during future site redevelopment and industrial/commercial use. Where there are uncertainties regarding the nature of impact of potential sources on groundwater quality, and the remediation vision does not include a cap/cover over the RU, the need to further evaluate the potential source is noted as a data gap to be addressed during the SRI. Where a cap/cover is identified as the remediation vision, the cap/cover design will incorporate measures to reduce/minimize infiltration through the materials. The DQO process will be used to develop the appropriate methods for defining and characterizing potential sources to groundwater.

The DQO process has seven steps. They are:

1. State the problem.
2. Identify the decision
3. Identify the inputs to the decision
4. Define the study area
5. Develop decision rules
6. Specify the allowable error on the decisions
7. If needed, optimize the sampling program

The primary purpose for following the DQO process was to develop an objective and data-supported decision regarding classification of each RU for the SRI/SFS. Figure 6-1 summarizes the DQO process as applied to the various RUs. A detailed discussion is provided in the following text of this section.

Step 1, State the Problem: The FMC Plant OU has been the subject of CERCLA and RCRA environmental investigations, and these investigations have identified constituents of concern that were released into the environment through various plant processes and material handling practices. The problem is that areas within the FMC Plant OU have been used for waste disposal, some areas are former working areas with the potential for P4 occurrence in the subsurface, and other areas have had multiple uses through the operational history of the plant. Characterization data may or may not be sufficient for evaluating the future exposure scenarios, or for conducting the SFS. A structured approach is needed to evaluate the available information, and support the decision (see Step 2).

Step 2, Identify the Decision: The decision that must be made is to classify RUs within one of the following categories:

1. No Further Action – RU does not contain materials or environmental media that exceed RBCs for the relevant exposure pathways, or
2. RU contains materials or environmental media with constituent concentration(s) that exceed RBCs, and no additional data are needed to support an evaluation of remedial action alternatives under the SFS process, or
3. Collect additional data to: (a) evaluate classification of No Further Action or (b) support the SFS analyses of remedial action alternatives.

Step 3, Inputs to the Decision: There are numerous inputs to the decision for each RU. The generic inputs for each RU are discussed below.

The 1998 EMF Site ROD detailed a decision for institutional controls, monitoring and a contingent extraction for hydraulic control to prevent exposure by human and ecological receptors to contaminated groundwater at the FMC Plant OU. In addition, the ROD selected deed restrictions to prevent future residential use at the FMC Plant OU, and it specified that new buildings shall be designed and built to prevent indoor radon exposure. The remedies selected in the ROD were protective of human health and the environment assuming continued plant operations, and in many respects also would be protective during plant shutdown (such as the ROD's requirement for institutional controls for future land use scenarios with respect to the old phossy ponds, calciner solids area, the Railroad Swale and groundwater).

RUs 17, 18, and 19 are landfills, or have landfills within their boundaries. In their comments on the draft Scoping and Planning Memorandum for the SRI/SFS, reviewing agencies recommended that FMC consider application of the Presumptive Remedy for CERCLA Municipal Landfill Sites (Directive 9355.0-49FS, EPA 1993) for these landfills. Other RUs within the FMC Plant OU that were identified for capping include the old phossy ponds (RU 22b), Railroad Swale (RU 22c), and the calciner solids storage area (RU 16). These areas were evaluated to determine if changes in site conditions require additional data collection prior to conducting the SFS or Remedial Design.

Other inputs to the decision include the Updated RBCs presented in Section 4 of this report, changes in operations since the 1998 ROD, and evaluation of spills/releases of process materials that occurred from 1994 (the end of the EMF remedial investigation field sampling period) to the present. Appendix A provides a detailed description of changes to the SWMUs that have occurred since the EMF RI.

Table 6-1 summarizes the Constituents of Concern (COCs) and Constituents of Potential Concern (COPCs) for each RU within the FMC Plant OU.

COCs are constituents known or considered likely to be present in fill and waste materials within the RU boundaries. For example, because cadmium was detected at levels above RBCs in soils within RU 13 during the EMF RI, cadmium is considered a COC within RU 13. Process knowledge was also used to determine the presence of COCs within several RUs. RU 8 is an example where knowledge of the kiln process (used before calciners were installed) indicates that residual sediments from the former kiln scrubber ponds within RU 8 contain materials with COCs similar to those contained in calciner solids.

A constituent is identified as a COPC where there is suspicion that a release containing that constituent may have occurred, or where there are insufficient data and process knowledge to rule out a past spill or release containing that constituent. For example, in RU 20, BAPCO used several above-ground fuel oil and diesel storage tanks. While there were no documented releases from these tanks, FMC considers fuel hydrocarbons a COPC at RU 20 recognizing that these most likely are within the CERCLA petroleum exclusion. Thus, a decision of no further action at RU 20 cannot be supported with the available data. Similarly, at RU 4 and 5, there were minor levels of VOCs detected in soil samples. These VOCs are associated with the Chem Lab Seepage Pit. As with fuel hydrocarbons in RU 20, FMC recognizes that VOC's at RU 4 and RU 5 must be adequately characterized to support a decision to either remediate hotspots or to take no further action.

The application of Pond Closure Decant Treatment (PCDT) water to FMC road segments for dust suppression is another input to the decision, and was evaluated in the discussion of RU 23. The discussion also applies to road segments within the boundaries of other RUs; however, discussing the PCDT water application on road segments within each RU would be redundant.

Step 4, Define the Study Boundaries: In this step, the lateral boundaries for each RU were selected based on knowledge of past activities and materials handled within the RU. In many cases, the RU can be easily defined laterally because it is bounded by roads, structures, or other features. A limited number of activities occurred within these spatial boundaries and known materials were associated with these activities. Vertically, the study boundaries are from existing grade to a depth of 10 feet (see updated Conceptual Site Model in Section 2). These vertical boundaries were selected because they encompass the exposure pathways for the various future commercial/industrial land use exposure scenarios identified in the updated CSM.

RU 14 is being remediated under the purview of the IDEQ, and RCRA Waste Management Units within RU 22a are being closed under EPA Region 10's RCRA standards. These RUs are not within the study boundaries, and will not be considered in the SRI/SFS.

Deeper soils have not been included in the study boundaries at this time because there is no evidence of an active source (i.e., source with sustained hydraulic head) of contamination to groundwater, and because exposure to these soils is not anticipated under future commercial/industrial exposure scenarios. The exception is that deeper soils beneath RU 1 and RU 2 (possibly RU 3 and RU 4), cannot be excluded because there is a potential for P4 migration into these deeper soils.

In addition, groundwater was not included in the study boundaries because the 1998 EMF ROD selected land use restrictions on the future use of groundwater at the FMC Plant OU.

However, each RU was evaluated to ensure that sources that could impact groundwater were identified and that the existing groundwater monitoring network would be sufficient to demonstrate achievement of the following 1998 ROD RAOs:

1. Prevent potential ingestion of ground water containing COCs having concentrations exceeding RBCs or MCLs (chemical-specific ARARs).
2. Restore ground water that has been impacted by site sources to meet RBCs or MCLs for the COCs

Step 5, Develop the Decision Rules: In this step, the decision rules for this DQO Process are stated:

1. Was the RU a former pond that is not part of a RCRA WMU or Calciner Pond subject to remediation under the IDEQ Consent Order and either, (i) used for disposal/storage of phossy waste, or (ii) used for storage of calciner solids? If yes, document any significant changes in site conditions since the 1998 ROD, and determine if the RU can be forwarded to the SFS (characterization and remedial action defined under 1998 ROD, Section 10.2.2.1). If no, go to the next question.
2. Was the RU a former working area with production, storage, or handling of P4 that created a significant potential for spills and/or leaks? If yes, evaluate the RU under the technical areas for former P4 working areas and determine if additional data are needed

under the SRI, or if the existing data are sufficient, the RU can be forwarded to the SFS. If no, got to the next question.

3. Was the RU a landfill, or is a landfill present within the RU boundaries? If yes, consider the RU for application of the presumptive remedy for CERCLA Municipal Landfills and evaluate the available data against the RI/FS Technical Areas for application of the presumptive remedy to decide if additional data are needed during the SRI or if the RU can be forwarded to the SFS. If no, continue to the next question.
4. For the remaining RUs, are there sufficient data to statistically compare the constituents of concern with RBCs or other relevant screening criteria? If yes, decide whether the RU can be classified as "No Further Action – RBCs are not exceeded in environmental media" or "RBCs are exceeded, RU is not eligible for NFA and the RU should proceed to the SFS." If no, forward the RU to the SRI process for additional sampling and/or analyses.

It should be noted that for all RUs, the following conditions must be met in order to forward the RU to the SFS:

- Data must be sufficient to meet the RI/FS technical areas for former P4 working areas and landfills, as applicable (in some cases, the technical areas can be addressed during the SFS, and these are described in more detail). Technical areas for landfills are those defined in the EPA's guidance on the presumptive for CERCLA landfills (EPA, 1993), whereas the technical areas for former P4 working areas are those described later in this section.
- At the former pond areas, available information must support the conclusion that site changes since 1998 are not significant, and do not require additional characterization data.
- In other areas, the statistical comparison between site data and RBCs must show that sufficient data are available to support the decisions for all COPCs.

Step 6, Specify the Allowable Error on the Decisions:

Decision 1 Error: The decision to classify an area as an old phossy pond or calciner solids storage area has a very low associated error. The boundaries of the old ponds and calciner solids storage areas are well-documented from historic aerial photos and from the current site conditions. For example, calciner solids storage areas can be readily delineated through visual inspection of disturbed ground vs. adjacent areas that are undisturbed. The old phossy ponds can be accurately delineated from aerial photos that show their location, size, and period of usage. Furthermore, classification of an area as a former phossy pond will cause the area to be forwarded to the SFS for implementation of the remedy selected in the 1998 ROD (capping or placement of the appropriate cover).

Decision 2 Error: Determining whether the RU was part of a former P4 working area has a very low error associated with the decision. Given the detailed information regarding past practices, and that the P4 processing and storage facilities were permanent structures, this "yes" or "no" question can be answered with a high degree of confidence. Furthermore, the evaluation of the RI/FS technical areas associated with the P4 former working areas decreases the error associated with this decision, because that evaluation requires an extensive review of past practices, spills,

fluid collection points, and potential leakage points (e.g., concrete-lined sumps, surface spill collection points, etc.) from which P4 could enter the subsurface.

Decision 3 Error: There is low error associated with the decision, because each RU that was a landfill will be forwarded to the SFS for application of the presumptive remedy of containment. If data are lacking to adequately address some or all of the RI/FS Technical Areas outlined in EPA's RI/FS guidance for data collection at landfill sites, these data gaps will be addressed as part of the SRI. The "yes" or "no" answer is straightforward, and can be verified through a review of aerial photos and a review of plant practices through the years. The review of the RI/FS Technical Areas from EPA guidance on presumptive remedies for landfills will serve to reduce the associated error, because that review will be based on the factors specified in that guidance.

Decision 4 Error: A Type I error (alpha) rate of 5% was selected, and a Type II (beta) rate of 10% was selected. For comparisons with RBCs, the delta value is defined as the difference between the 95% UCL of the mean of RU-specific data and the RBC value(s). When comparing site characterization data with representative or background levels, delta is the difference between the 95% UCL of the mean and the background value for a given constituent. Section 6.1.4 provides a detailed description of delta values. Variance and associated standard deviation values were estimated from RU-specific data where sufficient numbers of samples were available. EPA DQO Guidance allows for a Type I confidence level of 80% to 95%, and FMC has selected the conservative 95% confidence level for RUs that may be subject to redevelopment and future occupancy by other industries or commercial ventures (EPA, 2000a). The higher degree of confidence associated with the Type I error offers a higher degree of certainty that future site workers will not be inadvertently exposed to media above RBCs.

In cases where there were insufficient samples, a data gap was identified. These data gaps will be addressed as part of the SRI Work Plan.

Step 7, Optimize the Sampling Program: This step will be implemented in the SRI Work Plan, and is not part of the RI Update. However, the outcome of Steps 1 through 6 will be carried forward to the SRI Work Plan to ensure the SRI Work Plan meets the appropriate objectives. A preliminary scope of sampling and analyses (modeling) for the SRI is summarized in Section 7.0 of this RI Update.

6.1 Results of Step 5 – Classification of Remediation Units

The following discussion presents the results of Step 5, and is summarized in Table 6-2.

6.1.1 Former Ponds or Calciner Solids Storage Area

RU 22b (CERCLA RD/RA Units or "Old Phossy Ponds"), RU 22c (Railroad Swale), and RU 16 (Calciner Solids Stockpile) are areas identified for remedial action in the 1998 ROD. The ROD selected a capillary cap design or soil cover for these RUs, and noted that treatment technologies were neither cost-effective nor technologically feasible, thereby supporting the decision for capping. EPA's subsequent evaluation of potential treatment technologies for historical ponds containing elemental phosphorus (EPA 2003) is supportive of the remedy selected in the 1998 ROD for the old phossy ponds.

The former kiln scrubber ponds, located beneath Calciner #2 within RU 8, are included in this grouping for the following reasons:

1. The kiln scrubber ponds contain material similar to the calciner ponds. The similarity of material is due to the similarity between the kiln and calcining processes.
2. The 1998 ROD selected capping or covering the calciner solids, and the kiln scrubber solids contained in the former kiln scrubber ponds are of a similar nature.

Prior to concluding whether these RUs can be forwarded to the SFS, site conditions must be evaluated to ensure that no significant changes have occurred since the EMF RI that would contraindicate the remedial action selected in the 1998 ROD for these sources. Significant changes can be activities that released significantly different types of COPCs, and activities that might have significantly altered the chemical or physical characteristics of the materials or their mobility.

RU 22b – Old Ponds:

The following discussion is summarized in Figure 6-2. Since the issuance of the EMF ROD in 1998, the old phossy ponds (Figure 6-3) at FMC have not received additional process materials. This has been confirmed by FMC plant personnel who have worked at the site from 1994 through the present.

EPA's Technology Innovation Program (TIP) published a report in 2003 documenting the treatment technologies available for elemental phosphorus sludges contained in the old ponds (EPA, 2003). In this report, EPA concluded: "….no new treatment technologies have emerged as potentially applicable to treat the historical ponds since the FS report." The TIP document includes a reference to the FMC CERCLA Feasibility Study (FMC, 1997a). EPA cited the following factors in its 2003 study:

- Treatment would likely require pre-treatment, exhaustive characterization of the material, and a significant engineering effort to design the treatment system(s).
- Worker exposure to the materials during remediation would involve significant worker-health protection measures.
- No waste treatment performance data are available. Few phosphorus-bearing materials have been successfully treated, either in-situ or ex-situ. Capping has been the selected alternative at most sites with similar pond materials. In-situ treatment was selected at only one facility, and that involved a significantly smaller volume of material.
- Costs incurred with treatment would be significantly greater than costs associated with the capping alternative.

As stated in the 1998 ROD:

> "Due to the presence of buried elemental phosphorus in some areas, the higher level of permanence afforded by the capillary barrier cap is warranted and the additional cost is justified. A soil cover and vegetation may be sufficient in areas which were used for a relatively short period of time and/or contain significantly lower volume of waste."

EPA noted in the 1998 ROD that the selection of the type of cap would be made during the RD phase for each pond or pond area based on the information available at the time of the RD.

The nature and extent of site-related impacts associated with the old ponds were characterized in the EMF Remedial Investigation Report (Bechtel, 1996). As noted in the RI Report, the old

ponds were delineated through a review of historic air photos and site inspection. In the air photos, the location and boundaries of the old ponds can be readily seen and mapped in detail. Soil borings and samples were collected at the old ponds to confirm the presence of process materials and develop a conceptual model of the fate and transport of contaminants in the old ponds. Source material samples were collected and analyzed to characterize the materials placed in the ponds. A more detailed summary of the EMF RI findings can be found in Appendix A.

A cap infiltration analysis was performed as a follow-on activity to the Feasibility Study (FMC, 1997b). This infiltration study provided EPA with the necessary information to support cap designs for the various old pond areas. The old ponds at FMC were characterized in the EMF RI Report, Appendix M, and the history of the old ponds was used as the basis for proposing a cap design (Bechtel, 1996). FMC based the cap design on the amounts of residual materials remaining in the old ponds. If residual materials were excavated, capping to control surface water run-on/run-off and limit worker exposure would meet the RAOs. In old ponds where residual materials remained in place, infiltration reduction was an additional cap design objective.

A data gap associated with the lateral extent of buried phossy solids was identified during the review of available data, which could affect the area within RU 22b to be capped. Borings F058B and F059B, located in RU 13, encountered phossy solids at depths of approximately 5 to 7 feet below current grade. These boring locations are shown in Figure 3-1. During the SRI, the lateral extent of these phossy solids will be delineated to determine the final extent of capping within RU 22b. It is anticipated that step-out borings and/or trenching will be needed to identify the lateral extent of this waste layer. The extent will be mapped and used as supporting data for the SFS.

RU 22c – Railroad Swale

The discussion that follows is summarized in Figure 6-4.

The 1998 ROD states:

> "FMC shall install and maintain a synthetic liner in the eastern portion of the Railroad Swale to reduce infiltration of surface water and leaching potential. FMC shall modify and extend the existing liner at least 850 feet to the east. The liner shall have, at a minimum, a 30-mil PVC liner and be covered by a protective sand layer with a minimum thickness of 6 inches. Design and construction shall conform with work conducted on the existing liner in the western portion of the Railroad Swale and shall include sampling during design for potential generation of gases which could affect liner performance. FMC shall maintain the integrity and effectiveness of the liner and final cover, including making repairs to the cover as necessary to correct the effects of settling, subsidence, erosion, or other events."

The purpose of the Railroad Swale liner under the 1998 ROD was to prevent surface exposure of the materials in that unit and water infiltration into those materials. A number of post-RI surface spills of phossy water at the Phos Dock area drained to the Railroad Swale; Appendix A describes spill volumes, sources, and character of the liquids. Residues from these spills may be present in sediments above the partial liner installed in the Railroad Swale in 1993 or within the unlined portion of the swale downgradient from the liner (Figure 6-5).

The spills that occurred from 1994 through 2002 were relatively small volumes of phossy water from the furnace building and Phos Dock area. These spills were likely contained within the

low-lying areas of the Railroad Swale. Due to these spills, FMC has identified capping as the remedial action vision for the Railroad Swale.

A cap that extends over the area originally proposed for lining should cover the areas affected by past spills. As with the old ponds, historic air photos were used to delineate the extent of ponded water in the Railroad Swale; extending the cap beyond the known ponding areas to the eastern edge of the FMC property should ensure that past spills of process materials will be contained.

Capping the Railroad Swale will minimize the potential of exposure to any constituents that may have collected in the swale, and will also reduce migration potential of these constituents. Surface water run-on/run-off management at the Railroad Swale will be a design issue and require analysis as part of the RD. However, additional data are needed to support the design of a cap.

Data Gaps

During the SRI, FMC will collect confirmation soil samples along the exterior boundaries of the railroad swale to delineate the extent of P4 and other COCs that may have been released. These data will be used to confirm the area to be capped.

RU 8 – Former Kiln Scrubber Ponds and Calciners

Figure 6-6 summarizes the discussion that follows. FMC's remediation vision for RU 8 is installing a cap with the appropriate institutional controls to prevent exposure to any remaining kiln scrubber solids. Other objectives of the cap design will include minimization of infiltration through the old pond area and run-on/run-off management. The former ponds within RU 8 (Figure 6-7) were targeted for investigation during the RI. However, these ponds were inaccessible because the calciners were built over the pond footprint. In 2004, the calciners were physically removed as part of plant dismantling.

A 1965 aerial photo, which illustrates the former kiln scrubber ponds when they were in operation, was georeferenced and the pond outlines were drawn to show actual location and extent of the three ponds. This information will be used during the SFS to develop the cap/cover design for RU 8. The calciner foundations do not extend over the entire footprint of the former kiln scrubber ponds.

The RI identified the former kiln scrubber overflow pond as a potential source of contaminants to groundwater (Figure 6-8). The kiln scrubber overflow pond was operated as an overflow pond that received clarified water from the primary settling ponds. A portion of the ditch that conveyed water from the former kiln scrubber ponds to the former kiln scrubber overflow pond is within the boundaries of RU 8, and the remaining section of the ditch is within the boundary of RU 9. As with the kiln scrubber overflow pond, this ditch transported clarified water. Thus, there was low potential for significant accumulation of solids in this ditch or the overflow pond. For a further discussion of data gaps associated with these features, see the discussion of RU 9 in Section 6.1.4 of this document. All the kiln scrubber ponds were taken out of service in the late 1960's when the calciners were built. There is soil/slag backfill with a concrete slab covering the pond sediments left in place. The concrete slab over the former kiln scrubber ponds serves two purposes: reducing infiltration of water through any remaining pond solids, and preventing exposure to pond solids. However, some downward migration of metals may have occurred during operation of the calciners because there is a potential for leaks in the subsurface piping

and sumps. These facilities no longer contain water associated with the calciner scrubber system, and are no longer potential sources of infiltration.

Although there is no indication the kiln ponds contain or stored P4, there is evidence from the RI that the ponds were a source of heavy metals to groundwater. Boring F054B, drilled in the area of the former kiln scrubber overflow pond, showed that site-related constituents had migrated from the base of the pond to the silt aquitard overlying the uppermost aquifer. Specifically, cadmium, zinc, and arsenic were found at above-representative levels in soil samples collected from the silt aquitard overlying the uppermost aquifer. The silt aquitard beneath RU 8 and RU 9 was characterized as part of the overall hydrogeologic investigation of the EMF RI (see sections 3.1, 3.3, 4.4, 5, and Appendix K of the EMF RI, BEI, 1996). In the area of RU 8 and 9, the aquitard is generally flat-lying, with a vertical permeability of approximately 10^{-6} cm/s.

Since 1994, there have been no changes at the former kiln scrubber ponds. Calciner #2 remained in service from 1994 until plant shutdown in 2001, with no process changes that would have impacted the underlying former kiln scrubber pond residuals.

The 1998 ROD did not select a remedy for these ponds. However, the ROD selected a capping/cover remedy for the similar calciner solids stockpile and the ponds in the western area of the FMC Plant OU.

Given the similarities between kiln solids and calciner solids, the remedy selected in the 1998 ROD for the calciner solids stockpile (see RU 16, below), likely could be effectively applied at RU 8.

Data Gaps

The only data gap is confirmation of the lateral extent of kiln scrubber pond sediments. The SRI scope will include up to six shallow borings or trenches along the exterior boundary of RU 8 to ensure the area proposed for a cap/cover encompasses the lateral extent of residual kiln scrubber solids.

RU 16 – Calciner Solids Stockpile:

The following discussion is summarized in Figure 6-9. The remediation vision for RU 16 is to implement the remedy selected in the 1998 ROD. The remedy selected was grading and installing a soil cover to prevent exposure to the calciner solids. The grading plan would include provisions for managing storm water run-on and runoff to reduce infiltration through the waste mass. A detailed description of SWMU 17 (Storage Area B) and SWMU 1 (Calciner Solids Stockpile) can be found in the EMF RI Report (pages 4.2-161 through 4.2-165).

Changes to the Calciner Solids Stockpile (Figure 6-10) that have occurred since 1998 consist of an increased volume of material placed on the stockpile, and an increase in the extent of the stockpile. Since 1996, there were no changes to the calcining process. Construction and operation of the excess CO combustor in 2001 did not materially affect the calcining process. The materials placed on the stockpile after 1996 essentially were the same as those placed before that date. However, in the 1998 ROD, EPA notes:

> "Decisions on which cap/cover is applied at each of the old phossy ponds and calciner solids area will be made by EPA during the course of the RD using all relevant information available at that time."

Although the volume and areal extent (footprint) of materials has increased since the 1998 ROD, the materials themselves have remained consistent in terms of their chemical and physical characteristics.

Soil data from borings in the calciner solids stockpile show that some constituents from the calciner solids stockpile have migrated up to 10 feet into the native soils beneath the stockpile. Beyond 10 feet, there are few site-related constituents present at above-representative levels (EMF RI Report, Table 4.2.3-33 and page 4.2-164). This 10 feet of migration occurred from the late 1960's through 1992. Groundwater occurs at depths greater than 100 feet in this area. Although the 1998 ROD indicated that the primary objective of the calciner solids stockpile cap/cover was to prevent exposure to these materials, there remains some uncertainty regarding the mobility of metals in the calciner solids. The SRI will address this uncertainty by collecting additional source characterization data to support the type of cap/cover selected for RU 16. For example, if the SRI data indicate that metals in the calciner solids have a very low leachability potential, a soil cover may be sufficient. On the other hand, if the calciner solids testing indicate metals are leachable to the extent that groundwater quality may be impacted above relevant MCLs and RBCs, a cap that further reduces infiltration may be appropriate.

6.1.2 Former P4 Working Areas

Key points for considering remedial alternatives at the former P4 working areas are the delineation of P4 in the subsurface, mobility of P4, and the existing cover over P4 areas. The delineation of P4 poses unique challenges due the physical and chemical properties of P4. Specifically, P4 is a liquid at temperatures above 44 C and freezes (i.e., becomes solid) below that temperature and is essentially immobile in the subsurface. The P4 was maintained in a liquid during the majority of the manufacturing and handling processes at the plant. P4 was handled at temperatures typically in the range of 60 to 66 C while being transferred (i.e., displaced with water or pumped) between product vessels/tanks and for railcar loading. In the event of a P4 release, it would be released as a liquid, and migrate in the subsurface until it encountered soils with ambient temperatures less than 44 C. Once ambient soil temperatures fall below 44 C, P4 freezes and remains immobile as a solid. Soils beneath the slag pit and furnace building were heated to temperatures above 44 C from the intense heat source of continuous tapping of molten slag into the slag pit, until slag ladling was fully installed in 2000.

FMC has documented P4 releases from certain specific areas and suspects that other historic releases of P4 have occurred in the former P4 working areas. However, determining the exact release points from all the P4 process vessels, waste management units, and related piping would pose significant technical challenges such as drilling through reinforced concrete foundations, and would likely require a very dense grid of sample points. Even if all release points were confirmed and the local extent of P4 could be precisely delineated, the design of a treatment alternative for P4-containing soils would pose technical challenges similar to the potential treatment processes for pond sludges discussed in the EPA's TIP report (EPA, 2003).

An important consideration relating to the former P4 working areas is that FMC has already removed the majority of P4 in the process equipment, and is committed to the removal of all remaining P4 from process equipment, including P4 in subgrade sumps and other vessels. This P4 is being recovered for sale or off-site disposal (if it does not meet the quality standards for sale). When P4 removal from process equipment is complete, there will be no remaining

primary sources of P4. The only sources of P4 will be secondary source(s) from past releases to the subsurface.

Subgrade piping in the former P4 working areas has been emptied, and will be plugged and abandoned in place within the boundaries of RU 1 and RU 2. FMC will evaluate the feasibility of removing the subgrade piping in areas between the former P4 working areas and the old ponds in RU 22a and RU 22b. The underground P4 process piping outside of RU 1 and RU 2 is the only potential P4 source outside RU 1 and RU 2 (there are no process vessels outside these RUs). Any potential P4 releases from this piping would be immobile because the ambient soil temperatures along the pipeline route are below 44 C. Given this immobility, excavation and removal of any P4-containing soils and backfill associated with the piping should be feasible.

In the former P4 working areas, there are multiple potential P4 sources that may have impacted subsoils, including spills over the 50+ years of plant operations, leaks from process and waste management vessels, and leaks from in-ground unlined launders and underground piping. Soil temperatures in parts of the RU 1 and RU 2 area were likely above 44 C, creating the conditions that could facilitate P4 migration from the release point. This conceptual model of P4 migration implies that the delineation of P4 distribution at depth would be very difficult if not impossible. FMC believes that the overall extent of potential P4 migration was constrained by the extent of the >44 C subsurface isotherm, and that the maximum historic extent of this isotherm can be calculated during the SRI to support development of a perimeter for a RCRA-engineered cap that will cover areas where P4 is presumptively present in the subsurface.

For RUs classified as former P4 working areas, the following RI/FS technical areas, modeled after EPA's technical areas for CERCLA Municipal Landfills, were developed to determine if sufficient data exist to support the decision outlined in Step 5 of the DQO Process.

RI/FS technical areas for former P4 working areas:

1. Worker Hazards – Excavation of former P4 working areas is evaluated with regard to the hazards associated with excavation of building foundations and reclamation of the former P4 working areas.
2. P4 in subsurface delineation – Data and information to determine the extent of P4 in the subsurface include process knowledge (where P4-containing liquids were stored, collected, or processed), location of sumps, underground pipes, and other vessels that may have leaked, and documentation of spills and their ultimate fate (collection sumps, storm drains, etc.).
3. Migration potential assessment – P4 is a liquid at temperatures greater than 44 C. At lower temperatures, P4 is a solid. A release of P4 at temperatures above the melting point into soils with ambient temperatures above 44 C could allow P4 to migrate to greater depths than a release where the ground temperatures are lower than the melting point. Sustained subsoil temperatures in excess of 44 C arising from 50 years of discharge of molten slag in the Slag Pit (RU 2) could contribute to further subsurface migration of the P4.
4. Existing cover assessment – At several buildings, the existing cover is the concrete slab foundation of the building. In other areas there is no existing cover at this time, and for the subsurface pipes, the existing cover is the backfill used in the trenches. In the former P4 working areas, it is likely that the backfill for buried pipes is similar to the fill logged

in numerous soil borings drilled in the main plant area, slag mixed with a small proportion of native soils.

5. Surface water run-on/run-off management – Each RU and capped area will require evaluation within the context of site-wide drainage and grading patterns. In addition, the former P4 working areas have existing surface water catchments and storm drains that allow for surface runoff to drain from the former working areas. Prior to remediation, these storm drains will be evaluated for plugging/abandonment to control infiltration through leaking storm drains into P4-containing soils, and to reduce the runoff through the former P4 working areas.
6. Cap design/source material characterization – FMC assumes that former P4 working areas such as RU 1 and RU 2 will be capped to reduce exposure potential and infiltration through the soils potentially containing P4. Therefore, FMC will confirm the cap design with EPA, and confirm the suitability of the cap materials for the reduction of infiltration.

6.1.2.1 RU 1 – Furnace Building and RU 2 – Slag Pit

Figure 6-11 summarizes the following discussion. The Furnace Building, Phos Dock, and Secondary Condenser area (RU 1) and Slag Pit (RU 2) are considered together because of their proximity and because of the documented occurrence of P4 in the subsurface within the RU boundaries (Figure 6-12). In addition, these Former P4 Working Areas are former heat sources that likely affected the mobility of P4 in the subsurface.

Worker Hazards

Although not directly applicable to the former P4 working areas, the TIP Report (EPA, 2003) documents the worker hazards associated with delineation, excavation, handling and treatment of P4 containing materials. The P4 released from spills and leaks within RU 1 and RU 2 is intermixed with soils and materials beneath the building foundations. Treatment of these soils to remove P4 would pose similar technical challenges associated with treatment of P4-containing sludges at the old ponds. These hurdles include:

- Controlling worker exposure to P4 during excavation and treatment
- Design of the appropriate treatment system
- Operation of the treatment system with variable inputs (varying concentrations of P4, varying soil types, etc.)

The TIP report concluded that there are no applicable treatment technologies available for P4-containing soils and sludges containing P4, metals, and radionuclides. This is relevant to the former P4 working areas within the FMC Plant OU, although the metal and radionuclide content of the impacted soils would be less that that found in old phossy pond sludge. The main hurdle for treatment of P4-containing soil and sludges was designing the appropriate treatment system that could accommodate the highly variable P4 content of the material.

Another factor that poses significant challenges to removal and treatment of P4-containing materials at RU 1 and 2 is the identification of areas where P4 is present. Unlike the phossy ponds where P4 is present in the sludges at varying concentrations, the P4 beneath RU 1 and RU 2 is likely to be scattered in “pockets” beneath these former working areas. In other words, the P4 content in soils beneath RU 1 and RU 2 is likely to be more variable than in pond sludges. Identifying the location of each “pocket” and characterizing the extent of these spills/releases

would require a significant sampling effort, and the results would be inconclusive with respect to precluding all future exposure to P4. Extensive sampling of P4-impacted soils also increases the potential for worker exposure to P4 and other site hazards.

P4 in Subsurface Delineation

The following discussion focuses on the known and potential extent of P4 in the subsurface at the furnace building and slag pit. As described above, there are numerous concrete-lined P4 sumps, phossy water sumps, and other vessels that are potential P4 sources within RU 1. Past spills of process materials also can be considered potential P4 sources to subsurface soil and fill in the RU 1 area. Within RU 1 and RU 2, the slag and furnaces heated the underlying soils, providing conditions where P4 would have remained in a liquid state.

A leak in the #3 furnace P4 sump was discovered during the conversion to slag ladling in 1999-2000. During the conversion, P4 was encountered beneath the furnace building foundation. Upon investigation, small cracks were discovered in the concrete-lined sump, indicating this was a source of elemental phosphorus in liquid phase to the subsurface. Given the long service life of other concrete-lined sumps in the furnace building, the logical conclusion is that some of these process units are also potential sources of P4 within RU 1.

During the EMF RI, two soils borings were drilled in the paved area north of the furnace building (F064B and F069B). These borings did not encounter P4 at depths of 4.5 and 5.0 feet. Boring F052B, drilled in the secondary condenser area did not encounter P4. The total depth of this boring was 20 feet.

The CSM identifies potential exposure to soils and fill to depths of 10 feet. Only one soil boring within RU 1 and RU 2 extends beyond this depth, and there are no soil borings along the western and southern boundaries of RU 1 and 2 to confirm the extent of P4 in the 0-10 foot depth interval. There is insufficient data available to satisfy this technical area.

P4 Migration Potential Assessment

As noted above, when ambient temperatures exceed 44 C, elemental phosphorus is in a mobile, liquid state. In this state, it can seep through soil until it reaches areas with lower temperatures, at which time it solidifies and is no longer mobile as a liquid phase.

The density of P4 in a liquid state is 1.7 gm/cc. A P4 release from process equipment (all above the melting point) will migrate in a vertical, but tortuous path through the soil column. As long as there is a source of P4, and ambient temperatures remain above the melting point of P4, the P4 will continue migrating vertically to the water table. When the P4 encounters the groundwater, it will cool to below the melting point, and immobilize. As shown in Figure 6-13, the groundwater temperature at Well 108 exceeded 28 C, suggesting that groundwater with ambient temperatures of > 44 C could underlie the furnace building and slag pit (the most intense heat source). Once the ambient temperatures fall below the P4 melting point, only soluble concentrations of P4 would be transported by the groundwater. The solubility of P4 in water is 3 mg/l, and if the water has an oxidizing Eh, the P4 will be converted to an oxidized phosphorus compound (orthophosphate). The maximum concentration of P4 observed in Well 108 was 0.258 mg/l, well below the solubility limit of P4.

The 44 C isotherm in the soil column beneath RU 1 and RU 2 has not been mapped or modeled. This technical area is not satisfied, and additional evaluation is needed.

Existing Cover Assessment

At the Slag Pit, RU 2, there is no existing cover apart from the RCRA interim cover at the Slag Pit Sump, so an assessment cannot be performed. The Slag Pit Sump will be closed in accordance with the RCRA Closure Plan for this unit.

The furnace building foundation is primarily a level concrete slab with below grade sumps and launders. After demolition of the superstructure is completed, the sumps and below grade features will be backfilled and the fill material will be graded to manage run-on/run-off and prevent water accumulation in these areas. Below grade piping will be plugged and abandoned in place. If capping is selected as the remedy, the concrete foundation will be integrated into the final contouring of RU 1 and RU 2 during the RD phase. Cap design will be RCRA-equivalent, and will not rely on the concrete slab to minimize infiltration.. As part of the site decommissioning activity, all piping routed from the sumps will be emptied, plugged, and abandoned, and the sumps will be backfilled. Details of the foundation after all equipment and structures have been removed will be documented for the final cap/cover design.

Additional information to support a final cap/cover design is not required at this time. The integration of reinforced concrete slabs and paved areas into a final cover will be an engineering task during the SFS and RD.

Surface Water Run-on/Run-off Management

Management of surface water run-on/run-off within RU 1 and RU 2 will be a design consideration for capping these areas. The design can be performed during the SFS or RD phase, and the final cover configuration will be integrated into a master site drainage plan.

Cap Design/Source Material Characterization

As with the RCRA WMUs that have been capped or are undergoing closure, the borrow areas for soil covers are within the FMC Plant OU. These borrow areas have been characterized to confirm the material's suitability for cap material. Characterization includes permeability testing and sieve analyses to determine the grain size distribution and the clay and silt fraction of the material.

The permeability testing confirms the soils are suitable for reducing infiltration into the underlying waste-bearing material, thus reducing the potential for transport of contaminants to groundwater. The physical characterization data are presented in Appendix D.

As with the surface water management technical area, the final cap design would be performed during the SFS or RD phase, and the final cap design would be approved by EPA.

Statistical Comparison of Site Data with RBCs

The soil data collected within RU 1 and RU 2 were compiled and sorted to statistically compare with the 1998 RBCs, the Updated Site Worker RBCs, the Construction Worker RBCs, the Utility Worker RBCs and EMF RI background levels.

Only inorganic constituents were statistically analyzed.

Because there were no soil samples collected from 0' to 2', no comparison was made with the 1998 RBCs and the Updated Site Worker RBCs.

Constituent concentrations in soils within the 0' to 10' interval did not exceed the Construction Worker RBCs or the Utility Worker RBCs at the 95% confidence level.

Comparisons with the updated RBCs for P4 could not be performed because P4 analytical data were not available.

Site soil concentrations exceeded the EMF background levels for several constituents (Appendix C).

Data Gaps

A model to evaluate the extent of the 44 C isotherm should be performed to evaluate the areas where P4 may have migrated in a liquid state from potential sources in RU 1 and RU 2. The isotherm modeling study will be coupled with confirmation sampling to determine the extent of the area to be capped.

The confirmation sampling will be performed along the periphery of the modeled 44 C isotherm to confirm the modeling results and support decisions regarding the extent of the capped areas in RUs 1 and 2.

RU 6 – Long-term Phos Storage Facilities

The discussion of RU 6 is summarized in Figure 6-14. The long-term phosphorus storage area was built for P4 storage (Figure 6-15). This allowed FMC to own/lease and operate their railcar fleet with more flexibility.

In the early 1990's FMC determined that the long-term storage tanks were no longer economical. The P4 was removed from the tanks and the tanks were removed from the excavation. Tank removal occurred in two phases; eight were removed in 1994 and four removed in 1998. During both phases of tank removal, FMC personnel noted the presence of P4 in the tank backfill. The presence of P4 was around the fill holes, indicating the P4 in the backfill was due to overfilling rather than a P4 product leak.

Worker Hazards

Based on conditions observed during tank removal, low levels of P4 are anticipated in the subsurface. P4-related worker hazards are not anticipated to be significant at this RU.

P4 in Subsurface Delineation

As noted above, P4 was observed in the tank backfill at low levels. It has not been delineated within RU 6. Additional confirmation sampling is needed at RU 6.

P4 Migration Potential Assessment

P4 spills at RU 6 would be limited to the area immediately surrounding the former underground storage tanks and the railcar loading/unloading area. This is because spilled P4 would be cooled to below 44 C, and freeze if it had been released. As noted above, P4 was encountered in the tank backfill area. When the tanks were in operation, the P4 migration potential was very low, and after tank removal, there is no remaining P4 and therefore, no potential for P4 migration.

Existing Cover Assessment

There is no existing cover at RU 6. However, the removal of the P4 tanks and placement of clean backfill should not require the assessment of existing cover.

Surface Water Run-on/Run-off Management

Because the storage tanks and residual P4 in the tank backfill were removed during tank closure, surface water run-on/run-off management at RU 6 does not require a management plan.

Cap Design/Source Material Characterization

Because the P4 tanks have been removed, and P4-containing soils and backfill were removed, there is no need for a cap at RU 6. Therefore, cover source material characterization is not required.

Statistical Comparison of Site Data with RBCs

The soils sampled from the two borings within RU 6 did not exceed the RBCs for the analyzed COPCs (P4 was not analyzed). However, there is only one sample from the 0-2' interval and three samples from the 0-10' interval. These intervals are insufficiently characterized to reject the null hypothesis and accept the alternate hypothesis that concentrations of inorganics are less than RBCs.

The comparison against EMF RI background levels shows that several constituents exceed background levels and several are below the background levels. However, for many constituents, there are insufficient samples collected to support the decision at the 95% confidence level.

Data Gaps

There is a data gap in the 0-10' depth interval for inorganics. Additional samples are needed to perform the statistical tests at the prescribed confidence levels.

There is a potential that spills may have occurred during loading and unloading of railcars with P4. Shallow soil samples near the spur line are needed to evaluate the potential for P4 in the 0-10' depth interval.

Slag was not logged in the two EMF RI soil borings. However, slag was likely used as backfill in the old tank pit and as fill for the rail spur within RU 6. Gamma radiation measurements are needed to address the gamma radiations associated with slag backfill.

6.1.3 Landfills (RU 17, RU 18, and RU 19)

The discussion of landfills within the FMC Plant OU is summarized in Figure 6-16. The following discussion for landfills within the FMC Plant OU discusses all landfills together instead of each RU separately. Because of the similarities of the landfills, separate discussions would be redundant.

Three Remediation Units are known to contain solid waste landfills, RU 17, RU 18, and RU 19, at the FMC Plant OU (Figure 6-17). Given the known contents of the landfills, the agencies recommended that FMC consider application of the EPA's Presumptive Remedy for CERCLA Municipal Landfills. FMC's remedial vision for the three landfills includes capping or soil cover that effectively contains the wastes in these landfills. Key points that support the application of the presumptive remedy are:

- The 1998 ROD did not select a remedy for the operating landfills or the slag pile
- At RU 17 and 18, there is sufficient information to satisfy the EPA's six Technical Areas for RI/FS Data Collection for the presumptive remedy
- All three landfills fail EPA criteria for hotspot removal and treatment
- For RU 19, per the SPM, FMC will discuss potential infiltration/percolation of elemental phosphorus to groundwater and resulting impacts to groundwater quality from the 17 buried railcars (Figures 6-18, 6-19, 6-20, and 6-21). This will require

developing bounding assumptions for a source term and reasonably conservative hydraulic/transport properties to assess the possible impacts to groundwater. The potential source analysis of the sludge-filled railcars will be performed as part of the SRI.

- The landfills within RU 19 and RU 18 might have been disposal areas for solvents and waste oil. Past disposal practices may have allowed some of these materials to be placed in these landfills as a free liquid.
- The CSM recognizes that the former plant landfill, the railcars buried in the slag pile, and the existing plant landfill may be sources of contaminants to groundwater. Given this potential, an objective of the presumptive remedy will be to minimize infiltration through the waste mass in these RUs.

As noted above, the agencies recommended that FMC consider applying the presumptive remedy for the landfills within the FMC Plant OU. At RU 19, the presumptive remedy of containment will be applied to the former plant landfill and other areas of the Slag Pile known to contain process wastes, specifically phosphorus sludge buried in rail cars.

Each of these remediation units are considered in terms of the six Technical Areas defined in EPA's publication "Presumptive Remedies: CERCLA Landfill Caps RI/FS Data Collection Guide" (EPA, 1993). These six Technical Areas are:

1. Waste Area Delineation
2. Slope Stability and Settlement
3. Gas Generation/Migration
4. Existing Cover Assessment
5. Surface Water Run-on/Run-off Management
6. Clay Sources

Technical Area 3, Gas Generation/Migration, is primarily concerned with the migration of methane gases generated during the decomposition of organic materials within the landfill to structures and VOCs that may have been disposed in the landfills. FMC evaluated this Technical Area assuming gas migration could include radon as well as methane and VOCs.

Technical Area 6 can be restated as: Cover Material Characterization for the FMC Plant OU for the following reasons:

1. The FMC Plant OU is located in a semi-arid climate, which is conducive for installing a capillary barrier cap rather than a clay cap.
2. The performance of RCRA capillary barrier caps installed at FMC supports the installation of a capillary barrier cap, rather than the clay cap.
3. FMC has characterized the borrow areas from which cap material will be obtained (Appendix D). These materials have been used effectively at RCRA WMUs within the FMC Plant OU.

A seventh Technical Area was developed for this evaluation. This Technical Area is "Hotspot Removal and Treatment Evaluation".

In order to consider hotspot removal and treatment, the following questions must all be answered in the affirmative (EPA, 1993):

- Is there evidence for the presence and approximate location of waste?
- Is hotspot known to be a principal threat waste?
- Is the waste in a discrete, accessible part of the landfill?
- Is the hotspot known to be large enough that its remediation will reduce the threat posed by the overall site, but small enough that it is reasonable to consider removal (100,000 cubic yards or less)?

EPA recognizes the potential hazards and technical difficulties associated with characterizing wastes in a landfill. EPA states: "Characterization of a landfill's contents is not necessary or appropriate for selecting a response action for these sites except in limited cases; rather, existing data are used to determine whether the containment presumption is appropriate.… It is important to note that the decision to characterize hot spots should also be based on existing information, such as reliable anecdotal information, documentation, and/or physical evidence (see page 6)." (EPA, 1993).

The existing data regarding waste characterization in FMC's landfills are summarized in Table 6-3.

Technical Area 1 – Waste Area Delineation

The delineation of all three landfills has been performed by reviewing historic air photos to confirm that waste management has not occurred outside the current boundaries, and to determine the boundaries of the former plant landfill beneath the slag pile. At RU 17 and RU 18, the landfill areas have been delineated visually by confirming the extent of the disturbed soils and extent of past excavation.

The footprint of RU 17 and RU 18 may be extended during FMC's plant decommissioning and demolition activities. FMC anticipates that a significant volume of material generated during demolition will be hauled offsite and sold as scrap, or reclaimed for commercial value. Material that has no value as scrap will be landfilled in the area between RU 17 and RU 18 (Figure 6-17).

The Former Plant Landfill within RU 19 has been inactive and buried with over 40 feet of slag since the late 1960's or early 1970's. The timing of burial is difficult to pinpoint, but the 2003 air photo clearly shows the entire former landfill area seen in the 1965 air photo is covered with slag (Figure 6-20).

RU 19 also contains approximately 17 buried rail cars. These rail cars were filled with sludge in 1964 and hauled up to the slag pile (Figure 6-19). The rail cars are an older generation of tank cars, approximately 30 feet long (compared to 50 feet long for later generation tank cars), and 9.5 feet wide. RU 19 also encompasses the former plant landfill (Figure 6-21).

The reason for sludge disposal in surplus rail cars was explained by former FMC personnel. Apparently, in 1962 the plant became "sludge bound", meaning that the process was not efficiently separating pure P4 from particulates (dirt) in the furnace off-gas, causing the dirt content to be too high. The P4, dirt and other material formed a sludge that could not be reclaimed, and there was insufficient capacity in the existing ponds to contain the excess sludge.

To remove the sludge from the plant area, the rail cars were filled and hauled to the slag pile for burial.

Phosphorus sludge present in the buried railcars is an emulsion of P4, water, and "dirt." P4 globules suspended in water will join and form a continuous layer of elemental phosphorus at the bottom of collection sumps and storage tanks. In the presence of high dissolved solids in water, or impurities (i.e., dirt) carried in the furnace gas stream, the P4 globules cannot bind together and form a continuous layer of P4.

Phosphorus sludge formed when the dissolved solids (ions) and suspended dirt "coat" the P4 globules. This coating prevented the coalescing of P4 globules by preventing the globules from contacting each other. As a result, the globules remained in suspension, forming an emulsion with the water.

Ions and charged dust particles adhere to P4 globules in low pH environments, so sludge formation was more prevalent at pH <3, but would also form at higher pH if there was sufficient dust and ions in the water.

Another factor that influenced sludge occurrence is the rate of cooling in the primary condenser. Faster cooling rates led to smaller P4 globules, which would not coalesce as readily as larger globules.

The sludge buried in the railcars was excess sludge generated in 1962 to 1964 when the FMC furnaces and/or condensers were not operating optimally. There were too many impurities in the process not allowing P4 product to adequately settle out. Instead, a significant quantity of P4 globules was emulsified into sludge. Excess phosphorus sludge was temporarily stored in 30 railroad tank cars, specifically purchased for this storage. The contents of these railcars were reprocessed after process improvements had been implemented. FMC personnel emptied all 30 railcars to recover P4 product but left the phosphorus sludge in the railcars for expected removal during subsequent railcar cleaning.

After P4 product recovery was completed and the railcars were no longer needed for storage, nine of the 30 railcars were completely cleaned of phosphorus and phosphorus sludge and these cleaned railcars were sold for scrap. However, several "near miss" safety incidents associated with cleaning of these railcars in 1964 resulted in a decision not to attempt to clean but rather to bury the remaining 21 railcars at the south end of the slag pile (per the configuration of the slag pile in 1964). In the late Fall of 1964, the remaining 21 railcars were removed from their trucks, hauled to the slag pile, and buried with clay, then covered by slag. Subsequently, the railcars were further buried under the east slag pile as it advanced south. The location of the buried railcars is currently covered with a minimum of approximately 50 feet and a maximum of over 100 feet of slag.

The location of these buried railcars is documented in an aerial photo taken in June 1965, which shows seventeen identifiable, partially buried railcars. The tank dimensions are 30' in length by 9.5' in diameter. This yields a volume of 1703 cubic feet per rail car. The aggregate volume of all 21 railcars would be,1,325 cubic yards [(21 x 1703) / 27 cubic ft per cubic yd]. Current FMC personnel familiar with phosphorus reprocessing activities believe that the railcars may have contained phosphorus sludge at 50% to 75% of therailcar capacity. Thus, the amount of buried phosphorus sludge may range from 662 cubic yards (if 50% full) to 1,325 cubic yards (if 100%

full).Due to the P4 and potentially mobile metals in the sludge, FMC proposed to treat the burial area as a landfill and apply the presumptive remedy to this area of RU 19.

Technical Area 2 – Slope Stability and Settlement

Because there are no existing caps at RU 17 and RU 18, slope stability will be a design parameter for the SFS or RD phase of the project. RU 18 does have an existing soil cover with minimal slope over the inactive portions of the landfill. However, the essentially flat-lying nature of this soil cover does not require a slope stability analysis at this time.

Settlement of the waste mass is a concern due to uneven distribution of waste types, varying degrees of volume reduction during decay of the waste, and differential settling of the overburden. FMC has evaluated differential settling at several RCRA ponds that were capped in recent years, and the final caps have had survey monuments installed to monitor ongoing settling of the buried waste. This same approach can be implemented at the plant landfills to ensure differential settling does not lead to cracking of the cover or allow ponding of water on the surface.

At the former plant landfill in RU 19, the slope stability of slag can be confirmed from previous analyses, and the slopes will not exceed 3:1. Differential settling at the former plant landfill is unlikely to be a concern because the landfill has been compacted with over 40 feet of slag overburden in place since the late 1960's or early 1970's (over 35 years). This overburden should have compacted the underlying waste volume to the degree that ongoing settling will be minimal, if present at all. Similarly, the 50 feet of slag overburden on the buried rail cars should have a similar effect, meaning there will be little, if any differential compaction of rail cars and waste.

Technical Area 3 – Gas Generation/Migration

This technical area is primarily concerned with the potential for methane and VOC migration to structures, where it can accumulate. Sufficiently high gas concentrations can lead to explosive conditions, or displace oxygen and produce an oxygen-deficient environment. Another concern related to gas migration from landfills is that the gases can affect vegetation growing in the soil covers. High gas fluxes can displace oxygen from the root zone, and asphyxiate the plants, and some VOCs may be toxic to plants.

The landfills at FMC are located south of the slag pile, in an area of the FMC Plant OU that is considered much less likely to be redeveloped. In addition, the building design requirements to prevent radon buildup that are currently in force as deed restrictions will prevent the buildup of methane and VOCs in any future structures that may be built near the landfills.

There are two key points that affect the decision to collect soil gas measurements to characterize gas migration potential. First, the landfill contents must have a sufficiently high organic content to generate methane. Second, the landfill must contain sufficiently high quantities of VOCs to act as a soil gas source for the diffusion and migration of VOCs as a gas to a structure. At RU 17, there is no evidence to indicate that FMC used this for disposal of VOCs or material that could degrade and produce methane. The materials at RU 17 are characterized as building material (concrete, steel, and wood) and furnace dig-out material generated as waste during construction projects at the FMC plant. These materials do not produce methane in sufficient quantities or rates to be of concern, and therefore, RU 17 is unlikely to act as a source for methane or VOCs.

At RU 18, the plant practice was to store spent solvents and have them hauled off-site for disposal, so the volume of VOCs in the landfill are likely insufficient to produce a soil vapor plume that could impact nearby structures. Methane generation potential at RU 18 is also considered minimal; although it is likely some methane will be generated as paper and cardboard decays. Even if methane or VOCs migrate from the landfill area to a future structure located nearby, the radon control measures required for future buildings within the FMC Plant OU will limit the potential for VOC or methane buildup in these structures.

The former plant landfill in RU 19 is likely to contain a greater volume of spent solvents compared to RU 18, and may be a methane source. Future buildings that may be constructed in this area would have over 40 feet of vertical separation (slag) between the foundation and potential VOC sources within the former landfill, which would provide some degree of attenuation and dilution of gases emanating from the landfill. The buildings would require radon control design features, further reducing any potential intrusion of VOCs and methane into the structure.

Technical Area 4 – Existing Cover Assessment

Assessment of the existing cover is required when considering the presumptive remedy to determine if the existing cover is sufficient to utilize in the final cap design. In other words, if the soil covering a landfill or parts of a landfill is sufficiently thick, and the material is suitable for a cover layer, it can be integrated into the cap. If the existing cover is inappropriate, such as clay prone to cracking during dry periods, then it should not be integrated into the final cap design because it will not serve to reduce the infiltration potential of the cap.

Portions of the Recyclable Material Landfill, RU 17, are covered. The remaining portion does not have an existing cover. Because RU 17 and RU 18 are likely to be expanded to dispose of unsalvageable building material during plant decommissioning, an assessment of the existing cover should be performed after the landfill ceases operation.

Several cells at RU 18 have a soil cover. The soil is native soil excavated from within the footprint of RU 18, and is similar to the soil characterized for the RCRA pond covers. The soil map presented in the RI Report shows that soils in the RU 18 area are the same soil type as the soil from the RCRA cap borrow area. The permeability and sieve analyses from the RCRA cap soils are in Appendix D, and the data are summarized in Table 6-4. The uncovered cell has no cover that can be assessed at this time. It is likely that it, too, will have an initial cover of native soil placed over the waste.

RU 19 is covered by 40 to 60 feet of slag. FMC plans include recontouring the slag pile, with slopes of 3:1 (horizontal:vertical). This recontouring will maintain a minimum of 40 feet of slag over the Former Plant Landfill. Given the overall coarse grading of the slag and its uniform consistency, it will be analyzed as part of the final landfill cover design. In other words, the final cover design will integrate the slag into the landfill cover and be designed to minimize infiltration through the waste.

Technical Area 5 – Surface Water Run-on/Run-off Management

The surface water run-on/run-off effects of the cap configuration at RU 17, 18, and 19 must be considered within the overall FMC Plant OU surface drainage pattern. Remedial action at one RU must not induce ponding over other potential source materials or increase the erosion

potential in other parts of the FMC Plant OU. Surface water management is a design issue that will be addressed in the SFS or RD/RA phase.

Technical Area 6 – Cover Material Characterization

As noted in Technical Area 4, the soil used for RCRA caps at FMC has been characterized, and this same material would be used for the soil covers at the landfills.

The permeability data are summarized in Table 6-4.

Technical Area 7 – Hotspot Removal and Treatment

The criteria used to evaluate the feasibility for hotspot removal within a landfill are summarized against the information for each landfill. Included in this summary are the buried rail cars within RU 19, because the presumptive remedy of containment appears to apply to the sludge contained in the rail cars.

As shown in Table 6-5, the criteria are not met. A negative response means that hotspot remediation should not be considered as part of the presumptive remedy. And all the landfills within the FMC Plant OU should be considered for containment without hotspot removal.

Further supporting a containment remedy for the buried railcars is the fact that they contain P4-containing sludges. The EPA's TIP report concluded that treatment of these sludges is not technically feasible, and a containment remedy is the most suitable alternative. Even if the railcars could be excavated and removed, treatment of the sludges would not be feasible.

Summary

A summary of the RI/FS Technical Areas for the FMC Plant OU landfills is presented in Table 6-6.

FMC has identified an FS data gap associated with radon emission rates through a soil cover on the slag pile. Radon flux measurements will be collected during the SRI to support the SFS.

6.1.4 Other Remediation Units

This section discusses the RUs that are not classified as Old Ponds, Landfills, or Former P4 Working Areas. The RUs discussed in this section include:

- RU 3 – Receiving Stores, Paint Shop, and P4 Decon
- RU 4 – Office Buildings and Training Center
- RU 5 – Lab and Old Drainfield
- RU 7 – Shale Unload, Crushing and Stockpile
- RU 9 – Silica Stockpiles and Former Kiln Scrubber Overflow Pond
- RU 10 – IWW Pond and Ditch
- RU 11 – Equipment Area South of Calciners
- RU 12 – Former RP&S Area and Mobile Shop
- RU 13 – Pond 8S Recovery Process & Metal Scrap Preparation Area
- RU 15 – Oversize Ore, Used Electrode, Baghouse Dust Area
- RU 20 – Former Bannock Paving Area

- RU 21 – Other Onsite Railspurs
- RU 23 – Road segments not within RU Boundaries

A summary of the available datasets for soils in each RU is presented in Table 6-7. These datasets served as the starting point for statistical analysis, based on the DQO Process discussed above.

Methods:

First, the soil data at each RU was compiled. In some cases, source characterization data were also added to the RU-specific dataset because the presence of certain materials was observed during the RI. For example, at RU 20, slag was observed in the surficial fill material, so the six composite samples of slag characterized during the RI were added to the RU 20 dataset for comparison purposes. In addition, portions of RU 20 were used for ferrophos crushing, storage, and loading, so the RI composite sample for ferrophos was added to the dataset for RU 20.

Analytical data were also reviewed for data quality to determine that:

1. The detection limits were lower than levels of concern (RBCs, background, etc.)
2. There were no "R" flagged data in the dataset, "R" = analytical results rejected during the QA process. The "R" flagged data were not used in the statistical analyses.
3. Data were collected at locations across the Exposure Area, or RU, not centered in one area.
4. The sample depths corresponded to depths defined to be in an exposure pathway for one or more of the future exposure scenarios (i.e., sample depths greater than 10 feet were excluded because these soils are not considered to be in an exposure pathway, current or future).

Data were grouped to determine whether or not there was sufficient data collected to characterize various exposure scenarios. For example, future site workers may be exposed to soils in the upper 2 feet, whereas future construction and utility workers may be exposed to soils to depths of 10 feet below grade.

Once the data were grouped by depth (0-2 feet and 0-10 feet), the distribution of each constituent was checked using the Shapiro-Wilk Test, which was performed with EPA's ProUCL software at the 95% confidence level. Data distributions fell into three categories; normal distribution, lognormal distribution, or unknown distribution. The distribution for datasets with 4 to 9 samples were not checked. Instead, the 95% UCL was calculated using the non-parametric Chebyshev method, which is independent of distribution assumptions.

Then, the 95% Upper Confidence Limit about the mean value was calculated using the ProUCL software. Table 6-8 summarizes the statistical tests used for the various data distributions encountered.

For data values reported with a "U" or "UJ" qualifier, meaning the constituent was "not detected" at the reported value, the full value of the reported detection limit was used in the data set when performing the calculations or testing the data distributions. The treatment of "non-detects" is described in EPA Guidance (EPA, 2002). In cases where there were 10 or more samples in a dataset, and 15% or more of the data were reported as "not detected", no tests for distribution were performed, and a non-parametric method was used to calculate the 95% UCL of the mean.

Once the 95% UCL of the mean was established for each inorganic parameter, the 95% UCL value was compared against the RBC for the parameter, and the difference was defined as the "delta" value for testing whether or not sufficient samples had been collected for a valid comparison. These tests were done only in cases where the 95% UCL of the mean was 10% or more of the RBC value.

RU 20 Example:

Dataset Description – 10 soil samples, 6 slag composite samples, 1 ferrophos composite sample (total = 17).

Question: Do the materials contained in depth intervals 0-2 feet and 0-10 feet contain inorganic constituents above the RBCs?

Step One: Determine data distributions for various groupings of data. Slag and ferrophos results were included in all depth ranges because slag occurs from 0 to 7 feet bgs, and ferrophos occurs at ground surface (possibly to depths of 1 foot due to mechanical mixing while loading).

Step One Results are shown in Table 6-9 for the various sample groupings.

For 0-2 feet, there were no soil samples analyzed at RU 20. However, there were six slag composite samples and one ferrophos composite sample analyzed during the RI. Because slag fill and ferrophos are present across RU 20 to depths of 1 to 7 feet, and because ferrophos was crushed, stored, and loaded within RU 20, it is believed these samples are representative of site conditions for inorganic constituents in the upper 2 feet across the site.

Step Two: Using the appropriate method, calculate the 95% UCL about the mean for each constituent being analyzed.

Where 10 or more samples were available, the distribution of the dataset was analyzed using the Shapiro-Wilk method to determine if the distribution was normal or lognormal. If the data was not normally or lognormally distributed, a non-parametric technique was selected to calculated the 95% UCL. When the data were determined to be normally or lognormally distributed at the 90% confidence level, the 95% UCL was calculated using the student's t method.

The Chebyshev method was the selected non-parametric technique selected for calculating the 95% UCL where the distribution could not be determined.

When the dataset was comprised of 4 to 9 samples, a non-parametric approach was used for calculating the 95% UCL of the mean concentration. The Chebyshev method, which is typically the most conservative (i.e., highest), was selected for the appropriate value of the 95% UCL.

The 95% UCL for sample sizes less than 4 were not calculated, and for these RUs, a data gap was identified, and additional samples will be collected as part of the SRI. The sampling design will be described in detail in the SRI Work Plan, and will follow the EPA's DQO Process.In the example for RU 20, the native soils were analyzed separately from the slag samples because these materials are not from the same population. This can be readily seen when testing the distribution of the data. Concentrations in slag samples are normally distributed for many of constituents at the 90% confidence level. Similarly, the native soil samples show normal or lognormal distributions for many constituent concentrations. When the datasets are combined, the distributions are bimodal, and cannot be considered normal or lognormal.

The 95% UCL for the slag and native soil concentrations were compared to the future site worker RBCs separately.

While Gibbons (2003) advocates sample sizes of 20 or more to achieve adequate power for conducting statistical tests, it should be noted that the power of these tests relates to accepting the null hypothesis as true when it is false. In cases where the 95% UCL of site materials exceed an RBC, FMC will determine if additional characterization is warranted to reduce their risk of having to conduct a remedial action where it may not be needed. In some cases, it is considered unlikely that additional data will alter the outcome, even though the sample size may not have sufficient power.

Step Two Results are shown in Table 6-10, Table 6-11, Table 6-12.

Step Three: Calculate the delta (gray region) by subtracting the 95% UCL about the mean from the RBC. Because there are four RBCs calculated for each COPC, plus one representative level (background) for each COPC, five delta values were calculated.

Delta 1 = Difference between 95% UCL and RBC from 1996 HHRA (exposure interval from 0-2 feet)

Delta 2 = Difference between 95% UCL and updated RBC for future site worker (exposure interval from 0-2 feet)

Delta 3 = Difference between 95% UCL and updated RBC for future site construction worker (exposure interval from 0-10 feet)

Delta 4 = Difference between 95% UCL and updated RBC for future site utility worker (exposure interval from 0-10 feet)

Delta 5 = Difference between 95% UCL and representative level of constituent in soils

Step Three Results are shown in Table 6-13, Table 6-14, Table 6-15, Table 6-16, and Table 6-17.

Step Four: Calculate the number of samples needed to test the null hypothesis "95% UCL about the mean exceeds RBCs" at the 5% Alpha Level, and 10% Beta Level. The alternative hypothesis is "95% UCL about the mean does not exceed the RBCs (or representative levels)". The alpha level is the potential for a Type I error, or probability that a site is classified as not exceeding RBCs when in reality it exceeds RBCs. The Type II error, or beta level, is the probability that the decision was made that site soils exceed RBCs when in reality they do not.

Where 10 or more samples were available, the Shapiro-Wilk normality test was performed. If the samples indicated a normal or lognormal distribution was evident in the underlying population, then the equation below was used to calculate the number of samples required to support the decision:

$$n = \frac{s_{total}^2 \left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{\Delta^2} + 0.5 Z_{1-\alpha}^2$$

When there were between four and nine available samples, a non-parametric equation was used to analyze whether or not sufficient samples had been collected to support the decision. The equation below was used for cases where a normal distribution is not assumed:

$$n = 1.16\left[\frac{s_{total}^2\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{\Delta^2} + 0.5Z_{1-\alpha}^2\right]$$

No tests for the adequacy of sample size were performed when the 95% UCL of the mean was less than 10% of the RBC or comparison value. For example, if the 95% UCL of the mean was 4.3, and the RBC was 52.2 (4.3 is less than 5.22, which is 10% of the RBC), no tests for sample size adequacy were performed. No tests for sample size adequacy were performed for comparisons against background levels.

A further assumption underlying the calculations for sample size is that the samples are not correlated in space or time. Given the homogeneity of native soils observed in numerous borings throughout the FMC Plant OU, spatial correlation can be ruled out for native soils. Furthermore, the homogeneity of fill also precludes spatial correlation in the distribution of inorganics for media within exposure pathways (i.e., 0-10' depth intervals). Fill material is typically a mixture of slag and native soils. In RU 7, RU 9, and RU 10, fill is typically a mixture of ore and native soils. Slag is found on some roadways within these RUs.

Step Four Results are shown in Table 6-18.

Step Five: State the decision: Slag, ferrophos, and soils are sufficiently characterized at RU 20 to support the decision at the specified Type I and Type II errors.

In other words, none of the inorganic constituents exceeded the updated RBCs for future and/or current exposure scenarios, with the exception of arsenic. However, arsenic is sufficiently characterized to reject the null hypothesis when comparing against background (7.7 mg/kg) and accept the alternative hypothesis, that arsenic concentrations in the potential exposure pathways are less than the representative levels.

Thallium may be a potential concern in the Future Site Worker pathway because the analytical results for slag and ferrophos were rejected during the RI QA data review. The soil data from other areas of the FMC Plant OU indicate exposure to thallium will be much lower than the RBCs for Site Construction Workers and Site Utility Workers at depths below the slag fill.

Similar steps were followed to determine whether the site was adequately characterized for gamma radiation measurements.

RU 20 – Former Bannock Paving Area

The following discussion of RU 20 is summarized in Figure 6-22. FMC's remediation vision for RU 20 is No Further Action anticipated to be necessary.

As noted in Section 2, the CSM indicates some uncertainty associated with potential hydrocarbon sources to groundwater. Several of these potential sources are located within RU 20.

Since the EMF RI was completed, there have been no reported spills or releases within RU 20 (Figure 6-23). Some slag and ferrophos piles remain within RU 20, however, all fuel tanks and asphalt production equipment has been removed.

An alleged spill was investigated in 1997 by the Jack B. Parson Co. and the results show that TPH was present in one sample collected in the slag backfill at concentrations below action levels. Eight other samples collected during this investigation did not contain detectable levels of hydrocarbons.

Inorganics do not exceed updated RBCs for the three exposure scenarios evaluated (Appendix C). The decision is supported at the 95% confidence level.

During the EMF RI, elevated levels of nitrate were detected in groundwater samples from Well 139, located approximately 450 feet west of the coke drying scrubber basin. The source of this nitrate was not confirmed during the EMF RI. Subsequently, a potential source has been identified. Wet coke was stockpiled in the area of Well 139 before the coke was dried prior to introduction into FMC's production process. Coke production is a major source of ammonia sulfate, a fertilizer compound, and wet coke can contain a significant amount of ammonia because it has not been fully dried. The wet coke stockpile was not covered or lined, so precipitation could infiltrate the wet coke, oxidize and leach ammonia, and ultimately transport it to the uppermost aquifer. The Eh in the vadose zone would also allow mobilized ammonia to oxidize to nitrate as it was transported through the vadose zone.

The gamma radiation measurements are insufficient to support a decision. Twelve additional readings would be required to determine if the site exceeds gamma radiation levels. Because external gamma radiation makes up over 90% of the incremental cancer risk, the appropriate data for characterizing cancer risks associated with radionuclides at RU 20 is the gamma radiation measurements. These measurements account for all gamma emitters, rather than extrapolating gamma radiation from radionuclide concentrations measured in discrete or composite soil samples.

Residual coke remains on the ground surface near the coke drying facility. There is no available analytical data, other than a TCLP analysis, to characterize the coke.

Insufficient samples were collected to support a decision that all potential fuel release sites have been adequately characterized, nor has the potential for releases through the septic system been investigated.

Data Gaps

Additional data are needed to characterize potential hydrocarbon releases in areas where BAPCO maintained above-ground fuel storage tanks. Characterization of potential releases will include an evaluation of potential groundwater impacts, if there is evidence of vertical migration to sufficient depths.

Additional measurements are needed to characterize gamma radiation within RU 20 to support a valid statistical comparison with background levels. The number of gamma measurements will be detailed in the SRI Work Plan through the application of the DQO Process.

Characterization of residual coke is needed to support a decision to either forward RU 20 to the SFS or determine that no further action is needed. This characterization will include leachability testing for ammonia and nitrate to confirm the source of elevated nitrate in Well 139.

There is a lack of data needed to characterize radionuclides associated with phossy solids that may be present within portions of RU 20. Lead-210 and polonium-210, radionuclides associated with phossy solids, will be characterized through the use of field XRF analyses, described in Appendix H.

RU 3 – Receiving Stores, Paint Shop, and P4 Decon

Figure 6-24 summarizes the following discussion of RU 3. FMC remediation vision for RU 3 is "no further action anticipated to be necessary".

The buildings within the RU 3 footprint were in use during the RI, and continued in use through 2002 (Figure 6-25). The paint shop is no longer used, and the receiving area is used for storage of safety equipment.

The P4 Decon building was put into service after the EMF RI was completed, and is still in use. The P4 Decon building is used to remove P4 from equipment, piping, etc. before being shipped offsite for re-use/recycling. It is operated under RCRA, no spills or releases have been reported, and FMC will close the facility under RCRA standards after plant decommissioning.

Phossy water releases in RU 1 (Phos dock and furnace building) may have affected the RU 3 area. A storm drain connects RU 1 and the Railroad Swale, and this drain runs through RU 3. Several phossy water releases occurred that may have entered the storm drain, and if the storm drain leaked, some P4 and other constituents may be present near the storm drain.

The boiler fuel tank was removed from service, and confirmation soil samples, collected during tank removal, show that no residual hydrocarbons above action levels remain in surrounding soils.

Statistical Summary

There were insufficient soil samples collected to statistically evaluate the soil concentrations against RBCs or background levels.

Data Gaps

Statistical analyses of the existing data could not support a decision as to whether or not constituent concentrations in site soils exceed RBCs. Only two soil samples are available in RU 3 that could be used to characterize the site construction worker exposure scenario. Additional samples are needed to characterize inorganic constituent concentrations in the 0-2 foot interval and the 2-10 foot interval.

Evaluation of the storm drain condition is a data gap that will be addressed in the SRI. Video inspection of the storm drain will help determine its integrity, and if leaks are identified during this inspection, P4 sampling will be performed around the storm drain.

There is some evidence that slag was used as fill within RU 3. Gamma measurements will be needed in RU 3 to characterize the gamma radiation potential. The number of gamma measurements will be detailed in the SRI Work Plan through the application of the DQO Process.

Although lead-210 and polonium-210 are not identified as COPC's in Table 6-1 for RU 3, the XRF screening method for phossy solids will be conducted at RU 3 during the SRI to confirm that phossy solids and the associated radionuclides are not present at levels of concern.

RU 4 – Office Buildings and Training Center

Figure 6-26 summarizes the following discussion on RU 4. The remediation vision for RU 4 is "no further action anticipated to be necessary". However, during the EMF RI, toluene was detected in boring F028B in low levels in all sampled soil horizons. The VOCs detected in F028B are thought to be associated with the Chem Lab Seepage Pit (SWMU 39). Although the EMF RI concluded that there were was no indication of a VOC source to groundwater, there is some uncertainty and additional characterization will be needed.

There were no additional source mechanisms identified in the post-RI period. The septic system serving the plant buildings was emptied and backfilled in 1995, when the plant connected the sanitary lines to the Pocatello sewage treatment plant.

Plant piping drawings indicate that underground phossy water piping is not within RU 4 boundaries.

The EMF RI found slag fill in the shallow intervals in most borings drilled within RU 4 (Figure 6-25). The analyses of these samples identified some constituents above representative levels. Based on the EMF RI findings at roads and rail spurs in the FMC Plant OU, it is likely that rail lines and roads within RU 4 are underlain by several feet of slag.

The EMF RI did not identify any potential contaminant sources to groundwater within RU 4. Site-related constituents associated with the slag fill and the application of IWW water for irrigation were identified in shallow intervals, but they were attenuated at depths of 10 to 20 feet.

The laboratory seepage pit was investigated during the EMF RI as a potential source of organic compounds. Boring F028B was sampled and analyzed for organic compounds. The EMF RI concluded that there was no source of organic compounds to groundwater, and no soil impacts associated with the laboratory seepage pit.

Gamma radiation readings were made during the EMF RI, one indoor measurement and one unshielded outdoor measurement. The unshielded reading was 20 microrem/hour, which exceeds the background level of 13 microrem/hour.

Statistical Summary

There were insufficient data in the 0-2' interval to statistically evaluate whether or not concentrations of inorganic parameters exceed the RBCs.

In the 0-10' interval, the soil concentrations do not exceed the Construction Worker RBCs or the Utility Worker RBCs at the 95% confidence level.

EMF RI background concentrations for several parameters were exceeded at the 95% confidence level. Several parameters were below background levels; however, for many parameters, a statistical comparison was not supported by the number of available samples.

Data Gaps

Additional gamma radiation measurements are needed to characterize gamma radiation effects in the RU 4 area. The number of gamma measurements will be detailed in the SRI Work Plan through the application of the DQO Process.

Additional soil samples are needed to characterize the 0-2' soil interval. These data will support a statistical comparison between the site soil concentrations and the Updated Site Worker RBCs.

As noted for RU 3, there is no evidence that phossy solids were disposed or stored within RU 4; however, the XRF screening method described in Appendix H will be performed during the SRI.

RU 5 – Lab and Old Drainfield

The discussion of RU 5 is summarized in Figure 6-27. The remediation vision for RU 5 is "no further action anticipated to be necessary".

SWMU #61, the disposal area behind the laboratory, is also located within the RU 5. This area has been identified as a potential source for solvents and metals. There may have been some disposal of free liquids in this area, which is now covered with sidewalks and a parking area.

The EMF RI targeted the laboratory seepage pit at RU 5 as a potential source of inorganics and VOCs (Figure 6-25). The seepage pit received laboratory acids and solvents used in the preparation of ore samples for analyses. In 1980, the disposal of laboratory waste ceased, and in 1995 FMC grouted the seepage pit to prevent migration of any remaining metals or solvents.

A review of the site history since the 1998 ROD was signed did not identify additional or new potential sources at RU 5.

Statistical Summary

Only one soil sample was available within the depth intervals of concern (0-10'). Therefore, no statistical analyses could be performed.

Data Gaps

Gamma radiation measurements are needed at RU 5 to support the decision for no further action. The number of gamma measurements will be detailed in the SRI Work Plan through the application of the DQO Process. The XRF screening method described in Appendix H will be applied to RU 5 to confirm that lead-210 and polonium-210 are not above levels of concern in RU 5.

Although the EMF RI did not identify the disposal area behind the lab as a potential source to groundwater, additional characterization is needed for VOCs in the shallow soils in order for redevelopment to occur in this area. If VOCs are detected, limited hotspot remediation will be evaluated in the SFS. VOC potential impacts to groundwater may need additional investigation, depending on the results of the hotspot investigation.

Last, additional soil samples are needed to characterize inorganic contaminants at RU 5 to support the remedial action vision through the DQO process.

RU 7 – Shale Unload, Crushing and Stockpile

The Shale Unload, Crushing and Stockpile area has been used for the same purpose since the plant began operation (Figure 6-28 and 6-29). Although material handling practices have changed (e.g., ore was originally handled with bulldozers, and later with the stacker/reclaimer wheel), the material stored within the boundaries of RU 7 has always been ore.

The source for the ore has been the Phosphoria Formation from two mines in the region. The Gay Mine was the source of ore from 1949 through 1993, and Dry Valley Mine was the ore source since 1993.

No other potential sources, spills, or releases have been reported at RU 7 since the EMF RI was completed. RU 7 is not a P4 handling or storage area, so P4 is not a constituent of concern at this RU.

FMC has recently sold the ore, and it will be removed from the RU 7 area. Once removed, the area will be graded for potential future reuse. The remediation vision for this RU is "no further action anticipated to be necessary".

Statistical Summary

The soil data for RU 7 were analyzed to determine if sufficient samples have been collected and to compare the 95% UCL of the mean concentrations for inorganics against the RBCs.

The statistical comparisons showed that arsenic exceeds the 1998 RBC, the Updated Site Worker RBC, the Construction Worker RBC, and background levels. The arsenic concentrations do not exceed the Utility Worker RBC. Cadmium concentrations also exceed the construction worker RBC within RU 7, and there are insufficient data to support a decision regarding fluoride concentrations in the 0-10' interval at RU 7.

Other inorganic parameters do not exceed RBCs, although several exceed the EMF RI background levels (Appendix C).

Data Gaps

After removal of the ore, confirmation sampling will be performed to characterize residual levels of arsenic and cadmium in the 0-10' depth interval. Gamma measurements will be used to characterize external gamma exposure associated with radionuclides in the ore. Sample locations and the sampling approach will be documented in the SRI Work Plan.

The XRF screening method in Appendix H will also be performed at RU 7 to determine if phossy solids may be present in quantities where lead-210 and polonium-210 could be a concern.

Coke has not been characterized at RU 7, and the nature of coke used by FMC will be characterized to evaluate a decision of no further action. The vertical extent of the coke will be assessed to determine if mechanical mixing with shallow soils has occurred.

RU 9 – Silica Stockpiles and Former Kiln Scrubber Overflow Pond

The discussion that follows is summarized in Figure 6-30. RU 9 was largely used for silica stockpiling and handling. From approximately the 1950's through the late 1960's, the kiln scrubber overflow pond was operated within RU 9 (Figure 6-31). In the late 1960's, FMC installed calciners, and the kiln scrubber overflow pond was backfilled with silica.

Silica was formerly a process feedstock and is a naturally-occurring weathered quartzite that was mined at the Wells Cargo Mine, approximately 7 miles south of the FMC facility. Silica was crushed and screened at the mine then stockpiled on the plant site. Silica used in the elemental phosphorus process had a typical diameter ranging from 0.5 to 1.5 inches.

There are no records to confirm if pond solids were removed prior to backfilling, or to determine if any appreciable volume of solids had accumulated. Because the pond received clarified overflow water from the kiln scrubber ponds, it probably did not accumulate a large volume of solids. As described in the discussion of RU 8, the former kiln scrubber overflow pond and portions of the ditch are included in RU 9.

During the EMF RI, boring F054B was drilled through the silica stockpile, within the former pond footprint. The boring log shows 40 feet of silica fill was encountered before native soils. Should the stockpile be leveled to pre-existing grade, there would be over 15 feet of silica fill remaining over the former pond. However, the perimeter or pond edges may contain kiln solids that would remain within an exposure pathway for construction workers and utility workers.

Most roadways within FMC were constructed with a slag road base. Road segments within RU 9 may also have slag road base, and these road segments were not characterized during the EMF RI.

Statistical Summary

Soil samples collected from within RU 9 were compared to the various RBCs and the EMF RI background levels, where possible.

There were insufficient samples to evaluate the RBCs associated with the 0-2' interval (1998 RBCs and Updated Site Worker RBCs).

The cadmium concentrations at the site exceed the Construction Worker RBCs, and there was insufficient data to compare arsenic and fluoride site concentrations against the Construction Worker RBCs.

None of the inorganic constituents exceeded the Utility Worker RBCs.

Several inorganic parameters exceeded the EMF RI background levels, while several did not. In some cases, there were insufficient samples to conclude whether or not concentrations in site soils exceeded background.

Data Gaps

Additional characterization of the former kiln scrubber pond and ditch is needed to determine if inorganic constituents are above the RBCs within the exposure pathways.

General area site soils also need further inorganic constituent characterization to support the DQO process.

Gamma radiation measurements are needed to determine if the remediation vision can be supported. The number of gamma measurements will be detailed in the SRI Work Plan through the application of the DQO Process.

The XRF screening method described in Appendix H, will be used to characterize the 0-10' depth interval to evaluate the potential presence of phossy solids. The SRI will also investigate the feasibility of using XRF screening to delineate kiln solids, if residuals are present within the footprint of the former kiln scrubber overflow pond.

RU 10 – IWW Pond and Ditch

The IWW pond and ditch began operation in 1977 for the disposal of non-contact cooling water from the calciners and furnaces (Figures 6-31 and 6-32). Prior to 1977, FMC had placed non-contact cooling water in their ponds.

FMC operated the IWW system under an NPDES permit, and in 2002 FMC requested EPA to terminate the permit because the IWW system was no longer in use.

As noted in the summary, there were infrequent plant conditions where small volumes of phossy water were routed to the IWW system. FMC investigated the cause of the releases, and

reconfigured plant piping to reduce the potential that phossy water would be routed to the IWW system.

Minor amounts of P4 may have been released to the IWW system, and residual P4 may be contained in sediments that remain in the pond and ditch. Sediments that were dredged and placed at the pond and ditch edges likely no longer contain P4 due to the oxidation of P4 as these sediments dried.

Statistical Summary

Two soil samples were collected from boring F030B in the 0-10' interval, near the IWW Pond and six sediment samples were collected from the IWW ditch during the EMF RI.

The sediment data were not used in the statistical analysis because the IWW system operated from the period of the EMF RI through 2002, and the sediments sampled during the RI were probably dredged from the ditch. In addition, it is difficult to determine if these sediment samples would characterize a particular exposure scenario because the ditch has been backfilled with varying thicknesses of fill.

Therefore, insufficient soil samples are available to perform the statistical comparisons between site conditions and RBCs.

Data Gaps

There are insufficient data to determine if IWW sediments remaining in place after backfilling contain site-related constituents that exceed RBCs. The dredged sediments placed along pond and ditch edges have not been characterized sufficiently to determine that they do not contain constituent concentrations above RBCs.

Given the potential for past P4 releases through the IWW system, sampling for P4 should be conducted to characterize the pond and ditch sediments (those remaining in place, and those sediments dredged and placed along the pond and ditch edges). The P4 releases may have been associated with phossy solid releases, therefore, the radionuclides lead-210 and polonium-210 will be characterized in RU 10, as outlined in Appendix H.

Slag fill was used plant-wide for road base, and RU 10 is bounded by roads. Slag is a known gamma source, and gamma radiation measurements will be collected to compare site conditions against background gamma levels.

The number of gamma measurements and soil samples will be detailed in the SRI Work Plan through the application of the DQO Process.

RU 11 – Equipment Area South of Calciners

RU 11 is summarized in Figure 6-33 and shown in Figure 6-34. It is approximately 8 acres. The site was used for equipment storage and an equipment staging area in the past. There are no records or other evidence that FMC performed equipment maintenance within RU 11, so hydrocarbons and VOC's do not appear to be COPCs.

The primary concern associated with RU 11 is gamma radiation potential from slag in the road base. The EMF RI also found that areas within the FMC Plant OU had other site materials (ore and precipitator dust) mechanically mixed with native soils to depths of 2 to 5 feet in some areas.

Statistical Summary

There were no available data to use in a statistical comparison with RBCs, or to compare gamma radiation potential against background levels.

Data Gaps

Gamma radiation and inorganic constituent concentrations in shallow soils (0-10') are the two data gaps that will be addressed in the SRI. In order to support the remedial action vision, the data gaps will be addressed in a manner that supports the DQO process.

RU 12 – Former RP&S Area and Mobile Shop

Figure 6-35 summarizes the following discussion of RU 12, and the site is shown in Figure 6-36. Multiple site uses have occurred at RU 12 through the course of operations at the FMC Plant OU. Transformer salvage, PCB storage, fuel storage, phossy water pipeline cleaning, and other activities have all occurred within the RU 12 boundaries.

The EMF RI investigated the pipeline cleanouts located in RU 12. These pipelines transported phossy water to the ponds, where the solids were allowed to settle. Cleanouts were placed to access these pipes in the event they became clogged with phossy solids.

Inorganics and radionuclides were analyzed from soil samples collected around the pipeline cleanouts. The typical suite of phossy water constituents were detected in the shallow soil samples (cadmium, fluoride, zinc in addition to orthophosphate, arsenic, and several trace metals). Borings were drilled to depths ranging from 7 to 25 feet from grade. A detailed review of the results of this investigation is presented in the EMF RI Report, Section 4.2, pages 97-106

The EMF RI investigated the potential for PCB releases, and no significant PCB levels were identified (EMF RI Report, pages 4.2-97 through 4.2-99). The EMF RI also investigated the potential for phossy water pipeline cleanouts as a potential source (EMF RI Report, pages 4.2-99 through 4.2-106). Evidence was found that the underground pipes had leaked. The below-ground piping system was not investigated as part of the EMF RI; only the areas around the pipe cleanouts were investigated (Figure 6-36).

After the EMF RI was completed, FMC replaced the underground piping with an above-ground pipe system.

During the construction of the LDR, P4 was encountered in the shallow soils and fill. The source of the P4 is the former underground piping that crosses RU 12.

There have been three reported releases of diesel fuel from the fueling station. These have been above-ground releases, ranging from 40 gallons to 572 gallons. FMC personnel responded by placing sand berms around the spill areas, and cleaning up free-phase diesel pooled on the asphalt areas. Some of the diesel may have run off the paved areas and infiltrated the adjacent fill and soils; however, this has not been investigated. During the EMF RI, twelve samples were collected and analyzed for TPH from depths of 0 to 2 in six different locations (F060B, F061B, F105B, F111R, F112R, and F122R). TPH concentrations ranged from 30.1 mg/kg to 9,025.2 mg/kg.

Statistical Summary

Insufficient data were available to perform the statistical comparisons with the 1998 Site Worker and Updated Site Worker RBCs.

The statistical analysis of site data versus the Construction Worker RBCs shows that the 95% UCL of the mean concentrations for inorganics do not exceed the updated RBCs. However, there are insufficient data to compare site media with the RBCs for arsenic and cadmium. None of the inorganic constituents exceed the Utility Worker RBCs at the 95% confidence level. As with most areas of the FMC Plant OU, constituent concentrations in shallow soils exceed EMF RI background levels due to placement of slag, ore, and other materials as fill and mechanically mixing these materials with underlying native soils.

There was insufficient data to statistically analyze gamma radiation against background levels.

No P4 data have been collected to analyze against the updated RBCs.

Sampling has not been conducted to determine potential impacts from the diesel fuel releases, and a hotspot analysis could not be performed.

The PCB sampling pattern at RU 12 was too sparse to perform a hotspot analysis that would support a decision with reasonable error limits.

Data Gaps

Gamma radiation measurements are needed to determine if RU 12 is forwarded to the SFS or if no further action is warranted.

Phossy solids associated with the underground pipelines and pipeline cleanouts will be characterized as outlined in Appendix H. A selected subset of samples will be analyzed for lead-210 and polonium-210.

FMC will evaluate the feasibility of underground pipeline removal within RU 12, which will be a task for the SFS. No data are needed at this time to support this evaluation.

Soil samples should be collected and analyzed in low-lying areas downgradient from the fuel pumps to characterize potential impacts from the past diesel spills, recognizing that diesel fuel likely is within the CERCLA petroleum exclusion.

A hotspot sampling program should be developed to characterize PCBs in portions of RU 12.

RU 13 – Pond 8S Recovery Process & Metal Scrap Preparation Area

The following discussion is summarized in Figure 6-37 and RU 13 is shown in Figure 6-38. The former underground phossy water piping crosses RU 13 in the eastern portion of the site, while the soil borings from the EMF RI are located in the western portion.

RU 13 was the site of the Pond 8S Recovery Process, a system designed to recover P4 from process water before the sludges were placed in Pond 8S. The system was dismantled and closed under RCRA.

FMC used RU 13 as a staging area for their portable storage tank containing dielectric fluid. This unit was emptied and sold for scrap. Oil was removed, placed in drums, and shipped offsite to a used oil management facility.

Currently, the area is used for storage of decontaminated scrap metal.

Statistical Summary

Site Worker RBCs could not be statistically compared to site data because insufficient data are available in the 0-2' interval. The comparisons to Construction Worker and Utility Worker RBCs and background are included in Appendix C. Cadmium concentrations exceed the

Construction Worker RBC, as does arsenic at the 95% confidence level. There are insufficient data to compare site concentrations against Construction Worker RBCs for antimony, fluoride and lead.

Cadmium concentrations exceed the Utility Worker RBC, while none of the other inorganic constituents exceed the Utility Worker RBCs.

Data Gaps

The data gaps that will be addressed in the SRI are gamma radiation measurements; shallow site soils (0-10') for inorganics; and the potential for P4 occurrence along the underground piping in the eastern portion of RU 13.

In addition, confirmation sampling will be conducted around Borings F058B and F059B to determine the extent of the phossy solids at depth, and selected samples will be analyzed for lead-210 and polonium-210.

RU 15 – Oversize Ore, Used Electrode, Baghouse Dust Area

The following discussion on RU 15 is summarized in Figure 6-39, and the site is shown on Figure 6-40. This area of the FMC Plant OU has been used since the 1970's for storage of oversize ore, baghouse dust from ore handling facilities within the plant, and carbon electrodes from the furnaces.

Periodically, FMC would reclaim some of the oversize ore. The larger portions of electrodes were periodically sold. FMC performed confirmation sampling on the electrodes to ensure there was no P4 within the carbon matrix before selling the electrodes.

No additional sources were identified since the EMF RI.

FMC's remediation vision of grading and capping RU 15 is focused on reducing the potential exposure to ore and baghouse dust, and controlling run-on/run-off to prevent migration via surface water runoff. EMF RI data from the RU 7 area and ore feedstock indicates the material in RU 15 (ore and baghouse dust from ore handling facilities) exceed the RBCs for arsenic and possibly cadmium. Furthermore, the EMF RI borings in the RU 7 area also showed that the metals and inorganic constituents within ore are immobile, and do not readily leach from the ore when exposed to precipitation (EMF RI Report, pages 4.2-125 through 4.2-128). Results from soil boring F127B further supports the conclusion that constituents found in ore are relatively immobile. This boring was drilled to a depth of 38 feet bgs, where rhyolitic bedrock was encountered. Soil samples from the 5 foot depth exceeded background levels for orthophosphate, potassium, boron, thallium and zinc; all these concentrations were well below the RBCs. Soils from 15, 25, and 35 depths did not exceed background levels for any metals (EMF RI Report, pages 4.2-166 and 4.2-167).

As noted in the EMF RI (Section 4.2, page 4.2-166), only orthophosphate and potassium were detected at concentrations significantly exceeding background levels in samples from 15', 25', and 35' in boring F127B. Metals were near or below background levels in these samples. A sample collected from a depth of 5 feet in the native soils showed concentrations of potassium, orthophosphate, total phosphorus, boron, thallium, and zinc that were above background levels (however, all were significantly below the updated RBCs).

A characterization of the wastes around boring F127B was presented in the EMF RI Report, page 4.2-166. The boring encountered calciner pond sediments at a depth of 5 feet, and native soils below that interval. See also Table 4.2.3-33 of the EMF RI Report for the data from boring F127B,

Given the location of F127B, it is reasonable to expect similar depths of migration in other locations of RU 15 because the materials stored in RU 15 were dry (no free liquids), and data associated with ore and calciner solids indicate constituents of concern are not mobile. Coke dust was from coke that was received dry and handled within RU 7 before entering the furnaces, so the presence of soluble ammonia is not expected at RU 15.

Boring 163B was initially drilled to install a groundwater monitoring well. However, water-yielding material was not encountered. A single sample from a depth of 21 feet was analyzed for selenium. Results for this analysis were ND (1.4 mg/kg UJ). This information was not discussed in the RI Report, but was submitted to EPA during the RI

The relative immobility of ore constituents (cadmium, chromium, vanadium, and others) would not require infiltration reduction.

Statistical Summary:

There were insufficient soil samples to perform the statistical comparison between site soils and RBCs or background.

Data Gaps

No data gaps were identified for RU 15. Because ore is the primary material stockpiled in RU 15, and ore exceeds the site worker RBC for arsenic and possibly cadmium, the remediation vision is supported by the available information. Analysis, design, and implementation of the remediation vision do not require additional data.

RU 21 – Other Onsite Railspurs

Figure 6-41 summarizes the discussion on RU 21, shown in Figure 6-42. The railspurs that are not within the boundaries of other RUs were identified as potential sources of gamma due to the presence of slag fill. These railspurs do not include the locations of loading and unloading activities; these are addressed as noted in other RUs.

The railspurs were built to support plant operation. Once constructed, the locations have not changed through time. Slag fill was used as railspurs required maintenance and upgrading through the years. FMC received coke at RU 20 and RU 7, slag was loaded onto railcars within RU 20, and ore was unloaded at RU 7. P4 was loaded and unloaded within the boundaries of RU 1 and RU 6. The remaining railspurs were used for railcar staging. Within the boundaries of other RUs the specific materials handled along the railspurs are subject to investigation within these RUs.

The railspurs remain a key infrastructure component for most site redevelopment options, and FMC has no plans to remove the railspurs.

Statistical Summary

No statistical analyses were performed for inorganic constituents within RU 21 because there were insufficient data.

However, an analysis of the slag data (see Appendix C: RU 20) shows that slag does not contain inorganic constituents that exceed the updated RBCs at the 95% UCL. Beryllium concentrations exceed the 1998 RBCs, but the 95% UCL of the mean for beryllium does not exceed the updated RBCs for future site workers, construction workers, and utility workers.

Data Gaps

The EMF RI identified the presence of slag along most railspurs at varying thickness. Because slag is a known gamma source, the scope of the SRI will include characterization of gamma radiation along the RU 21 railspurs.

RU 23 – Road Segments not included in other RUs

Figure 6-43 summarizes the following discussion relating to RU 23. Road segments that do not fall within other RU boundaries can be seen in Figure 3-1. The rationale for classifying road segments within other RUs or within RU 23 was presented in the Scoping and Planning Memorandum (FMC, 2004) and is repeated below:

"Roadways within the FMC Plant OU will be assigned to RUs as follows:

- Roadways coincident with RUs identified as likely capping remedy candidates will be evaluated as part of (i.e., within footprint of) that RU.
- Roadways coincident with NFA candidate RUs will be sufficiently characterized (including collection of new data, as needed) to evaluate and support NFA status.
- Roadway segments not otherwise included in these two classes of RUs will be identified as RU 23 (Miscellaneous roadways) that will be separately evaluated."

These road segments are not located in plant areas where material handling occurred, reducing the likelihood of spills or releases along these road segments. A review of plant records and interviews with FMC employees did not identify any spills or releases along plant roads within RU 23. However, FMC has applied Pond Closure Decant Water (PCDT), pond and decontamination water treated in the on-site water treatment plant, to various road segments for dust suppression (Appendix I). FMC provided EPA with an estimate of the mass loadings of inorganic and radiologic constituents to the roadways associated with the use of PCDT water (FMC, November 21, 2003). The estimated mass loadings show that overall increases to constituent concentrations would be minimal, and the resulting increases would not cause any constituent to increase in concentration above the 1998 RBCs. The mass loading estimates showed arsenic concentrations in shallow roadbase materials would increase by 2.7%, from 18.51 mg/kg to 19.01 mg/kg. The RBC for arsenic is the EMF Site background, which is 7.7 mg/kg. Information on the loading rate calculations and water chemistry can be found in Section 3 of this report.

Similar to the railspurs within the FMC Plant OU, the road locations have not changed much over the course of FMC plant operations. Minor shifts occurred as plant processes were upgraded and facilities added. However, most of these changes occurred within the boundaries of other RUs, and the road routes within RU 23 have remained unchanged once the roads were constructed. In other words, the locations of roads within RU 23 are well-known from air photos, and on-the-ground surveys (Figure 44).

Roads were built with a relatively thick (1 to 3') slag road base to accommodate the heavy equipment used by FMC. In the 1990's, many of the roads were paved to reduce fugitive dust emissions.

Statistical Summary

As with RU 21 (Railspurs), statistical analyses were not performed for inorganic constituents within RU 23 because there were insufficient data. Appendix C (RU 20) includes a statistical comparison between the RBC thresholds against the 95% UCL of mean concentrations in slag for inorganic constituents. There is also a comparison of constituent concentrations and the EMF RI background concentrations.

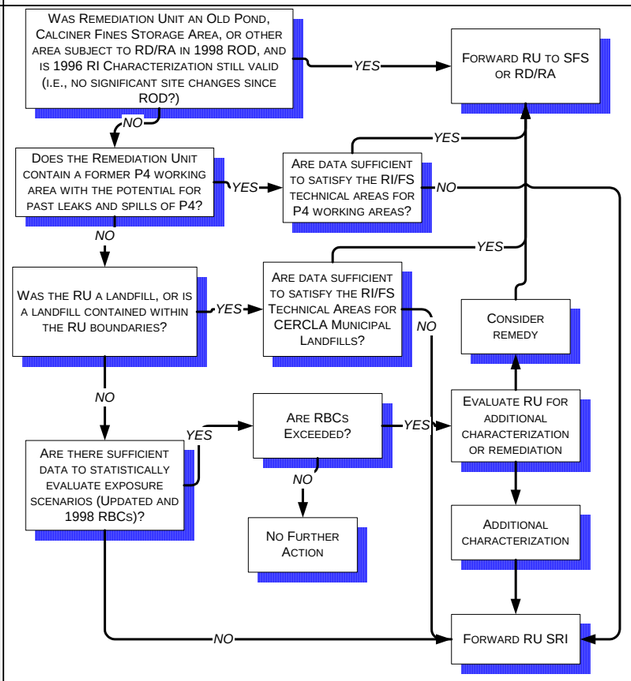
As shown in Appendix C, inorganic concentrations in slag do not exceed the RBCs, and there were no reported spills of fuels or PCBs along RU 23 roadways. Therefore, additional characterization of these constituents is not required to support decisions relating to the need for remedial actions.

Data Gaps

The EMF RI identified the presence of slag along most roads at varying thickness. Because slag is a known gamma source, the scope of the SRI will include characterization of gamma radiation potential along the RU 23 plant roads. Because the roads are made of a slag road base, FMC believes the inorganics on roadways require no further characterization. However, gamma radiation from slag has not been adequately characterized for individual road segments.

In addition, road segments where precipitator dust may have been applied in the past will be characterized for the potential occurrence of lead-210. Some road segments within other RUs where no further action is the remediation vision (e.g., RU 11 and RU 4), may require lead-210/precipitator dust characterization. Road segments where precipitator dust may have been applied will be identified in the SRI Work Plan, after a more detailed review of the history of plant roadways has been performed. The historical review will identify road segments in use during the period through 1993, when the practice was ceased. Current FMC employees report that precipitator dust application in winter months was infrequent, and occurred only when conditions on plant roadways were extremely icy. Furthermore, the use of precipitator dust appeared to be limited to areas around the plant entrance and parking areas.

Lead-210 is not considered a COC on any road segment built after 1993, because the practice of using precipitator was ceased in 1993.

Step 1 – *State the Problem*	CERCLA and RCRA environmental investigations have identified constituents of concern released into the environment through various plant processes and material handling practices. The 1998 EMF Site ROD selected remedies for the Old Phossy Ponds, Railroad Swale, and Calciner Solids Storage Area, but those remedies have not been implemented pending further EPA review. The FMC plant ceased manufacturing operations in 2001, and future commercial/industrial redevelopment opportunities are being explored for the site. Site conditions must be evaluated with respect to potential exposure pathways for commercial/industrial land use (described by the updated Conceptual Site Model in Section 2 of the RI Report Update). Problem Statement: Are available site characterization data sufficient to (a) identify portions of the site (i.e., Remediation Units) that warrant remedial action (either similar to that selected in the 1998 ROD or a Presumptive Remedy), or (b) support a decision for No Further Action. Data gaps identified by this evaluation process will be addressed under the SRI process.
Step 2 – *Identify the Decision*	Do existing data support a decision to forward an RU to the Supplemental Feasibility Study (SFS) of remedial action alternatives or the Remedial Design/Remedial Action process, or to assign a No Further Action (NFA) classification to the RU? Or, are additional data needed to make such decisions?
Step 3 – *Identify the Inputs to the Decision*	1998 EMF Site ROD; evaluation of former working areas of the FMC Plant OU to identify potential sources, release mechanisms, exposure pathways, and potential receptors; updated Conceptual Site Model (CSM), RBCs and Updated RBCs relevant to the updated CSM, EPA Policy Guidance, EMF Site RI Data, Other Data, IDEQ Consent Order for Calciner Ponds
Step 4 – *Define the Study Boundaries*	Lateral boundaries of each RU, and soils from 0 to 10 feet deep to characterize exposure pathways. Some RU's are stratified, meaning there are areas within the RU requiring special attention.
Step 5 – *Develop the Decision Rules*	

Step 6 – *Specify Tolerance Limits on Decision Errors*	Decision 1 Error: The decision to classify an area as an old phossy pond, Railroad Swale, or calciner solids storage area has a very low associated error. Decision 2 Error: Given the detailed information regarding past practices, and that P4 processing and storage facilities were permanent structures, this "yes" or "no" question can be answered with a high degree of confidence. Decision 3 Error: There is low error associated with the decision, because each RU that contains a landfill will be forwarded to the SFS for application of a presumptive remedy. Decision 4 Error: A Type I error (alpha) rate of 5% was selected, and a Type II (beta) rate of 10% was selected.
Results: Old Pond Areas	RU 22B – Old Phossy Ponds: Remedy selected in 1998 ROD. No changes in site conditions since EMF RI was completed. Delineate phossy solids in limited areas. Collect radon flux measurements. Forward to SRI. RU 16 – Calciner Solids Storage Area: Remedy selected in 1998 ROD. Extent of area increased since EMF RI. Assess leachability of metals in solids. Forward to SRI. RU 22C – Railroad Swale: Remedy selected in 1998 ROD. Phossy water spills since EMF RI may have introduced P4 above liner in swale or downgradient of the lined portion of the swale. FMC envisions capping the length of the swale to prevent exposure to P4; forward to SRI. RU 8– Calciners/former kiln scrubber ponds. As with old phossy ponds and calciner solids areas, exposure to residuals left in place will be prevented by capping. Confirm extent of pond sediments. Forward to SRI.
Results: Former P4 Working Areas	RU 1 and 2 – Furnace Building, Phos Dock, Secondary Condenser and Slag Pit: Technical Areas not satisfied. P4 known or presumed to be present in soils. Delineation of the lateral extent of a RCRA-engineered cap to prevent exposure to P4 is needed. Extent of P4 migration from RU 1 and 2 sources should be limited by the 44 C isotherm (subsoils heated by discharge of molten slag in RU 2 during historic plant operations). Forward to SRI. RU 6 – Long Term Phos Storage: Tanks removed since EMF RI. Sampling tank pits show P4 from overfilling was removed. Potential spills at railcar loading/unloading area require investigation. Slag presence requires evaluation for gamma exposure. Lead-210 and polonium-210 data are needed. Forward to SRI.
Results: Landfills	RU 17 – Recyclable Material Landfill: Technical Areas satisfied. Forward to SFS. RU 18 – Plant Landfill: Technical Areas are satisfied. Forward to SFS. RU 19 – Slag Pile/Bull Rock Pile: Buried sludge-filled railcars to be evaluated as source term to support cap design. Collect radon flux measurements. Other technical areas are met. Forward to SRI.

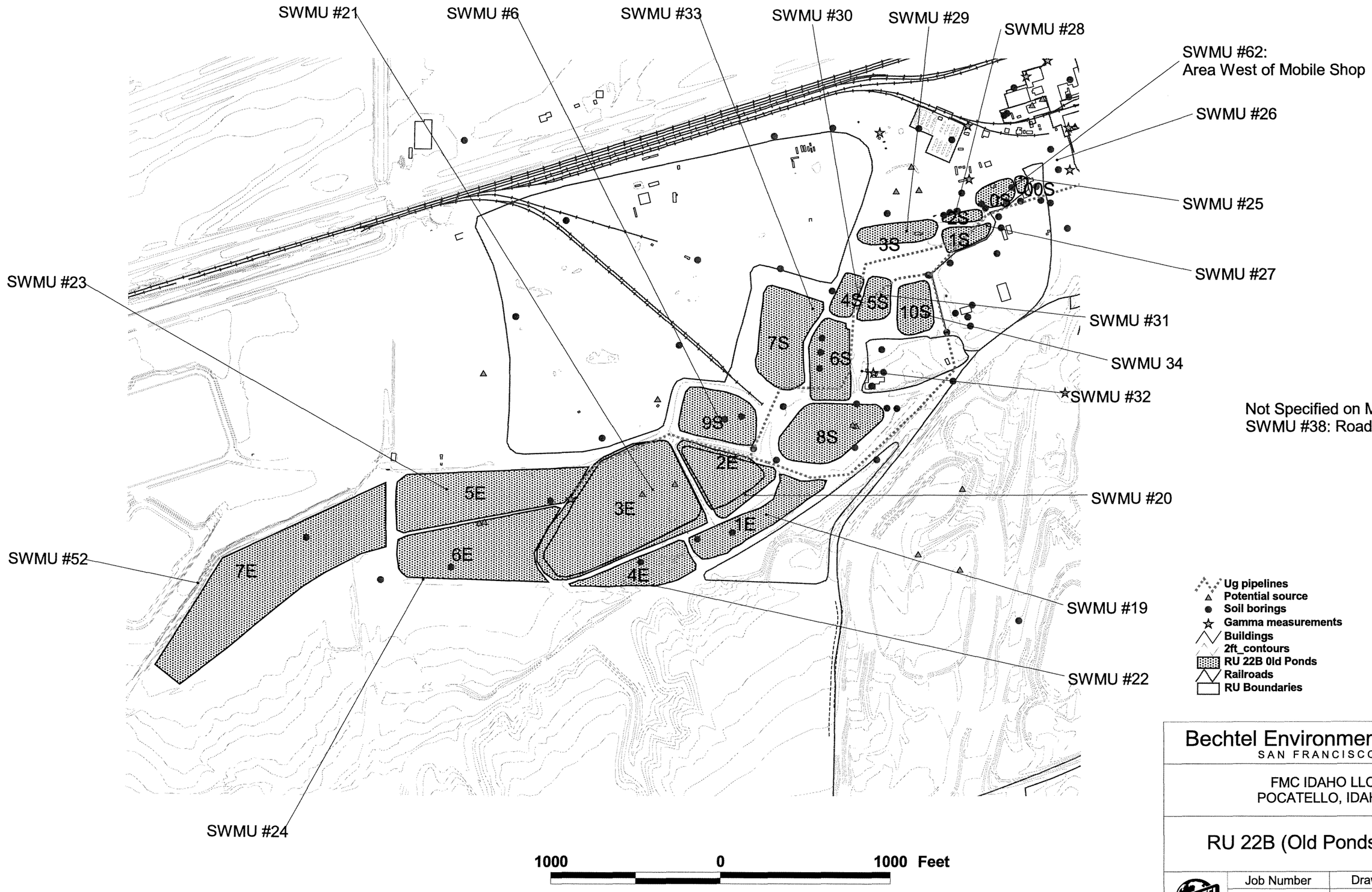
Results: Other Areas	RU 3 – Insufficient inorganic and gamma data to characterize exposure pathways. Storm drain video inspection is needed. Forward to SRI. RU 4– Insufficient inorganic and gamma data to characterize exposure pathways. Forward to SRI RU 5– Insufficient inorganic and gamma data to characterize exposure pathways. Additional characterization for VOC's needed. Forward to SRI RU 7– Insufficient gamma data to characterize exposure pathways. Lead-210 and polonium-210 data are needed. Forward to SRI RU 9– Insufficient inorganic and gamma data to characterize exposure pathways. Lead-210 and polonium-210 data are needed. Forward to SRI RU 10– Insufficient gamma data to characterize exposure pathways. P4 sampling along ditch, and lead-210/polonium-210 data are needed. Forward to SRI RU 11– Insufficient inorganic and gamma data to characterize exposure pathways. Lead-210 and polonium-210 data are needed. Forward to SRI RU 12– Insufficient gamma data to characterize exposure pathways. Confirmation sampling for PCBs, and characterize past diesel spills. Lead-210 and polonium-210 data are needed. Forward to SRI RU 13– Insufficient inorganic and gamma data to characterize exposure pathways. Delineate phossy solids around borings F058B and F059B for inclusion in RU 22b. Collect lead-210 and polonium-210 data. Forward to SRI RU 15– Forward to SFS. RU 20– Potential fuel releases and residual coke require investigation. Gamma exposure potential requires evaluation. Forward to SRI RU 21– Insufficient gamma data to characterize exposure pathways. Lead-210 and polonium-210 data are needed. Forward to SRI RU 23– Insufficient gamma data to characterize exposure pathways. Additional analyses for lead-210 and polonium-210 are needed. Forward to SRI
Results: Areas Addressed by Other Authority	RU 14– Calciner ponds are being addressed under IDEQ purview. Defer to IDEQ. RU 22a – RCRA WMUs are being addressed under EPA RCRA standards. Defer to RCRA program.
Step 7 – *Optimize the Sampling Design*	This will be performed as part of the SRI Work Plan.

Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.

Figure 6-1
Overview of Section 6

RU 22B Summary	
RU Description	Old phossy ponds located southwest of the furnace building. Ponds vary in size, volume of material remaining, and P4 content; however, the location and extent of each pond is well-documented by plant data and historic air photos. All old ponds have had hydraulic head removed.
EMF ROD Remedy	"Due to the presence of buried elemental phosphorus in some areas, the higher level of permanence afforded by the capillary barrier cap is warranted and the additional cost is justified. A soil cover and vegetation may be sufficient in areas which were used for a relatively short period of time and/or contain significantly lower volume of waste."
EMF RI Findings	Most of the S-series old ponds were found to contain residual precipitator slurry or sludges at thicknesses from 1 to 10 feet. EMF-related constituents could be found in the soil column beneath these old ponds to the uppermost aquifer. The E-series old ponds typically do not contain residual materials, but there was evidence that EMF-related constituents had migrated into the native soils underlying these old ponds.
RI Update: Current status; post EMF RI data; additional sources; COPCs	Ponds remain empty or backfilled. No additional materials placed in old ponds. No additional data collected. No additional COPCs
Remediation Vision	Old phossy ponds will be remediated per the ROD (June 1998).
Do existing data support remediation vision in context of updated CSM?	Yes.
Data Gaps	Delineation of lateral extent of phossy solids in the vicinity of borings F058B and F059B to determine cap/cover extent. Radon flux measurements. Note that remedy selected in the ROD will also address any remaining underground piping within the boundaries of RU 22B.
CONCLUSION: Forward RU 22B to SRI	

Figure 6-2
RU 22B Summary



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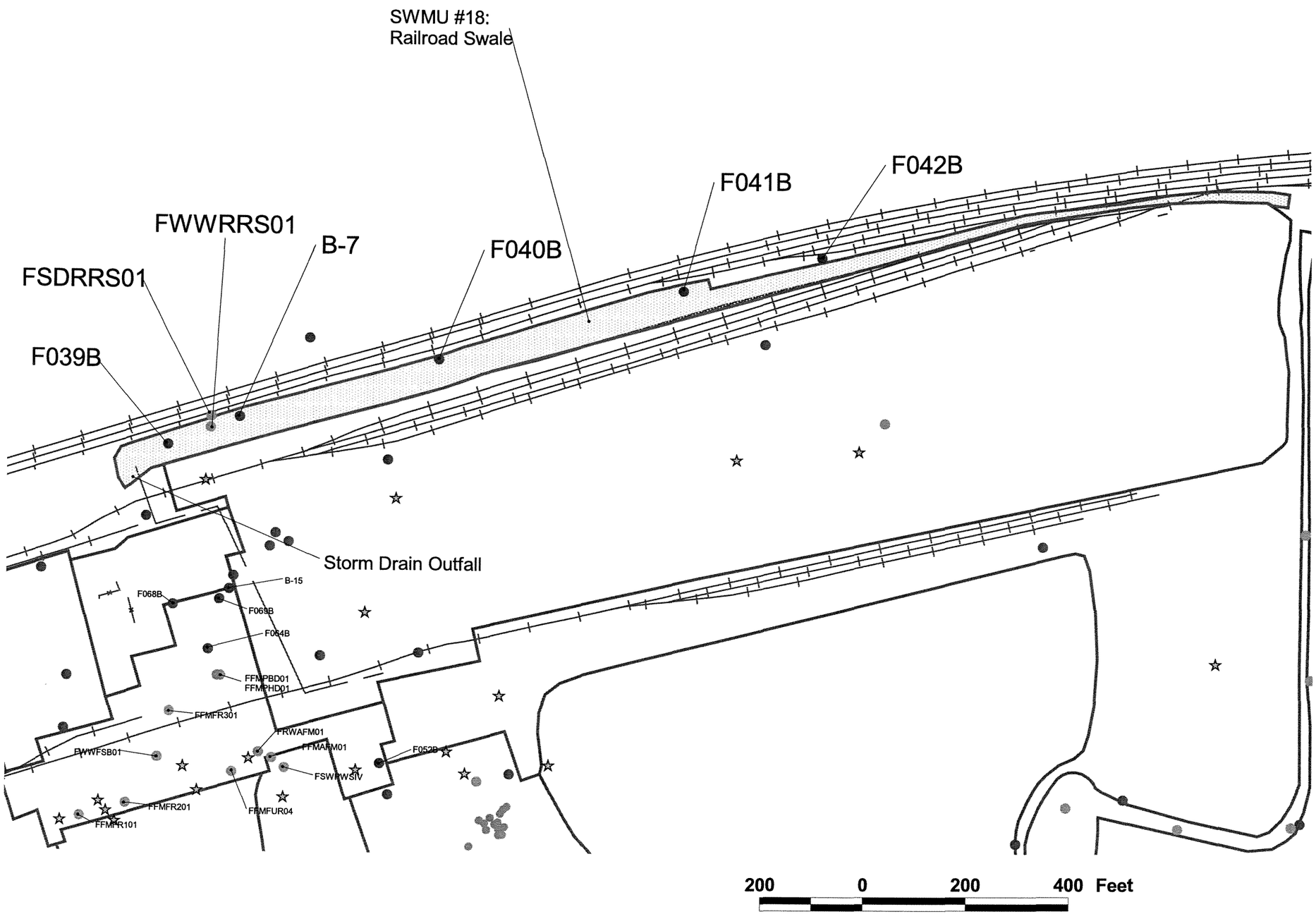
RU 22B (Old Ponds) Map

Job Number	Drawing No.	Rev.
20906	Figure 6-3	

RU 22C Summary	
RU Description	The Railroad Swale is located to the north of the P4 production areas, and received releases of phossy water from spills within the RU 1 area. It was partially lined in 1993, during the performance of the EMF RI.
EMF ROD Remedy	"FMC shall install and maintain a synthetic liner in the eastern portion of the Railroad Swale to reduce infiltration of surface water and leaching potential."
EMF RI Findings	Slag and fill from 7.5 to 18 feet thick. Samples taken from slag and fill contained above-representative concentrations of EMF-related constituents. Concentrations decrease with depth. In two borehole locations, soil samples were taken at depths greater than 2.5 feet below the fill/native soil interface. Samples taken at these depths showed little to no effect from EMF-related activities. However, the presence of elevated orthophosphate and total phosphorus in a sample from 70 feet may be an indication of infiltration.
RI Update: Current status; post EMF RI data; additional sources; COPCs	Documented incidences of phossy water spills from RU 1 (Phos Dock) discharged to Railroad Swale after RI field sampling period. No additional COPCs
Remediation Vision	Cap the Railroad Swale in lieu of lining. Divert storm water run-off from area
Do existing data support remediation vision in context of updated CSM?	No. Known phossy water spills entered Railroad Swale after installation of liner. Railroad swale no longer needed for stormwater retention. Extent of cap defined by liner area specified in 1998 ROD.
Data Gaps	Potential for P4 above the liner.
CONCLUSION: Forward RU 22C to SRI	

Figure 6-4

RU 22C Summary



Gamma measurements
Confirmation samples
Potential source
Soil borings
RR Swale
RU Boundaries
Railroads

N

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RU 22C Map			
BECHTEL	Job Number	Drawing No.	Rev.
	20906	Figure 6-5	

RU 8 Summary	
RU Description	The three former kiln scrubber ponds were identified on historic air photos and delineated on site maps as part of the EMF RI. These ponds operated from 1949 through the late 1960's. Kiln scrubber pond solids were dredged when the ponds filled and the solids were placed in the Former Plant Landfill (RU 19). The ponds were backfilled to grade in preparation for the construction of the calciners. Since the late 1960's, the calciners have occupied their current location within RU 8.
EMF ROD Remedy	The 1998 ROD selected a remedy of capping or soil cover for the calciner solids area (RU 16). Any solids remaining in the former kiln scrubber ponds are considered very similar in nature to the calciner solids (kilning and calcining ore results in similar waste product streams).
EMF RI Findings	Calciner solids, when stored dry, are not a source of contaminants to groundwater. Based on the RI data for the calciner solids stockpile area, absent a sustained hydraulic head, the kiln solids will not be a source of contaminants to groundwater. The kiln scrubber overflow pond, located east of RU 8, was investigated during the EMF RI. Results indicate that this pond had been a source of contaminants to groundwater while it was operating with a sustained hydraulic head.
RI Update: Current status; post EMF RI data; additional sources; COPCs	No additional COPCs
Remediation Vision	Leave existing concrete slabs in-place, grade to design subgrade elevation and construct soil cover (cap) over entire footprint of these areas.
Do existing data support remediation vision in context of updated CSM?	Yes. Because it considered likely that some kiln solids remained in place when the ponds were backfilled, capping RU 8 will minimize the potential for exposure to these solids. Capping, with the appropriate run-on/run-off management will also reduce the potential for future migration of contaminants to groundwater.
Data Gaps	Confirmation borings to determine lateral extent of cap/cover around former kiln scrubber ponds.
CONCLUSION: Forward RU 8 to SRI	

Figure 6-6

RU 8 Summary

1965 Air Photo

2003 Air Photo

100 0 100 200 Feet

N

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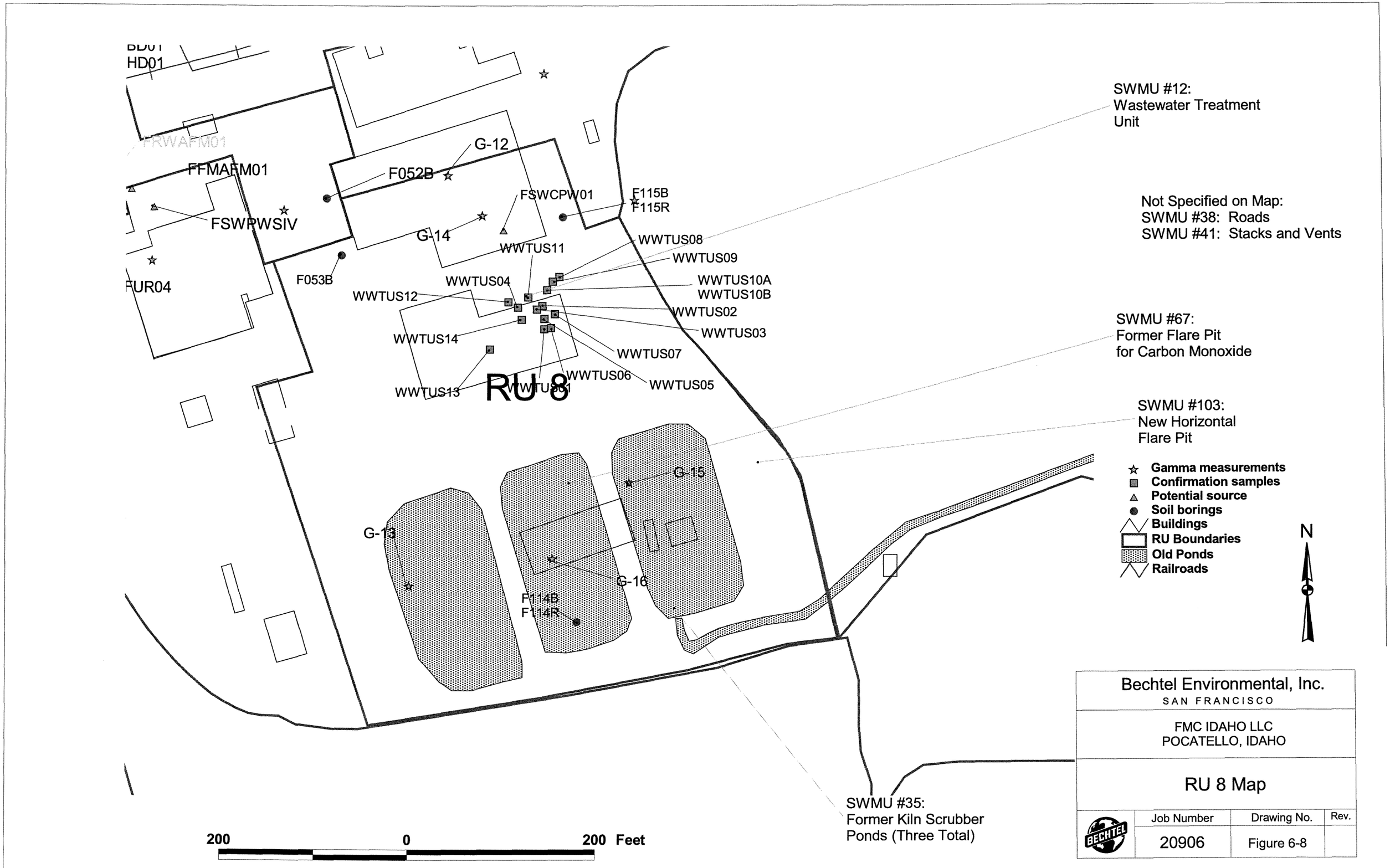
Current Location of
Former Kiln Scrubber Ponds

Job Number	Drawing No.	Rev.
20906	Figure 6-7	


HD01
FRWAFM01
FFMAFM01
FSWPWSIV
FUR04
G-12
F052B
FSWCPW01
F115B
F115R
G-14
WWTUS11
WWTUS08
WWTUS09
F053B
WWTUS04
WWTUS10A
WWTUS10B
WWTUS12
WWTUS02
WWTUS03
WWTUS14
WWTUS07
WWTUS06
WWTUS05
WWTUS13
RU 8
G-15
G-13
G-16
F114B
F114R
SWMU #12:
Wastewater Treatment
Unit
Not Specified on Map:
SWMU #38: Roads
SWMU #41: Stacks and Vents
SWMU #67:
Former Flare Pit
for Carbon Monoxide
SWMU #103:
New Horizontal
Flare Pit
Gamma measurements
Confirmation samples
Potential source
Soil borings
Buildings
RU Boundaries
Old Ponds
Railroads
N
SWMU #35:
Former Kiln Scrubber
Ponds (Three Total)
200
0
200 Feet
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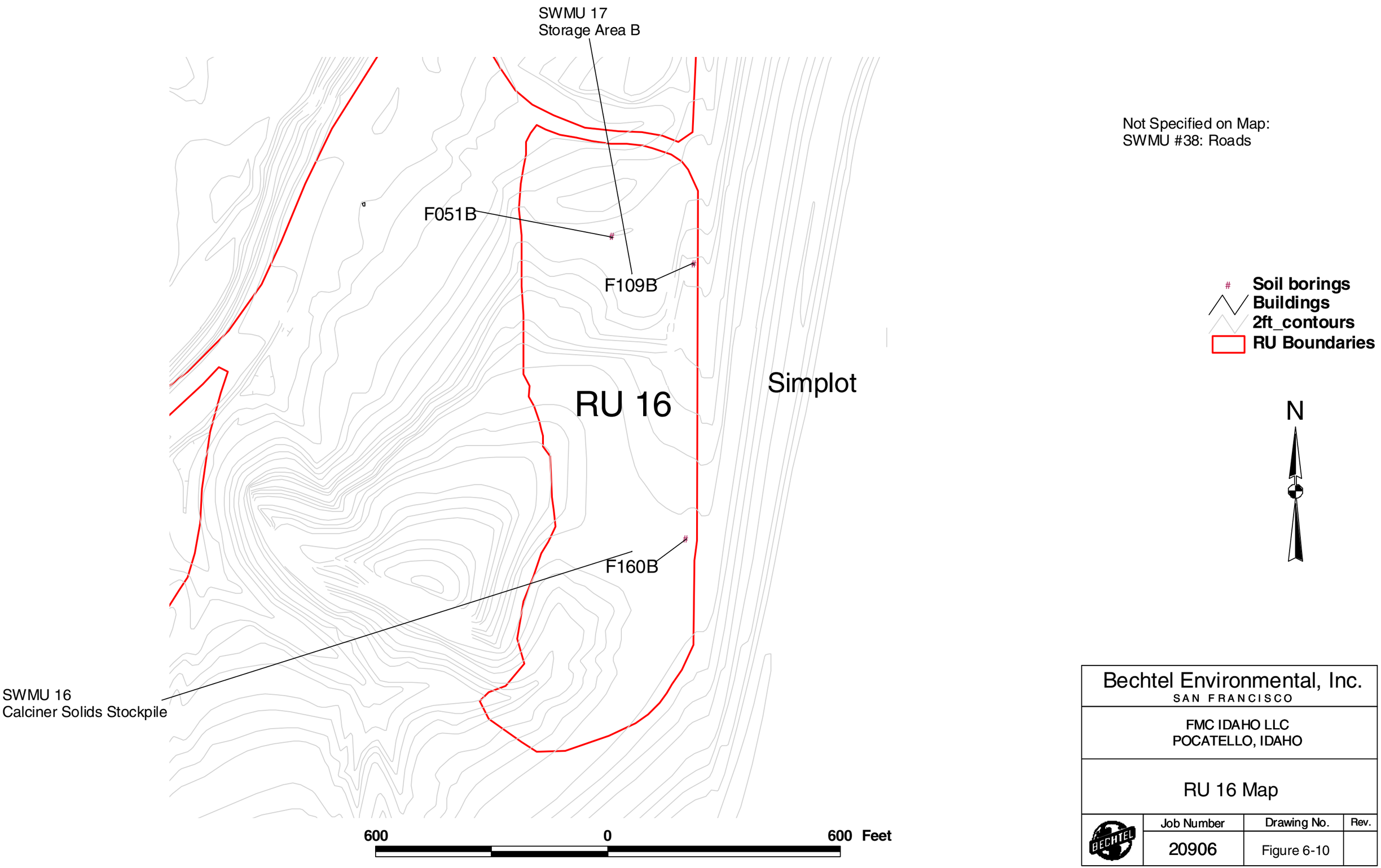
RU 8 Map
Job Number
20906
Drawing No.
Figure 6-8
Rev.

RU 16 Summary	
RU Description	The Calciner solids stockpile is located south of the calciner ponds. As the material in the calciner scrubber water settled out and accumulated in the ponds, it was removed from the ponds and stockpiled within the boundaries of RU 16.
EMF ROD Remedy	The 1998 ROD selected a remedy of capping or soil cover for the calciner solids area.
EMF RI Findings	Calciner solids, when stored dry, are not a source of contaminants to groundwater. Soil borings show very little, if any, migration of metals or other EMF-related constituents into native soils beneath the calciner solids.
RI Update: Current status; post EMF RI data; additional sources; COPCs	FMC continued to remove calciner solids from the ponds and these were added to the stockpile after the EMF RI was completed. The lateral extent of the stockpile has increased, but the nature of the source material has remained the same No additional COPCs
Remediation Vision	Calciner solids will be remediated per the ROD (June 1998).
Do existing data support remediation vision in context of updated CSM?	Yes. Existing data show that there have been no significant changes to RU 16 after the 1998 ROD. It continued to receive calciner solids, but no other process materials after that date .
Data Gaps	Leachability testing of calciner solids to assess mobility of metals.
CONCLUSION: Forward RU 16 to SRI	

Figure 6-9

RU 16 Summary



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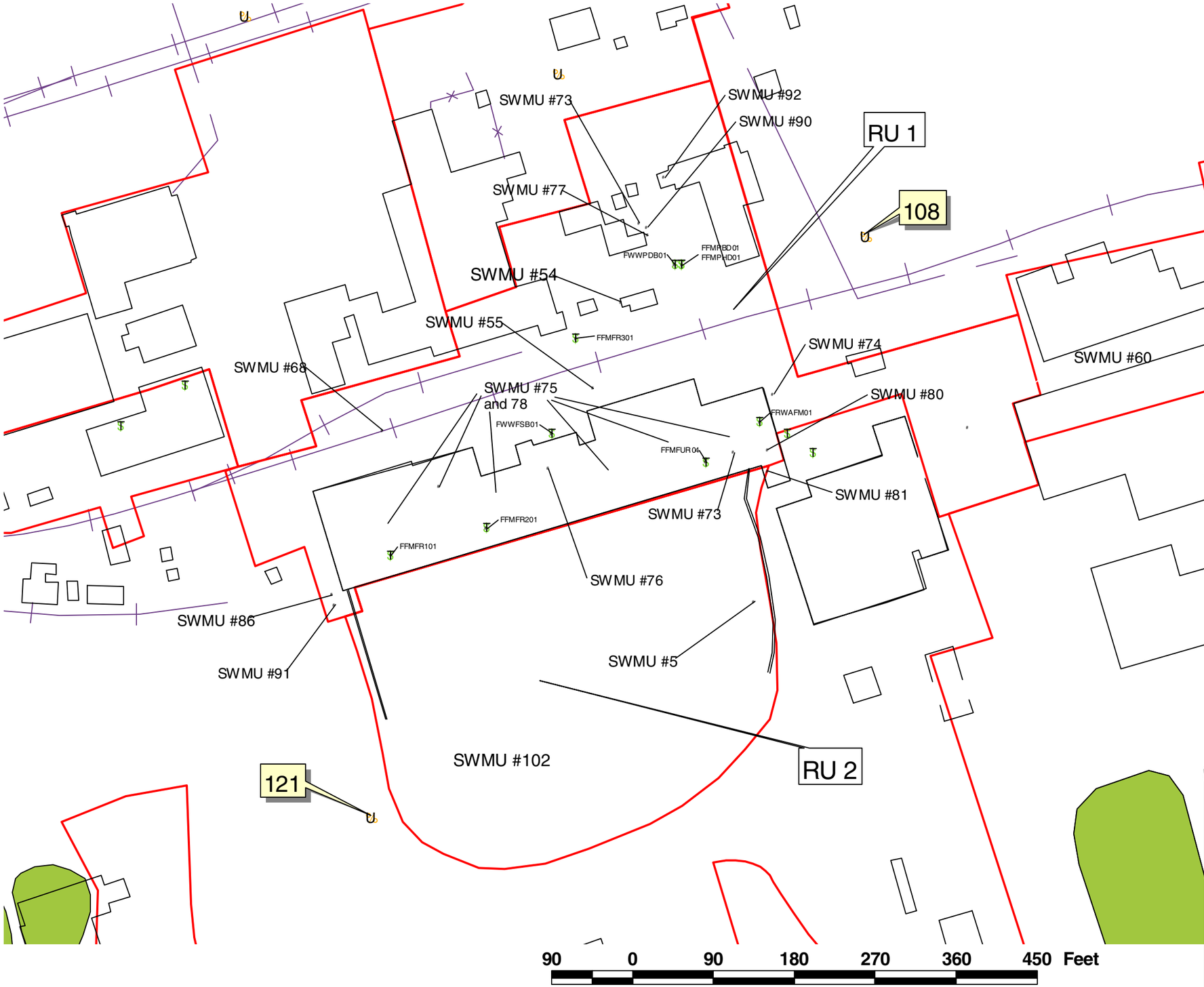
RU 16 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-10	

RU 1 and RU 2 Summary	
RU Description	RU 1 encompasses the furnace building, secondary condenser, and Phos Dock. These are the primary P4 production, storage, and handling areas within the FMC OU. The furnace building had four electric arc furnaces, primary condensers, P4 sumps, and various tanks. The secondary condenser had a single P4 sump. P4 from sumps was pumped to the Phos Dock for storage and loading onto rail cars. The slag pit is south of the furnace building. It is a pit where slag from the furnaces was poured, cooled, broken, and loaded onto slag haul trucks to be placed on the slag pile. In 1999/2000, FMC converted to slag ladling, where the molten slag was poured from the furnaces into ladles. The ladles were truck mounted, and the trucks hauled the molten slag to the slag pile.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	RU 1 and RU 2 were the heat source for the thermal plume in the shallow groundwater. Well 108, downgradient from the slag pit, had temperatures of 28 C. P4 was not encountered in either of the soil borings drilled in RU 1. No borings were drilled in RU 2.
RI Update: Current status; post EMF RI data; additional sources; COPCs	The furnace building and slag pit are no longer used for phosphorus production. In 1999/2000, the furnace building and slag pit were reconfigured during the slag ladling conversion. P4 was encountered beneath the furnace building foundation at the #3 Furnace P4 sump area. Groundwater temperatures in Well 108 are declining. In the fourth quarter sampling event of 2003, temperatures were 22.2 C, indicating a decrease of 5.8 C from the period of the EMF RI. Declining temperatures indicates a reduction in migration potential of liquid P4 around RU 1 and RU 2. The Phos Dock remains in service for storage and handling of P4 recovered from process vessels and piping.
Remediation Vision	Leave existing concrete slabs in-place, grade to design subgrade elevation and construct a RCRA-engineered cap over entire footprint of these areas.
Do existing data support remediation vision in context of updated CSM?	No. The lateral extent of the cap cannot be defined from existing data. Although process piping and vessel locations are known, the elevated temperatures in the subsurface may have allowed liquid P4 to migrate laterally from sources.
Data Gaps	Thermal modeling of the soil column beneath RU 1 and RU 2 is needed to determine the maximum potential extent of P4 in the subsurface. Confirmation soil sampling to test model results.
CONCLUSION: Forward to SRI for "44 C isotherm" study and confirmation soil sampling of RU 1 and RU 2 to support cap delineation.	

Figure 6-11

RU 1 and 2 Summary



Key:
SWMU #54: Phos Dock Area
SWMU #55: Paved Area North of Furnace Bldg
SWMU #60: Secondary Condenser/Former Fluid Bed Dryer Area
SWMU #68: Railroad Spurs
SWMU #73: Satellite Storage Areas for Spent AFM
SWMU #74: East AFM Bin Area
SWMU #75: Precipitator Dust Slurry Pots
SWMU #76: Medusa Scrubber Blowdown Collection Tank
SWMU #77: Phosphorus Loading Dock, Andersen Scrubber Blowdown Sump, and North Solid Tank
SWMU #78: Washdown Collection Sumps
SWMU #79: Northeast Collection Sump
SWMU #80: Southeast Collection Sump
SWMU #81: Furnace Washdown Collection Tank (V-3600)
SWMU #82: Underground wastewater piping system
SWMU #86: V-3700 Tank and Associated Piping
SWMU #90: V-3800 Tank and Associated Piping
SWMU #91: NOSAP Intercept Tank (Tank 8010)
SWMU #104: #3 P4 Sump
SWMU #5: Slag Pit Wastewater Collection Sump
SWMU #102: Former Slag Pit (prior to slag ladling)

Not Specified on Map:
SWMU #38: Roads
SWMU #82: U/G Wastewater Piping
SWMU #41: Stacks and Vents
SWMU #13: AFM Washing Unit

Monitoring Wells
Buildings
Potential source
RU Boundaries
Old Ponds
Railroads

N

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RU 1 and RU 2 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-12	

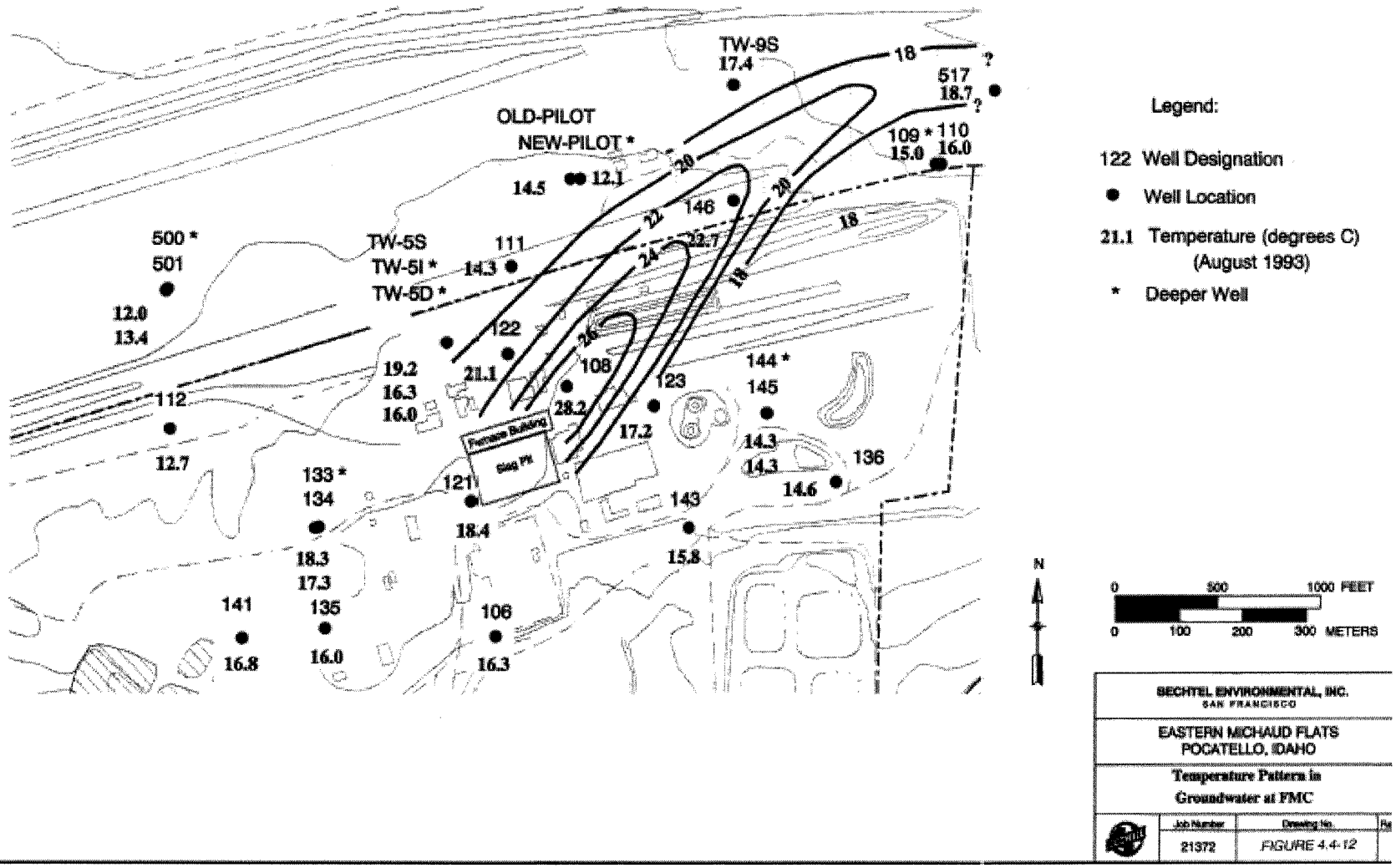
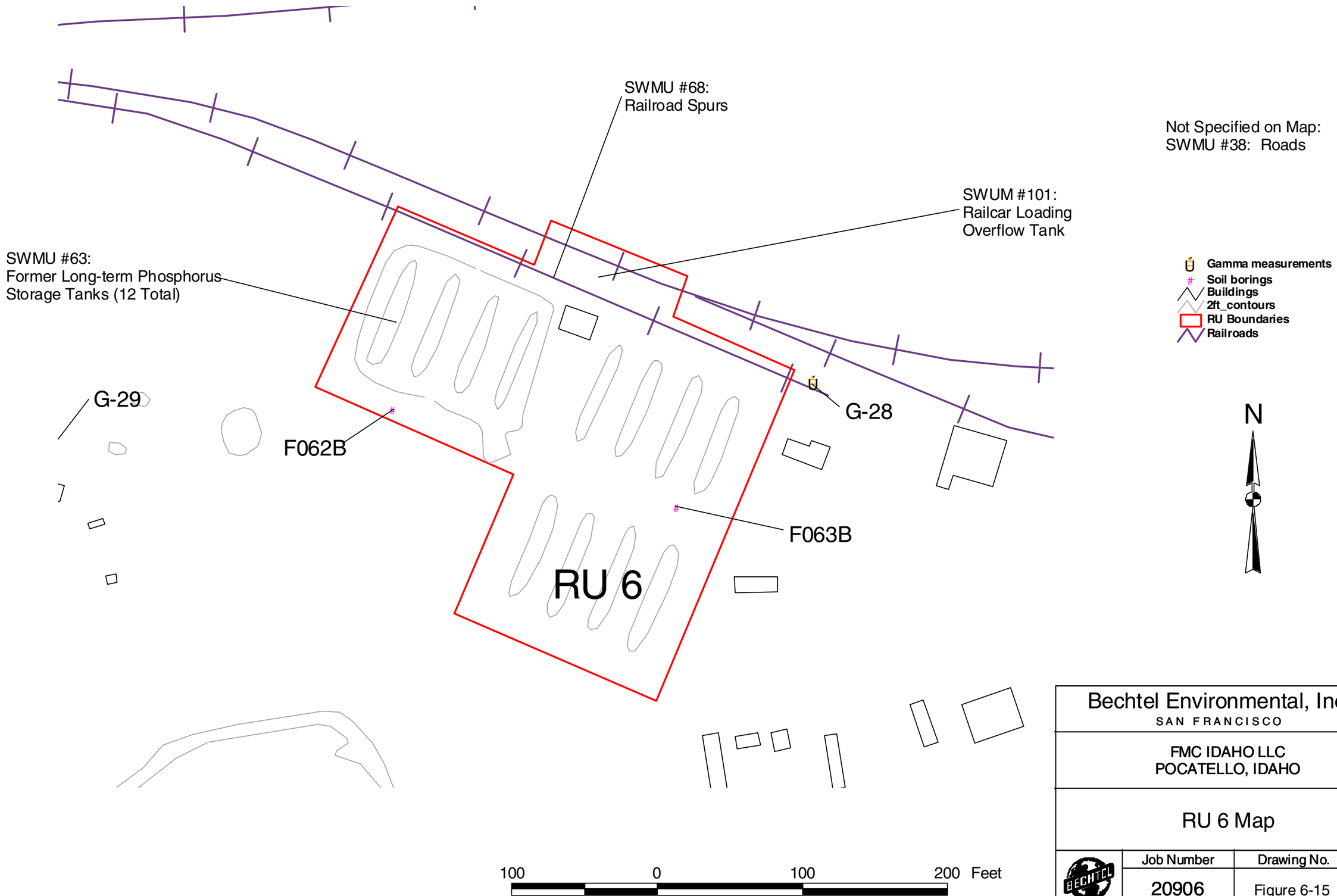


FIGURE 6-13
Thermal Plume Figure from EMF RI

RU 6 Summary	
RU Description	FMC installed 12 underground steel storage tanks for additional storage of P4. The tanks were two sizes, 104,000 gallons and 52,000 gallons. Tanks were filled by transporting P4 in railcars from the Phos Dock, so there is no underground P4 piping leading to RU 6. Pumps in the tanks were used to load the P4 onto railcars when the P4 was sold. The RU is located on a fairly level area of the FMC plant, and it is bounded by roads on the south and east, and a railroad spur line along the northeast. No underground process pipelines are near or within the RU boundaries.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	P4 was not encountered in either of the soil borings drilled in RU 6. Some inorganics were detected at above-representative levels. Maximum depth investigated was 7 feet. Borings did not encounter slag, ore, or precipitator dust.
RI Update: Current status; post EMF RI data; additional sources; COPCs	In 1994, FMC removed eight tanks and backfilled the excavation. In 1998, the last four tanks were removed. During both phases of tank closure, FMC collected samples from the native soils within the excavation to confirm that all soil and tank backfill containing P4 was removed during closure.
Remediation Vision	No action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. See Data Gaps below.
Data Gaps	Insufficient data to characterize inorganics in the 0-6' depth interval. Confirmation sampling at railcar loading/unloading area for P4 Confirmation sampling around tank pit for P4 Gamma radiation measurements to characterize slag fill.
CONCLUSION: Forward to SRI for P4 confirmation sampling, gamma radiation measurements, and characterization of inorganics, lead-210 and polonium-210 in 0' to 10' depths. Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.	

Figure 6-14

RU 6 Summary



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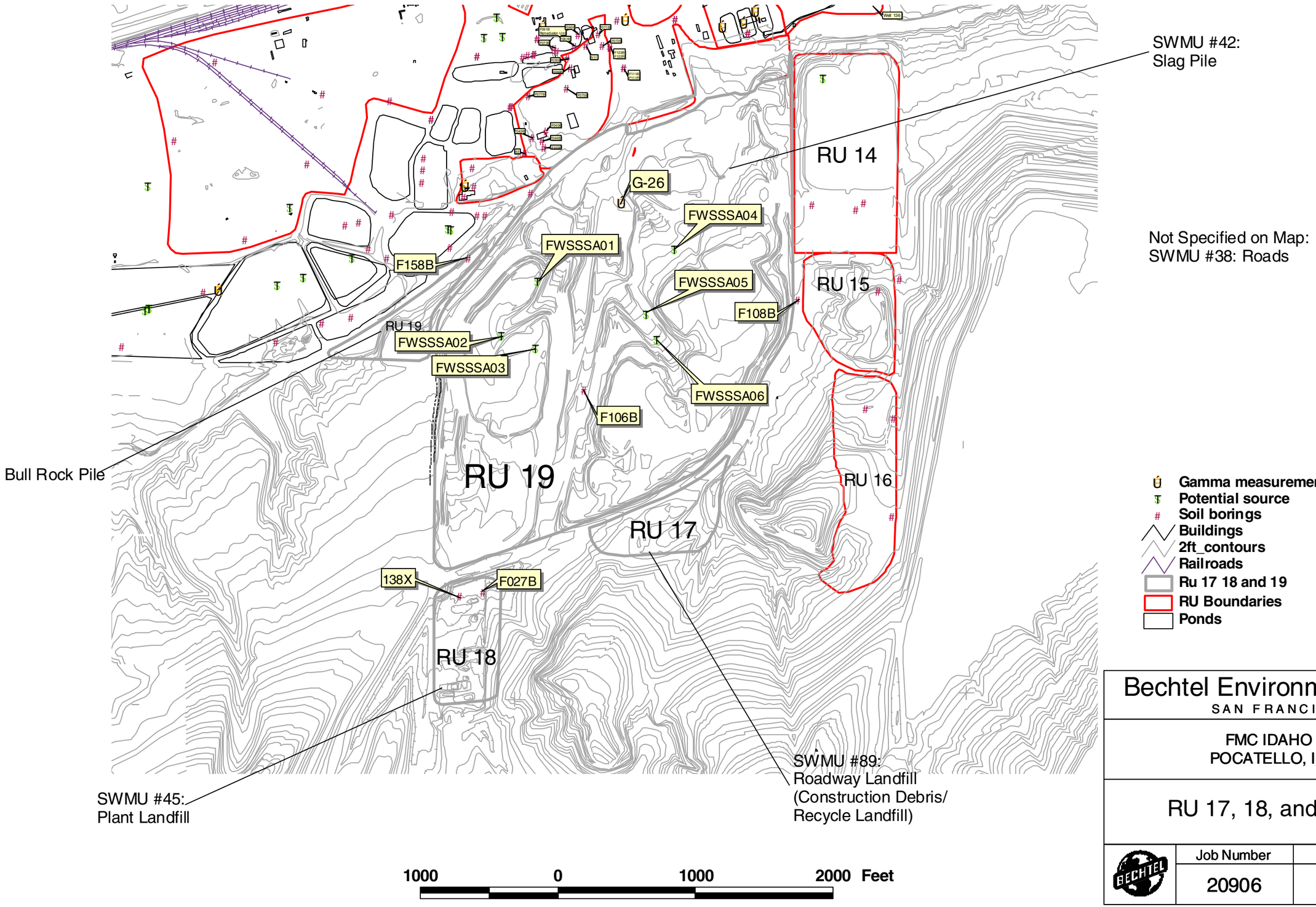
RU 6 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-15	

RU 17, 18, and 19 Summary	
RU Description	Plant landfills have been used by FMC since operations began in 1949. These landfills received various wastes during their operational history. Wastes include scrapped building materials, filter media, asbestos insulation, furnace dig-out material, and office waste, along with minor amounts of spent solvents and oily residuals.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	One boring was drilled through the plant landfill in RU 18. Groundwater was not encountered at depths to 150 feet.
RI Update: Current status; post EMF RI data; additional sources; COPC's	A review of historic air photos and interviews with former plant personnel confirm the presence of approximately 17 sludge-filled railcars beneath the slag pile. RU 17 and RU 18 will continue to receive non-hazardous waste during the plant decommissioning.
Remediation Vision	Implement EPA's Presumptive Remedy for Municipal CERCLA Landfills.
Do existing data support remediation vision in context of updated CSM?	Yes.
Data Gaps	Groundwater source term evaluation for buried rail cars in RU 19. Radon flux emissions at slag pile.
CONCLUSION: Forward RU 17 and RU 18 to SFS. Forward RU 19 to SRI.	

Figure 6-16

RU 17, 18, And 19 Summary



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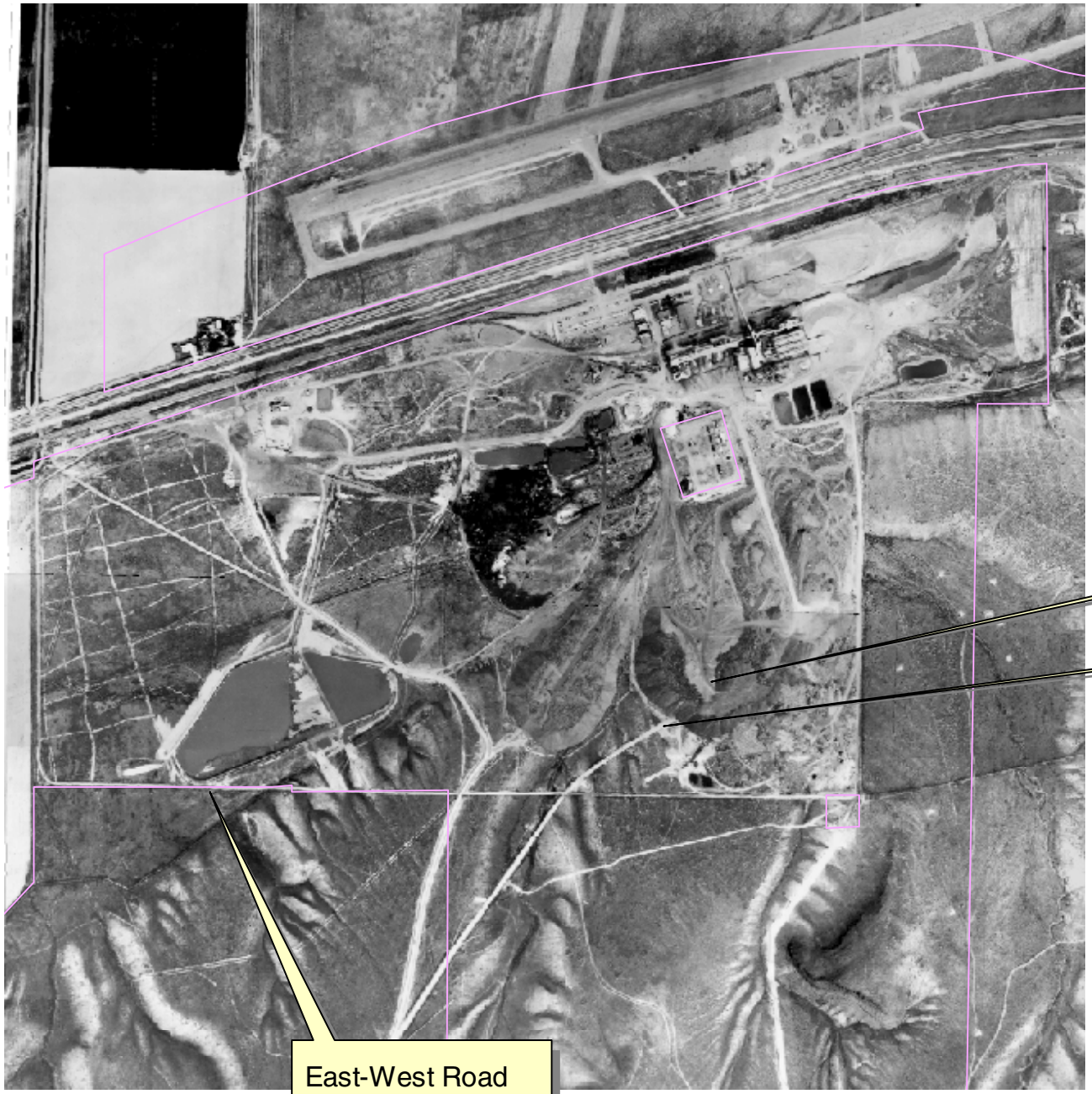
RU 17, 18, and 19 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-17	



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1965 Air Photo of FMC Facility

Job Number	Drawing No.	Rev.
20906	Figure 6-18	

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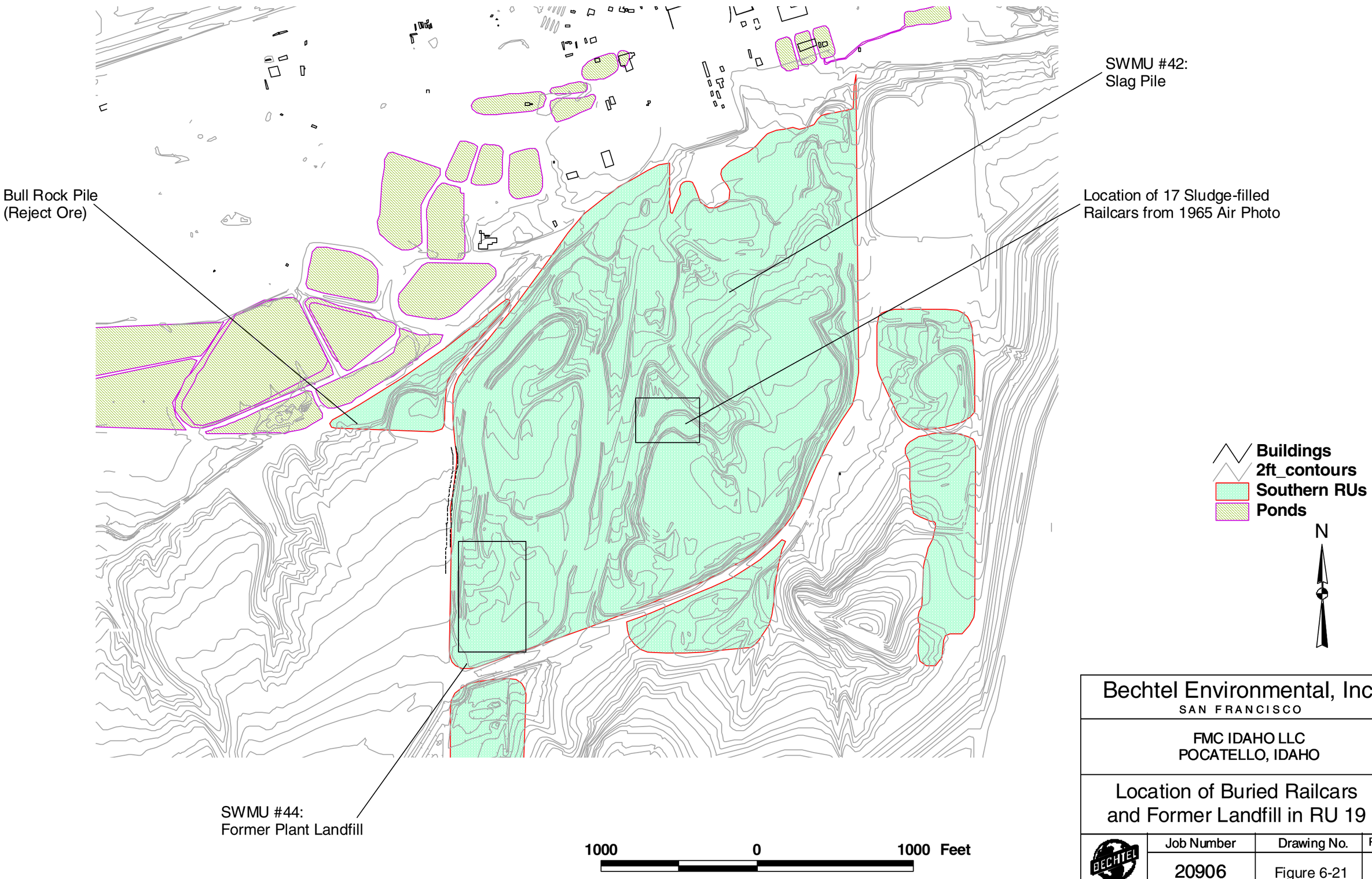
Blow-Up of Area with Sludge-Filled Railcars at South End of Slag Pile

Job Number	Drawing No.	Rev.
20906	Figure 6-19	

Figure 6-20

2003 Air Photo



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Location of Buried Railcars
and Former Landfill in RU 19

Job Number	Drawing No.	Rev.
20906	Figure 6-21	

RU 20 Summary	
RU Description	Bannock Paving Company (BAPCO) leased approximately 61.5 acres of FMC land for the production of asphalt, crushing and sales of slag, ferrophos crushing and loading, coke loading and unloading, drying coke for FMC, and equipment maintenance. BAPCO began operations at RU 20 in 1969 and ceased operations in 1996.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	Slag underlies the majority of the site. Ferrophos and slag were stockpiled at the site during the RI. EMF-related constituents did not migrate more than 5 feet into the native soils beneath the slag fill. No petroleum hydrocarbons or PCBs were detected.
RI Update: Current status; post EMF RI data; additional sources; COPCs	In 1997, BAPCO conducted an investigation into the alleged release of "oily sludge" from a railcar. The investigation identified TPH and BTEX compounds at a depth of 2.5' in one test pit. EPA notified the Jack B. Parson Company, owner of BAPCO, that no further investigation was needed based on the results of the investigation.
Remediation Vision	No action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. Gamma radiation, potential hydrocarbon sources, and coke are not adequately characterized.
Data Gaps	Gamma radiation has not been adequately characterized. Additional gamma measurements are needed. There is insufficient data to evaluate other potential hydrocarbon sources (former fuel tanks and septic tank at shop) and coke has not been characterized. Fuel hydrocarbons may fall within the CERCLA petroleum exclusion.
CONCLUSION: Forward RU 20 to the SRI for additional characterization.	

Figure 6-22

RU 20 Summary

Not Specified on Map:
SWMU #48: Surface Roads
Bannock Paving Area

SWMU #46:
Railcar Loading and
Unloading Areas

SWMU #47:
Bannock Paving Areas
(General Area)

F102B
F103B
Hot-Mix Batch
Plant Location
Office/Shop
F081B
Former Hot-Mix
Batch Plant Location
F082B
F084B
159
140
F080B
F083B
139
132
B-10

Coke Settling Pond

SWMU #46:
Railcar Loading and
Unloading Areas

Monitoring Wells
Soil borings
Buildings
2ft_contours
RU Boundaries
Old Ponds
Railroads

N

400 0 400 800 1200 Feet

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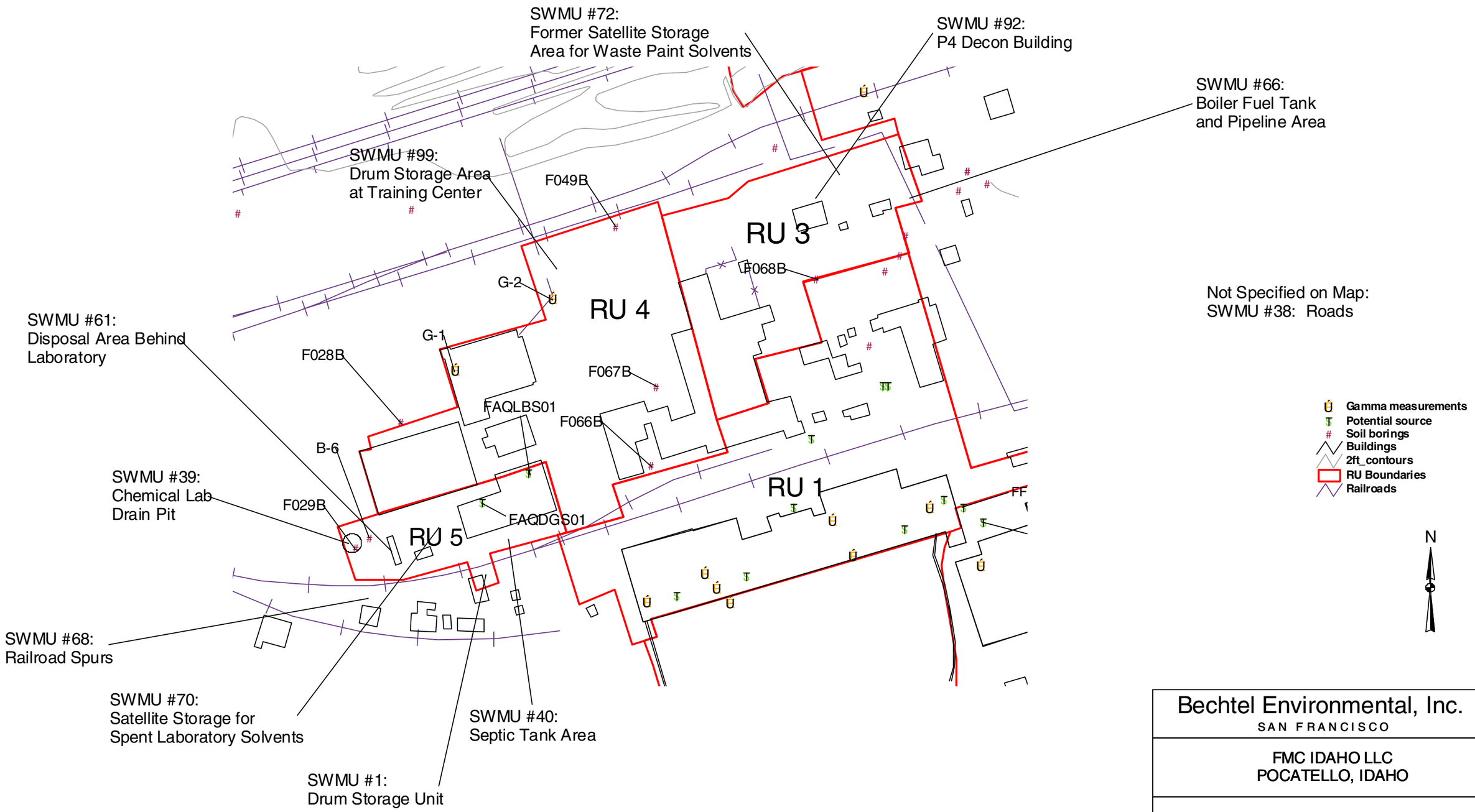
RU 20 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-23	

RU 3 Summary	
RU Description	RU 3 is located in the northern part of the FMC OU. It is a relatively flat area, with several buildings and paved areas. RU 3 is north of the Phos Dock and furnace building and south of the Railroad Swale.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	Boring F068B encountered fill material from 0-2.5 feet. Based on descriptions from other nearby borings, the fill contains some slag. Lithium and mercury were slightly above representative levels in both the 3 and 5 foot samples.
RI Update: Current status; post EMF RI data; additional sources; COPCs	Phossy water spills from RU 1 were allowed to flow to a storm drain that was routed across RU 3 to the Railroad Swale. Although there are no documented leaks in the storm drain, some P4 may be present in the subsurface near the storm drain. The boiler fuel tank was removed in 1993, and confirmation soil samples were collected. These samples show that impacted backfill and soils were removed during tank closure. There were no releases from the P4 Decon Building, which will be closed under RCRA. The available data were insufficient to compare against the updated RBCs at the appropriate confidence levels.
Remediation Vision	No action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. Confirmation that P4 releases did not occur from storm drain is needed, as well as additional sampling to characterize inorganic constituents and gamma radiation.
Data Gaps	Insufficient data to statistically compare site conditions against RBCs for inorganics, and gamma radiation levels. The storm drain routed across RU 3 was identified as a potential source, and video inspection of this drain will help determine if P4 is COPC within RU 3.
CONCLUSION: Forward RU 3 to SRI for additional soil sampling (inorganics), gamma measurements, and investigation of the storm drain for potential P4 releases.	

Figure 6-24

RU 3 Summary



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RU 3, 4 and 5 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-25	

RU 4 Summary	
RU Description	RU 4 is immediately to the west of RU 3, and north of RU 5. Several buildings are within RU 4, including the change house, office buildings, and training center. It is relatively flat-lying with a gentle slope to the north.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	Fill was encountered in shallow depths in all borings. The fill contained varying amounts of slag, and the analytical results indicated the presence of slag in the upper 0 to 5 feet. In native soils, few constituents were above representative levels, indicating no migration to groundwater.
RI Update: Current status; post EMF RI data; additional sources; COPCs	Buildings within RU 4 are still in use. No post-RI data have been identified, and no additional sources have been identified in RU 4. Sufficient data are available to conclude inorganic constituents do not exceed the updated RBCs for the three exposure scenarios in the CSM.
Remediation Vision	No further anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. There is insufficient data to compare inorganic constituents against the Future Site Worker RBC's (0-2' interval), and gamma radiation measurements are needed.
Data Gaps	Gamma radiation measurements are needed to support the DQO decisions at the appropriate confidence levels. Inorganic analyses are needed to characterize the soils in the 0-2' interval for the Future Site Worker scenario.
CONCLUSION: Forward RU 4 to SRI for additional soil characterization (inorganics), VOC hotspot analysis, and gamma radiation measurements.	

Figure 6-26

RU 4 Summary

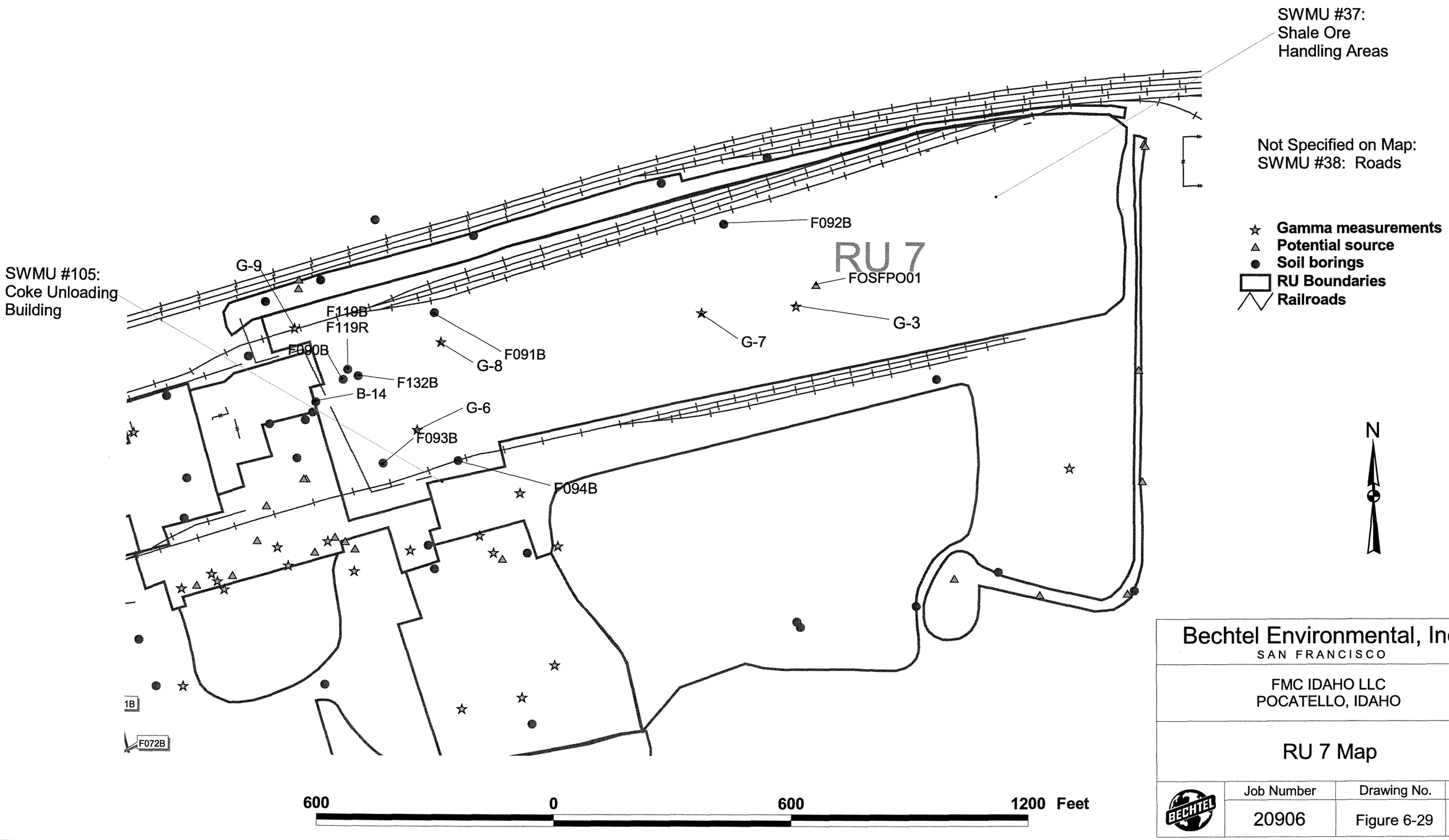
RU 5 Summary	
RU Description	RU 5 contains the FMC laboratory, and the associated drainfield or seepage pit. The laboratory was used to analyze ore and product samples. The laboratory disposed various solutions and organic solvents in the seepage pit., In 1980 that practice ceased. In 1995, the seepage pit was grouted, and a closure report was submitted to EPA in 2002.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	Boring F029B was drilled to investigate the effects of the seepage pit (along with boring F028B in RU 4). Low concentrations of toluene were found in soil samples from shallow depths to approximately 50 feet. Other organic compounds were found in low levels in a soil sample collected near the water table. The EMF RI concluded these were site-related, but likely to be from a source other than the seepage pit.
RI Update: Current status; post EMF RI data; additional sources; COPCs	The building in RU 5 is used for storage and offices. No other sources have been identified within RU 5.No additional data are available.
Remediation Vision	No further action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. While there are sufficient data to characterize potential sources to groundwater and organic compounds in the shallow soils, there are insufficient data to perform the statistical comparisons with the 1998 RBCs and the updated RBCs. In addition, no gamma radiation measurements were collected during the EMF RI. The past disposal of VOC's in the lab drain field requires some confirmation sampling to assess the presence of hotspots.
Data Gaps	Insufficient data to support statistical comparisons with updated RBCs for inorganic constituents. Gamma radiation measurements are needed to support the DQO decisions at the appropriate confidence levels. VOC analyses at the lab disposal area are needed to determine if hotspot remediation is needed.
CONCLUSION: Forward RU 5 to SRI for additional soil characterization (inorganics), VOC hotspot analysis, and gamma radiation measurements.	

Figure 6-27

RU 5 Summary

RU 7 Summary	
RU Description	RU 7 is located in the northeastern portion of the FMC OU, adjacent to the JR Simplot facility. Historic air photos and plant records show this area has been used for ore handling since the plant began operation in 1949. Other materials handled within RU 7 include coke, which was unloaded from railcars and placed on conveyors to the furnace building. RU 7 has been built up from original grade, possibly because of ore stockpiling and material handling requirements at the plant. Currently, there are two long shallow trenches and a portion of the ore pile remains in the bermed area.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	RU 7 is covered by varying thickness of ore. Ore contains several inorganic constituents above representative levels (arsenic, cadmium, chromium, fluoride, total phosphorus, zinc, nickel and vanadium). Soil samples from native soils beneath the ore pile showed little to no migration potential for these constituents. Unshielded gamma radiation measurements were above background.
RI Update: Current status; post EMF RI data; additional sources; COPCs	The reclaimer and much of the other equipment has been scrapped, and some ore remains within RU 7. Roads and railspurs remain in place and are in use to support plant decommissioning activities. There are no post EMF RI data available for RU 7. Slag fill was noted along roadways surrounding RU 7. No additional sources have been identified at RU 7, and no other COPCs have been identified for the RU 7 area. Inorganics are adequately characterized, and the statistical comparisons with updated RBCs show no inorganics exceed the RBCs at the 95% confidence level.
Remediation Vision	Following sale and removal of ore inventory, no action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. A statistical comparison of gamma radiation measurements indicates additional measurements are needed to support the decision. Coke has not been evaluated as a potential source material (although coke compounds are immobile, the material itself has not been analyzed for PAHs, PNAs, etc.)
Data Gaps	Additional gamma radiation measurements are needed to perform the statistical comparison with background at the 95% confidence level. Characterization of coke, and the soils within the exposure pathway is needed to support the remedial action vision.
CONCLUSION: Forward RU 7 to SRI for characterization of the coke, shallow soils in the coke handling area, gamma radiation measurements and screening and analysis for lead-210 and polonium-210. Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.	

Figure 6-28
RU 7 Summary



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RU 7 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-29	

RU 9 Summary	
RU Description	The silica stockpile area is the relatively flat-lying area south of the ore stockpile. FMC has always used most of the area within RU 9 for silica handling. The former kiln scrubber overflow pond was located in this area, and was backfilled in the late 1960's after the kilns were replaced with calciners. The pond was backfilled with silica.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	The former kiln scrubber overflow pond appeared to have been a source of metals to groundwater, based on the occurrence of above-representative levels of metals in the soil column from the base of the pond to the uppermost aquifer. No other pond contaminant sources were identified during the RI, and borings through the pond footprint did not encounter any residual sludge or kiln solids at the base of the pond. There was over 40 feet of silica backfill encountered in boring F054B.
RI Update: Current status; post EMF RI data; additional sources; COPCs	Roads through the RU 9 area may be underlain by slag. However, the road segments in this area may use a silica base. P4 was not identified as a COPC in this RU. No P4 handling or storage activities occurred in RU 9.
Remediation Vision	No further action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. There are insufficient gamma radiation data, and the potential for residual pond solids should be investigated.
Data Gaps	Potential presence of slag, and associated gamma radiation characterization is needed.Confirmation borings in former kiln scrubber pond are needed to determine if there are residual solids, and if these are at depths within the potential exposure pathways from updated CSM. Additional soil samples are needed to support the DQO process for inorganic constituents.
CONCLUSION: Forward RU 9 to SRI for confirmation borings, gamma measurements, and soil sampling (inorganics and lead-210 and polonium-210). Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.	

Figure 6-30

RU 9 Summary

Not Specified on Map:
SWMU #38: Roads

FRSIWW01
FSWIWW01

SWMU #50:
IWW Ditch

FSDIWW02

SWMU #106:
Nodule Pile

G-5

FSDIWW03

Silica Pile

F030B

F054B

F110B

B-8

FSDIWW05

FSDIWW04

F130B

FSDIWW06

SWMU #51:
Former Kiln Scrubber
Overflow Pond and Ditch

SWMU #49:
Industrial Wastewater
Basin

400 0 400 Feet

☆ Gamma measurements
△ Potential source
● Soil borings
RU Boundaries
Old Ponds
Railroads

N

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RU 9 and 10 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-31	

RU 10 Summary	
RU Description	The IWW pond and ditch are located in the flat-lying eastern portion of the FMC OU. The pond is approximately 100 feet in diameter, and the ditch runs northeast from the pond for 350 feet, then turns and runs north for 1200 feet along FMC's eastern property boundary. Discharge from the IWW system was routed to an underground pipe as it left FMC's property and flowed to the Portneuf River.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	During the EMF RI, it was determined that the IWW system was subject to occasional plant upsets, when process water was introduced into the IWW system. These upsets were infrequent, but had the potential to introduce P4 into the pond and ditch. Inorganics were identified in sediment samples at above-representative levels, however, none of the EMF-related constituents was found at above-representative levels in the soils beneath the pond and ditch area.
RI Update: Current status; post EMF RI data; additional sources; COPCs	In 1995, a potential release of up to 2 pounds of P4 was reported. Minor amounts of P4 may remain in the IWW pond and ditch sediments. The IWW pond and ditch have been backfilled with silica from the silica stockpile.
Remediation Vision	Backfill with silica, no further action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. Inorganic constituent data are insufficient to support the remediation vision. The lack of gamma radiation measurements also does not support the remediation vision.
Data Gaps	Confirmation sampling of the IWW dredged sediments and material remaining in the pond and ditch is needed to support remediation vision. Insufficient gamma measurements are available to support the DQO process.
CONCLUSION: Forward RU 10 to SRI for soil and sediment sampling (inorganics and lead-210 and polonium-210), and gamma radiation measurements. Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.	

Figure 6-32

RU 10 Summary

RU 11 Summary	
RU Description	RU 11 is located at the northern edge of the slag pile. It slopes to the north, toward the calciners.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	This area was not investigated during the EMF RI. There were no potential sources and no waste or process material was stored within RU 11.
RI Update: Current status; post EMF RI data; additional sources; COPCs	No post-RI sources were identified.
Remediation Vision	No further action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. The presence of slag fill under area roads is a potential gamma source. In addition, there are no soil samples to characterize site conditions.
Data Gaps	Gamma radiation measurements to characterize external exposure from nearby slag pile and slag road base are needed. Soil samples from the 0-10' interval are needed to characterize the exposure scenarios in the updated CSM.
CONCLUSION: Forward RU 11 to SRI for soil sampling (inorganics and lead-210 and polonium-210) and gamma radiation measurements. Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.	

Figure 6-33

RU 11 Summary

Old Ponds
Roads
Soil borings
Potential source
RU Boundaries
Railroads

N

300 0 300 600 Feet

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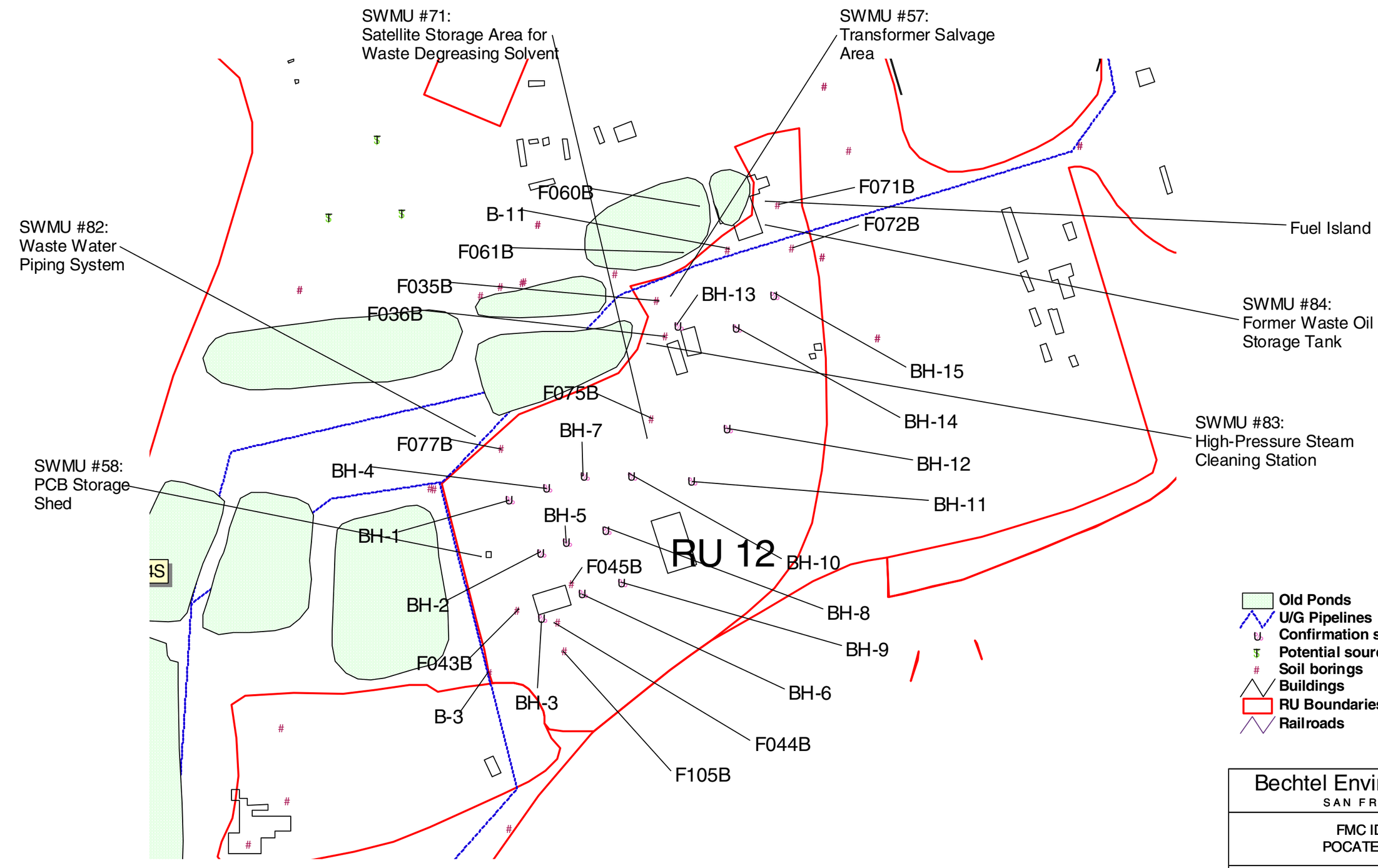
RU 11 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-34	

RU 12 Summary	
RU Description	RU 12 is located in the central portion of the FMC OU. It is gently sloping to the northwest, and there are several buildings located within the RU boundaries. Buildings include the LDR facility and the PCB storage shed (removed in 200). There is also a fueling station located within RU 12, with two associated underground diesel fuel tanks.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	The area is underlain by slag fill. Three soil samples contained very low concentrations of PCBs, and 12 samples did not contain detectable levels of PCBs. Phossy water pipeline cleanouts were investigated during the RI, and the soil samples indicated that there were releases of phossy water around the cleanouts.
RI Update: Current status; post EMF RI data; additional sources; COPCs	Three documented releases of diesel fuel have occurred since the EMF RI was completed. While FMC recovered spilled fuel, some site soils were likely impacted by these releases. Former underground pipelines running through RU 12 are potential sources of P4 and metals.
Remediation Vision	No action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. Additional data are needed to support the remediation vision. Specifically, gamma radiation measurements, P4 characterization along underground piping, TPH in soils that may be affected by fuel spills, and possibly some additional PCB characterization.
Data Gaps	Soils impacted by fuel releases (hotspot sampling), recognizing that this may fall within the CERCLA petroleum exclusion. Potential for soils impacted by former phossy water underground pipes. Gamma radiation measurements to characterize slag fill. PCB's in soils around the PCB storage shed and transformer salvage area (hotspot sampling).
CONCLUSION: Forward RU 12 to SRI for additional characterization of TPH, gamma radiation, P4, lead-210 and polonium-210, and PCBs. Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.	

Figure 6-35

RU 12 Summary



Not Specified on Map:
SWMU #38: Roads
SWMU #64: Possy Waste Pipeline Cleanouts
SWMU #65: Precipitator Slurry Pipeline Cleanouts

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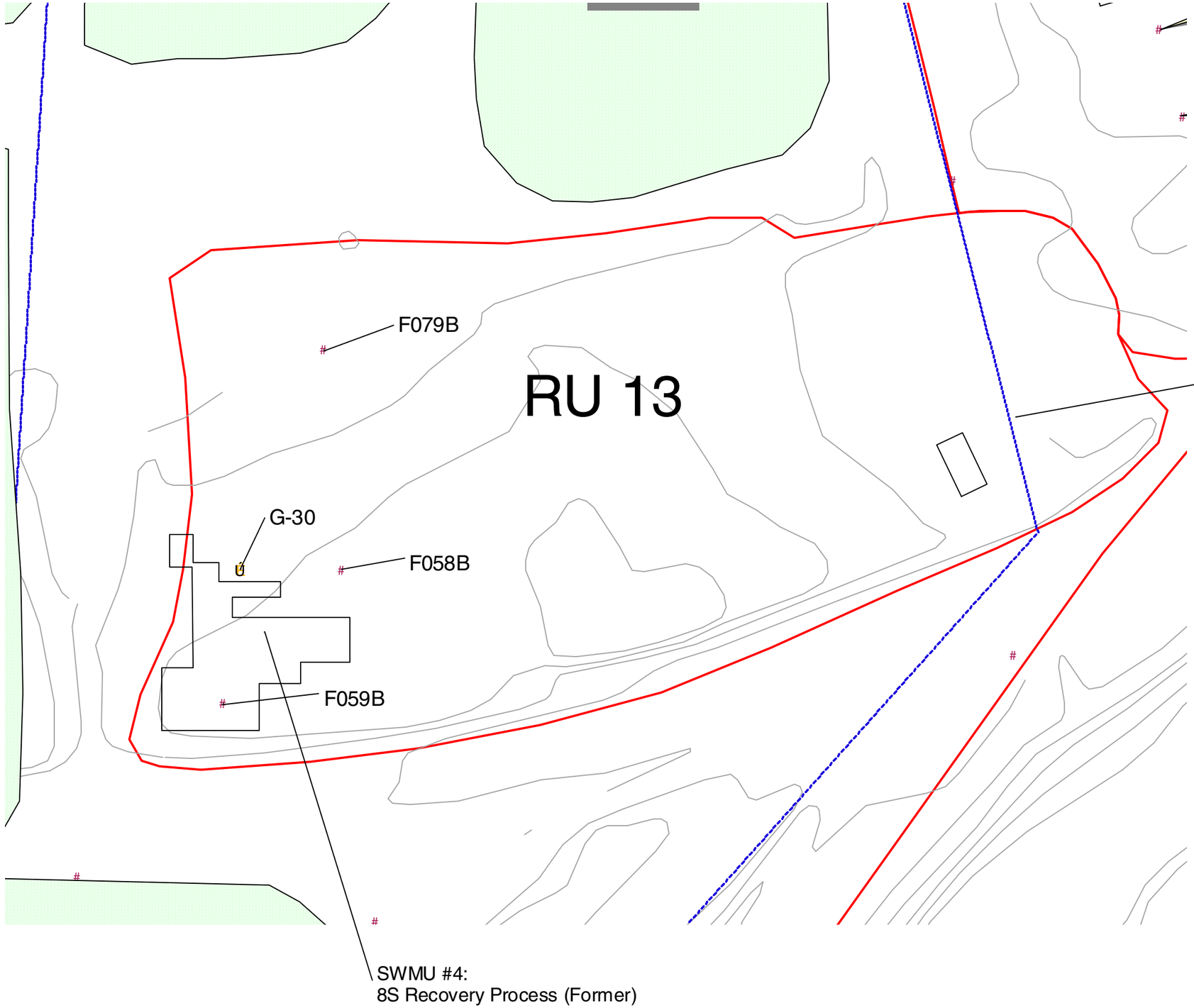
RU 12 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-36	

RU 13 Summary	
RU Description	RU 13 is located in the south-central portion of the FMC OU. It is immediately southwest of RU 12, and is adjacent to several old ponds. The Pond 8S Recovery Process facilities were previously located in RU 13; however, these facilities were closed and dismantled under a RCRA Closure Plan. Former underground pipes for handling phossy water and precipitator slurry are located within RU 13. These pipes were left in place after FMC installed above-ground pipes between the furnace building and the ponds.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	The site is underlain by slag fill. There was evidence that the underground piping had leaked, and some phossy water constituents had migrated to depths >10 feet.
RI Update: Current status; post EMF RI data; additional sources; COPCs	Potential sources identified in RU 13 include the former underground pipes and the slag fill..
Remediation Vision	No further action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. Slag fill has not been characterized for gamma radiation levels, and the shallow soils (0-10') cannot be statistically compared to RBC's. The underground piping within RU 13 has not been fully characterized with respect to potential P4 releases.
Data Gaps	P4 presence in soils and fill adjacent to former underground pipes. Gamma radiation measurements are needed to characterize slag fill. Confirmation soil samples will be collected and analyzed for lead-210 and polonium-210. Inorganic constituents in shallow soils (0-10')
CONCLUSION: Forward RU 13 to SRI for collection of gamma radiation measurements, P4 and inorganic characterization in the shallow soils (0-10'). Soils will be analyzed for lead-210 and polonium-210. Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.	

Figure 6-37

RU 13 Summary



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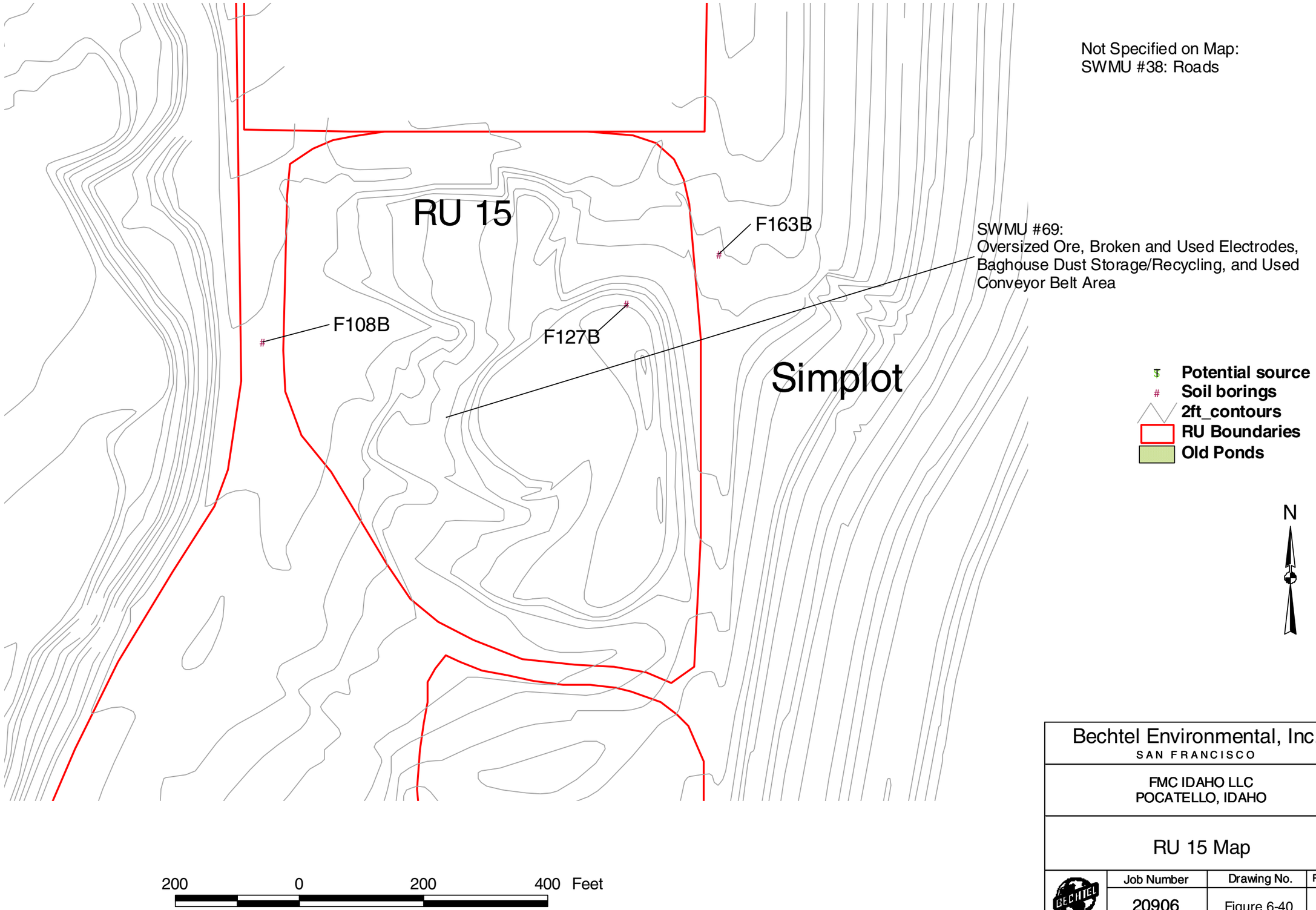
RU 13 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-38	

RU 15 Summary	
RU Description	RU 15 is located south of the calciner ponds, in the Bannock Range area. It is south of the main plant area, and east of the slag pile, near the FMC property boundary with Simplot. It contains mounds of reject ore (similar to the bull rock pile in RU 19), and baghouse dust. The dust originated from raw material handling, such as ore and coke unloading from rail cars. There are some smaller pieces of used or broken carbon electrodes. Larger pieces of carbon electrodes have been sold.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	The EMF RI identified EMF-related constituents in the shallow native soils immediately underlying the ore. There was no evidence that these constituents were migrating to groundwater. Ore contains cadmium, chromium, vanadium and zinc at concentrations above background soils, as well as fluoride and phosphorus.
RI Update: Current status; post EMF RI data; additional sources; COPCs	The larger pieces of carbon electrodes have been sold and were removed from the site, after confirmation sampling of the electrodes was performed. RU 15 no longer receives ore, baghouse dust, and other materials for disposal/storage.
Remediation Vision	Consolidate material into minimal footprint, grade to design subgrade elevation and construct soil cover (cap) over area.
Do existing data support remediation vision in context of updated CSM?	Yes. Ore, baghouse dust, and remaining pieces of carbon electrodes can be effectively removed from exposure pathways through implementation of the remediation vision. No other data are required to support the SFS or RD.
Data Gaps	None.
CONCLUSION: Forward RU 15 to SFS	

Figure 6-39

RU 15 Summary



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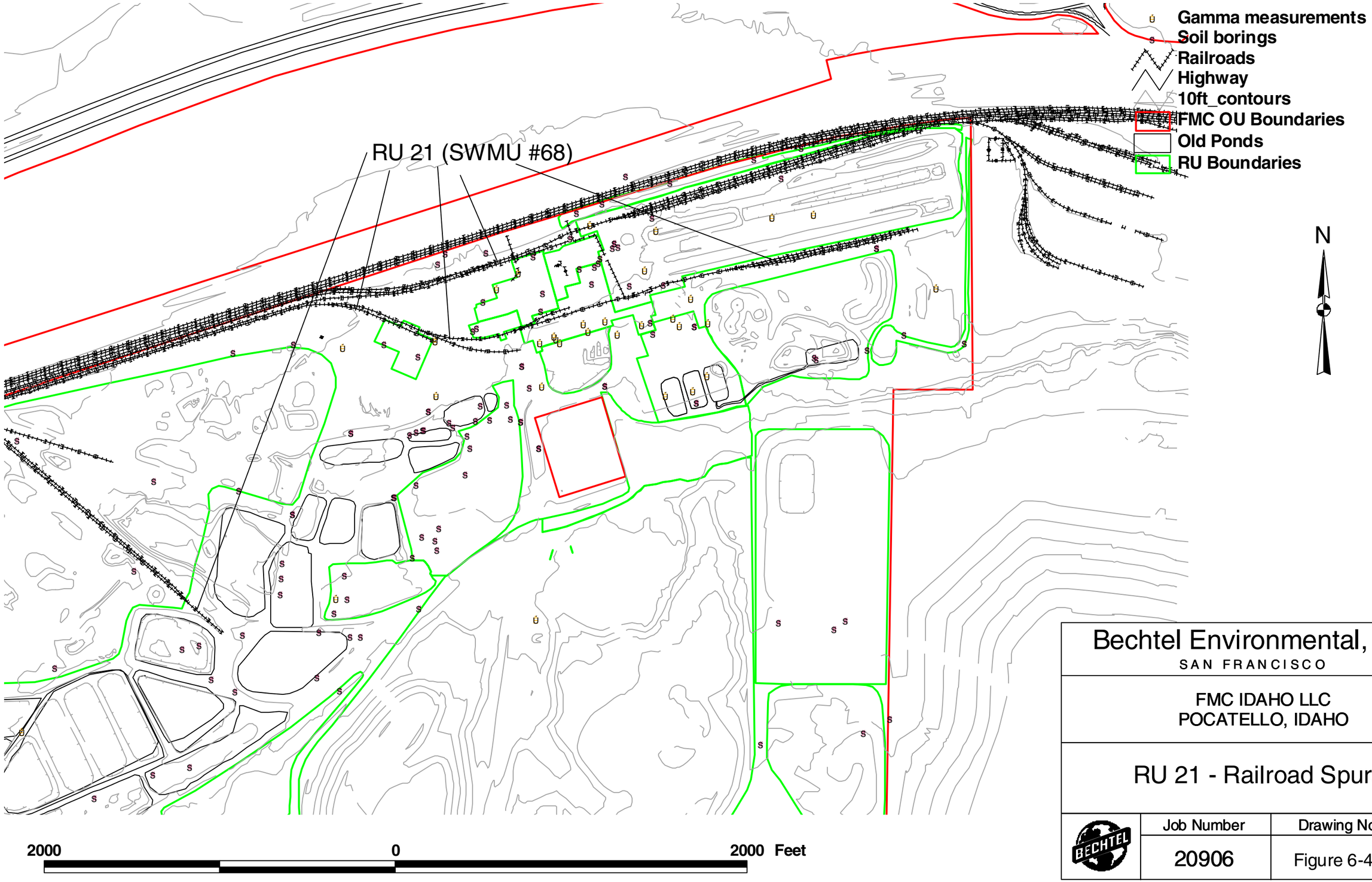
RU 15 Map

Job Number	Drawing No.	Rev.
20906	Figure 6-40	

RU 21 Summary	
RU Description	Several thousand feet of rail spurs served the FMC plant. These rail spurs are located near the northern plant boundary, and were used to deliver coke, ore, and heavy equipment. FMC used the rail spurs to load and transport P4 product. In early years, slag was crushed and loaded onto rail cars for use as ballast. Ferrophos was also transported from the site using the rail spurs within the FMC OU. These activities occurred within RU 20, and are not subject to investigation within RU 21.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	None. FMC intended to characterize rail spurs during the EMF RI, but access to rail spurs was not feasible at that time.
RI Update: Current status; post EMF RI data; additional sources; COPCs	There were no reported spills or releases by rail cars within the FMC OU, and none since the EMF RI was completed. Areas where P4 was actively loaded and unloaded into railcars fall within other RU boundaries, and will be investigated as appropriate.
Remediation Vision	No action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. Presence of slag is likely.
Data Gaps	Gamma radiation measurements are needed to characterize slag fill. Soils will be analyzed for lead-210 and polonium-210.
CONCLUSION: Forward RU 21 to SRI Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.	

Figure 6-41

RU 21 Summary



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RU 21 - Railroad Spurs

Job Number	Drawing No.	Rev.
20906	Figure 6-42	

RU 23 Summary	
RU Description	Most roads within the FMC OU were constructed on a base of crushed and graded slag. Many of these roads were paved during the 1990's to reduce fugitive dust emissions.
EMF ROD Remedy	The 1998 ROD selected site-wide institutional controls to prohibit residential use and prevent ingestion of groundwater exceeding MCLs/RBCs. The ROD also selected site-wide institutional controls requiring future structures be constructed with radon control measures.
EMF RI Findings	Numerous borings were drilled along roadways throughout the FMC OU to characterize materials used in road construction, and to assess the potential of these materials to be a source to groundwater.
RI Update: Current status; post EMF RI data; additional sources; COPCs	There were no reported spills or releases on roadways within the FMC OU, and none since the EMF RI was completed. Spills of P4 on road segments that fall outside other RU's have not been reported. It appears that the primary concern with roads continues to be the ubiquitous presence of slag fill, and possibly minor amounts of precipitator dust (used during winter months on icy roads), and possibly some ore.
Remediation Vision	No action anticipated to be necessary.
Do existing data support remediation vision in context of updated CSM?	No. Presence of slag is likely in most road segments. In the past, precipitator dust may have been applied to road surfaces in the plant area during winter months.
Data Gaps	Gamma radiation measurements are needed to characterize slag fill. Portions of RU 23 may have had precipitator dust applied in the past during icy winter conditions. These portions of RU 23 will be characterized for lead-210 and polonium-210.
CONCLUSION: Forward RU 23 to SRI Note: Lead-210 and polonium-210 are radionuclides associated with phossy solids. Phossy solids may be detectable through the use of surrogates, as described in Appendix H.	

Figure 6-43

RU 23 Summary

Table 6-1 - Constituents of Concern in each Remediation Unit

RU No.	RU Name	Parameters									Information Basis
		P4	Ra-226[a]	Arsenic	Cadmium	Solvents[b]	Liquid Petroleum Fuels[c]	PCBs	Lead-210[d]	Other	
RU 1	Furnace Building	COC	COC	COPC	COPC						P4 encountered under foundation of furnace building during slag ladling conversion project (No. 3 furnace P4 sump). Occurrence within other areas anticipated based on process knowledge and spill assessments.
RU 2	Slag Pit	COC	COC	COPC	COPC						Process knowledge
RU 3	Receiving Stores, Paint Shop, and P4 Decon	COC	COC								Process knowledge, EMF RI
RU 4	Office Buildings and Training Center		COC								EMF RI
RU 5	Lab and Old Drainfield		COC			COPC					EMF RI
RU 6	Former Long-Term P4 Storage	COC	COC						COPC		EMF RI and post-RI spill history.
RU 7	Shale Unload, Crushing and Stockpile		COC	COC					COPC		Process knowledge, EMF RI
RU 8	Former Kiln Scrubber Ponds and Calciners		COC		COC				COPC		Process knowledge, EMF RI
RU 9	Silica Stockpiles and Former Kiln Scrubber Overflow Pond		COC		COC				COC		EMF RI
RU 10	IWW Pond and Ditch	COPC	COC						COPC		EMF RI and post-RI spill history.
RU 11	Equipment Area South of Calciners		COC						COPC		Process knowledge, EMF RI
RU 12	Former RP&S Area and Mobile Shop	COC	COC	COC	COC		COPC	COPC	COPC		EMF RI, post-RI spill history, LDR pre-construction soil sampling.
RU 13	Pond 8S Recovery Process & Metal Scrap Preparation Area	COC	COC	COC	COC				COPC		Process knowledge, EMF RI
RU 15	Oversize Ore, Used Electrode, Baghouse Dust Area		COC	COC	COC				COPC		Process knowledge, EMF RI
RU 16	Calciner Solids Stockpile		COC		COC				COC		EMF RI
RU 17	Recyclable Material Landfill								COPC	See Table 6-3, landfill contents	Process knowledge.
RU 18	Plant Landfill					COC	COC		COPC	See Table 6-3, landfill contents	Process knowledge.
RU 19	Slag Pile, Bull Rock Pile	COC	COC	COC		COC	COC		COPC	See Table 6-3, landfill contents	EMF RI, process knowledge, historic aerial photo review.
RU 20	Former Bannock Paving Area		COC			COPC	COPC				EMF RI and post-RI spill history.
RU 21	Other Onsite Railspurs		COC								EMF RI
RU 22b	Old Ponds	COC		COC	COC				COC		EMF RI
RU 22c	Railroad Swale	COC									EMF RI and post-RI spill history.
RU 23	Road segments not within RU Boundaries		COC						COPC		Process knowledge, EMF RI

COC − Constituent of Concern. Evidence of presence in a specific RU based on EMF RI data, process knowledge, post-RI spill history, or other line of evidence

COPC − Constituent of Potential Concern. Potential presence, not confirmed

[a] Gamma radiation measurements will be used as a surrogate to quantify primary risks associated with Ra-226 (ie, external gamma exposure) in RU's where a cap/cover is not envisioned

[b] Includes TCE, PCE, Chloroform, 2-Butanone, and 1,1,1 TCA

[c] Includes benzene, toluene, ethylbenzene, and xylenes

[d] Lead-210 and Polonium-210 are known to occur in precipitator dust and phossy solids. XRF methodology outlined in Appendix H will be used for characterization.

Table 6-2

Classification of Remediation Units within the FMC OU

Section	Classification	Remediation Units
6.1.1	Former Ponds, Railroad Swale, or Calciner Solids Storage Area	**RU 22B** (CERCLA RD/RA UNITS), **RU 22C** (Railroad Swale), **RU 16** (Calciner solids stockpile), **RU 8** (Former Kiln Scrubber Ponds and Calciners)
6.1.2	Former P4 Working Area	**RU 1** (Furnace Building, Phos Dock), **RU 2** (Slag pit), **RU 6** (Former Long-term Phos Storage)
6.1.3	Landfill	**RU 17** (Recyclable Material Landfill), **RU 18** (Plant Landfill), **RU 19** (Slag Pile, Former Plant Landfill, and Bull Rock Pile)
6.1.4	Other	**RU 3** (Receiving/Stores, Old Paint Shop and New P4 Decon Bldg)**,** **RU 4** (Office Bldgs and Training Center), **RU 5** (Laboratory and Old Drainfield), **RU 7** (Shale Unloading/Crushing and Stockpile), **RU 9** (Silica Stockpile), **RU 10** (IWW Pond and Ditch), **RU 11** (Equipment/Supply Storage Area South of Calciners), **RU 12** (Former RP&S and Mobile Shop), **RU 13** (Pond 8S Recover Process), **RU 15** (Oversized Ore, Broken Electrodes, and Baghouse Dust Recycle Material), **RU 20** (Former Bannock Paving Area and Associated Rail Spurs), **RU 21** (Railspurs not associated with other RU's), and **RU 23** (Road segments not associated with other RU's)

RU 22a and RU 14 are not included in this listing because they are being addressed respectively by EPA Region X's RCRA and the IDEQ

.

TABLE 6-3
Landfill Contents

RU # and Name	Office Wastes	Industrial Wastes	Other	Solvents and Lubricants	AFM
RU 17 – Recyclable Material Landfill	No	Excess baghouse dust, furnace rebuild and dig-out material, unsalvageable building material (bricks, wood, sheathing, etc.), cement truck washout	No	No	No
RU 18 – Plant Landfill: Main Cells[1]	Nearly all office-related waste went to this landfill, including; paper, food, packaging material, toner, office equipment, etc.	Tires, personal protective equipment (respirators, clothing, hardhats, etc.), crushed empty drums and metal containers, pallets, baghouse materials (not dust), ***unsalvageable building materials and equipment including:*** bricks, wood, fiberglass, carpet, tile (non-asbestos), windows, concrete, refractory material (non-hazardous), HDPE, birdballs, PCDT filter cake (non-hazardous), AFM (non-hazardous)	No	Minor amounts of spent solvents and lubricants[2]	Yes (Cell 1)
RU 18 – Plant Landfill: Dedicated Asbestos Cells (South End)		Asbestos containing materials (insulation, tile, etc.)			
RU 19 – Former Plant Landfill	Paper, food, packaging material, toner, office equipment, etc.	Asbestos insulation, tires, PPE, pallets, empty drums, scale from calciner pallets	Possibly some furnace internals, kiln scrubber pond solids, fluid bed dryer solids, P4-bearing wastes	Spent solvents and oily residuals, non-PCB transformer oil,	Yes

Notes:

[1] FMC will continue to use the RU 18 Landfill for disposal of non-hazardous waste generated during the decommissioning and dismantling of the plant.

[2] FMC's plant practice was to store waste oil for pickup and recycling by a third party. Spent solvents were stored and shipped offsite for disposal as hazardous wastes. However, FMC plant personnel consider it likely that minor amounts were disposed in the landfills through the years.

Table 6-4
Permeability Test Results from Soil Borrow Area

Sample Designation	Lab Permeability (cm/sec)
18-1	1.5 E-05 to 6.6 E-05
18-2	3.3 E-05 to 1.7 E-05
18-3	9.6 E-06 to 4.5 E-04
18-4	3.8 E-05 to 9.3 E-05
18-5	6.9 E-05 to 9.1 E-05
18-6	3.8 E-05 to 8.1 E-05

Table 6-5
Hotspot Criteria Applied to FMC Landfills

Criteria	RU 17 – Recyclable Material Landfill	RU 18 Plant Landfill	RU 19 Former Plant Landfill	RU 19 Buried Rail Cars
Is there evidence for the presence and approximate location of waste?	No	No	No	Yes
Is hotspot known to be a principle threat waste?	No evidence for a hotspot	No	No	Yes
Is the waste in a discrete, accessible part of the landfill?	No evidence for a hotspot	No	No	No (buried by over 50' of slag, not accessible)
Is the hotspot known to be large enough that its remediation will reduce the threat posed by the overall site, but small enough that it is reasonable to consider removal (100,000 cubic yards or less)?	No evidence for a hotspot	No	No	No (No evidence of migration, indications are that most metals will be bound to alkaline soils within vadose zone, if infiltration is controlled)

Table 6-6
Summary of Technical Areas for Landfills at the FMC OU

Technical Area	RU 17 (Recyclable Material Landfill)	RU 18 (Plant Landfill)	RU 19 (Slag Pile/Bull Rock Pile)
Waste Area Delineation	Delineated	Delineated	Delineated
Slope Stability and Settlement	Final cover design will be evaluated in SFS/RD	Final cover design will be evaluated in SFS/RD	Final cover design will be evaluated in SFS/RD
Gas Generation/Migration	Radon control features for future buildings (1998 ROD). Future buildings considered unlikely, low potential for gas generation due to low organic waste content	Radon control features for future buildings (1998 ROD). Low potential for future nearby buildings, low VOC content in waste mass.	Radon control features for future buildings (1998 ROD). Low potential for future nearby buildings, significant thickness of slag between waste mass and any future foundation.
Existing Cover Assessment	No existing cover. No assessment warranted	Existing cover is flat.	30 to 50 feet of slag.
Surface Water Run-on/Run-off Management	Evaluate in SFS/RD	Evaluate in SFS/RD	Evaluate in SFS/RD
Cover Material Characterization	Done.	Done.	Done.
Hotspot Removal and Treatment	No known hotspots	No known hotspots	Buried rail cars. Removal and treatment not applicable.

Table 6-7
Summary of Available Soil Data for Evaluating Updated CSM

RU Number and Name	Soil Borings within RU	Number of Soil Samples (0-2 feet)	Number of Soil Samples (0-10 feet)
RU 3 – Receiving Stores, Paint Shop, and P4 Decon	2	0	2
RU 4 – Office Buildings and Training Center	4	2	**10**
RU 5 – Lab and Old Drainfield	2	1	1
RU 7 – Shale Unload, Crushing and Stockpile	**6**	**7**	**17**
RU 9 – Silica Stockpiles	3	2	3
RU 10– IWW Pond and Ditch	2	1	2
RU 11 - Equipment Area South of Calciners	0	0	0
RU 12– Former RP&S Area and Mobile Shop	28	3	**29**
RU 13– Pond 8S Recovery Process & Metal Scrap Preparation Area	2	0	**4**

(table continues)

Table 6-7 (continued)

RU 15– Oversize Ore, Used Electrode, Baghouse Dust Area	1	1	2
RU 20– Former Bannock Paving Area and Associated Railspurs	4 1 Ferrophos 6 Slag	0	**10**

Table 6-8
Statistical Tests for Determining 95% UCL of Mean Concentrations

Data Distribution	**Statistical test for 95% UCL of the Mean**
Normal where there are 10 or more samples in dataset, and <15% are non-detects	Student's t-test
Lognormal where there are 10 or more samples in dataset, and <15% are non-detects	H-UCL
Unknown distribution or, >15% Non-Detects reported or, 4 to 9 samples available	Chebyshev

Table 6-9
Results of Distribution Tests (RU 20)

Constituent	Distribution (Soils to 10 feet, No. of Samples =10)
Antimony	Normal
Arsenic	Normal
Barium	Normal
Beryllium	Unknown
Boron	Normal
Cadmium	Unknown
Chromium	Unknown
Cobalt	Normal
Copper	Normal
Fluoride	Unknown
Lead	Normal
Lithium	Normal
Manganese	Normal
Mercury	Normal
Molybdenum	Normal
Nickel	Normal
Selenium	Lognormal
Silver	Normal
Vanadium	Normal
Zinc	Unknown
Thallium	Unknown

Table 6-10
95% UCL of the Mean Concentration
(Slag/Ferrophos in RU 20 No. of Samples = 7)

Constituent	95% UCL of Mean	Calculation Method
Antimony	25.21	C
Arsenic	2.95	C
Barium	337	C
Beryllium	2.19	C
Boron	122	C
Cadmium	83.8	C
Chromium	1874	C
Cobalt	10	C
Copper	313	C
Fluoride	22292	C
Lead	6.07	C
Lithium	25.7	C
Manganese	215	C
Mercury	.36	C
Molybdenum	69.9	C
Nickel	411	C
Selenium	7.13	C
Silver	21.4	C
Vanadium	2065	C
Zinc	392	C
Thallium	NA	C

Table 6-11
95% UCL of the Mean Concentration
(Soil from 10 feet or less, No. of Samples = 10)

Constituent	95% UCL of Mean	Method
Antimony	17.25	C
Arsenic	6.64	C
Barium	173.5	S
Beryllium	1.05	C
Boron	21.2	C
Cadmium	2.19	C
Chromium	27.57	C
Cobalt	6.39	S
Copper	13.2	S
Fluoride	1287	C
Lead	12.51	C
Lithium	15.74	S
Manganese	403.4	S
Mercury	.479	C
Molybdenum	2.95	C
Nickel	14.16	S
Selenium	3.49	C
Silver	.895	C
Vanadium	39.75	C
Zinc	136	C
Thallium	26.89	C

Table 6-12
Difference Between the 95% UCL of the Mean Slag and Ferrophos Samples, Characterizing the Future Site Worker Exposure at RU 20

Constituent	95% UCL of Mean	EMF ROD RBC's	Delta 1
Antimony	25.21	359	333.79
Arsenic	2.95	1.43*	1.52
Barium	337	61612	61275
Beryllium	2.19	**0.58***	1.61
Boron	122	80636	80514
Cadmium	83.8	448	364.2
Chromium	1874	896457	894583
Cobalt	10	NC	
Copper	313	33259	32946
Fluoride	22292	53787	31495
Lead	6.07	NC	
Lithium	25.7	17929	17903.3
Manganese	215	4475	4260
Mercury	0.36	269	268.64
Molybdenum	69.9	4482	4412
Nickel	411	17929	17518
Selenium	7.13	4482	4474.9
Silver	21.4	4482	4460.6
Vanadium	2065	6275	4210
Zinc	392	268937	268545
Thallium	NA	71.72	

Note:
* Arsenic RBC exceeds representative level of 7.7 mg/kg, Beryllium RBC exceeds representative level of 1.0 mg/kg.

Table 6-13
Difference Between the 95% UCL of the Mean for Slag and Ferrophos Samples, and Updated RBC's for Future Industrial/Commercial Workers

Constituent	95% UCL of Mean	Updated RBCs for Industrial or Commercial Worker	Delta 2
Antimony	25.21	454	428.8
Arsenic	2.95	**1.76***	1.19
Barium	337	67649	67312
Beryllium	2.19	1060	1057.8
Boron	122	101628	101506
Cadmium	83.8	894	810.2
Chromium	1874	1702725	1700851
Cobalt	10	908	898
Copper	313	42015	41702
Fluoride	22292	68109	45817
Lead	6.07	800	793.93
Lithium	25.7	22711	22685.3
Manganese	215	35325	35110
Mercury	0.36	340	339.64
Molybdenum	69.9	5676	5606
Nickel	411	10597	10186
Selenium	7.13	5676	5668.9
Silver	21.4	5676	5654.6
Vanadium	2065	7949	5884
Zinc	392	340545	340153
Thallium	NA	77.19	

Table 6-14
Difference Between the 95% UCL of the Mean Soil Samples and Updated RBC's for Site Construction Workers
(exposure interval 0-10 feet)

Constituent	95% UCL of Mean	Construction Worker RBC's	Delta 3
Antimony	17.25	104	86.73
Arsenic	6.64	14.6	7.96
Barium	173.5	8355	8181.5
Beryllium	1.05	61	59.95
Boron	21.2	5213	5191.8
Cadmium	2.19	81.3	79.11
Chromium	27.57	550729	550701.43
Cobalt	6.39	52.2	45.81
Copper	13.2	22036	22022.8
Fluoride	1287	33044	31757
Lead	12.51	800	787.49
Lithium	15.74	11911	11895.26
Manganese	403.4	77102	76698.6
Mercury	0.479	464	463.521
Molybdenum	2.95	2754	2751.05
Nickel	14.16	404	389.84
Selenium	3.49	2754	2750.51
Silver	0.895	2754	2753.105
Vanadium	39.75	3503	3463.25
Zinc	136	165219	165083
Thallium	26.89	375	348.11

Table 6-15
Difference Between the 95% UCL of the Mean for Soil Samples, and Updated RBC's for Site Utility Workers
(exposure interval 0-10 feet)

Constituent	95% UCL of Mean	Utility Worker RBCs	Delta 4
Antimony	17.25	1370	1352.75
Arsenic	6.64	196.6	189.96
Barium	173.5	116513	116339.5
Beryllium	1.05	866	864.95
Boron	21.2	68492	68470.8
Cadmium	2.19	1154	1151.81
Chromium	27.57	7205461	7205433.43
Cobalt	6.39	742	735.61
Copper	13.2	286470	286456.8
Fluoride	1287	432328	431041
Lead	12.51	800	787.49
Lithium	15.74	154848	154832.26
Manganese	403.4	1008764	1008360.6
Mercury	0.479	6437	6436.521
Molybdenum	2.95	36027	36024.05
Nickel	14.16	5718	5703.84
Selenium	3.49	36027	36023.51
Silver	0.895	36027	36026.105
Vanadium	39.75	46169	46129.25
Zinc	136	2161638	2161502
Thallium	26.89	4900	4873.11

Table 6-16
Difference Between the 95% UCL of the Mean for Soil Samples and EMF Representative Soil Concentrations

Constituent	95% UCL of Mean	Background	Delta 5
Antimony	17.25	2.2	15.05
Arsenic	6.64	7.7	1.06
Barium	173.5	188.0	14.5
Beryllium	1.05	1.0	0.05
Boron	21.2	12.8	8.4
Cadmium	2.19	1.9	0.29
Chromium	27.57	27.5	0.07
Cobalt	6.39	7.6	1.21
Copper	13.2	12.6	0.6
Fluoride	1287	600.0	687
Lead	12.51	29.1	16.59
Lithium	15.74	16.1	0.36
Manganese	403.4	482.0	78.6
Mercury	0.479	0.16	0.319
Molybdenum	2.95	2.2	0.75
Nickel	14.16	15.5	1.34
Selenium	3.49	1.36	2.13
Silver	0.895	1.9	1.005
Vanadium	39.75	45.4	5.65
Zinc	136	52.8	83.2
Thallium	26.89	0.27	26.62

Table 6-17
Step Four Results: Number of Samples Needed to Support Decision
(Calculations Performed Where 95% UCL of mean concentration is > 10% of RBC)

Constituent	RBC from 1998 ROD	Updated Future Site Worker RBC	Samples Analyzed	Future Site Construction Worker	Samples Analyzed
Antimony				2	10
Arsenic		3	7	2	10
Barium					
Beryllium	3	3	7		
Boron					
Cadmium					
Chromium					
Cobalt				2	10
Copper					
Fluoride		2	7		
Lead					
Mercury					
Nickel					
Selenium					
Silver					
Thallium					
Vanadium					
Zinc					

Notes:
[a] Test shows insufficient samples were collected to support a decision regarding arsenic concentrations. However, the RBC from the 1998 ROD and the Updated Future Site Worker RBC are less than the representative level of 7.7 mg/kg.
[b] Thallium results for six slag composite samples and the ferrophos sample were rejected when the analytical QA was performed.

Section 7
Summary and Next Steps

This section summarizes the evaluation results for all of the former working areas and SWMUs within the FMC Plant OU presented in the previous sections of this report. It identifies (a) areas that can be excluded from further evaluation;[1] (b) areas where sufficient data are available to support the evaluation of remedial action alternatives under the SFS process; and (c) areas that require additional site characterization data before it can be concluded that remedial action is warranted or that the area can be excluded from further evaluation. Tables 7-1 through 7-24 summarize these findings on an RU and SWMU-specific basis. Table 7-25 summarizes findings for FMC properties north of Highway 30 within the FMC Plant OU that do not contain former working areas or SWMUs.

7.1 Areas That Can Be Excluded From Further Evaluation

None of the Remediation Units can be excluded from further evaluation at this time. Each RU contains former working areas or SWMUs that warrant either further characterization or an evaluation of remedial action alternatives.

However, certain SWMUs and former working areas within certain RUs can be excluded from further evaluation under the CERCLA SRI/SFS process. These are:

- RCRA Interim Status hazardous waste management units and generator accumulation areas that have been, or will be closed in accordance with RCRA standards;
- The Calciner Ponds, which are being remediated pursuant to an IDEQ Consent Order;
- SWMUs and former working areas from which wastes and hazardous substances were contained during operation and have been subsequently removed, and that had minimal potential to impact soil or groundwater during their operation.

7.2 Areas Where Adequate Data Exist For Supplemental FS

RUs, SWMUs, and former working areas were determined to have sufficient data to proceed to an evaluation of remedial action alternatives under the SFS process when:

- A remedy was selected for the SWMU or former working area in the 1998 EMF ROD (e.g., Old Phossy Ponds – RU 22b, Calciner Solids Stockpile – RU 16) and there have been no material changes at the SWMU or area since the EMF RI that contraindicate the remedial action selected in that ROD.
- The EMF Site baseline human health risk assessment determined that the risk to a future commercial/industrial site worker at a SWMU or former working area

[1] FMC is required to record deed restrictions on FMC properties in accordance with Sections 10.2.3 and 10.2.3.1 of the 1998 ROD. These restrictions prohibit future residential uses of FMC properties and domestic use of contaminated groundwater. These restrictions also require future office buildings to be constructed using the radon control methods specified in Section 10.2.3.1 of the ROD. These land use restrictions are assumed to be in place during any future commercial or industrial land use of the FMC Plant OU.

exceeded the 1x10-4 risk level or hazard quotient of 1, and there have been no revisions to risk assessment protocols (e.g., toxicity criteria) that contraindicate this calculation. For example, the EMF Site risk assessment determined that gamma radiation at the Slag Pile (RU 19) exceeded a 1x10-4 risk level for a future commercial/industrial site worker, although FMC's administrative controls in effect during Slag Pile operation prevented worker exposures above the 1x10-4 risk level.

- The remediation unit is a landfill, or contains a landfill that warrants application of a containment remedy under EPA's Presumptive Remedy for Municipal Waste Landfills (EPA 1993).
- The SWMU or former working area is a former P4 working area at which P4 is likely to have been released to the subsurface through historic spills or leaks from process equipment (e.g., RU 1 and RU 2). These areas warrant application of a containment remedy, similar to the cap design and deed restrictions that prohibit cap intrusion that are in place to isolate phossy wastes in RCRA hazardous waste surface impoundments such as Pond 8S. Evaluation of site conditions incidental to delineation of the lateral extent of the cap at these former P4 working areas is recognized as a data need to be addressed by the SRI process, however.

7.3 Areas with Data Gaps

Data gaps were identified for RUs, SWMUs, and former working areas when:

- Sufficient site characterization data are not available to evaluate site conditions under the updated Conceptual Site Model and the Remedial Action Vision for the RU contemplates no further action.
- Specific data gaps were discussed in Section 6. In general, additional gamma radiation measurements are needed to characterize the extent of radiological impact from constituents in the uranium-238 decay series at RUs where no further action is currently contemplated. In addition, the extent of potential impact of precipitator dusts on soils at RUs where no further action is currently contemplated (such as roads) warrants further characterization to evaluate risks associated with lead-210 and polonium-210. Characterization of VOCs and petroleum hydrocarbons in soils within certain RUs where no further action is currently contemplated is needed, recognizing that some of these constituents may be within the CERCLA petroleum exclusion. Delineation of the potential lateral extent of elemental phosphorus in soils within the RU 1 and 2 area is needed to confirm the necessary extent of a cap over this area. Soil sampling at RU 6 is needed to confirm that any potentially spilled P4 product was removed during closure of the long-term P4 storage tanks. Delineation of the lateral extent of pond solids (i.e., pond footprint) is needed at RU 8 and RU 13 to confirm the necessary lateral extent of a cap over the former kiln scrubber ponds and phossy waste pond 6S. Leachability characterization of coke and calciner solids is needed to confirm the source of nitrate in Well 139 at RU 20 and support cap/cover design at RU 15, respectively. Radon flux measurements from slag are needed to evaluate the design of a cover over the Slag Pile (RU 19) with respect to UMTRCA guidelines.

In addition to the data gaps listed above, the SRI Work Plan will include a methodology for assessing risks (chemical and radiological) associated with potential redistribution of fill excavated during future site construction or utility trenching. This methodology will be limited to RUs with a remedial action vision of no further action anticipated to be necessary.

These data gaps will be addressed in the upcoming SRI, and details of the data collection will be provided in the SRI Work Plan. Tables 7-1 through 7-25 list principal data gaps, where identified, and the type of data that will be collected to provide sufficient information to evaluate site conditions with respect to the updated Conceptual Site Model.

Table 7-1
Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 1

RU 1	**Remedial Action Vision:**	**Leave existing concrete slabs in place, grade to design subgrade elevation and construct a RCRA-engineered cap over entire footprint of these areas.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
13	Andersen Filter Media (AFM) Washing Unit	Not a potential source. Waste materials were contained during SWMU operation and have been removed from the site.	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site.	NFA
41 (partial)	Stacks and Vents	Not a potential source. Past releases were P2O5 during P4 manufacturing.	No. Past emission potential is not relevant to the updated Conceptual Site Model.	NFA
54	Phos Dock Area	Area is a potential source due to historic spills of phossy water.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
36 & 55	Rail Car Loading & Unloading Areas; Paved Area North of Furnace Bldg. incl. Phos Dock	Area is a potential source due to historical spills of phossy water.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
60	Secondary Condenser/Former Fluid Bed Dryer Area	No releases from the Secondary Condenser Sump have been documented. However, given the similarity of the Secondary Condenser Sump to the #3 P4 Sump (SWMU 104), releases are suspected. The Former Fluid Bed Dryer no longer exists and was closed by waste removal and equipment decontamination.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
68 (partial)	Railroad Spurs (portion within RU 1)	Potential source of P4 release to soil beneath P4 loadout areas prior to installation of containment pans in mid-1990's. May also contain byproduct (slag) used as fill.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
73	Satellite Storage Areas for Spent Anderson Filter Media	Not a potential source. Waste materials were contained during SWMU operation and have been removed from the site.	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site.	NFA
74	East AFM Bin Area	Not a potential source. Waste materials were contained during SWMU operation and have been removed from the site.	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site.	NFA
75	Precipitator Dust Slurry Pots	Prior to secondary containment upgrade in 1999, potential migration of releases would have been impeded by the concrete floor of the Furnace Building. Units have been physically removed. Not a potential source.	No. Unit does not exist. Unit has been closed by waste removal and equipment decontamination. Waste materials were contained during unit operation. Unit has been closed by waste removal and equipment decontamination.	NFA
76	Medusa Scrubber Blowdown Collection Tank	Not a potential source. Between 1991 and cessation of operation, potential release migration would have been impeded by the concrete floor of the Furnace Building. Containment control prior to 1991 is unknown.	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site.	NFA
77	Phosphorus Loading Dock, Andersen Scrubber Blowdown Sump, and North Solid Tank	Potential source due to historical spills of phossy water.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
78	Washdown Collection Sumps -- Furnace Building Area	Potential source due to historical spills of phossy water.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.

Table 7-1 (continued)

SWMU #	SWMU or Former Working Area	Potential Source?	Are further characterization data necessary to implement the Remedial Action Vision?	Next Steps
79	Northeast Collection Sump - Furnace Building Area	Potential source prior to containment system upgrades.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
80	Southeast Collection Sump -- Furnace Building Area	Potential source.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
81	Furnace Washdown Collection Tank (V-3600)	Potential source due to historic spills of phossy water.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
82 (partial)	Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #1 footprint]	No pre-upgrade releases are documented. However, pre-upgrade P4 release to soil from East Launder (and potentially other launders) is suspected.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
86	V-3700 Tank and Associated Piping	Not a potential source. Waste materials were contained during unit operation, and there are no documented releases during operation. Unit has been closed by waste removal and equipment decontamination.	No. Unit does not exist. Waste materials were contained during unit operation. Unit has been closed by waste removal and equipment decontamination.	NFA
90	V-3800 Tank and Associated Piping	Not a potential source. Waste materials were contained during unit operation, and there are no documented releases during operation. Unit has been closed by waste removal and equipment decontamination.	No. Unit does not exist. Waste materials were contained during unit operation. Unit has been closed by waste removal and equipment decontamination.	NFA
91	NOSAP Intercept Tank (Tank T-8010)	Not a potential source. Waste materials were contained during unit operation, and there are no documented releases during operation. Unit has been closed by waste removal and equipment decontamination.	No. Unit does not exist. Waste materials were contained during unit operation. Unit has been closed by waste removal and equipment decontamination.	NFA
104	#3 P4 Sump	The release from the #3 P4 sump impacted subsurface soil. The #1 furnace P4 sump was emptied and decommissioned in 2001, although the concrete foundation remains. The #2 and #3 P4 tanks that replaced the use of the old P4 sumps and the #4 P4 sump were emptied and decommissioned in 2003. No releases from the #1, #2, and #4 furnace P4 sumps have been documented. However, prior releases from the #1, #2, and #4 furnace P4 sumps to underlying soils are suspected, given the similarity in the design of these sumps to the #3 furnace P4 sump.	Historic release of P4 to subsoils is documented. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 40C isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
38 (partial)	Road segments within RU 1	Potential source: use of slag for road subgrade.	Further characterization of source area is unnecessary; cap will prevent exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of RCRA-engineered cap in controlling potential exposure to gamma radiation.

Table 7-2
Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 2

RU 2	Remedial Action Vision:	Grade to design subgrade elevation and cap entire slag pit consistent with RCRA cap design for slag pit sump (WMU #5) in Closure Plan (June 1998, revised April 2000).		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
5	Slag Pit Wastewater Collection Sump	Potential source: historic infiltration of constituents present in phossy water to the soil column and groundwater.	Historic release of P4 to subsoils is presumed. Delineation of P4 within local area of source unnecessary. The lateral extent of the cap should be defined by evaluating the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 source	FMC plans to implement the RCRA Closure Plan so that the final cover of the Slag Pit sump is consistent with final grading plan for Slag Pit.
102	Former Slag Pit (prior to slag ladling)	Potential source: historic infiltration of constituents present in phossy water to the soil column and groundwater.	Historic release of P4 to subsoils is presumed. Delineation of P4 within local area of source unnecessary. The lateral extent of the cap should be defined by evaluating the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 source	Forward to SRI as component of "40C isotherm" study of RU 1 & RU 2 to support cap delineation. Evaluate effectiveness of RCRA-engineered cap in controlling potential exposure to gamma radiation during SFS.
82 (partial)	Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #2 footprint]	Potential source: historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	Historic release of P4 to subsoils is presumed. Delineation of P4 within the local area of this source is unnecessary. The lateral extent of the cap above this source area will be initially evaluated by modeling the potential downgradient extent of P4 migration from collective RU 1 & RU 2 P4 sources based on 44 isotherm. Test borings may be advanced during the SRI to evaluate model results.	Forward to SRI as component of "44C isotherm" study of RU 1 & RU 2 to support cap delineation.
38 (partial)	Road segments within RU 2	Potential source: use of slag for road subgrade.	Further characterization of source area is unnecessary; cap will prevent exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of RCRA-engineered cap in controlling potential exposure to gamma radiation.

Table 7-3
Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 3

RU 3	Remedial Action Vision:	No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
66	Boiler Fuel Tank and Pipeline Area	None. No soil contamination detected in samples collected during closure.	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site.	NFA
72	Former Satellite Storage Area for Waste Paint Solvents	Not a potential source.	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site.	NFA
92	P4 Maintenance Cleaning Facility (Decon Building)	Not a potential source. Unit is operated and will be closed by waste removal and equipment decontamination under RCRA standards.	No. Unit is designed and operated and will be closed by waste removal and equipment decontamination under RCRA standards.	NFA. Unit will be closed per RCRA standards.
na	Former Paint Shop (aka Carpenter Shop or Lube Shop)	Not a potential source.	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site.	NFA
na	Former Fire Extinguisher Maintenance Shed	Not a potential source.	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site.	NFA
na	Laydown Area for Decon Building	Not a potential source.	No. Waste materials are sealed during operation and are removed from the site.	NFA
na	Stormwater Runoff Drainage Network (portions)	Potential source: P4 could be present in soils surrounding leaks in the drain piping, although no breaks or leaks in the system are documented.	Yes. Conduct video inspection of stormdrain piping to identify potential leaks and break points. If leaks/breaks found, sample soils at break for P4.	Forward to SRI for video inspection
38 (partial)	Road segments within RU 3	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
na	General site soils	None known.	Yes. Obtain additional inorganic data to evaluate soil conditions against RBCs using DQO process.	Forward to SRI.

Table 7-4

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 4

RU 4	**Remedial Action Vision:**	**No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
40	Septic tank area	Not a potential source	No. As of April 1, 1995, all septic wastes were routed to the Pocatello sewage treatment plant (STP). The septic tanks have been emptied and removed, and the areas in which the tanks had been installed have been backfilled, in accordance with Idaho Dept. of Health standards. The septic drainfield area had trace metals, anions (fluoride and total phosphorus), gross alpha, and gross beta in the surficial topsoils and near-surface soil above representative levels. With a few exceptions, the concentrations of these parameters do not persist with depth. The effect of EMF-related activities has been minimal in the area.	NFA
99	Drum Storage Area at Training Center	Not a potential source	No. Unit is designed and operated and will be closed by waste removal and equipment decontamination under RCRA standards.	NFA. Unit will be closed per RCRA standards.
68 (partial)	Railroad Spurs	Potential source: may contain byproduct (slag) used as fill.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
38 (partial)	Road segments within RU 4	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
na	General site soils	None known.	Yes. Obtain additional inorganic data to evaluate soil conditions against RBCs using DQO process.	Forward to SRI.

Table 7-5

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 5

RU 5	**Remedial Action Vision:**	**No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
1	Drum Storage Unit	Not a potential source	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site. Soils beneath footprint of secondary containment pad were sampled following waste removal and equipment decontamination. Closure by removal under RCRA has been certified.	NFA. Unit was closed per RCRA standards.
39	Chemical Lab Drain Pit	Potential source of localized VOCs (hotspot).	Yes. Evaluate potential VOC contamination using soil gas sampling methods.	Forward to SRI for VOC "hotspot" evaluation.
61	Disposal Area Behind Laboratory	Potential source of localized VOCs (hotspot)	Yes. Evaluate potential VOC contamination using soil gas sampling methods.	Forward to SRI for VOC "hotspot" evaluation.
70	Satellite Storage Area for Spent Laboratory Solvents	Not a potential source. Area has been operated under RCRA SAA standards and will be closed by waste removal and equipment decontamination.	No. Unit is designed and operated and will be closed by waste removal and equipment decontamination under RCRA standards.	NFA. Unit will be closed per RCRA standards.
68 (partial)	Railroad Spurs	Potential source: may contain byproduct (slag) used as fill.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
38 (partial)	Road segments within RU 5	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
na	General site soils	None known.	Yes. Obtain additional inorganic data to evaluate soil conditions against RBCs using DQO process.	Forward to SRI.

Table 7-6

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 6

RU 6	**Remedial Action Vision:**	**No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
63	Long-Term Phosphorus Storage Tanks (former)	No. Tanks and P4 inventory were removed.	Yes. Obtain P4 data to evaluate soil conditions against RBCs using DQO process.	Forward to SRI for closure confirmation sampling
101	Railcar Loading Overflow Tank	Not a potential source. Unit is operated and will be closed by waste removal and equipment decontamination under RCRA standards.	No. Unit is designed and operated and will be closed by waste removal and equipment decontamination under RCRA standards.	NFA. Unit will be closed per RCRA standards.
68 (partial)	Railroad Spurs	Potential source: may contain byproduct (slag) used as fill.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
38 (partial)	Road segments within RU 6	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
na	General site soils	None known.	Yes. Obtain additional inorganic data to evaluate soil conditions against RBCs using DQO process. XRF analyses for precipitator dust on roadways and fixed lab analyses for Po-210 and Pb-210 at a selected subset of sample locations.	Forward to SRI.

Table 7-7

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 7

RU 7	**Remedial Action Vision:**	**Following sale of ore inventory, no action anticipated to be necessary.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
37	Shale Ore Handling Areas	Potential source, pending removal of ore inventory.	Yes. Obtain gamma radiation measurements following ore removal. XRF analyses for precipitator dust on roadways and fixed lab analyses for Po-210 and Pb-210 at a selected subset of sample locations.	Forward to SRI for measurement of gamma radiation levels.
105	Coke Unloading Building	Potential source	Yes. Obtain soil characterization data within CSM zone (0-10 ft bgs) and characterize coke	Forward to SRI
68 (partial)	Railroad Spurs	Potential source: may contain byproduct (slag) used as fill.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
38 (partial)	Road segments within RU 7	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.

Table 7-8

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 8

RU 8	**Remedial Action Vision:**	**Leave existing concrete slabs in-place, grade to design subgrade elevation and construct soil cover (cap) over entire footprint of these areas.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
12	Wastewater Treatment Unit	Not a potential source. Residual impact to soils from 1995 spill found to be below soil cleanup criteria established in approved RCRA Closure Plan.	No. Closure by waste removal and equipment decontamination confirmed during RCRA closure. Soil in historic spill area meets RCRA cleanup criteria.	NFA
35	Three Kiln Scrubber Ponds	Potential source.	No. Kiln scrubber solids are compositionally similar to Calciner scrubber solids. Apply 1998 ROD remedy to RU 8.	Forward to SFS.
67	Former Flare Pit for Carbon Monoxide	Not a potential source. Excess CO Combustor constructed on concrete pad installed within footprint of former flare pit during 2000.	No. Unit does not exist. Residual contamination, if present, would have been removed during construction of Excess CO Combustor.	NFA
41 (partial)	Stacks and Vents (i.e., calciner system)	Not a potential source. Past releases were emissions during manufacturing.	No.	NFA
103	New Horizontal Flare Pit	Not a potential source. The interior base and walls were lined with slag to absorb heat. This slag layer overlies a liner system, designed to RCRA Minimum Technology Standards, to prevent any subsurface contamination.	No.	NFA
38 (partial)	Road segments within RU 8	Potential source: use of slag for road subgrade.	Further characterization of source area is unnecessary; cap will prevent exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of cover in controlling potential exposure to gamma radiation.

Table 7-9

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 9

RU 9	**Remedial Action Vision:**	**Following sale or use of silica inventory, no action anticipated to be necessary.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
51	Kiln Scrubber Overflow Pond (under nodule fines pile)	Potential source	Yes. Obtain soil characterization data within CSM zone (0-10 ft bgs)	Forward to SRI.
106	Nodule Pile	Potential source. Residual nodules remain at area.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
na	Silica Pile	Not a potential source. Silica is not a hazardous constituent.	No. The majority of the silica has been used for remedial construction projects or sold for use off the site. The balance is expected to be used or sold.	NFA
38 (partial)	Road segments within RU 9	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
na	General site soils	None known.	Yes. Obtain additional inorganic data to evaluate soil conditions against RBCs using DQO process. XRF analyses for precipitator dust on roadways and fixed lab analyses for Po-210 and Pb-210 at a selected subset of sample locations.	Forward to SRI.

Table 7-10
Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 10

RU 10	**Remedial Action Vision:**	**Plug and abandon pipe from plant to discharge, backfill pond and ditch to level of surrounding grade.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
49	Industrial Wastewater Basin	The sediments within the basin and dredged sediments at the edge of the basin may contai minor levels of P4 as the result of previous inadvertent discharges of ICW water to the IWW system.	Yes. Sample soils/sediments within CSM zone (0-10 ft bgs).	Forward to SRI.
50	Industrial Wastewater Ditch	Potential source: the sediments below the silica backfill in the former ditch and dredged sediments along the ditch route may contain minor levels of P4 as the result of previous inadvertent discharges of ICW water to the IWW system. Sediments formerly dredged and stockpiled along the berm of the ditch may also be a potential source.	Yes. Sample soil/sediments within CSM zone (0-10 ft bgs).	Forward to SRI.

Table 7-11
Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 11

RU 11	**Remedial Action Vision:**	**No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
38 (partial)	Road segments within RU 11	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements. XRF analyses for precipitator dust on roadways and fixed lab analyses for Po-210 and Pb-210 at a selected subset of sample locations.	Forward to SRI for measurement of gamma radiation levels.
na	General site soils	None known.	Yes. Obtain additional inorganic data to evaluate soil conditions against RBCs using DQO process.	Forward to SRI.

Table 7-12
Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 12

RU 12	Remedial Action Vision:	No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
57	Transformer Salvage Area	Potential source: use of byproduct (slag) as fill. Also, for at least the first 6 to 10 feet, native soils appear to have been mechanically mixed with precipitator dust or phossy solid either during grading or placement. No PCBs were detected in the soil samples.	Yes. Characterize COPCs within CSM zone (0-10 ft bgs). Gamma radiation measurements, coupled with fixed lab analyses for Ra-226 and U-238 at a selected subset of locations.	Forward to SRI for soil sampling and measurement of gamma radiation levels.
58	PCB Storage Shed (removed 2000)	Potential source: use of byproduct (slag) as fill. Fifteen soil samples were collected during the EMF RI and analyzed for PCBs (Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260). Six of the aroclors were not detected (at 0.65 mg/kg detection level) in any of the samples. Aroclor 1260 was detected at 0.58J mg/kg or less in 3 of the 15 samples. The PCB storage shed was removed in 2000 prior to construction of the LDR Treatment System.	Yes. Gamma radiation measurements. Confirmation sampling for PCBs.	Forward to SRI for measurement of gamma radiation levels.
71	Satellite Storage Areas for Waste Degreasing Solvents	Not a potential source. RCRA Satellite Accumulation Areas were closed in 1993 by waste removal and equipment decontamination.	No. Units do not exist and were closure by waste removal and equipment decontamination.	NFA. Units were closed per RCRA standards.
64 (partial)	Phossy Waste Pipeline Cleanout Areas and Intervals	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	Yes. Delineate underground pipelines to design investigation and/or removal plan. Sample sediments within CSM zone (0-10 ft bgs) at cleanouts and at locations where historic pipeline leaks are identified. XRF analyses for precipitator dust and fixed lab analyses for Po-210 and Pb-210 at a selected subset of locations.	Forward to SRI
65 (partial)	Precipitator Slurry Pipeline Cleanout Areas and Intervals	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.		Forward to SRI
82 (partial)	Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #12 footprint]	The above-grade portion of the pipeline system is not a potential source. Historical releases from underground segments of the former pipeline system, in addition to the June 1996 incident, while undocumented, are suspected, making the underground segments a potential source.		Forward to SRI
83	High-Pressure Steam Cleaning Station	Yes. No documented releases, but oil and grease may be present from vehicle steam cleaning.	Yes. Sample historic spill footprint to evaluate TPH and diesel fuel constituents under Idaho petroleum hydrocarbon spill cleanup guidelines.	Forward to SRI.
84	Used Oil Collection Tank	Not a potential source. Was an aboveground tank with concrete containment wall. The tank was emptied and has been removed.	No. Unit was contained during operation, has been emptied and removed.	NFA.
na	Fuel Island	Constituents of diesel fuel might be present at historic spill areas.	Yes. Sample historic spill footprint to evaluate TPH and diesel fuel constituents under Idaho petroleum hydrocarbon spill cleanup guidelines.	Forward to SRI to evaluate historic spill impacts. UST closure deferred to EPA UST program.
38 (partial)	Road segments within RU 12	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements. XRF analyses for precipitator dust and fixed lab analyses for Po-210 and Pb-210 at a selected subset of sample locations.	Forward to SRI for measurement of gamma radiation levels.
na	PCDT System (tanks T-8000; T-8100A; T-8141; T-8201/8202; T-8203; filter press FP-8300; process unit UV-8000)	No. System and equipment is designed and operated to present potential releases.	No. System will be closed by waste removal and equipment decontamination in a manner consistent with RCRA tank system standards.	NFA. Unit will be closed in manner consistent with RCRA standards.

Table 7-13
Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 13

RU 13	Remedial Action Vision:	No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
4	Former 8S Recovery Process	Not a potential source. Closed RCRA unit that has been decontaminated, dismantled, and removed in accordance with a RCRA Closure Plan.	No. Unit no longer exists. Unit was decontaminated, dismantled, and removed in accordance with a RCRA Closure Plan.	NFA. Unit was closed per RCRA standards.
64 (partial)	Phossy Waste Pipeline Cleanout Areas and Intervals	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	Yes. Delineate underground pipeline to design investigation and/or removal plan. Sample sediments within CSM zone (0-10 ft bgs) at cleanouts and at locations where historic pipeline leaks are identified.	Forward to SRI.
65 (partial)	Precipitator Slurry Pipeline Cleanout Areas and Intervals	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.		Forward to SRI.
82 (partial)	Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #13 footprint]	The above-grade portion of the pipeline system is not a potential source. Historical releases from underground segments of the former pipeline system, while undocumented, are suspected, making the underground segments a potential source.		Forward to SRI.
107	Portable Storage Tanker for Dielectric Fluid	Not a potential source. The tanker no longer exists. The tanker was emptied and decontaminated in 2003 and cut up for scrap. The oil removed from the tanker was transferred to drums and shipped to an offsite used oil management facility in 2003.	No. Unit does not exist. Unit was decontaminated, dismantled, and removed.	NFA
na	Scrap Metal Stockpile	No. Decontaminated scrap metal only.	No. Contains only decontaminated scrap metal.	NFA
38 (partial)	Road segments within RU 13	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
na	General site soils	None known.	Yes. Obtain additional inorganic data to evaluate soil conditions against RBCs using DQO process. XRF analyses for precipitator dust on roadways and fixed lab analyses for Po-210 and Pb-210 at a selected subset of sample locations.	Forward to SRI.

Table 7-14
Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 14

RU 14	Remedial Action Vision:	Consistent with the FMC-IDEQ AOC and SOW for calciner ponds remediation, complete initial fill of ponds that require consolidation period, grade to design subgrade elevation and construct RCRA-engineered cap over entire footprint of these areas.		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
14	Old Ponds 1C, 2C [now termed "Old Calciner Pond" in Remedial Action Plan submitted to IDEQ 12/02]	Yes.	No. Area remains covered beneath Calciner Ponds. Functionally addressed by the Calciner Pond Remedial Action Plan addressed under the IDEQ Consent Order.	NFA. SWMU being remediated per IDEQ Consent Order.
15	Calciner Ponds 1C (new), 2C (new), 3C, 4C	Yes, but no documented releases	No. Remedial action at the Calciner Ponds began in 2003 pursuant to a Remedial Action Plan approved by IDEQ. The initial fill and temporary cover were placed at Ponds 1C, 3C, and 4C in 2003. The final cap is expected to be placed over Ponds 1C, 3C, and 4C, as well as Ponds 2C and 5C, in 2005.	NFA. SWMU being remediated per IDEQ Consent Order.
85 (overlies site of SWMU 17)	Solar Drying Area (Pond 5C) [overlies former Calciner Solids Storage Area A]	Yes, but no documented releases	No. Remedial action at the Calciner Ponds began in 2003 pursuant to a Remedial Action Plan approved by IDEQ. The initial fill and temporary cover were placed at Ponds 1C, 3C, and 4C in 2003. The final cap is expected to be placed over Ponds 1C, 3C, and 4C, as well as Ponds 2C and 5C, in 2005.	NFA. SWMU being remediated per IDEQ Consent Order.
na	Calciner Solids Storage Area A [former]	Yes. Excavated fines from original calciner ponds excavated to install new Ponds 1C, 2C, 3C, and 4C in 1986 and 1988; subsequently relocated during construction of Pond 5C and capped with a soil cover.	No. Functionally addressed by the Calciner Pond Remedial Action Plan addressed under the IDEQ Consent Order.	NFA. SWMU being remediated per IDEQ Consent Order.

Table 7-15

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 15

RU 15	**Remedial Action Vision:**	**Consolidate material into minimal footprint, grade to design subgrade elevation and construct soil cover (cap) over area.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
69	Oversized Ore, Broken and Used Electrode, Baghouse Dust Storage/Recycling, and Used Conveyor Belt Area	Potential source. Area used to store reject phosphate ore, which was periodically reclaimed. Formerly accepted phosphate ore dust from baghouses as well as furnace charge of ore briquettes and coke. Also received broken and used electrodes and used conveyor belts.	No. Further characterization of source area is unnecessary; cap will prevent exposure to materials placed at unit.	Forward to SFS.
38 (partial)	Road segments within RU 15	Potential source: use of slag for road subgrade.	Further characterization of source area is unnecessary; cap will prevent exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of cover in controlling potential exposure to gamma radiation.

Table 7-16

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 16

RU 16	**Remedial Action Vision:**	**Consolidate material into minimal footprint (may include consolidation back into calciner pond[s] as fill consistent with Calciner Pond remediation described above), grade to design subgrade elevation and construct soil cover (cap) over area consistent with the design of the CERCLA soil cover described in ROD (June 1998).**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
16	Calciner Solids Stockpile	Potential source.	No. Composition of material already documented, and 1998 EMF ROD remedy still appropriate. Need to delineate extent and topography of stockpile to support cover design plan.	Forward to SFS after delineating stockpile extent and topography.
17	Calciner Pond Sediment Areas South of Calciner Ponds [SWMU 17 = "Storage Area B"]	Potential source.	No. Area is inactive since the soil cap was placed in 1993. Composition of material already documented, and 1998 EMF ROD remedy still appropriate.	Forward to SFS.
38 (partial)	Road segments within RU 16	Potential source: use of slag for road subgrade.	Further characterization of source area is unnecessary; cap will prevent exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of cover in controlling potential exposure to gamma radiation.

Table 7-17

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 17

RU 17	**Remedial Action Vision:**	**Consolidate material into minimal footprint, grade to design subgrade elevation and construct soil cover (cap) over area.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
89	Roadway Landfill (also referred to as Construction Debris and/or Recycle Landfill)	Potential source: candidate for EPA's containment presumptive remedy for landfills.	No. Evaluate containment remedy using EPA's Technical Areas for Presumptive Remedy Guidance for Municipal Waste Landfills.	Forward to SFS.
38 (partial)	Road segments within RU 17	Potential source: use of slag for road subgrade.	Further characterization of source area is unnecessary; cap will prevent exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of landfill cover in controlling potential exposure to gamma radiation.

Table 7-18

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 18

RU 18	**Remedial Action Vision:**	**Consolidate material into minimal footprint, grade to design subgrade elevation and construct soil cover (cap) over area.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
45	Landfill (also referred to as Solid Waste Landfill)	Potential source: candidate for EPA's containment presumptive remedy for landfills.	No. Evaluate containment remedy using EPA's Technical Areas for Presumptive Remedy Guidance for Municipal Waste Landfills.	Forward to SFS.
38 (partial)	Road segments within RU 18	Potential source: use of slag for road subgrade.	Further characterization of source area is unnecessary; cap will prevent exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of landfill cover in controlling potential exposure to gamma radiation.

Table 7-19

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 19

RU 19	**Remedial Action Vision:**	**Reclaim in-place; shape external slopes to approximately 3H:1V slope, place topsoil over slag and revegetate with native grasses and shrubs.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
42	Slag Pile	Yes. Slag is a potential source of gamma radiation and radon emissions	Yes. Evaluate cover remedy in conjunction with containment remedy for underlying Old Landfill (SWMU 44). Base cover design on controlling potential exposure to gamma radiation and radon emissions.	Forward to SRI to evaluate potential impact on groundwater from buried railcars containing sludge. Evaluate those findings in the SFS with regard to groundwater protection, and evaluate the effectiveness of cover in controlling potential exposure to gamma radiation.
44	Landfill (old)	Potential source: candidate for EPA's containment presumptive remedy for landfills.	No. Evaluate containment remedy using EPA's Technical Areas for Presumptive Remedy Guidance for Municipal Waste Landfills.	Forward to SFS.
na	Bull Rock Pile	Potential source of gamma radiation.	No. Base cover design on controlling potential exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of cover in controlling potential exposure to gamma radiation.
38 (partial)	Road segments within RU 19	Potential source: use of slag for road subgrade.	Further characterization of source area is unnecessary; cap will prevent exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of cover in controlling potential exposure to gamma radiation.

Table 7-20

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 20

RU 20	**Remedial Action Vision:**	**No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
46	Railcar Loading & Unloading Areas-BPC	Yes: use of byproduct as fill.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
47	Bannock Paving Areas	Yes: use of byproduct as fill; may also have TPH hotspots.	Yes. Gamma radiation measurements, and TPH data at former batch plant locations.	Forward to SRI.
incl. in # 47	Coke settling pond (former BAPCO unit)	Potential source.	No. Obtain PAH/PNA analyses for coke samples.	Forward to SRI.
na	Two-building Former Bannock Paving Company Office - Shop Complex	Potential source: former septic tank and stained soils outside of shop.	Yes. Characterization of area around shop and septic tank for solvent/hydrocarbons.	Forward to SRI.
68 (partial)	Railroad Spurs	Potential source: use of slag for subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.
48	Surface Road - Bannock Paving Company	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.

Table 7-21

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 21

RU 21	**Remedial Action Vision:**	**No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
68	Railroad Spurs	Potential source: use of slag for subgrade.	Yes. Gamma radiation measurements. XRF analyses for precipitator dust and fixed lab analyses for Po-210 and Pb-210 at a selected subset of sample locations.	Forward to SRI for measurement of gamma radiation levels.

Table 7-22a

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 22a

RU 22a	**Remedial Action Vision:**	**RCRA WMUs will be closed per current version of Closure Plan**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
3	Phossy Waste Surface Impoundment - Pond 15S	Yes.	No. Subject to RCRA closure and post-closure monitoring and maintenance standards. Interim cover installed 1999; final cover scheduled to be installed summer 2004.	NFA. Unit is being closed per RCRA standards.
7	Phossy Waste Surface Impoundment - Pond 8S	Yes.	No. Subject to RCRA closure and post-closure monitoring and maintenance standards. Final cover installed 1999; in post-closure care period.	NFA. Unit was closed per RCRA standards.
8	Phase IV Ponds--Phossy Water Clarifier Surface Impoundments (Ponds 11S, 12S, 13S, 14S)	Yes.	No. Subject to RCRA closure and post-closure monitoring and maintenance standards. Interim cover installed 1999; final cover scheduled to be installed summer 2004.	NFA. Unit is being closed per RCRA standards.
9	Precipitator Slurry Drying Surface Impoundment (Pond 9E)	Yes.	No. Subject to RCRA closure and post-closure monitoring and maintenance standards. Interim cover installed 2000; final cover scheduled to be installed summer 2004.	NFA. Unit was closed per RCRA standards.
10	Phossy Water Surface Impoundment (Pond 16S)	Yes.	No. Subject to RCRA closure and post-closure monitoring and maintenance standards. Final cover installed 2000; in post-closure care period.	NFA. Unit is being closed per RCRA standards.
11	Precipitator Slurry Surface Impoundment (Pond 8E)	Yes.	No. Subject to RCRA closure and post-closure monitoring and maintenance standards. Interim cover installed 1999; final cover scheduled to be installed summer 2004.	NFA. Unit is being closed per RCRA standards.
87	Pond 17	Yes.	No. Subject to RCRA closure and post-closure monitoring and maintenance standards. Interim cover installed 2002; final cover to be installed per schedule in closure plan.	NFA. Unit is being closed per RCRA standards.
88	Pond 18	Yes.	No. Subject to RCRA closure and (Cell A) post-closure monitoring and maintenance standards. Cell A: interim cover installed 2002; final cover to be installed per schedule in closure plan. Cell B: closure by removal per schedule in closure plan.	NFA. Unit is being closed per RCRA standards.
100	Pond Closure Surge Tank	No.	No. Waste materials are contained during unit operation. Unit will be closed by waste removal and equipment decontamination.	NFA. Unit will be closed per RCRA standards.
82 (partial)	Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #22a footprint]	The above-grade portion of the pipeline system, which was emptied in 2001 and is being decommissioned and removed, is not a potential source. Historical releases from underground segments of the former pipeline system, while undocumented, are suspected, making the underground segments a potential source.	Yes. Delineate underground segments to verify that they are either contained within the footprint of the cap for the RCRA WMU, or are within the footprint of a cap to be installed under RU 22b.	Above-ground pipelines: NFA. Underground pipelines: addressed under RU 22b and RCRA closure plans.
38 (partial)	Road segments within RU 22a	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements.	Forward to SRI for measurement of gamma radiation levels.

Table 7-22b

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 22b

RU 22b	**Remedial Action Vision:**	**Areas identified on the plant site for CERCLA remediation (old phossy ponds and groundwater) will be remediated per the ROD (June 1998).**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
6	Area 9S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
19	Pond 1E	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
20	Pond 2E	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
21	Pond 3E	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
22	Pond 4E	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
23	Pond 5E	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
24	Pond 6E	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
25	Pond 0S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
26	Pond 00S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
27	Pond 1S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
28	Pond 2S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
29	Pond 3S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
30	Pond 4S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
31	Pond 5S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
32	Pond 6S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
33	Pond 7S	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
34	Pond 10S (Including Precipitator Dust Pile atop Pond 10S)	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
43	Ferrophos Storage Areas	Remaining ferrophos is a potential source.	No. Sufficient data are available to characterize ferrophos.	Forward to SFS.
52	Pond 7E	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
53	Old Pond 7S Tree–Line Area	Yes.	No. Sufficient data are available to implement the remedy selected in the 1998 EMF ROD.	Forward to SFS.
56	Drum Storage Area for other Nonhazardous Wastes [see SWMU 59]	see SWMU 59.	see SWMU 59	see SWMU 59
59	Waste Oil Storage Area	No. Waste materials were contained during operation and will be removed from the site. Moreover, the former storage area is within the footprint of former Pond 2S (SWMU 28).	No. Further data are not necessary. The containment pad will be included within the cover to be installed over former Pond 2S (SWMU 28).	Forward to SFS.
62	Area West of Mobile Shop	Potential source: use of byproduct as fill. Soils in the shallow subsurface in the vicinity of the mobile shop have been heavily affected by facility activities. These soils may be slag mixed with phossy solids and precipitator dust.	Yes. Gamma radiation measurements and characterize COPCs within CSM zone (0-10 ft bgs).	Forward to SRI for soil sampling and measurement of gamma radiation levels.
64 (partial)	Phossy Waste Pipeline Cleanout Areas and Intervals	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	Yes. Delineate underground segments to verify that they are contained within the footprint of a cap.	Forward to SRI for underground pipeline delineation.
65 (partial)	Precipitator Slurry Pipeline Cleanout Areas and Intervals	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	Yes. Delineate underground segments to verify that they are contained within the footprint of a cap.	Forward to SRI for underground pipeline delineation.
82 (partial)	Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #22b footprint]	The above-grade portion of the pipeline system is not a potential source. Historical releases from underground segments of the former pipeline system, in addition to the June 1996 incident, while undocumented, are suspected, making the underground segments a potential source.	Yes. Delineate underground segments to verify that they are contained within the footprint of a cap.	Forward to SRI for underground pipeline delineation.
38 (partial)	Road segments within RU 22b	Potential source: use of slag for road subgrade.	Further characterization of source area is unnecessary; cap will prevent exposure to gamma radiation.	Forward to SFS to evaluate effectiveness of cover in controlling potential exposure to gamma radiation.

Table 7-22c

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 22c

RU 22c	**Remedial Action Vision:**	**Areas identified on the plant site for CERCLA remediation (railroad swale) will be remediated per the ROD (June 1998).**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
18	Railroad Swale	Area is a potential source due to historical spills of phossy water. Residual levels of P4 may be present in sediments accumulated above the liner, owning to post-liner installation spills of phossy water.	Determine if P4 is present in sediments above lined portion of Railroad Swale and/or proceed to design of cap over entire Railroad Swale footprint (including the previously-lined portion).	Forward to SRI and/or SFS.

Table 7-23

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for RU 23

RU 23	**Remedial Action Vision:**	**No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
38 (partial)	Road segments not within other RUs	Potential source: use of slag for road subgrade.	Yes. Gamma radiation measurements. XRF analyses for precipitator dust on roadways and fixed lab analyses for Po-210 and Pb-210 at a selected subset of sample locations.	Forward to SRI for measurement of gamma radiation levels.

Table 7-24

Next Steps in SRI - SFS Process for SWMUs and Former Working Areas for SWMUs not associated with RU 1 - RU 23

	Remedial Action Vision:	**No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.**		
SWMU #	**SWMU or Former Working Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
2	West Andersen Filter Media (AFM) Bin Area	Not a potential source. Waste materials were contained during SWMU operation and have been removed from the site.	No. Unit does not exist. Waste materials were contained during SWMU operation and have been removed from the site.	NFA. Unit was closed per RCRA standards.

Table 7-25

Next Steps in SRI - SFS Process for Other Areas of the FMC Plant OU Not Associated with a Remediation Unit

	Remedial Action Vision:	**No action anticipated to be necessary. It is anticipated that the analytical results for this area will either show that there are no unacceptable risks, or that any unacceptable risks are isolated and could be mitigated via hotspot removal.**		
SWMU #	**Area**	**Potential Source?**	**Are further characterization data necessary to implement the Remedial Action Vision?**	**Next Steps**
na	FMC properties between Highway 30 and Interstate 86	Surface soils have been impacted by deposition of particulates from historic former emissions. Owing to the substantial reduction in particulate emissions from FMC sources following the EMF RI, potential post-RI impacts would be expected to be minimal. Cessation of manufacturing has effectively eliminated further impacts.	Yes. Obtain gamma radiation measurements to evaluate risks from external exposure to radionuclides in the uranium-238 decay series. Analyze samples for radium-226 activities.	Forward to SRI.
na	FMC properties north of Interstate 86	The impact on surface soils by particulate deposition from historic emissions is significantly less than that identified at FMC properties between Highway 30 and Interstat Highway 86. Owing to the substantial reduction in particulate emissions from FMC sources following the EMF RI, potential post-RI impacts would be expected to be minimal. Cessation of manufacturing has effectively eliminated further impacts. (see above).	Yes. Obtain gamma radiation measurements to evaluate risks from external exposure to radionuclides in the uranium-238 decay series. Analyze samples for radium-226 activities.	Forward to SRI.

Section 8
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APPENDIX A

EVALUATION OF FORMER WORKING AREAS

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ACRONYMS/ABBREVIATIONS

BEI	Bechtel Environmental, Inc.
C	Celsius
COPC	chemical of potential concern
CSM	conceptual site model
EPA	U.S. Environmental Protection Agency
FIP	Federal Implementation Plan
GAA	generator accumulation area
HHRA	human-health risk assessment
IDEQ	Idaho Department of Environmental Quality
LDR	land disposal restriction
mg/L	milligrams per liter
NORM	naturally-occurring radioactive material
OU	operable unit
RCRA	Resource Conservation and Recovery Act
ROD	record or decision
RU	remediation unit
RU-1, RU-2, etc.	Remediation Unit 1, Remediation Unit 2, etc.
SEP	supplemental environmental project
SFS	supplemental feasibility study
SMWU	solid waste management units
SPM	Scoping and Planning Memorandum
SRI	supplemental remedial investigation
WMU	waste management units

Appendix A
Evaluation of Former Working Areas

The operational histories of former working areas and related SWMUs are summarized in Appendix A. This appendix also summarizes findings from the EMF Site Remedial Investigation Report (Bechtel 1996) and subsequent information concerning the nature and extent of contamination associated with former working areas and SWMUs.

The information sources reviewed in preparation of Appendix A include:

- EMF Site Remedial Investigation Report (Bechtel 1996);
- FMC's RCRA Part B Permit Application (FMC 1997, as revised through September 2002);
- FMC's February 27, 1998 response to EPA's January 22, 1998 CERCLA Section 104/RCRA Section 3007 information request;
- FMC's February 19, 1999 response to EPA's October 23, 1998 and January 12, 1999 information requests; and
- FMC's September 17, 2002 response to EPA's July 8, 2002 RCRA Section 3008 information request.
- Information on releases at the FMC facility that have been reported since the EMF remedial investigation.

A1 Evaluation Objectives

These operational histories, information sources, and previous studies were reviewed to determine:

- Are there additional potential sources or further understandings of source characteristics and release mechanisms that should be reflected in the updated Conceptual Site Model (CSM)? How do the issues reported by the public concerning former working areas[1] affect the identification of potential sources or influence the evaluation of site conditions?
- Does the cessation of manufacturing or the prospective commercial/industrial redevelopment of the site introduce new classes of potential receptors or potential exposure pathways that were not evaluated during the EMF Site RI? Are there significant changes in the nature of potential exposure pathways? How should these receptors, pathways, or changes in pathway characteristics be addressed in the updated CSM?
- Are there site-related constituents that were not evaluated during the EMF Site Remedial Investigation? How should these constituents be addressed in the updated CSM?

[1] These issues are recorded in Section 3.2 of the SPM (FMC 2004).

- How should closures of RCRA Waste Management Units (WMUs) and RCRA Generator Accumulation Areas (GAA), remediation of the Calciner Ponds, and decommissioning of manufacturing process units be reflected in the updated CSM?

Summaries of the findings of the EMF remedial investigation and a subsequent study of groundwater quality are reprinted in Section A.2 to provide readers with relevant background information. Section A.3 presents findings from the evaluations of operational histories, information sources, and previous studies for each of the evaluation objectives listed above.

A2 Summary of EMF RI Findings

The remedial investigation for the EMF Superfund site[2] included analysis of approximately 1,500 groundwater samples; potential source and soil samples from 200 locations; 3,600 air quality samples; 250 surface water and sediment samples; and aquatic and terrestrial ecology sampling. Groundwater flow was determined through quarterly measurements of groundwater elevations at over 100 wells. Characterization of groundwater flow was supplemented by a groundwater flow modeling study. An atmospheric dispersion modeling study was performed using emission inventories for 119 point, area, and line sources at the facilities (75 of which were within the FMC facility area, including emissions from the then-active Bannock Paving area). Field sampling activities occurred between 1992 and 1994.

The EMF RI Report was submitted to EPA Region 10, IDEQ, and the Shoshone-Bannock Tribes for review in 1995. Revision pages and additional information were submitted in August 1996 to address agency comments on the 1995 submission. EPA accepted the EMF RI Report on July 31, 1996. The final EMF RI Report is cited “Bechtel 1996” to distinguish it from the 1995 submission.

Summary discussions from the EMF RI Report are reproduced as Figures A-1 through A-4 to provide readers of this RI Report Update with an understanding of the scope and findings from the EMF RI Report relevant to the FMC Plant OU:

- Figure A-1: Summaries of the characterization of Potential Source and Facility Soils (Section 4.2 of the EMF RI Report),
- Figure A-2: FMC Potential Sources (Section 4.2.3.1 of the EM RI Report);
- Figure A-3: FMC Facility Summary (Section 4.2.3.4 of EMF RI Report);
- Figure A-4: Surface Soil Characterization (Section 4.3 of EMF RI Report);
- Figure A-4: Overview of Nature and Extent of Groundwater Impact (Figure 4.4.1 of EMF RI Report).

[2] The EMF site is comprised of the FMC elemental phosphorus manufacturing facility and adjacent JR Simplot phosphate fertilizer products manufacturing facility and surrounding areas.

A3 Evaluation Results

Tables A-1 through A-23 provide the following information for each RU:

- The Remedial Action Vision for the RU presented in the SPM;
- A description of SWMUs and former working areas within the RU;
- A summary of EMF RI Report findings, where available, regarding the nature and extent of impact attributable to each SWMU or former working area within the RU;
- Post-EMF RI information concerning the operations or activities at each SWMU or former working area that might have resulted in changes to site conditions;
- A description of reported releases that occurred after the EMF RI field sampling period at a SWMU or former working area;
- The current status or condition of the SWMU or former working area; and
- Whether the SWMU or former working area should be identified as a potential source in the updated CSM.

Table A-24 provides a similar assessment for the former West Andersen Filter Media Bin Area (SWMU #2) that is not associated with an RU. Table A-25 provides a summary of RI findings, post-RI information, current status, and source evaluation for FMC properties north of the former manufacturing area that do not contain former worker areas or SWMUs.

One hundred seven (107) SWMUs are listed in Table J-1 of Section J (Corrective Action) of FMC's RCRA Part B Permit Application (as revised through September 2002). FMC believes that SWMU 56 (Drum Storage Area for other Nonhazardous Wastes) and SWMU 59 (Waste Oil Storage Area) designate the same feature and, consequently, considers this to be the same SWMU. Six of the 107 (SWMUs 93 through 98) are assigned to components of the LDR Treatment System. Construction of the LDR Treatment System was terminated when the FMC facility ceased manufacturing operations in 2001. While the LDR Treatment System was never placed into operation to treat hazardous wastes, SWMU numbers assigned to the LDR Treatment System were not reassigned. Consequently, 100 SWMUs were evaluated in preparation of Tables A-1 through A-24.

Of these 100 SWMUs, 72 were identified as potential sources for the updated CSM. The remaining 28 SWMUs were not identified as potential sources for the following reasons:

- The SWMU no longer exists. It was closed by waste removal and equipment decontamination, and there is no reason to suspect residual soil contamination due to the design and operation of the unit (i.e., unit built with RCRA compliant secondary containment).
- The SWMU was originally listed due to its emission potential (e.g., SWMU 41 – Stack and Vents) during facility manufacturing operations. These emissions were terminated with the cessation of manufacturing.

Four former working areas were identified as potential sources, in addition to the 72 SWMUs. These former working areas were locations at which hazardous constituents or hazardous substances could have been released during facility operations.

A3.1 What potential sources, further understanding of source characteristics, and release mechanisms should be reflected in the updated Conceptual Site Model?

The evaluation identified the following former working areas and SWMUs as additional potential sources in the updated CSM:

- Areas where elemental phosphorus (P4) might be present in soil owing to spills and process unit leaks at P4 production, storage, and handling areas. These areas are found within RU 1, 2, 6, and 8, and along the route of underground pipelines formerly used to convey phossy water and precipitator slurry to ponds in RU 1, 12, 13, 22b, and certain intervening areas.
- Railcars buried beneath the Slag Pile (RU 19) that are believed to contain sludge from the P4 production process.
- Alleged buried transformers[3] west of the Slag Pit (the site of alleged burial is within RU 12).
- The sites of former unlined stockpiles of coke (SWMU 105) in RU 7 and nodules (SWMU 106) in RU 9.

The evaluation also provided a further understanding of sources and source characteristics that should be reflected in the updated CSM:

- The original (1998) CSM did not distinguish among sources based on whether the source was operated with, or without, a sustained hydraulic head. The EMF Site RI found that unlined waste management units (e.g., Pond 8S) that operated with a sustained applied hydraulic head impacted both underlying soils to depths of up to 90 feet and groundwater in the upper aquifer. The RI also found that potential source areas that operated without a sustained applied hydraulic head did not significantly impact underlying soils (except where locally mixed through mechanical action) and that these sources did not contribute to contamination of the uppermost aquifer. However, free liquids may have been present in wastes that were managed at certain unlined units that did not operate with a sustained hydraulic head. These units were the landfills in RU 17, 18, and 19, the Calciner Solids Stockpiles in RU 16, the Disposal Area Behind the Laboratory and the Chemical lab Seepage Pit in RU 5. If present, these free liquids may have seeped into underlying soils and perhaps groundwater. In addition, areas where petroleum fuels where stored at RU 20 may have impacted soils and groundwater. These distinctions between sources should be introduced to the updated CSM to clarify the nature and extent of impacted exposure media.
- FMC terminated the IWW discharge to the Portneuf River in August 2002 and, at FMC's request, EPA subsequently terminated the associated NPDES permit. This was the only point-source discharge associated with the FMC Plant OU.

[3] As noted in the SPM, FMC is unaware of any transformers having been buried at this area. Burial of such used equipment would have been unlikely, given the recycling value of a used transformer (i.e., copper wire content, steel casing). Moreover, historic plant practice was to rewind the coils of large transformers and place them back in service.

Consequently, the point-source discharge from the IWW Ditch (RU 10) should no longer be identified as a potential source in the updated CSM.

- Subsequent to publication of the EMF ROD, EPA issued a Federal Implementation Plan (FIP) under the Clean Air Act that required reductions in particulate emissions from the FMC facility. Concurrently, FMC completed 13 Supplemental Environmental Projects (SEPs) during 1999-2001 pursuant to the FMC RCRA Consent Decree (entered July 13, 1999) that collectively reduced particulate emissions from on-going facility operations by approximately 80%. These emission controls met the reduction requirements established by the FIP. Moreover, emissions from these sources as well as other sources evaluated during the RI were subsequently eliminated upon cessation of elemental phosphorus manufacturing operations in December 2001. Consequently, FMC plant emissions associated with stacks and vents and operating areas should not be identified as sources in the updated CSM.
- As noted in Figure A-5, post-RI groundwater quality monitoring data demonstrates patterns of groundwater flow (indicated by the quarterly groundwater elevation monitoring data) that are consistent with the patterns observed during the RI. This indicates that the direction of plume migration from FMC sources has not changed since the RI.
- Post RI groundwater quality monitoring data also indicate that the nature and extent of groundwater contamination within FMC-owned properties is consistent with that identified by the EMF remedial investigation with one exception. Analyses of groundwater samples from Wells 108, and 122 since the RI have detected low concentrations of P4 (ranging from ND to 0.258 mg/L at Well 108). These monitoring wells are downgradient of the unlined Slag Pit Wastewater Collection Sump, as well as the Slag Pit – Furnace Building – Phos Dock complex. The presence of P4 in these samples implies a P4 release from a source within this P4 production, storage, and handling complex.
- Post-RI groundwater detection monitoring programs at lined RCRA WMUs have identified no new sources of impact to the uppermost aquifer.

The evaluation confirmed that potential release mechanisms evaluated in the EMF ROD and HHRA remain relevant to the site. The evaluation found that:

- The use of by-product (i.e., slag) from the manufacturing process as construction fill and roadbed has been widespread at the site, as recognized in the original CSM. Exposure to gamma radiation associated with naturally occurring radioactive materials (NORM) in slag was also recognized as a release mechanism in the original CSM.[4]

[4] The 1998 ROD established a Remedial Action Objective to prevent external exposure to radiation in soils at levels that pose estimated excess risk greater than 1 x 10-4, or site-specific background where that is not practical.

- Direct contact with contaminated surface soils and industrial feedstocks, by-products, and wastes stored on the ground surface continues to be possible[5], in part due to the imposed delay in implementing the source containment remedies selected in the 1998 ROD for the old phossy ponds and calciner solids area.
- Excavation during utility line installation or facility construction could encounter residual P4 from historic spills and process equipment leaks.
- Erosion/storm water runoff could expose or transport contaminated surface soils and industrial feedstocks, by-products, and wastes that are stored on the ground surface.
- Infiltration and percolation could facilitate migration of COPCs into soils and groundwater from a) unlined waste management units that operated with a sustained applied hydraulic head, b) unlined waste management units at which wastes containing free liquids were managed, and c) petroleum storage facilities within RU 20.
- Traffic on unpaved roads during site construction activities could generation fugitive dusts containing COPCs. Fugitive dusts could also be generated by wind and excavation-related activities.
- P4 release in liquid form from spills and process equipment leaks could migrate into unsaturated or saturated soils if the soils were heated above approximately 44° C (above approximately 44° C, P4 is molten; below approximately 44° C, P4 is a solid with a solubility of approximately 3 mg/L). The discharge of molten slag into the Slag Pit since manufacturing began in 1949 until conversion to slag ladling in 1999/2000 could have provided substantial heat to soils within the RU 1 and 2 area.

A3.2 Are there new potential receptor exposure pathways?

A generic commercial/industrial worker was evaluated in EPA's 1996 baseline human health risk assessment for the FMC facility. Consideration of potential commercial/industrial redevelopment of the site (See Section 2) indicates that this generic commercial/industrial worker scenario should be retained in the updated CSM.

Moreover, construction activities and utility line installation may be performed to support commercial/industrial redevelopment or reuse of the site. The EMF HHRA did not evaluate a construction worker or utility worker exposure scenario. Construction or utility workers potentially could be exposed to fire or inhalation of smoke (P2O5) if P4 in sufficient concentration is exposed to air during excavation[6] of subsoils containing P4. Consequently, the construction worker and utility worker should be included as additional potential receptors in the updated CSM.

[5] FMC maintains administrative controls that minimize the opportunity for such contact. However, the Conceptual Site Model assumes that such administrative controls are not in place under a future commercial/industrial land use of the site.

[6] These activities are not expected at the closed RCRA Waste Management Units (RU 22a) or at the capped Calciner Ponds (RU 14); RCRA closure/post-closure requirements and the IDEQ-approved Calciner Pond Remedial Action Plan obligate FMC to file land use restrictions that prohibit disturbance of, or intrusion into, the covers of these units.

A3.3 Are there site-related constituents that were not evaluated during the EMF Site RI?

P4 and P2O5 were recognized as site-related constituents in the 1998 EMF ROD.[7] Given the cessation of the P4 manufacturing process, it is inappropriate to evaluate P4 as an airborne constituent. Rather, P4 and its oxidation products should be evaluated as potential soil-based constituents.

A3.4 How should closures of RCRA waste management units, remediation of the Calciner Ponds, and decommissioning of manufacturing process units be reflected in the updated CSM?

The FMC facility contains hazardous waste management units (WMU) regulated under the Resource Conservation and Recovery Act (RCRA) that are closing under RCRA and that in many cases require post-closure care. As of November 2002, FMC had completed closure at two of the RCRA-regulated ponds (Pond 8S and Pond 9E) and initiated closure at all the remaining RCRA-regulated ponds. Table A-24 describes the closure status of each RCRA Interim Status WMU. For purposes of the SRI/SFS process, the RCRA WMUs are identified as RU 22a.

FMC agreed to a consent order with the State of Idaho Department of Environmental Quality (IDEQ) on July 8, 2002 to implement remedial action for the calciner ponds (SWMU 15 at RU 14), located on State-jurisdiction land in the eastern portion of the FMC facility. The Remedial Action Plan for the calciner ponds was approved by IDEQ in December 2003 in accordance with the IDEQ consent order. The interim fill and temporary cover were placed at calciner ponds 1C, 3C, and 4C in 2003; the final cover is expected to be placed over these ponds and the adjacent Calciner Ponds 2C and 5C (SWMU 85) in 2005.

Certain RCRA "90-day" Generator Accumulation Areas[8] (GAA) are in operation to support facility-decommissioning activities. As required by the RCRA hazardous waste management standards,[9] these GAAs are designed and operated to prevent releases. Moreover, as required by RCRA closure standards for GAAs, these units will be closed by waste removal and equipment decontamination.

RCRA standards require that waste management units and GAAs be closed in a manner that (a) minimizes the need for further maintenance, (b) controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere, and (c) complies with closure requirements specific to the type of unit being closed (i.e., tank system, container storage area).

RCRA closure plans and post-closure plans (for units at which wastes remain after closure) describe how these regulatory standards will be met for each RCRA Interim Status WMU. EPA

[7] "Quantitative evaluation of potential risks from phosphorus and its oxidation products [e.g., P2O5] were unavailable due to the lack of a standard EPA method for measurement of these constituents in air due to the lack of a standard EPA method for measurement of these constituents in air, and lack of information of the toxicological effects from inhaling low levels of these substances over a prolonged period of time." (EPA 1998, page 48-49)

[8] The P4 Maintenance Cleaning Facility (SWMU 92 in RU 3) and the Drum Storage Area at Training Center (SWMU 102 in RU 4) are anticipated to be operational during the facility decommissioning process.

[9] RCRA standards for GAAs are found at 40 C.F.R. §262.34. GAAS may be container storage areas, tank system, and containment buildings.

has reviewed and, after notice and opportunity for public comment, has approved the closure and post-closure care plans for WMU 3 – Pond 15S (1/13/03); WMU 7 - Pond 8S (10/5/98), the WMU 8 - Phase IV Ponds (1/13/04), WMU 9 – Pond 9E (3/14/00); WMU 10 – Pond 16S (2/6/04); and WMU 11 – Pond 8E (1/13/03) upon finding that the closure and post-closure programs will be protective of human health and the environment. Closure and post-closure plans have been submitted for the remaining[10] RCRA WMUs (WMU 5 - the Slag Pit Wastewater Collection Sump; WMU 14 - Pond 17; and WMU 15 - Pond 18). EPA has authorized the initial fill and temporary cover elements for these WMUs; authorization of the final cap designs and post-closure plans is pending.

EPA has also approved the RCRA closure plans for WMU 1 – Drum Storage Unit (8/5/02); WMU 12 – Wastewater Treatment Unit (2/7/01); and WMU 13 - AFM Washing Unit (8/5/02). FMC has certified that these WMUs were closed by waste removal and equipment decontamination. Consequently, these WMUs are not subject to post-closure care requirements.

FMC submitted documentation to EPA in October 1997 that WMU #4 - the 8S Recovery Process – was closed in 1993 in the manner described in the RCRA closure plan (i.e., waste removal and equipment decontamination) for this unit and requested EPA approval of the closure plan. FMC will certify closure of this WMU following EPA approval of the closure plan.

Potential releases from RCRA WMUs and GAAs and from the Calciner Ponds may be encompassed within the scope of the SRI/SFS. However, as noted in the Statement of Work for the SRI/SFS, pursuant to EPA's One Cleanup Program Initiative, closure activities for the RCRA WMUs and GAAs, including any necessary waste removal and equipment decontamination, will be addressed pursuant to RCRA and will not be examined or subject to review in the SRI/SFS process. Also as noted in the Statement of Work for the SRI/SFS, the remedial actions being taken at the Calciner Ponds pursuant to the IDEQ consent order will not be further examined or subject to review in the SRI/SFS process.

A4 References

Bechtel 1996. Remedial Investigation for the Eastern Michaud Flats Site. Bechtel Environmental, Inc. Draft issued September 1995 and revised August 1996.

Bechtel Environmental Inc. (BEI), 2002. Revisions to RCRA Corrective Action Environmental Indicators. FMC Idaho LLC, Pocatello, Idaho. June 2002.

Ecology & Environment 1996. Baseline Human Health and Ecological Risk Assessments for the EMF Site. Prepared for U.S. Environmental Protection Agency, Region 10. Draft issued March 1995 and revised March 1996.

FMC 1998. FMC Corporation Response to EPA Region 10 January 22, 1998 Request for Information. FMC Corporation, Phosphorus Chemicals Division, Pocatello, Idaho. February 27, 1998.

FMC 1999. Response to EPA Region 10 RCRA Section 3007 Supplemental Information Request. FMC Corporation, Phosphorus Chemicals Division, Pocatello, Idaho. February 12, 1999.

[10] WMU # 2 (West AFM Bin Area) was a protective filing and operated only as a 90-day Generator Accumulation Area. WMU # 6 (Area 9S) was a protective filing and never operated under RCRA Interim Status. WMU # 16 (LDR Treatment System) never operated.

FMC 2002a. RCRA Part B Permit Application. Submitted to the U.S. Environmental Protection Agency, Region 10. FMC Idaho LLC, Pocatello, Idaho. As amended through September 2002.

FMC 2002b. Response to EPA Region 10 July 8, 2002 Information Request. FMC Idaho LLC. September 2002.

FMC 2004. Scoping and Planning Memorandum (February 2004 Revision of the November 2003 Draft). Supplemental Remedial Investigation and Supplemental Feasibility Study for the FMC Plant Operable Unit. FMC Idaho LLC. Pocatello, Idaho. February 2004.

FMC Pocatello RCRA Consent Decree 1999. RCRA Consent Decree in United States vs. FMC Corporation in the United States District Court for the District of Idaho. Civil Action No. 98-0406-E-BLW. Entered July 13, 1999.

Section 4.2 presents the results of the investigations of potential sources and soils at the EMF facilities. These investigations were begun in Phase I of the RI in 1992 and continued in Phase II in 1993. Data from investigations at FMC in 1990 were also used in the evaluations. Samples were, by intent, collected in areas of known or suspected facility influence. As such, the sampling program was biased toward identification of facility effects and any interpolation between individual areas of investigation is inappropriate.

Potential Source and Facility Soils Investigation Objectives

The objectives of the potential source and facility soils investigation were:

- To examine the nature of constituents present in feedstocks, coproducts, by-products, and wastes from the industrial processes, and to identify any distinctive patterns in the chemical content of these materials that would allow them to be readily differentiated from each other.
- To evaluate whether units used to store, transport, or dispose of these materials have affected soils in the vicinity of the units, and, if so, to identify the vertical and horizontal extent of any effects. The chemical characteristics of the materials described under the first objective were used as a tool in evaluating sampling results; these characteristics also allowed specific sources to be identified in areas where multiple sources were possible.

Overview of Potential Source and Facility Soils Investigation Findings

The major findings of the investigation of potential sources and facility soils were as follows:

- The principal feed stock at the EMF facilities is phosphate rock mined from the Phosphoria Formation. This shale contains apatite, a mineral containing calcium, phosphate, and fluoride. The ore also contains trace levels of arsenic, cadmium, chromium, vanadium, uranium-238 and its daughters, zinc, and other elements. The processing operations at the EMF facilities separate these components into various products, coproducts, by-products, and wastes.
- A suite of characteristic constituents was identified by concentration for major feed stocks, coproducts, by-products, and waste materials. The primary constituents found in the solid fraction of these materials at both FMC and Simplot are cadmium, chromium, fluoride, total phosphorus, vanadium, and zinc. Four or more of these six characteristic constituents were usually among the predominant constituents detected in fill material or EMF-affected soils sampled as part of the potential source and facility soils investigation. For this reason, the presence of four or more of these constituents in excess of their concentrations in undisturbed, native soils indicates EMF facility effects. Indications of EMF-related materials were also based on visual inspection of the samples as noted in the soil boring logs (Appendix B).
- Specific feed stocks, coproducts, by-products, and wastes can be distinguished by characteristic levels of additional constituents. At FMC, these materials include: phossy waste solids, containing characteristic levels of cadmium, lead-210 and zinc; precipitator slurry, containing characteristic levels of arsenic, potassium and zinc; ferrophos, containing characteristic levels of chromium, iron, and vanadium; and calciner pond sediments, containing characteristic levels of calcium, fluoride, potassium, and selenium. At Simplot, these materials include gypsum, containing characteristic levels of calcium, fluoride, phosphorus, and sulfate.
- Soil quality has generally been degraded only where mechanical actions have mixed native soils with the source materials or where a sustained hydraulic head has transported constituents from source materials into underlying soils.
- Where a sustained head is absent, inorganic and radiological constituents introduced into subsurface soils through mechanical actions are generally below soil representative levels in deeper soils.
- PCBs and other organics were not found in facility soils in significant quantities.

Figure A-1

Reproduction of Section 4.2 of EMF RI Report: Potential Sources and Facility Soils

To determine the potential constituents that may be released from FMC, chemical analyses were performed on feedstock (ore and pond sediment from coke-washing), coproducts (ferrophos), by-products (slag), and wastewater streams (phossy water/solids, precipitator slurry, calciner water/solids, and IWW ditch water/solids). Standing water and sediments in the railroad swale were also collected and analyzed. Information gathered from these analyses was then compared with the chemical analyses of soil samples to determine the potential source of the constituents found in the soils. This section of the report discusses ore, by-products, and wastestreams, with emphasis on the general characteristics and any unique characteristic that may enable an analyst to uniquely identify the material.

Nine FMC source areas/materials were examined during Phases I and II to ascertain the chemical composition of their matrices. The following general conclusions were reached:

- Phosphate ore, slag, precipitator dust, phossy water/solids, ferrophos, and calciner water/fines contain significantly higher concentrations of various trace metals and other constituents than do the native soils and waters.
- There are six constituents that appear in all of the solid materials that enable the source material to be identified when it is mixed with native soils or sediments. These characteristic constituents are fluoride, total phosphorus, cadmium, chromium, vanadium, and zinc. [Note: When they occur as a group, they are underlined in the following text.]
- In addition to the six characteristic constituents, each of the above materials has unique concentrations of other constituents that allow for its identification, provided it is mixed in a matrix (soil or sediment) in sufficient quantity. For example, a soil with ferrophos mixed with it can be distinguished from a soil in which precipitator dust is present based on the relative levels of arsenic, iron, or potassium.
- To a lesser extent than the solid matrices, the wastewaters associated with phossy wastes, precipitator slurry, and calciner slurry also have enriched concentrations of various constituents that can be used to identify them as sources. These sources can be distinguished by the relative amount of arsenic, chloride, fluoride, total phosphorus, potassium, sodium, and sulfate.
- The railroad swale contains identifiable constituents of phosphate ore.
- The IWW ditch sediments contains constituents identified with precipitator dust and phosphate ore.
- The coke settling pond does not appear to have any constituents in it that could affect the composition of the native soils.

Figure A-2
Reproduction of Section 4.2.3.1 of EMF RI Report: FMC Potential Sources

The following summary discussion of the FMC potential source and facility soil investigation is divided into two parts: the first part addressing areas not subjected to a sustained hydraulic head, and the second part addressing areas to which a sustained hydraulic head has been applied. Data from both sets of areas indicate that a large portion of the FMC facility, as well as Bannock Paving, has been graded with fills composed of native soils and facility-related materials (primarily slag). The depth of the fill layer ranges from several feet to over 30 feet. The fill materials themselves often contain a number of constituents with concentrations that exceed representative soil levels. This is a result of on-site storage of feedstocks, coproducts and by-products, and the use of some by-products, primarily slag, as fill material.

The investigation of areas where there has not been a sustained hydraulic head has led to the following observations:

- When native soils are encountered beneath fill, trace metals are generally only measured at concentrations above soil representative levels in the first several feet of native soil. This observation is illustrated with chemical data from borings 103, 119 and 120, which were drilled in areas where no hydraulic head has been applied, in Figures 4.2.3-4 and 4.2.3-5. (The boring locations and sections lines are shown in Figure 4.2.2-4.)
- Radioactivity as measured in terms of gross alpha and gross beta tended to follow the same pattern as trace metals.
- In a number of samples, total phosphorus, fluoride, potassium, sodium and to lesser extent zinc, exceeded representative levels to depths of 10 feet below the fill/native soil interface. Fluoride, phosphorus and zinc data for borings 103, 119 and 120, which were drilled in areas where no hydraulic head has been applied, are illustrated in Figure 4.2.3-6.
- Samples taken at or below road surfaces generally exhibited EMF-related effects in the surficial horizon; very little to no effects were observed in the 2-foot horizon.
- Volatile organic compounds (primarily xylenes and toluene) were found near detection limits in the boreholes drilled in the chemical drain field and near the active landfill. No EMF-related semivolatile organics were detected in any sample.
- TPH were detected in several locations near the surface and on the roads. They were not detected at depth.
- PCBs were detected at levels below 1 mg/kg in several road samples as well as in surficial soil samples. However, most samples analyzed for PCBs did not contain any at detectable levels. PCBs were not detected in any sample at depth.

These observations support the general conclusion that the site has widespread surficial effects due to EMF-related activities including the use of EMF-related materials for fill. However, in the absence of a sustained hydraulic head there has been little effect on the subsurface native soils.

(figure continues)

Figure A-3

Reproduction of Section 4.2.3.4 of EMF RI Report: FMC Facility Summary

The results of the investigation of areas where an artificial hydraulic head had been applied by an industrial activity (e.g., unlined impoundments or ditches and sludge drying areas) has led to the following observations:

- Trace metals are generally below soil representative levels within 20 to 30 feet of the source/native soil interface. The general exception is zinc, which was detected above representative levels at still greater depths. Some EMF-related constituents may be present in the soils at concentrations too low to enable distinguishing the constituents from their naturally occurring equivalents.
- Cadmium, lead, and vanadium concentrations in borings in the southwest pond and calciner pond areas are shown on Figures 4.2.3-4 and 4.2.3-7. Note the generally steep decline in concentrations from the surface in the sludge/fill to the native soils at 20 feet. Figures 4.2.3-5 and 4.2.3-8 depict arsenic, chromium and copper data for the southwest pond and calciner pond area. The same general pattern of high surficial values and rapidly declining concentrations with depth is observed for these constituents. Selenium (not shown) exhibits the same pattern as arsenic.
- Total phosphorus, fluoride, sodium, potassium and zinc were, in many borings, observed throughout the entire soil column at above-representative levels.

  Figures 4.2.3-6 and 4.2.3-9 display data for fluoride, total phosphorus and zinc in the southwest pond and calciner pond areas. While the concentrations in the surficial samples are elevated relative to those in the subsurface, the concentrations generally remain above representative levels at depth.

Figure A-3 (Continued)

REPRESENTATIVE GROUNDWATER QUALITY (SECTION 4.4.3):	• Seventeen wells characterize representative groundwater quality. • Three hydrogeochemical regimes are present. • Concentrations are typically low, pH is neutral to basic.
GROUNDWATER QUALITY AT SOURCE AREAS	FMC FACILITY *SECTION 4.4.4* / SIMPLOT FACILITY *SECTION 4.4.5* / JOINT FENCELINE AREA *SECTION 4.4.6* • Organic compounds are largely not detected, many metals are within representative concentrations. • Shallow groundwater has been impacted by releases from unlined waste management units at both facilities. • Primary site-related constituents of potential concern are arsenic, chloride, fluoride, nitrate, selenium, sodium, sulfate, and alpha emitters. Gross beta activities correlate with potassium-40. • Areas of impact at FMC are in the vicinity of former unlined ponds (phossy waste, kiln and calciner scrubbers) and slag pit. • Areas of impact at Simplot are the gypsum stacks and former east overflow pond. • Several potential sources may contribute constituents within the joint fenceline area. • Closures of unlined waste management units at both facilities have greatly reduced constituent releases; this has lead to improved groundwater quality.
NORTHERN FMC/SIMPLOT PROPERTIES (SECTION 4.4.7):	• Commingling plumes from all source areas influence groundwater quality in this area, and there is still a significant (10 to 100 times) reduction in constituent concentrations.
AREA NORTH OF I-86 (SECTION 4.4.8):	• EMF-impacted groundwater discharges at two springs near the Portneuf River (Batiste Spring and Swanson Road Spring). Groundwater underflowing all source areas contributes to these springs. Sulfate and total phosphorus concentrations were consistently above representative levels, whereas arsenic, barium, boron, lithium, nitrate, ammonia, and selenium sporadically exceeded representative levels.
RADIOLOGICAL SPECIATION RESULTS (SECTION 4.4.9):	• Potassium-40 is EMF-related, whereas the alpha emitting radionuclides appear to be related to the silicic volcanic tuffs and rhyolite flows in the Bannock Range.

Figure A-4

Reproduction of Figure 4.4.1 of EMF RI Report:
Overview of Nature and Extent of Groundwater Impact

This attachment to the 2002 Proposed Update for the RCRA Corrective Action Environmental Indicator: Migration of Contaminated Groundwater Under Control for the FMC Idaho LLC facility summarizes groundwater-monitoring data obtained by FMC since completion of the remedial investigation (RI) for the Eastern Michaud Flats (EMF) Superfund Site.

2. Groundwater flow patterns beneath FMC-owned properties are consistent with those identified during the EMF RI

As noted in Section 1, groundwater elevations were measured across the EMF site study area on a quarterly basis during the RI to characterize groundwater flow patterns (see Figures 2-3 through 2-5). FMC has measured groundwater elevations in 76 wells uniformly distributed between the area upgradient from source areas and Batiste Spring on a quarterly basis since the RI to monitor groundwater flow rates and directions. This includes monitoring groundwater elevations at wells installed at RCRA hazardous waste surface impoundments that were not in service during the RI field study period (i.e., Ponds 17 and 18).

The post-RI groundwater elevation contour plots for FMC-owned properties show a consistent pattern of groundwater flow with those identified during the RI field study period. This indicates several important points:

- Groundwater flow patterns related to FMC sources that contributed to groundwater contamination (e.g., Pond 8S) have not changed appreciably since the RI field study period;
- There is no technical rationale for concluding that the extent of contamination has expanded beyond the area delineated by the EMF RI, even if there were no groundwater quality monitoring data available from wells outside the areal extent of groundwater contamination delineated during the RI investigation.

Of course, post-RI groundwater quality data are available for wells that were unimpacted by releases from EMF facility sources during the RI, as well as for wells that established the areal extent of contamination. These data are described in Section 3.

3. The nature and extent of groundwater contamination within FMC-owned properties is consistent with that identified by the EMF remedial investigation

FMC has collected samples from 35 RCRA groundwater quality wells on a quarterly basis under its RCRA Interim Status Groundwater Monitoring Program — as well as an additional 24 CERCLA wells uniformly distributed between the area upgradient from source areas and Batiste Spring on a semi-annual basis since the RI under its voluntary CERCLA Groundwater Monitoring Program — to monitor groundwater quality on FMC properties. The locations of these wells are shown on Figure 2-15. FMC has submitted these data to EPA.

Analyses of these samples for EMF-facility related parameters indicate that the extent of EMF-facility related impact has not increased beyond the area defined by RI data (except that FMC cannot comment on groundwater quality on Simplot properties, which is associated with the eastern area of EMF-facility related impacts and release sources).

This conclusion can be understood by examining sampling results for wells listed in Table A-1. These wells are located either outside the area of groundwater impact identified by the RI or are located just inside the leading edge of this zone of impact. The order in which the wells are listed in the table generally follows along the edge of this zone of impact in a clockwise manner, starting with background (i.e., upgradient) Well 101 in the southwest area of the FMC facility, proceeding along the western and northern perimeter toward the Portneuf River, and then along a southerly direction to background Well 305 to the east of the Simplot facility.

(figure continues)

Figure A-5*

Excerpts from Summary of Groundwater Monitoring Data for the FMC Idaho LLC Facility Since Completion of the Remedial Investigation for the Eastern Michaud Flats Superfund Site

The RI found that the nature of groundwater impacts within the FMC facility include elevated arsenic (highest mean concentration at 0.19 mg/L), nitrate (highest mean concentration at 24.7mg/l), and selenium (highest mean concentration at 0.29 mg/L). The RI also found that the nature of groundwater impacts within the Simplot facility include elevated arsenic (highest mean concentration at 0.61mg/L), nitrate (mean concentration up to 74.3 mg/L) and selenium (mean concentration up to 0.15 mg/L). The RI found the extent of groundwater impact to be limited to properties owned by FMC and the J.R. Simplot Company, with the exception of intervening railroad and highway right-of-ways.

Sampling results for the wells listed in Table A-1 are presented in Figures 2-16 through 2-18. These figures display the reported levels of arsenic and selenium (non-detects and results outside accuracy and precision targets are not displayed) over the RI and post-RI sampling periods. The figures also identify the background levels of arsenic and selenium as well as the date of the Record of Decision for the EMF Superfund Site. Trend lines for arsenic and selenium are also shown. These figures illustrate that wells not impacted by EMF-facility related sources during the RI field study period have not been impacted since that period. Figures 2-19 through 2-21 display nitrate data for these wells in a similar manner.

Post-RI sampling data for groundwater monitoring wells that delineated the eastern extent of EMF-facility related impact are located on Simplot properties. While these data are unavailable to FMC, it is unlikely that post-RI data from these wells would lead to a different overall finding regarding the migration of releases from FMC-related sources, since these wells would be expected to be influenced by sources within the Simplot facility.

4. Summary

Post-RI groundwater quality monitoring data — along with the consistent patterns of groundwater flow indicated by the quarterly groundwater elevation monitoring data — indicate that the areal extent of EMF-facility related groundwater impact delineated during the RI fields sampling period (1992 – 1994) has not expanded. This supports the finding that the migration of groundwater contamination associated with sources on FMC-owned properties is under control, as defined by the RCRA Environmental Indicator for groundwater migration.

* Submitted to EPA Region 10 as Attachment A to the RCRA Corrective Action Environmental Indicator Migration of Contaminated Groundwater Under Control, FMC, June 2002.

Figure A-5 (Continued)

Remediation Unit #1: Furnace Building, Phos Dock, Secondary Condenser Area

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Andersen Filter Media (AFM) Washing Unit	13	yes	miscellaneous (tank-like)	solid fabric and liquid wash water	Former Subpart Q treatment unit. Unit operated briefly and managed D006 and D010 waste. Ceased operation on November 27, 1995. Closed by waste removal and equipment decontamination in December 2002 per EPA-approved Closure Plan. Unit no longer physically exists. Unit was on second floor of the Furnace Building. When operational, it was input and output rollers separated by a bank of spray nozzles inside containment, located on the second floor of the furnace building. The secondary containment system had a dedicated drain line that discharged to a furnace building sump.	SWMU was not evaluated during the remedial investigation.	Closed by waste removal and equipment decontamination in December 2002 per EPA-approved RCRA closure plan. Unit has not impacted environmental media.	No releases are recorded.	Closed by waste removal and equipment decontamination; unit has been removed. No potential impact to soil beneath Furnace Building during operation, due to secondary containment and elevated (second floor) location.	Not a potential source.	
Stacks and Vents	41	no	NA	liquid, solids, gas	Phos Dock Anderson scrubber and 2 boilers at boiler house.	Emission sources included in RI dispersion model. Impacts reflected in RI air monitoring data.	Boilers were replaced with 6 packaged natural-gas fired boilers in November 1995. Phos Dock scrubber upgraded in 1999; stack test showed low PM10 emissions.	Post-RI releases from Anderson scrubber system were P2O5 emissions to air that quickly dissipated.	Phos Dock Anderson scrubber and 6 package boilers at boiler house remain active or available.	Not a potential source. Past releases were P2O5 emissions from Andersen scrubbers during P4 manufacturing.	
Phos Dock Area	54	no	sump	solids, liquids	Phosphorus loading dock area where elemental phosphorus is handled. Per RCRA Consent Decree (1999), Point of Generation (POG) upgrades implemented in 1999. Area includes the former Maintenance Pad, which is an at-grade basin sloped toward a corner to contain washwater generated by cleaning equipment that potentially contained P4.	Both soil samples taken in the phos dock area contained above-representative levels of parameters generally associated with materials handled by the facility. The soils were apparently from fill zone. Native soils were not sampled. Hence the area can be said to contain affected fill to a depth of at least 4.5 feet.	Operations are currently active pending facility decommissioning. Anderson Scrubber Blowdown Sump converted from a <90-day GAA to process vessel as part of Consent Decree (1999) POG upgrades. North Solids tank (operated as a <90-day GAA) was removed in 1999 pursuant to installation of Tank V-3800 under RCRA Consent Decree POG upgrades	Post-RI spills occurred when equipment washwater overtopped the Maintenance Pad basin. Spills from units in the Phos Dock operating area (SWMU 77) could also drain to SWMU 54 prior to POG upgrades. Prior to POG upgrades in 1999, spills could drain to the north across the paved roadway to a storm drain that discharges to the Railroad Swale (RU 22c). POG included process upgrades that eliminated phossy water discharges.	Phos Dock remains active to support management of P4 removed from manufacturing process units during facility decommissioning. Decon Building (SWMU 92) replaced maintenance pad. Phos Dock will be decommissioned after management of the residual inventory of P4 in former process manufacturing units is completed.	Area is a potential source due to historic spills of phossy water.	
Rail Car Loading & Unloading Areas; Paved Area North of Furnace Bldg. incl. Phos Dock	36 & 55	no	Paved area with rail spur; below-grade sanitary sewer; in-ground former unlined launder and at-grade pipeline	liquid, slurry	Area between the phosphorus-loading dock and furnace building where elemental phosphorus is loaded into rail cars. Secondary containment upgrades implemented per POG Upgrades required by RCRA Consent Decree (1999). Includes at-grade historically unlined P4 product launder used to convey phossy water from the furnace building to a wastewater sump. Accumulated P4 in launder was periodically removed.	This area contained a fill layer of varying depth that showed some evidence of the presence of EMF-related parameters. Effects, however, appeared to be limited to 3 to 5 feet.	At-grade pipeline installed within launder in mid-1990's. Launder/pipeline located outside north side of Furnace Building; launder/pipeline drained to a sump near the southeast corner of the Furnace Building; sump contents were pumped to the Phos Dock. Phos Dock railcar loadout area lined in mid-1990's with stainless steel pans (discharging to a sump) to contain spills. These upgrades minimized the potential for discharge of phossy water spills to stormdrains leading to the Railroad Swale (SWMU 18).	Several post-RI spills of Furnace Building washwater drained from Furnace Building across paved roadway to storm drain that discharged to Railroad Swale (RU 22c).	Launder/pipeline out of service; not yet removed. Railcar loadout area remains active to support management of P4 removed from manufacturing process units during facility decommission. See SWMU 54 for decommissioning plans.	Area is a potential source due to historical spills of phossy water.	
Secondary Condenser/Former Fluid Bed Dryer Area	60	no	below-grade sumps and above-grade tank-like equipment	liquid, slurry	Secondary condenser used to remove elemental phosphorus from furnace exhaust gases; built north of former fluid bed drier unit used in early 1970s to dry and oxidize precipitator slurry. P4 stored in below-grade sumps. Fluid bed dryer operation ceased in 1970's and unit was subsequently dismantled except for stack and framework of building. Building subsequently housed miscellaneous material storage and calciner maintenance shop.	Some evidence of EMF-related effects was found below the fill/native soil interface. However, the constituents encountered appeared to be related to slag rather than precipitator slurry. Also there was evidence that the native soils had been disturbed by mechanical mixing of the soil with the fill probably before or during the placement of the 10-foot-thick slag-fill overburden. Some migration of zinc, fluoride, and phosphate, as well as alpha emitters, was also evident.	Gap in cement containment wall of P4 sump observed. Unknown if gap extends below product storage level; impact unknown.	Air emissions through gap observed during normal operations when sump was heated and under slight positive pressure.	Secondary condenser has be decommissioned and is partially dismantled. Sumps are being decommissioned, including removal of residual P4.	Potential source	
Railroad Spurs (portion within RU 1)	68 (partial)	no	railcars	railcars containing liquid, solids	Rail spurs were first constructed in 1949; no records of significant spills along tracks in the plant area. Slag may have been used as construction fill or ballast.	SWMU was not evaluated during the remedial investigation.	Stainless steel pans installed at Phos Dock railcar loadout area in mid-90's to contain spills.	No releases are recorded.	Active to support shipment of residual P4 product removed from manufacturing process units. Might also be used to support shipment of recyclable metals. Rail spurs are significant assets for future redevelopment and are not anticipated to be removed.	Potential source of P4 release to soil beneath P4 railcar loadout areas prior to installation of containment pans in mid-1990's. May also contain byproduct (slag) used as fill.	

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Satellite Storage Areas for Spent Anderson Filter Media	73	yes	container storage area	solids	RCRA Satellite Accumulation Area was closed in 2001 by waste removal and equipment decontamination. Dry material was stored within plastic bags within the rolloffs. Closure is documented in RCRA Operating Record.	SWMU was not evaluated during the remedial investigation.	Closed in 2001 by waste removal and equipment decontamination	No releases are recorded.	Closed by waste removal and equipment decontamination; unit has been removed. No potential impact to underlying soil, due to containment afforded by bins and underlying paved area.	Not a potential source.	
Former East AFM Bin Area	74	yes	container storage area	solids	Unit operated as a RCRA 90-day GAA. Unit was closed in 2001 by waste removal and equipment decontamination. It operated as a container storage area (265 Subpart I). AFM was placed in individual plastic bags prior to storage in the bin. AFM was managed as D006 and D010 RCRA characteristic hazardous waste.	SWMU was not evaluated during the remedial investigation.	Closed in 2001 by waste removal and equipment decontamination.	No releases are recorded.	Closed by waste removal and equipment decontamination; unit has been removed. No potential impact to underlying soil, due to containment afforded by bins and underlying paved area.	Not a potential source.	
Precipitator Dust Slurry Pots	75	yes	tanks	slurry	Precipitator dust was slurried in closed steel 800-gallon-to 1040-gallon capacity tanks (pots) with secondary containment; two pots at each of 4 furnaces. Operated from the 1950s. Secondary containment upgrades of slurry lines to V-3700 and V-3600 completed in 1999 pursuant to RCRA Consent Decree (1999). These pots operated as RCRA 90-day GAAs under the RCRA tank standards (265 Subpart J). The pots slurried precipitator dust as an element of the NOSAP treatment process.	SWMU was not evaluated during the remedial investigation.	Slurry pots were taken out of service and emptied in 2001. The two pots associated with the #1 Furnace were decommissioned and removed in 2001. The remaining 6 slurry pots were decommissioned and removed in January and February 2004.	No releases are recorded.	Closed by waste removal and equipment decontamination; units have been removed.	Prior to secondary containment upgrade in 1999, potential migration of releases would have been impeded by the concrete floor of the Furnace Building. Units have been physically removed. Not potential source.	
Medusa Scrubber Blowdown Collection Tank	76	no	Tank	liquid	A vertical cylindrical tank with a dish-shaped bottom. Approximately 5 feet diameter and 6 feet high. Secondary containment provided by the Furnace Building washdown sumps and collection system installed in 1991. The tank was removed in 1999 as part of POG upgrades.	SWMU was not evaluated during the remedial investigation.	Tank removed in 1999 as part of POG upgrades pursuant to the RCRA Consent Decree. Releases would have been drained over the concrete floor of Furnace Building to the Furnace Building washdown sumps.	No releases are recorded.	Closed by waste removal and equipment decontamination; unit has been removed.	Not a potential source. Between 1991 and cessation of operation, potential release migration would have been impeded by the concrete floor of the Furnace Building. Containment control prior to 1991 is unknown.	
Phosphorus Loading Dock, Andersen Scrubber Blowdown Sump, and North Solid Tank	77	no	operations area with tanks, sumps, miscellaneous equipment	liquid, slurry	Anderson Scrubber Blowdown Sump converted from a <90-day GAA to process vessel as part of RCRA Consent Decree (1999) POG upgrades. North Solids tank (operated as a <90-day GAA) was removed in 1999 pursuant to installation of Tank V-3800 under the Consent Decree (1999) POG upgrades. Operations are currently active pending facility decommissioning. N Solid Tank? Above-grade P4 storage tanks are contained within a concrete vault. Overflow from these tanks are directed to a launder that returns the flow to the process. Prior to approximately 1970, product storage tank was a large in-ground covered concrete sump.	Soil samples taken in the phos dock area contained above-representative levels of parameters generally associated with materials handled by the facility to a depth of at least 4.5 feet. The soils were apparently from a fill zone. Native soils were not sampled.	Anderson Scrubber Blowdown Sump converted from a <90-day GAA to process vessel as part of RCRA Consent Decree (1999) POG upgrades. North Solids tank (operated as a <90-day GAA) was removed in 1999 pursuant to installation of Tank V-3800 under the Consent Decree (1999) POG upgrades. Operations are currently active pending facility decommissioning.	Post-EMF RI spills were contained within operations area. These spills would have released P2O5 as fugitive emissions.	Phos Dock remains active to support management of P4 removed from manufacturing process units during facility decommissioning. Decon Building (SWMU 92) replaced maintenance pad. Phos Dock will be decommissioned after management of the residual inventory of P4 in former process manufacturing units is completed.	Potential source due to historical spills of phossy water.	
Washdown Collection Sumps -- Furnace Building Area	78	yes	Sump	liquid, slurry	Seven concrete sumps (flow-through process tanks) and connecting launders in Furnace Building used to collect phossy wastewater generated from furnace washdown. Sumps had pumps to transfer wastewater to Tank V-3600 (installed 1991) in southeast corner of building. If one sump should overflow due to pump problems, wastewater would drain into an adjacent sump. Operators routinely monitored sump operation. Operated as RCRA 90-day GAA (tank system); During operation, overtopping would have been contained by the concrete floor of the Furnace Building. Secondary containment was upgraded in 1999 per POG Upgrades under the RCRA Consent Decree. Closed in 2001 by waste removal and equipment decontamination.	SWMU was not evaluated during the remedial investigation.	Secondary containment was upgraded in 1999 per POG Upgrades under the RCRA Consent Decree. Closed in 2001 by waste removal and equipment decontamination.	Prior to POG Upgrades, phossy water spills from various sumps drained to Slag Pit (SWMU 102).	Closed in 2001 by waste removal and equipment decontamination.	Potential source due to historical spills of phossy water.	

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Northeast Collection Sump - Furnace Building Area	79	yes	Sump	liquid, slurry	6X6X7-foot stainless steel-lined sump used for collection of phossy wastewater, which is pumped to Tank V-3600. Located in northeast area of the Furnace Building area. Operational since 1979. Wastewater is pumped to the phosphorus loading dock for further use in the process. If the sump were to overflow, wastewater would flow to one of the furnace washdown sumps. Operated as a RCRA 90-day GAA (tank system). During operation, overtopping would have been contained by the concrete floor of the Furnace Building. Secondary containment was upgraded in 1999 per POG Upgrades under the RCRA Consent Decree. Closed in 2002 by waste removal and equipment decontamination.	SWMU was not evaluated during the remedial investigation.	Secondary containment was upgraded in 1999 per POG Upgrades under the RCRA Consent Decree. Closed in 2002 by waste removal and equipment decontamination.	No releases are recorded.	Closed in 2002 by waste removal and equipment decontamination.	Potential source prior to containment system upgrades.	
Southeast Collection Sump -- Furnace Building Area	80	yes	Sump	liquid, slurry	10,000-gallon capacity sump used for collection of nonhazardous storm water runoff and tapping floor washwater from east side of No. 1 Furnace, which is pumped to Tank V-3600. Prior to 1992, used for collection of phossy wastewater. Secondary containment pad and delumper added to SE sump in 1999 as part of POG upgrades per RCRA Consent Decree (1999) Appendix 2. Located in southeast area of the furnace building area. Earliest operation unknown. Sump taken out of service in 2001. Residual wastes removed and unit decontaminated in 2002.	SWMU was not evaluated during the remedial investigation.	Sump taken out of service in 2001. Residual wastes removed and unit decontaminated in 2002.	Several cases of overflow onto adjacent roadway due to pump malfunction. Potential release migration into underlying soils from overtopping would have been impeded by the concrete floor of the Furnace Building.	RCRA 90-day GAA closed in 2001 by waste removal and equipment decontamination. It operated under the RCRA tank standards (265 Subpart J).	Potential source.	
Furnace Washdown Collection Tank (V-3600)	81	yes	Tank system	liquid, slurry	Stainless steel tank (V 3600) with 46,000-gallon capacity in southeast corner of the Furnace Building area. Replaced the Slag Pit Wastewater Collection Sump (SWMU 5) in 1991. Operated as RCRA 90-day GAA (tank system). Managed D001, D003, and D006 wastes. Tank was equipped with level controls, alarms, and secondary containment. Per Consent Decree, Attachment 2 (1999) POG secondary containment and piping upgrades implemented in 1999. Prior to upgrades, overtopping would have been contained by the concrete floor of the Furnace Building. Unit taken out of service in 2001. Residual wastes removed and unit decontaminated in 2002.	SWMU was not evaluated during the remedial investigation.	Unit closed in 2002 by waste removal and equipment decontamination.	Several post-RI spills of phossy water that drained across paved roadway to storm drain that discharged to Railroad Swale (RU 22c) or to the Slag Pit (SWMU 102).	Closed in 2002 by waste removal and equipment decontamination.	Potential source due to historic spills of phossy water.	
Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #1 footprint]	82 (partial)	yes	Tank system appurtenance	liquid, slurry	Piping used to transport precipitator slurry and phossy water within the furnace building is above grade. Prior to 1998, underground piping was used to transport phossy water from the Phos Dock to the ponds, and to transport phossy water and precipitator slurry from Furnace Building to the ponds. The piping system from the Furnace Building and Phos Dock was upgraded in 1998 per RCRA Consent Decree. Several lines were eliminated.	The portion of the piping system within RU 1 was not evaluated during the remedial investigation.	The piping system from the Furnace Building and Phos Dock was upgraded in 1998 per RCRA Consent Decree. Several lines were eliminated. Use of East Launder at the Phos Dock was ceased.	One spill is recorded for the segment of the pipeline system within RU1. An estimated 25 gallons or less of phossy water spilled into the Slag Pit (SWMU 102) due to a plug between the #2 Washdown Collection Sump (SWMU 78) and Tank V-3600 (SWMU 81).	Underground pipeline segments have not been used since 1998. These underground lines are in their original locations and have been plugged. Above-ground segments will be removed, decontaminated and sold for metal recycling.	Pre-upgrade releases are undocumented. However, pre-upgrade P4 release to soil from East Launder (and potentially other launders) is suspected.	
V-3700 Tank and Associated Piping	86	yes	Tank system	liquid, slurry	7,000-gallon stainless steel tank in southwest corner of the Furnace Building. Operated as RCRA 90-day GAA (tank system). Managed D003 and D006 wastes. Tank was equipped with level controls, alarms, and secondary containment pursuant to 40 CFR 265 Subpart J standards. Used as part of NOSAP process to treat precipitator slurry pursuant to RCRA Pond Management Plan. Secondary containment was upgraded in 1999 under the RCRA Consent Decree. Unit taken out of service in 2001. Residual wastes removed and unit decontaminated in 2001.	SWMU was constructed and placed into service after the remedial investigation.	V-3700 was placed into service after the remedial investigation and was used as part of the NOSAP system to treat precipitator slurry with lime prior to discharge of the slurry to RCRA Pond 8E (SWMU 11) or Pond 17 (SWMU 87). The unit was closed in 2001 by waste removal and equipment decontamination.	No releases are recorded.	Closed in 2001 by waste removal and equipment decontamination.	Not a potential source.	

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
V-3800 Tank and Associated Piping	90	yes	Tank system	liquid, slurry	RCRA 90-day generator accumulation area at the Phos Dock. Installed in 1999 as replacement for North Solids Tank and Anderson Scrubber Blowdown Sump (SWMU # 77) under Consent Decree POG upgrades. Tank was equipped with level controls, alarms, and secondary containment pursuant to 40 CFR 265 Subpart J standards. Tank was emptied in 2001 by waste removal. The tank system was decommissioned and physically removed in November 2003.	SWMU was constructed and placed into service after the remedial investigation.	Tank was emptied in 2001 by waste removal. The tank system was decommissioned and physically removed in November 2003.	No releases are recorded.	The tank system was emptied and hydraulically isolated in 2001. The tank was decommissioned by removal of residual waste and equipment decontamination and physically removed in November 2003.	Not a potential source.	
NOSAP Intercept Tank (Tank T-8010)	91	yes	Tank system	liquid, slurry	5,000-gallon stainless steel tank installed in 2000 to treat off-spec NOSAP slurry from Tank V-3700 to NOSAP standards. Operated as RCRA 90-day GAA (tank system). Tank was equipped with level controls, alarms, and secondary containment pursuant to 40 CFR 264 Subpart J standards. Unit taken out of service in 2001. Residual wastes removed and unit decontaminated in 2001.	SWMU was constructed and placed into service after the remedial investigation.	Tank T-8010 was placed into service after the remedial investigation and was used as part of the NOSAP system to treat precipitator slurry with lime prior to discharge of the slurry to RCRA Pond 17 (SWMU 87). The unit was closed in 2001 by waste removal and equipment decontamination.	No releases are recorded.	Closed in 2001 by waste removal and equipment decontamination.	Not a potential source.	
#3 P4 Sump	104	no	product sump and surrounding soil	liquid P4 in sump and solid P4 in soil	Sump accumulated elemental phosphorus product stream from the #3 Furnace condenser prior to refinement at the Phos Dock. A stainless steel tank was installed within the sump in August 1999 after excavation beneath the floor of the Furnace Building revealed the presence of P4 in soil. Each furnace has a similar in ground, brick-lined, concrete product sump.	SWMU was not identified as a potential source in the conceptual site model or evaluated during the remedial investigation.	P4 was encountered in soil adjacent to the sump during excavation in 2000 related to installation of the Slag Ladling System. Stainless steel tank installed within unemptied sump to store P4 from # 3 Furnace. Soil outside of sump containing P4 was removed to the extent feasible.	P4 was encountered in soil adjacent to the sump during excavation in 2000 related to installation of the Slag Ladling System. Release notifications were made to the NRC.	Steel tank within the #3 Product sump was emptied and decontaminated in 2002. Empty steel tank remains in place.	The release from the #3 P4 sump impacted subsurface soil. The #1 furnace P4 sump was emptied and decommissioned in 2001, although the concrete foundation remains. The #2 and #3 tanks that replaced the use of the old P4 sumps and the #4 P4 sumps were emptied and decommissioned in 2003. No releases from the #1, #2, and #4 furnace P4 sumps have been documented. However, prior releases from the #1, #2, and #4 furnace P4 sumps to underlying soils are suspected, given the similarity in the design of these sumps to the #3 furnace P4 sump.	
Road segments within RU 1	38	no	na	na	Most of the surface of RU 1 is paved with asphalt. The subgrade of the paved area is probably slag. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Several post-RI phossy water spills within Furnace Building drained over paved roads into a stormdrain, from which the spill discharged to the Railroad Swale (SWMU 18). Several other spills drained over a small unpaved road segment east of the Furnace Building into the Slag Pit (SWMU 102). Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Paved areas are in service to support facility decommissioning.	Potential source: use of slag for road subgrade.	

Remediation Unit #2: Slag Pit

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-EMF RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Slag Pit Wastewater Collection Sump	5	yes	impoundment	liquid	RCRA Interim Status Closure Subpart K Surface Impoundment. Pit cooling water and furnace washdown wastewater was historically drained to the unlined Slag Pit collection sump, which is about 10 feet by 10 feet in southeast corner of the slag pit. Replaced in 1991 by furnace wastewater collection tank. Closure Plan submitted. A temporary cap was placed in November 1999, pursuant to RCRA Consent Decree (1999), consisting of a liner and cover material. Placement of final cover pending EPA approval of Closure Plan.	Groundwater quality monitoring wells downgradient of the slag pit sump sampled during the RI indicated the presence of site-related constituents.	The slag pit sump is subject to ongoing groundwater assessment monitoring under FMC's RCRA Interim Status program. Elemental phosphorus was detected at parts-per-trillion levels in one of the downgradient wells. Groundwater quality assessment reports are submitted to EPA pursuant to 40 C.F.R. Part 265 Subpart F.	A temporary cap was placed in November 1999, pursuant to RCRA Consent Decree (1999), consisting of a liner and cover material. Placement of final cover pending EPA approval of Closure Plan. Closure Plan submitted September 2001. Prior to placement of the temporary cap, the sump received stormwater runoff and runoff from occasional spills of phossy water in the Furnace Building.	Temporary cap in place (11/99), pursuant to RCRA Consent Decree (1999), consisting of a liner and cover material. Closure Plan submitted September 2001. FMC plans to amend the RCRA Closure Plan so that the final cover of the Slag Pit sump is consistent with final grading plan for Slag Pit.	Potential source: historic infiltration of constituents present in phossy water to the soil column and groundwater.	
Former Slag Pit (prior to slag ladling)	102	no	temporary waste pile	molten slag and liquid (phossy water)	Molten slag from furnace tapping cooled within the pit. After sufficient cooling, the slag was removed and transported to the Slag Pile. Slag cooling was facilitated with a water spray. Historically, furnace building floor wash water and uncontained phossy water spills within the furnace building were directed to the slag pit. Discharge of furnace building floor wash water to the slag pit was discontinued with the installation of Tank V-3600 (SWMU 81) in 1991. Discharge of molten slag to the slag pit ended in 1999/2000 upon installation of the slag ladling system to collect slag directly from furnace tapping. 12,000 yd3 of material were removed from the central part of the northern edge of the slag pit to a maximum depth of approx. 20 feet in 1999/2000 to facilitate installation of the slag ladling system associated with the #2 and #3 furnaces. The Slag Pit Wastewater Collection Sump (SWMU 5) was located in the southeastern corner of the slag pit (see above).	Slag was characterized during the RI (samples were collected at the Slag Pile, SWMU 42). Slag Pit emissions were characterized during RI; emission profile included in the atmospheric dispersion modeling study. Groundwater monitoring during the RI identified elevated groundwater temperatures in monitoring wells downgradient of the slag pit. The source of the elevated temperatures was attributed to the heated soils beneath the slag pit.	Elemental phosphorus was detected at parts-per-trillion levels in a monitoring well downgradient of the slag pit, under FMC's RCRA Interim Status assessment monitoring program for the Slag Pit Wastewater Collection Sump.	Two documented spills of phossy water (4/30/96 and 7/17/97) within the furnace building drained into the slag pit. An estimated 500 gallons of phossy water spilled in each incident.	The area is used to store segments of the former phossy water pipeline pending removal of P4 product. The segments are sealed to prevent potential release of P4.	Residual slag is present within the pit. P4 may be present in the subsurface due to historic discharge of phossy water.	
Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #2 footprint]	82 (partial)	yes	Tank system appurtenance	liquid, slurry	Former underground pipelines used to transport phossy water to the ponds are present along the eastern and southern edge of the slag pit. Use of these underground pipelines was discontinued when a new above-grade pipeline system was installed in 1998.	The portion of the former piping system within RU #2 was not evaluated during the remedial investigation.	No information to report	The above-grade pipeline system was designed and constructed to meet RCRA standards and inspection requirements. No releases from the above-grade pipeline system are documented.	The above-grade pipeline system was emptied in 2001 and is being decommissioned and removed.	Potential source: historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	
Road segments within RU 2	38	no	road	na	The slag haul road within the slag pit is unpaved slag; fugitive emissions were controlled with dust suppressants. There is a paved road along the east, south, and west perimeters of the slag pit. The subgrade of the paved road is probably slag. Fugitive emissions from this paved road were controlled through periodic sweeping and watering.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	

Remediation Unit #3: Receiving, Stores, Paint Shop and P4 Decon

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Boiler Fuel Tank and Pipeline Area	66	no	tank	liquid	Boiler fuel tank and associated piping contained fuel oil; 20,000-gallon capacity. Removed in 1993. No soil contamination detected in samples collected during closure. (see Hydrometrics report)	SWMU was not evaluated during the remedial investigation.	Removed in 1993. Area paved.	None	Paved area - used for equipment storage	None. No soil contamination detected in samples collected during closure.	
Former Satellite Storage Area for Waste Paint Solvents	72	yes	container storage area	liquid	RCRA Satellite Accumulation Area contained one 55-gallon drum used for collecting waste paint solvent from maintenance shop. Used until September 1991. Once a drum was filled, it was moved to the RCRA Drum Storage Unit (SWMU #1).	SWMU was not evaluated during the remedial investigation.	Unit was not in use during or after the EMF RI.	No releases are recorded.	Unit does not exist.	Not a potential source	
P4 Maintenance Cleaning Facility (Decon Building)	92	yes	Containment building	solid, liquid	Unit used to decontaminate and prepare equipment for repairs, recycle, or discard. Unit designed/operated as a RCRA 90-Day GAA (Containment Building Standards) and will be closed by waste removal and equipment decontamination. Approx. 800 sq. ft facility with complete secondary containment (meets 40 C.F.R. Part 265 Subpart DD standards, built in 1999). P4 from this unit has been recovered at the Phos Dock.	SWMU was constructed and placed into service after the remedial investigation.	Unit is operated and will be closed by waste removal and equipment decontamination under RCRA standards.	No releases are recorded.	Unit is in daily service to support facility decommissioning.	Not a potential source. Unit is operated and will be closed by waste removal and equipment decontamination under RCRA standards.	
Former Paint Shop (aka Carpenter Shop or Lube Shop)	na	no	building	liquid	The paint shop was used to make small signs that were placed at points around the manufacturing facility. The signs were painted using typical consumer-type spray cans. The structure is presently used to store waste lubricants (greases and oils) pending off-site transfer.	Building was not evaluated during the remedial investigation.	Facility continued to be used to make signs. The structure is now used to store waste lubricants in 55-gallon drums or in smaller containers.	No releases are recorded.	The structure is now used to store waste lubricants in closed 55-gallon drums or in smaller containers. The drums are filled at the site of removal of the lubricants and not within the Paint Shop.	Not a potential source	
Former Fire Extinguisher Maintenance Shed	na	no	building	solid	Small shed (approximately 36 ft2) with paved floor used to refill fire extinguishers with fire retardant. Operation discontinued. Fire extinguisher maintenance is now performed by an outside vendor.	Shed was not evaluated during the remedial investigation.	Continued in operation until plant shutdown.	No releases are recorded.	Inactive. Fire suppression powder used to fill extinguishers remains in storage within building pending facility decommissioning.	Not a potential source	
Laydown Area for Decon Building	na	no	paved area	solid	Outdoor paved area (approximately 6,400 ft2) adjacent to the Decon Building (SWMU 92) used to store equipment that has been decontaminated, or is to be decontaminated. Equipment to be decontaminated is sealed to prevent release.	Area was placed into service after the remedial investigation.	Area was placed into service after the remedial investigation for the purposes described earlier.	No releases are recorded.	Unit is in service to support facility decommissioning.	Not a potential source	
Stormwater Runoff Drainage Network (portions)	na	no	underground storm drain	liquid	Portion of the facility stormwater runoff drainage system. Portion within RU 3 discharged stormwater runoff to the Railroad Swale (SWMU 18).	The RI found that the Railroad Swale received phossy water resulting from spills at the Phos Dock and Furnace Building area via the portion of the stormwater runoff drainage network north of the Phos Dock/Furnace Building area.	Prior to POG upgrades in 1999, spills could drain to the north across the paved roadway to a storm drain that discharges to the Railroad Swale (RU 22c). POG included process upgrades that eliminated phossy water discharges.	See SWMU 54 in RU 1	The stormwater runoff drainage system is in use pending design and construction of a revised site-wide stormwater runoff drainage system.	Potential source: P4 could be present in soils surrounding leaks in the drain piping, although no breaks or leaks in the system are documented.	
Road segments within RU 3	38	no	paved area	na	Most of the surface of RU 3 is paved with asphalt. The subgrade of the paved area is probably slag. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	See SWMU 54 in RU 2	Paved areas are in service to support facility decommissioning.	Potential source: use of slag for road subgrade.	

Remediation Unit #4: Office Buildings and Training Center

Former Working Area Description						Impact Assessment Summary				
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**
Drum Storage Unit	1	yes	Container storage area	liquid	Former Subpart I Unit converted to <90-Day Generator Accumulation Area subject to 40 C.F.R. 262.34. Established via RCRA Part A submittal in March 1990; storage of drummed wastes including degreasing, laboratory, and paint solvents. Closed in 2003 by waste removal and equipment decontamination, in accordance with Closure Plan.	SWMU was not evaluated during the remedial investigation.	Drum Storage Unit was closed by waste removal and equipment decontamination in 2003 in accordance with RCRA interim status standards. Analysis of soil samples collected beneath footprint of unit confirm that closure meets "clean closure" criteria. Unit no longer exists.	No documented releases.	Unit does not exist.	Not a potential source
Chemical Lab Drain Pit	39	no	other	liquid	see description for SWMU 39 in RU 5	see description for SWMU 39 in RU 5	see description for SWMU 39 in RU 5	see description for SWMU 39 in RU 5	see description for SWMU 39 in RU 5	see description for SWMU 39 in RU 5
Septic tank area	40	no	septic tanks and drain fields	slurry, liquid	Two large drainfields service administration building and change house; change house connected to Pocatello POTW in 1990. Administrative Building connected to Pocatello POTW in 1993. Seven drainfields served main plant.	The septic drainfield area had trace metals, anions (fluoride and total phosphorus), gross alpha, and gross beta in the surficial topsoils and near-surface soil above representative levels. With a few exceptions, the concentrations of these parameters do not persist with depth. The effect of EMF-related activities has been minimal in the area.	As of April 1, 1995, all septic wastes were routed to the Pocatello sewage treatment plant (POTW).	No documented releases.	As of April 1, 1995, all septic wastes were routed to the Pocatello sewage treatment plant (STP). The septic tanks have been emptied and removed, and the areas in which the tanks had been installed have been backfilled, in accordance with Idaho Dept. of Health standards.	Not a potential source
Drum Storage Area at Training Center	99	yes	Container storage area	solid, slurry, liquid	A <90-day hazardous waste generator accumulation container storage area within the former enclosed ambulance bay, designed and operated in accordance with 40 C.F.R. §262.34. Unit stores high phosphorus content wastes from plant decommissioning work pending off-site transfer. Operation began May 10, 2002. Unit is used to manage wastes generated during facility decommissioning.	SWMU was constructed and placed into service after the remedial investigation.	Operation began May 2002. Enclosed unit operated as <90-day hazardous waste generator accumulation container storage area.	No documented releases.	Unit is operated and will be closed by waste removal and equipment decontamination pursuant to RCRA standards.	Not a potential source
Railroad Spurs	68	no	railcars	railcars (tanker) containing liquid, solids	First constructed in 1949; no records of significant spills along tracks in the plant area. Slag was used as construction fill or ballast. Rail spurs used to store railcars potentially containing elemental phosphorus, RCRA pond closure water, and other materials managed during facility decommissioning and demolition.	Rail spurs within RU 4 were not evaluated during the remedial investigation.	No information to report for railspurs within RU 4.	No documented releases, but historic phossy water spills could pool in the area between the furnace building and the Phos Dock.	Active to support shipment of residual P4 product removed from manufacturing process units. Might also be used to support shipment of recyclable metals. Rail spurs are significant assets for future redevelopment and are not anticipated to be removed.	Potential source: byproduct (slag) used as fill.
Road segments within RU 4	38	no	na	na	Roads and parking lots within RU 4 are paved with asphalt. The subgrade of the paved area is probably slag.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Paved areas are in service to support facility decommissioning.	Potential source: use of slag for road subgrade.

Remediation Unit #5: Laboratory and Old Drainfield

Former Working Area Description						Impact Assessment Summary				
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**
Chemical Lab Drain Pit	39	no	other	liquid	An area now beneath the main parking lot that was formerly used to dispose of organic and inorganic chemical wastes from laboratory from 1953 through 1989. Records of wastes disposed unavailable but are believed to be predominantly organic reagents (xylene, toluene, benzene) used in analyses of P4. Between 1989 and 1993, only rinsate water from laboratory glassware was discharged to the pit. Laboratory sink wastes were routed to the Pocatello POTW in 1993. Not an engineered structure; lined with slag. Pit has been backfilled with grout.	Surficial samples at the two locations chosen to investigate the chemical laboratory seepage pit showed evidence of facility effects with reference to inorganic parameters. However, this soil horizon is not sufficiently deep to reflect effects of the drain pit. The deeper horizons in one borehole showed no evidence of EMF effects, and those in the other borehole indicated slight downward migration of phosphate and zinc to a depth of 30 feet. Deeper soils did not show evidence of EMF effects. Above-representative levels of gross alpha and gross beta were confined to the first sample taken in both boreholes. The level of activity correlated well with the presence of other EMF-related parameters. There was no evidence of vertical migration. Toluene was found at low levels in most soil samples taken in F028B and several samples taken in F029B. Its presence in the subsurface is probably related to site activities. Several volatiles (TCA, xylenes, ethylbenzene) found in low concentrations at depth near the groundwater table may be related to groundwater contamination from a source other than the one investigated here. (See Section 4.4 for discussion of organics in groundwater.) Other semivolatile and volatile organics found in the two boreholes are probably artifacts of the sampling and analysis process. The EMF RI found no significant VOC levels in groundwater samples collected from monitoring wells in the southwest and central portions of the FMC plant area. VOCs were not detected in 149 of 168 samples; VOCs detected between 0.001 - 0.035 mg/l in 19 of 168 samples.	Area was not used for disposal after the EMF RI field investigation period. A closure report for the Chem Lab Drainfield was submitted to EPA on 9/17/02.	None. Area was not used for disposal after the EMF RI field investigation period.	Pit has been backfilled with grout.	Potential source of localized VOCs (hotspot).
Satellite Storage Area for Spent Laboratory Solvents	70	yes	Container storage area	liquid	A 55-gallon drum was used to collect spent laboratory solvents and acids. Since September 1991, spent solvents were placed in a fire-safe container in the lab and transferred to RCRA WMU#1. Drums were provided with secondary containment. The storage area was moved approx. 100 feet west of the west wall of mining lab in September 1998.	Samples of wastes stored at the unit were analyzed during the RI.	Unit continued in service to support analytical laboratory operations.	No documented releases.	Area has been operated under RCRA SAA standards and will be closed by waste removal and equipment decontamination.	Not a potential source
Railroad Spurs	68	no	railcars	railcars (tanker) containing liquid, solids	First constructed in 1949; no records of significant spills along tracks in the plant area. Slag was used as construction fill or ballast. Rail spurs used to store railcars potentially containing elemental phosphorus, RCRA pond closure water, and other materials managed during facility decommissioning and demolition.	Rail spurs within RU 5 were not evaluated during the remedial investigation.	No information to report for railspurs within RU 4.	No documented releases.	Active to support shipment of residual P4 product removed from manufacturing process units. Might also be used to support shipment of recyclable metals. Rail spurs are significant assets for future redevelopment and are not anticipated to be removed.	Potential source: byproduct (slag) used as fill.
Road segments within RU 5	38	no	na	na	Roads and parking lots within RU 4 are paved with asphalt. The subgrade of the paved area is probably slag.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Paved areas are in service to support facility decommissioning.	Potential source: use of slag for road subgrade.

Remediation Unit #6: Former Long Term P4 Storage

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Long-Term Phosphorus Storage Tanks (former)	63	no	tanks	solid, liquid, slurry	Twelve former underground tanks used to store elemental phosphorus. Located south of railroad spur west of the Furnace Building. P4 product was transfer to/from the tanks by railcar. Each tank could store approximately 1M pounds of P4. Eight tanks were removed in 1994 and the remaining four were removed in October 1998.	The investigation at the long-term phosphorus storage area indicates that subsurface soils (samples were collected in September 1992) in some parts of the area have been affected. The extent of the effect is to at least 7 feet. The source of the effect was not discussed in the RI.	Tanks were taken out of service in 1994 after it was determined that they could not be upgraded to comply with UST standards for cathodic protection. After P4 inventory in the tanks was removed as product, the tank shells were removed and recycled as scrap metal. Eight of the tanks were physically removed in 1994; the remaining four tanks were physically removed in 1998.	A disk rupture on the #6 tank in Mat 1992 resulted in a soill of an estimated 5 pounds of P4. A September 1994 spill (10,000 gallons phossy water with estimated 0.1 pounds P4) due to overfilling impacted soils. Spill residuals were removed during tank removal.	The tanks no longer exist. Eight of the tanks were physically removed in 1994; the remaining four tanks were physically removed in 1998.	Residual P4 is not believed to be a present, but confirmational soil samples should be obtained during the SRI.	
Railroad Spurs (portion within RU 6)	68	no	railcars	railcars containing liquid, solids	First constructed in 1949; no records of significant spills along tracks in the plant area. Slag was used as construction fill or ballast.	Rail spurs within RU 6 were not evaluated during the remedial investigation.	Railspurs continued in use to support plant operations.	None documented.	Active to support shipment of residual P4 product removed from manufacturing process units. Rail spurs are significant assets for future redevelopment and are not anticipated to be removed.	The railcar spur at the site where P4 was transferred to/from the former Long Term P4 Storage Tanks (SWMU 63) is a potential source given absence of containment pans. May contain byproduct (slag) used as fill.	
Railcar Loading Overflow Tank	101	yes	tank	liquid	The unit is a <90-day hazardous waste generator accumulation tank designed and operated in accordance with 40 C.F.R. 262.34. The tank began operation on July 2, 2002 to provide spill control during filling railcars with Pond 17 Decant Water. The tank will also be used in support of filling railcars with water removed during closure of other ponds. Unit is a 1,000-gallon capacity HDPE tank.	SWMU was constructed and placed into service after the remedial investigation.	Unit was used to support loading of Pond 17 decant water in 2002. Unit not currently in service.	None documented.	Unit is in placed but not currently in service.	Not a potential source	

Remediation Unit #7: Shale Unloading, Crushing, Stockpiles

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Shale Ore Handling Areas	37	no	other	solid	All areas used to handle shale ore from point of rail unloading, to stockpiling, to crushing, to transporting into briquetting building.	One composite ore sample was taken from the FMC ore piles during the RI and analyzed for inorganic and radiological parameters. Constituents which exceeded soil representative levels are arsenic (14.6 mg/kg), cadmium (77.8 mg/kg), chromium (822 mg/kg), copper (104 mg/kg), fluoride (13,200 mg/kg), nickel (126 mg/kg), total phosphorus (65,900 mg/kg), vanadium (996 mg/kg), and zinc (991 mg/kg). Duplicate samples were analyzed for gross alpha and gross beta. Activities were greater than 200 pCi/g for gross alpha and about 100 pCi/g for gross beta. A further distinguishing characteristic of the ore is its light reddish brown color. Ore-related materials can be found to at least 5 feet in some parts of the phosphate ore handling area. Where native soils were encountered, there was little to no evidence of downward migration of ore-related constituents. Fugitive emissions associated with shale ore handling evaluated in air dispersion modeling study.	Shale ore source mine changed to from Gay Mine to Dry Valley in 1995. Fugitive emission reduction projects for shale ore handling implemented pursuant to SEP projects under RCRA Consent Decree.	No documented releases.	Equipment associated with shale ore handling process area largely removed in 2004.	Potential source of historic fugitive emissions. Residual shale ore remains at area.	
Coke Unloading Building	105	no	other	solid	A building (approx. 80.l feet long, 19.1 feet wide, and 26.8 feet high) in which coke (used as a raw material in elemental phosphorus manufacturing operations) was unloaded from single rail cars placed within the building. Coke was bottom-dropped from cars onto a conveyor belt within the building. Constructed and placed into service in circa 1996. Operation ended in December 2001 with the cessation of elemental phosphorus manufacturing in December 2001. Building and coke handling system are empty. Building overlies former coke unloading area.	SWMU not evaluated in EMF RI.	Analytical data for coke was reported to EPA in FMC's September 17, 2002 response to EPA's July 8, 2002 information request. Coke contained approximately 86.5% fixed carbon, 3.4% volatiles, 2.7% silica, 2.3% water, 1.3% Al_2O_3, 1.2% CaO, 1.2 % S, 0.5% Fe_2O_3, 0.46% MgO, and 0.05% K_2O. Also TCLP analysis of coke from FMC's Kemmerer, WY coke plant. This plant supplied 70% of the coke used by FMC.	No documented releases.	The empty building will be removed.	Potential source	
Railroad Spurs	68	no	railcars	railcars (tanker) containing liquid, solids	First constructed in 1949; no records of significant spills along tracks in the plant area. Slag may have been used as construction fill or ballast. Rail spurs used to store railcars potentially containing elemental phosphorus, RCRA pond closure water, and other materials managed during facility decommissioning and demolition.	Rail spurs within RU 7 were not evaluated during the remedial investigation.	No additional information available.	No releases are recorded.	Active to support shipment of residual P4 product removed from manufacturing process units. Might also be used to support shipment of recyclable metals. Rail spurs are significant assets for future redevelopment and are not anticipated to be removed.	Potential source: byproduct (slag) used as fill.	
Road segments within RU 7	38	no	na	na	Most of the surface of RU 7 is paved with asphalt. The subgrade of the paved area is probably slag. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Paved areas are in service to support facility decommissioning.	Potential source: use of slag for road subgrade.	

Remediation Unit #8: Calciner Area

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Wastewater Treatment Unit	12	yes	other	slurry, liquid	Former Subpart J above-ground tank system that was closed in accordance with an EPA-approved Closure Plan. Equipment decontaminated during August 1999 per approved Closure Plan and certification of closure submitted to EPA. WWT Unit was used at the FMC plant to treat primary and secondary calciner scrubber blowdown and wastewater from the calciner pad sumps (all Bevill-exempt, non-hazardous wastes). The WWT Unit consisted of a reactor tank, secondary containment structures, sump containment area, and sump pump, and associated piping. Previously, rinsewater discharged from the AFM Washing Unit (WMU #13), and Medusa scrubber blowdown from the furnace building, were managed by the WWT Unit.	Unit was not evaluated during the EMF RI.	Equipment decontaminated during August 1999 per approved Closure Plan and certification of closure submitted to EPA. Unit placed back in service to support Bevill-exempt calciner scrubber system wastewater treatment operations until plant shutdown in 2001.	Approximately 54,000 gallons of scrubber blowdown water were spilled on February 2, 1995. Incident reported to EPA. Release to soil was characterized during the RCRA closure; soil samples collected in spill impact area in July 2001 were below soil cleanup criteria (see page 16 of October 2001 WWT Unit Closure Report).	Unit undergoing decommissioning and removal during 2004.	Residual impact to soils from 1995 spill found to be below soil cleanup criteria established in approved RCRA Closure Plan. Not a potential source.	
Three Kiln Scrubber Ponds	35	no	ponds	slurry, liquid	Former unlined ponds used to hold kiln scrubber blowdown. Ponds were excavated in 1966 for construction of Calciner 2. Area is paved.	The area could not be accessed during the EMF RI due to active operations of the calciner system. However, soil samples beneath the former Kiln Scrubber Overflow Pond (SWMU 51 in RU 9) showed that the pond was a source of cadmium, zinc and arsenic to groundwater. These constituents were found above representative levels in soil samples collected from the silt aquitard overlying the uppermost aquifer.	No additional information. Former ponds remained under paving and active calciner system operation.	No additional information.	Former ponds remain under paving and discontinued calciner system operation.	Potential source	
Former Flare Pit for Carbon Monoxide	67	no	flare pit	gas	Flare pit used to combust excess carbon monoxide gas stream not needed to support calciner operation. Gas stream contained P4. Replaced by Excess CO Combustor (SEP #2 under the FMC RCRA Pocatello Consent Decree). Unit removed during construction of Excess Carbon Monoxide Combustor in 2000.	Emissions were evaluated during the EMF RI.	Air emissions and gas stream were further characterized pursuant to SEP #2 of the RCRA Consent Decree. Gas stream characterization used to design Excess CO Combustor and New Horizontal Flare Pit (SWMU 103).	Emissions continued until flare pit was shut down in 1999. Excess CO Combustor constructed on concrete pad installed within footprint of former flare pit during 2000.	Excess CO Combustor is present, but not operational, above footprint of former flare pit.	Not a potential source.	
Stacks and Vents (i.e., calciner system)	41	no	other	gas, liquid, solid	Emissions from the calciners were controlled by a system of primary and secondary scrubbers. Scrubber water was managed at the Wastewater Treatment Unit (SWMU 12) to adjust pH and remove primary solids. pH-adjusted scrubber water was conveyed from the WWT Unit to the Calciner Ponds (see RU 14) for clarification; clarified water was returned to scrubber system. Scrubber water conveyance system was above-grade. Fugitive emissions from calcined nodule handling system were controlled by baghouses. Baghouse dust was pneumatically conveyed to the Dust Silo, from which dusts were transported by vacuum truck to the Baghouse Dust Reclaim Pile (SWMU 69).	Emissions were evaluated during the EMF RI.	FMC facility emissions became subject to regulation under the Federal Implementation Plan for PM10. The FIP required emission reductions and improved process control. These improvements resulted in an approximately 60% reduction in PM10 emissions associated with calciner operations.	Emissions continued until the calciners were shut down in 2001.	Emissions were discontinued upon plant shutdown in 2001.	Not a potential source.	

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
New Horizontal Flare Pit	103	no	other	gas	A flare pit (80 ft diameter by 10 ft depth) used to combust excess carbon monoxide gas stream from furnace operation when it was necessary to bypass the Excess CO Combustor. Unit was placed into service January 2001 and operated through December 2001. The interior base and walls were lined with slag to absorb heat. This slag layer overlies a liner system, designed to RCRA Minimum Technology Standards, to prevent any subsurface contamination. The unit replaced the former Flare Pit for Calciner Carbon Monoxide (SWMU #67), which was removed during construction of the Excess CO Combustor.	SWMU was constructed and placed into service after the remedial investigation.	Flaring became subject to regulation under the Federal Implementation Plan for PM10. The FIP required reporting of all flaring incidents and improved process control.	Flaring events continued until the furnaces were shut down in 2001.	The horizontal flare remains in place, but is not operational	Not a potential source.	
Road segments within RU 8	38	no	na	na	Most of the surface of RU 8 is paved with asphalt. The subgrade of the paved area is probably slag. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	P4 spill during decommissioning of CO line to Excess CO Combustor in 2002 was contained in water basin positioned on road below line.	Paved areas are in service to support facility decommissioning.	Potential source: use of slag for road subgrade.	

Remediation Unit #9: Silica Stockpiles

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Kiln (Scrubber) Overflow Pond (under nodule fines pile)	51	no	pond	slurry, liquid	Former unlined pond. Located under the current silica pile; not an engineered structure; measures about 100 feet by 300 feet by 15 feet.	Two borings were advanced into the subsurface at the former kiln scrubber pond. Boring F054B encountered 10 feet of EMF-affected soils. The predominant above-representative level constituents were cadmium, fluoride, total phosphorus, and zinc. While there was some decrease in constituent concentrations with depth, the zinc and cadmium levels remained elevated. In F130, this same pattern was observed, with cadmium and zinc remaining above-representative levels though diminishing to 50 feet. Concentrations of most of the trace metals and anions were within representative levels by 30 feet. There was little to no evidence of soil effects near the groundwater table. Gross alpha and beta were only detected above representative levels in the surficial ore layer in boring B130. There was no evidence of their migration into the deeper subsurface.	No additional information available.	No documented releases, but historic phossy water spills could pool in the area between the furnace building and the Phos Dock.	Former pond remains under Silica Pile.	Potential source	
Silica Pile	na	no	stockpile	solid	The Silica Stockpile is not a SWMU. Silica is not listed as a hazardous constituent under 40 CFR 261 App. VIII.	Area was not evaluated in the EMF RI.	No additional information available.	100-gallon s of hydraulic fluid spilled in June 1997 onto soil and silica.	The majority of the silica has been used for remedial construction projects or sold for use off the site. The balance is expected to be used or sold.	Not a potential source.	
Nodule Pile	106	no	stockpile	solid	A stockpile for nodules (briquettes) of phosphate ore that have been calcined to remove water and naturally present organic matter. The nodules were withdrawn from the stockpile for feed to the furnaces to produce elemental phosphorus. Operation ended with the cessation of calciner operation on or about November 12, 2001; the remaining 8,900 tons of nodules (a raw material) will be removed upon sale.	Particulate emissions from nodule handling operations were evaluated in the EMF RI.	Particulate emissions from nodule handling operations were reduced pursuant to RCRA Consent Decree SEPs # 8 and 13.	No documented releases.	The remaining nodules will be removed upon sale.	Potential source. Residual nodules remain at area.	
Road segments within RU 9	38	no	na	na	Most of the surface of RU 9 is paved with asphalt. The subgrade of the paved area is probably slag. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Paved areas are in service to support facility decommissioning.	Potential source: use of slag for road subgrade.	

Remediation Unit #10: IWW Pond and Ditch

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Industrial Wastewater Basin	49	no	basin	liquid	Unlined pond for noncontact cooling water (industrial wastewater) from calciners and furnaces; built in 1977; maximum 6 feet deep; has oil absorbent boom; discharge was regulated by NPDES Permit No. ID-000022-1; measures approximately 130 feet by 100 feet by 4.5 feet deep.	There was no evidence of the migration of EMF-related parameters into the subsurface at the IWW ditch, not even for the more mobile cations and anions.	See SWMU 50.	See SWMU 50.	Discharge from the basin was blocked in 2002 with the termination of discharge to the IWW Ditch and termination of the NPDES permit.	The sediments within the basin may contain minor levels of P4 as the result of previous inadvertent discharges of ICW water to the IWW system.	
Industrial Wastewater Ditch	50	no	ditch	liquid	Discharge ditch from cooling water (industrial wastewater) pond to culvert then to Portneuf River; constructed in 1970; about 1, 700 feet long and averages 6 feet wide by 3 feet deep; regulated by NPDES permit. Wastewater discharge to Portneuf River discontinued in August 2002.	A grab sample of IWW ditch water was taken during Phase I and analyzed for inorganics and radiological parameters. The results of these analyses indicated that the ditch water contained a number of constituents above representative groundwater and upstream river water concentrations (Table 4.2.3-3). These constituents included arsenic (1.76 mg/l), cadmium (0.034 mg/l), copper (0.163 mg/l), fluoride (61.6 mg/l), total phosphorus (2,590 mg/l), potassium (7,470 mg/l), selenium (4.2 mg/l), sulfate (8,400 mg/l), and zinc (5.25 mg/l). Gross alpha and gross beta activities were both elevated in the Phase I water sample (155 ± 95.9 pCi/l and 6,890 ± 145 pCi/l). During Phase II, 14 time-composite samples were collected from the ditch water over a 2-week period; the six samples obtained during the three highest periods of flow and the three lowest periods of flow were sent to the laboratory for analyses. The results of these analyses indicate a significantly different water quality than that found in the ditch in Phase I. For the most part, all six water samples had the same water quality as that found in monitoring well 125. Gross alpha activities in the Phase II samples were either not detected (2 pCi/l) or were within the representative groundwater levels. Gross beta activities were also low. However, there was one sampling event in Phase II (July 29, 1993-sample IWG) where radium-228 was detected at 6.5 ± 0.8 pCi/l. FMC conducted an IWW ditch study to investigate the differences in water quality between the Phase I and Phase II IWW ditch water samples. The findings of the study are provided in Appendix L. The study indicates that the time composite samples collected during Phase II are more representative of ditch water quality than the sample collected in Phase I. Samples of IWW ditch sediments contained above-representative levels of a number of constituents related to EMF industrial activities. It appears that the soil matrices contained varying percentages of precipitator dust and ore. There was no evidence of the migration of site-related parameters into the subsurface at the IWW ditch, not even for the more mobile cations and anions.	Ditch was dredged periodically and dredged materials were placed along the banks of the ditch. EPA renewed the NPDES permit in 2000. FMC terminated the IWW discharge to Portneuf River in August 2002 and requested EPA to withdraw the NPDES Permit. The IWW Ditch was subsequently backfilled with silica.	Clarified wastewater was inadvertently discharge to the IWW system in August 1995. The discharge, which contained an estimated 2 pounds of P4, is believed to have reached the Portneuf River. The release was reported to the NRC and SERC.	The IWW Ditch has been backfilled to grade with silica.	Potential source: the sediments below the silica backfill in the former ditch may contain minor levels of P4 as the result of previous inadvertent discharges of ICW water to the IWW system. Sediments formerly dredged and stockpiled along the berm of the ditch may also be a potential source.	

Remediation Unit #11: Equipment Area South of Calciners

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Road segments within RU 11	38	no	na	na	Roads within RU 11 are predominantly unpaved slag. Fugitive emissions from the road is controlled through the use of dust suppressants.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	

Remediation Unit #12: Former RP&S and Mobile Maintenance Shop

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Transformer Salvage Area	57	no	other	solid, liquid	Area located near inactive Pond 1S, used to store used transformers containing PCBs. Transformers were removed offsite. The area is now graded.	Soils in the vicinity of the transformer storage area have been affected by site activities. For at least the first 6 to 10 feet, native soils appear to have been mechanically mixed with precipitator dust or phossy solids either during grading or placement. There is no evidence of trace metals migration. Phosphorus and potassium, however, do appear to have moved downward into the subsurface. **No PCBs were detected in the soil samples.** Gross alpha and gross beta activities were above representative levels in several samples. However, their presence and mobility appeared to be similar to those of the trace metals.	A member of the public reported to EPA that two large transformers may be buried in the vicinity of the Transformer Salvage Area. FMC has noted that this is unlikely, given the scrap value of large transformers. FMC agreed to investigate this issue as part of the supplemental RI process.	No documented releases.	Transformers has been removed offsite. The area is now graded.	Potential source	
PCB Storage Shed (removed 2000)	58	no	small building	container storage area	Former PCB storage shed, concrete structure used to store drums of transformer oil containing greater than 50 parts per million PCBs. No PCBs onsite. Building demolished prior to construction of LDR Treatment System in 2001.	Fill was found in all three boreholes. It ranged from 7.5 feet to 17 feet deep. All three fills sampled at this location showed some facility effects. Native soils sampled beneath the fills indicated that little to no migration of trace metals, radionuclides, or other inorganics had occurred. Low levels of PCBs were detected in three of 15 soil samples taken in the subsurface at the former PCB storage shed. The three affected samples were in fill. There was no evidence of movement into the native soils below the fill.	The PCB storage shed was removed in 2000 prior to construction of the LDR Treatment System.	No documented releases.	The PCB storage shed was removed in 2000 during construction of LDR Treatment System.	Potential source: use of byproduct as fill.	
Satellite Storage Areas for Waste Degreasing Solvents	71	yes	Container storage area	liquid	There are 2 active satellite stations (55-gallon drums) for accumulation of waste degreasing solvents: (1) maintenance shop (crews 5, 6, 6M, and 7), and (2) the maintenance shop in the old kiln building. The lubrication shop (crew 93) satellite station was closed on May 26, 1993. The mobile maintenance shop satellite station was closed on June 1, 1993. The mining lab satellite station drums were transferred to SWMU #1 when the spent laboratory solvent satellite station drum was transferred there. There are no records of spills or releases from these stations.	SWMU was not evaluated during the remedial investigation.	Units discontinued operation during the EMF RI field sampling period.	No reported releases	RCRA Satellite Accumulation Areas were closed in 1993 by waste removal and equipment decontamination.	Not a potential source.	
Phossy Waste Pipeline Cleanout Areas and Intervals	64 (partial)	no	other	liquid, slurry	Phosphorus-containing water pumped from furnace washdown collection tank and phosphorus-loading dock via pipelines to Ponds 11S, 12S, 13S, 14S; cleanout taps located along pipeline routes.	Ten locations along the pipelines leading from the plant to the surface impoundments that carry phossy water/solids and precipitator slurry were sampled to investigate the presence of releases from these two potential sources. Two locations (borings F077B and F079B) were found to have evidence of releases associated with pipeline operations. The vertical extent of the impact was not determined during Phase I or Phase II. However, neither location was sampled at a substantial depth (greater than 10 feet) into the naturally occurring soils. Effects related to other site activities, such as mechanical placement of fill, were evident in most of the locations sampled. The depth of visually recognizable fill, which generally contained slag and other EMF-related materials, varied considerably (3 to 25 feet) across the locations sampled. For the most part, when native subsurface soils were sampled, EMF-related parameters did not appear to have migrated into them from the overlying fill.	P4 encountered during excavation of soils for construction of LDR Treatment System in 2000 (an uncompleted facility within the footprint of RU 12). P4 was attributed to an undocumented historical leak from an abandoned underground phossy water or precipitator slurry pipeline or pipeline cleanout area.	No additional documented releases.	The underground segments of the former pipeline remain in place.	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	
Precipitator Slurry Pipeline Cleanout Areas and Intervals	65 (partial)	no	other	liquid, slurry	Precipitator slurry pumped from Furnace Building via pipelines to Pond 8E; cleanout taps located along pipeline routes.			No additional reported releases.	The underground segments of the former pipeline remain in place.	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	
Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #12 footprint]	82 (partial)	yes	Tank system appurtenance	liquid, slurry	Phossy wastewater and precipitator slurry waste pumped from points of generation at Furnace Building area and Phosphorus loading Dock to various WMUs via piping system. Clean-out taps located in various locations where pipelines bend or change direction. Earliest operation unknown. Piping upgraded to welded joints and located above-grade in December 1997.	The portion of the piping system within RU 12 was not evaluated during the remedial investigation.		An estimated 150 gallons of non-clarified phossy water (containing an estimated 4.5 pounds of P4) spilled from the line from the Phos Dock to the Phase IV Ponds in June 1996. The incident was reported to the NRC and SERC.	The above-grade pipeline system was emptied in 2001 and is being decommissioned and removed.	The above-grade portion of the pipeline system is not a potential source. Historical releases from underground segments of the former pipeline system, in addition to the June 1996 incident, while undocumented, are suspected, making the underground segments a potential source.	

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
High-Pressure Steam Cleaning Station	83	no	na	na	Station located west of the mobile equipment shop. Small metal shed on concrete pad houses only cleaning equipment. Washing conducted in open outside area adjacent to station. Operated since June 1981. Has never managed hazardous wastes.	SWMU was not evaluated during the remedial investigation.	Unit is not in operation.	No reported releases, but oil and grease may be present from vehicle steam cleaning.	Unit is not in operation.	Sample historic spill footprint to evaluate TPH and diesel fuel constituents under Idaho petroleum hydrocarbon spill cleanup guidelines.	
Used Oil Collection Tank	84	no	tank	liquid	Aboveground tank with concrete containment wall used for collection of used oil. Has never managed hazardous wastes. Oil sold as fuel to area cement kiln operator. Date of operation startup unknown.	SWMU was not evaluated during the remedial investigation.	No additional indformation.	No reported releases.	The tank was emptied and has been removed.	Not a potential source.	
Road segments within RU 12	38	no	na	na	Roads within RU 12 are predominantly unpaved slag. Fugitive emissions from the road is controlled through the use of dust suppressants.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	
Fuel Island	na	no	na	liquid	A fueling station to support operation of on-site heavy equipment. Two underground storage tanks are regulated under the UST program.	The area was not evaluated during the remedial investigation.	No additional information is available.	Three diesel fuel spills(40 gallons, 150 gallons, and 572 gallons) were reported to state and/or federal agencies. Spilled fuel was recovered to be extent feasible; spills appear to have contacted soils.	Fuel station remains in operation to support facility decommissioning activities. USTs will be closed per xxx after completion of facility decommissioning activities.	Residue from diesel spills should be evaluated.	
PCDT System (tanks T-8000; T-8100A; T-8141; T-8201/8202; T-8203; filter press FP-8300; process unit UV-8000)	na	may be operated as a RCRA GAA	tank systems and filter press	Liquid, slurry, solid	System of tanks and a filter press used to treat water removed during clousre of ponds. System constructed in large part using some of the tank systems and secondary containment systems installed for the LDR Treatment System (LDR Treatment System was never placed in operation).	The PCDT system did not exist during the remedial investigation.	In operation to treat water removed during pond closures.	None reported.	In operation to treat water removed during pond closures.	None. System and equipment is designed and operated to present potential releases. System will be closed by waste removal and equipment decontamination in a manner consistent with RCRA tank system standards.	

Remediation Unit #13: Pond 8S Recovery Process and Metal Scrap Preparation Area

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Former 8S Recovery Process	4	yes	miscellaneous unit	slurry, liquid	Closed Subpart Q Treatment Unit that has been decontaminated, dismantled, and removed in accordance with a RCRA Closure Plan submitted to EPA. Established via RCRA Part A submittal. The elemental phosphorus recovery process for Pond 8S sediments was built in 1983 and was located on a concrete pad within a diked area near Pond 8S.	Borings drilled to the west and north of the recovery process encountered fill to at least 9 feet. Analysis of the lower reaches of this fill indicated elevated levels of trace metals, fluoride, total phosphorus, and gross alpha and beta that are associated with precipitator slurry and phossy water solids. These sludges are believed to be associated with former Pond 6S rather than the recovery process operations. The vertical depth of the impact was not determined.	Detailed documentation on closure process submitted to EPA.	Unit no longer exists; no releases documented.	Unit no longer exists.	Underlying fill (present prior to Pond 8S Recovery System operation) is a potential source. Pond 8S Recovery System no longer exists and is not a potential source.	
Phossy Waste Pipeline Cleanout Areas and Intervals	64 (partial)	no	other	liquid, slurry	Phosphorus-containing water pumped from furnace washdown collection tank and phosphorus-loading dock via pipelines to Ponds 11S, 12S, 13S, 14S; cleanout taps located along pipeline routes.	See Remediation Unit 12, SWMU 64 and 65	No further information to report.	No documented releases.	The underground segments of the former pipeline remain in place.	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	
Precipitator Slurry Pipeline Cleanout Areas and Intervals	65 (partial)	no	other	liquid, slurry	Precipitator slurry pumped from Furnace Building via pipelines to Pond 8E; cleanout taps located along pipeline routes.		No further information to report.	No documented releases.	The underground segments of the former pipeline remain in place.	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	
Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #13 footprint]	82 (partial)	yes	Tank system appurtenance	liquid, slurry	Phossy wastewater and precipitator slurry waste pumped from points of generation at Furnace Building area and Phosphorus loading Dock to various WMUs via piping system. Clean-out taps located in various locations where pipelines bend or change direction. Earliest operation unknown. Piping upgraded to welded joints and located above-grade in December 1997.	The portion of the piping system within RU 13 was not evaluated during the remedial investigation.	No information to report for segment of pipeline system within RU 13.	No documented releases.	The above-grade pipeline system was emptied in 2001 and is being decommissioned and removed.	The above-grade portion of the pipeline system is not a potential source. Historical releases from underground segments of the former pipeline system, while undocumented, are suspected, making the underground segments a potential source.	
Road segments within RU 13	38	no	na	na	Roads within RU 13 are predominantly unpaved slag. Fugitive emissions from the road is controlled through the use of dust suppressants.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	
Portable Storage Tanker for Dielectric Fluid	107	no	mobile container	liquid	A 6,500-gallon capacity tanker (mounted on a trailer frame) that was used to store used dielectric fluid oil removed from Furnace Building transformers during overhauls and fluid change out. The tanker was towed to the Furnace Building to be loaded and unloaded and was otherwise positioned southeast of the Furnace Building. The tanker contents were tested for PCBs in 2003; no PCBs were detected. The tanker was emptied and decontaminated in 2003 and cut up for scrap. The oil removed from the tanker was transferred to drums and shipped to an offsite used oil management facility in 2003.	SWMU was not evaluated during the remedial investigation.	The tanker was towed to the Furnace Building to be loaded and unloaded and was otherwise positioned southeast of the Furnace Building. The tanker contents were tested for PCBs in 2003; no PCBs were detected. The tanker was emptied and decontaminated in 2003 and cut up for scrap. The oil removed from the tanker was transferred to drums and shipped to an offsite used oil management facility in 2003.	No documented releases.	The tanker no longer exists. The tanker was emptied and decontaminated in 2003 and cut up for scrap. The oil removed from the tanker was transferred to drums and shipped to an offsite used oil management facility in 2003.	Not a potential source.	
Scrap Metal Stockpile	na	no	stockpile area	solid	Stockpile of decontaminated scrap metal. Metal is periodically removed by scrap metal dealers.	Areas was not evaluated during the remedial investigation.	Contains only decontaminated scrap metal.	No documented releases.	Remains in use to stockpile decontaminated scrap metal during facility decommissioning.	Not a potential source.	

Remediation Unit #14: Calciner Ponds

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Old Ponds 1C, 2C [now termed "Old Calciner Pond" in Remedial Action Plan submitted to IDEQ 12/02]	14	functionally addressed under IDEQ Consent Order	surface impoundment	slurry, liquid	Former unlined settling ponds for calciner scrubber liquor; original ponds operated 1969 to 1987; a dike constructed south of original pond created second pond - relabeled Ponds 1C and 2C; two ponds eventually merged to again form one pond before 1985; no release controls; approximately 600 feet by 625 feet. Old calciner pond sediments excavated for construction of new calciner ponds 1C, 2C, 3C and 4C.	Calciner sediments were found in the bed of the former pond. By the 10-foot level, most of the trace metals were within representative levels. The exceptions, which appeared consistently at deeper horizons in all of the calciner areas, were cadmium, nickel, and zinc. Given the general immobility of cadmium, its presence at depth (30 feet) was unexpected. By 40 feet, all EMF-related trace metals with the exception of zinc were within representative levels. However, the more mobile cations (calcium and potassium) and anions (total phosphorus and fluoride) remained above representative levels. Radionuclides, as evidenced by above-representative levels of gross alpha/beta, were only associated with sludge samples and do not appear to be mobile.	Groundwater monitoring continues under FMC's voluntary CERCLA groundwater monitoring program. Groundwater monitoring has been initiated under the IDEQ-approved Remedial Action Plan to evaluate the effectiveness of the remedial action for the calciner ponds.	No additional documented releases beyond that characterized in the EMF RI Report.	Area remains covered beneath Calciner Ponds.	Functionally addressed by the Calciner Pond Remedial Action Plan addressed under the IDEQ Consent Order.	
Calciner Ponds 1C (new), 2C (new), 3C, 4C	15	yes	surface impoundment	slurry, liquid	Settling pond for calciner scrubber slurry; constructed 1987 at site of original calciner ponds; double lined with leachate collection system; Pond 1C measures 341 feet by 335 feet by 19 feet; Pond 2C measures 401 feet by 258 feet by 30 feet; Pond 3C measures 432 feet by 302 feet by 20 feet; Pond 4C measures 432 feet by 302 feet by 20 feet. A 500-foot heavy gauge 10-inch ID HDPE pipeline was used to convey wastewater to calciner ponds from the Wastewater Treatment Unit (SWMU # 12). Remediation Action Plan approved by IDEQ in December 2003 per the IDEQ Consent Order.	In 1987, FMC changed the operation of its calciner unit to enable recycling of the scrubber water. This change in process also changed the composition of the wastewater by concentrating the dissolved solids. Wastewater released from the former, unlined calciner ponds would have had a composition somewhat different than that now found in the double-lined ponds. The available chemical composition (FMC, 1993) of the scrubber water in 1987 before the change was fully implemented indicates that the following constituents were present: fluoride (148 to 964 mg/l), chloride (149 to 1,175 mg/l), orthophosphate (140 to 4,300 mg/l), sulfate (250 to 1,250 mg/l), and cadmium (656 to 5,268 mg/l). These values are somewhat different from those detected in samples collected from the calciner ponds during the period of the RI.	A description of sampling conducted at the calciner ponds after May 1997, including any sampling from the manholes, and the leak collection, detection, and removal systems, is presented in Section 3 of *Remedial Design Work Plan – Calciner Ponds* . FMC Idaho LLC. Pocatello, Idaho (September 2002). Remedial action at the Calciner Ponds began in 2003 pursuant to a Remedial Action Plan approved by IDEQ. Groundwater monitoring continues under FMC's voluntary CERCLA groundwater monitoring program. Groundwater monitoring has been initiated under the IDEQ-approved Remedial Action Plan to evaluate the effectiveness of the remedial action for the calciner ponds.	No documented releases.	Remedial action at the Calciner Ponds began in 2003 pursuant to a Remedial Action Plan approved by IDEQ. The initial fill and temporary cover were placed at Ponds 1C, 3C, and 4C in 2003. The final cap is expected to be placed over Ponds 1C, 3C, and 4C, as well as Ponds 2C and 5C, in 2005.	Addressed under IDEQ Consent Order.	
						In these more recent samples, the following constituents were detected: fluoride (134 mg/l), chloride (3,750 mg/l), orthophosphate (3,930 mg/l), sulfate (19,800 mg/l), cadmium (0.818 mg/l), arsenic (4 mg/l), total phosphorus (5,340 mg/l), potassium (19,330 mg/l), selenium (2.785 mg/l), vanadium (1.14 mg/l), and zinc (10.13 mg/l). Calciner pond sediments, as shown both in a sample collected from an active pond and from samples of the sludges removed from the ponds for storage to the south of the ponds near borings F050B and F051B, were enriched with a variety of constituents. Of special note for identification and evaluation purposes were cadmium (426 mg/kg), calcium (284,000 mg/kg), chromium (531 mg/kg), fluoride (191,000 mg/kg), total phosphorus (91,000 mg/kg), potassium (79,800 mg/kg), selenium (3.8 mg/kg), sodium (20,300 mg/kg), vanadium (607 mg/kg), and zinc (6,000 mg/kg) in the sediment sample from an active calciner pond. In the samples of the calciner sludges, selenium values ranged from 0.94 to 47.5 mg/kg.					
						The selenium concentration in the pond sediment sample was less than the levels of selenium present in calciner sediment found in the calciner sediment storage areas. Calciner sludges have a reddish gray to reddish brown color, depending upon the amount of weathering that has occurred. Gross alpha was detected at 225 ± 33.6 pCi/g and gross beta at 111 ± 10.88 pCi/g in the active pond sediment sample. The latter value is considerably less than the activity found in the liquid sample. Given the amount of potassium in the sample, the gross beta value reported here is probably understated. Neither lead-210 nor uranium-238 was detected in the sediment sample.					

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Solar Drying Area (Pond 5C) [overlies former Calciner Solids Storage Area A]	85 (overlies site of SWMU 17)	yes	surface impoundment	slurry, liquid	Constructed in 1993 to RCRA MTR specifications. Solids dredged from calciner ponds into this unit for drying prior to transfer to Calciner Solids Storage Area (SWMU # 17). Remedial Action Plan approved by IDEQ in December 2003 per IDEQ Consent Order.	SWMU #85 overlies site of former calciner solids "Storage Area A." Material from this stockpile was moved to the south during construction of SWMU #85, which post-dates the RI sampling period. See Remediation Unit #16 (Calcincer Solids Stockpile)	Groundwater monitoring continues under FMC's voluntary CERCLA groundwater monitoring program. Groundwater monitoring has been initiated will also be performed under the IDEQ Consent Order to evaluate the effectiveness of the remedial action for the calciner ponds.	No documented releases.	Remedial action at the Calciner Ponds began in 2003 pursuant to a Remedial Action Plan approved by IDEQ. The initial fill and temporary cover were placed at Ponds 1C, 3C, and 4C in 2003. The final cap is expected to be placed over Ponds 1C, 3C, and 4C, as well as Ponds 2C and 5C, in 2005.	Addressed under IDEQ Consent Order.	
Calciner Solids Storage Area A [former]	na	functionally addressed under IDEQ Consent Order	stockpile	solids	Excavated fines from original calciner ponds excavated to install new Ponds 1C, 2C, 3C, and 4C in 1987; subsequently relocated during construction of Pond 5C and capped with a soil cover. Approximately 100 feet by 400 feet; no release controls.	Storage Area A: F050B found calciner sludge to 10 feet below grade. Boring B128B found fingerprint constituent impact down to 100 ft below grade.	No additional information available.	No documented releases.	Area remains covered.	Functionally addressed by the Calciner Pond Remedial Action Plan addressed under the IDEQ Consent Order.	
Road segments within RU 14	38	no	na	na	Surface roads throughout site; roads oiled in past with dust suppressants. Roads are predominantly unpaved slag.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue in use to support remediation of the calciner ponds.	Potential source: use of slag for road subgrade.	

Remediation Unit #14: Calciner Ponds

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Old Ponds 1C, 2C [now termed "Old Calciner Pond" in Remedial Action Plan submitted to IDEQ 12/02]	14	functionally addressed under IDEQ Consent Order	surface impoundment	slurry, liquid	Former unlined settling ponds for calciner scrubber liquor; original ponds operated 1969 to 1987; a dike constructed south of original pond created second pond - relabeled Ponds 1C and 2C; two ponds eventually merged to again form one pond before 1985; no release controls; approximately 600 feet by 625 feet. Old calciner pond sediments excavated for construction of new calciner ponds 1C, 2C, 3C and 4C.	Calciner sediments were found in the bed of the former pond. By the 10-foot level, most of the trace metals were within representative levels. The exceptions, which appeared consistently at deeper horizons in all of the calciner areas, were cadmium, nickel, and zinc. Given the general immobility of cadmium, its presence at depth (30 feet) was unexpected. By 40 feet, all EMF-related trace metals with the exception of zinc were within representative levels. However, the more mobile cations (calcium and potassium) and anions (total phosphorus and fluoride) remained above representative levels. Radionuclides, as evidenced by above-representative levels of gross alpha/beta, were only associated with sludge samples and do not appear to be mobile.	Groundwater monitoring continues under FMC's voluntary CERCLA groundwater monitoring program. Groundwater monitoring has been initiated under the IDEQ-approved Remedial Action Plan to evaluate the effectiveness of the remedial action for the calciner ponds.	No additional documented releases beyond that characterized in the EMF RI Report.	Area remains covered beneath Calciner Ponds.	Functionally addressed by the Calciner Pond Remedial Action Plan addressed under the IDEQ Consent Order.	
Calciner Ponds 1C (new), 2C (new), 3C, 4C	15	yes	surface impoundment	slurry, liquid	Settling pond for calciner scrubber slurry; constructed 1987 at site of original calciner ponds; double lined with leachate collection system; Pond 1C measures 341 feet by 335 feet by 19 feet; Pond 2C measures 401 feet by 258 feet by 30 feet; Pond 3C measures 432 feet by 302 feet by 20 feet; Pond 4C measures 432 feet by 302 feet by 20 feet. A 500-foot heavy gauge 10-inch ID HDPE pipeline was used to convey wastewater to calciner ponds from the Wastewater Treatment Unit (SWMU # 12). Remediation Action Plan approved by IDEQ in December 2003 per the IDEQ Consent Order.	In 1987, FMC changed the operation of its calciner unit to enable recycling of the scrubber water. This change in process also changed the composition of the wastewater by concentrating the dissolved solids. Wastewater released from the former, unlined calciner ponds would have had a composition somewhat different than that now found in the double-lined ponds. The available chemical composition (FMC, 1993) of the scrubber water in 1987 before the change was fully implemented indicates that the following constituents were present: fluoride (148 to 964 mg/l), chloride (149 to 1,175 mg/l), orthophosphate (140 to 4,300 mg/l), sulfate (250 to 1,250 mg/l), and cadmium (656 to 5,268 mg/l). These values are somewhat different from those detected in samples collected from the calciner ponds during the period of the RI.	A description of sampling conducted at the calciner ponds after May 1997, including any sampling from the manholes, and the leak collection, detection, and removal systems, is presented in Section 3 of *Remedial Design Work Plan – Calciner Ponds* . FMC Idaho LLC. Pocatello, Idaho (September 2002). Remedial action at the Calciner Ponds began in 2003 pursuant to a Remedial Action Plan approved by IDEQ. Groundwater monitoring continues under FMC's voluntary CERCLA groundwater monitoring program. Groundwater monitoring has been initiated under the IDEQ-approved Remedial Action Plan to evaluate the effectiveness of the remedial action for the calciner ponds.	No documented releases.	Remedial action at the Calciner Ponds began in 2003 pursuant to a Remedial Action Plan approved by IDEQ. The initial fill and temporary cover were placed at Ponds 1C, 3C, and 4C in 2003. The final cap is expected to be placed over Ponds 1C, 3C, and 4C, as well as Ponds 2C and 5C, in 2005.	Addressed under IDEQ Consent Order.	
						In these more recent samples, the following constituents were detected: fluoride (134 mg/l), chloride (3,750 mg/l), orthophosphate (3,930 mg/l), sulfate (19,800 mg/l), cadmium (0.818 mg/l), arsenic (4 mg/l), total phosphorus (5,340 mg/l), potassium (19,330 mg/l), selenium (2.785 mg/l), vanadium (1.14 mg/l), and zinc (10.13 mg/l). Calciner pond sediments, as shown both in a sample collected from an active pond and from samples of the sludges removed from the ponds for storage to the south of the ponds near borings F050B and F051B, were enriched with a variety of constituents. Of special note for identification and evaluation purposes were cadmium (426 mg/kg), calcium (284,000 mg/kg), chromium (531 mg/kg), fluoride (191,000 mg/kg), total phosphorus (91,000 mg/kg), potassium (79,800 mg/kg), selenium (3.8 mg/kg), sodium (20,300 mg/kg), vanadium (607 mg/kg), and zinc (6,000 mg/kg) in the sediment sample from an active calciner pond. In the samples of the calciner sludges, selenium values ranged from 0.94 to 47.5 mg/kg.					
						The selenium concentration in the pond sediment sample was less than the levels of selenium present in calciner sediment found in the calciner sediment storage areas. Calciner sludges have a reddish gray to reddish brown color, depending upon the amount of weathering that has occurred. Gross alpha was detected at 225 ± 33.6 pCi/g and gross beta at 111 ± 10.88 pCi/g in the active pond sediment sample. The latter value is considerably less than the activity found in the liquid sample. Given the amount of potassium in the sample, the gross beta value reported here is probably understated. Neither lead-210 nor uranium-238 was detected in the sediment sample.					

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Solar Drying Area (Pond 5C) [overlies former Calciner Solids Storage Area A]	85 (overlies site of SWMU 17)	yes	surface impoundment	slurry, liquid	Constructed in 1993 to RCRA MTR specifications. Solids dredged from calciner ponds into this unit for drying prior to transfer to Calciner Solids Storage Area (SWMU # 17). Remedial Action Plan approved by IDEQ in December 2003 per IDEQ Consent Order.	SWMU #85 overlies site of former calciner solids "Storage Area A." Material from this stockpile was moved to the south during construction of SWMU #85, which post-dates the RI sampling period. See Remediation Unit #16 (Calcincer Solids Stockpile)	Groundwater monitoring continues under FMC's voluntary CERCLA groundwater monitoring program. Groundwater monitoring has been initiated will also be performed under the IDEQ Consent Order to evaluate the effectiveness of the remedial action for the calciner ponds.	No documented releases.	Remedial action at the Calciner Ponds began in 2003 pursuant to a Remedial Action Plan approved by IDEQ. The initial fill and temporary cover were placed at Ponds 1C, 3C, and 4C in 2003. The final cap is expected to be placed over Ponds 1C, 3C, and 4C, as well as Ponds 2C and 5C, in 2005.	Addressed under IDEQ Consent Order.	
Calciner Solids Storage Area A [former]	na	functionally addressed under IDEQ Consent Order	stockpile	solids	Excavated fines from original calciner ponds excavated to install new Ponds 1C, 2C, 3C, and 4C in 1987; subsequently relocated during construction of Pond 5C and capped with a soil cover. Approximately 100 feet by 400 feet; no release controls.	Storage Area A: F050B found calciner sludge to 10 feet below grade. Boring B128B found fingerprint constituent impact down to 100 ft below grade.	No additional information available.	No documented releases.	Area remains covered.	Functionally addressed by the Calciner Pond Remedial Action Plan addressed under the IDEQ Consent Order.	
Road segments within RU 14	38	no	na	na	Surface roads throughout site; roads oiled in past with dust suppressants. Roads are predominantly unpaved slag.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue in use to support remediation of the calciner ponds.	Potential source: use of slag for road subgrade.	

Remediation Unit #15: Oversized Ore, Broken Electrodes and Baghouse Dust Recycle Material

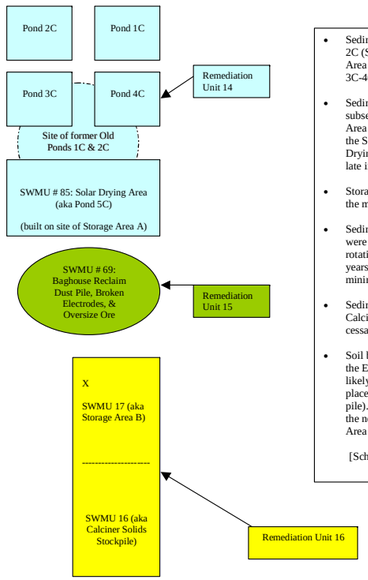
Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Oversized Ore, Broken and Used Electrode, Baghouse Dust Storage/Recycling, and Used Conveyor Belt Area	69	no	stockpiles	solid	Area used to store reject phosphate ore, which was periodically reclaimed. Formerly accepted phosphate ore dust from baghouses as well as furnace charge of ore briquettes and coke. Also received broken and used electrodes and used conveyor belts.	Area used to store reject phosphate ore, which was periodically reclaimed. Formerly accepted phosphate ore dust from baghouses as well as furnace charge of ore briquettes and coke. Also received broken and used electrodes and used conveyor belts. Emission impact reflected in RI air monitoring record.	Carbon was periodically reclaimed for use in slag runners.	No documented releases	Used carbon is being sold.	Potential source	
Road segments within RU 15	38	no	na	na	Surface roads throughout site; roads oiled in past with dust suppressants. Roads are predominantly unpaved slag.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	

Remediation Unit #16: Calciner Solids Stockpile

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Calciner Solids Stockpile	16	no	stockpile	solid	Pile of calciner sludge removed from Calciner Pond 5C.	Use of area for calciner solids stockpiling post-dates the RI.	Analytical data for calciner solids is presented in *Remedial Design Work Plan – Calciner Ponds* . FMC Idaho LLC. Pocatello, Idaho (September 2002).	No documented releases	Area is inactive since plant shutdown.	Potential source	
Calciner Pond Sediment Areas South of Calciner Ponds [SWMU 17 = "Storage Area B"]	17	no	stockpile	solid	Excavated fines from original calciner ponds excavated to install new Ponds 1C, 2C, 3C, and 4C in 1987; subsequently relocated to current position during construction of Pond 5C and capped with a soil cover. Approximately 100 feet by 400 feet; no release controls.	SWMU 17 contains calciner pond sediments from Storage Area A. Boring F127B found site impact (ortho-P, K) at 15 feet below grade. From RI: Storage Area A: F050B found calciner sludge to 10 feet below grade. Boring B128B found fingerprint constituent impact down to 100 ft below grade. Storage Area B: F051B found calciner fines mixed with fill to a depth of 14 feet. Boring F127B found site impact (ortho-P, K) at 15 feet below grade.	No additional information. The has been no activity at the area since the EMF RI field investigation period.	No documented releases	Area is inactive since the soil cap was placed in 1993.	Potential source	
Road segments within RU 16	38	no	na	na	Surface roads throughout plant site; roads oiled in past with dust suppressants.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	

Gary - don't print this chart

DISCUSSION OF SWMUS 16 AND 17 WITHIN REMEDIATION UNIT #16



- Sediments were removed from Old Ponds 1C & 2C (SWMU 14) in 1988 and placed in Storage Area A to facilitate construction of New Ponds 3C-4C (SWMU 15).
- Sediments in Storage Area A were subsequently transferred in 1993 to Storage Area B (SWMU 17) to facilitate construction of the Solar Drying Area (SWMU 85). The Solar Drying Area (aka Pond 5C) began operation late in 1993.
- Storage Area B was covered (soil) sometime in the mid to late 1990's.
- Sediments from New Ponds 1C, 3C, and 4C were transferred to the Solar Drying Area in a rotating series after settling in the pond for two years. Pond 2C was a surge basin and had minimal sediment accumulation.
- Sediments from Pond 5C were placed in the Calciner Solids Stockpile (SWMU 16) until cessation of calciner operations in 2001.
- Soil boring F127B (drilled during Phase II of the EMF remedial investigation in 1993) is likely misplotted on RI & FS documents, which place in within SWMU 69 (baghouse dust, etc. pile). This soil boring was likely drilled within the northwest area of SWMU #17 (Storage Area B). See X in figure.

[Schematic diagram at left is not to scale]

Remediation Unit #17: Recyclable Material Landfill

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Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Roadway Landfill (also referred to as Construction Debris and/or Recycle Landfill)	89	no	landfill	solid	Constructed in 1981. Unit is southeast of the slag pile. Unit has been misidentified with the "Recycle Landfill," which is SWMU # 69. Construction debris landfill for disposal of demolition debris such as concrete, rocks, etc. These wastes were typically generated during major projects at the plants, including furnace rebuilds and digouts. May also have received baghouse dust. The landfill was not intended for office trash, packaging materials, scrap metals, process waste streams, or liquid wastes.	SWMU was not evaluated during the remedial investigation. However, results of samples collected from downgradient groundwater monitoring wells were within background concentrations and did not indicate impact to groundwater quality.	Unit continued in operation.	No documented releases.	Unit is in service to support management of nonhazardous construction/demolition debris from facility decommissioning.	Potential source. Evaluate landfill using EPA's Presumptive Remedy Guidance for Municipal Waste Landfills.	
Road segments within RU 17	38	no	na	na	Roads within RU 17 are predominantly unpaved slag. Fugitive emissions from the road is controlled through the use of dust suppressants.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	

Remediation Unit #18: Plant Landfill

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Landfill (also referred to as Solid Waste Landfill)	45	no	landfill	solid wastes	Constructed in 1980. Received office and lunchroom trash and solid waste from plant machine and equipment shop operations; these wastes were collected in approx. 50 trash collection bins located within the facility. Cell 1 was used for Anderson Filter Media but now inactive. Landfill is active for management of nonhazardous wastes. Drums crushed at site. Closed double-bags of asbestos waste removed from process equipment are also disposed of in a registered and dedicated portion of the landfill. No process or liquid waste is stored or disposed at unit. May have also received tires, clothing, empty drums, pallets, scrap metal, conveyor belts, baghouse materials (not dust), unsalvageable building materials, and minor amounts of spent solvents and lubricants.	Analyses of the soil samples taken from this borehole [F027B] indicate little to no EMF effects with regard to inorganic or radiological parameters. There were a number of volatile organics detected in a random fashion within the borehole. For the most part these organics appear to be laboratory artifacts at the off-site lab. There does not appear to be a clear association with site landfill activities. No groundwater was encountered to a depth of 140 feet below ground surface during drilling for planned groundwater monitoring well installation.	Information on landfill operations and waste managed at the landfill was provided to EPA in FMC's February 27, 1998 response to EPA's January 22, 1998 information request. The response described FMC's landfill management policies, which directed plant personnel not to place any P4-containing materials in the landfill or in solid waste tote bins used to accumulate solid wastes destined for disposal in the landfill.	No documented releases.	Unit is active in support of management of nonhazardous waste during facility decommissioning.	Evaluate landfill using EPA's Presumptive Remedy Guidance for Municipal Waste Landfills.	
Road segments within RU 18	38	no	na	na	Road segments within RU 18 are constructed of unpaved slag. Fugitive emissions are controlled with dust suppressants.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads are active in support of management of nonhazardous waste during facility decommissioning.	Potential source: use of slag for road subgrade.	

Remediation Unit #19: Slag Piles and Bullrock Pile Landfill

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Slag Pile	42	no	waste pile	solid	Slag piles located south of plant operations areas; stored on bare ground; covers about 135 acres. From plant startup (circa 1949) to 1999, harden slag was removed from the Slag Pit (SWMU 102) and placed at the slag pile. Slag was removed from the slag pile periodically for use in on-site projects (fill, road bed, pond berm construction and backfill). Slag was also sold to non-FMC parties until 1995 and used primarily for roadbed construction and railroad track ballast. Starting in 1999, molten slag and ferrophos were transported in ladles and poured onto the existing slag pile.	Six composite samples of slag were taken during the RI and tested for inorganics and radioactivity. The results indicated a calcium silicate base with fluoride and other constituents. Of particular interest in making native soil/slag comparisons were the following: arsenic (not detected), cadmium (not detected to 32.4 mg/kg), calcium (255,000 to 290,000 mg/kg), chromium (172 to 290 mg/kg), fluoride (12,400 to 17,800 mg/kg), total phosphorus (1,610 to 5,680 mg/kg), potassium (6,780 to 8,220 mg/kg), vanadium (150 to 250 mg/kg), and zinc (36.4 to 450 mg/kg). Gross alpha activity ranged between 179 ± 22.4 pCi/g and 240 ± 37 pCi/g, and gross beta activity ranged between 74.7 ± 9.34 pCi/g and 102 ± 9.74 pCi/g). These activities are relatively high compared to natural soils and can be further utilized to identify a material that contains slag. Uranium-238 was detected in the slag samples, but lead-210 was not. A further characteristic of slag is its dull gray color. Emissions from slag handling practices and unpaved roads within the slag pile were evaluated.	Approximately 17 railcars were identified by examination of a 1965 aerial photo; discussions with retired plant employees indicate that the railcars likely contain excess sludge from Phos Dock operations. Sludge is believed to be a colloidal mixture of P4, silica gel, carbon, and precipitator dust. Railcars were covered with slag and are not visible in the next-available (1971) aerial photo. The railcars are believed to be covered with at least 50 feet of slag. FMC provided an assessment of groundwater quality data for wells downgradient of the slag pile to EPA in 2002. This assessment found no demonstrable impact from the slag pile on groundwater quality.	No documented releases.	Slag is no longer produced since plant shutdown in 2001. Slag is being used as part of pond closure activities and may be considered for use as a construction material for final plant remediation and regrading.	Use of byproduct as fill. Slag is also a potential source of gamma radiation.	
Landfill (old)	44	no	landfill	solid waste	Located under existing slag pile; inaccessible; no documentation exists for first use or depth; not an engineered project; ceased operation in 1980. Received office and lunchroom trash and solid waste from plant machine and equipment shop operations; these wastes were collected in approx. 50 trash collection bins located within the facility. Also received asbestos insulation, tires, clothing, pallets, empty drums, scale from calciner pallets, possibly furnace internals, kiln scrubber pond solids, fluid bed dryer solids, P4-bearing wastes, spent solvents and oily residuals, and transformer oil.	SWMU was not evaluated in the EMF RI.	No additional documentation available.	No documented releases.	SWMU is covered by an estimated 30 to 50 feet of slag.	Landfill remediation may be addressed using EPA's Presumptive Remedy Guidance for Municipal Waste Landfills.	
Bull Rock Pile	na	no	waste pile	solid	An approximately ___ square foot area used for storage of pieces of oversized phosphate ore screened from offloading railcars that could not be used in the industrial process. The oversized ore was segregated and transported to the bull rock pile for contingent future use. Placement of oversized ore at the pile was discontinued circa 1994 when ore crushing equipment was installed at the shale handling area (SWMU 37).	SWMU was not evaluated in the EMF RI.	The top of the Bull Rock Pile was used to stockpile crushed slag for subsequent use within the plant.	No documented releases.	Crushed slag stockpile has been removed. The bull rock (oversized ore) pile remains and is covered with a veneer of crushed slag.	Potential source of gamma radiation.	
segment of FMC surface road network	38	no	na	na	insert standard road text Surface roads throughout plant site; roads oiled in past with dust suppressants.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads are active in support of management of nonhazardous waste during facility decommissioning.	Potential source: use of slag for road subgrade.	

Remediation Unit #20: Former BAPCO Area

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Railcar Loading & Unloading Areas-BPC	46	no	na	solid	Railcar loading area for ferrophos and slag and railcar unloading area for coke. Active for ferrophos loading facilities, and inactive for coke unloading and slag loading facilities.	The subsurface in the vicinity of the Bannock railcar-loading area appears to have a fairly uniform 5-foot-thick slag fill layer. There is evidence that material from this fill has been mixed into the underlying soils to a minor degree. This mixing zone is to at least 7 feet in some areas.	No further information available.	No documented releases	Active to support shipment of ferrophos. Might also be used to support shipment of scrap metals. Rail spurs are significant assets for future redevelopment and are not anticipated to be removed.	Potential source.	
Bannock Paving Areas	47	no	na	na	Slag stored throughout the property leased by Bannock Paving from FMC until March 1995. Hot Mix Asphalt Batch plant operated at two historic locations.	Minor leaching from overlying fill was observed in soils taken from two of the three boreholes drilled in this location. There does not appear to be any significant EMF-related effects at the 5-foot horizon under the Bannock Paving Company operation. Impacts from batch plant were not evaluated during the remedial investigation.	A former BAPCO employee alleged that a spill occurred of approximately 1,000 gallons of liquids described as oily sludge from a tank car that BAPCO was converting to an onsite storage tank. In May 1997, Jack B. Parson Companies, operators of Bannock Paving, conducted a site investigation to determine the impacts, if any, at the site of the alleged disposal of oily sludges. TPH and BTEX compounds were detected in one test pit. The other 7 test pits had no detectable hydrocarbons. After reviewing the site investigation report, EPA stated that "Based on the sampling results we do not believe that further investigation of this area is warranted at this time."	None. BAPCO's lease was terminated during the RI period, and since then, there were no releases that might have impacted environmental media.	Area used for contractor lay-down area, equipment storage, and staging in support of construction work at the former RCRA ponds.	Potential source: need for TPH data at former batch plant locations.	
Coke settling pond (former BAPCO unit)	incl. in # 47	no	basin	liquid, solid	Concrete-lined basins.	Sediments collected from concrete-lined settling basin. The results indicate a mineral-poor matrix with only cadmium (2.6 mg/kg), molybdenum (3.6 mg/kg), orthophosphate (15.9 mg/kg), and zinc (67.4 mg/kg) slightly above -soil representative levels. (inorganics and rad data only)	Analytical data for coke was reported to EPA in FMC's September 17, 2002 response to EPA's July 8, 2002 information request. Coke contained approximately 86.5% fixed carbon, 3.4% volatiles, 2.7% silica, 2.3% water, 1.3% Al_2O_3, 1.2% CaO, 1.2 % S, 0.5% Fe_2O_3, 0.46% MgO, and 0.05% K_2O. Also,TCLP analysis of coke from FMC's Kemmerer, WY coke plant. This plant supplied 70% of the coke used by FMC.	Coke drying operations ceased when BAPCO lease was terminated in 1996.	Idle. Some coke left at grade.	Possible need for PAH/PNA analyses for coke samples.	
Surface Roads - Bannock Paving Company	48	no	na	na	Surface roads throughout site; roads oiled in past with dust suppressants. Roads are predominantly unpaved slag.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	
Two-building Former Bannock Paving Company Office - Shop Complex	2-bldg. Former BPC office shop complex	no	na	building	Shop was used to maintain/repair BAPCO paving and construction equipment.	SWMU was not evaluated during the remedial investigation.	None.	None. BAPCO's lease was terminated during the RI period, and since then, there were no releases that might have impacted environmental media.	Idle.	Characterization of area around shop and septic tank for solvent/hydrocarbons.	
Railroad Spurs	68	no	railcars	railcars (tanker) containing liquid, solids	First constructed in 1949; no records of significant spills along tracks in the plant area. Slag may have been used as construction fill or balast. Rail spurs used to store railcars potentially containing elemental phosphorus, RCRA pond closure water, and other materials managed during facility decommissioning and demolition.	SWMU was not evaluated during the remedial investigation.	No additional information available.	No documented releases.	Active to support shipment of ferrophos. Might also be used to support shipment of scrap metals. Rail spurs are significant assets for future redevelopment and are not anticipated to be removed.	Potential source: byproduct (slag) used as fill.	

Remediation Unit #21: Other On-plant Railspurs

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Railroad Spurs	68	no	railcars	railcars (tanker) containing liquid, solids	First constructed in 1949; no records of significant spills along tracks in the plant area. Slag may have been used as construction fill or ballast. Rail spurs used to store railcars potentially containing elemental phosphorus, RCRA pond closure water, and other materials managed during facility decommissioning and demolition. Railcar loading/unloading occurred elsewhere (see information for SWMU 38 in RU 1, 6 and 7; and SWMU 46 in RU 20).	Rail spurs were not evaluated during the remedial investigation. Soil sampling was attempted during the EMF RI (locations F085B - F088B), but utilities prevented access.	No information to report.	No documented releases.	Active to support shipment of residual P4 product removed from manufacturing process units. Might also be used to support shipment of recyclable metals. Rail spurs are significant assets for future redevelopment and are not anticipated to be removed.	Potential source: byproduct (slag) used as fill.	

Remediation Unit #22a: RCRA Waste Management Units

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Phossy Waste Surface Impoundment - Pond 15S	3	yes	surface impoundment (closed)	slurry, liquid	Interim Status Closure Subpart K Surface Impoundment. Closure in progress. Ceased receiving hazardous waste prior to 9/1/93. Initial fill and temporary cover installed in 1999. Settlement monitoring reported quarterly to EPA. Revised Closure Plan with cap design submitted to EPA May 2002; initial fill phase of closure plan approved by EPA. Established via RCRA Part A submittal. . Final cover to be installed following EPA approval of revised Closure Plan and when settlement rate stabilizes at £1 inch per year. Former use as settling pond for solids from Ponds 11S, 12S, 13S, 14S; decant water from Pond 9E; and wastewater liquor from the Pond 8S recovery process unit; double lined with 30-mil polyvinyl chloride with leak detection and leachate collection systems; about 9.4 acres. Underlain by former unlined ponds 5E and 6E.	Characterization of Pond 15S sediments identified arsenic (20.4 to 256 mg/kg), cadmium (1,100 to 2,040 mg/kg), chromium (71.6 to 133 mg/kg), copper (41.7 to 74.9 mg/kg), fluoride (8,600 to 17,100 mg/kg), lead (185 to 386 mg/kg), total phosphorus (21,300 to 28,000 mg/kg), potassium (7,910 to 20,100 mg/kg), selenium (10.8 to 49.6 mg/kg) , silver (106 to 199 mg/kg), vanadium (42.9 to 93.4 mg/kg), and zinc (10,400 to 26,600 mg/kg). The pH at which these solids exist within the ponds is in the acidic range (less than 5.5). Phossy solids are gray to dark gray in color. Gross alpha values ranged from 71.1 ± 21.6 pCi/g to 289 ± 39.8 pCi/g. Gross beta ranged from 254 ± 26.2 pCi/g to 783 ± 44.4 pCi/g. Lead-210 was also analyzed in these samples and the range detected was from 204 ± 53.8 pCi/g to 465 ± 117 pCi/g. Uranium-238 was not detected.	RCRA Interim Status groundwater detection monitoring program continues to be implemented. Analytical data are reported annually to EPA. No evidence of impact on uppermost aquifer detected.	No releases reported.	Interim cover installed 1999; final cover scheduled to be installed summer 2004.	Subject to RCRA closure and post-closure monitoring and maintenance standards.	
Phossy Waste Surface Impoundment - Pond 8S	7	yes	surface impoundment (closed)	slurry, liquid	Interim Status Closure Subpart K Surface Impoundment. Interim fill placed in 1994 and final cover installed in 1999 pursuant to approved RCRA Closure Plan. Final Closure Report and Certification submitted to EPA in 1999. Unit in post-closure monitoring and maintenance program. Former unlined settling pond for phossy-containing water; out of service since 1981; 3.2 acres.	Former Pond 8S is surrounded by a fill layer of variable depth (10 to 14 feet). To the north is a slag layer and to the south is a black clayey material with the constituents of phossy water solids or precipitator dust. The fill in general contains above-representative levels of various constituents associated with site activities. Beneath this fill there is little evidence of downward migration of any constituents other than total phosphorus, fluoride, and zinc. The zinc occurs with such persistence relative to other sampling locations that it is not possible to determine whether it is naturally occurring or EMF-related. These three borings may have been close enough to one or both of the unlined ponds 8S or 2E to have been slightly influenced by belling from their contents. Gross alpha and gross beta activities were above representative levels only in identifiable fill horizons.	RCRA Interim Status assessment monitoring program continues to be implemented to evaluate impact to the uppermost aquifer. Analytical data are reported annually to EPA.	RCRA Interim Status assessment monitoring program continues to be implemented to evaluate impact to the uppermost aquifer. Analytical data are reported annually to EPA.	Final cover installed 1999; in post-closure care period.	Subject to RCRA closure and post-closure monitoring and maintenance standards.	
Phase IV Ponds--Phossy Water Clarifier Surface Impoundments (Ponds 11S, 12S, 13S, 14S)	8	yes	surface impoundment (closed)	slurry, liquid	Interim Status Closure Subpart K Surface Impoundments. Ceased receiving hazardous wastes 12/1/98. Initial fill and temporary cover installed in 1999. Settlement monitoring reported as required quarterly to EPA. Initial phase of closure approved by EPA. Closure to be completed in construction season following EPA approval of Closure Plan, per RCRA Consent Decree. Established via RCRA Part A submittal. Series of 4 phossy water clarifier ponds; 94.5-acre foot capacity. Constructed with single 30-mil PVC liner and leak detection system in 1980. Sediments dredged to Pond 15S. Underlain by former unlined Pond 3E.	A composite sample of a phossy wastewater stream was taken during the RI. The results are displayed in Table 4.2.3-3. Of interest were the levels of the following trace metals: arsenic (0.145 mg/l), cadmium (0.023 mg/l), chromium (0.41 mg/l), vanadium (0.37 mg/l), and zinc (41.8 mg/l). Potassium (2,890 mg/l), total phosphorus (1,370 mg/l), and fluoride (436 mg/l) were also detected. Because this sample was not filtered, the results represent both dissolved-phase and solid-phase constituents. Gross alpha and gross beta activities for phossy wastewater indicated enriched levels of gross beta). The levels detected for one composite were 21.8 ± 26.2 pCi/l for gross alpha and 2,420 ± 37.1 pCi/l for gross beta. While a portion of the gross beta can be attributed to the presence of naturally occurring potassium-40 in the potassium-rich wastewater, there were other unidentified beta emitters contributing to this total. Radium-226 was also detected at 1.9 ± 0.56 pCi/l.	RCRA Interim Status groundwater detection monitoring program continues to be implemented. Analytical data are reported annually to EPA. No evidence of impact on uppermost aquifer detected.	No releases reported.	Interim cover installed 1999; final cover scheduled to be installed summer 2004.	Subject to RCRA closure and post-closure monitoring and maintenance standards.	
Precipitator Slurry Drying Surface Impoundment (Pond 9E)	9	yes	surface impoundment (closed)	slurry, liquid	Ceased receiving wastes 1/23/94. Waste dredged to the extent practicable in 1994 and placed in Pond 16S. Backfilled and capped in 2000 pursuant to RCRA Closure Plan. Final Closure Report and Certification submitted to EPA January 2001. Established via RCRA Part A submittal. Former evaporation pond for electrostatic precipitator dust slurry dredged from Pond 8E; double lined with leak detection and leachate collection systems; installed 1986; about 12.9 acres; standing water decanted to Pond 15S once per year; Pond 9E sediments turned, air dried, and excavated to waste pile at Pond 9S.	A composite sample of sediments from Pond 9E was collected during Phase I and analyzed for inorganics and radioactivity... the sample was enriched in all trace metals that are associated with the ore, with some being at greatly increased concentrations. Of particular note were the concentrations of cadmium (2,410 mg/kg), fluoride (16,100 mg/kg), lead (338 mg/kg), total phosphorus (33,500 mg/kg), selenium (45.3 mg/kg), silver (218 mg/kg), vanadium (169 mg/kg), and zinc (21,400 mg/kg). Precipitator slurry is dark gray to black in color. The sediments from Pond 9E contained 120 ± 26 pCi/g of gross alpha and 579 ± 33.4 pCi/g of gross beta. Unlike the phossy waste, no lead-210 was detected in the precipitator slurry sediments. The uranium-238 activity was 8.36 ± 5.32 pCi/g.	RCRA Interim Status groundwater detection monitoring program continues to be implemented. Analytical data are reported annually to EPA. No evidence of impact on uppermost aquifer detected.	Residual P4 in pond sediments burned when exposed to air while sediments were being removed from the inactive and dry pond in 1998.	Final cover installed 2000; in post-closure care period.	Subject to RCRA closure and post-closure monitoring and maintenance standards.	

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Phossy Water Surface Impoundment (Pond 16S)	10	yes	surface impoundment (closed)	slurry, liquid, solids	Initial fill and temporary cover installation completed November 2000. Settlement monitoring reported quarterly to EPA. Closure Plan submitted; initial phase of closure approved by EPA. Closure to be completed in construction season following EPA approval of Closure Plan, per RCRA Consent Decree. Established via RCRA Part A submission. Began operation in January 1993. Former 140-acre foot capacity impoundment with double liner and LDCRS. Unit design, construction, and operation met RCRA MTRs and RCRA Pond Management Plan	SWMU was placed into operation near the end of the EMF RI field investigation program, and was not evaluated during the EMF RI.	RCRA Interim Status groundwater detection monitoring program continues to be implemented. Analytical data are reported annually to EPA. No evidence of impact on uppermost aquifer detected.	Continuous release of phosphine and hydrogen cyanide reported to NRC in 1997. Open-path FTIR system installed around pond in 1999 to continuously monitor phosphine and hydrogen cyanide levels, pursuant to RCRA Pond management Plan. Monitoring data were reported to EPA. Phosphine emission occurred through the interim cover in 2001; phosphine emissions were subsequently controlled with a gas collection and treatment system pending installation of final cap and gas detection and contingent control system.	Interim cover installed 2000; final cover scheduled to be installed summer 2004.	Subject to RCRA closure and post-closure monitoring and maintenance standards.	
Precipitator Slurry Surface Impoundment (Pond 8E)	11		surface impoundment (closed)	slurry, liquid	Initial fill and temporary cover installed in 1999 pursuant to RCRA Closure Plan. Closure Plan submitted; initial phase of closure approved by EPA. Closure to be completed in construction season following EPA approval of Closure Plan, per RCRA Consent Decree. Settlement monitoring reported quarterly to EPA. Established via RCRA Part A submittal. Former interim evaporation pond for electrostatic precipitator dust slurried with clarified phossy water; water was then pumped to Pond 9E; Pond 8E double lined with leak detection and leachate collection systems; installed 1984; about 2.8 acres; underlain by inactive Ponds 1E and 2E. Waste dredged to the extent practicable in 1994 and placed in Pond 16S. Pond subsequently received NOSAP slurry in 1995 and 1996.	A composite sample of precipitator slurry was taken from the pipeline transporting slurry to Pond 8E. The sample was not filtered and contained a considerable amount of suspended solids. The concentrations detected of note were cadmium (1.66 mg/l), chromium (2.03 mg/l), fluoride (1,510 mg/l), mercury (0.00027 mg/l), nickel (2.45 mg/l), total phosphorus (7,680 mg/l), potassium (9,890 mg/l), silver (2.45 mg/l), and zinc (5,210 mg/l). In Pond 8E wastewater, gross alpha and gross beta activities were elevated relative to representative groundwater values (Table 4.2.3-3). The values detected were 668 ± 122 pCi/l and 6,480 ± 136 pCi/l, respectively. While radium-228 was not detected, radium-226 was present at 103 ± 4.48 /l. No other radionuclides were analyzed.	RCRA Interim Status groundwater detection monitoring program continues to be implemented. Analytical data are reported annually to EPA. No evidence of impact on uppermost aquifer detected.	No releases reported.	Interim cover installed 1999; final cover scheduled to be installed summer 2004.	Subject to RCRA closure and post-closure monitoring and maintenance standards.	
Pond 17	87	yes	surface impoundment (closed)	slurry, liquid	Ceased receiving hazardous waste on October 16, 2001. Closure in process; installation of initial fill and temporary cover in progress during 2002 construction season. Established via RCRA Part A submittal in June 1997. Placed into service May 15, 1998. 85-acre foot capacity SI with double-liner and LDCRS; unit design, construction, and operation meet RCRA MTRs and RCRA Pond Management Plan.	SWMU was constructed and placed into service after the EMF remedial investigation.	RCRA Interim Status groundwater detection monitoring program continues to be implemented. Analytical data are reported annually to EPA. No evidence of impact on uppermost aquifer detected.	Phosphine emission through interim cover (detected in 2004) controlled with gas collection and treatment system pending installation of final cap and gas detection and contingent control system.	Interim cover installed 2002; final cover to be installed per schedule in closure plan.	Subject to RCRA closure and post-closure monitoring and maintenance standards.	
Pond 18	88	yes	surface impoundment (Cell A closed; Cell B inactive pending closure)	slurry, liquid	Ceased receiving hazardous waste on December 31, 2001. Waste-in-place closure of Cell A began in 2002 construction season with installation of initial fill and temporary cover. Closure of Cell B by waste removal will be completed at a later date in accordance with Closure Plan submitted to EPA. Established via RCRA Part A Submittal May 1998. Placed in service December 1, 1998. Two-celled surface impoundment unit with 40 acre-foot capacity for Cell A and 100 acre-foot capacity for Cell B/with double-liner and LDCRS; unit design, construction, and operation meet RCRA MTRs and RCRA Pond Management Plan.	SWMU was constructed and placed into service after the EMF remedial investigation.	RCRA Interim Status groundwater detection monitoring program continues to be implemented. Analytical data are reported annually to EPA. No evidence of impact on uppermost aquifer detected.	Open-path FTIR system installed around pond in 1999 to continuously monitor phosphine and hydrogen cyanide levels, pursuant to RCRA Pond management Plan. Monitoring data were reported to EPA.	Cell A: interim cover installed 2002; final cover to be installed per schedule in closure plan. Cell B: closure by removal per schedule in closure plan.	Subject to RCRA closure and post-closure monitoring and maintenance standards.	
Pond Closure Surge Tank	100	yes	Tank system appurtenance	liquid	The unit is a <90-day hazardous waste generator accumulation tank designed and operated in accordance with 40 C.F.R. 262.34. Unit is a 20,000-gallon carbon steel tank (ASTM -516 grade 70 carbon steel). Unit began operation on July 1, 2002 to manage Pond 17 decant water. May also be used to manage water removed during closure of other RCRA ponds.	SWMU was constructed and placed into service after the EMF remedial investigation.	No additional information to report.	No releases reported.	The unit is currently used to manage non-hazardous water removed during closure of several RCRA ponds.	Subject to RCRA closure and post-closure monitoring and maintenance standards.	

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Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #22a footprint]	82 (partial)	yes	Tank system appurtenance	liquid, slurry	Phossy wastewater and precipitator slurry waste pumped from points of generation at Furnace Building area and Phosphorus loading Dock to various WMUs via piping system. Clean-out taps located in various locations where pipelines bend or change direction. Earliest operation unknown. Piping upgraded to welded joints and located above-grade in December 1997.	The portion of the piping system within RU 22a was not evaluated during the remedial investigation.	The piping system from the Furnace Building and Phos Dock was upgraded in 1998 per RCRA Consent Decree. Several lines were eliminated. Above-grade pipeline installed in 2002 to convey Pond 17 decant water from Pond 17 to the Railcar Loading station. The above-grade portion of the pipeline system was inspected for leaks on a weekly basis, pursuant to RCRA Interim Status inspection requirements.	Three reported spills. (1) Pond 16S decant water (estimated 15,000 gallons water, 2.5 lbs elemental phosphorus) spilled in November 1994 from a decant line at Pond 16S onto soil adjacent to Pond 16S. Contaminated soil cleaned up and placed into Pond 16S. (2) Non-clarified phossy water (estimated 150 gallons water, 4.8 lbs elemental phosphorus) spilled in June 1996 from a phossy water line near Pond 8S and impacted local soil. (3) Non-clarified wastewater (estimated 19,000 gallons water, 34 lbs cadmium, 10.5 lbs elemental phosphorus) spilled into Pond 9E in July 1997 from a line running from the Furnace Building to Pond 16S.	The above-grade pipeline system was emptied in 2001 and is being decommissioned and removed.	The above-grade portion of the pipeline system is not a potential source. Historical releases from underground segments of the former pipeline system, in addition to the June 1996 incident, while undocumented, are suspected, making the underground segments a potential source.	
Road segments within RU 22a	38	no	na	na	Roads within RU 22a are predominantly unpaved slag. Fugitive emissions from the road is controlled through the use of dust suppressants.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads are in use to support closure and post-closure care activities within RU 22a	Potential source: use of slag for road subgrade.	

Remediation Unit #22b: CERCLA RD/RA Units

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Area 9S	6	no	waste pile	solid	Inactive since the effective date of RCRA Interim status. Prior to July 23, 1990, waste precipitator dust excavated from Pond 9E piled atop inactive Pond 9S; about 3 acres; unlined, constructed 1971; contained within an unlined excavated area; pile below grade. Protective RCRA Filing Unit (waste pile never operated as a RCRA hazardous waste treatment, storage, or disposal unit).	About a 5-foot-deep fill layer was encountered in borings in the eastern and western sections of the 9S storage area. This fill appeared to be a mixture of slag and precipitator dust. Below this depth, most trace metals (with the exception of zinc) do not appear to have migrated into the subsurface. There is evidence of fluoride, phosphate, potassium, and zinc migration to 10 to 15 feet below the land surface. However, in the 20-foot boring all constituents were within representative levels.	Groundwater quality assessment for former unlined phossy waste ponds continued under FMC's voluntary post-RI CERCLA groundwater monitoring program. Analytical data provided to EPA Region 10 on an annual basis. EPA's Technology Innovation Program evaluated potential technologies to treat phossy wastes managed in former unlined ponds (EPA 2003). Otherwise, no additional information available.	No reported releases.	The area is inactive and covered with a veneer of slag	Potential source.	
Pond 1E	19	no	former surface impoundment	liquid, slurry	Former unlined evaporation pond for phosphorus-containing water; not an engineered structure; approximately 125 feet by 550 feet; no release controls; built over during construction of Ponds 8E and 11S.	Investigation of former Pond 1E revealed precipitator slurry dust and/or phossy water solids to a depth of at least 4.5 feet in some areas of the former pond. These materials contained elevated levels of trace metals, fluoride, total phosphorus, and gross alpha/beta. Analytical results for soil samples taken beneath the fill area indicated, with the exception of zinc, little to no migration of any trace metals into the soils. There is evidence of the continued migration to depth of fluoride, total phosphorus, potassium, and to a lesser extent zinc. It appears that the natural attenuation properties (calcareous and alkaline) of the soils in the area combined with the solubility of the deposited solids preclude migration of measurable quantities of most of the constituents into the subsurface. Measurable is defined here as the ability to distinguish between representative and above-representative concentrations of a given constituent in the soil.	See discussions of FMC's voluntary post-EMF RI CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	The area is partially overlain by RCRA Ponds 8E and 11S.	Potential source.	
Pond 2E	20	no	former surface impoundment	liquid, slurry	Former unlined evaporation pond for phosphorus-containing water; not an engineered structure; approximately 375 feet by 350 feet; no release controls; pond sediments excavated and placed in Pond 4E; Pond 2E removed during construction of Pond 8E.	Pond 2E and Pond 3E underlie Pond 8E and the Phase IV Ponds. Sediments from Ponds 2E and 3E were excavated prior to constructing these newer ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	The area is overlain by RCRA Ponds 8E.	Potential source.	
Pond 3E	21	no	former surface impoundment	liquid, slurry	Former unlined evaporation pond for phosphorus-containing water; not an engineered structure; approximately 600 feet by 900 feet; no release controls; removed during construction of Ponds 11S through 14S.	Pond 2E and Pond 3E underlie Pond 8E and the Phase IV Ponds. Sediments from Ponds 2E and 3E were excavated prior to constructing these newer ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	The area is overlain by RCRA Ponds 11S through 14S.	Potential source.	

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Pond 4E	22	no	former surface impoundment	liquid, slurry	Former unlined evaporation pond for phosphorus-containing water; not an engineered structure; approximately 150 feet by 700 feet; no release controls.	As with former Pond 1E, the investigation of former Pond 4E yielded evidence of precipitator slurry dust and/or phossy water solids in the near-surface soils of the former pond. These materials contained elevated levels of trace metals, fluoride, total phosphorus, and gross alpha/beta. Analytical results for soil samples taken beneath the fill area indicated that with the exception of zinc, little to no migration of trace metals into the soils has occurred. There is evidence of the continued migration to depth of fluoride, total phosphorus, potassium, and to a lesser extent zinc. It appears that the natural attenuation properties (calcareous and alkaline) of the soils in the area combined with the solubility of the deposited solids preclude migration of measurable quantities of most of the constituents into the subsurface. There was a change in lithology from silt to gravel at approximately 55 feet, with a corresponding increase in radioactivity. This increase is believed to be naturally occurring in origin.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area is inactive and uncovered.	Potential source.	
Pond 5E	23	no	former surface impoundment	liquid, slurry	Former unlined evaporation pond for phossy water; not an engineered structure; approximately 325 feet by 1,125 feet; no release controls; removed during construction of Pond 15S.	Investigation of former Pond 5E yielded evidence of phossy water solids to a depth of at least 10 feet in some areas of the former pond. These materials contained elevated levels of trace metals, fluoride, total phosphorus, and gross alpha/beta. Analytical results for soil samples taken beneath the fill area indicate little to no migration of any trace metals into the soils has occurred. There is evidence of the continued migration to depth of fluoride, total phosphorus, and potassium. It appears that the natural attenuation properties (calcareous and alkaline) of the soils in the area combined with the solubility of the deposited solids preclude migration of measurable quantities of most of the constituents into the subsurface.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	The area is overlain by RCRA Pond 15S.	Potential source.	
Pond 6E	24	no	former surface impoundment	liquid, slurry	Former unlined evaporation pond for phosphorus-containing water; not an engineered structure; approximately 425 feet by 850 feet; no release controls; removed during construction of Pond 15S.	Although drilled into the center of former Pond 6E, F026B encountered no visible fill layer. There was no evidence of facility-related sludges in the surficial sample. However, the distribution of fluoride, total phosphorus, potassium, and zinc suggested a migration of these constituents from FMC phossy water/solids or precipitator slurry ponds. As was also expected beneath these ponds, there was no evidence of trace metal migration in the subsurface, other than zinc.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	The area is overlain by RCRA Pond 15S.	Potential source.	
Pond 0S	25	no	former surface impoundment	liquid, slurry	Former unlined pond. Location inaccessible; not an engineered structure, dimensions not available; no release controls known. Ponds 0S and 00S thought to be beneath Mobile Equipment Shop.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Ponds 0S thought to be beneath Mobile Equipment Shop.	Potential source.	
Pond 00S	26	no	former surface impoundment	liquid, slurry	Former unlined pond. Pond location inaccessible; not an engineered structure, dimensions not available; no release controls known. Ponds 0S and 00S thought to be beneath Mobile Equipment Shop.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Ponds 00S thought to be beneath Mobile Equipment Shop.	Potential source.	
Pond 1S	27	no	former surface impoundment	liquid, slurry	Former unlined pond. Settling pond for phosphorus-containing water dried and covered with slag in 1972; inaccessible; not an engineered structure; approximately 100 feet by 350 feet; no release controls.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area remains covered with slag.	Potential source.	
Pond 2S	28	no	former surface impoundment	liquid, slurry	Former unlined pond. Settling pond for phosphorus-containing water dried and covered with slag in 1972; inaccessible; not an engineered structure; approximately 100 feet by 300 feet; no release controls; covered.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area remains covered with slag. Waste Oil Storage Area	Potential source.	
Pond 3S	29	no	former surface impoundment	liquid, slurry	Former unlined pond. Settling pond dried and covered with 3 to 6 feet of dirt in 1976; not an engineered structure.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area remains covered with fill.	Potential source.	
Pond 4S	30	no	former surface impoundment	liquid, slurry	Former unlined pond. Settling pond dried and covered in 1976; not an engineered structure.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area remains covered with fill.	Potential source.	

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Pond 5S	31	no	former surface impoundment	liquid, slurry	Former unlined pond. Settling pond for phosphorus-containing water covered with 3 to 6 feet of dirt in 1976; not an engineered structure; approximately 250 feet by 175 feet; no release controls.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area remains covered with fill.	Potential source.	
Pond 6S	32	no	former surface impoundment	liquid, slurry	Former unlined pond. Settling pond dried and covered with dirt and slag in 1980; not an engineered structure.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area remains covered with fill.	Potential source.	
Pond 7S	33	no	former surface impoundment	liquid, slurry	Former unlined pond. Settling pond covered; not an engineered structure.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area remains covered with fill.	Potential source.	
Pond 10S (Including Precipitator Dust Pile atop Pond 10S)	34	no	former surface impoundment	liquid, slurry	A former pond for storage of precipitation slurry before processing in the fluidized bed dryer process, which ceased operation in 1986. Remaining precipitation slurry in pond has dried out and crusted over. No precipitation dust has been piled atop the dried pond 1.7 acres; single lined with no leak detection system.	Characterization of unit expected to be similar to other former unlined S-series ponds.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area is inactive; wastes are exposed.	Potential source.	
Ferrophos Storage Areas	43	no	by-product stockpile	solid	Ferrophos piles stored on bare ground on site; number and locations of piles varies; one ferrophos pile located atop Pond 7S as of September 1991. Most of the stockpiled ferrophos will be removed between 2002 and 2005	Three ferrophos composite samples collected during the RI were analyzed for inorganics and radioactivity. Ferrophos, as analyzed by nonstandard EPA methods, was approximately 50 to 60 percent iron, 25 to 30 percent total phosphorus, 4 to 5.5 percent vanadium, 3.5 to 4.5 percent chromium, 0.5 to 4.5 percent silicate, plus impurities. The material has a slight gloss when first produced but oxidizes to a dull light gray with time. The results reported by the laboratory utilizing standard EPA methods indicated an iron, chromium-, and vanadium-rich material with noticeably (compared to native soils) high levels of copper (4..04 to 851 mg/kg), molybdenum (90.6 to 151 mg/kg), and nickel (535 to 1,150 mg/kg). Leachable (by nitric acid digestion) quantities of total phosphorus and potassium were relatively low (1,070 mg/kg and 603 mg/kg, respectively). Gross alpha activities were high compared with soils but low compared with slag (24.8 ± 11.98 pCi/g to 70.4 ± 32.8 pCi/g). Gross beta activities ranged from 22.5 ± 8.46 pCi/g to 55.4 ± 15.12 pCi/g.	No additional documentation available.	No reported releases.	Inventory of ferrophos being removed and transported offsite to purchaser.	Veneer of residual ferrophos is a potential source.	
Pond 7E	52	no	former surface impoundment	liquid, slurry	Former unlined evaporation pond for phossy water; not an engineered structure; approximately 75 feet by 175 feet; no release controls; dried in 1981.	Investigation of former Pond 7E revealed relatively little evidence, if any, of effects from FMC facility operations. This conclusion is based on the relatively small number of constituents that exceeded representative levels, the relatively small margin by which they exceeded representative levels, and the relatively small number of characteristic constituents which exceeded representative levels. If the constituents which exceeded representative levels are in fact indicative of EMF effects, they, in any case, fell to near or below representative levels at depth.	See discussions of FMC's voluntary post-CERCLA groundwater monitoring program and EPA TIP Report presented for Area 9S (SWMU 6) above.	No reported releases.	Area is inactive and uncovered.	Potential source.	
Old Pond 7S Tree–Line Area	53	no	former surface impoundment	liquid, slurry	Former unlined pond. Adjacent to pond 7S (SWMU #33); area used for storage of ferrophos chills and PCB-containing items.	The purpose for sampling in this area was to determine the presence or absence of PCBs. In addition, inorganics and radioactivity were measured to characterize the levels of constituents in the area of former Pond 7S. There was no intention to determine the depth of potential impact, and, hence, no further activities were conducted in this area during Phase II. The sampling confirmed the absence of PCBs and the presence of precipitator dust in the subsurface to a depth of at least 7 feet.	No additional documentation available.	No reported releases.	Area used for storage of ferrophos.	Potential source.	
Drum Storage Area for other Nonhazardous Wastes [see SWMU 59]	56	no	container storage area	liquid, solid	EPA's RFA describes this unit as: "This storage areas is a bermed concrete pad used for temporarily storing drums containing waste heavy lubricating oils and used nonpolychlorinated biphenyl transformer oils (less than 50 ppm PCB's." FMC believes that SWMU # 56 is identical to SWMU #59.	see SWMU 59	see SWMU 59	see SWMU 59	see SWMU 59	see SWMU 59	

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	**SWMU #**	**RCRA or IDEQ CO Unit**	**Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)**	**Physical Characteristics of Material Handled (solid, liquid, slurry)**	**SWMU Description**	**EMF RI Findings**	**Post-EMF RI Information**	**Post-RI releases that might have impacted environmental media**	**Current Status**	**Potential for Impact / Significance to updated CSM or RI Update**	
Waste Oil Storage Area	59	no	container storage area	liquid, solid	Located atop portion of former unlined Pond 2S used to store drummed non-hazardous lubrication oils and transformer oils containing less than 50 parts per million PCBs; constructed 1990.	The subsurface in the vicinity of the waste oil storage area contains materials related to Pond 2S to a depth of at least 20 feet. Evidence of elemental phosphorus was found in the subsurface. No organics were detected at 20 feet, although a number of inorganic concentrations and gross alpha and gross beta activities were above representative levels. The depth of impact of the pond (not materials from the waste storage area) was not determined.	No additional documentation available.	No reported releases.	Area continues to be used for storage of liquid and solid non-hazardous waste.	Not a potential source. Wastes are contained are will be removed from the site. However, the footprint of the unit is within the footprint of former Pond 2S and will be encompassed by the cover to be installed over former Pond 2S.	
Area West of Mobile Shop	62	no	na	na	Area west of mobile shop used to store and maintain equipment, store fuel, motor oil, lubricants.	Soils in the shallow subsurface in the vicinity of the mobile shop have been heavily affected by facility activities. These soils appeared to be fill. [data suggest slag plus phossy solids and ppt dust] Native soil was not encountered at the 2-foot mark.	The Mobile Shop was decommissioning in 2002 and placed into use for storage of contractor-operated construction equipment.	No reported releases	The Mobile Shop remains in use for storage of contractor-operated construction equipment, pending completion of facility decommissioning.	Potential source	
Phossy Waste Pipeline Cleanout Areas and Intervals	64 (partial)	no	other	liquid, slurry	Phosphorus-containing water pumped from furnace washdown collection tank and phosphorus-loading dock via pipelines to Ponds 11S, 12S, 13S, 14S; cleanout taps located along pipeline routes.	Ten locations along the pipelines leading from the plant to the surface impoundments that carry phossy water/solids and precipitator slurry were sampled to investigate the presence of releases from these two potential sources. Two locations (borings F077B and F079B) were found to have evidence of releases associated with pipeline operations. The vertical extent of the impact was not determined during Phase I or Phase II. However, neither location was sampled at a substantial depth (greater than 10 feet) into the naturally occurring soils. Effects related to other site activities, such as mechanical placement of fill, were evident in most of the locations sampled. The depth of visually recognizable fill, which generally contained slag and other EMF-related materials, varied considerably (3 to 25 feet) across the locations sampled. For the most part, when native subsurface soils were sampled, EMF-related parameters did not appear to have migrated into them from the overlying fill.	No additional documentation available.	No reported releases.	The underground segments of the former pipeline remain in place.	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	
Precipitator Slurry Pipeline Cleanout Areas and Intervals	65 (partial)	no	other	liquid, slurry	Precipitator slurry pumped from Furnace Building via pipelines to Pond 8E; cleanout taps located along pipeline routes.		No additional documentation available.	No reported releases.	The underground segments of the former pipeline remain in place.	Potential source; historical releases from underground segments of the former pipeline system, while undocumented, are suspected.	
Facility-Wide Wastewater Piping System (Phossy Water and Precipitator Slurry) [portion of pipeline network within RU #22b footprint]	82 (partial)	yes	Tank system appurtenance	liquid, slurry	Phossy wastewater and precipitator slurry waste pumped from points of generation at Furnace Building area and phosphorus loading dock to various WMUs via piping system. Clean-out taps located in various locations where pipelines bend or change direction. Earliest operation unknown. Piping upgraded to welded joints and located above-grade in 12/97.	With the exception of cleanout areas, the below-grade portion of the piping system within RU #22b was not evaluated during the remedial investigation. The above-grade portion of the pipeline system was placed into service after the EMF RI field sampling program.	The piping system from the Furnace Building and Phos Dock was upgraded in 1998 per RCRA Consent Decree. Several lines were eliminated. The above-grade portion of the pipeline system was inspected for leaks on a weekly basis, pursuant to RCRA Interim Status inspection requirements.	No reported releases.	The above-grade pipeline system was emptied in 2001 and is being decommissioned and removed.	The above-grade portion of the pipeline system is not a potential source. Historical releases from underground segments of the former pipeline system, in addition to the June 1996 incident, while undocumented, are suspected, making the underground segments a potential source.	
Road segments within RU 22b	38	no	na	na	Surface roads throughout plant site; roads oiled in past with dust suppressants.	See discussion of EMF RI findings for roads under RU 23, SWMU 38.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	

Remediation Unit #22c: Railroad Swale

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	SWMU #	RCRA or IDEQ CO Unit	Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)	Physical Characteristics of Material Handled (solid, liquid, slurry)	SWMU Description	EMF RI Findings	Post-EMF RI Information	Post-RI releases that might have impacted environmental media	Current Status	Potential for Impact / Significance to updated CSM or RI Update	
Railroad Swale	18	no	other	liquid	Partially lined (in 1993) depression along railroad tracks to collect surface water runoff; no discharge points except downward percolation; no engineering drawings available, date of construction unknown; has received stormwater runoff from facility phosphorus-loading dock since 1965.	Borings in the area of the railroad swale encountered slag and fill layers from 7.5 to 18 feet thick. Samples taken within these layers contained above-representative concentrations of EMF-related constituents, which include gross alpha and gross beta. These concentrations were observed to decrease with depth. In two borehole locations, soil samples were taken at depths greater than 2.5 feet below the fill/native soil interface. Samples taken at these depths showed little to no effect from EMF-related activities. However, the presence of elevated orthophosphate and total phosphorus in a sample from 70 feet may be an indication of infiltration. The RR Swale was partially lined in 1993.	POG upgrades under RCRA Consent Decree in 1998 significantly reduced the potential for process operations spills at the Furnace Building and Phos Dock to drain into the Railroad Swale. See RU1 for further information on SWMUs subject to POG containment upgrades.	Post-RI spills of Furnace Building washwater drained from Furnace Building across paved roadway to storm drain that discharged to Railroad Swale and when equipment washwater overtopped the Maintenance Pad basin. Spills from units in the Phos Dock operating area (SWMU 77) could also drain to SWMU 54 prior to POG upgrades.	Area continues to receive stormwater runoff.	Area is a potential source due to historical spills of phossy water. Residual levels of P4 may be present in sediments accumulated above the liner, owning to post-liner installation spills of phossy water.	

Remediation Unit #23: Road Segments not included in other RUs

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	SWMU #	RCRA or IDEQ CO Unit	Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)	Physical Characteristics of Material Handled (solid, liquid, slurry)	SWMU Description	EMF RI Findings	Post-EMF RI Information	Post-RI releases that might have impacted environmental media	Current Status	Potential for Impact / Significance to updated CSM or RI Update	
Surface Roads - FMC	38	no	na	na	Surface roads throughout plant site not within the footprint of other Remediation Units. Many roads and parking lots are paved with asphalt. The subgrade of the paved area is probably slag. Unpaved roads are generally constructed of slag. Unpaved roads oiled in past with dust suppressants.	With few exceptions, all of the road samples taken at FMC indicated that the roads were constructed from EMF-related fill materials (generally slag, but in some cases ore and/or native soils mixed with EMF-related materials). These materials, by their very nature, contained above-representative levels of inorganics and radionuclides. However, samples collected below the fill materials indicated very little to no migration of the bed constituents. The constituents for which some mobility was most often evidenced were phosphates, fluoride, potassium, and, to some extent zinc. The radionuclides and other trace metals were immobile. PCBs and TPH were also extensively measured in the road samples. While TPH were occasionally observed at very elevated levels (hundreds of mg/kg), PCBs were rarely detected, and then at less than 1 mg/kg. This observation coincides with observations from other soil sampling at the site. Fugitive emissions from paved and unpaved roads were evaluated in the EMF RI air emission dispersion modeling study.	FMC instituted a fugitive dust suppression program for unpaved roads in 1999 using periodic applications of magnesium chloride. Fugitive emissions from paved roads are controlled through periodic sweeping and watering.	Fugitive emissions from paved roads are controlled through periodic sweeping and watering. Fugitive emissions from unpaved roads are controlled with dust suppressants. Water withdrawn from the RCRA ponds during closure and treated in the PCDT system to meet the Universal Treatment Standards (UTS) applied to roads in 2004 and 2005 for dust control. No documented post-RI releases to roads.	Roads continue to be used to support facility decommissioning, although the volume of traffic is substantially less than during plant operations.	Potential source: use of slag for road subgrade.	

SWMUs Not Associated with a Remediation Unit

Former Working Area Description						Impact Assessment Summary					
Former Working Area (SWMU Name)	SWMU #	RCRA or IDEQ CO Unit	Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)	Physical Characteristics of Material Handled (solid, liquid, slurry)	SWMU Description	EMF RI Findings	Post-EMF RI Information	Post-RI releases that might have impacted environmental media	Current Status	Potential for Impact / Significance to updated CSM or RI Update	
West Andersen Filter Media (AFM) Bin Area	2	yes	Container	Solids	Unit operated as a RCRA 90-day GAA. Unit was closed in 2001 by waste removal and equipment decontamination. It operated as a container storage area (265 Subpart I). AFM was placed in individual plastic bags prior to storage in the bin. AFM was managed as RCRA characteristic hazardous waste codes D006, D007, D008 and D010 until 07/07/99. All subsequent shipments begining on 07/30/99 were shipped as D006 and D010.	SWMU was not evaluated during the remedial investigation.	Unit was closed in 2001 by waste removal and equipment decontamination. Cubic yard container was shipped off site.	No releases are recorded.	Closed by waste removal and equipment decontamination; unit has been removed. No potential impact to underlying soil, due to containment afforded by bins and underlying paved area.	Not a potential source.	

Other Areas of the FMC Plant OU Not Associated with a Remediation Unit

Area Description						Impact Assessment Summary				
Area Name	SWMU #	RCRA or IDEQ CO Unit	Unit/Area Type (Container, storage/waste pile, tank, impoundment, landfill)	Physical Characteristics of Material Handled (solid, liquid, slurry)	Description	EMF RI Findings	Post-EMF RI Information	Post-RI releases that might have impacted environmental media	Current Status	Potential for Impact / Significance to updated CSM or RI Update
FMC properties between Highway 30 and Interstate 86	na	no	na	na	Parcels D, I, J, and K (as identified on Figure 1-3 of the EMF Site RI Report) between Highway 30 and Interstate Highway 86 owned by FMC.	Concentrations of EMF-related constituents, including uranium-238, in soils above representative levels outside the operational areas are primarily on properties owned by FMC or Simplot. The highest concentrations of EMF-related constituents in surface soils are found to the north and east of the industrial operation areas of the facilities. The principal area of accumulation lies between the operations area and I-86. Constituent concentrations decrease rapidly with increasing distance from the facilities. The suite of constituents present in these soils is characteristic of phosphate ore, and it appears that windblown dusts from ore handling activities have affected these soils. Subsurface soils have not been affected by airborne releases, with the possible exception of several samples taken near I-86 just north of the operations area, where mechanical turning of surface soils during highway construction may have introduced constituents into the subsurface. The Ecological Risk Assessment found a potential for minor exceedances of target risk thresholds for avian and plant receptors exposed to fluoride with a marginal likelihood that an adverse effect on population size or community composition will occur.	No additional data have been collected in this area since completion of the RI.	FMC completed 13 Supplemental Environmental Projects (SEPs) during 1999 and 2000 pursuant to the FMC RCRA Consent Decree (entered July 13, 1999), including upgrades in ore handling emission controls, that collectively reduced particulate emissions from facility operations by approximately 80%. Emissions from these sources as well as other sources evaluated during the RI were eliminated upon cessation of elemental phosphorus manufacturing operations in December 2001.	The area is inactive.	Surface soils have been impacted by deposition of particulates from historic former emissions. Owing to the substantial reduction in particulate emissions from FMC sources following the EMF RI, potential post-RI impacts would be expected to be minimal. Cessation of manufacturing in 2001 effectively eliminated further impacts. Additional characterization of gamma radiation may be warranted based on the finding of uranium-238 activities above representative levels in this area in the RI.
FMC properties north of Interstate 86	na	no	na	na	Parcels D and L (as identified on Figure 1-3 of the EMF Site RI Report) north of Interstate Highway 86 owned by FMC. Parcel L contains the site of Batiste Spring near the Portneuf River.		No additional data have been collected in this area since completion of the RI.		The area is inactive.	The impact on surface soils from particulate deposition from historic emissions is significantly less than that identified for FMC properties between Highway 30 and Interstate Highway 86. Owing to the substantial reduction in particulate emissions from FMC sources following the EMF RI, potential post-RI impacts would be expected to be minimal. Cessation of manufacturing in 2001 effectively eliminated further impacts. (see above). Additional characterization of gamma radiation may be warranted based on the finding of uranium-238 activities above representative levels in this area in the RI.

APPENDIX B

ECOLOGICAL RISK ASSESSMENT
EASTERN MICHAUD FLATS
POCATELLO, IDAHO

ZP3090_D4709

Ecological Risk Assessment
Eastern Michaud Flats
Pocatello, Idaho

ARCS Region 10

Contract No. 68-W9-0020
Work Assignment No. 20-21-0PD2

July 1995

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Document Control No. ZP3090.11 .O

Table A-3

EASTERN MICHAUD FLATS SITE
OFF-SITE SURFACE SOIL SUMMARY

Chemical	Units	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration
Aluminum, total	mg/kg	142/143	1150	18900	12520.21
Antimony, total	mg/kg	16/127	3.8	26.6	3.965354
Arsenic, total	mg/kg	128/137	1	18.4	5.388358
Barium, total	mg/kg	143/143	69.8	770	169.0336
Beryllium, total	mg/kg	125/138	0.14	2	0.772536
Boron, total	mg/kg	132/136	1.42	197	10.86493
Cadmium, total	mg/kg	135/139	0.32	189	22.08169
Calcium	mg/kg	36/37	4500	203000	57417.57
Chromium, total	mg/kg	143/143	9.3	608	81.84895
Cobalt, total	mg/kg	115/138	1.8	11.3	4.754493
Copper, total	mg/kg	143/143	8.7	84.4	21.51958
Fluoride	mg/kg	143/143	164	27200	2469.951
Fluoride, soluble	mg/kg	1/1	188	188	188
Iron, total	mg/kg	143/143	6040	20000	13066.29
Lead, total	mg/kg	143/143	0.8	2030	42.54937
Lead-210	pCi/g	76/94	0.441	50.8	6.775894
Lithium, total	mg/kg	143/143	6.1	65.6	13.44545
Magnesium	mg/kg	37/37	3590	15000	6654.054
Manganese, total	mg/kg	143/143	44.9	1330	428.321
Mercury, total	mg/kg	79/115	0.05	1.2	0.148348
Molybdenum, total	mg/kg	32/134	1.3	19.1	2.612687
Nickel, total	mg/kg	134/143	6.7	124	23.19545
Orthophosphate	mg/kg	142/143	0.59	154	14.4386
pH	Std. Units	143/143	5.25	9.87	7.697762
Phosphorus, total	mg/kg	143/143	300	84900	7853.105

Table A-3

EASTERN MICHAUD FLATS SITE
OFF-SITE SURFACE SOIL SUMMARY

Chemical	Units	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration
Polonium-210	pCi/g	94/94	0.387	50.9	7.761202
Potassium	mg/kg	35/35	2350	4920	3640.857
Potassium-40	pCi/g	94/94	5.96	31.4	16.97106
Selenium, total	mg/kg	87/129	0.29	16.3	1.74876
Silver, total	mg/kg	100/139	0.2	10.8	1.721187
Sulfate	mg/kg	14/35	20	9730	429.8571
Thallium, total	mg/kg	117/137	0.02	3.9	0.480109
Total organic carbon	mg/kg	3/3	6100	8000	7033.333
Uranium-238	pCi/g	81/94	0.0111	26.9	3.974994
Vanadium, total	mg/kg	143/143	10.6	729	101.3832
Zinc, total	mg/kg	143/143	43.7	1540	223.2091

Table B-9

**TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE AND RIPARIAN HABITATS
CADMIUM, FLUORIDE, AND ZINC IN SOIL
(mg/kg)**

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
Bannock Hills SW (Sagebrush Steppe)						
DOCU0101	31.6	31.6	1,520	1,520	282	282
DOCU0102	28.1	28.1	1,540	1,540	252	252
DOCU0103	28.7	28.7	1,370	1,370	281	281
DOCU0104	21	21	1,330	1,330	202	202
DOCU0105	29.9	29.9	1,630	1,630	262	262
DOCU0106	22.7	22.7	1,100	1,100	220	220
DOCU0107	34.1	34.1	1,680	1,680	342	342
DOCU0108	18.6	18.6	1,260	1,260	183	183
DOCU0109	27	27	1,270	1,270	244	244
DOCU0110	30.5	30.5	1,840	1,840	290	290
Michaud Flats (Sagebrush Steppe)						
DOCU0201	14.4	14.4	1,380	1,380	110	110
DOCU0202	31.1	31.1	3,200	3,200	219	219
DOCU0203	25.5	25.5	2,120	2,120	176	176
DOCU0204	29.1	29.1	1,830	1,830	193	193
DOCU0205	13.7	13.7	1,320	1,320	97.6	97.6

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Table B-9

**TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE AND RIPARIAN HABITATS
CADMIUM, FLUORIDE, AND ZINC IN SOIL
(mg/kg)**

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
DOCU0206	27.3	27.3	2,580	2,580	201	201
DOCU0207	9.4	9.4	850	850	88.4	88.4
DOCU0208	16.3	16.3	1,045	1,045	137	137
DOCU0209	26.9	26.9	1,960	1,960	201	201
DOCU0210	16.7	16.7	1,640	1,640	136	136
Ferry Butte (Sagebrush Steppe)						
DOCU0301	0.62	0.62	342	342	61.1	61.1
DOCU0302	0.57	0.57	421	421	56.4	56.4
DOCU0303	1.2	1.2	375	375	49.4	49.4
DOCU0304	0.51	0.51	344	344	59.5	59.5
DOCU0305	0.7	0.7	365	365	53.7	53.7
DOCU0306	0.57	0.57	330	330	57.1	57.1
DOCU0307	0.84	0.84	349	349	64.1	64.1
DOCU0308	0.47	0.47	372	372	54.9	54.9
DOCU0309	0.47	0.47	330	330	58.3	58.3
DOCU0310	0.81	0.81	406	406	50.2	50.2

Table B-9

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE AND RIPARIAN HABITATS
CADMIUM, FLUORIDE, AND ZINC IN SOIL
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
Portneuf River (Riparian)						
DOCU0401	4.9	4.9	600	600	81.6	81.6
DOCU0402	7.6	7.6	950	950	101	101
DOCU0403	12.8	12.8	1,300	1,300	142	142
DOCU0404	0.64	0.64	321	321	47.4	47.4
DOCU0405	4.3	4.3	670	670	75.5	75.5
DOCU0406	4.4	4.4	720	720	72.3	72.3
DOCU0407	5.6	5.6	435	435	80.9	80.9
DOCU0408	27.6	27.6	2,930	2,930	197	197
DOCU0409	18.9	18.9	1,260	1,260	173	173
DOCU0410	16.6	16.6	1,540	1,540	167	167
Snake River (Riparian)						
DOCU0501	0.26 J8	0.26	298	298	26.1	26.1
DOCU0502	0.17 J8	0.17	226	226	26.7	26.7
DOCU0503	0.4 J8,15	0.4	275	275	31.5	31.5
DOCU0504	0.3 J8,15	0.3	253	253	21.2	21.2
DOCU0505	0.31 J8	0.31	252	252	28.5	28.5

Table B-9

**TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE AND RIPARIAN HABITATS
CADMIUM, FLUORIDE, AND ZINC IN SOIL
(mg/kg)**

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
DOCU0506	0.2 J8	0.2	175	175	15.5	15.5
DOCU0507	0.25 J8	0.25	213	213	21.2	21.2
DOCU0508	0.23 J8	0.23	250	250	23.2	23.2
DOCU0509	0.3 J8,15	0.3	238	238	24.3	24.3
DOCU0510	0.2 J8,15	0.2	265	265	22.9	22.9

Table B-12

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN SAGEBRUSH FOLIAGE (unwashed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
Bannock Hills SW (Sagebrush Steppe)						
VSUU0101	0.86	0.86	70.4 J14	70.4	28.6	28.6
VSUU0102	1	1	82.4 J14	82.4	26.1	26.1
VSUU0103	0.88	0.88	47.3 J14	47.3	31.4	31.4
VSUU0104	1.1	1.1	74.4 J14	74.4	27.1	27.1
VSUU0105	1.1	1.1	90.7 J14	90.7	30.9	30.9
VSUU0106	1.2	1.2	<24.2 UJ14	12.1	39.8	39.8
VSUU0107	1	1	86.3 J14	86.3	28	28
VSUU0108	0.97	0.97	80.4 J14	80.4	34.5	34.5
VSUU0109	1	1	115 J14	115	32.3	32.3
VSUU0110	0.81	0.81	115 J14	115	33.5	33.5
VSUU0111	NA	NA	122 J14	122	NA	NA
VSUU0112	NA	NA	98.2 J14	98.2	NA	NA
VSUU0113	NA	NA	58.5 J14	58.5	NA	NA
VSUU0114	NA	NA	76.5 J14	76.5	NA	NA
VSUU0115	NA	NA	77.6 J14	77.6	NA	NA

Key at end of table.

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Table B-12

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN SAGEBRUSH FOLIAGE (unwashed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
VSUU0116	NA	NA	51.7 J14	51.7	NA	NA
VSUU0117	NA	NA	61.8 J14	61.8	NA	NA
VSUU0118	NA	NA	57.4 J14	57.4	NA	NA
VSUU0119	NA	NA	<24.7 UJ14	12.35	NA	NA
VSUU0120	NA	NA	93.6 J14	93.6	NA	NA
Michaud Flats (Sagebrush Steppe)						
VSUU0201	1.2	1.2	43.9 J14	43.9	30.6	30.6
VSUU0202	1	1	35 J14	35	33.5	33.5
VSUU0203	1.2	1.2	41.9 J14	41.9	35.2	35.2
VSUU0204	0.97	0.97	46.4 J14	46.4	36.8	36.8
VSUU0205	1.3	1.3	43.3 J14	43.3	36.5	36.5
VSUU0206	1.2	1.2	48 J14	48	37.3	37.3
VSUU0207	1	1	34.5 J14	34.5	38.2	38.2
VSUU0208	1.5	1.5	51.4 J14	51.4	44.2	44.2
VSUU0209	1.7	1.7	86.2 J14	86.2	49.1	49.1
VSUU0210	1.6	1.6	114 J14	114	41.2	41.2

Key at end of table.

Table B-12

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN SAGEBRUSH FOLIAGE (unwashed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
VSUU0211	NA	NA	31.5 J14	31.5	NA	NA
VSUU0212	NA	NA	52.4 J14	52.4	NA	NA
VSUU0213	NA	NA	25.5 J14	25.5	NA	NA
VSUU0214	NA	NA	56.1 J14	56.1	NA	NA
VSUU0215	NA	NA	66.9 J14	66.9	NA	NA
VSUU0216	NA	NA	<22.3 J14	11.15	NA	NA
VSUU0217	NA	NA	56.4 J14	56.4	NA	NA
VSUU0218	NA	NA	67.4 J14	67.4	NA	NA
VSUU0219	NA	NA	87.8 J14	87.8	NA	NA
VSUU0220	NA	NA	31.3 J14	31.3	NA	NA
Ferry Butte (Sagebrush Steppe)						
VSUU0301	0.35	0.35	<24 UJ14	12	29.1	29.1
VSUU0302	<0.19 U	0.095	<24.5 UJ14	12.25	29.4	29.4
VSUU0303	<0.19 U	0.095	<24.9 UJ14	12.45	28.1	28.1
VSUU0304	<0.19 U	0.095	<24.4 UJ14	12.2	30.1	30.1
VSUU0305	<0.19 U	0.095	<23.4 UJ14	11.7	25.6	25.6

Key at end of table.

Table B-12

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN SAGEBRUSH FOLIAGE (unwashed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
VSUU0306	0.2	0.2	<24.5 UJ14	12.25	27.8	27.8
VSUU0307	0.21	0.21	<24.8 UJ14	12.4	36.4	36.4
VSUU0308	0.29	0.29	<24 UJ14	12	44.1	44.1
VSUU0309	0.21	0.21	<23.6 UJ14	11.8	28.7	28.7
VSUU0310	<0.2 U	0.1	<24.7 UJ14	12.35	22.7	22.7
VSUU0311	NA	NA	<24 UJ14	12	NA	NA
VSUU0312	NA	NA	<24.4 UJ14	12.2	NA	NA
VSUU0313	NA	NA	<24.3 UJ14	12.15	NA	NA
VSUU0314	NA	NA	<23.2 UJ14	11.6	NA	NA
VSUU0315	NA	NA	<24.3 UJ14	12.15	NA	NA
VSUU0316	NA	NA	<24.8 UJ14	12.4	NA	NA
VSUU0317	NA	NA	<23.7 UJ14	11.85	NA	NA
VSUU0318	NA	NA	<24.4 UJ14	12.2	NA	NA
VSUU0319	NA	NA	<24.4 UJ14	12.2	NA	NA
VSUU0320	NA	NA	<22.7 UJ14	11.35	NA	NA

Key:

NA = Not analyzed.

Table B-13

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN SAGEBRUSH FOLIAGE (washed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
Bannock Hills SW (Sagebrush Steppe)						
VSUU0101	0.6	0.6	<39 UJ	19.5	22.7	22.7
VSUU0102	0.81	0.81	<57.9 UJ	28.95	22.5	22.5
VSUU0103	0.68	0.68	<52.3 UJ	26.15	26.1	26.1
VSUU0104	0.68	0.68	<62.4 UJ	31.2	23.5	23.5
VSUU0105	0.76	0.76	<52.3 UJ	26.15	31.5	31.5
VSUU0106	0.87	0.87	<68.7 UJ	34.35	30.2	30.2
VSUU0107	0.77	0.77	<51.6 UJ	25.8	25.1	25.1
VSUU0108	0.76	0.76	<63.8 UJ	31.9	27.1	27.1
VSUU0109	01.2	1.2	<47.6 UJ	23.8	22.4	22.4
VSUU0110	0.59	0.59	<60.2 UJ	30.1	28.7	28.7
VSUU0111	NA	NA	<46.4 UJ	23.2	NA	NA
VSUU0112	NA	NA	<54.5 UJ	27.25	NA	NA
VSUU0113	NA	NA	<51.4 UJ	25.7	NA	NA
VSUU0114	NA	NA	<53.8 UJ	26.9	NA	NA
VSUU0115	NA	NA	<51.7 UJ	25.85	NA	NA
VSUU0116	NA	NA	<35.6 UJ	17.8	NA	NA

Key at end of table.

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Table B-13

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN SAGEBRUSH FOLIAGE (washed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
VSUU0117	NA	NA	<56.4 UJ	28.2	NA	NA
VSUU0118	NA	NA	<58.2 UJ	29.1	NA	NA
VSUU0119	NA	NA	<52.8 UJ	26.4	NA	NA
VSUU0120	NA	NA	<30.1 UJ	15.05	NA	NA
Michaud Flats (Sagebrush Steppe)						
VSUU0201	1.1	1.1	<55.6 UJ	27.8	31.7	31.7
VSUU0202	0.92	0.92	<76.5 UJ	38.25	24	24
VSUU0203	1.2	1.2	<76.6 UJ	38.3	38.6	38.6
VSUU0204	1.3	1.3	<45.8 UJ	22.9	36.7	36.7
VSUU0205	1.2	1.2	<52.1 UJ	26.05	35	35
VSUU0206	1.5	1.5	<58.9 UJ	29.45	41.5	41.5
VSUU0207	1.1	1.1	<49.6 UJ	24.8	35.3	35.3
VSUU0208	1.1	1.1	<59.1 UJ	29.55	43.9	43.9
VSUU0209	0.61	0.61	<59.5 UJ	29.75	15	15
VSUU0210	0.96	0.96	<174 UJ	87	24.9	24.9
VSUU0211	NA	NA	<64 UJ	32	NA	NA
VSUU0212	NA	NA	<43.1 UJ	21.55	NA	NA

Key at end of table.

Table B-13

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN SAGEBRUSH FOLIAGE (washed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
VSUU0213	NA	NA	<43.6 UJ	21.8	NA	NA
VSUU0214	NA	NA	<74.7 UJ	37.35	NA	NA
VSUU0215	NA	NA	<89.3 UJ	44.65	NA	NA
VSUU0216	NA	NA	<78.3 UJ	39.15	NA	NA
VSUU0217	NA	NA	<109 UJ	54.5	NA	NA
VSUU0218	NA	NA	<55.2 UJ	27.6	NA	NA
VSUU0219	NA	NA	<93.8 UJ	46.9	NA	NA
VSUU0220	NA	NA	<99.4 UJ	49.7	NA	NA
Ferry Butte (Sagebrush Steppe)						
VSUU0301	0.34	0.34	<24.6 UJ14	12.3	27.4	27.4
VSUU0302	0.2 U	0.1	<24.8 UJ14	12.4	25.6	25.6
VSUU0303	0.2 U	0.1	<24.8 UJ14	12.4	25.8	25.8
VSUU0304	0.2 U	0.1	<24.8 UJ14	12.4	27	27
VSUU0305	0.2 U	0.1	<25.2 UJ14	12.6	24.3	24.3
VSUU0306	.2 U	0.1	<24.1 UJ14	12.05	25.8	25.8
VSUU0307	0.21	0.21	<24.6 UJ14	12.3	26.9	26.9
VSUU0308	0.28	0.28	<27.8 UJ	13.9	40.7	40.7

Key at end of table.

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Table B-13

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN SAGEBRUSH FOLIAGE (washed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
VSUU0309	0.23	0.23	<56 UJ	28	29.2	29.2
VSUU0310	.2 U	0.1	<24.4 UJ14	12.2	23.5	23.5
VSUU0311	NA	NA	<39.5 UJ	19.75	NA	NA
VSUU0312	NA	NA	<24.3 UJ14	12.15	NA	NA
VSUU0313	NA	NA	<24.3 UJ14	12.15	NA	NA
VSUU0314	NA	NA	<24.3 UJ14	12.15	NA	NA
VSUU0315	NA	NA	<36.3 UJ14	18.15	NA	NA
VSUU0316	NA	NA	<24.4 UJ14	12.2	NA	NA
VSUU0317	NA	NA	<24.4 UJ14	12.2	NA	NA
VSUU0318	NA	NA	<36.6 UJ	18.3	NA	NA
VSUU0319	NA	NA	<24.2 UJ14	12.1	NA	NA
VSUU0320	NA	NA	<36.1 UJ	18.05	NA	NA

Key:

NA = Not analyzed.

Table B-14

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN THICKSPIKE WHEATGRASS LEAVES AND STEMS (unwashed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
Bannock Hills SW (Sagebrush Steppe)						
VGU0101	0.33	0.33	40.2 J14	40.2	8	8
VGU0102	0.35	0.35	39.6 J14	39.6	8.2	8.2
VGU0103	0.5	0.5	46.6 J14	46.6	10	10
VGU0104	0.45	0.45	39.6 J14	39.6	6.5	6.5
VGU0105	0.77	0.77	96.7 J14	96.7	15	15
VGU0106	0.88	0.88	111 J14	111	13.5	13.5
VGU0107	0.53	0.53	58.5 J14	58.5	16.5	16.5
VGU0108	0.69	0.69	52 J14	52	13.4	13.4
VGU0109	0.49	0.49	96.3 J14	96.3	11.1	11.1
VGU0110	0.4	0.4	40.7 J14	40.7	12.7	12.7
Michaud Flats (Sagebrush Steppe)						
VGU0201	0.52	0.52	35.4 J14	35.4	10.2	10.2
VGU0202	0.42	0.42	<25 UJ14	12.5	8	8
VGU0203	0.36	0.36	<24.4 UJ14	12.2	8.4	8.4
VGU0204	0.49	0.49	<22.7 UJ14	11.35	7.9	7.9
VGU0205	0.45	0.45	<23.8 UJ14	11.9	13	13

Table B-14

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN THICKSPIKE WHEATGRASS LEAVES AND STEMS (unwashed)
(mg/kg)

Sample	Cadmium		Fluoride		Zinc	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
VGU0206	0.33	0.33	<24.2 UJ14	12.1	10.8	10.8
VGU0207	0.49	0.49	<24.1 UJ14	12.05	11.1	11.1
VGU0208	0.59	0.59	51.1 J14	51.1	15.1	15.1
VGU0209	0.44	0.44	40.9 J14	40.9	9.1	9.1
VGU0210	.52	0.52	25 J14	25	14.1	14.1
Ferry Butte (Sagebrush Steppe)						
VGU0301	<0.19 U	0.095	<24 UJ14	12	7.6	7.6
VGU0302	<0.2 U	0.1	<24.1 UJ14	12.05	5.2	5.2
VGU0303	<0.19 U	0.095	<23.5 UJ14	11.75	7.8	7.8
VGU0304	0.39	0.39	<24.1 UJ14	12.05	8.3	8.3
VGU0305	<0.17 U	0.085	<25 UJ14	12.5	9.4	9.4
VGU0306	<0.2 U	0.1	<24.8 UJ14	12.4	9.1	9.1
VGU0307	<0.13 U	0.065	<24.8 UJ14	12.4	10.5	10.5
VGU0308	<0.19 U	0.095	<24.4 UJ14	12.2	7.4	7.4
VGU0309	0.14	0.14	<24.5 UJ14	12.25	8.1	8.1
VGU0310	<0.15 U	0.075	<24.4 UJ14	12.2	8.9	8.9

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Table B-16

TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN DEER MOUSE TISSUE
(mg/kg)

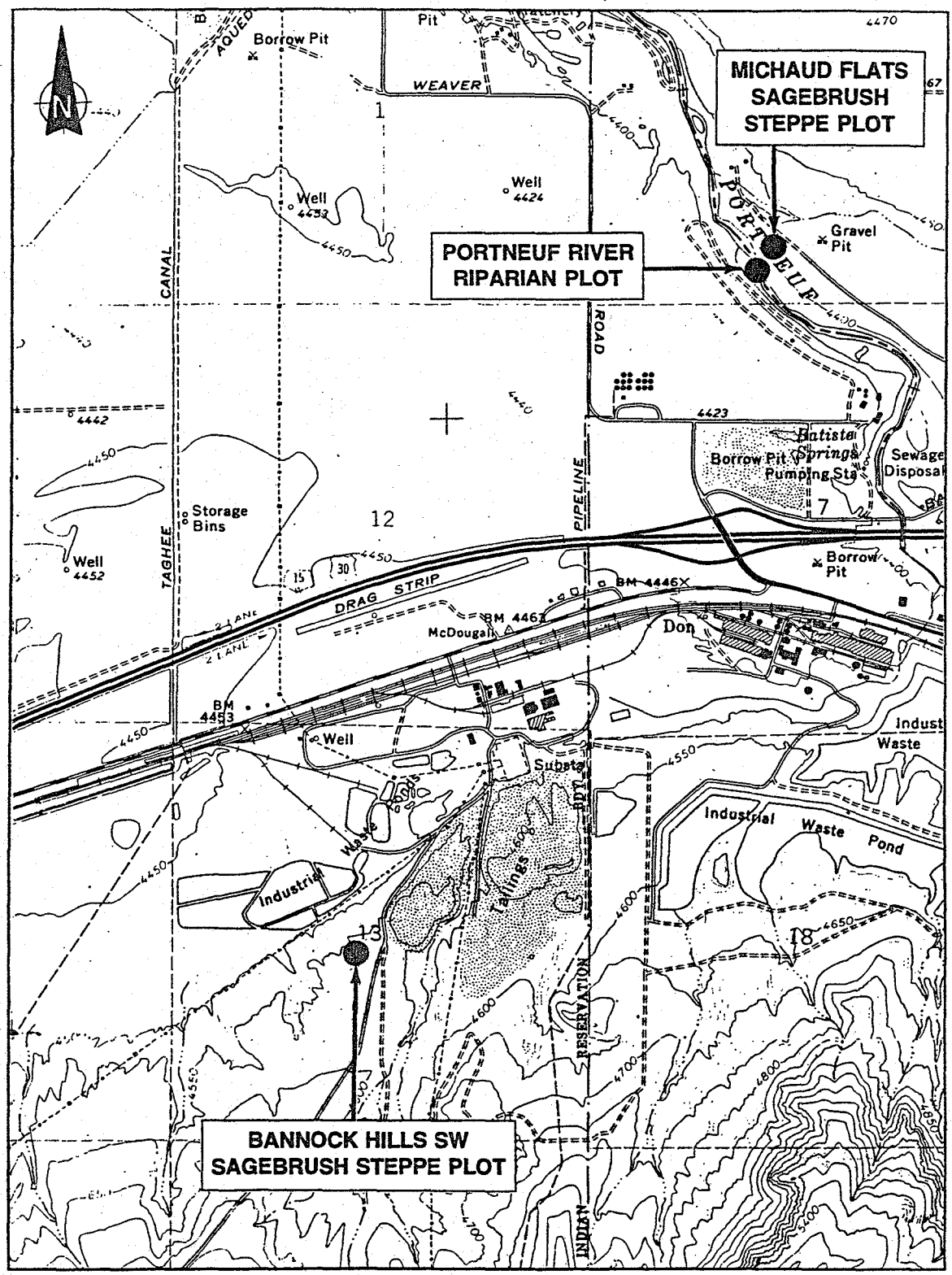
Sample	Cadmium (whole body)		Fluoride (whole body)		Fluoride (femur)		Zinc (whole body)	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
Bannock Hills SW (Sagebrush Steppe)								
MWBU0101	1.2 J10	1.2	149 J8	149	226 J14	226	48.1	48.1
MWBU0102	0.68 J10	0.68	173 J8	173	451 J14	451	31.7	31.7
MWBU0103	0.64 J10	0.64	135 J8	135	280 J14	280	37.2	37.2
MWBU0104	0.37 J10	0.37	105 J8	105	285 J14	285	36.9	36.9
MWBU0105	0.59 J10	0.59	112 J8	112	<188 UJ14	94	36.9	36.9
MWBU0106	0.53 J10	0.53	109 J8	109	<375 UJ14	187.5	37.3	37.3
MWBU0107	0.24 J10	0.24	156 J8	156	<188 UJ14	94	41.5	41.5
MWBU0108	0.39 J10	0.39	93.8 J8	93.8	196 J14	196	34	34
MWBU0109	0.71 J10	0.71	109 J8	109	399 J14	399	40.4	40.4
MWBU0110	0.79 J10	0.79	143 J8	143	760 J14,10	760	40.8	40.8
Michaud Flats (Sagebrush Steppe)								
MWBU0201	0.4 J10	0.4	50.4 J8	50.4	423 J14,10	423	34.7	34.7
MWBU0202	0.12 J10	0.12	56.6 J8	56.6	519 J14,10	519	34.4	34.4
MWBU0203	0.09 J10	0.09	135 J8	135	853 J14,10	853	43.5	43.5
MWBU0204	0.14 J10	0.14	114 J8	114	561 J14,10	561	37	37
MWBU0205	0.23 J10	0.23	83.8 J8	83.8	609 J14,10	609	41.6	41.6

ecology and environment

Table B-16

**TERRESTRIAL INVESTIGATIONS
SAGEBRUSH STEPPE HABITAT
CADMIUM, FLUORIDE, AND ZINC IN DEER MOUSE TISSUE
(mg/kg)**

Sample	Cadmium (whole body)		Fluoride (whole body)		Fluoride (femur)		Zinc (whole body)	
	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment	Detected Concentration	Concentration for Risk Assessment
MWBU0206	0.19 J10	0.19	91.1 J8	91.1	677 J14,10	677	42.9	42.9
MWBU0207	0.36 J10	0.36	102 J8	102	1,030 J14,10	1,030	33	33
MWBU0208	0.14 J10	0.14	84 J8	84	537 J14,10	537	34.3	34.3
MWBU0209	0.08 J10	0.08	59.4 J8	59.4	291 J14,10	291	36	36
MWBU0210	0.42 J10	0.42	133 J8	133	833 J14,10	833	38.5	38.5
Ferry Butte (Sagebrush Steppe)								
MWBU0301	0.12 J5B	0.12	<12.5 UJ8	6.25	301 J14,10	301	46.4	46.4
MWBU0302	0.04 J5B	0.04	<13.6 UJ8	6.8	264 J14,10	264	34.1	34.1
MWBU0303	0.02 J5B	0.02	<13.4 UJ8	6.7	<160 UJ14,10	80	40.5	40.5
MWBU0304	0.14	0.14	<15 UJ8	7.5	<115 UJ14,10	57.5	48.3	48.3
MWBU0305	0.03 J5B	0.03	<13.2 UJ8	6.6	<234 UJ14,10	117	28.2	28.2
MWBU0306	0.02 J5B	0.02	<14.7 UJ8	7.35	<160 UJ14,10	80	32.6	32.6
MWBU0307	0.06	0.06	<12.1 UJ8	6.05	<139 UJ14,10	69.5	37	37
MWBU0308	0.03	0.03	<13.6 UJ8	6.8	<119 UJ14,10	59.5	33.6	33.6
MWBU0309	0.15	0.15	<13.9 UJ8	6.95	195 J14,10	195	43.6	43.6
MWBU0310	0.05	0.05	<14.2 UJ8	7.1	<160 UJ14,10	80	41.4	41.4



SOURCE: USGS 7.5 Minute Series (Topographic) Quadrangle: Michaud, ID 1971, Photoinspected 1974.

SCALE 1:24,000

0 ½ 1 Mile

0 .5 1 Kilometer

Figure B-2 POTENTIALLY IMPACTED TERRESTRIAL SAMPLING POINTS

Appendix C
Results of Statistical Evaluation of Site Soil Data

Statistical analyses were performed on soil sample datasets from various RU's within the FMC OU to determine if sufficient data were available to decide if site soils exceeded certain threshold values.

The threshold values were: 1998 RBC's, EMF RI representative levels (background), Updated Site Worker RBC's, Construction Worker RBC's, and Utility Worker RBC's. The last three threshold values are the RBC's from Section 4 of the RI Update Memo.

Exposure depths associated with these various threshold values are:

1998 Site Worker: 0-2 feet

Updated Site Worker: 0-2 feet

Construction Worker: 0-10 feet

Utility Worker: 0-10 feet

Background: 0-10

The methods used in these comparison were detailed in Section 6, and this Appendix presents a summary of the data used in the comparisons, the results of the comparisons, and a determination if enough soil samples are available to support the null hypothesis at the 95% confidence level (null hypothesis: concentrations in site soil/fill exceed threshold values; alternate hypothesis: concentrations in site soil/fill are less than threshold values).

At several RU's, these tests could not be performed. ProUCL (EPA, 2004), requires 4 samples to calculate the 95% confidence level of the mean concentrations. In many cases there were not enough data points within the specific depth intervals of interest.

Although many tests show there are either insufficient data to compare site data against background concentrations or the 1998 RBC's, this does not mean the RU is inadequately characterized. The comparison with updated RBC's typically shows that where four samples are available, the null hypothesis can be accepted or rejected at the 95% confidence level.

The value of these tests is apparent at RU's where FMC identified the Remedial Action Vision is "No further action is anticipated to be necessary." At these RUs, the comparisons between site data and RBC's will aid investigators in filtering out which exposure scenarios are adequately characterized, and those which require additional characterization.

At RUs where FMC has a Remedial Action Vision of capping/cover, with appropriate institutional controls, the characterization of soils associated with various exposure scenarios is much less critical. For example, at the various landfills, the agencies recommended FMC consider the presumptive remedy for CERCLA landfills. The RUs containing landfills often have little or no soil chemical data, and it is not necessary to characterize soils for the exposure scenarios if the presumptive remedy is selected.

The analyses presented in this Appendix focus on inorganic parameters. Petroleum hydrocarbons, VOC's, SVOC's, and PCB's were not used, stored, or disposed on a site-wide basis, so it was determined that focused sampling will be needed in specific areas within the FMC OU where these materials were handled.

The HHRA determined that external gamma exposure was the principle driver behind ICR at the FMC OU. Gamma exposure measurements were collected as part of the EMF RI, both shielded and unshielded. The unshielded gamma exposure measurements were analyzed against background levels, and it was found that 12 gamma exposure measurements are needed within the RU boundary to make a decision at the 95% confidence level. None of the RU's within FMC has sufficient gamma exposure measurements to support a decision regarding site conditions against background levels.

RU's with insufficient inorganic data for comparisons are:

RU 2, 3, 5, 6, 8, 10, 11, 15, 16, 17, 18, 19, 21, and 23

RU's that were not analyzed because the remedy was selected in the 1998 ROD, and FMC intends to implement the selected remedy:

RU 22b (old ponds)

RU 16 Calciner Solids Storage Area

Similarly, FMC is evaluating whether to line or cap the Railroad Swale (RU 22c), and no statistical analysis was performed on the available data.

RU's that were not analyzed because they are being remediated under the IDEQ Consent Order or being closed under RCRA Standards:

RU 14 (Calciner Ponds)

RU 22a (RCRA Waste Management Units)

RU 1

The following tables summarize the data and comparisons with the various threshold values (RBC's and Background):

Table C-1: Data Summary

Table C-2: Site Data vs. Construction Worker RBC's

Table C-3: Site Data vs. Utility Worker RBC's

Table C-4: Site Data vs. Background Concentrations

Note that no comparisons were made to 1998 RBC's or Updated Site Worker RBC's because no data were available to characterize the 0-2 foot interval.

RU 4

The following tables summarize the data and comparisons with the various threshold values (RBC's and Background):

Table C-5: Data Summary

Table C-6: Site Data vs. Construction Worker RBC's

Table C-7: Site Data vs. Utility Worker RBC's

Table C-8: Site Data vs. Background Concentrations

Insufficient data are available to perform a statistical analysis of site data and the 1998 RBC's or the Updated Site Worker RBC's.

RU 7

The following tables summarize the data and comparisons with the various threshold values (RBC's and Background):

Table C-9: Data Summary

Table C-10: Site Data vs. 1998 RBC's and Updated Site Worker RBC's

Table C-11: Site Data vs. Construction Worker RBC's

Table C-12: Site Data vs. Utility Worker RBC's

Table C-13: Site Data vs. Background Concentrations

RU 9

The following tables summarize the data and comparisons with the various threshold values (RBC's and Background):

Table C-14: Data Summary

Table C-15: Site Data vs. Construction Worker RBC's

Table C-16: Site Data vs. Utility Worker RBC's

Table C-17: Site Data vs. Background Concentrations

Insufficient data were available to performed that comparisons between site data and the 1998 RBCs, the Updated Site Worker RBCs, and the Construction Worker RBCs.

RU 12

The following tables summarize the data and comparisons with the various threshold values (RBC's and Background):

Table C-18: Data Summary

Table C-19: Site Data vs. Construction Worker RBCs

Table C-20: Site Data vs. Utility Worker RBC's

Table C-21: Site Data vs. Background Concentrations

There were insufficient data to perform the comparison with the 1998 RBCs and the Updated Site Worker RBCs.

RU 13

The following tables summarize the data and comparisons with the various threshold values (RBC's and Background):

Table C-22: Data Summary

Table C-23: Site Data vs. Construction Worker RBC's

Table C-24: Site Data vs. Utility Worker RBC's

Table C-25: Site Data vs. Background Concentrations

Insufficient data are available to perform the comparisons between site data and the 1998 RBC's, the Updated Site Worker RBC's, or the Construction Worker RBC's.

RU 20

The following tables summarize the data and comparisons with the various threshold values (RBC's and Background):

Table C-26: Data Summary

Table C-27: Site Data vs. 1998 RBCs and Updated Site Worker RBCs

Table C-28: Site Data vs. Construction Worker RBCs

Table C-29: Site Data vs. Utility Worker RBC's

Table C-30: Site Data vs. Background Concentrations

TABLE C-1: RU 1 Soil Data Summary

Boring Designation	Sample Depth	Aluminum	Antimony		Arsenic		Barium	Beryllium		Boron		Cadmium		Calcium	Chromium	Cobalt	Copper	Fluoride	Iron	Lead		Lithium
	0-2 Feet																					
	NO DATA																					
	0-10 Feet																					
F069B	3	14300	16	UJ	3.1		152	0.72		19.3	U	1	U	49100	18.2	6	9.8	510	12700	9.6		14
F069B	5	14400	16.8	UJ	3.5		120	0.87		13.9	U	1.1	U	38400	17.2	5.8	12.2	510	13600	8.2		15.3
F064B	2.5	14000	17.4	UJ	4.5	J	137	0.46	U	35.8	UJ	1.1	U	51900	29.8	3.1	9.6	2520	12200	9.3		12.6
F064B	4.5	12900	17.8	UJ	2.1	J	127	0.41	U	18.4	UJ	1.8		53400	31.5	3.7	11.3	3860	13000	15.4		12.2
F052B	10	12300	17	UJ	2.3	J	122	1.3	U	12.8	UJ	1.7		37200	21.2	4.2	9	1390	12000	7.5		12.6
> 10 feet (not in an exposure pathway)																						
F052B	12.5	11000	16.5	UJ	3.8	J	123	1.2	U	8.9	UJ	1.6		34700	16.4	4	8	1140	11900	7.6		11.6
F052B	15	10400	16.7	UJ	2.8	J	113	1.3	U	9.7	UJ	1.1	U	28400	15.4	3.9	10.8	510	12100	7.5		11.2
F052B	17.5	9890	16.6	UJ	3.8	J	111	1.3	U	8.2	UJ	1.7		29100	18.3	3.4	8.9	800	11000	9.4		10.6
F052B	20	8610	17.2	UJ	3.7	J	97.1	1.3	U	5.3	UJ	1.1	U	29100	13.6	4.6	27.4	500	11200	6.9	U	10.3

Boring Designation	Sample Depth	Magnesium	Manganese		Mercury		Molybdenum		Nickel		Orthophosphate	Total Phosphorus	Potassium	Selenium		Silver		Sodium	Thallium		Vanadium	Zinc
	0-10 Feet																					
F069B	3	11400	329		0.23	J	2.7	U	11.5		1	737	NA	2.2	U	0.83	U	NA	25	U	28.2	43.7
F069B	5	12800	382		0.19	J	2.8	U	14.7		1.6	711	NA	1.8	U	0.87	U	NA	26.2	U	29.3	46.6
F064B	2.5	7290	375	J	0.72	J	2.9	U	11.8		95.9	17100	4350	1.8		0.9	U	1660	27.1	U	36	150
F064B	4.5	7130	373	J	1.4	J	3	U	12.1		254	15600	4750	1.6		0.93	U	1400	27.8	U	38	157
F052B	10	10500	321	J	0.86	J	2.9	U	11.3		3.7	896	2960	1.6	U	0.88	U	765	26.5	U	30.9	47.9
> 10 feet (not in an exposure pathway)																						
F052B	12.5	11400	339	J	0.87	J	2.8	U	10.5	U	3.7	914	2650	1.7	U	0.86	U	825	25.7	U	26.9	53
F052B	15	9820	427	J	0.29	J	3.8	U	11.9		5.1	718	2600	1.8	U	0.87	U	934	26	U	23.6	55.7
F052B	17.5	9180	332	J	0.16	J	2.8	U	12.4		5.7	710	2250	1.7	U	0.86	U	698	25.8	U	24.5	45.8
F052B	20	10400	449	J	0.33	J	2.9	U	16.2		9.9	883	1980	1.6	U	0.89	U	669	26.8	U	19.5	43.3

All concentrations are in mg/kg

Table C-2: RU 1 Comparison between Site Data and Construction Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	16	3.1	152	0.72	19.3	1	18.2	6	9.8	510	9.6
	16.8	3.5	120	0.87	13.9	1.1	17.2	5.8	12.2	510	8.2
	17.4	4.5	137	0.46	35.8	1.1	29.8	3.1	9.6	2520	9.3
	17.8	2.1	127	0.41	18.4	1.8	31.5	3.7	11.3	3860	15.4
	17	2.3	122	1.3	12.8	1.7	21.2	4.2	9	1390	7.5
Std Dev	0.678	0.969	13.16	0.36	9.24	0.378	6.65	1.29	1.32	1436	3.13
95% UCL	18.32	4.99	157	1.45	38.1	2.08	36.5	7.07	12.96	4557	16.11
Method	C	C	C	C	C	C	C	C	C	C	C
Construction Worker RBC	104	14.6	8,355	61	5,213	81.3	550,729	52.2	22,036	33,044	800.00
Delta	86	9.6	8,198	60	5,175	79	550,693	45.1	22,023	28,487	783.89
Is 95% UCL > 10% of RBC?	yes	yes	no	no	no	no	no	yes	no	yes	no
# Samples Needed	2	2						2		2	
# Samples Collected	5	5						5		5	
Sufficient samples to support comparison?	**yes**	**yes**						**yes**		**yes**	
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	14	329	0.23	2.7	11.5	2.2	0.83	25	28.2	43.7
	15.3	382	0.19	2.8	14.7	1.8	0.87	26.2	29.3	46.6
	12.6	375	0.72	2.9	11.8	1.8	0.9	27.1	36	150
	12.2	373	1.4	3	12.1	1.6	0.93	27.8	38	157
	12.6	321	0.86	2.9	11.3	1.6	0.88	26.5	30.9	47.9
Std Dev	1.29	28.6	0.499	0.114	1.39	0.245	0.037	1.05	4.29	58.9
95% UCL	15.86	412	1.65	3.08	14.98	2.28	0.954	28.56	40.85	204
Method	C	C	C	C	C	C	C	C	C	C
Construction Worker RBC	11,911	77,102	464	2,754	404	2,754	2,754	375	3,503	165,219
Delta	11,895	76,690	462	2,751	389	2,751	2,753	346	3,463	165,015
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Table C-3: RU 1 - Comparison between Site Data and Utility Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	16	3.1	152	0.72	19.3	1	18.2	6	9.8	510	9.6
	16.8	3.5	120	0.87	13.9	1.1	17.2	5.8	12.2	510	8.2
	17.4	4.5	137	0.46	35.8	1.1	29.8	3.1	9.6	2520	9.3
	17.8	2.1	127	0.41	18.4	1.8	31.5	3.7	11.3	3860	15.4
	17	2.3	122	1.3	12.8	1.7	21.2	4.2	9	1390	7.5
Std Dev	0.678	0.969	13.16	0.36	9.24	0.378	6.65	1.29	1.32	1436	3.13
95% UCL	18.32	4.99	157	1.45	38.1	2.08	36.5	7.07	12.96	4557	16.11
Method	C	C	C	C	C	C	C	C	C	C	C
Utility Worker RBC	1,370	196.6	116,514	866	68,492	1,154	7,205,461	742.1	286,470	432,328	800.00
Delta	1,352	191.6	116,357	864	68,454	1,152	7,205,425	735.0	286,457	427,771	783.89
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no	no	no	no	no
# Samples Needed											
# Samples Collected											
Sufficient samples to support comparison?											
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	14	329	0.23	2.7	11.5	2.2	0.83	25	28.2	43.7
	15.3	382	0.19	2.8	14.7	1.8	0.87	26.2	29.3	46.6
	12.6	375	0.72	2.9	11.8	1.8	0.9	27.1	36	150
	12.2	373	1.4	3	12.1	1.6	0.93	27.8	38	157
	12.6	321	0.86	2.9	11.3	1.6	0.88	26.5	30.9	47.9
Std Dev	1.29	28.6	0.499	0.114	1.39	0.245	0.037	1.05	4.29	58.9
95% UCL	15.86	412	1.65	3.08	14.98	2.28	0.954	28.56	40.85	204
Method	C	C	C	C	C	C	C	C	C	C
Utility Worker RBC	154,848	1,008,765	6,437	36,027	5,718	36,027	36,027	4,900	46,169	2,161,638
Delta	154,833	1,008,353	6,436	36,024	5,703	36,025	36,026	4,871	46,128	2,161,434
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's-t, C=Chebyshev, H=H-UCL

No Decision = There are insufficient samples available to support the decision at the prescibed alpha and beta levels

Table C-4: RU 1 - Comparison between Site Data and Background

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	16	3.1	152	0.72	19.3	1	18.2	6	9.8	510	9.6
	16.8	3.5	120	0.87	13.9	1.1	17.2	5.8	12.2	510	8.2
	17.4	4.5	137	0.46	35.8	1.1	29.8	3.1	9.6	2520	9.3
	17.8	2.1	127	0.41	18.4	1.8	31.5	3.7	11.3	3860	15.4
	17	2.3	122	1.3	12.8	1.7	21.2	4.2	9	1390	7.5
Std Dev	0.678	0.969	13.16	0.36	9.24	0.378	6.65	1.29	1.32	1436	3.13
95% UCL	18.32	4.99	157	1.45	38.1	2.08	36.5	7.07	12.96	4557	16.11
Method	C	C	C	C	C	C	C	C	C	C	C
Background	2.2	7.7	188	1	12.8	1.9	27.5	7.6	12.6	600	29.10
Delta	-16.12	2.71	31.00	-0.45	-25.30	-0.18	-9.00	0.53	-0.36	-3,957	12.99
Do soils exceed background?	yes	no	no	yes	yes	yes	yes	no	yes	yes	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	14	329	0.23	2.7	11.5	2.2	0.83	25	28.2	43.7
	15.3	382	0.19	2.8	14.7	1.8	0.87	26.2	29.3	46.6
	12.6	375	0.72	2.9	11.8	1.8	0.9	27.1	36	150
	12.2	373	1.4	3	12.1	1.6	0.93	27.8	38	157
	12.6	321	0.86	2.9	11.3	1.6	0.88	26.5	30.9	47.9
Std Dev	1.29	28.6	0.499	0.114	1.39	0.245	0.037	1.05	4.29	58.9
95% UCL	15.86	412	1.65	3.08	14.98	2.28	0.954	28.56	40.85	204
Method	C	C	C	C	C	C	C	C	C	C
Background	16.1	482	0.16	2.15	15.5	1.36	1.9	0.27	45.4	52.8
Delta	0.24	70.00	-1.49	-0.93	0.52	-0.92	0.95	-28.29	4.55	-151
Do soils exceed background?	no	no	yes	yes	no	yes	no	yes	no	yes

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's-t, C=Chebyshev, H=H-UCL

No Decision = There are insufficient samples available to support the decision at the prescibed alpha and beta levels

TABLE C-5: RU 4 Data Summary

Boring Designation	Sample Depth	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Fluoride	Iron	Lead	Lithium
	0-2 feet															
F028B	0	17000	7.8 U	5.4 UJ	152	1.3	44.6 J	1.3	149000	95.7 J	3.8	17 J	10300	12600	10.7	9.1
F049B	1.5	13700	17.2 UJ	3.5 J	154	0.43 U	18.4 UJ	1.1 U	31300	20.7	6	11	650	13500	11.4	11.1
	2-10 feet															
F066B	3	11100	15.4 UJ	0.53 UJ	180	0.59	19.9 U	1 U	27900	18.9	8.6	8.7	270	8840	6.3	7.9
F049B	4	15400	17.8 UJ	3.4 J	156	1.3 U	13.3 UJ	1.2 U	47900	18.4	6.1	12	600	11000	4.8	5.7
F066B	5	7570	16.1 UJ	2.2 U	147	0.51	9.2 U	1 U	44000	16.7	5.7	7.7	520	13100	9.2 U	13
F067B	5	15400	16.2 U	5.1	155	0.95	32.4 J	8.5	85400	48.9	4.8	11.6	4300	9520 J	14.8	11.5 J
F049B	6.5	11900	16.3 UJ	4.3 J	131	1.2 U	16.1 UJ	1.1 U	36600	17.9	5.4	9.4	510	10600 J	10 U	9.5 J
F049B	9	13700	17.4 UJ	2.5 J	136	1.3 U	22.8 UJ	1.1 U	37300	20	5.5	11.1	1240	9680 J	9.3 U	10.2 J
F067B	9	12400	16.3 U	5.3	123	0.43	16 UJ	1.1 U	33400	17.1	5.9	9.1	530	10700 J	8.5 U	10 J
F028B	10	9630	8.4 U	6.1 UJ	125	0.64	7.8 UJ	0.55 U	34200	12.9 J	5.3	9.1 J	430	9790	10.9	13.3
	>10 feet (not in an exposure pathway)															
F049B	11.5	11100	16.1 UJ	3.5 J	167	1.2 U	10.4 UJ	1 U	31200	20	5.6	9.9	930	11100 J	6.5 U	6.4 J
F028B	20	8560	8.2 U	5.4 UJ	82.9	0.52	5.4 UJ	0.53 U	19000	12.9 J	4.7	7.3 J	350	12200	7.1	11.4
F028B	30	9480	8.9 U	5.5 UJ	118	0.54	6 UJ	0.58 U	41100	12.8 J	5.1	9.1 J	390	13700	7.6	14
F028B	70	14600	10.6 U	4.1 UJ	125	0.84	8.6 UJ	0.69 U	47700	18.4 J	6.9	11.7 J	490	14800	10.8	17.3

Boring Designation	Sample Depth	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Orthophosphate	Total Phosphorus	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
	0-2 feet														
F028B	0	5700	309	1.1 J	2.7 U	7.3	1.6	860	NA	1.2 U	0.84 U	NA	25.1 U	23.7	56.1
F049B	1.5	8450	470 J	0.21	1.9 U	15.3	12.3	1100	2220	0.33 UJ	0.5 U	464	0.5 U	20.3	57.3
	2-10 feet														
F066B	3	11500	299 J	0.19	1.5 U	9.1	2.1	730	1340	0.3 UJ	0.47 U	345	0.47 U	14.9	34.6
F049B	4	2180	140 J	0.14	1.4 U	11.2	1.9	141	765	0.26 UJ	0.42 U	274	0.42 U	7.6	22.1
F066B	5	13400	285	0.09	3.1 U	12.1 U	2.4	630	2550	0.84 UJ	0.97 U	790	29 UJ	23.7	44.1
F067B	5	10000 J	220 J	1.8	4.9	24.8	22.7	13800	5590 J	47.5	3.4	964 J	11.9 U	146 J	328 J
F049B	6.5	13800 J	209 J	0.17 U	1.4 U	27.1	220	2460	2910 J	4.9	0.44 U	458 J	13.3 U	21.4 J	566 J
F049B	9	12200 J	323 J	0.09 U	1.4 U	36.6	163	1570	1920 J	2.8	0.44 U	447 J	13.2 U	19.5 J	32.5 J
F067B	9	8400 J	393 J	0.12 U	1.4 U	27	183	1410	1670 J	1.4	0.42 U	441 J	12.7 U	19.2 J	33.9 J
F028B	10	9030	259	1.1	2.7 UJ	11.6	7	1440	NA	2.1 UJ	1.1	NA	25.3 U	54.6	199
	>10 feet (not in an exposure pathway)														
F049B	11.5	5940 J	326 J	0.05 U	1.4 U	22.1	133	891	988 J	1.6	0.43 U	359 J	12.8 U	15.3 J	36.3 J
F028B	20	11400	366	0.16	2.8 UJ	11.1	3.8	569	NA	2.6 UJ	0.85 U	NA	25.4 U	26.2	46.8
F028B	30	11300	348	0.39 J	3 U	13.2	0.7	649	NA	1.9 U	0.91 U	NA	27.4 U	28.8	43.5
F028B	70	13100	430	0.37 J	2.9 U	12.5	1.3	643	NA	1.7 U	0.9 U	NA	27 U	29.5	51.7

All concentrations are in mg/kg

Table C-6: RU 4 - Comparison between Site Data and Construction Worker RBC's

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	7.8	5.4	152	1.3	44.6	1.3	95.7	3.8	17	10300	10.7
	17.2	3.5	154	0.43	18.4	1.1	20.7	6	11	650	11.4
	15.4	0.53	180	0.59	19.9	1	18.9	8.6	8.7	270	6.3
	17.8	3.4	156	1.3	13.3	1.2	18.4	6.1	12	600	4.8
	16.1	2.2	147	0.51	9.2	1	16.7	5.7	7.7	520	9.2
	16.2	5.1	155	0.95	32.4	8.5	48.9	4.8	11.6	4300	14.8
	16.3	4.3	131	1.2	16.1	1.1	17.9	5.4	9.4	510	10
	17.4	2.5	136	1.3	22.8	1.1	20	5.5	11.1	1240	9.3
	16.3	5.3	123	0.43	16	1.1	17.1	5.9	9.1	530	8.5
	8.4	6.1	125	0.64	7.8	0.55	12.9	5.3	9.1	430	10.9
Distribution	NC	NC	N	NC	N	NC	NC	N	N	NC	NC
Std Dev	3.65	1.74	17.4	0.38	11.1	2.36	25.6	1.22	2.63	3171	2.76
95% UCL	19.9	6.23	156	1.39	26.5	5.05	64	6.42	12.19	6307	13.4
Method	C	C	S	C	S	C	C	S	S	C	C
Construction Worker RBC	104	14.6	8,355	61	5,213	81.3	550,729	52.2	22,036	33,044	800.00
Delta	84.40	8.37	8,199	59.61	5,186	76.25	550,665	45.78	22,024	26,737	786.60
Is 95% UCL > 10% RBC?	yes	yes	no	no	no	no	no	yes	no	yes	no
# Samples Needed	2	2						2		2	
# Samples Collected	6	6						6		6	
Sufficient samples to support comparison?	**yes**	**yes**						**yes**		**yes**	
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	9.1	309	1.1	2.7	7.3	1.2	0.84	25.1	23.7	56.1
	11.1	470	0.21	1.9	15.3	0.33	0.5	0.5	20.3	57.3
	7.9	299	0.19	1.5	9.1	0.3	0.47	0.47	14.9	34.6
	5.7	140	0.14	1.4	11.2	0.26	0.42	0.42	7.6	22.1
	13	285	0.09	3.1	12.1	0.84	0.97	29	23.7	44.1
	11.5	220	1.8	4.9	24.8	47.5	3.4	11.9	146	328
	9.5	209	0.17	1.4	27.1	4.9	0.44	13.3	21.4	566
	10.2	323	0.09	1.4	36.6	2.8	0.44	13.2	19.5	32.5
	10	393	0.12	1.4	27	1.4	0.42	12.7	19.2	33.9
	13.3	259	1.1	2.7	11.6	2.1	1.1	25.3	54.6	199
Distribution	N	N	NC	NC	NC	NC	NC	NC	L	L
Std Dev	2.29	94	0.61	1.14	9.88	14.59	0.915	10.68	40.83	180.0
95% UCL	11.46	345	1.34	3.81	31.83	26.28	2.16	27.91	68.3	464
Method	S	S	C	C	C	C	C	C	H	H
Construction Worker RBC	11,911	77,102	464	2,754	404	2,754	2,754	375	3,503	165,219
Delta	11,900	76,757	463	2,750	372	2,727	2,751	347	3,435	164,755
Is 95% UCL > 10% RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

Table C-7: RU 4 Comparison between Site Data and Utility Worker RBC's

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	7.8	5.4	152	1.3	44.6	1.3	95.7	3.8	17	10300	10.7
	17.2	3.5	154	0.43	18.4	1.1	20.7	6	11	650	11.4
	15.4	0.53	180	0.59	19.9	1	18.9	8.6	8.7	270	6.3
	17.8	3.4	156	1.3	13.3	1.2	18.4	6.1	12	600	4.8
	16.1	2.2	147	0.51	9.2	1	16.7	5.7	7.7	520	9.2
	16.2	5.1	155	0.95	32.4	8.5	48.9	4.8	11.6	4300	14.8
	16.3	4.3	131	1.2	16.1	1.1	17.9	5.4	9.4	510	10
	17.4	2.5	136	1.3	22.8	1.1	20	5.5	11.1	1240	9.3
	16.3	5.3	123	0.43	16	1.1	17.1	5.9	9.1	530	8.5
	8.4	6.1	125	0.64	7.8	0.55	12.9	5.3	9.1	430	10.9
Distribution			N		N			N	N		
Std Dev	3.65	1.74	17.4	0.38	11.1	2.36	25.6	1.22	2.63	3171	2.76
95% UCL	19.9	6.23	156	1.39	26.5	5.05	64	6.42	12.19	6307	13.4
Method	C	C	S	C	S	C	C	S	S	C	C
Utility Worker RBC	1,370	196.61	116,514	865.79	68,492	1,154	7,205,461	742.11	286,470	432,328	800.00
Delta	1,350	190.38	116,358	864.40	68,466	1,149	7,205,397	735.69	286,458	426,021	786.60
Is 95% UCL > 10% RBC?	no	no	no	no	no	no	no	no	no	no	no
# Samples Needed											
# Samples Collected											
Sufficient samples to support comparison?											
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	9.1	309	1.1	2.7	7.3	1.2	0.84	25.1	23.7	56.1
	11.1	470	0.21	1.9	15.3	0.33	0.5	0.5	20.3	57.3
	7.9	299	0.19	1.5	9.1	0.3	0.47	0.47	14.9	34.6
	5.7	140	0.14	1.4	11.2	0.26	0.42	0.42	7.6	22.1
	13	285	0.09	3.1	12.1	0.84	0.97	29	23.7	44.1
	11.5	220	1.8	4.9	24.8	47.5	3.4	11.9	146	328
	9.5	209	0.17	1.4	27.1	4.9	0.44	13.3	21.4	566
	10.2	323	0.09	1.4	36.6	2.8	0.44	13.2	19.5	32.5
	10	393	0.12	1.4	27	1.4	0.42	12.7	19.2	33.9
	13.3	259	1.1	2.7	11.6	2.1	1.1	25.3	54.6	199
Distribution	N	N							L	L
Std Dev	2.29	94	0.61	1.14	9.88	14.59	0.915	10.68	40.83	180.0
95% UCL	11.46	345	1.34	3.81	31.83	26.28	2.16	27.91	68.3	464
Method	S	S	C	C	C	C	C	C	H	H
Utility Worker RBC	154,848	1,008,765	6,437	36,027	5,718	36,027	36,027	4,900	46,169	2,161,638
Delta	154,837	1,008,420	6,436	36,023	5,686	36,001	36,025	4,872	46,101	2,161,174
Is 95% UCL > 10% RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

Table C-8: RU 4 Comparison between Site Data and Background

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	7.8	5.4	152	1.3	44.6	1.3	95.7	3.8	17	10300	10.7
	17.2	3.5	154	0.43	18.4	1.1	20.7	6	11	650	11.4
	15.4	0.53	180	0.59	19.9	1	18.9	8.6	8.7	270	6.3
	17.8	3.4	156	1.3	13.3	1.2	18.4	6.1	12	600	4.8
	16.1	2.2	147	0.51	9.2	1	16.7	5.7	7.7	520	9.2
	16.2	5.1	155	0.95	32.4	8.5	48.9	4.8	11.6	4300	14.8
	16.3	4.3	131	1.2	16.1	1.1	17.9	5.4	9.4	510	10
	17.4	2.5	136	1.3	22.8	1.1	20	5.5	11.1	1240	9.3
	16.3	5.3	123	0.43	16	1.1	17.1	5.9	9.1	530	8.5
	8.4	6.1	125	0.64	7.8	0.55	12.9	5.3	9.1	430	10.9
Distribution			N		N			N	N		
Std Dev	3.65	1.74	17.4	0.38	11.1	2.36	25.6	1.22	2.63	3171	2.76
95% UCL	19.9	6.23	156	1.39	26.5	5.05	64	6.42	12.19	6307	13.4
Method	C	C	S	C	S	C	C	S	S	C	C
Background	2.2	7.7	188	1	12.8	1.9	27.5	7.6	12.6	600	29.1
Delta	-17.7	1.47	32	-0.39	-13.7	-3.15	-36.5	1.18	0.41	-5707	15.7
Do soils exceed Background?	yes	no	no	yes	yes	yes	yes	yes	no	yes	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	9.1	309	1.1	2.7	7.3	1.2	0.84	25.1	23.7	56.1
	11.1	470	0.21	1.9	15.3	0.33	0.5	0.5	20.3	57.3
	7.9	299	0.19	1.5	9.1	0.3	0.47	0.47	14.9	34.6
	5.7	140	0.14	1.4	11.2	0.26	0.42	0.42	7.6	22.1
	13	285	0.09	3.1	12.1	0.84	0.97	29	23.7	44.1
	11.5	220	1.8	4.9	24.8	47.5	3.4	11.9	146	328
	9.5	209	0.17	1.4	27.1	4.9	0.44	13.3	21.4	566
	10.2	323	0.09	1.4	36.6	2.8	0.44	13.2	19.5	32.5
	10	393	0.12	1.4	27	1.4	0.42	12.7	19.2	33.9
	13.3	259	1.1	2.7	11.6	2.1	1.1	25.3	54.6	199
Distribution	N	N							L	L
Std Dev	2.29	94	0.61	1.14	9.88	14.59	0.915	10.68	40.83	180.0
95% UCL	11.46	345	1.34	3.81	31.83	26.28	2.16	27.91	68.3	464
Method	S	S	C	C	C	C	C	C	H	H
Background	16.1	482	0.16	2.15	15.5	1.36	1.9	0.27	45.4	52.8
Delta	4.64	137	-1.18	-1.66	-16.33	-24.92	-0.26	-27.64	-22.9	-411.2
Do soils exceed Background?	no	no	yes	yes	yes	yes	yes	yes	yes	yes

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-9: RU 7 Data Summary

Boring Designation	Sample Depth	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Fluoride	Iron	Lead	Lithium
	0-2 feet															
F091B	0	7290	15.2 UJ	4.4	93.2	0.81	5.8 J	7.1	34800	66.1	4.1	16.3	1060	14400 J	6.3 U	6.3 J
F092B	0	9830	16 UJ	15.2	121	2.7	68.1 J	83.3	212000	689	1.6	109	18500	15500 J	6.6 U	6.2 J
F132B	0	10900	6 J	11.1	99.6 J	2	64	124	NA	670	0.33	102	19700	6350 J	14 U	13.1 J
F119R	0.5	11300	15.8 UJ	10.5	109	2.7	62.7 J	98.9	226000	728 J	1.4	101 J	15660	9230	8.2 U	10.7 U
F091B	2	13900	16.2 UJ	2.9	137	1	14.4 J	3	48100	36.9	5.8	11.2	1030	13100 J	7.9 U	15 J
F092B	2	14100	17.5 UJ	4.1	151	1	12.6 J	1.1 U	44700	20.4	6.4	10.9	530	12600 J	9.2 U	12 J
F119R	2	11100	16.2 U	35	110	2.7	88.4 J	94.2	219000	744	2.2	106	20000	8720	9.4	10 U
	2-10 feet															
F132B	2.5	10100	4.8 UJ	25.7	90.5 J	2	51.4	104	NA	709	0.32	111	17300	13200 J	8.2 U	5.6 J
F090B	3	11300	16.1 UJ	8.9	113	2.9	54.2 J	94.6	228000	781	0.84 U	106	18000	15300 J	7.4 U	3.2 UJ
F093B	3	17200	16.3 UJ	5.3	147	0.86	15.4 U	2.4	42700	29.5	6.9	13.6	2070	12900 J	7.3 U	15.1 J
F090B	5	13000	16.1 UJ	9.1	125	3.1	60.1 J	108	212000	871	1.1	119	17300	11700 J	4.6 U	8.6 J
F093B	5	17100	15.9 UJ	2.8	166	0.75	20.2 U	1 U	52000	24.8	7.1	11.5	510	8870 J	3.5 U	6.3 J
F132B	5	11500	4.7 UJ	3.5	121 J	0.63	10.1 U	1.2	NA	17.5	5.3	8.8	560	12600	10.1 J	6.1
F094B	6	13300	16 UJ	2.7	145	0.79	14.1 U	1 U	31200	17.2	5.8	10.6	480	16400	9.6	8.4
F132B	7.5	10800	4.8 UJ	3.4	121 J	0.62	6.5 U	0.32 U	NA	14.3	5.3	8.4	470	11300	98.7 J	11.8
F094B	8	13300	16.7 UJ	0.55 UJ	127	0.78	16.8 U	1.1 U	37200	18.2	6.7	11.1	420	12500	9.1	11.4
F132B	10	11500	4.7 UJ	4	113 J	0.61	9.8 U	0.5 U	NA	15.4	5.4	8.5	430	12100	8.4 J	12.4

Boring Designation	Sample Depth	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Orthophosphate	Total Phosphorus	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
	0-2 feet														
F091B	0	2440 J	329 J	0.08 U	1.3 U	13.2	145	705	903 J	1.6	0.42 U	463 J	12.5 U	15.9 J	40.7 J
F092B	0	2160 J	363 J	0.15 U	1.3 U	8.1	129	681	938 J	0.94	0.41 U	455 J	12.2 U	15.8 J	48.2 J
F132B	0	5400 J	319 J	0.08 U	7.3	54.2	41.6	20200	5680 J	6.2	6.5	2070 J	12 U	299 J	644 J
F119R	0.5	2180	121	0.52	19.9 U	128 J	14.6	52500		10.1	6.7		24.7 U	917 J	1040
F091B	2	11400 J	370 J	0.71 U	1.4 U	11.7	6.8	747	3640 J	0.29 UJ	0.44 U	705 J	13.2 U	26 J	45.6 J
F092B	2	14000 J	359 J	1.7	1.5 U	11.8	3.1	744	2510 J	0.29 UJ	0.46 UJ	519 J	13.9 U	28 J	44.1 J
F119R	2	2230	148	0.46	25.8	153	22.3	35600		15.2 J	6.8		25.2 U	1000	1190
	2-10 feet														
F132B	2.5	2950 J	238 J	1	1.3 U	10.3	1.8	146	1220 J	0.27 U	0.42 U	266 J	12.5 U	11.8 J	22.8 J
F090B	3	1350 J	260 J	0.11 U	4.8	8.6	2	268	870 J	0.25 UJ	0.83	275 J	12.4 U	9.3 J	27 J
F093B	3	9110 J	369 J	1.1	1.5 U	12.6	2.8	685	2770 J	0.3 UJ	0.46 U	716 J	13.9 U	23.3 J	41.9 J
F090B	5	4990 J	340 J	0.71 U	1.5 U	12.5	1.9	404	1700 J	0.29 UJ	0.46 U	1280 J	13.8 U	17.6 J	32.4 J
F093B	5	3650 J	247 J	0.12 U	1.4 U	4.5	45.2	840	902 J	0.28 UJ	0.45 U	586 J	13.4 U	10.3 J	28.8 J
F132B	5	3550	239 J	0.06 U	4.5	10	1530 J	33400	13600	1.3 UJ	0.88 U	856	26.4 U	30.7	19300 J
F094B	6	4020	110	0.27 U	1.5	15.3	138 J	5760 J	12200	7.6	0.34 U	20 U	14.9	139	1050
F132B	7.5	9970	651 J	0.06 U	3.3	45.4	2280	49900	8670	3 UJ	26.8	1040	26.8 U	90.8	4250 J
F094B	8	15100	274	0.12 U	1.5 U	24.8	112 J	2640	4660	1.2	0.34 U	80	2.9	28.9	1220
F132B	10	12200	356 J	0.05 U	2.6 U	12.6	750 J	2500	4510	1.4 UJ	0.81 U	712	24.4 U	23.4	46.7 J

all concentrations are in mg/kg

TABLE C-10: RU 7 Comparison between Site Data and Site Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	15.2	4.4	93.2	0.81	5.8	7.1	66.1	4.1	16.3	1060	6.3
	16	15.2	121	2.7	68.1	83.3	689	1.6	109	18500	6.6
	6	11.1	99.6	2	64	124	670	0.33	102	19700	14
	15.8	10.5	109	2.7	62.7	98.9	728	1.4	101	15660	8.2
	16.2	2.9	137	1	14.4	3	36.9	5.8	11.2	1030	7.9
	17.5	4.1	151	1	12.6	1.1	20.4	6.4	10.9	530	9.2
	16.2	35	110	2.7	88.4	94.2	744	2.2	106	20000	9.4
Std Dev	3.9	11.1	20.6	0.89	33.2	52.900	357	2.340	49.1	9508	2.58
95% UCL	21.1	30.24	151	3.30	99.80	146	1011	6.970	146	26591	13
Method	C	C	C	C	C	C	C	C	C	C	C
Site Worker Updated RBC	454.06	1.76	67,649	1,060	101,628	894.00	1,702,725	908.00	42,015	68,109	800.00
Delta	432.96	-28.48	67,498	1,056	101,529	748.00	1,701,714	901.03	41,869	41,518	787.00
# Samples Needed		4				2					
# Samples Collected		7				7					
Sufficient samples to support comparison?		**yes**				**yes**					
Do soils exceed RBC's?	no	**yes**	no	no	no	no	no	no	no	no	no
Site Worker RBC (1998)	359.00	1.43	61,600	0.58	80,600	448.00	896,000		33,300	53,800	NC
Delta	337.90	-28.81	61,449	-2.72	80,500	302.00	894,989		33,154	27,209	NC
# Samples Needed		4		3		2					
# Samples Collected		7		7		7					
Sufficient samples to support comparison?		**yes**		**yes**		**yes**					
Do soils exceed RBC's?	no	yes	no	yes	no	no	no		no	no	

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	6.3	329	0.08	1.3	13.2	1.6	0.42	12.5	15.9	40.7
	6.2	363	0.15	1.3	8.1	0.94	0.41	12.2	15.8	48.2
	13.1	319	0.08	7.3	54.2	6.2	6.5	12	299	644
	10.7	121	0.52	19.9	128	10.1	6.7	24.7	917	1040
	15	370	0.71	1.4	11.7	0.29	0.44	13.2	26	45.6
	12	359	1.7	1.5	11.8	0.29	0.46	13.9	28	44.1
	10	148	0.46	25.8	153	15.2	6.8	25.2	1000	1190
Std Dev	3.31	106	0.571	10.280	61.400	5.83	3.333	5.98	443	515
95% UCL	15.90	462	1.469	25.29	155.44	14.55	8.6	26.1	1058	1284
Method	C	C	C	C	C	C	C	C	C	C
Site Worker Updated RBC	22,711	35,325	340.00	5,676	10,597	5,676	5,676	77.19	7,949	340,545
Delta	22,695	34,863	338.53	5,651	10,442	5,661	5,667	51.09	6,891	339,261
Is 95% UCL > 10% RBC?	no	no	no	no	no	no	no	yes	yes	no
# Samples Needed								2	2	
# Samples Collected								7	7	
Sufficient samples to support comparison?								**yes**	**yes**	
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no
Site Worker RBC (1998)	17,900	4,480	269.00	4,480	17,900	4,480	4,480	71.70	6,280	269,000
Delta	17,884	4,018	267.53	4,455	17,745	4,465	4,471	45.60	5,222	267,716
Is 95% UCL > 10% RBC?	no	yes	no	no	no	no	no	yes	yes	no
# Samples Needed		2						2	2	
# Samples Collected		7						7	7	
Sufficient samples to support comparison?		**yes**						**yes**	**yes**	
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-11: RU 7 Comparison between Site Data and Construction Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	15.2	4.4	93.2	0.81	5.8	7.1	66.1	4.1	16.3	1060	6.3
	16	15.2	121	2.7	68.1	83.3	689	1.6	109	18500	6.6
	6	11.1	99.6	2	64	124	670	0.33	102	19700	14
	15.8	10.5	109	2.7	62.7	98.9	728	1.4	101	15660	8.2
	16.2	2.9	137	1	14.4	3	36.9	5.8	11.2	1030	7.9
	17.5	4.1	151	1	12.6	1.1	20.4	6.4	10.9	530	9.2
	16.2	35	110	2.7	88.4	94.2	744	2.2	106	20000	9.4
	4.8	25.7	90.5	2	51.4	104	709	0.32	111	17300	8.2
	16.1	8.9	113	2.9	54.2	94.6	781	0.84	106	18000	7.4
	16.3	5.3	147	0.86	15.4	2.4	29.5	6.9	13.6	2070	7.3
	16.1	9.1	125	3.1	60.1	108	871	1.1	119	17300	4.6
	15.9	2.8	166	0.75	20.2	1	24.8	7.1	11.5	510	3.5
	4.7	3.5	121	0.63	10.1	1.2	17.5	5.3	8.8	560	10.1
	16	2.7	145	0.79	14.1	1	17.2	5.8	10.6	480	9.6
	4.8	3.4	121	0.62	6.5	0.32	14.3	5.3	8.4	470	98.7
	16.7	0.55	127	0.78	16.8	1.1	18.2	6.7	11.1	420	9.1
	4.7	4	113	0.61	9.8	0.5	15.4	5.4	8.5	430	8.4
Distribution		L	N	U			U	N	U	U	
Std Dev	3.9	11.14	20.6	0.89	33.2	52.96	357	2.34	49.1	9508	2.58
95% UCL	21.1	41.15	132.4	3.3	69.5	146	1011	4.84	146	26591	13
Method	C	H	S	C	S	C	C	S	C	C	C
Construction Worker RBC	104	14.6	8,355	61	5,213	81.3	550,729	52.2	22,036	33,044	800.00
Delta	83.20	-26.55	8,222.80	57.70	5,143.40	-64.70	549,718.00	47.36	21,890.00	6,453.00	787.00
Is 95% UCL > 10% RBC?	yes	yes	no	no	no	yes	no	no	no	yes	no
# Samples Needed	2	4				9				24	
# Samples Collected	17	17				17				17	
Sufficient samples to support comparison?	**yes**	**yes**				**yes**				**no**	
Do soils exceed RBC's?	no	yes	no	no	no	yes	no	no	no	No Decision	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	6.3	329	0.08	1.3	13.2	1.6	0.42	12.5	15.9	40.7
	6.2	363	0.15	1.3	8.1	0.94	0.41	12.2	15.8	48.2
	13.1	319	0.08	7.3	54.2	6.2	6.5	12	299	644
	10.7	121	0.52	19.9	128	10.1	6.7	24.7	917	1040
	15	370	0.71	1.4	11.7	0.29	0.44	13.2	26	45.6
	12	359	1.7	1.5	11.8	0.29	0.46	13.9	28	44.1
	10	148	0.46	25.8	153	15.2	6.8	25.2	1000	1190
	5.6	238	1	1.3	10.3	0.27	0.42	12.5	11.8	22.8
	3.2	260	0.11	4.8	8.6	0.25	0.83	12.4	9.3	27
	15.1	369	1.1	1.5	12.6	0.3	0.46	13.9	23.3	41.9
	8.6	340	0.71	1.5	12.5	0.29	0.46	13.8	17.6	32.4
	6.3	247	0.12	1.4	4.5	0.28	0.45	13.4	10.3	28.8
	6.1	239	0.06	4.5	10	1.3	0.88	26.4	30.7	19300
	8.4	110	0.27	1.5	15.3	7.6	0.34	14.9	139	1050
	11.8	651	0.06	3.3	45.4	3	26.8	26.8	90.8	4250
	11.4	274	0.12	1.5	24.8	1.2	0.34	2.9	28.9	1220
	12.4	356	0.05	2.6	12.6	1.4	0.81	24.4	23.4	46.7
Distribution	N	U			L				U	U
Std Dev	3.308	106.1	0.571	10.28	61.4	4.31	6.55	6.73	310	4653
95% UCL	12.9	461.7	1.47	25.29	160.2	7.52	10.08	23.3	486	6629
Method	S	C	C	C	C	C	C	C	C	C
Construction Worker RBC	11,911	77,102	464	2,754	404	2,754	2,754	375	3,503	165,219
Delta	11,898	76,640	463	2,728	244	2,746	2,744	351	3,017	158,590
Is 95% UCL > 10% RBC?	no	no	no	no	yes	no	no	no	yes	no
# Samples Needed					3				2	
# Samples Collected					17				17	
Sufficient samples to support comparison?					**yes**				**yes**	
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-12: RU 7 Comparison between Site Data and Utility Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	15.2	4.4	93.2	0.81	5.8	7.1	66.1	4.1	16.3	1060	6.3
	16	15.2	121	2.7	68.1	83.3	689	1.6	109	18500	6.6
	6	11.1	99.6	2	64	124	670	0.33	102	19700	14
	15.8	10.5	109	2.7	62.7	98.9	728	1.4	101	15660	8.2
	16.2	2.9	137	1	14.4	3	36.9	5.8	11.2	1030	7.9
	17.5	4.1	151	1	12.6	1.1	20.4	6.4	10.9	530	9.2
	16.2	35	110	2.7	88.4	94.2	744	2.2	106	20000	9.4
	4.8	25.7	90.5	2	51.4	104	709	0.32	111	17300	8.2
	16.1	8.9	113	2.9	54.2	94.6	781	0.84	106	18000	7.4
	16.3	5.3	147	0.86	15.4	2.4	29.5	6.9	13.6	2070	7.3
	16.1	9.1	125	3.1	60.1	108	871	1.1	119	17300	4.6
	15.9	2.8	166	0.75	20.2	1	24.8	7.1	11.5	510	3.5
	4.7	3.5	121	0.63	10.1	1.2	17.5	5.3	8.8	560	10.1
	16	2.7	145	0.79	14.1	1	17.2	5.8	10.6	480	9.6
	4.8	3.4	121	0.62	6.5	0.32	14.3	5.3	8.4	470	98.7
	16.7	0.55	127	0.78	16.8	1.1	18.2	6.7	11.1	420	9.1
	4.7	4	113	0.61	9.8	0.5	15.4	5.4	8.5	430	8.4
Distribution		L	N	U			U	N	U	U	
Std Dev	3.9	11.14	20.6	0.89	33.2	52.96	357	2.34	49.1	9508	2.58
95% UCL	21.1	41.15	132.4	3.3	69.5	146	1011	4.84	146	26591	13
Method	C	H	S	C	S	C	C	S	C	C	C
Utility Worker RBC	1,370	196.61	116,514	865.79	68,492	1,154.39	7,205,461	742.11	286,470	432,328	800.00
Delta	1,349	155.46	116,381	862.49	68,423	1,008.39	7,204,450	737.27	286,324	405,737	787.00
Is 95% UCL > 10% RBC?	no	yes	no	no	no	no	no	no	no	no	no
# Samples Needed		2									
# Samples Collected		17									
Sufficient samples to support comparison?		**yes**									
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	6.3	329	0.08	1.3	13.2	1.6	0.42	12.5	15.9	40.7
	6.2	363	0.15	1.3	8.1	0.94	0.41	12.2	15.8	48.2
	13.1	319	0.08	7.3	54.2	6.2	6.5	12	299	644
	10.7	121	0.52	19.9	128	10.1	6.7	24.7	917	1040
	15	370	0.71	1.4	11.7	0.29	0.44	13.2	26	45.6
	12	359	1.7	1.5	11.8	0.29	0.46	13.9	28	44.1
	10	148	0.46	25.8	153	15.2	6.8	25.2	1000	1190
	5.6	238	1	1.3	10.3	0.27	0.42	12.5	11.8	22.8
	3.2	260	0.11	4.8	8.6	0.25	0.83	12.4	9.3	27
	15.1	369	1.1	1.5	12.6	0.3	0.46	13.9	23.3	41.9
	8.6	340	0.71	1.5	12.5	0.29	0.46	13.8	17.6	32.4
	6.3	247	0.12	1.4	4.5	0.28	0.45	13.4	10.3	28.8
	6.1	239	0.06	4.5	10	1.3	0.88	26.4	30.7	19300
	8.4	110	0.27	1.5	15.3	7.6	0.34	14.9	139	1050
	11.8	651	0.06	3.3	45.4	3	26.8	26.8	90.8	4250
	11.4	274	0.12	1.5	24.8	1.2	0.34	2.9	28.9	1220
	12.4	356	0.05	2.6	12.6	1.4	0.81	24.4	23.4	46.7
Distribution	N	U			L				U	U
Std Dev	3.308	106.1	0.571	10.28	61.4	4.31	6.55	6.73	310	4653
95% UCL	12.9	461.7	1.47	25.29	160.2	7.52	10.08	23.3	486	6629
Method	S	C	C	C	C	C	C	C	C	C
Utility Worker RBC	154,848	1,008,765	6,437	36,027	5,718	36,027	36,027	4,900	46,169	2,161,638
Delta	154,836	1,008,303	6,436	36,002	5,557	36,020	36,017	4,876	45,683	2,155,009
Is 95% UCL > 10% RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-13: RU 7 Comparison between Site Data and Background

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	7.6	4.4	93.2	0.81	5.8	7.1	66.1	4.1	16.3	1060	3.15
	8	15.2	121	2.7	68.1	83.3	689	1.6	109	18500	3.3
	6	11.1	99.6	2	64	124	670	0.33	102	19700	7
	7.9	10.5	109	2.7	62.7	98.9	728	1.4	101	15660	4.1
	8.1	2.9	137	1	14.4	3	36.9	5.8	11.2	1030	3.95
	8.75	4.1	151	1	12.6	0.55	20.4	6.4	10.9	530	4.6
	8.1	35	110	2.7	88.4	94.2	744	2.2	106	20000	9.4
	2.4	25.7	90.5	2	51.4	104	709	0.32	111	17300	4.1
	8.05	8.9	113	2.9	54.2	94.6	781	0.42	106	18000	3.7
	8.15	5.3	147	0.86	7.7	2.4	29.5	6.9	13.6	2070	3.65
	8.05	9.1	125	3.1	60.1	108	871	1.1	119	17300	2.3
	7.95	2.8	166	0.75	10.1	0.5	24.8	7.1	11.5	510	1.75
	2.35	3.5	121	0.63	5.05	1.2	17.5	5.3	8.8	560	10.1
	8	2.7	145	0.79	7.05	0.5	17.2	5.8	10.6	480	9.6
	2.4	3.4	121	0.62	3.25	0.16	14.3	5.3	8.4	470	98.7
	8.35	0.275	127	0.78	8.4	0.55	18.2	6.7	11.1	420	9.1
	2.35	4	113	0.61	4.9	0.25	15.4	5.4	8.5	430	8.4
Distribution	U	L	N	U			U	N	U	U	
Std Dev	3.9	11.14	20.6	0.89	33.2	52.96	357	2.34	49.1	9508	2.58
95% UCL	21.1	41.15	132.4	3.3	69.5	146	1011	4.84	146	26591	13
Method	C	H	S	C	S	C	C	S	C	C	C
Background	2.2	7.7	188	1	12.8	1.9	27.5	7.6	12.6	600	29.1
Delta	-18.9	-33.45	55.6	-2.3	-56.7	-144.1	-983.5	2.76	-133.4	-25991	16.1
Do soils exceed Background?	yes	yes	no	yes	yes	yes	yes	no	yes	yes	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	6.3	329	0.08	1.3	13.2	1.6	0.42	12.5	15.9	40.7
	6.2	363	0.15	1.3	8.1	0.94	0.41	12.2	15.8	48.2
	13.1	319	0.08	7.3	54.2	6.2	6.5	12	299	644
	10.7	121	0.52	19.9	128	10.1	6.7	24.7	917	1040
	15	370	0.71	1.4	11.7	0.29	0.44	13.2	26	45.6
	12	359	1.7	1.5	11.8	0.29	0.46	13.9	28	44.1
	10	148	0.46	25.8	153	15.2	6.8	25.2	1000	1190
	5.6	238	1	1.3	10.3	0.27	0.42	12.5	11.8	22.8
	3.2	260	0.11	4.8	8.6	0.25	0.83	12.4	9.3	27
	15.1	369	1.1	1.5	12.6	0.3	0.46	13.9	23.3	41.9
	8.6	340	0.71	1.5	12.5	0.29	0.46	13.8	17.6	32.4
	6.3	247	0.12	1.4	4.5	0.28	0.45	13.4	10.3	28.8
	6.1	239	0.06	4.5	10	1.3	0.88	26.4	30.7	19300
	8.4	110	0.27	1.5	15.3	7.6	0.34	14.9	139	1050
	11.8	651	0.06	3.3	45.4	3	26.8	26.8	90.8	4250
	11.4	274	0.12	1.5	24.8	1.2	0.34	2.9	28.9	1220
	12.4	356	0.05	2.6	12.6	1.4	0.81	24.4	23.4	46.7
Distribution	N	U			L				U	U
Std Dev	3.308	106.1	0.571	10.28	61.4	4.31	6.55	6.73	310	4653
95% UCL	12.9	461.7	1.47	25.29	160.2	7.52	10.08	23.3	486	6629
Method	S	C	C	C	C	C	C	C	C	C
Background	16.1	482	0.16	2.15	15.5	1.36	1.9	0.27	45.4	52.8
Delta	3.2	20.3	-1.31	-23	-144.7	-6.16	-8.18	-23.03	-440.6	-6576
Do soils exceed Background?	no	no	yes	yes	yes	yes	yes	yes	yes	yes

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-14: RU 9 Data Summary

Boring Designation	Sample Depth	Aluminum	Antimony		Arsenic		Barium	Beryllium		Boron		Cadmium		Calcium	Chromium	Cobalt		Copper	Fluoride	Iron	Lead	
	0-2 feet																					
F130B	0	5760	3.9	UJ	1.9		97.7	1.3		217		77.7		264000	304	0.4	U	77.7	37400	12400	13.6	J
F110B	0.5	20600	16.5	UJ	6	J	201	1.5	U	55.7	J	32.8		132000	182	5.5		48.8	4420	9390	6.6	U
	2-10 feet																					
F110B	2.5	16300	18.4	UJ	3.1	J	155	0.46	U	16.5	UJ	3.3		42500	26.8	6.1		13.1	1460	14400	10.1	
F130B	10	16900	4.5	UJ	11.3		159	1.5		12.1		281		36800	22.8	9		10.8	3380	12300	9.1	J
>10 feet (not in an exposure pathway																						
F130B	20	9560	4.6	UJ	11.5		139	1.1		5.3	UJ	176		49100	13.1	8.1		11.1	1390	12700	13.5	J
F130B	30	3080	4	UJ	2.4		59.1	0.3		3.2	U	76		6530	22.7	2.4		5.7	349	13500	9.4	J
F054B	40	18600	18.7	UJ	13.7	J	144	1.7		19.2	UJ	286		42200	22.2	9.5		11.7	2700	11300	69.7	J
F130B	40	1720	3.8	UJ	4.5		38.3	0.17		2.4	U	18.3		4900	5.7	3.4		6.1	108	13400	14.7	J
F054B	42.5	11700	16.5	UJ	7.7	UJ	127	1.4		13.3	UJ	355		43200	16.8	6.7		8.1	1720	12300	12.5	J
F054B	45	9780	15.9	UJ	5.9	UJ	79.5	0.84		9.4	UJ	123		39600	14.1	7.5		7.8	1280	12700	11.3	J
F054B	47.5	7540	16.3	UJ	12.5	J	92.1	0.62		10	UJ	89		26600	11.1	6.4		7.4	840	14300	21.3	
F054B	50	12900	16.4	UJ	5.3		115	0.91		15.7	J	111		43500	19.2	7.1		8.3	920	14800	11	
F130B	50	1810	3.8	UJ	12.4		30.8	0.31		2.1	U	16		1960	8.9	4.9		14.2	244	13300	6.6	U
F130B	60	2290	8.2	J	3		72.5	0.38		1.8	U	1		6380	5.7	3.9		14.2	232	13600	7.2	
F130B	70	15200	4.8	UJ	7.4		139	1		7.2	U	0.41		4820	20.5	8		10.3	540	15200	6.6	U
F130B	80	8840	4.5	UJ	3.7		185	0.7		9.7		1.1		19000	18.9	7.7		38.3	325	9030	209	
F130B	100	8820	4.7	UJ	3.1		116	0.66		5.1	U	0.36	U	26400	12.8	6.1		6.9	378	8530	48.7	

Boring Designation	Sample Depth	Lithium		Magnesium	Manganese		Mercury		Molybdenum		Nickel	Orthophosphate	Total Phosphorus	Potassium	Selenium		Silver		Sodium	Thallium		Vanadium	Zinc	
	0-2 feet																							
F130B	0	12.8		13100	402	J	0.06	U	2.9	U	13	295	1920	4710	1.5	UJ	0.88	U	685	26.4	U	22.4	54.7	J
F110B	0.5	30		10600	490	J	1.1	J	5.7	U	28.5	9.8	3370	6020	1.2		3.3		1910	25.7	U	183	400	
	2-10 feet																							
F110B	2.5	16.1		11300	398	J	0.41	J	3.1	U	15.8	8.1	2030	4080	1.7		0.96	U	922	28.7	U	36.7	67.4	
F130B	10	13		15000	399	J	0.06	U	2.7	U	13.3	452	2320	5050	1.5	UJ	0.84	U	853	25.3	U	23.1	50.7	J
>10 feet (not in an exposure pathway																								
F130B	20	13.2		8280	487	J	0.05	U	2.8	U	25.8	950	8850	5640	1.8	UJ	0.86	U	659	25.7	U	32	1400	J
F130B	30	13.2		13800	401	J	0.05	U	2.6	U	13.9	46.5	816	4550	1.2	UJ	0.81	U	626	24.3	U	27.2	93.9	J
F054B	40	12.1		11000	347	J	0.05	U	2.7	U	19.5	147	7160	5710	2.6	UJ	21		825	25	U	59.3	2740	J
F130B	40	14.9		12200	410	J	0.06	U	2.7	U	14.7	54.8	1150	5640	1.4	UJ	0.84	U	721	25.2	U	27.7	116	J
F054B	42.5	13		13500	365	J	0.06	U	2.8	U	12.1	48.5	851	4980	1.4	UJ	0.86	U	621	25.9	U	24.4	48.4	J
F054B	45	19.2		11600	179	J	0.06	U	2.7	U	10.8	96.1	8020	9490	1.4	UJ	0.84		968	25.1	U	23.1	449	J
F054B	47.5	12.7	UJ	14300	409		0.05	U	2.7	U	12.8	3.3	663	3310	1.5	UJ	0.83	U	705	**24.9**	**R**	28.7	71	
F054B	50	11.8	UJ	13900	404		0.06	U	2.7	U	13.5	8.6	775	3050	1.6	UJ	0.84	U	782	**25.2**	**R**	33.7	55.6	
F130B	50	9.8	UJ	12800	381		0.79		2.8	U	11.9	4.2	726	2520	1.4	UJ	0.86	U	1000	**25.7**	**R**	28.7	43.6	
F130B	60	11.7	UJ	13000	415		0.2		2.9	U	12.4	5.6	775	3200	1.5	UJ	0.89	U	1550	**26.8**	**R**	29.5	47.5	
F130B	70	10.3	UJ	12900	386		0.06	U	2.8	U	12.8	5.4	745	2810	1.4	UJ	0.86	U	1450	**25.7**	**R**	35	47.9	
F130B	80	8.1	UJ	3750	242		0.06		12.9	U	162	72.4	65700	5040	12	J	6.4		2580	**26.2**	**R**	881	1610	
F130B	100	7.1	UJ	3210	285		0.09		15.1	U	154	38.3	84000	4380	12.2	J	5.8		2610	**25.3**	**R**	864	1420	

All concentrations are in mg/kg

TABLE C-15: RU 9 Comparison between Site Data and Construction Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	3.9	1.9	97.7	1.3	217	77.7	304	0.4	77.7	37400	13.6
	16.5	6	201	1.5	55.7	32.8	182	5.5	48.8	4420	6.6
	18.4	3.1	155	0.46	16.5	3.3	26.8	6.1	13.1	1460	10.1
	4.5	11.3	159	1.5	12.1	281	22.8	9	10.8	3380	9.1
Std Dev	7.69	4.19	42.4	0.496	96.5	125.3	135.5	3.58	31.9	17200	2.9
95% UCL	27.6	14.7	245.6	2.27	285.6	**371.8**	429	13	107	49152	16.2
Method	C	C	C	C	C	C	C	C	C	C	C
Construction Worker RBC	104	14.6	8,355	61	5,213	81.3	550,729	52.2	22,036	33,044	800.00
Delta	77	-0.10	8,110	58.73	4,927	-290.50	550,300	39.20	21,929	-16,108	783.80
Is 95% UCL > 10% RBC?	yes	yes	no	no	no	yes	no	yes	no	yes	no
# Samples Needed	2	10000				4		2		13	
# Samples Collected	4	4				4		4		4	
Sufficient samples to support comparison?	**yes**	**no**				**yes**		**yes**		**no**	
Do soils exceed RBC's?	no	No Decision	no	no	no	yes	no	no	no	No Decision	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	12.8	402	0.06	2.9	13	1.5	0.88	26.4	22.4	54.7
	30	490	1.1	5.7	28.5	1.2	3.3	25.7	183	400
	16.1	398	0.41	3.1	15.8	1.7	0.96	28.7	36.7	67.4
	13	399	0.06	2.7	13.3	1.5	0.84	25.3	23.1	50.7
Std Dev	8.16	45.2	0.49	1.41	7.34	0.206	1.2	1.52	78.1	171
95% UCL	35.7	521	1.476	6.67	33.65	1.92	4.11	29.8	236	517
Method	C	C	C	C	C	C	C	C	C	C
Construction Worker RBC	11,911	77,102	464	2,754	404	2,754	2,754	375	3,503	165,219
Delta	11,875	76,581	463	2,747	370	2,752	2,749	345	3,267	164,702
Is 95% UCL > 10% RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-16: RU 9 Comparison between Site Data and Utility Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	3.9	1.9	97.7	1.3	217	77.7	304	0.4	77.7	37400	13.6
	16.5	6	201	1.5	55.7	32.8	182	5.5	48.8	4420	6.6
	18.4	3.1	155	0.46	16.5	3.3	26.8	6.1	13.1	1460	10.1
	4.5	11.3	159	1.5	12.1	281	22.8	9	10.8	3380	9.1
Std Dev	7.63	4.19	42.4	0.496	96.5	125.3	135.5	3.58	31.9	17200	2.9
95% UCL	27.6	14.7	245.6	2.27	285.6	**371.8**	429	13	107	49152	16.2
Method	C	C	C	C	C	C	C	C	C	C	C
Utility Worker RBC	1,370	196.61	116,514	865.79	68,492	1,154	7,205,461	742.11	286,470	432,328	800.00
Delta	1,342	181.91	116,268	863.52	68,206	782.59	7,205,032	729.11	286,363	383,176	783.80
Is 95% UCL > 10% RBC?	no	no	no	no	no	yes	no	no	no	yes	no
# Samples Needed						2				2	
# Samples Collected						4				4	
Sufficient samples to support comparison?						**yes**				**yes**	
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	12.8	402	0.06	2.9	13	1.5	0.88	26.4	22.4	54.7
	30	490	1.1	5.7	28.5	1.2	3.3	25.7	183	400
	16.1	398	0.41	3.1	15.8	1.7	0.96	28.7	36.7	67.4
	13	399	0.06	2.7	13.3	1.5	0.84	25.3	23.1	50.7
Std Dev	8.16	45.2	0.49	1.41	7.34	0.206	1.2	1.52	78.1	171
95% UCL	35.7	521	1.476	6.67	33.65	1.92	4.11	29.8	236	517
Method	C	C	C	C	C	C	C	C	C	C
Utility Worker RBC	154,848	1,008,765	6,437	36,027	5,718	36,027	36,027	4,900	46,169	2,161,638
Delta	154,813	1,008,244	6,436	36,021	5,684	36,025	36,023	4,870	45,933	2,161,121
Is 95% UCL > 10% RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

Table C-17: RU 9 Comparison between Site Data and Background

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	3.9	1.9	97.7	1.3	217	77.7	304	0.4	77.7	37400	13.6
	16.5	6	201	1.5	55.7	32.8	182	5.5	48.8	4420	6.6
	18.4	3.1	155	0.46	16.5	3.3	26.8	6.1	13.1	1460	10.1
	4.5	11.3	159	1.5	12.1	281	22.8	9	10.8	3380	9.1
Std Dev	7.63	4.19	42.4	0.496	96.5	125.3	135.5	3.58	31.9	17200	2.9
95% UCL	27.6	14.7	245.6	2.27	285.6	**371.8**	429	13	107	49152	16.2
Method	C	C	C	C	C	C	C	C	C	C	C
Background	2.2	7.7	188	1	12.8	1.9	27.5	7.6	12.6	600	29.1
Delta	-25.4	-7	-57.6	-1.27	-272.8	-369.9	-401.5	-5.4	-94.4	-48552	12.9
Do soils exceed Background?	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	12.8	402	0.06	2.9	13	1.5	0.88	26.4	22.4	54.7
	30	490	1.1	5.7	28.5	1.2	3.3	25.7	183	400
	16.1	398	0.41	3.1	15.8	1.7	0.96	28.7	36.7	67.4
	13	399	0.06	2.7	13.3	1.5	0.84	25.3	23.1	50.7
Std Dev	8.16	45.2	0.49	1.41	7.34	0.206	1.2	1.52	78.1	171
95% UCL	35.7	521	1.476	6.67	33.65	1.92	4.11	29.8	236	517
Method	C	C	C	C	C	C	C	C	C	C
Background	16.1	482	0.16	2.15	15.5	1.36	1.9	0.27	45.4	52.8
Delta	-19.6	-39	-1.316	-4.52	-18.15	-0.56	-2.21	-29.53	-190.6	-464.2
Do soils exceed Background?	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-18: RU 12 Data Summary

Boring Designation	Sample Depth	Aluminum	Antimony		Arsenic		Barium		Beryllium		Boron		Cadmium		Calcium	Chromium	Cobalt		Copper	Fluoride	Iron	Lead		Lithium	
	0-2 feet																								
F036B	1	13200	16.5	UJ	3.7	UJ	128	J	0.71		16.1	U	8.4		29800	18.8	5.6		17	1580	10500	7.2	U	11.4	U
F035B	2	14300	17	UJ	5.7	UJ	130	J	0.85		50.1		135		24300	23.1	2.3		10.6	1330	14000	10.1	J	12.1	
F044B	2	12900	22.1	UJ	69.7	J	123		2		65.1	U	229		231000	834	1.3		88.7	19200	15300	17	J	16.1	
	2-10 feet																								
F045B	3	13200	17	UJ	5.3	UJ	140	J	0.63		46.5		1.5		46100	15.5	5.9		11.4	530	12400	18.4	J	14	
F036B	3.5	12500	15.6	UJ	4.1	UJ	137	J	0.69		12.7	U	1.8		46400	18.5	6.4		11.3	480	14500	14.4	J	13.6	
F035B	4.5	14500	17.2	UJ	5.6	UJ	139	J	0.94		23.1	U	81.7		68800	94.6	6		26.3	3620	13600	11		13.5	
F044B	4.5	12100	28.7	UJ	61.2	J	131		2		74.8	U	184		229000	746	0.84	U	84.8	19800	13400	7.2	U	14.8	
F071B	5	12800	17.5	U	5.2		129		0.48		20.6	J	2.3		42800	18.5	5.9		10.7	750	11800	6.5	U	13.2	
F075B	5	13300	16.7	UJ	3.8	U	129		0.48		13.1	UJ	1.1	U	45500	16	4.9		9.8	550	13200	7	U	14.2	
F077B	5	22500	7.8	UJ	1.9	U	202		1.7		47.4		14.2		196000	124	2.9		13.9	12600	12800	6.5	U	11.6	
F045B	5.5	11700	17.1	UJ	5.1	UJ	97.4	J	0.57		13.5	U	2		49000	17	5.5		10.6	470	11700	12.7	J	13.1	
F036B	6	13100	16.1	UJ	5.5	UJ	131	J	0.8		17.1	U	118		54400	47.3	5.6		25.2	2700	10200	50.2	J	5.1	U
BH-10	5		10	U	2	U	103		0.502				0.317	J		13.5						4.32	J		
BH-11	5		9.9	U	2.54	J	108		0.512				0.2	U		11.5						4.54	J		
BH-14	5		10.6	J	2	U	99.5		0.536				0.2	U		13.4						5.28	J		
BH-5	5		10	U	2	U	98.9		0.482				0.278	J		12.5						4.69	J		
BH-6	5		9.9	U	2	U	87		0.422				0.2	U		11.8						5.92	J		
F035B	7	11700	15.6	UJ	3.8	UJ	118	J	0.67		20.2	U	1	U	38000	15.2	5.6		9.9	380	8790	106	J	5.1	U
F044B	7	13800	21.5	UJ	23	J	130		1.4		53.3	U	135		179000	479	2.2		59.9	13500	7400	133	J	8	U
F071B	7	11700	16.7	U	6.4		119		0.48		14.8	UJ	1.1		33700	16.6	6		9.8	460	8150	52.6	J	4.3	U
F075B	7	11800	17	UJ	3.5	U	110		0.4		16.4	UJ	1.1	U	24800	13.1	3.8		9	440	8530	71.7	J	4.3	U
F072B	8	13900	16.7	U	4.3		131		0.4		21.2	J	4.1		68800	43.5	4.6		13.8	2450	3870	13.8	UJ	4	U
F045B	8	14500	17.1	UJ	2.8	UJ	154	J	0.77		55.7		3.8		46700	22.1	6.4		12.6	680	13600	12.6	J	15.4	
F036B	8.5	13900	16.2	UJ	4.3	UJ	150	J	0.75		27.1	U	3.6		33700	17.1	6.1		12.9	550	12100	6.7	UJ	10.3	U
F035B	9.5	11600	16.9	UJ	4.1	UJ	130	J	0.68		11.7	U	1.1	U	41800	15.4	5.9		12.4	430	13100	10.9	UJ	3.2	U
F044B	9.5	13300	16.8	UJ	2.5	UJ	121		0.23		15.1	U	1.1	U	48300	17.8	5.9		9.2	U 480	13400	8.1	UJ	3.5	U
F072B	10	13500	17.2	U	5.2		141		0.45		13.1	UJ	1.5		36600	21.2	6.7		12.5	840	13800	6.7	UJ	5.2	U
BH-11	10		9.9	U	3.14	J	142		0.502				0.243	J		11.8						4.53	J		
BH-2	10		9.9	U	2.9	J	67.2		0.445				0.2	U		13.1						5.63	J		
>10 feet (not in an exposure pathway)																									
F045B	10.5	12600	17.1	UJ	4.1	UJ	137	J	0.61		28	U	1.7		39100	17.8	5.6		10.7	530	12000	12.3	J	13.5	
F036B	11	12000	16.6	UJ	3.7	UJ	123	J	0.63		11.7	U	1.1	U	46900	15.1	5.6		12.1	490	14700	7.5	U	15	U
F035B	12	11800	16.3	UJ	4.3	UJ	150	J	0.66		28.2	U	1.1	U	39300	14.7	5.3		11	440	10900	6.6	U	9.6	U
F044B	12	12600	16.4	UJ	3.9	J	123		0.22		14.4	U	2.1	U	47400	21.9	5.2		9.5	U 630	10500	6.4	U	9.2	U
F045B	13	10900	15.8	UJ	4.6	UJ	134	J	0.58		23.5	U	1	U	41400	16.3	5.4		8.9	410	11500	8.4	J	11.1	
F077B	14	15500	9.2	J	3.7	U	141		1.1		26.9		98.2		83100	208	5		37.9	2660	11000	6.6	U	7.4	U
F076B	15	11700	8.1	UJ	5.6	U	118		0.59		23.1		0.53	U	39400	17.2	5.6		6.4	470	12600	11.6	J	12.3	
F043B	17	13900	16	UJ	4.6	J	223		0.24		17.9	U	1	U	43400	20.5	6.3		9.4	U 490	2130	569	J	13	
F076B	17	12900	8.2	UJ	5.4	U	137		0.66		26.1		3.3		42200	16.9	5.6		7.7	820	7870	56.8	J	13.5	
F043B	19.5	13700	16.2	UJ	4.8	J	148		0.22		13.5	U	1.1	U	43300	20.6	5.9		7.9	U 460	1920	763	J	2.9	U
F043B	22	11700	16.5	UJ	4.1	J	146		0.21	UJ	12.5	U	1.1	U	39200	17.8	5.4		7.5	U 430	7580	74.4		15	
F043B	24.5	14900	17.2	UJ	5.3	J	137		0.23		28.4	U	1.1	U	40400	19.5	5.9		8	U 410	8630	122		15.3	
F043B	27	13200	16.5	UJ	5.1	J	119		0.21	UJ	25	U	1.1	U	34300	22.4	6.2		8	U 480	7060	153		15.8	

All concentrations are in mg/kg

TABLE C-18 (cont.)

Boring Designation	Sample Depth	Magnesium	Manganese		Mercury		Molybdenum		Nickel		Orthophosphate		Total Phosphorus	Potassium	Selenium		Silver		Sodium	Thallium		Vanadium	Zinc	
	0-2 feet																							
F036B	1	11200	208		0.06	U	3	U	10.8		7.2		706	2620	1.7	UJ	0.93	U	696	27.9	U	18.8	42.6	
F035B	2	8270	383		0.08	U	2.8	U	12.4		4		1350	2810	2.1	J	0.87	U	825	26.2	U	33	65.3	
F044B	2	11700	395		0.09	U	3	U	14.1		2		725	3930	1.2	UJ	0.91	U	842	27.4	U	31.2	51.9	
	2-6 feet																							
F045B	3	11900	351	J	0.06	U	2.9	U	13		244		1740	6000	1.3	UJ	0.88	U	873	26.4	U	25.6	50.6	J
F036B	3.5	11700	419		0.09	U	2.9	U	14.4		1.5		739	2930	1.2	UJ	0.9	U	795	27.1	U	26	51.3	
F035B	4.5	9740	446	J	2	J	2.9	U	10.5		6.8		881	3610	1.1	U	0.89	U	931	26.8	U	34.3	48.7	
F044B	4.5	9470	347	J	0.48	J	3	U	14.2		4.3		598	4080	1.3	U	0.92	U	788	27.7	U	27.6	45.1	
F071B	5	10300	333	J	0.3	J	2.7	U	15.1		2.9		641	3000	1.3	U	0.84	U	676	25.3	U	24.1	39.2	
F075B	5	11000	381	J	0.41	J	2.9	U	13.7		4.4		732	3580	1.1	U	0.9	U	881	27.1	U	28.9	49.5	
F077B	5	10800	387	J	0.28	J	2.7	U	15.8		6		734	2710	1	U	0.84	U	630	25.1	U	24.7	45.6	
F045B	5.5	14100	330	J	0.06	U	2.9	U	13.4		27.1		821	4000	1	UJ	0.89	U	822	26.6	U	26.7	72.1	J
F036B	6	2380	46.1		15.6	J	36.3		41.1		1850		19700	38400	680		49.7		4730	29.7	U	632	1070	
BH-10	5				0.04	U			9.4	J	0.6	U			10	U	0.671	J		10	U	21.3	41.9	J
BH-11	5				0.04	U			10.1		0.676	J			9.9	U	0.59	U		9.9	U	17.5	43.8	J
BH-14	5				0.04	U			9.88	J	0.6	U			10	U	0.61	J		10	U	10.1	50.3	
BH-5	5				0.04	U			9.61	J	0.65	J			10	U	0.6	U		10	U	20.2	40.8	J
BH-6	5				0.04	U			9.53	J	0.702	J			9.9	U	0.59	U		9.9	U	18.8	44.4	J
F035B	7	1750	30.1		24	J	35.5		53.1		2320		35400	69800	748		110		5300	34.4	U	794	1640	
F044B	7	4080	35.2		22.3	J	39		36.4		1860		32800	13300	744		107		5150	33.1	U	954	1780	
F071B	7	2130	56		10.4	J	25.1		47.5		2070		38600	19800	618		37.1		3600	29.3	U	596	2080	
F075B	7	2030	75.8		9.9	J	23.5		58.2		2590		37900	27700	751		59.4		3200	29.4	U	586	2920	
F072B	8	1190	50.4		1	J	16.1	U	120		1190		85800	8810	805		9.5		4870	26.7	U	390	1250	
F045B	8	14400	419	J	0.06	U	2.9	U	14.7		47.3		1410	5050	1.1	UJ	0.89	U	984	26.7	U	32.4	112	J
F036B	8.5	9680	383		0.25	J	2.8	U	15.1		72.3		2000	5320	4.5	U	0.87	U	992	26	U	44.1	73.2	
F035B	9.5	2060	120		3	J	9	U	14.7		131		6750	5040	187		1.2		1300	24.8	U	110	437	
F044B	9.5	2710	91.1		5.4	J	13.2	U	20.9		140		10500	7010	61.2		2.4		1980	26.7	U	163	480	
F072B	10	3570	135		1.6	J	8.8	U	23.1		147	J	16100	6600	40.8		0.84	U	1700	25.2	U	169	538	
BH-11	10				0.04	U			11.8		1.09	J			9.9	U	0.769	J		9.9	U	18.1	42.2	J
BH-2	10				0.04	U			9.82	J	1.04	J			9.9	U	0.59	U		9.9	U	21.8	41.3	J
>10 feet (not in an exposure pathway)																								
F045B	10.5	13100	363	J	0.06	U	2.9	U	11.9		9.8		756	3800	1.3	UJ	0.89	U	794	26.6	U	27.3	68.5	J
F036B	11	13400	407		0.06	U	3.2	U	26		36.7		2580	4020	4.8	UJ	0.97	U	835	29.2	U	174	889	
F035B	12	12400	357		0.06	U	2.8	U	17.5		29.5		2660	2520	21.8	J	0.86	U	680	25.7	U	107	1100	
F044B	12	13300	312		0.06	U	2.7	U	17.4		23.6		1570	1960	5.4	J	0.82	U	683	24.7	U	79.3	512	
F045B	13	12400	381	J	0.05	U	2.7	U	12.6		2.9		697	2670	1	UJ	0.82	U	742	24.6	U	25.1	42.8	J
F077B	14	9510	387		0.09	U	2.8	U	13.6		28.3		1380	1710	16.7	J	0.85	U	703	25.5	U	39.9	399	
F076B	15	14300	385		0.09	U	2.8	U	17.8		31.9		1330	2910	4.7	J	0.85	U	673	25.5	U	62.6	565	
F043B	17	2380	325		0.17	J	10.5		40.8		133000		59700	38000	16.4		307		4700	36.8		115	48700	
F076B	17	6420	416		0.31	J	15		229		9440		53100	4130	11		7.2		3200	26.7	U	842	1790	
F043B	19.5	1080	55.1		0.35	J	5.2	U	8	U	11800		40900	21700	29.3		1000		3340	47.8	U	105	9800	
F043B	22	4870	451		0.8		64.7		34.5		20.7		7130	N/A	2.5	U	4.9		N/A	25	U	170	410	
F043B	24.5	6230	384		0.39	U	8.9		47.9		41.6		9770	N/A	3.4	U	28.8		N/A	25.2	U	242	4690	
F043B	27	6350	395		0.25	U	4.5		35.5		151		17100	N/A	3	U	45.9		N/A	25.6	U	232	7970	

TABLE C-19: RU 12 Comparison between Site Data and Construction Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	16.5	3.7	128	0.71	16.1	8.4	18.8	5.6	17	1580	7.2	11.4	208	0.06	3	10.8	1.7	0.93	27.9	18.8	42.6
	17	5.7	130	0.85	50.1	135	23.1	2.3	10.6	1330	10.1	12.1	383	0.08	2.8	12.4	2.1	0.87	26.2	33	65.3
	22.1	69.7	123	2	65.1	229	834	1.3	88.7	19200	17	16.1	395	0.09	3	14.1	1.2	0.91	27.4	31.2	51.9
	17	5.3	140	0.63	46.5	1.5	15.5	5.9	11.4	530	18.4	14	351	0.06	2.9	13	1.3	0.88	26.4	25.6	50.6
	15.6	4.1	137	0.69	12.7	1.8	18.5	6.4	11.3	480	14.4	13.6	419	0.09	2.9	14.4	1.2	0.9	27.1	26	51.3
	17.2	5.6	139	0.94	23.1	81.7	94.6	6	26.3	3620	11	13.5	446	2	2.9	10.5	1.1	0.89	26.8	34.3	48.7
	28.7	61.2	131	2	74.8	184	746	0.84	84.8	19800	7.2	14.8	347	0.48	3	14.2	1.3	0.92	27.7	27.6	45.1
	17.5	5.2	129	0.48	20.6	2.3	18.5	5.9	10.7	750	6.5	13.2	333	0.3	2.7	15.1	1.3	0.84	25.3	24.1	39.2
	16.7	3.8	129	0.48	13.1	1.1	16	4.9	9.8	550	7	14.2	381	0.41	2.9	13.7	1.1	0.9	27.1	28.9	49.5
	7.8	1.9	202	1.7	47.4	14.2	124	2.9	13.9	12600	6.5	11.6	387	0.28	2.7	15.8	1	0.84	25.1	24.7	45.6
	17.1	5.1	97.4	0.57	13.5	2	17	5.5	10.6	470	12.7	13.1	330	0.06	2.9	13.4	1	0.89	26.6	26.7	72.1
	16.1	5.5	131	0.8	17.1	118	47.3	5.6	25.2	2700	50.2	5.1	46.1	15.6	36.3	41.1	680	49.7	29.7	632	1070
	15.6	3.8	118	0.67	20.2	1	15.2	5.6	9.9	380	106	5.1	30.1	24	35.5	53.1	748	110	34.4	794	1640
	21.5	23	130	1.4	53.3	135	479	2.2	59.9	13500	133	8	35.2	22.3	39	36.4	744	107	33.1	954	1780
	16.7	6.4	119	0.48	14.8	1.1	16.6	6	9.8	460	52.6	4.3	56	10.4	25.1	47.5	618	37.1	29.3	596	2080
	17	3.5	110	0.4	16.4	1.1	13.1	3.8	9	440	71.7	4.3	75.8	9.9	23.5	58.2	751	59.4	29.4	586	2920
	16.7	4.3	131	0.4	21.2	4.1	43.5	4.6	13.8	2450	13.8	4	50.4	1	16.1	120	805	9.5	26.7	390	1250
	17.1	2.8	154	0.77	55.7	3.8	22.1	6.4	12.6	680	12.6	15.4	419	0.06	2.9	14.7	1.1	0.89	26.7	32.4	112
	16.2	4.3	150	0.75	27.1	3.6	17.1	6.1	12.9	550	6.7	10.3	383	0.25	2.8	15.1	4.5	0.87	26	44.1	73.2
	16.9	4.1	130	0.68	11.7	1.1	15.4	5.9	12.4	430	10.9	3.2	120	3	9	14.7	187	1.2	24.8	110	437
	16.8	2.5	121	0.23	15.1	1.1	17.8	5.9	9.2	480	8.1	3.5	91.1	5.4	13.2	20.9	61.2	2.4	26.7	163	480
	17.2	5.2	141	0.45	13.1	1.5	21.2	6.7	12.5	840	6.7	5.2	135	1.6	8.8	23.1	40.8	0.84	25.2	169	538
	9.9	3.14	142	0.502		0.243	11.8				4.53			0.04		11.8	9.9	0.769	9.9	18.1	42.2
	9.9	2.9	67.2	0.445		0.2	13.1				5.63			0.04		9.82	9.9	0.59	9.9	21.8	41.3
	10	2	103	0.502		0.317	13.5				4.32			0.04		9.4	10	0.671	10	21.3	41.9
	9.9	2.54	108	0.512		0.2	11.5				4.54			0.04		10.1	9.9	0.59	9.9	17.5	43.8
	10.6	2	99.5	0.536		0.2	13.4				5.28			0.04		9.88	10	0.61	10	10.1	50.3
	10	2	98.9	0.482		0.278	12.5				4.69			0.04		9.61	10	0.6	10	20.2	40.8
	9.9	2	87	0.422		0.2	11.8				5.92			0.04		9.53	9.9	0.59	9.9	18.8	44.4
Distribution			N	U			U	U	U	U			U			U				U	U
Std Dev	4.45	16.2	24.4	0.46	19.77	63.7	212	1.77	23.66	6237	31.7	4.58	158	6.65	12.5	23.2	295	30.3	7.94	270	759
95% UCL	19.2	21.8	145	1.11	47.9	83.8	266	6.48	43.9	9606	47.2	14.1	392.9	8.76	22.7	41.6	401	38.1	29.7	388	1071
Method	C	C	S	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Construction Worker RBC	104	14.6	8,355	61	5,213	81.3	550,729	52.2	22,036	33,044	800.00	11,911	77,102	464	2,754	404	2,754	2,754	375	3,503	165,219
Delta	85	-7.20	8,210	59.89	5,165	-2.50	550,463	45.72	21,992	23,438	752.80	11,897	76,709	455	2,731	362	2,353	2,716	345	3,115	164,148
Is 95% UCL > 10% RBC?	yes	yes	no	no	no	yes	no	yes	no	yes	no	no	no	no	no	yes	yes	no	no	yes	no
# Samples Needed	2	52				6452		2								2	2			2	
# Samples Collected	29	29				29		22								29	29			29	
Sufficient samples to support comparison?	**yes**	**no**				**no**		**yes**								**yes**	**yes**			**yes**	
Do soils exceed RBC's?	no	No Decision	no	no	no	No Decision	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-20: RU 12 Comparison between Site Data and Utility Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	16.5	3.7	128	0.71	16.1	8.4	18.8	5.6	17	1580	7.2	11.4	208	0.06	3	10.8	1.7	0.93	27.9	18.8	42.6
	17	5.7	130	0.85	50.1	135	23.1	2.3	10.6	1330	10.1	12.1	383	0.08	2.8	12.4	2.1	0.87	26.2	33	65.3
	22.1	69.7	123	2	65.1	229	834	1.3	88.7	19200	17	16.1	395	0.09	3	14.1	1.2	0.91	27.4	31.2	51.9
	17	5.3	140	0.63	46.5	1.5	15.5	5.9	11.4	530	18.4	14	351	0.06	2.9	13	1.3	0.88	26.4	25.6	50.6
	15.6	4.1	137	0.69	12.7	1.8	18.5	6.4	11.3	480	14.4	13.6	419	0.09	2.9	14.4	1.2	0.9	27.1	26	51.3
	17.2	5.6	139	0.94	23.1	81.7	94.6	6	26.3	3620	11	13.5	446	2	2.9	10.5	1.1	0.89	26.8	34.3	48.7
	28.7	61.2	131	2	74.8	184	746	0.84	84.8	19800	7.2	14.8	347	0.48	3	14.2	1.3	0.92	27.7	27.6	45.1
	17.5	5.2	129	0.48	20.6	2.3	18.5	5.9	10.7	750	6.5	13.2	333	0.3	2.7	15.1	1.3	0.84	25.3	24.1	39.2
	16.7	3.8	129	0.48	13.1	1.1	16	4.9	9.8	550	7	14.2	381	0.41	2.9	13.7	1.1	0.9	27.1	28.9	49.5
	7.8	1.9	202	1.7	47.4	14.2	124	2.9	13.9	12600	6.5	11.6	387	0.28	2.7	15.8	1	0.84	25.1	24.7	45.6
	17.1	5.1	97.4	0.57	13.5	2	17	5.5	10.6	470	12.7	13.1	330	0.06	2.9	13.4	1	0.89	26.6	26.7	72.1
	16.1	5.5	131	0.8	17.1	118	47.3	5.6	25.2	2700	50.2	5.1	46.1	15.6	36.3	41.1	680	49.7	29.7	632	1070
	15.6	3.8	118	0.67	20.2	1	15.2	5.6	9.9	380	106	5.1	30.1	24	35.5	53.1	748	110	34.4	794	1640
	21.5	23	130	1.4	53.3	135	479	2.2	59.9	13500	133	8	35.2	22.3	39	36.4	744	107	33.1	954	1780
	16.7	6.4	119	0.48	14.8	1.1	16.6	6	9.8	460	52.6	4.3	56	10.4	25.1	47.5	618	37.1	29.3	596	2080
	17	3.5	110	0.4	16.4	1.1	13.1	3.8	9	440	71.7	4.3	75.8	9.9	23.5	58.2	751	59.4	29.4	586	2920
	16.7	4.3	131	0.4	21.2	4.1	43.5	4.6	13.8	2450	13.8	4	50.4	1	16.1	120	805	9.5	26.7	390	1250
	17.1	2.8	154	0.77	55.7	3.8	22.1	6.4	12.6	680	12.6	15.4	419	0.06	2.9	14.7	1.1	0.89	26.7	32.4	112
	16.2	4.3	150	0.75	27.1	3.6	17.1	6.1	12.9	550	6.7	10.3	383	0.25	2.8	15.1	4.5	0.87	26	44.1	73.2
	16.9	4.1	130	0.68	11.7	1.1	15.4	5.9	12.4	430	10.9	3.2	120	3	9	14.7	187	1.2	24.8	110	437
	16.8	2.5	121	0.23	15.1	1.1	17.8	5.9	9.2	480	8.1	3.5	91.1	5.4	13.2	20.9	61.2	2.4	26.7	163	480
	17.2	5.2	141	0.45	13.1	1.5	21.2	6.7	12.5	840	6.7	5.2	135	1.6	8.8	23.1	40.8	0.84	25.2	169	538
	9.9	3.14	142	0.502		0.243	11.8				4.53			0.04		11.8	9.9	0.769	9.9	18.1	42.2
	9.9	2.9	67.2	0.445		0.2	13.1				5.63			0.04		9.82	9.9	0.59	9.9	21.8	41.3
	10	2	103	0.502		0.317	13.5				4.32			0.04		9.4	10	0.671	10	21.3	41.9
	9.9	2.54	108	0.512		0.2	11.5				4.54			0.04		10.1	9.9	0.59	9.9	17.5	43.8
	10.6	2	99.5	0.536		0.2	13.4				5.28			0.04		9.88	10	0.61	10	10.1	50.3
	10	2	98.9	0.482		0.278	12.5				4.69			0.04		9.61	10	0.6	10	20.2	40.8
	9.9	2	87	0.422		0.2	11.8				5.92			0.04		9.53	9.9	0.59	9.9	18.8	44.4
Distribution			N	U			U	U	U	U			U			U				U	U
Std Dev	4.45	16.2	24.4	0.46	19.77	63.7	212	1.77	23.66	6237	31.7	4.58	158	6.65	12.5	23.2	295	30.3	7.94	270	759
95% UCL	19.2	21.8	145	1.11	47.9	83.8	266	6.48	43.9	9606	47.2	14.1	392.9	8.76	22.7	41.6	401	38.1	29.7	388	1071
Method	C	C	S	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Utility Worker RBC	1,370	196.61	116,514	865.79	68,492	1,154.39	7,205,461	742.11	286,470	432,328	800.00	154,848	1,008,765	6,437	36,027	5,718	36,027	36,027	4,900	46,169	2,161,638
Delta	1,351	174.81	116,369	864.68	68,444	1,070.59	7,205,195	735.63	286,426	422,722	752.80	154,834	1,008,372	6,428	36,005	5,676	35,626	35,989	4,870	45,781	2,160,567
Is 95% UCL > 10% RBC?	no	yes	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
# Samples Needed		2																			
# Samples Collected		29																			
Sufficient samples to support comparison?		**yes**																			
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-21: RU 12 Comparison between Site Data and Background

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	16.5	3.7	128	0.71	16.1	8.4	18.8	5.6	17	1580	7.2	11.4	208	0.06	3	10.8	1.7	0.93	27.9	18.8	42.6
	17	5.7	130	0.85	50.1	135	23.1	2.3	10.6	1330	10.1	12.1	383	0.08	2.8	12.4	2.1	0.87	26.2	33	65.3
	22.1	69.7	123	2	65.1	229	834	1.3	88.7	19200	17	16.1	395	0.09	3	14.1	1.2	0.91	27.4	31.2	51.9
	17	5.3	140	0.63	46.5	1.5	15.5	5.9	11.4	530	18.4	14	351	0.06	2.9	13	1.3	0.88	26.4	25.6	50.6
	15.6	4.1	137	0.69	12.7	1.8	18.5	6.4	11.3	480	14.4	13.6	419	0.09	2.9	14.4	1.2	0.9	27.1	26	51.3
	17.2	5.6	139	0.94	23.1	81.7	94.6	6	26.3	3620	11	13.5	446	2	2.9	10.5	1.1	0.89	26.8	34.3	48.7
	28.7	61.2	131	2	74.8	184	746	0.84	84.8	19800	7.2	14.8	347	0.48	3	14.2	1.3	0.92	27.7	27.6	45.1
	17.5	5.2	129	0.48	20.6	2.3	18.5	5.9	10.7	750	6.5	13.2	333	0.3	2.7	15.1	1.3	0.84	25.3	24.1	39.2
	16.7	3.8	129	0.48	13.1	1.1	16	4.9	9.8	550	7	14.2	381	0.41	2.9	13.7	1.1	0.9	27.1	28.9	49.5
	7.8	1.9	202	1.7	47.4	14.2	124	2.9	13.9	12600	6.5	11.6	387	0.28	2.7	15.8	1	0.84	25.1	24.7	45.6
	17.1	5.1	97.4	0.57	13.5	2	17	5.5	10.6	470	12.7	13.1	330	0.06	2.9	13.4	1	0.89	26.6	26.7	72.1
	16.1	5.5	131	0.8	17.1	118	47.3	5.6	25.2	2700	50.2	5.1	46.1	15.6	36.3	41.1	680	49.7	29.7	632	1070
	15.6	3.8	118	0.67	20.2	1	15.2	5.6	9.9	380	106	5.1	30.1	24	35.5	53.1	748	110	34.4	794	1640
	21.5	23	130	1.4	53.3	135	479	2.2	59.9	13500	133	8	35.2	22.3	39	36.4	744	107	33.1	954	1780
	16.7	6.4	119	0.48	14.8	1.1	16.6	6	9.8	460	52.6	4.3	56	10.4	25.1	47.5	618	37.1	29.3	596	2080
	17	3.5	110	0.4	16.4	1.1	13.1	3.8	9	440	71.7	4.3	75.8	9.9	23.5	58.2	751	59.4	29.4	586	2920
	16.7	4.3	131	0.4	21.2	4.1	43.5	4.6	13.8	2450	13.8	4	50.4	1	16.1	120	805	9.5	26.7	390	1250
	17.1	2.8	154	0.77	55.7	3.8	22.1	6.4	12.6	680	12.6	15.4	419	0.06	2.9	14.7	1.1	0.89	26.7	32.4	112
	16.2	4.3	150	0.75	27.1	3.6	17.1	6.1	12.9	550	6.7	10.3	383	0.25	2.8	15.1	4.5	0.87	26	44.1	73.2
	16.9	4.1	130	0.68	11.7	1.1	15.4	5.9	12.4	430	10.9	3.2	120	3	9	14.7	187	1.2	24.8	110	437
	16.8	2.5	121	0.23	15.1	1.1	17.8	5.9	9.2	480	8.1	3.5	91.1	5.4	13.2	20.9	61.2	2.4	26.7	163	480
	17.2	5.2	141	0.45	13.1	1.5	21.2	6.7	12.5	840	6.7	5.2	135	1.6	8.8	23.1	40.8	0.84	25.2	169	538
	9.9	3.14	142	0.502		0.243	11.8				4.53			0.04		11.8	9.9	0.769	9.9	18.1	42.2
	9.9	2.9	67.2	0.445		0.2	13.1				5.63			0.04		9.82	9.9	0.59	9.9	21.8	41.3
	10	2	103	0.502		0.317	13.5				4.32			0.04		9.4	10	0.671	10	21.3	41.9
	9.9	2.54	108	0.512		0.2	11.5				4.54			0.04		10.1	9.9	0.59	9.9	17.5	43.8
	10.6	2	99.5	0.536		0.2	13.4				5.28			0.04		9.88	10	0.61	10	10.1	50.3
	10	2	98.9	0.482		0.278	12.5				4.69			0.04		9.61	10	0.6	10	20.2	40.8
	9.9	2	87	0.422		0.2	11.8				5.92			0.04		9.53	9.9	0.59	9.9	18.8	44.4
Distribution			N	U			U	U	U	U			U			U				U	U
Std Dev	4.45	16.2	24.4	0.46	19.77	63.7	212	1.77	23.66	6237	31.7	4.58	158	6.65	12.5	23.2	295	30.3	7.94	270	759
95% UCL	19.2	21.8	145	1.11	47.9	83.8	266	6.48	43.9	9606	47.2	14.1	392.9	8.76	22.7	41.6	401	38.1	29.7	388	1071
Method	C	C	S	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Background	2.2	7.7	188	1	12.8	1.9	27.5	7.6	12.6	600	29.1	16.1	482	0.16	2.15	15.5	1.36	1.9	0.27	45.4	52.8
Delta	-17	-14.1	43	-0.11	-35.1	-81.9	-238.5	1.12	-31.3	-9006	-18.1	2	89.1	-8.6	-21	-26.1	-400.73	7.3	23.1	-388	-1071
Do soils exceed Background?	yes	yes	no	yes	yes	yes	yes	no	yes	yes	yes	no	no	yes	yes	yes	yes	no	no	yes	yes

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL

No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-22: RU 13 Data Summary

Boring Designation	Sample Depth	Aluminum	Antimony		Arsenic	Barium	Beryllium	Boron		Cadmium	Calcium	Chromium	Cobalt	Copper	Fluoride	Iron	Lead	Lithium
	0-2 feet																	
	NO DATA																	
	2-10 feet																	
F079B	5	15100	16.8	UJ	4.7	147	0.85	18.8	U	121	45200	24.6	6.4	14.5	1730	11100	420	13.2
F058B	7	9120	140	J	68.9	69.2	0.7	277		3280	43700	151	7	109	30200	12200	9.3	12.6
F079B	7	17500	17	UJ	7.9	148	1.1	35.4	U	231	60900	50.5	5.3	20.9	3650	13000	15.4	12.2
F058B	9	10800	17.1	U	66.9	108	0.85	55.3		202	201000	730	3.2	82.3	16800	15500	9.9	11.3

Boring Designation	Sample Depth	Magnesium	Manganese		Mercury		Molybdenum		Nickel	Orthophosphate	Total Phosphorus	Potassium	Selenium		Silver		Sodium	Thallium		Vanadium	Zinc
	0-2 feet																				
	NO DATA																				
	2-10 feet																				
F079B	5	7720	330		0.51	U	6		28.7	874	34300	N/A	4.9	U	124		N/A	28.3	U	131	20400
F058B	7	7290	375	J	0.72	J	2.9	U	11.8	95.9	17100	4350	1.8		0.9	U	1660	27.1	U	36	150
F079B	7	7130	373	J	1.4	J	3	U	12.1	254	15600	4750	1.6		0.93	U	1400	27.8	U	38	157
F058B	9	9700	514		0.75	J	2.6	U	11.1	3.8	598	NA	1.1	U	0.8	U	NA	24.1	U	31.1	46.1

All concentrations are in mg/kg

TABLE C-23: RU 13 Comparison between Site Data and Construction Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	8.4	4.7	147	0.85	9.4	121	24.6	6.4	14.5	1730	420
	140	68.9	69.2	0.7	277	3280	151	7	109	30200	9.3
	8.5	7.9	148	1.1	17.7	231	50.5	5.3	20.9	3650	15.4
	8.55	66.9	108	0.85	55.3	202	730	3.2	82.3	16800	9.9
Std Dev	61.5	35.6	37.5	0.166	121	1548	332	1.67	46.4	13225	204
95% UCL	182	114.7	200	1.24	361	4333	962	9.12	158	41917	559
Method	C	C	C	C	C	C	C	C	C	C	C
Construction Worker RBC	104	14.6	8,355	61	5,213	81.3	550,729	52.2	22,036	33,044	800.00
Delta	-78	-100.10	8,155	59.76	4,852	-4,252	549,767	43.08	21,878	-8,873	241.00
Is 95% UCL > 10% of RBC?	yes	yes	no	no	no	yes	no	yes	no	yes	yes
# Samples Needed	8	3				3		2		24	9
# Samples Collected	4	4				4		4		4	4
Sufficient samples to support comparison?	**no**	**yes**				**yes**		**yes**		**no**	**no**
Do soils exceed RBC's?	**No Decision**	**yes**	no	no	no	**yes**	no	no	no	No Decision	No Decision

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	13.2	330	0.255	6	28.7	2.45	124	14.15	131	20400
	12.6	375	0.72	1.45	11.8	1.8	0.45	13.55	36	150
	12.2	373	1.4	1.5	12.1	1.6	0.465	13.9	38	157
	11.3	514	0.75	1.3	11.1	0.55	0.4	12.05	31.1	46.1
Std Dev	0.797	80.1	0.39	1.59	8.53	1.72	61.6	1.88	48.1	10141.0
95% UCL	14.06	572	1.68	7.09	34.5	6.11	166	30.9	163.8	27290
Method	C	C	C	C	C	C	C	C	C	C
Construction Worker RBC	11,911	77,102	464	2,754	404	2,754	2,754	375	3,503	165,219
Delta	11,897	76,530	462	2,747	369	2,747	2,588	344	3,340	137,929
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no	no	no	yes
# Samples Needed										2
# Samples Collected										4
Sufficient samples to support comparison?										**yes**
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-24: RU 13 Comparison between Site Data and Utility Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	8.4	4.7	147	0.85	9.4	121	24.6	6.4	14.5	1730	420
	140	68.9	69.2	0.7	277	3280	151	7	109	30200	9.3
	8.5	7.9	148	1.1	17.7	231	50.5	5.3	20.9	3650	15.4
	8.55	66.9	108	0.85	55.3	202	730	3.2	82.3	16800	9.9
Std Dev	61.5	35.6	37.5	0.166	121	1548	332	1.67	46.4	13225	204
95% UCL	182	114.7	200	1.24	361	4333	962	9.12	158	41917	559
Method	C	C	C	C	C	C	C	C	C	C	C
Utility Worker RBC	1,370	196.61	116,514	865.79	68,492	1,154	7,205,461	742.11	286,470	432,328	800.00
Delta	1,188	81.91	116,314	864.55	68,131	-3,179	7,204,499	732.99	286,312	390,411	241.00
Is 95% UCL > 10% of RBC?	yes	yes	no	no	no	yes	no	no	no	no	yes
# Samples Needed	2	4				4					9
# Samples Collected	4	4				4					4
Sufficient samples to support comparison?	**yes**	**yes**				**yes**					**no**
Do soils exceed RBC's?	no	no	no	no	no	**yes**	no	no	no	no	No Decision

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	13.2	330	0.255	6	28.7	2.45	124	14.15	131	20400
	12.6	375	0.72	1.45	11.8	1.8	0.45	13.55	36	150
	12.2	373	1.4	1.5	12.1	1.6	0.465	13.9	38	157
	11.3	514	0.75	1.3	11.1	0.55	0.4	12.05	31.1	46.1
Std Dev	0.797	80.1	0.39	1.59	8.53	1.72	61.6	1.88	48.1	10141.0
95% UCL	14.06	572	1.68	7.09	34.5	6.11	166	30.9	163.8	27290
Method	C	C	C	C	C	C	C	C	C	C
Utility Worker RBC	154,848	1,008,765	6,437	36,027	5,718	36,027	36,027	4,900	46,169	2,161,638
Delta	154,834	1,008,193	6,436	36,020	5,683	36,021	35,861	4,869	46,005	2,134,348
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-25: RU 13 Comparison between Site Data and Background

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	8.4	4.7	147	0.85	9.4	121	24.6	6.4	14.5	1730	420
	140	68.9	69.2	0.7	277	3280	151	7	109	30200	9.3
	8.5	7.9	148	1.1	17.7	231	50.5	5.3	20.9	3650	15.4
	8.55	66.9	108	0.85	55.3	202	730	3.2	82.3	16800	9.9
Std Dev	61.5	35.6	37.5	0.166	121	1548	332	1.67	46.4	13225	204
95% UCL	182	114.7	200	1.24	361	4333	962	9.12	158	41917	559
Method	C	C	C	C	C	C	C	C	C	C	C
Background	2.2	7.7	188	1	12.8	1.9	27.5	7.6	12.6	600	29.1
Delta	-179.8	-107	-12	-0.24	-348.2	-4331.1	-934.5	-1.52	-145.4	-41317	-529.9
Do soils exceed Background?	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Orthophosphate	Total Phosphorus	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	13.2	330	0.255	6	28.7	874	34300	2.45	124	14.15	131	20400
	12.6	375	0.72	1.45	11.8	95.9	17100	1.8	0.45	13.55	36	150
	12.2	373	1.4	1.5	12.1	254	15600	1.6	0.465	13.9	38	157
	11.3	514	0.75	1.3	11.1	3.8	598	0.55	0.4	12.05	31.1	46.1
Std Dev	0.797	80.1	0.39	1.59	8.53	392	13787	1.72	61.6	1.88	48.1	10141.0
95% UCL	14.06	572	1.68	7.09	34.5	1161	46947	6.11	166	30.9	163.8	27290
Method	C	C	C	C	C	C	C	C	C	C	C	C
Background	16.1	482	0.16	2.15	15.5	3.7	672	1.36	1.9	0.27	45.4	52.8
Delta	2.04	-90	-1.52	-4.94	-19	-1157.3	-46275	-4.75	-164.1	-30.63	-118.4	-27237.2
Do soils exceed Background?	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescribed alpha and beta levels

TABLE C-26: RU 20 Data Summary

Boring Designation	Sample Depth	Aluminum	Antimony		Arsenic		Barium	Beryllium	Boron		Cadmium		Calcium	Chromium	Cobalt		Copper	Fluoride	Iron		Lead		Lithium	
Sample #	**0-2 feet**																							
FWSFSA03	Ferrophos	2330	28.5	J	3.7	UJ	23.4	1.8	6.1		2.8	UJ	24300	2370	12.6		404	3370	32800	J	6	U	2.2	UJ
FWSSSA01	Slag	23600	14.9	UJ	0.51	UJ	223	1.9	97.8		2.8	UJ	274000	238	1.2	U	15.8	14400	1150	J	6	U	16.5	UJ
FWSSSA02	Slag	25800	14.5	UJ	0.48	UJ	229	2.1	67.5		1.2	UJ	283000	230	1.6	U	10.9	17800	772	J	5.8	U	17.2	UJ
FWSSSA03	Slag	26900	14.2	UJ	0.52	UJ	254	2	88.9		13	J	291000	290	1.6	U	17.9	17300	1160	J	5.7	U	19.5	UJ
FWSSSA04	Slag	24400	14.6	UJ	0.5	UJ	214	1.8	68.6		32.4	J	255000	172	1.6	U	11.9	12400	1970	J	5.9	U	17.9	UJ
FWSSSA05	Slag	25700	14.1	UJ	0.48	UJ	251	1.9	88		103	J	286000	280	1.4		17.7	16500	1530	J	5.7	U	18.9	UJ
FWSSSA06	Slag	24500	14	UJ	0.58	UJ	233	1.9	83.9		4.3	UJ	290000	273	1.6		17	16200	1410	J	5.6	U	18	UJ
	2-10 feet																							
F081B	4	14200	16.2	U	4.3		139	0.67	19	U	1.1		43700	23	6.3		12.8	670	13200		9.5	J	13.3	
F080B	5	19100	17	UJ	6.3	U	183	1.1	19.1	UJ	1.1	U	58200	20.3	7.3		13.9	560	16100		8.8		18	
F084B	5	16600	16.7	U	3.7		145	0.7	16.8	U	3.1		24700	18.8	5.4		13.2	1680	14500		11.1	J	15.1	
F082B	5	15100	16.4	UJ	6	U	189	0.9	15.4	UJ	1.1	U	49800	18.9	5.9		11.5	580	14300		8.2		15	
F083B	5	15900	16.5	UJ	4.7	U	177	0.96	20.7	UJ	1.1	U	42400	17.3	6.5		11.4	500	15000		8.9		15.4	
F081B	7	11100	16	U	3.2		91.3	0.67	11.1	U	1.1		46900	17.5	5.1		8.9	530	11300		6.4	UJ	10.2	
F084B	7	15400	16.9	U	1.3	U	145	0.71	15.9	U	1.1		31300	17.3	5		14.4	1200	13500		7.3	J	14.3	
F080B	7	18000	17.6	UJ	5.6	U	181	1	20	UJ	1.1	U	55000	33.9	6.5		14	760	15500		13.5		16.7	
F082B	9	14900	16.5	UJ	6	U	133	0.89	18.8	UJ	1.1	U	42900	21.4	5.6		11.1	460	13700		10.1		13.8	
F083B	9	13700	16.3	U	3.3		174	0.68	14.9	U	1.3		51500	17.8	6.1		10.6	500	12200		11.8	UJ	13.3	U

Boring #	Sample Depth	Magnesium	Manganese	Mercury		Molybdenum		Nickel		Orthophosphate	Total Phosphorus		Potassium	Selenium		Silver		Sodium	Thallium		Vanadium	Zinc	
Sample #	**0-2 feet**																						
FWSFSA03	Ferrophos	710	190	0.24	UJ	90.6		535		31.1	1070		663	1.1	UJ	26.7		593	23.1	R	2630	169	J
FWSSSA01	Slag	3200	114	0.17	UJ	2.5	U	8.8		46.1	1900		6780	4.5	J	2.6		4200	23.2	R	215	52.5	J
FWSSSA02	Slag	3200	127	0.05	UJ	2.5	U	3.8	U	44.6	1610		7130	4.6	J	2.3		4110	22.6	R	183	36.4	J
FWSSSA03	Slag	3580	169	0.12	UJ	2.4	U	8.8		91.1	4580		8160	2.8	UJ	4.8		3970	22.2	R	243	194	J
FWSSSA04	Slag	5510	205	0.05	UJ	2.5	U	6.5		57.2	3800		7700	4.3	J	4.9		3730	22.8	R	150	450	J
FWSSSA05	Slag	3610	168	0.05	UJ	2.4	U	11.9		30.3	3930		8220	6.9	J	3.7		4210	22	R	249	136	J
FWSSSA06	Slag	3690	126	0.39	UJ	2.4	U	7.9		104	5680	J	7360	4.9	J	4.3		4180	21.8	R	250	85.5	J
	2-10 feet																						
F081B	4	10100	372	0.26	J	2.7	U	13.4		9.7	684		4520	2.6	U	0.84	U	799	25.2	U	30.1	51.2	
F080B	5	11600	421	0.19	U	2.9	U	14.3		1.1	657		N/A	1.6	U	0.88	U	N/A	26.5	U	32	60.2	
F084B	5	9660	312	0.38	J	2.8	U	12.5		104	1900		5080	2.5	U	0.87	U	722	26	U	32.7	207	
F082B	5	14400	398	0.27	U	2.8	U	11.8		1.1	722		N/A	1.2	U	0.85	U	N/A	25.5	U	31.3	50.4	
F083B	5	13900	437	0.22	U	2.8	U	14.8		1	662		NA	4.5		0.86	U	NA	25.7	U	30.3	54.4	
F084B	7	8900	391	0.42	J	2.9	U	10.6		86.4	1500		4580	2	U	0.88	U	710	26.4	U	26.7	60.8	
F081B	7	12300	327	0.17	J	2.7	U	12.1		7.5	745		2340	2.1	U	0.83	U	632	24.9	U	26.8	41.5	
F080B	7	12900	418	0.35	U	3	U	15		0.9	934		N/A	1.7	U	0.91	U	N/A	27.4	U	46.6	61.6	
F083B	9	12700	345	0.57	J	2.8	U	12.1		2.9	776		3160	2.3	U	0.85	U	622	25.4	U	26.3	44.5	
F082B	9	13400	372	0.16	U	2.8	U	15.5		2.2	624		N/A	1.2	U	0.86	U	N/A	25.8	U	33.8	48.7	

all concentrations are in mg/kg

TABLE C-27: RU 20 Comparison between Site Data and Site Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	28.5	1.85	23.4	1.8	6.1	1.4	2370	12.6	404	3370	3
	7.45	0.255	223	1.9	97.8	1.4	238	0.6	15.8	14400	3
	7.25	0.24	229	2.1	67.5	0.6	230	0.8	10.9	17800	2.9
	7.1	0.26	254	2	88.9	13	290	0.8	17.9	17300	2.85
	7.3	0.25	214	1.8	68.6	32.4	172	0.8	11.9	12400	2.95
	7.05	0.24	251	1.9	88	103	280	1.4	17.7	16500	2.85
	7	0.29	233	1.9	83.9	2.15	273	1.6	17	16200	2.8
Std Dev	5.34	1.21	80.9	0.106	30.88	37	803	4.2	147	5035	0.16
95% UCL	25.21	2.95	337	2.19	122.00	83.8	1874.000	10	313.000	22292.000	6.07
Method	C	C	C	C	C	C	C	C	C	C	C
Site Worker Updated RBC	454.06	1.76	67,649	1,060	101,628	894.00	1,702,725	908.00	42,015	68,109	800.00
Delta	428.85	-1.19	67,312	1,058	101,506	810.20	1,700,851	898.00	41,702	45,817	793.93
Is 95% UCL > 10% of RBC?	no	Yes	no	no	no	no	no	no	no	yes	no
# Samples Needed		3**								2	
# Samples Collected		7								7	
Sufficient samples to support comparison?		**Yes**								**yes**	
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no
Site Worker RBC (1998)	359.00	1.43	61,600	0.58	80,600	448.00	896,000	NC	33,300	53,800	NC
Delta	333.79	-1.52	61,263	-1.61	80,478	364.20	894,126	NC	32,987	31,508	NC
Is 95% UCL > 10% of RBC?	no	Yes	no	Yes	no	no	no		no	no	
# Samples Needed		2252**		2							
# Samples Collected		7		7							
Sufficient samples to support comparison?		**no**		**yes**							
Do soils exceed RBC's?	no	yes	no	yes	no	no	no		no	no	

Arsenic does not exceed background (7.7 mg/kg) at the specified confidence levels

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	1.1	190	0.12	90.6	535	0.55	26.7	**NA**	2630	169
	8.25	114	0.085	1.25	8.8	4.5	2.6	**NA**	215	52.5
	8.6	127	0.025	1.25	1.9	4.6	2.3	**NA**	183	36.4
	9.75	169	0.06	1.2	8.8	1.4	4.8	**NA**	243	194
	8.95	205	0.025	1.25	6.5	4.3	4.9	**NA**	150	450
	9.45	168	0.025	1.2	11.9	6.9	3.7	**NA**	249	136
	9	126	0.195	1.2	7.9	4.9	4.3	**NA**	250	85.5
Std Dev	6.05	35	0.13	33.3	199.000	1.81	8.73		914	140
95% UCL	25.7	215	0.36	69.9	411	7.13	21.4		2065	392
Method	C	C	C	C	C	C	C		C	C
Site Worker Updated RBC	22,711.00	35,325.00	340.00	5,676.00	10,597.00	5,676.00	5,676.00	77.19	7,949.00	340,545.00
Delta	22,685.30	35,110.00	339.64	5,606.10	10,186.00	5,668.87	5,654.60		5,884.00	340,153.00
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no		no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	No Decision	no	no
Site Worker RBC (1998)	17,900	4,480	269.00	4,480	17,900	4,480	4,480	71.70	6,280	269,000
Delta	17,874	4,265	268.64	4,410	17,489	4,473	4,459		4,215	268,608
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no		no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	No Decision	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's-t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescibed alpha and beta levels

**sufficient samples were collected for comparison to the 7.7 mg/kg background value for arsenic

TABLE C-28: RU 20 Comparison between Site Data and Construction Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	8.5	3.15	183	1.1	9.55	0.55	20.3	7.3	13.9	560	8.8
	8.8	2.8	181	1	10	0.55	33.9	6.5	14	760	13.5
	8.1	4.3	139	0.67	9.5	1.1	23	6.3	12.8	670	9.5
	8	3.2	91.3	0.67	5.55	1.1	17.5	5.1	8.9	530	3.2
	8.2	3	189	0.9	7.7	0.55	18.9	5.9	11.5	580	8.2
	8.25	3	133	0.89	9.4	0.55	21.4	5.6	11.1	460	10.1
	8.25	2.35	177	0.96	10.35	0.55	17.3	6.5	11.4	500	8.9
	8.15	3.3	174	0.68	7.45	1.3	17.8	6.1	10.6	500	5.9
	8.35	3.7	145	0.7	8.4	3.1	18.8	5.4	13.2	1680	11.1
	8.45	0.65	145	0.71	7.95	1.1	17.3	5	14.4	1200	7.3
Distribution			N	U		U	U	N	N	U	
Std Dev	0.463	1.6	30.65	0.161	2.93	0.629	5.04	0.72	1.77	394	2.14
95% UCL	17.25	6.64	173.5	1.05	21.2	2.19	27.57	6.39	13.2	1287	12.51
Method	C	C	S	C	C	C	C	S	S	C	C
Construction Worker RBC	104	14.6	8,355	61	5,213	81.3	550,729	52.2	22,036	33,044	800.00
Delta	87.05	7.96	8,182	59.95	5,192	79.11	550,701	45.81	22,023	31,757	787.49
Is 95% UCL > 10% of RBC?	yes	yes	no	no	no	no	no	yes	no	no	no
# Samples Needed	2	2						2			
# Samples Collected	10	10						10			
Sufficient samples to support comparison?	**yes**	**yes**						**yes**			
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	18	421	0.095	1.45	14.3	0.8	0.44	13.25	32	60.2
	16.7	418	0.175	1.5	15	0.85	0.455	13.7	46.6	61.6
	13.3	372	0.26	1.35	13.4	1.3	0.42	12.6	30.1	51.2
	10.2	327	0.17	1.35	12.1	1.05	0.415	12.45	26.8	41.5
	15	398	0.135	1.4	11.8	0.6	0.425	12.75	31.3	50.4
	13.8	372	0.08	1.4	15.5	0.6	0.43	12.9	33.8	48.7
	15.4	437	0.11	1.4	14.8	4.5	0.43	12.85	30.3	54.4
	6.65	345	0.57	1.4	12.1	1.15	0.425	12.7	26.3	44.5
	15.1	312	0.38	1.4	12.5	1.25	0.435	13	32.7	207
	14.3	391	0.42	1.45	10.6	1	0.44	13.2	26.7	60.8
Distribution	N	N			N	L			U	U
Std Dev	2.12	41.63	0.131	0.092	1.63	0.955	0.023	0.732	5.87	49.3
95% UCL	15.74	403.4	0.479	2.95	14.16	3.49	0.895	26.89	39.75	136
Method	S	S	C	C	S	C	C	C	C	C
Construction Worker RBC	11,911	77,102	464	2,754	404	2,754	2,754	375	3,503	165,219
Delta	11,895	76,699	463.62	2,751	389.64	2,750	2,753	347.61	3,464	165,083
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's-t, C=Chebyshev, H=H-UCL

No Decision = There are insufficient samples available to support the decision at the prescibed alpha and beta levels

TABLE C-29: RU 20 Comparison between Site Data and Utility Worker RBCs

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	8.5	3.15	183	1.1	9.55	0.55	20.3	7.3	13.9	560	8.8
	8.8	2.8	181	1	10	0.55	33.9	6.5	14	760	13.5
	8.1	4.3	139	0.67	9.5	1.1	23	6.3	12.8	670	9.5
	8	3.2	91.3	0.67	5.55	1.1	17.5	5.1	8.9	530	3.2
	8.2	3	189	0.9	7.7	0.55	18.9	5.9	11.5	580	8.2
	8.25	3	133	0.89	9.4	0.55	21.4	5.6	11.1	460	10.1
	8.25	2.35	177	0.96	10.35	0.55	17.3	6.5	11.4	500	8.9
	8.15	3.3	174	0.68	7.45	1.3	17.8	6.1	10.6	500	5.9
	8.35	3.7	145	0.7	8.4	3.1	18.8	5.4	13.2	1680	11.1
	8.45	0.65	145	0.71	7.95	1.1	17.3	5	14.4	1200	7.3
Distribution			N	U		U	U	N	N	U	
Std Dev	0.463	1.6	30.65	0.161	2.93	0.629	5.04	0.72	1.77	394	2.14
95% UCL	17.25	6.64	173.5	1.05	21.2	2.19	27.57	6.39	13.2	1287	12.51
Method	C	C	S	C	C	C	C	S	S	C	C
Utility Worker RBC	1,370	196.61	116,514	865.79	68,492	1,154	7,205,461	742.11	286,470	432,328	800.00
Delta	1,353	189.97	116,340	864.74	68,471	1,152	7,205,434	735.72	286,456	431,041	787.49
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no	no	no	no	no
# Samples Needed											
# Samples Collected											
Sufficient samples to support comparison?											
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no	no

Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	18	421	0.095	1.45	14.3	0.8	0.44	13.25	32	60.2
	16.7	418	0.175	1.5	15	0.85	0.455	13.7	46.6	61.6
	13.3	372	0.26	1.35	13.4	1.3	0.42	12.6	30.1	51.2
	10.2	327	0.17	1.35	12.1	1.05	0.415	12.45	26.8	41.5
	15	398	0.135	1.4	11.8	0.6	0.425	12.75	31.3	50.4
	13.8	372	0.08	1.4	15.5	0.6	0.43	12.9	33.8	48.7
	15.4	437	0.11	1.4	14.8	4.5	0.43	12.85	30.3	54.4
	6.65	345	0.57	1.4	12.1	1.15	0.425	12.7	26.3	44.5
	15.1	312	0.38	1.4	12.5	1.25	0.435	13	32.7	207
	14.3	391	0.42	1.45	10.6	1	0.44	13.2	26.7	60.8
Distribution	N	N			N	L			U	U
Std Dev	2.12	41.63	0.131	0.092	1.63	0.955	0.023	0.732	5.87	49.3
95% UCL	15.74	403.4	0.479	2.95	14.16	3.49	0.895	26.89	39.75	136
Method	S	S	C	C	S	C	C	C	C	C
Utility Worker RBC	154,848	1,008,765	6,437	36,027	5,718	36,027	36,027	4,900	46,169	2,161,638
Delta	154,833	1,008,361	6,437	36,024	5,703	36,024	36,026	4,873	46,129	2,161,502
Is 95% UCL > 10% of RBC?	no	no	no	no	no	no	no	no	no	no
# Samples Needed										
# Samples Collected										
Sufficient samples to support comparison?										
Do soils exceed RBC's?	no	no	no	no	no	no	no	no	no	no

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's-t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescibed alpha and beta levels

TABLE C-30: RU 20 Comparison between Site Data and Background

Constituent	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Fluoride	Lead
(all values in mg/kg)	8.5	3.15	183	1.1	9.55	0.55	20.3	7.3	13.9	560	8.8
	8.8	2.8	181	1	10	0.55	33.9	6.5	14	760	13.5
	8.1	4.3	139	0.67	9.5	1.1	23	6.3	12.8	670	9.5
	8	3.2	91.3	0.67	5.55	1.1	17.5	5.1	8.9	530	3.2
	8.2	3	189	0.9	7.7	0.55	18.9	5.9	11.5	580	8.2
	8.25	3	133	0.89	9.4	0.55	21.4	5.6	11.1	460	10.1
	8.25	2.35	177	0.96	10.35	0.55	17.3	6.5	11.4	500	8.9
	8.15	3.3	174	0.68	7.45	1.3	17.8	6.1	10.6	500	5.9
	8.35	3.7	145	0.7	8.4	3.1	18.8	5.4	13.2	1680	11.1
	8.45	0.65	145	0.71	7.95	1.1	17.3	5	14.4	1200	7.3
Distribution	N	N	N	U	N	U	U	N	N	U	N
Std Dev	0.463	1.6	30.65	0.161	2.93	0.629	5.04	0.72	1.77	394	2.14
95% UCL	17.25	6.64	173.5	1.05	21.2	2.19	27.57	6.39	13.2	1287	12.51
Method	C	C	S	C	C	C	C	S	S	C	C
Background	2.2	7.7	188	1	12.8	1.9	27.5	7.6	12.6	600	29.1
Delta	-15.05	1.06	14.5	-0.05	-8.4	-0.29	-0.07	1.21	-0.6	-687	16.59
Do soils exceed Background?	yes	no	no	yes	yes	yes	yes	no	yes	yes	no

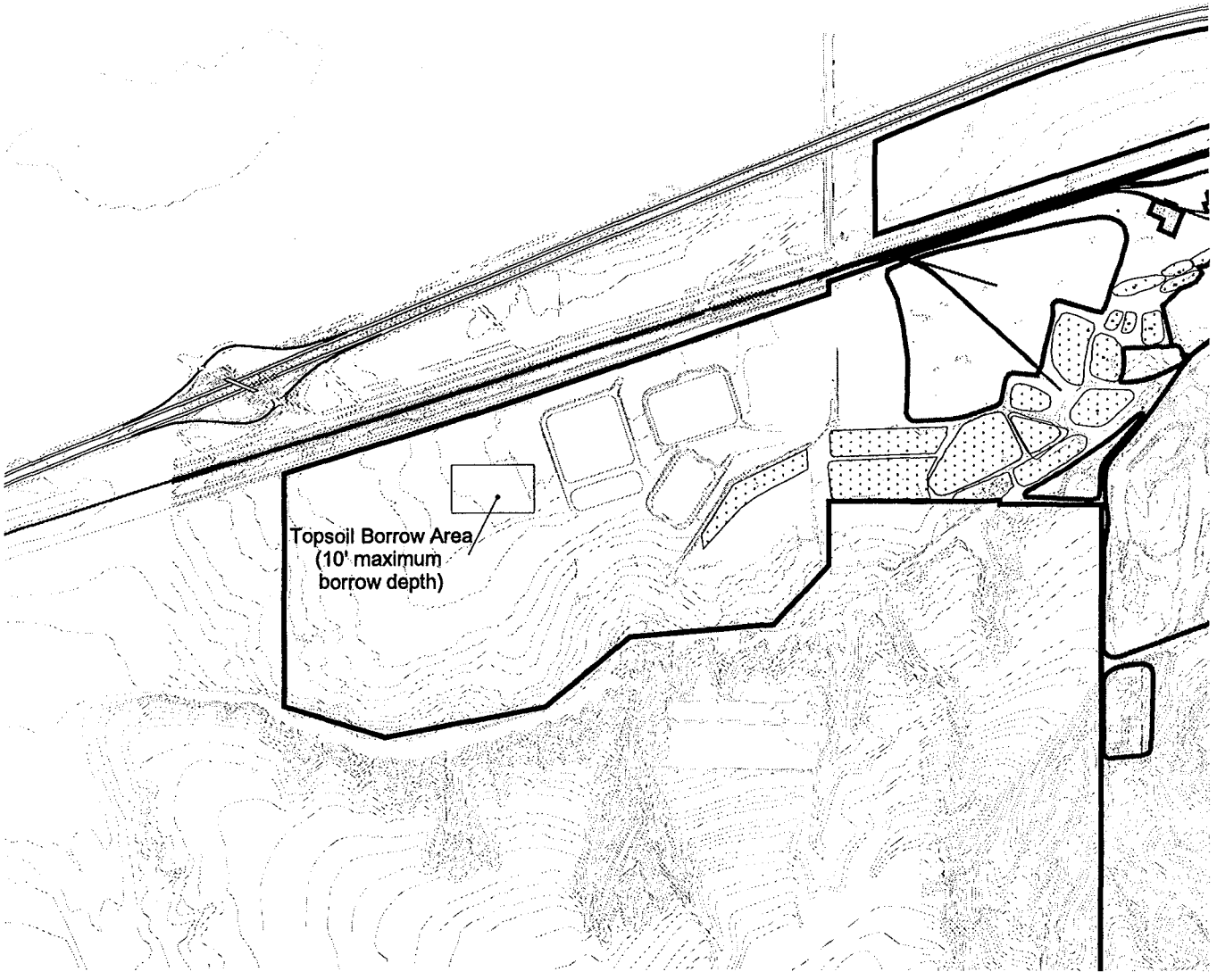
Constituent	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
(all values in mg/kg)	18	421	0.095	1.45	14.3	0.8	0.44	13.25	32	60.2
	16.7	418	0.175	1.5	15	0.85	0.455	13.7	46.6	61.6
	13.3	372	0.26	1.35	13.4	1.3	0.42	12.6	30.1	51.2
	10.2	327	0.17	1.35	12.1	1.05	0.415	12.45	26.8	41.5
	15	398	0.135	1.4	11.8	0.6	0.425	12.75	31.3	50.4
	13.8	372	0.08	1.4	15.5	0.6	0.43	12.9	33.8	48.7
	15.4	437	0.11	1.4	14.8	4.5	0.43	12.85	30.3	54.4
	6.65	345	0.57	1.4	12.1	1.15	0.425	12.7	26.3	44.5
	15.1	312	0.38	1.4	12.5	1.25	0.435	13	32.7	207
	14.3	391	0.42	1.45	10.6	1	0.44	13.2	26.7	60.8
Distribution	N	N	N	N	N	L	N	N	U	U
Std Dev	2.12	41.63	0.131	0.092	1.63	0.955	0.023	0.732	5.87	49.3
95% UCL	15.74	403.4	0.479	2.95	14.16	3.49	0.895	26.89	39.75	136
Method	S	S	C	C	S	C	C	C	C	C
Background	16.1	482	0.16	2.15	15.5	1.36	1.9	0.27	45.4	52.8
Delta	0.36	78.6	-0.319	-0.8	1.34	-2.13	1.005	-26.62	5.65	-83.2
Do soils exceed Background?	no	no	yes	yes	no	yes	no	yes	no	yes

Distribution N=Normal, L=Lognormal, U=Unknown Method S=Student's-t, C=Chebyshev, H=H-UCL
No Decision = There are insufficient samples available to support the decision at the prescibed alpha and beta levels

APPENDIX D

GEOTECHNICAL LABORATORY RESULTS FROM COVER/CAP BORROW AREA

Figure A-D1
Borrow Area



FMC OU Boundaries
RU Boundaries
Highway
Railroads
Old Ponds
2ft_contours

N

0.7 0 0.7 Miles

Samples 18-1 through 18-6
Collected from Borrow Area
Shown

PERMEABILITY TEST RESULTS
ASTM D5084

Project: FMC Pond Closure
Client: A & E Engineering

Date: August 31,2001
File: AEENGR P01081A

Permeability Test Results
ASTM D5084

Sample ID.	Lab Number	Soil Description	Maximum Dry Density	Optimum Moisture	Initial % Remold	Final % Remold	Initial Density	Initial Moisture	Final Density	Final Moisture	Permeability Rate cm/sec	Inches per day
18-1	B1L1740	Silt	107.5 pcf	17.0%	80	93.2	85.6	17.4	100.1	25.3	7.5 E-05	2.54
18-1	B1L1740	Silt	107.5 pcf	17.0%	85	95.0	92.1	17.4	102.1	24.3	1.5 E-05	0.50
18-1	B1L1740a	Silt w/ *	110 pcf	16.8%	80	88.5	89.6	16.6	103.8	26.6	6.6 E-05	2.23
18-2	B1L1741	Silt	104.0 pcf	17.5%	80	92.1	83.4	17.5	95.7	27.5	3.3 E-05	1.10
18-2	B1L1741	Silt	104.0 pcf	17.5%	85	92.5	88.7	17.5	96.2	28.4	9.4 E-05	3.20
18-2	B1L1741a	Silt w/ *	111.0 pcf	16.5%	80	90.0	89.5	16.2	100.2	24.2	1.7 E-04	5.62
18-3	B1L1742	Calcitic Silt	97.5 pcf	21.5%	80	95.0	78.3	21.3	92.7	29.6	9.6 E-06	0.33
18-3	B1L1742	Calcitic Silt	97.5 pcf	21.5%	85	93.0	83.1	21.3	90.7	33.2	2.7 E-04	9.14
18-3	B1L1742a	Calcitic Silt w/ *	106.0 pcf	18.5%	80	88.9	86.5	18.0	95.8	26.1	4.5 E-04	15.47
18-4	B1L1743	Clayey Silt	100.5 pcf	20.5%	80	88.6	80.4	20.5	89.0	33.3	5.8 E-05	1.98
18-4	B1L1743	Clayey Silt	100.5 pcf	20.5%	85	89.6	84.9	20.5	90.1	35.1	9.3 E-05	3.15
18-4	B1L1743a	Clayey Silt w/ *	108.0 pcf	21.0%	80	87.9	82.7	21.0	90.5	33.2	3.8 E-05	1.29
18-5	B1L1744	Silt	105.5 pcf	16.0%	80	87.3	84.7	16.0	92.1	29.7	8.4 E-05	2.84
18-5	B1L1744	Silt	105.5 pcf	16.0%	85	89.9	89.7	16.0	94.8	29.8	9.1 E-05	3.10
18-5	B1L1744a	Silt w/ *	111.0 pcf	15.5%	80	88.2	89.5	15.2	96.6	29.1	6.9 E-05	2.33
18-6	B1L1745	Clayey Silt	108.5 pcf	16.0%	80	84.5	87.2	16.5	91.7	28.7	3.8 E-05	1.28
18-6	B1L1745	Clayey Silt	108.5 pcf	16.0%	85	90.3	92.5	16.5	97.9	28.9	8.1 E-05	2.76
18-6	B1L1745a	Clayey Silt w/ *	116.5 pcf	14.0%	80	86.5	90.7	14.2	99.0	25.6	6.2 E-05	2.09

* = 15% Pea Gravel

Note: Soils with loose densities tend to collapse at saturation causing an increase in density.
Classifications based on ASTM D422 (Hydrometer Analysis) and ASTM D2488 (Visual Classification)
All soils had varying amounts of calcium.

Reviewed by: _____

STRATA
GEOTECHNICAL ENGINEERING & MATERIALS TESTING
4460 Kings Way #3 Chubbuck, ID 83202 (208) 237 3400

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1740
CLIENT:	A&E Engineering	DATE:	8-15-01
SAMPLE ID:	18-1	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Silt

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 107.5
OPTIMUM MOISTURE, %: 17.0

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 97%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.01	2.50	260.30	17.4	31.67	221.7	85.6	79.6%
Final	1.88	2.39	277.90	25.3	28.94	221.7	100.1	93.2%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
45.20	33.85	12.16	45.05	34.65	11.15	112	21	1.02E-04
45.05	34.65	11.15	44.80	36.50	8.90	349	23	8.10E-05
44.80	36.50	8.90	44.50	38.50	6.43	501	23	8.14E-05
48.80	42.00	7.29	48.50	43.50	5.36	509	23	7.58E-05
48.50	43.50	5.36	48.30	45.00	3.54	787	23	6.61E-05
48.30	45.00	3.54	48.20	45.60	2.79	395	23	7.56E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	7.5E-05	Final Density, pcf:(see note)	100.1
Maximum Gradient:	4.8	Final Moisture, pct:	25.3
Minimum Gradient:	1.4	Conductivity, in/day	2.5429

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT: FMC Pond Closure
CLIENT: A&E Engineering
SAMPLE ID: 18-1

SAMPLE NO: B1L1740
DATE: 8-15-01
PROJ NO: P01081A
CLIENT NO: AEENGR

SAMPLE DESCRIPTION: Silt w/15% Pea Gravel

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 111.0
OPTIMUM MOISTURE, %: 16.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 99%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	1.99	2.49	266.00	16.5	31.42	228.3	89.8	80.9%
Final	1.90	2.37	286.00	25.3	28.46	228.3	103.8	93.5%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
44.50	31.00	14.47	44.30	33.00	12.11	365	22	6.44E-05
44.30	33.00	12.11	44.00	35.00	9.65	463	22	6.47E-05
44.00	35.00	9.65	43.70	36.70	7.50	528	22	6.30E-05
43.70	36.70	7.50	43.50	38.20	5.68	560	22	6.55E-05
48.50	38.20	11.04	48.10	40.40	8.25	561	22	6.86E-05
48.10	40.40	8.25	47.90	42.00	6.32	573	22	6.14E-05
47.90	42.00	6.32	47.70	43.10	4.93	489	22	6.71E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	6.6E-05	Final Density, pcf:	103.8
Maximum Gradient:	5.7	Final Moisture, pct:	25.3
Minimum Gradient:	2.5	Conductivity, in/day	2.23

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT: FMC Pond Closure
CLIENT: A&E Engineering
SAMPLE ID: 18-1

SAMPLE NO: B1L1740
DATE: 8-15-01
PROJ NO: P01081A
CLIENT NO: AEENGR

SAMPLE DESCRIPTION: Silt

STANDARD: ASTM D 698 REMOLD %: 85
MAXIMUM DRY DENSITY, PC 107.5
OPTIMUM MOISTURE, %: 17.0

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 99%

TEST DATA

Unit No =	3		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.00	2.49	276.50	17.4	31.42	235.5	92.1	85.7%
Final	1.91	2.42	292.80	24.3	29.67	235.5	102.1	95.0%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
12.70	7.70	7.24	12.20	8.20	5.73	788	20	1.61E-05
22.40	8.40	20.82	21.45	9.25	18.11	450	20	1.68E-05
21.45	9.25	18.11	20.80	9.90	16.15	406	20	1.53E-05
20.80	9.90	16.15	20.20	10.50	14.34	463	20	1.39E-05
20.20	10.50	14.34	19.50	11.20	12.22	578	20	1.50E-05
19.50	11.20	12.22	19.10	11.60	11.02	373	20	1.50E-05
19.10	11.60	11.02	18.50	12.20	9.20	650	20	1.50E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec: 1.5E-05
Maximum Gradient: 8.2
Minimum Gradient: 2.9

Final Density, pcf: 102.1
Final Moisture, pct: 24.3
Conductivity, in/day 0.5014

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT: FMC Pond Closure
CLIENT: A&E Engineering
SAMPLE ID: 18-2

SAMPLE NO: B1L1741
DATE: 8/21/01
PROJ NO: P01081A
CLIENT NO: AEENGR

SAMPLE DESCRIPTION: Silt ML

STANDARD: ASTM D 698 REMOLD %: 85
MAXIMUM DRY DENSITY, PC 104.0
OPTIMUM MOISTURE, %: 17.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 95%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.01	2.49	267.70	17.5	31.42	227.8	88.7	85.3%
Final	1.93	2.44	292.50	28.4	30.17	227.8	96.2	92.5%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
44.00	32.70	12.11	43.60	35.00	9.22	350	22	9.86E-05
43.60	35.00	9.22	43.40	36.50	7.39	286	22	9.79E-05
47.90	36.50	12.22	47.50	39.00	9.11	369	22	1.01E-04
47.50	39.00	9.11	47.20	41.00	6.64	406	22	9.86E-05
49.80	41.00	9.43	49.60	43.00	7.07	391	22	9.32E-05
49.60	43.00	7.07	49.50	44.40	5.47	381	22	8.52E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec: 9.4E-05
Maximum Gradient: 4.8
Minimum Gradient: 2.8

Final Density, pcf: (see note) 96.2
Final Moisture, pct: 28.4
Conductivity, in/day 3.2117

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1741
CLIENT:	A & E Engineers	DATE:	8/21/01
SAMPLE ID:	18-2	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Silt w/ 15% Pea Gravel

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 111.3
OPTIMUM MOISTURE, %: 15.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 95%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.01	2.49	264.80	15.2	31.42	229.9	89.5	80.4%
Final	1.90	2.42	285.50	24.2	29.67	229.9	100.2	90.0%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
41.20	30.30	11.68	40.90	32.70	8.79	201	22	1.79E-04
40.90	32.70	8.79	40.60	34.50	6.54	214	22	1.75E-04
45.90	34.50	12.22	45.50	37.00	9.11	215	22	1.73E-04
45.50	37.00	9.11	45.20	39.00	6.64	238	22	1.68E-04
48.60	39.00	10.29	48.20	41.50	7.18	282	22	1.62E-04
48.20	41.50	7.18	48.00	43.00	5.36	234	22	1.58E-04
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	1.7E-04	Final Density, pcf: (see note)	100.2
Maximum Gradient:	4.8	Final Moisture, pct:	24.2
Minimum Gradient:	2.8	Conductivity, in/day	5.6212

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

STRATA
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1742
CLIENT:	A&E Engineering	DATE:	8/17/01
SAMPLE ID:	18-2	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Silt

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 104.0
OPTIMUM MOISTURE, %: 17.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 96%

TEST DATA

Unit No =	1 Ht, in	Dia, in	Wet Wt g	Moist Cont %	Area sq cm	Dry Wt g	Density pcf	Actual Remold %
Initial	2.01	2.49	251.90	17.5	31.42	214.4	83.4	80.2%
Final	1.87	2.41	273.40	27.5	29.43	214.4	95.7	92.1%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
49.30	11.90	40.08	48.90	15.10	36.22	470	20	2.84E-05
48.80	15.40	35.80	48.40	18.25	32.31	340	20	3.98E-05
48.40	18.25	32.31	48.00	20.30	29.69	320	20	3.48E-05
48.00	20.30	29.69	47.80	22.30	27.33	350	20	3.12E-05
47.80	22.30	27.33	47.60	23.70	25.61	254	20	3.37E-05
47.60	23.70	25.61	47.30	25.80	23.04	430	20	3.24E-05
47.30	25.80	23.04	47.05	27.35	21.11	342	20	3.37E-05
47.05	27.35	21.11	47.00	28.00	20.36	153	20	3.12E-05
47.00	28.00	20.36	46.90	28.70	19.51	170	20	3.31E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	3.3E-05	Final Density, pcf:(see note)	95.7
Maximum Gradient:	15.8	Final Moisture, pct:	27.5
Minimum Gradient:	8.0	Conductivity, in/day	1.1090

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

STRATA
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT: FMC Pond Closure
CLIENT: A&E Engineering
SAMPLE ID: 18-3

SAMPLE NO: B1L1742
DATE: 9/4/01
PROJ NO: P01081A
CLIENT NO: AEENGR

SAMPLE DESCRIPTION: Silt w/calcium

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 97.5
OPTIMUM MOISTURE, %: 21.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 99%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.00	2.49	243.60	21.2	31.42	201.0	78.6	80.6%
Final	1.89	2.36	260.50	29.6	28.22	201.0	92.6	95.0%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
44.70	20.10	26.36	44.50	21.50	24.65	834	22	1.07E-05
44.50	21.50	24.65	44.40	22.20	23.79	458	22	1.03E-05
44.40	22.20	23.79	44.30	22.70	23.15	432	22	8.36E-06
44.30	22.70	23.15	44.20	23.40	22.29	533	22	9.41E-06
44.20	23.40	22.29	44.10	24.10	21.43	557	22	9.36E-06
44.10	24.10	21.43	44.00	24.80	20.58	556	22	9.64E-06
44.00	24.80	20.58	43.90	25.50	19.72	568	22	9.95E-06
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec: 9.6E-06
Maximum Gradient: 10.4
Minimum Gradient: 8.1

Final Density, pcf:(see note) 92.6
Final Moisture, pct: 29.6
Conductivity, in/day 0.33

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

STRATA
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by: _____

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1742
CLIENT:	A & E Engineers	DATE:	8/21/01
SAMPLE ID:	18-3	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Calcitic Silt w/15% Pea Gravel

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 106.5
OPTIMUM MOISTURE, %: 18.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 99%

TEST DATA

Unit No =	5 Ht, in	Dia, in	Wet Wt g	Moist Cont %	Area sq cm	Dry Wt g	Density pcf	Actual Remold %
Initial	2.01	2.49	259.30	18.0	31.42	219.7	85.5	80.3%
Final	1.90	2.42	275.00	25.1	29.67	219.7	95.8	89.9%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
14.71	7.01	19.56	14.30	7.70	16.76	30	22	5.38E-04
14.30	7.70	16.76	13.81	8.30	14.00	35	22	5.37E-04
13.81	8.30	14.00	13.34	8.71	11.76	40	22	4.55E-04
13.34	8.71	11.76	12.93	9.28	9.27	45	22	5.52E-04
12.93	9.28	9.27	12.56	9.69	7.29	50	22	5.02E-04
12.56	9.69	7.29	12.19	10.11	5.28	75	22	4.49E-04
12.19	10.11	5.28	11.98	10.32	4.22	55	22	4.26E-04
11.98	10.32	4.22	11.81	10.50	3.33	50	22	4.95E-04
11.81	10.50	3.33	11.61	10.70	2.31	85	22	4.50E-04
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	4.5E-04	Final Density, pcf: (see note)	95.8
Maximum Gradient:	7.7	Final Moisture, pct:	25.1
Minimum Gradient:	1.3	Conductivity, in/day	15.47

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1742
CLIENT:	A&E Engineering	DATE:	8/22/01
SAMPLE ID:	18-3	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Calcitic Silt

STANDARD: ASTM D 698 REMOLD %: 85
MAXIMUM DRY DENSITY, PC 97.5
OPTIMUM MOISTURE, %: 21.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 99%

TEST DATA

Unit No =	2 Ht, in	Dia, in	Wet Wt g	Moist Cont %	Area sq cm	Dry Wt g	Density pcf	Actual Remold %
Initial	2.01	2.49	258.90	21.3	31.42	213.4	83.1	85.2%
Final	1.95	2.42	284.30	33.2	29.67	213.4	90.7	93.0%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
11.65	6.00	6.06	11.40	6.60	5.14	60	21	3.65E-04
11.40	6.60	5.14	11.02	7.08	4.22	90	21	2.92E-04
11.02	7.08	4.22	10.73	7.35	3.62	70	21	2.92E-04
10.73	7.35	3.62	10.22	7.91	2.48	220	21	2.29E-04
10.22	7.91	2.48	10.01	8.11	2.04	90	21	2.89E-04
10.01	8.11	2.04	9.90	8.21	1.81	60	21	2.65E-04
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	2.7E-04	Final Density, pcf:(see note)	90.7
Maximum Gradient:	2.4	Final Moisture, pct:	33.2
Minimum Gradient:	0.8	Conductivity, in/day	9.14

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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FLEXWALL PERM ASTM D5084

PROJECT: FMC Pond Closure
CLIENT: A&E Engineering
SAMPLE ID: 18-4

SAMPLE NO: B1L1743
DATE: 8/15/01
PROJ NO: P01081A
CLIENT NO: AEENGR

SAMPLE DESCRIPTION: Clayey Silt w/15% Pea Gravel ML/CL

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 103.0
OPTIMUM MOISTURE, %: 21.0

CHMBR PRES 10 psi
BACK PRESS: 9 psi
PCT SATURAT 99%

TEST DATA

Unit No =	5		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.01	2.49	257.67	21.3	31.42	212.4	82.7	80.3%
Final	1.96	2.41	283.00	33.2	29.43	212.4	90.5	87.9%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
13.55	3.35	25.91	12.85	4.30	21.72	240	20	8.38E-05
10.00	4.57	13.79	9.41	5.21	10.67	571	20	5.12E-05
9.41	5.21	10.67	8.50	6.15	5.97	1451	20	4.56E-05
8.50	6.15	5.97	8.28	6.40	4.78	600	20	4.23E-05
8.28	6.40	4.78	8.17	6.53	4.17	542	20	2.87E-05
8.17	6.53	4.17	7.94	6.74	3.05	1010	20	3.53E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	20	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	20	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec: 3.8E-05
Maximum Gradient: 10.2
Minimum Gradient: 1.6

Final Density, pcf: (see note) 90.5
Final Moisture, pct: 33.2
Conductivity, in/day 1.29

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1743
CLIENT:	A&E Engineering	DATE:	8/15/01
SAMPLE ID:	18-4	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Clayey Silt ML/CL

STANDARD: ASTM D 698 REMOLD %: 85
MAXIMUM DRY DENSITY, PC 100.5
OPTIMUM MOISTURE, %: 20.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 98%

TEST DATA

Unit No =	4		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.02	2.49	264.30	20.5	31.42	219.3	84.9	84.5%
Final	2.00	2.43	296.40	35.1	29.92	219.3	90.1	89.6%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
18.10	8.30	14.79	17.30	9.20	12.22	120	20	8.95E-05
17.30	9.20	12.22	15.60	10.90	7.09	360	20	8.51E-05
15.60	10.90	7.09	15.05	11.45	5.43	180	20	8.34E-05
15.05	11.45	5.43	14.30	12.20	3.17	368	20	8.23E-05
22.70	12.20	15.84	21.90	12.90	13.58	90	20	9.62E-05
21.90	12.90	13.58	21.20	13.60	11.47	96	20	9.90E-05
21.20	13.60	11.47	20.20	14.60	8.45	201	20	8.55E-05
20.20	14.60	8.45	19.60	15.20	6.64	151	20	8.98E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	9.3E-05	Final Density, pcf: (see note)	90.1
Maximum Gradient:	6.2	Final Moisture, pct:	35.1
Minimum Gradient:	2.1	Conductivity, in/day	3.15

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1744
CLIENT:	A&E Engineering	DATE:	8/23/01
SAMPLE ID:	18-5	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Silt ML

STANDARD: ASTM D 698 REMOLD %: 85
MAXIMUM DRY DENSITY, PC 105.5
OPTIMUM MOISTURE, %: 16.0

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 98%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.01	2.49	267.28	16.0	31.42	230.4	89.7	85.0%
Final	1.98	2.44	299.10	29.8	30.17	230.4	94.8	89.9%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
45.10	31.00	15.11	45.00	31.70	14.25	86	21.5	9.06E-05
45.00	31.70	14.25	44.90	32.40	13.40	86	21.5	9.51E-05
44.90	32.40	13.40	44.80	33.10	12.54	90	21.5	9.80E-05
44.80	33.10	12.54	44.70	33.80	11.68	102	21.5	9.26E-05
44.70	33.80	11.68	44.60	34.60	10.72	124	21.5	9.19E-05
44.60	34.60	10.72	44.50	35.30	9.86	126	20.5	9.04E-05
44.50	35.30	9.86	44.40	36.00	9.00	139	20.5	8.94E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	9.1E-05	Final Density, pcf: (see note)	94.8
Maximum Gradient:	5.9	Final Moisture, pct:	29.8
Minimum Gradient:	3.9	Conductivity, in/day	3.10

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1743
CLIENT:	A&E Engineering	DATE:	8/15/01
SAMPLE ID:	18-4	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Clayey Silt ML/CL

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 100.5
OPTIMUM MOISTURE, %: 20.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 99%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.00	2.50	249.70	20.5	31.67	207.2	80.4	80.0%
Final	1.96	2.40	276.30	33.3	29.19	207.2	89.0	88.6%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
41.80	30.55	12.06	41.60	31.90	10.40	296	21	6.80E-05
41.60	30.90	11.47	41.30	33.20	8.68	637	23	5.68E-05
41.30	33.20	8.68	41.00	35.00	6.43	602	23	6.47E-05
41.00	35.00	6.43	40.80	36.40	4.72	679	23	5.91E-05
48.40	38.50	10.61	48.00	40.60	7.93	615	23	6.14E-05
48.00	40.60	7.93	47.70	42.50	5.57	819	23	5.60E-05
47.70	42.50	5.57	47.50	43.80	3.97	783	23	5.61E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	5.8E-05	Final Density, pcf: (see note)	89.0
Maximum Gradient:	4.7	Final Moisture, pct:	33.3
Minimum Gradient:	2.2	Conductivity, in/day	1.98

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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GEOTECHNICAL ENGINEERING & MATERIALS TESTING

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Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1744
CLIENT:	A&E Engineering	DATE:	8/22/01
SAMPLE ID:	18-5	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Silt ML

STANDARD: ASTM D 698 REMOLD %: 80

MAXIMUM DRY DENSITY, PC 105.5

OPTIMUM MOISTURE, %: 16.0

CHMBR PRES 20 psi

BACK PRESS: 19 psi

PCT SATURAT 96%

TEST DATA

Unit No =	2		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.01	2.49	252.30	16.0	31.42	217.5	84.7	80.2%
Final	1.94	2.43	282.00	29.7	29.92	217.5	92.1	87.3%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
39.70	16.30	25.08	39.60	17.10	24.11	60	21	8.63E-05
39.60	17.10	24.11	39.50	17.80	23.26	63	21	7.48E-05
39.50	17.80	23.26	39.40	18.60	22.29	63	21	8.88E-05
39.40	18.60	22.29	39.30	19.30	21.43	61	21	8.47E-05
39.30	19.30	21.43	39.20	20.00	20.58	68	21	7.82E-05
39.20	20.00	20.58	39.10	20.70	19.72	68	21	8.24E-05
39.10	20.70	19.72	39.00	21.60	18.65	88	21	8.32E-05
39.00	21.60	18.65	38.90	22.10	18.01	53	21	8.65E-05
38.90	22.10	18.01	38.80	22.80	17.15	78	21	8.24E-05
38.80	22.80	17.15	38.70	23.50	16.29	82	21	8.24E-05

Average K, cm/sec:	8.4E-05	Final Density, pcf: (see note)	92.1
Maximum Gradient:	9.9	Final Moisture, pct:	29.7
Minimum Gradient:	6.8	Conductivity, in/day	2.84

Average based on last 4 readings within 25% of mean.

Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1744
CLIENT:	A&E Engineering	DATE:	8/23/01
SAMPLE ID:	18-5	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Silt w/15% Pea Gravel

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 111.5
OPTIMUM MOISTURE, %: 13.5

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 99%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.01	2.49	260.90	13.5	31.42	229.9	89.5	80.2%
Final	1.93	2.41	296.80	29.1	29.43	229.9	99.5	89.2%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
45.60	22.50	24.76	45.50	23.20	23.90	78	21.5	6.02E-05
45.50	23.20	23.90	45.40	24.00	22.94	71	21.5	7.67E-05
45.40	24.00	22.94	45.30	24.70	22.08	78	21.5	6.51E-05
45.30	24.70	22.08	45.20	25.40	21.22	77	21.5	6.85E-05
45.20	25.40	21.22	45.10	26.10	20.36	77	21.5	7.14E-05
45.10	26.10	20.36	45.00	26.90	19.40	92	21	6.97E-05
45.00	26.90	19.40	44.90	27.60	18.54	95	20.5	6.50E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	6.9E-05	Final Density, pcf:(see note)	99.5
Maximum Gradient:	9.7	Final Moisture, pct:	29.1
Minimum Gradient:	7.6	Conductivity, in/day	2.33

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT: FMC Pond Closure
CLIENT: A&E Engineering
SAMPLE ID: 18-6

SAMPLE NO: B1L1745
DATE: 8/23/01
PROJ NO: P01081A
CLIENT NO: AEENGR

SAMPLE DESCRIPTION: Clayey Silt

STANDARD: ASTM D 698 REMOLD %: 85
MAXIMUM DRY DENSITY, PC 108.5
OPTIMUM MOISTURE, %: 16.0

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 97%

TEST DATA

Unit No =	2		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.01	2.49	276.90	16.5	31.42	237.7	92.5	85.3%
Final	2.01	2.42	306.30	28.9	29.67	237.7	97.9	90.3%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
47.50	32.00	16.61	47.40	32.70	15.75	88	21	8.29E-05
47.40	32.70	15.75	47.30	33.40	14.90	94	21	8.10E-05
47.30	33.40	14.90	47.20	34.10	14.04	99	21	8.24E-05
47.20	34.10	14.04	47.10	34.90	13.08	118	21	8.23E-05
47.10	34.90	13.08	47.00	35.60	12.22	115	21	8.11E-05
47.00	35.60	12.22	46.90	36.30	11.36	128	21	7.82E-05
46.90	36.30	11.36	46.80	37.00	10.50	130	21	8.31E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	8.1E-05	Final Density, pcf:(see note)	97.9
Maximum Gradient:	6.5	Final Moisture, pct:	28.9
Minimum Gradient:	4.5	Conductivity, in/day	2.76

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

STRATA
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT:	FMC Pond Closure	SAMPLE NO:	B1L1745
CLIENT:	A&E Engineering	DATE:	8/23/01
SAMPLE ID:	18-6	PROJ NO:	P01081A
		CLIENT NO:	AEENGR

SAMPLE DESCRIPTION: Clayey Silt

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 108.5
OPTIMUM MOISTURE, %: 16.0

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT. 99%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	1.99	2.49	258.27	16.5	31.42	221.7	87.2	80.3%
Final	1.97	2.44	285.40	28.7	30.17	221.7	91.7	84.5%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
45.10	22.30	24.44	45.00	23.00	23.58	120	21	3.95E-05
45.00	23.00	23.58	44.90	23.70	22.72	127	21	3.87E-05
44.90	23.70	22.72	44.80	24.60	21.65	170	21	3.75E-05
44.80	24.60	21.65	44.70	25.20	20.90	123	21	3.79E-05
44.70	25.20	20.90	44.60	25.80	20.15	118	21	4.10E-05
44.60	25.80	20.15	44.50	26.50	19.29	154	21	3.75E-05
44.50	26.50	19.29	44.40	27.20	18.43	167	21	3.61E-05
44.40	27.20	18.43	44.30	27.90	17.58	172	21	3.63E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec:	3.8E-05	Final Density, pcf:(see note)	91.7
Maximum Gradient:	9.6	Final Moisture, pct:	28.7
Minimum Gradient:	7.3	Conductivity, in/day	1.28

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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GEOTECHNICAL ENGINEERING & MATERIALS TESTING

Reviewed by:

Strata Engineering & Testing

FLEXWALL PERM ASTM D5084

PROJECT: FMC Pond Closure
CLIENT: A&E Engineering
SAMPLE ID: 18-6

SAMPLE NO: B1L1745
DATE: 8/23/01
PROJ NO: P01081A
CLIENT NO: AEENGR

SAMPLE DESCRIPTION: Clayey Silt w/15% Pea Gravel

STANDARD: ASTM D 698 REMOLD %: 80
MAXIMUM DRY DENSITY, PC 115.5
OPTIMUM MOISTURE, %: 14.0

CHMBR PRES 20 psi
BACK PRESS: 19 psi
PCT SATURAT 97%

TEST DATA

Unit No =	1		Wet Wt	Moist	Area	Dry Wt	Density	Actual Remold
	Ht, in	Dia, in	g	Cont %	sq cm	g	pcf	%
Initial	2.02	2.49	270.40	14.2	31.42	236.8	91.7	79.4%
Final	1.98	2.41	297.30	25.6	29.43	236.8	99.9	86.5%

START H2	H1	delta 1	STOP H2	H1	delta 2	T sec	Temp Tx	K cm/s
48.20	33.70	15.54	47.70	36.20	12.32	473	21	6.69E-05
47.70	36.20	12.32	47.40	38.50	9.54	567	21	6.15E-05
47.40	38.50	9.54	47.10	40.10	7.50	511	21	6.42E-05
47.10	40.10	7.50	46.90	41.60	5.68	574	21	6.60E-05
48.80	41.60	7.72	48.50	43.70	5.14	1013	21	5.47E-05
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00
0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00E+00

Average K, cm/sec: 6.2E-05
Maximum Gradient: 6.1
Minimum Gradient: 3.0

Final Density, pcf:(see note) 99.9
Final Moisture, pct: 25.6
Conductivity, in/day 2.09

Average based on last 4 readings within 25% of mean.
Note: Samples with loose densities tend to collapse at saturation causing an increase in density.

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GEOTECHNICAL ENGINEERING & MATERIALS TESTING

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MOISTURE-DENSITY RELATIONSHIP
ASTM D 698
METHOD A/METHOD B

MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

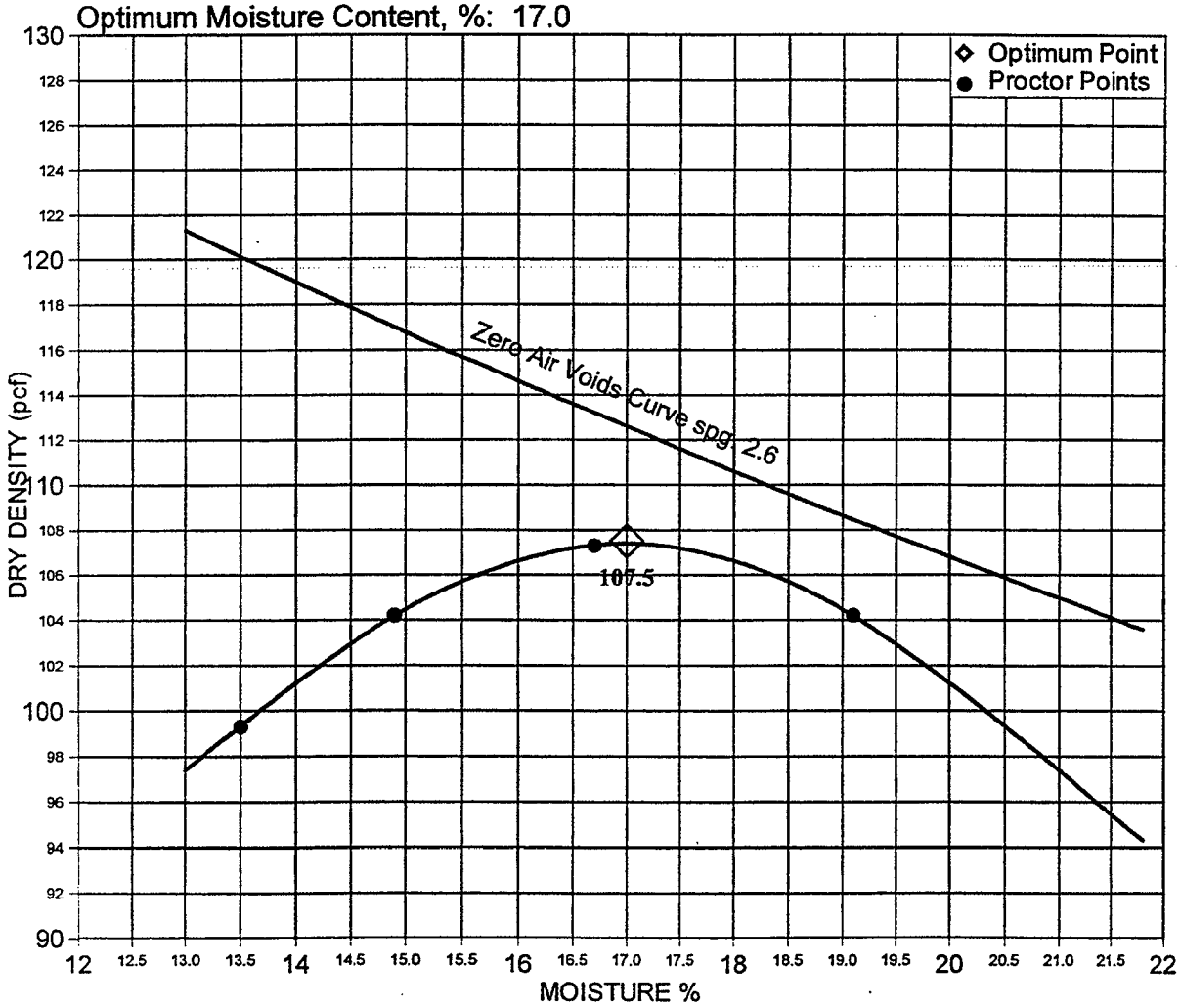
Method A

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/9/01
Tested By: CV - Strata
Sample Number: B1L1740
Sample Location: Test Hole 18-1
Sample Description: Silt
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch		
#4 screen	100	100

Maximum Dry Density, pcf : 107.5
Optimum Moisture Content, %: 17.0



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

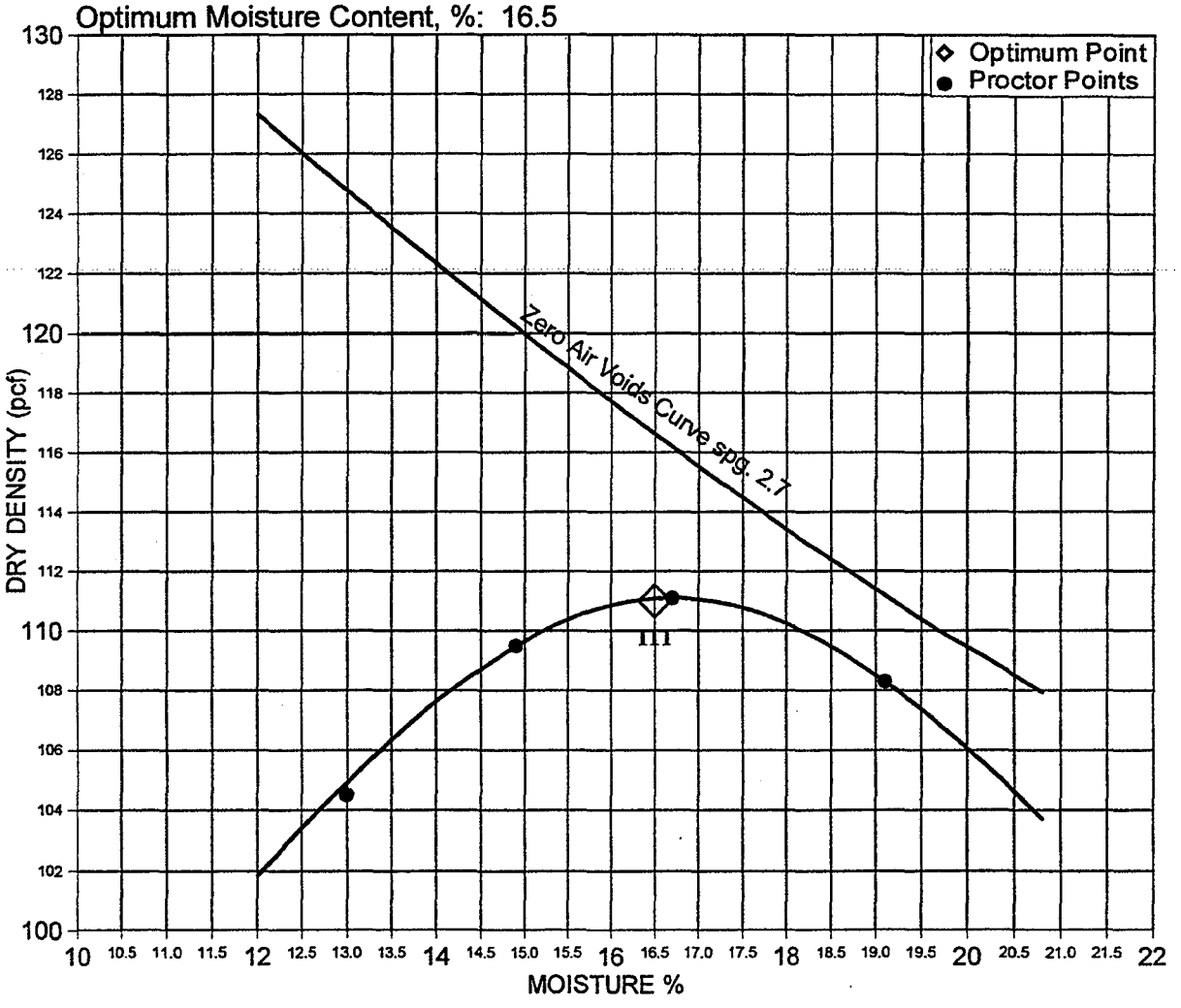
Method B

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/10/01
Tested By: CV - Strata
Sample Number: B1L1740A
Sample Location: Test Hole 18-1
Sample Description: Silt w/15% Pea Gravel
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch	100	100
#4 screen		

Maximum Dry Density, pcf : 111.0
Optimum Moisture Content, %: 16.5



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

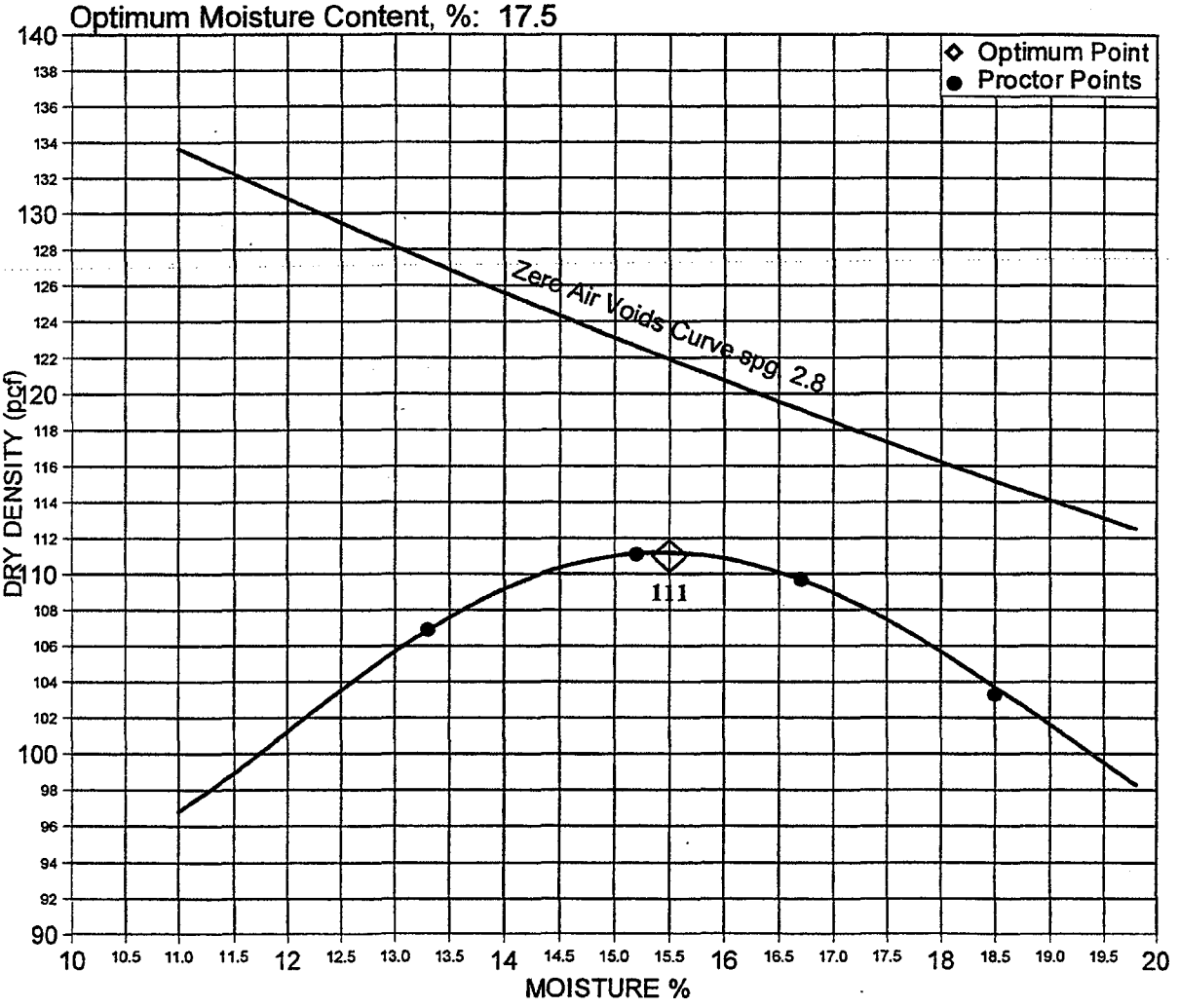
Method A

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/9/01
Tested By: JD - Strata
Sample Number: B1L1741
Sample Location: 18-2
Sample Description: Silt
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch		
#4 screen	100	100

Maximum Dry Density, pcf : 104.0
Optimum Moisture Content, %: 17.5



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

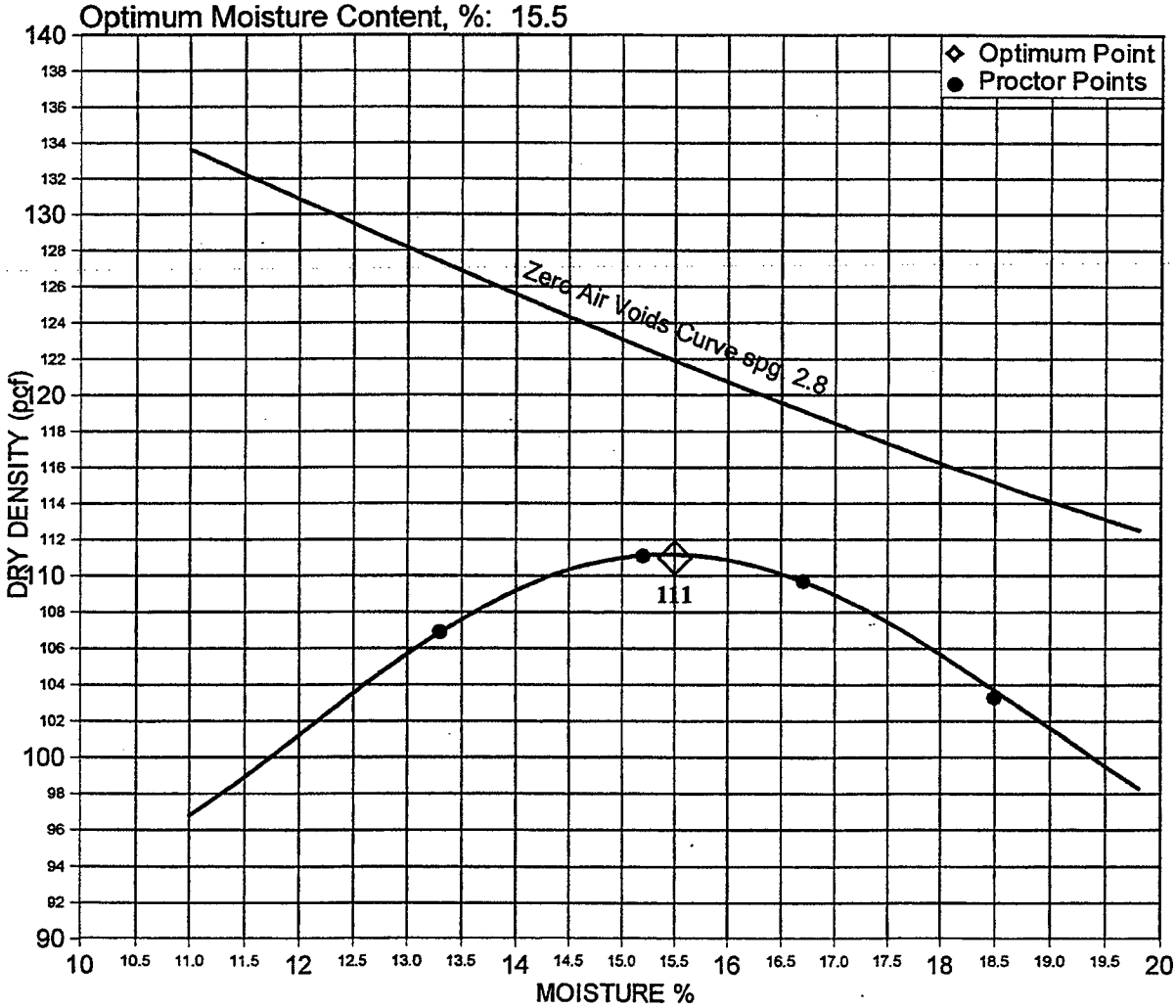
Method B

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/10/01
Tested By: JD - Strata
Sample Number: B1L1741A
Sample Location: 18-2
Sample Description: Silt w/15% Pea Gravel
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch	100	100
#4 screen		

Maximum Dry Density, pcf : 111.0
Optimum Moisture Content, %: 15.5



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

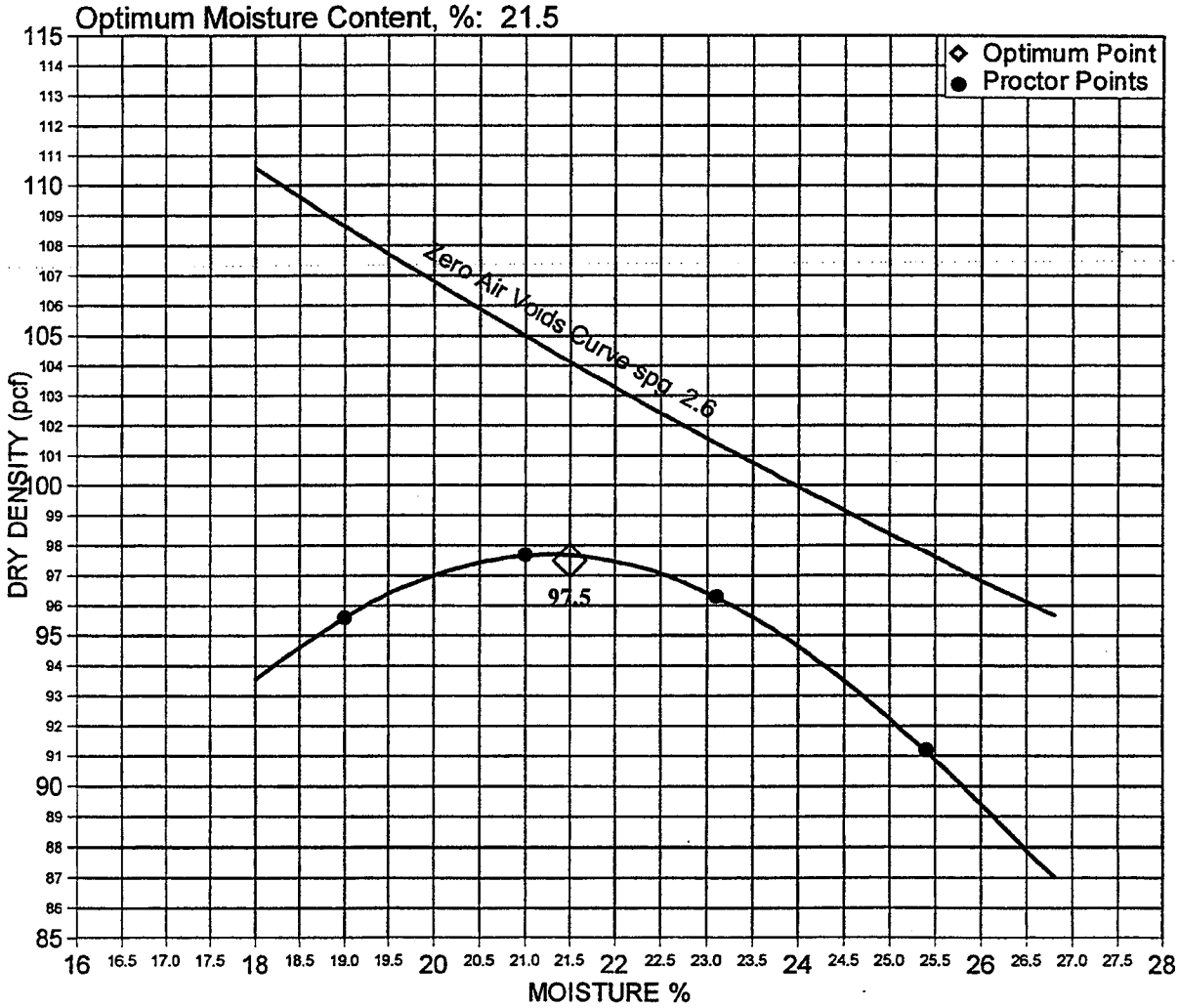
Method A

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/9/01
Tested By: CV - Strata
Sample Number: B1L1742
Sample Location: 18-3
Sample Description: Calcitic Silt
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch		
#4 screen	100	100

Maximum Dry Density, pcf : 97.5
Optimum Moisture Content, %: 21.5



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

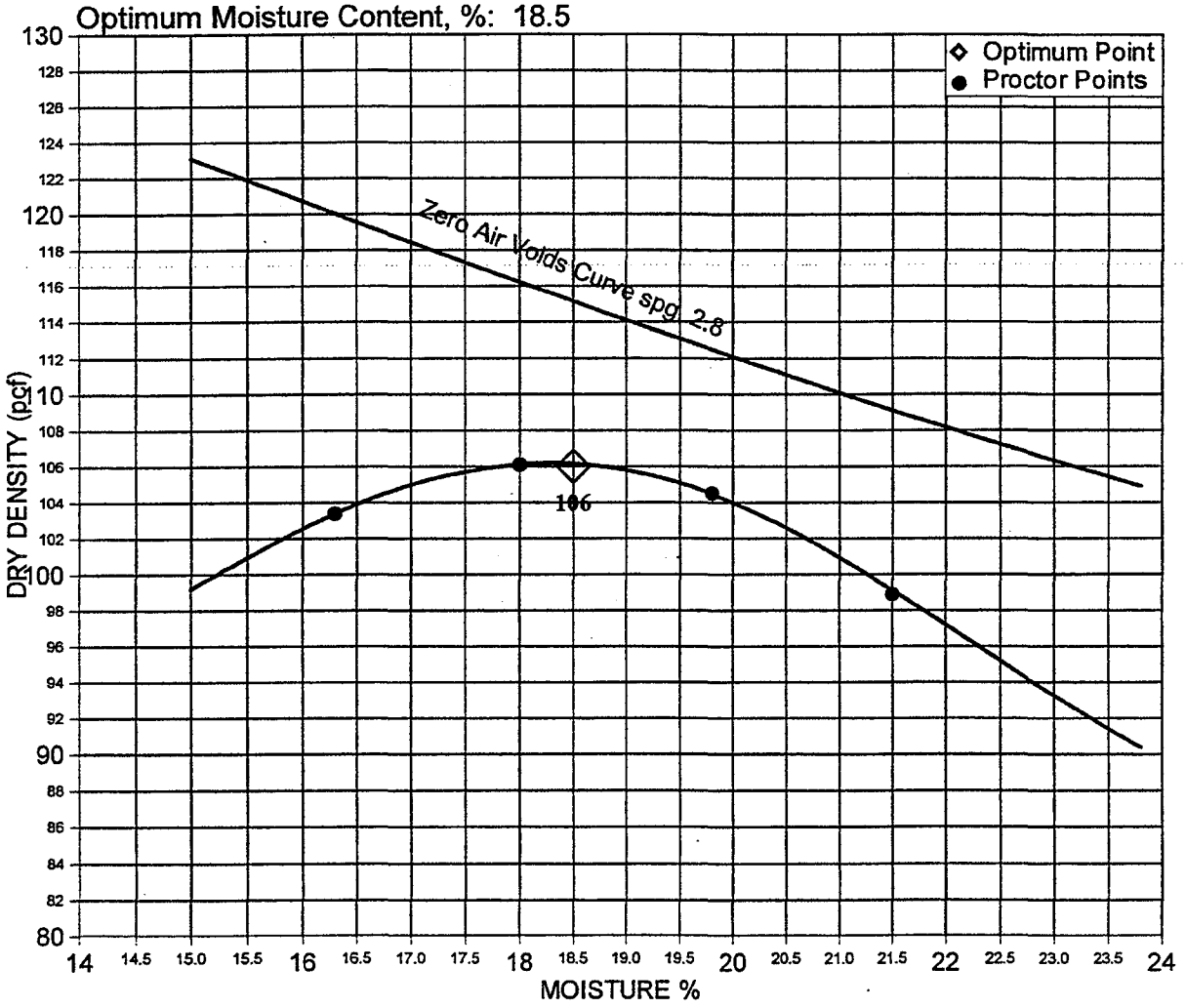
Method B

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/10/01
Tested By: CV - Strata
Sample Number: B1L1742A
Sample Location: 18-3
Sample Description: Calcitic Silt w/15% Pea Gravel
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch	100	100
#4 screen		

Maximum Dry Density, pcf : 106.0
Optimum Moisture Content, %: 18.5



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

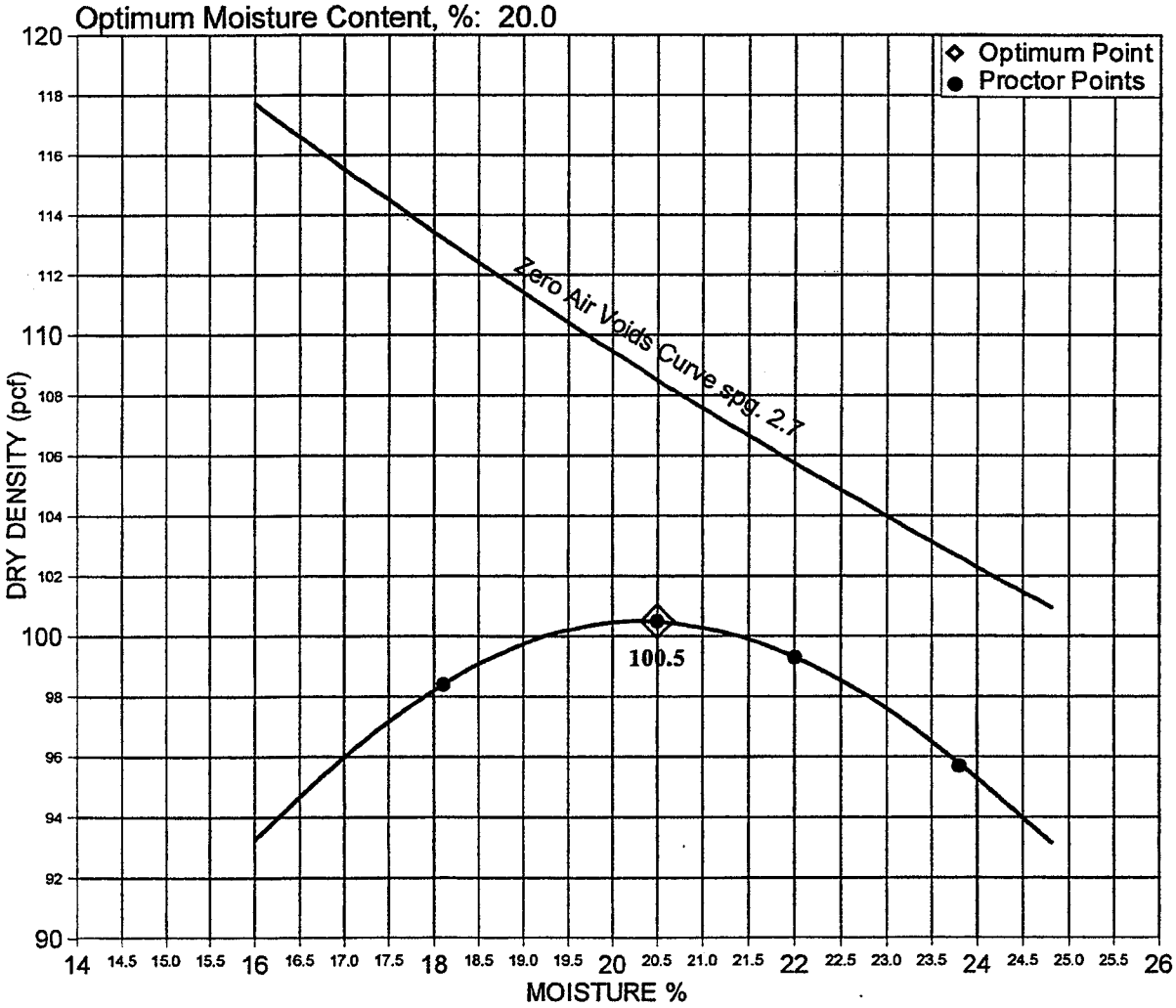
Method A

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/9/01
Tested By: CV - Strata
Sample Number: B1L1743
Sample Location: Test Hole 18-4
Sample Description: Clayey Silt
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch		
#4 screen	100	100

Maximum Dry Density, pcf : 100.5
Optimum Moisture Content, %: 20.0



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

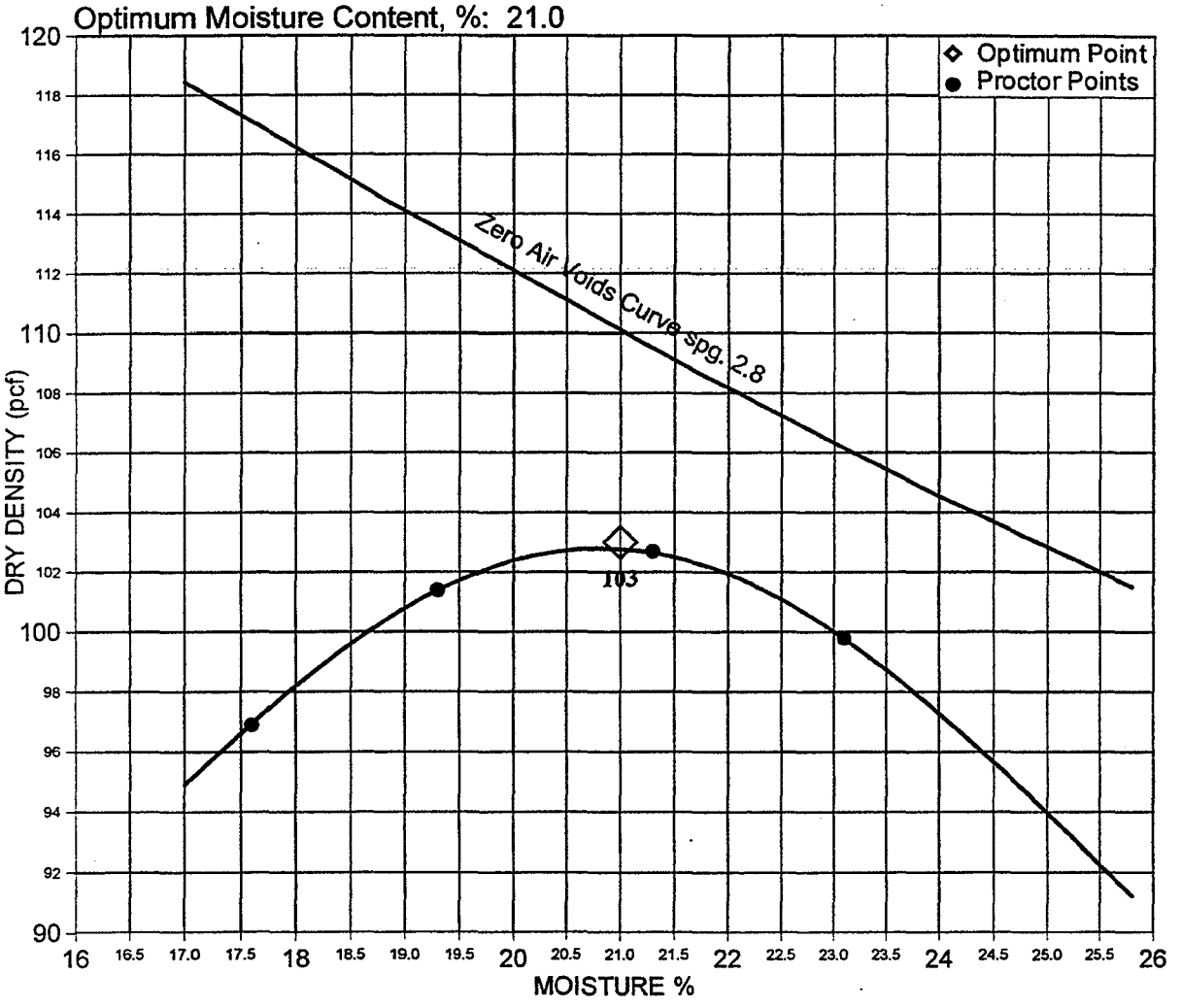
Method B

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/10/01
Tested By: CV - Strata
Sample Number: B1L1743A
Sample Location: Test Hole 18-4
Sample Description: Clayey Silt w/15% Pea Gravel
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch	100	100
#4 screen		

Maximum Dry Density, pcf : 103.0
Optimum Moisture Content, %: 21.0



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

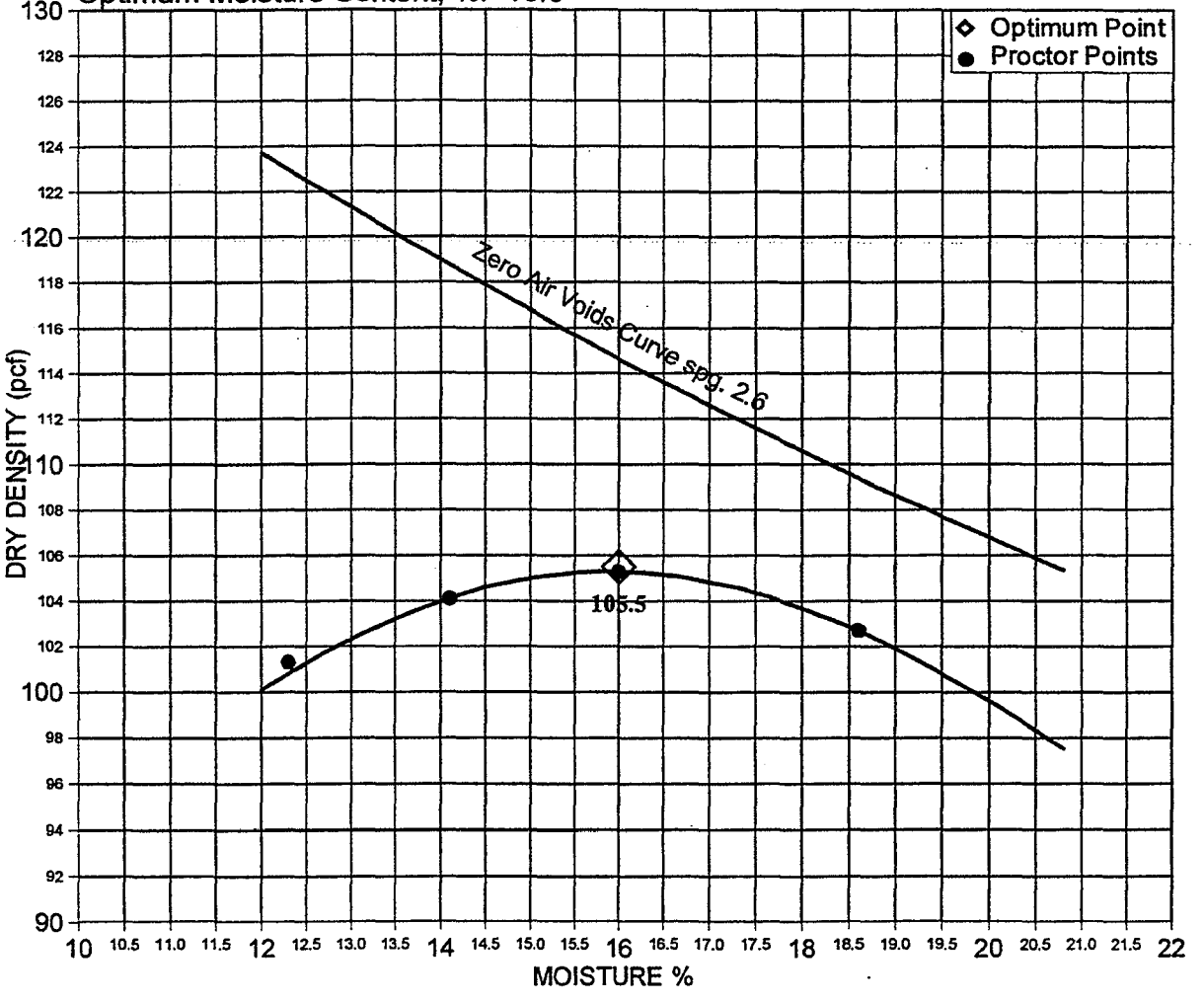
Method A

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/9/01
Tested By: JD - Strata
Sample Number: B1L1744
Sample Location: 18-5
Sample Description: Silt
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch		
#4 screen	100	100

Maximum Dry Density, pcf : 105.5
Optimum Moisture Content, %: 16.0



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

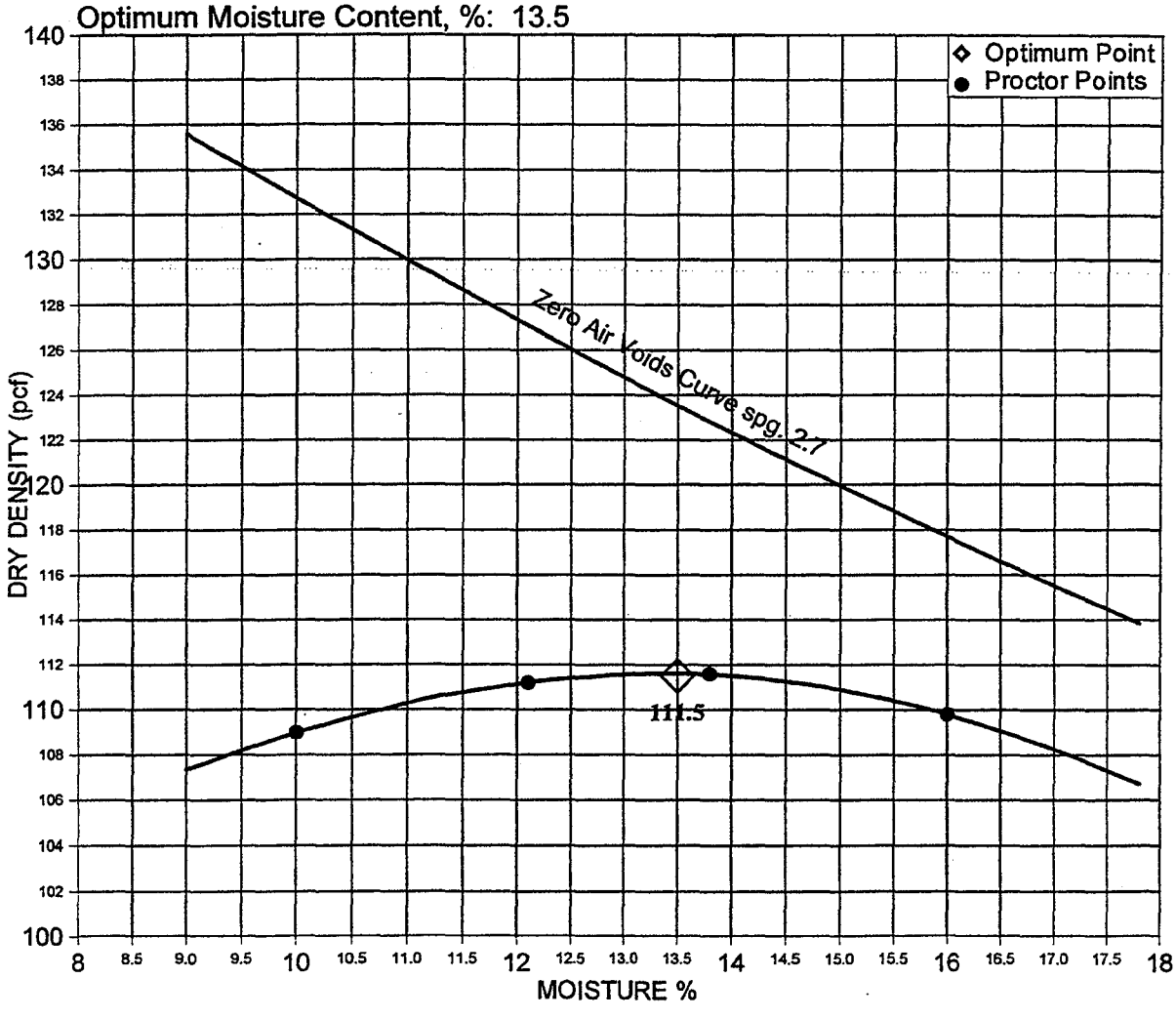
Method B

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/10/01
Tested By: JD - Strata
Sample Number: B1L1744A
Sample Location: 18-5
Sample Description: Silt w/15% Pea Gravel
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch	100	100
#4 screen		

Maximum Dry Density, pcf : 111.5
Optimum Moisture Content, %: 13.5



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

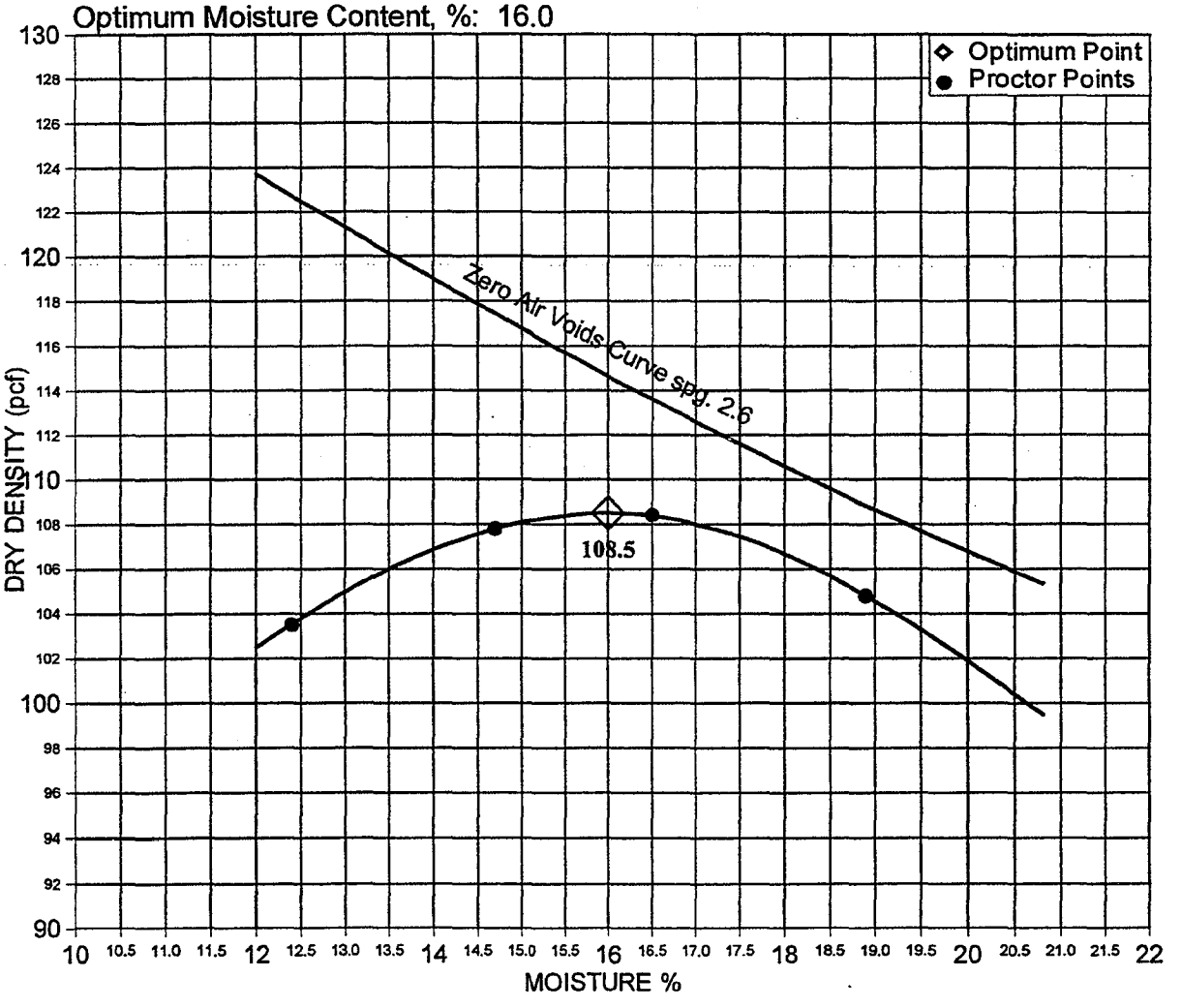
Method A

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/9/01
Tested By: CV - Strata
Sample Number: B1L1745
Sample Location: Test Hole 18-6
Sample Description: Clayey Silt
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch		
#4 screen	100	100

Maximum Dry Density, pcf : 108.5
Optimum Moisture Content, %: 16.0



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MOISTURE-DENSITY RELATIONSHIP CURVE

ASTM D 698

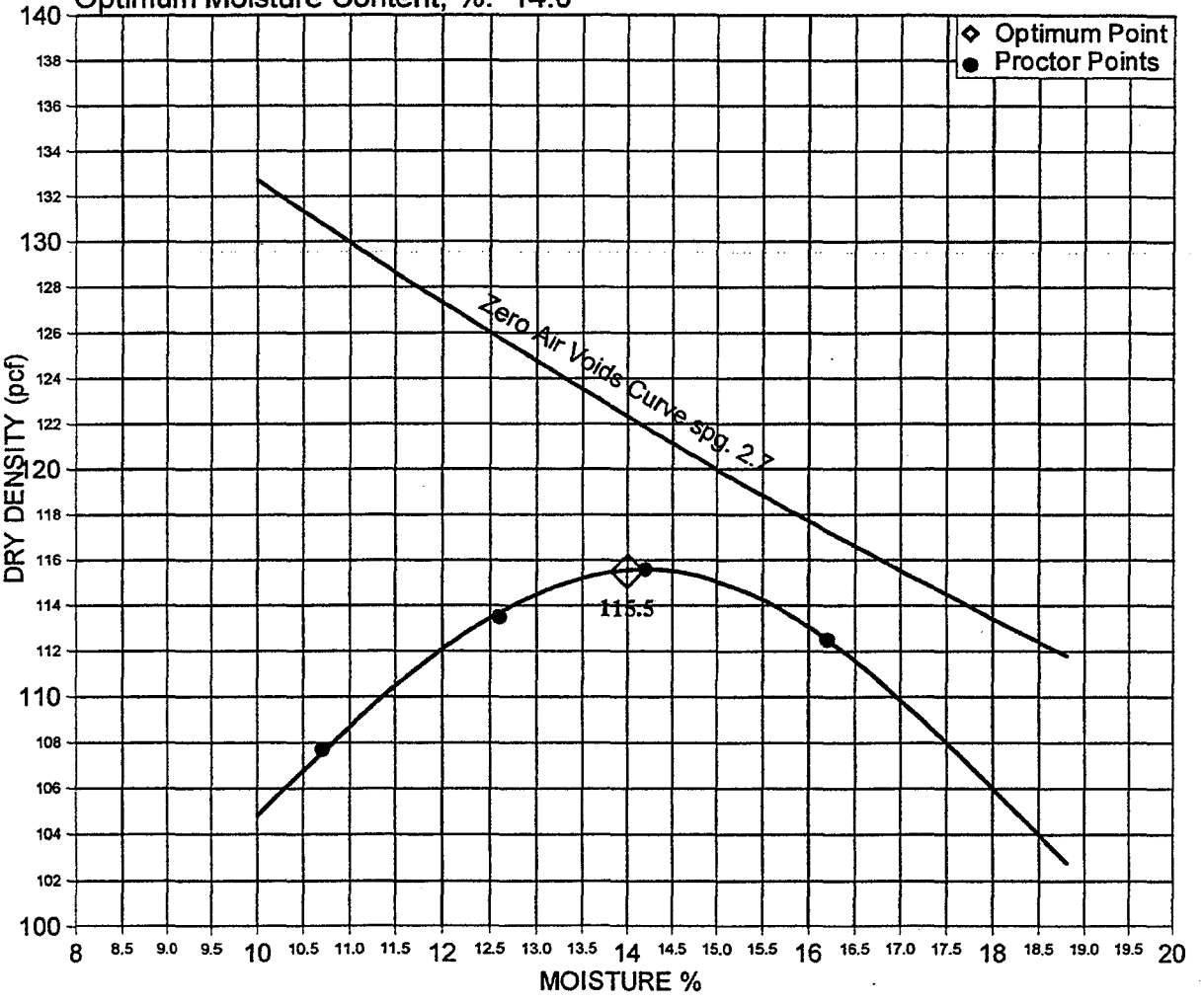
Method B

Project: FMC Pond Closure
Client: A & E Engineering
File Name: AEENGR P01081A
Date Tested: 8/13/01
Tested By: CV - Strata
Sample Number: B1L1745A
Sample Location: Test Hole 18-6
Sample Description: Clayey Silt w/15% Pea Gravel
Soil Tempered: Yes
Rammer Type: Manual

GRADING ANALYSIS

SCREEN SIZE	% PASSING	AS TESTED
6 inch		
4 inch		
2 inch		
3/4 inch		
3/8 inch	100	100
#4 screen		

Maximum Dry Density, pcf : 115.5
Optimum Moisture Content, %: 14.0



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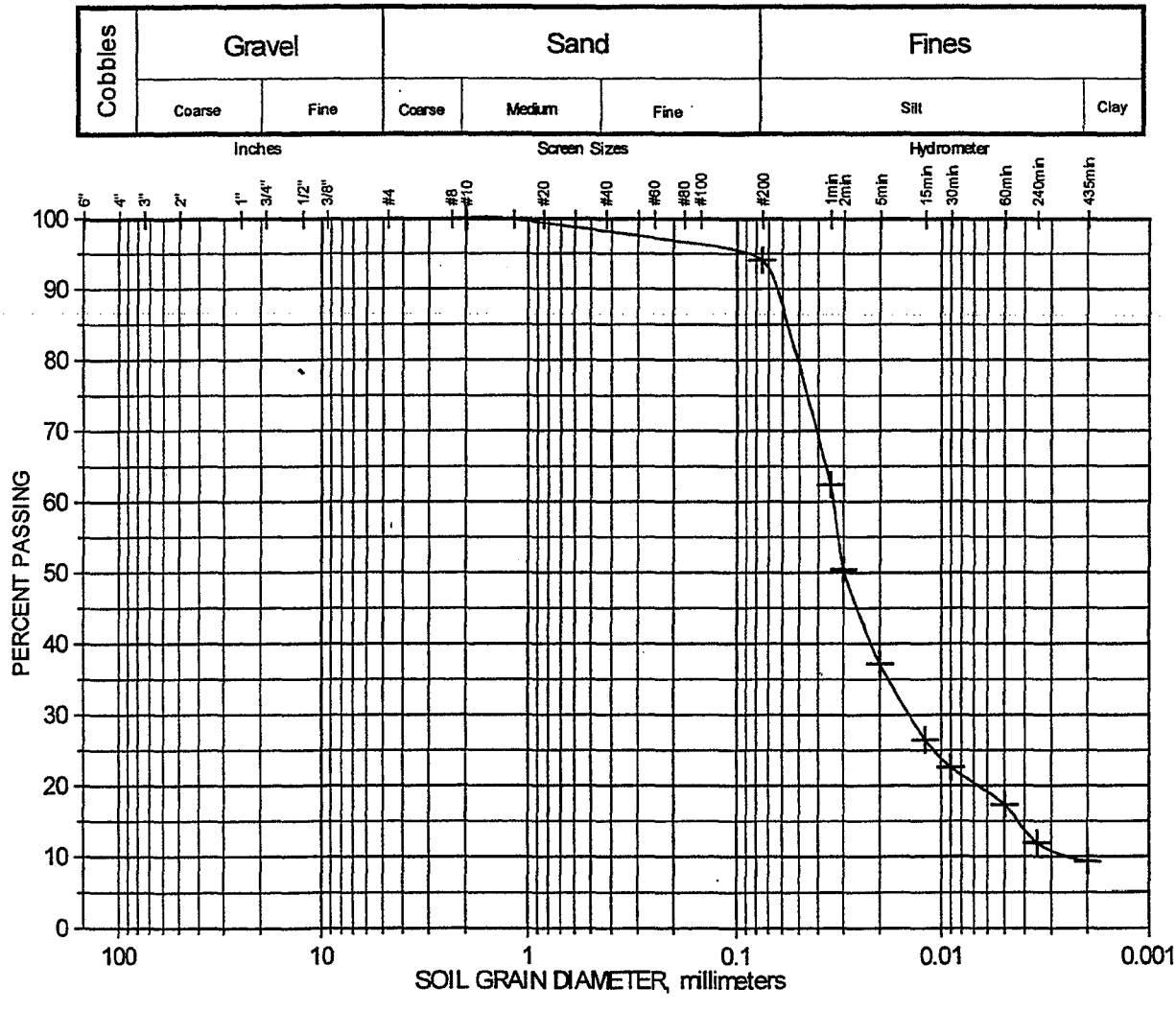
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS
ASTM D422

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closure
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1740
Sample Location: 18-1
Description: Silt
Date Received: 8/8/01
Date tested: 8/10 by PV



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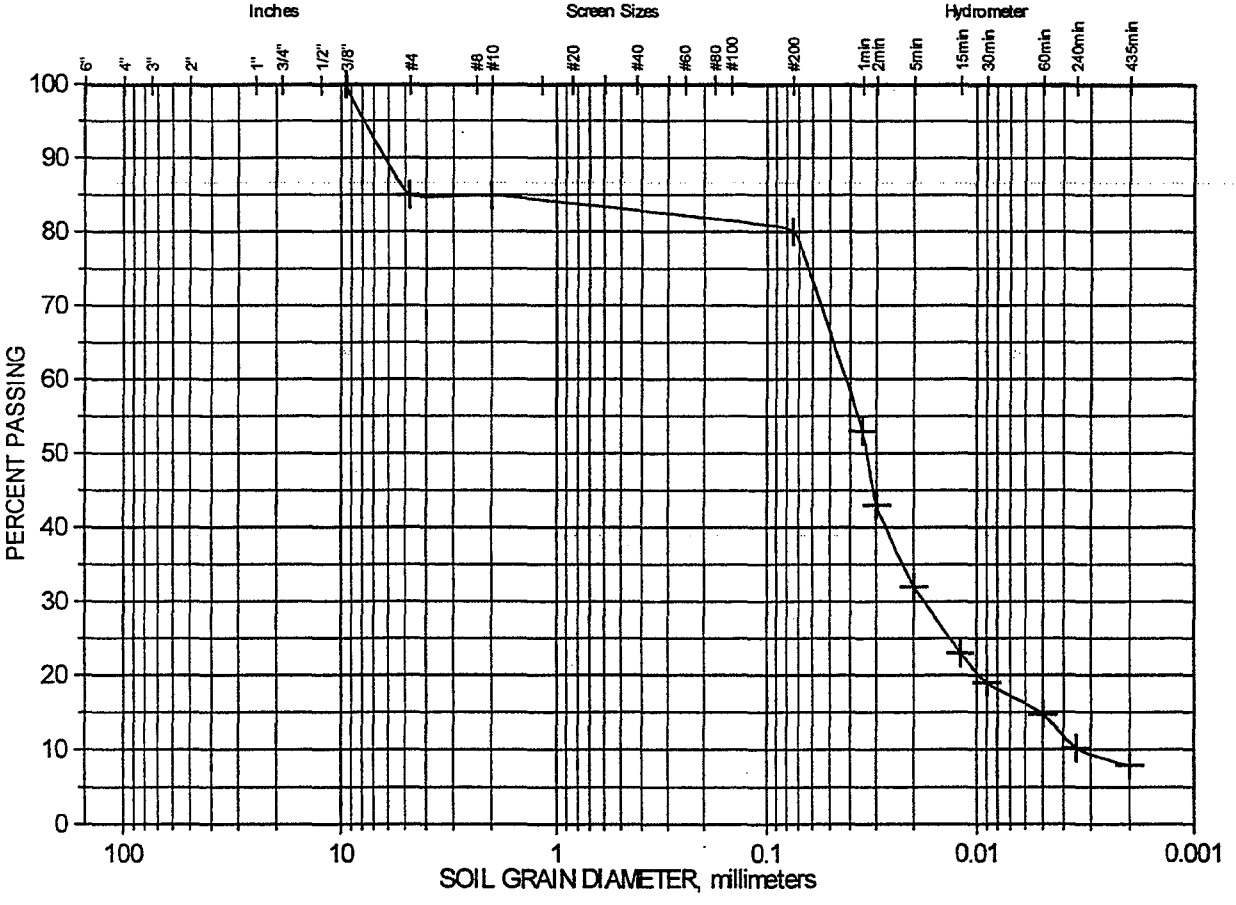
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closure
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1740
Sample Location: 18-1
Description: Silt w/15% Pea Gravel
Date Received: 8/8/01
Date tested: 8/10 by PV

Cobbles	Gravel		Sand			Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



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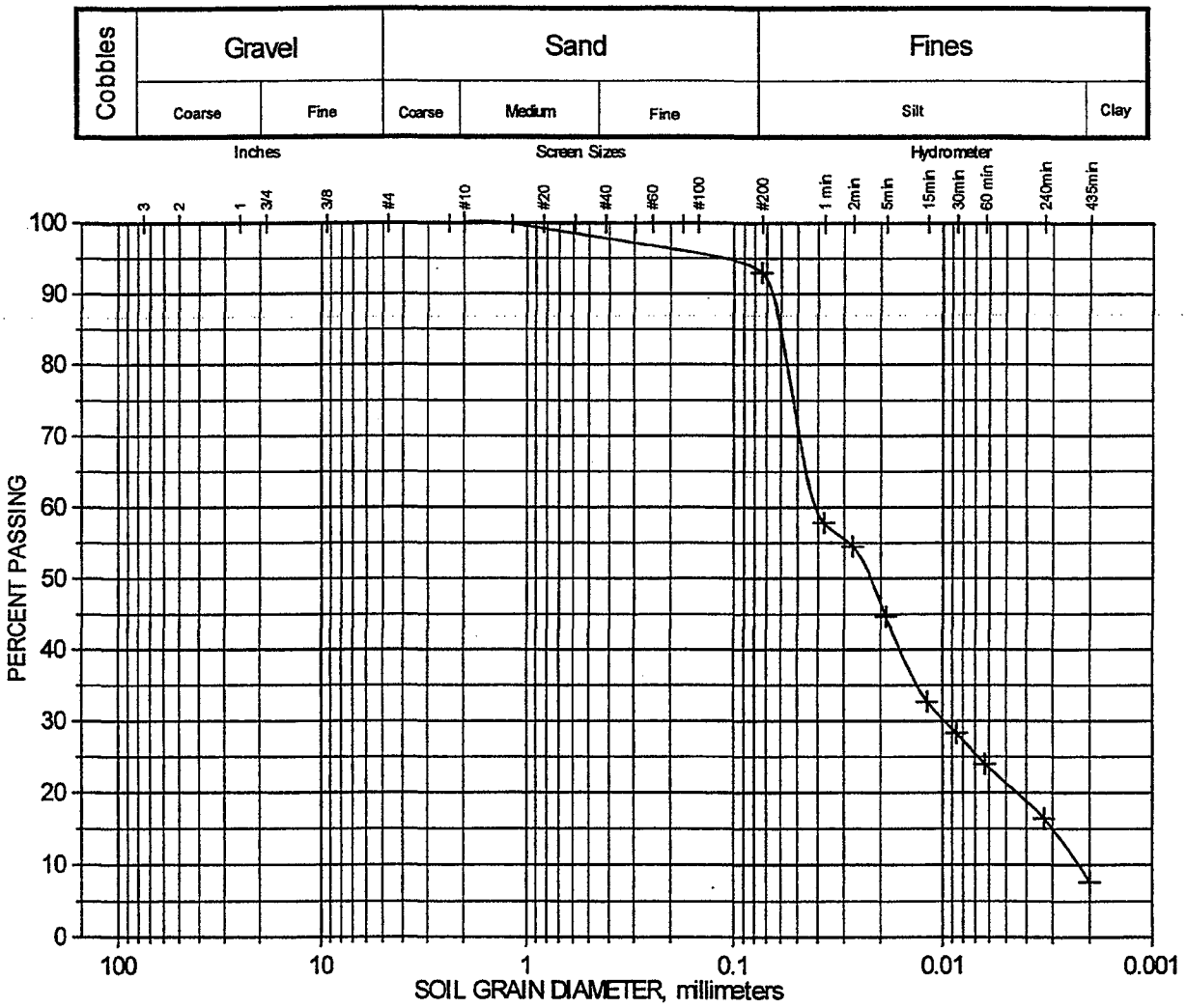
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1741
Sample Location: TH 18-2
Description: Silt
Date tested: 8/10/01



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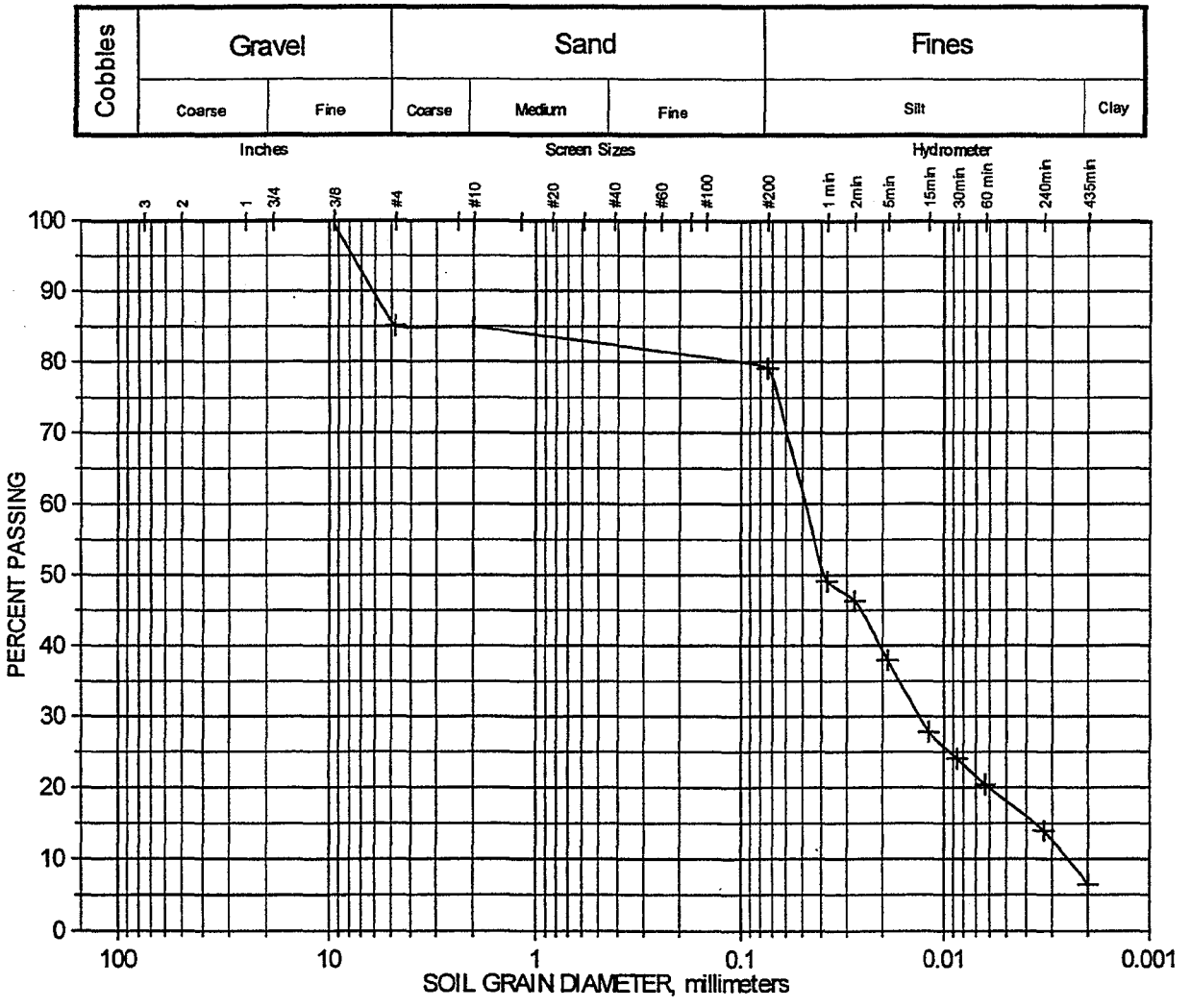
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1741
Sample Location: TH 18-2
Description: Silt w/15% Pea Gravel
Date tested: 8/10/01



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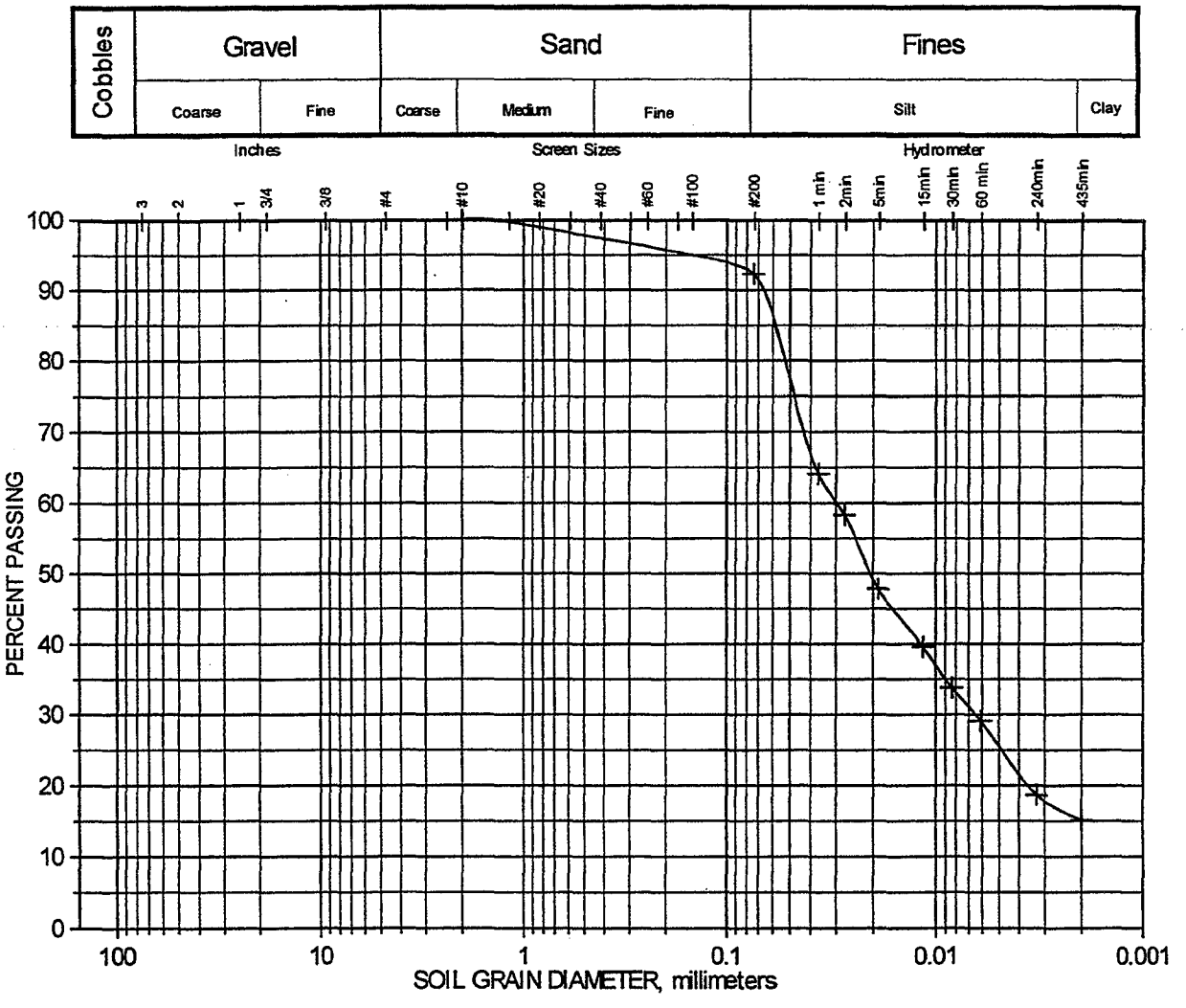
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1742
Sample Location: TH 18-3
Description: Calcitic Silt
Date tested: 8/10/01



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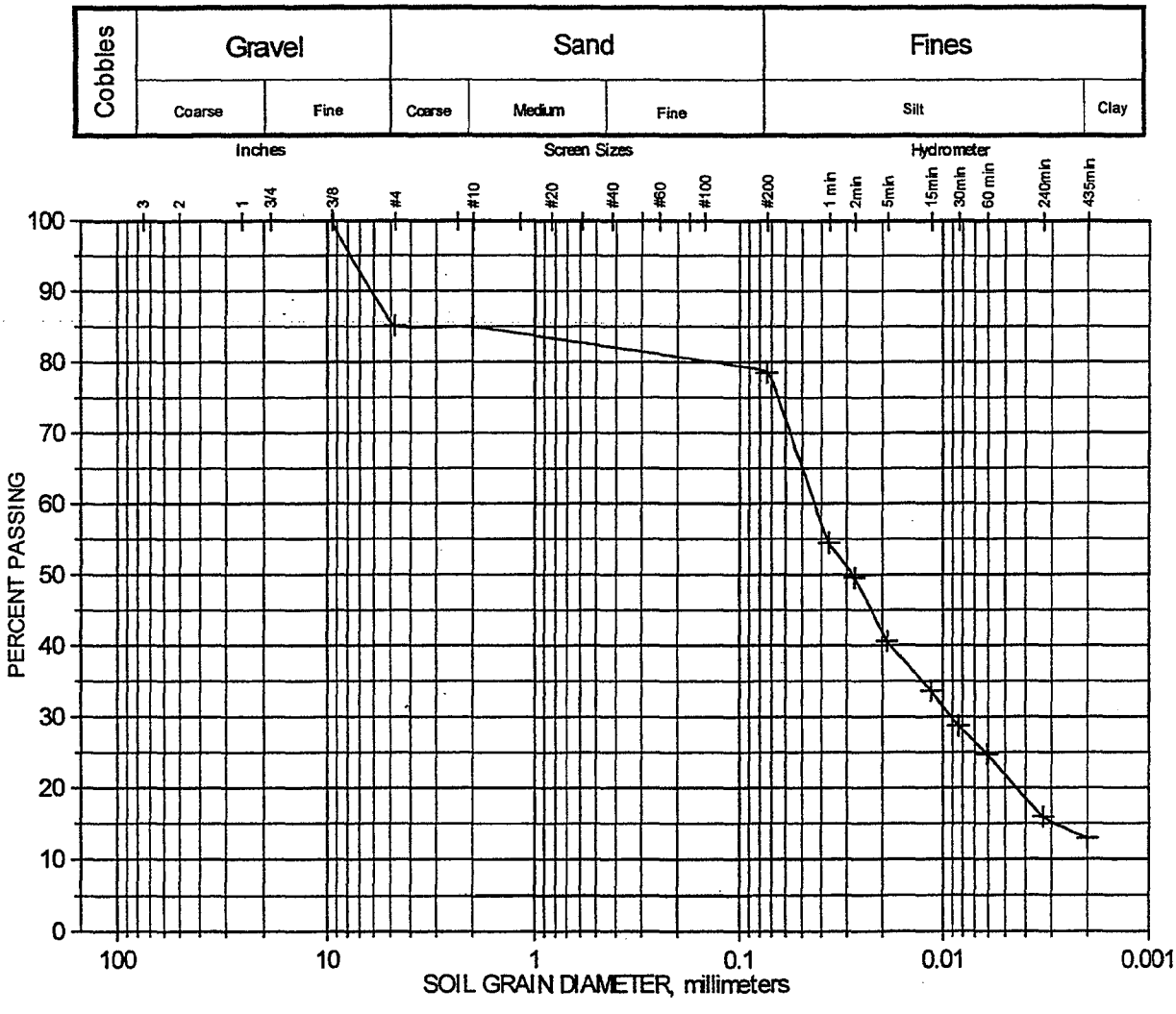
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1742
Sample Location: TH 18-3
Description: Calcitic Silt w/15% Pea Gravel
Date tested: 8/10/01



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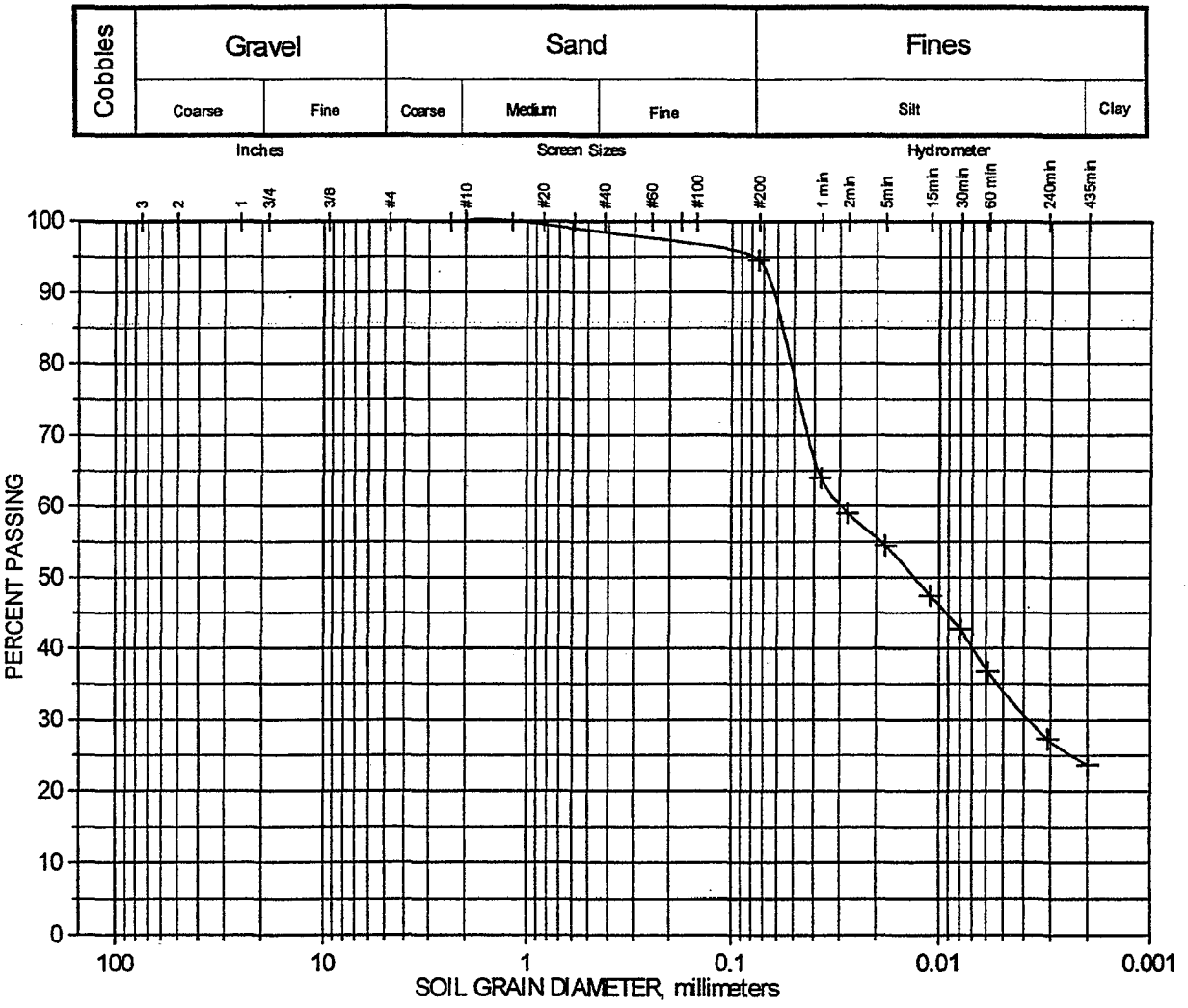
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1743
Sample Location: TH 18-4
Description: Clayey Silt
Date tested: 8/10/01



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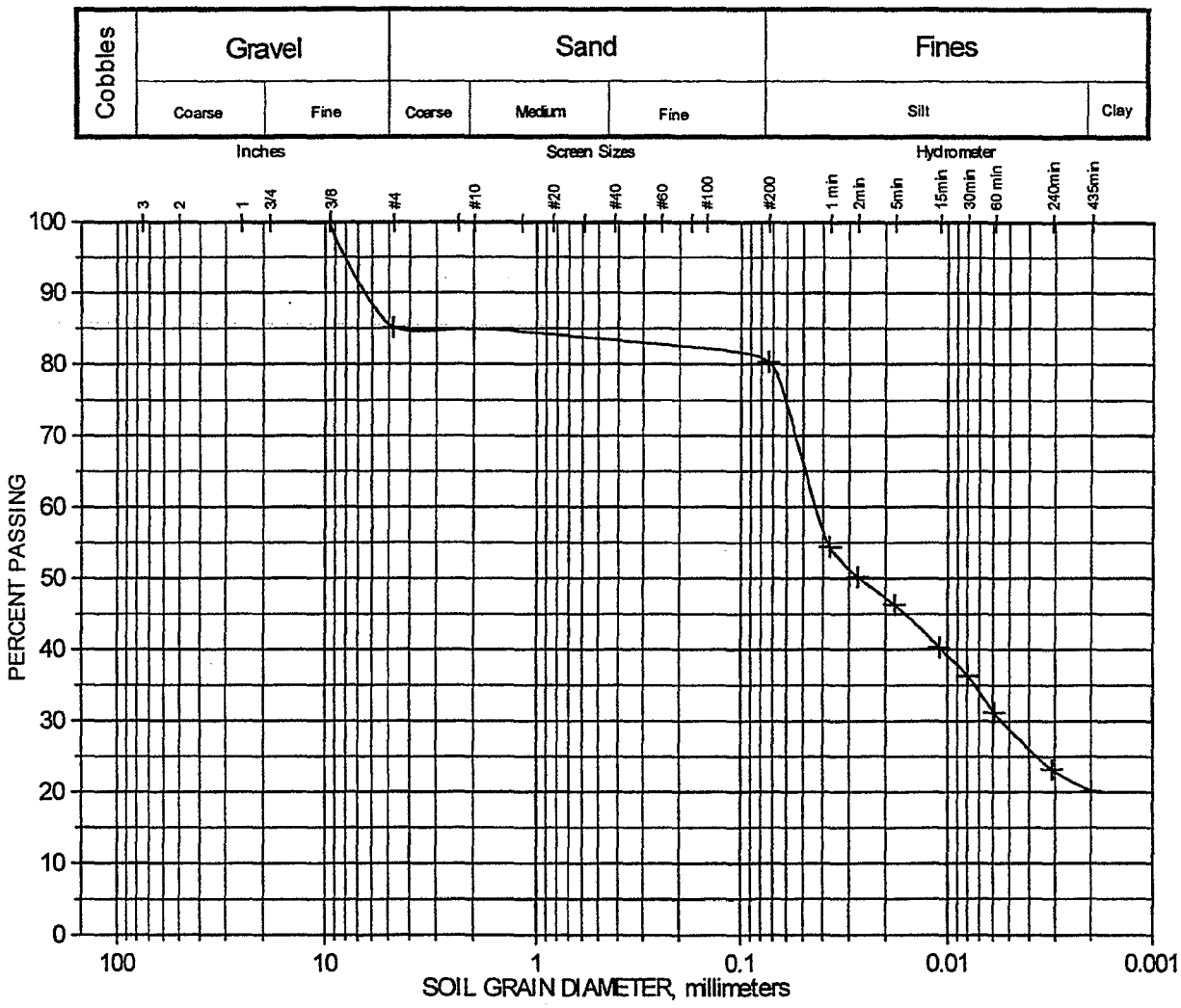
GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
~~File: AEENGR P01081A~~
Sample No.: B1L1743
Sample Location: TH 18-4
Description: Clayey Silt w/15% Pea Gravel
Date tested: 8/10/01



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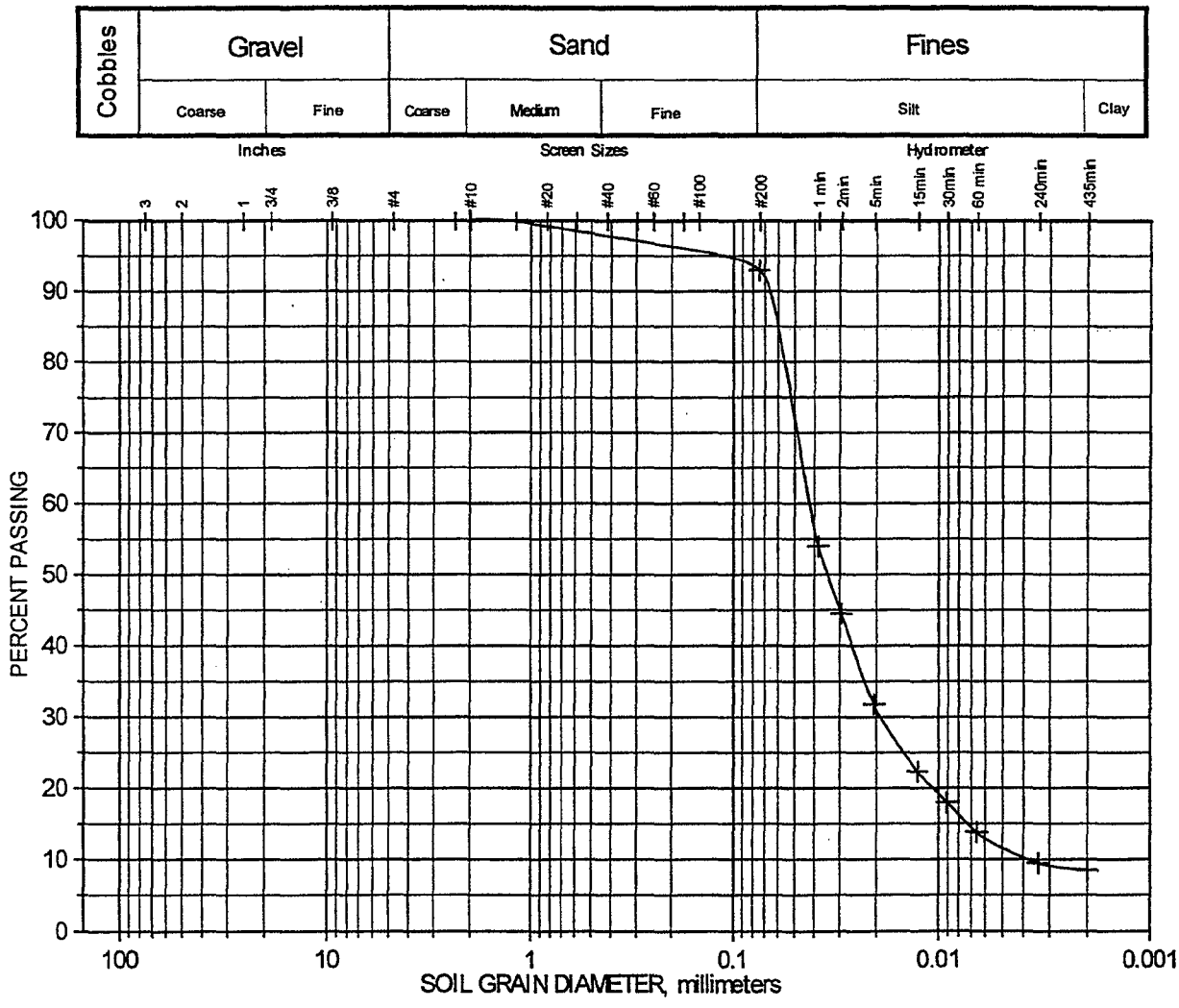
GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1744
Sample Location: TH 18-5
Description: Silt
Date tested: 8/10/01



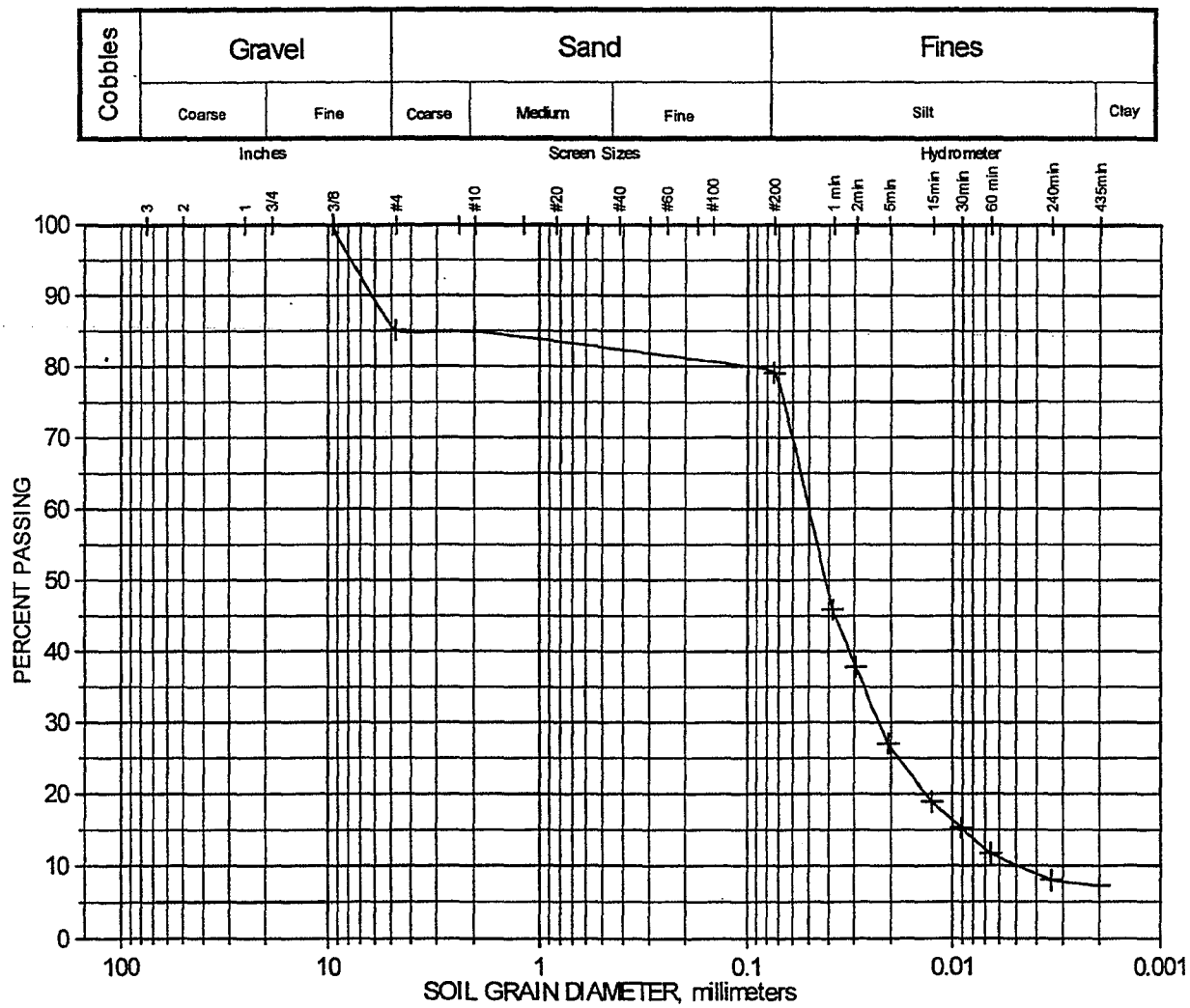
Reviewed by: _____

STRATA
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1744
Sample Location: TH 18-5
Description: Silt w/Pea Gravel
Date tested: 8/10/01



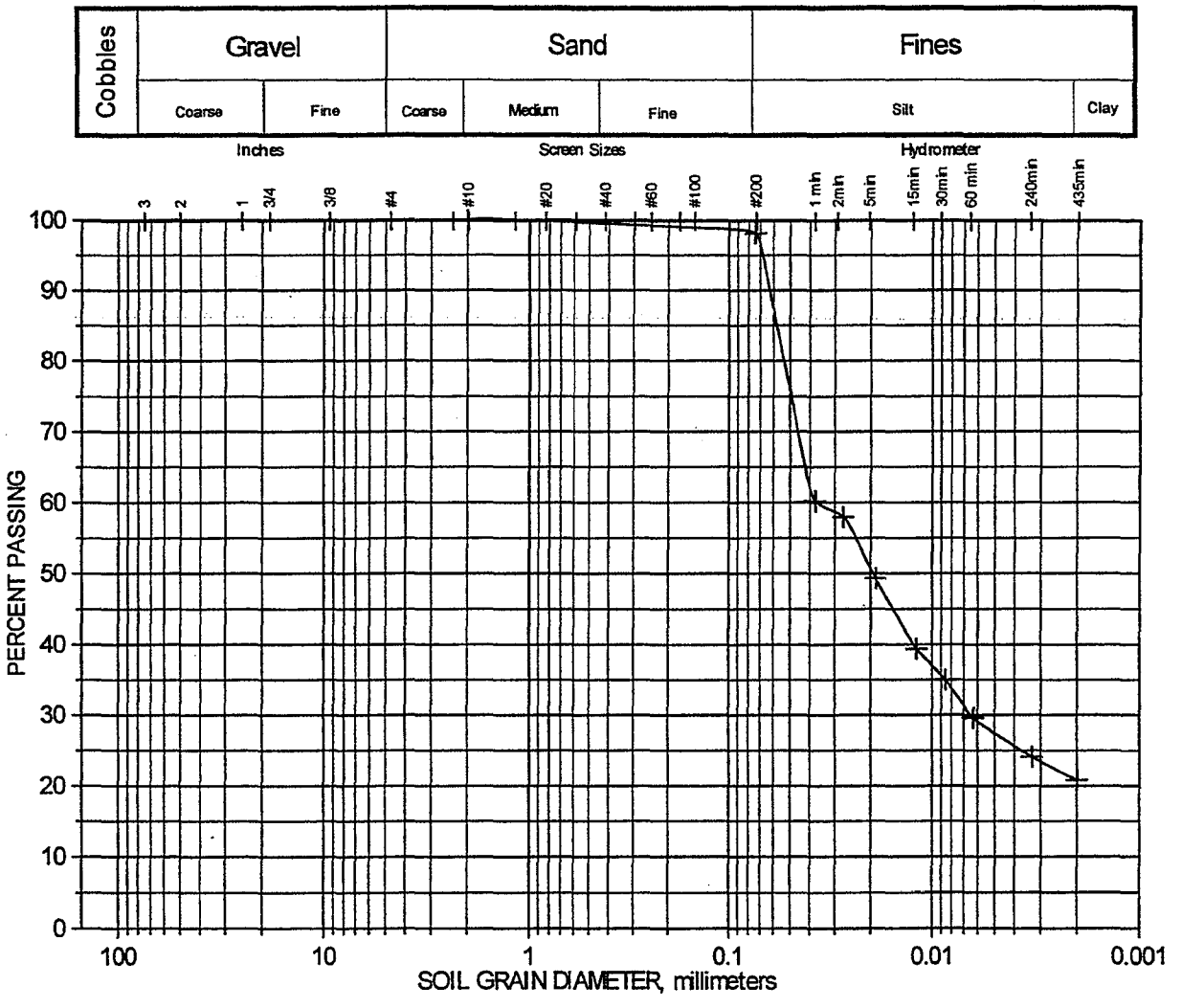
Reviewed by:

STRATA
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1745
Sample Location: TH 18-6
Description: Clayey Silt
Date tested: 8/10/01



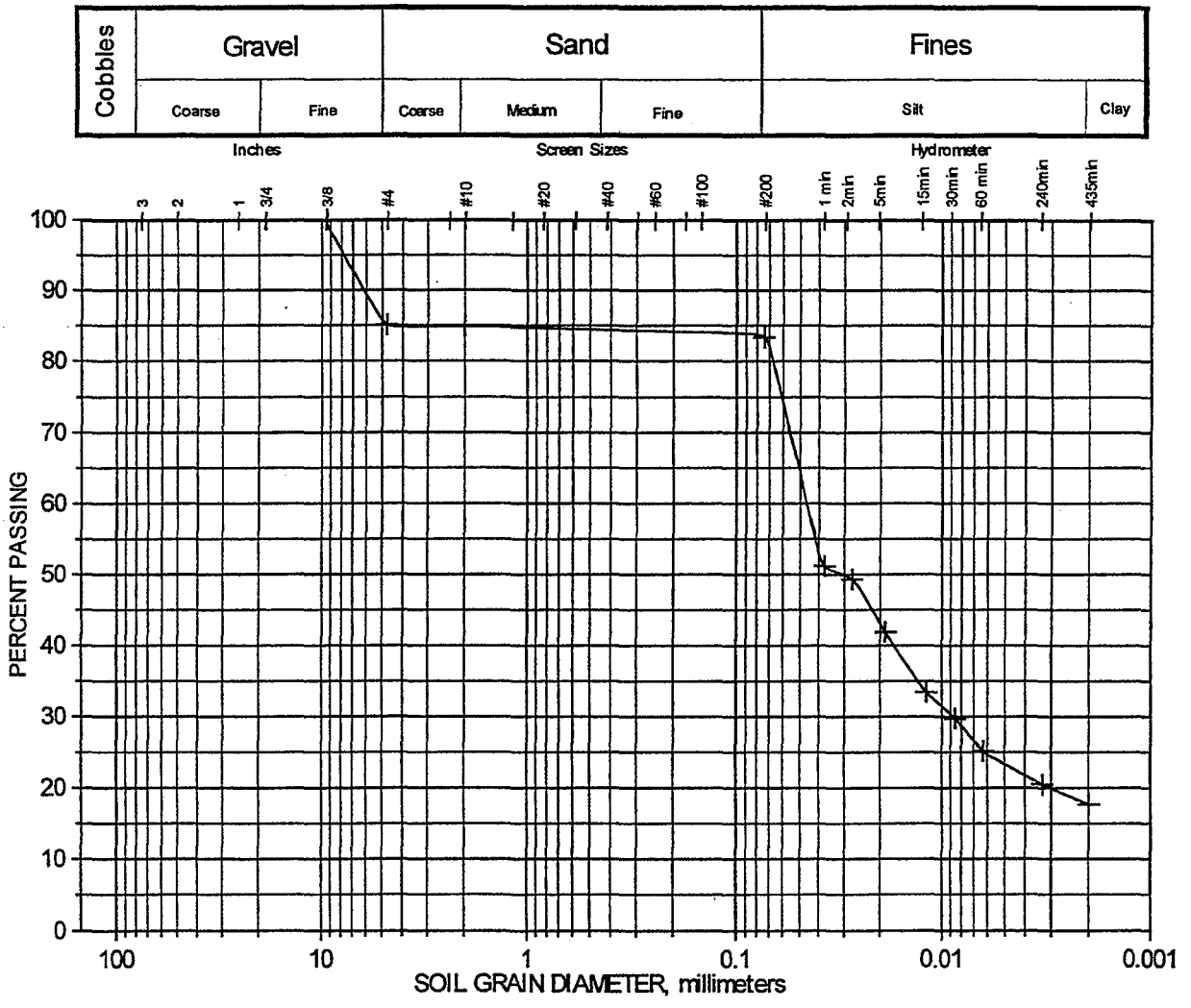
Reviewed by: _____

STRATA
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

GRADATION ANALYSIS

ASTM D422

Project: FMC Pond Closures
Client: A&E Engineering
File: AEENGR P01081A
Sample No.: B1L1745
Sample Location: TH 18-6
Description: Clayey Silt w/Pea Gravel
Date tested: 8/10/01



Reviewed by: _____

STRATA
GEOTECHNICAL ENGINEERING & MATERIALS TESTING

CAPILLARY-MOISTURE RELATIONS
ASTM D 3152

CAPILLARY-MOISTURE RELATIONS

Sample 18-1, at 80 % Mdd

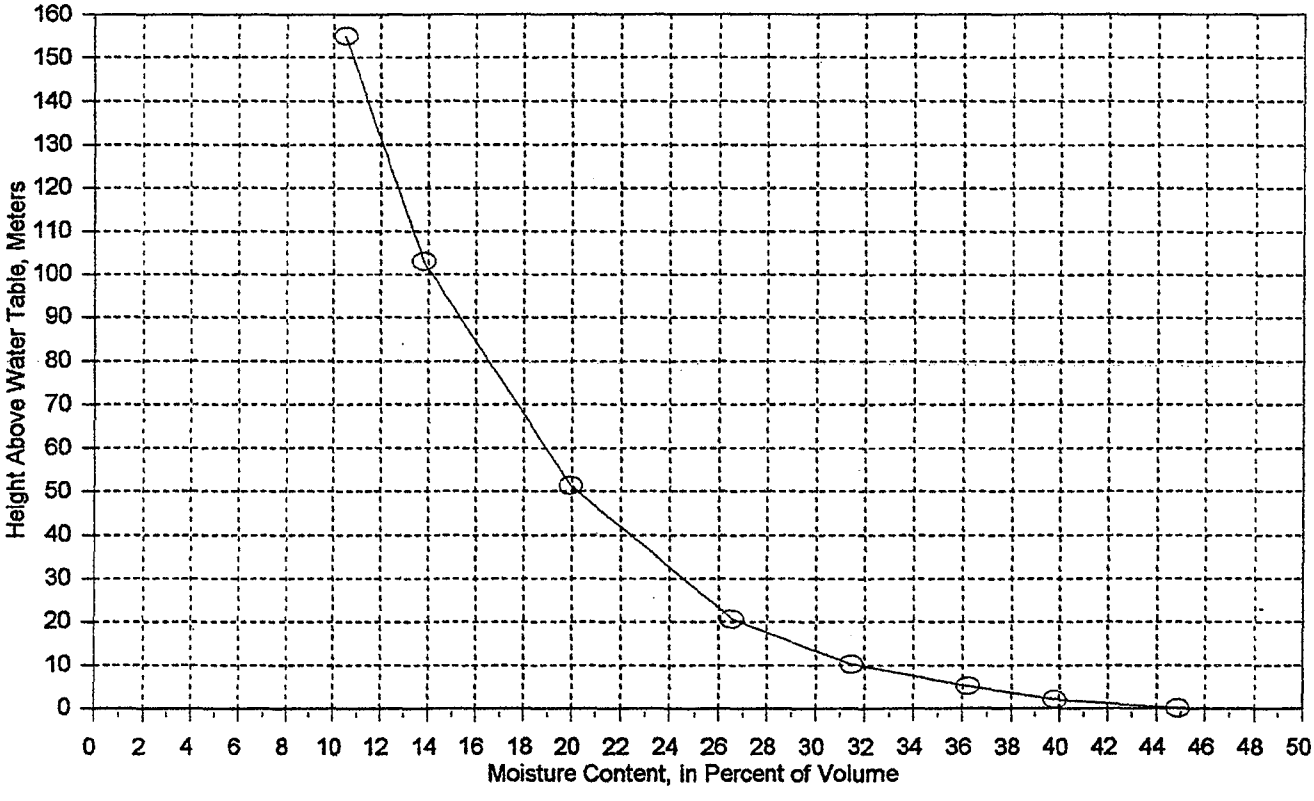


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-1, at 80 % Mdd

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	33.08	38.03	36.99	36.24	35.27	34.25	32.89	31.62	30.95
(5)	4.3	9.25	8.21	7.46	6.49	5.47	4.11	2.84	2.17
(7)	28.78	28.78	28.78	28.78	28.78	28.78	28.78	28.78	28.78
(8)	14.94	32.14	28.53	25.92	22.55	19.01	14.28	9.87	7.54
(9)	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
(10)	20.88	44.91	39.86	36.22	31.51	26.56	19.95	13.79	10.53

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 23

CAPILLARY-MOISTURE RELATIONS

Sample 18-1, at 85 % Mdd

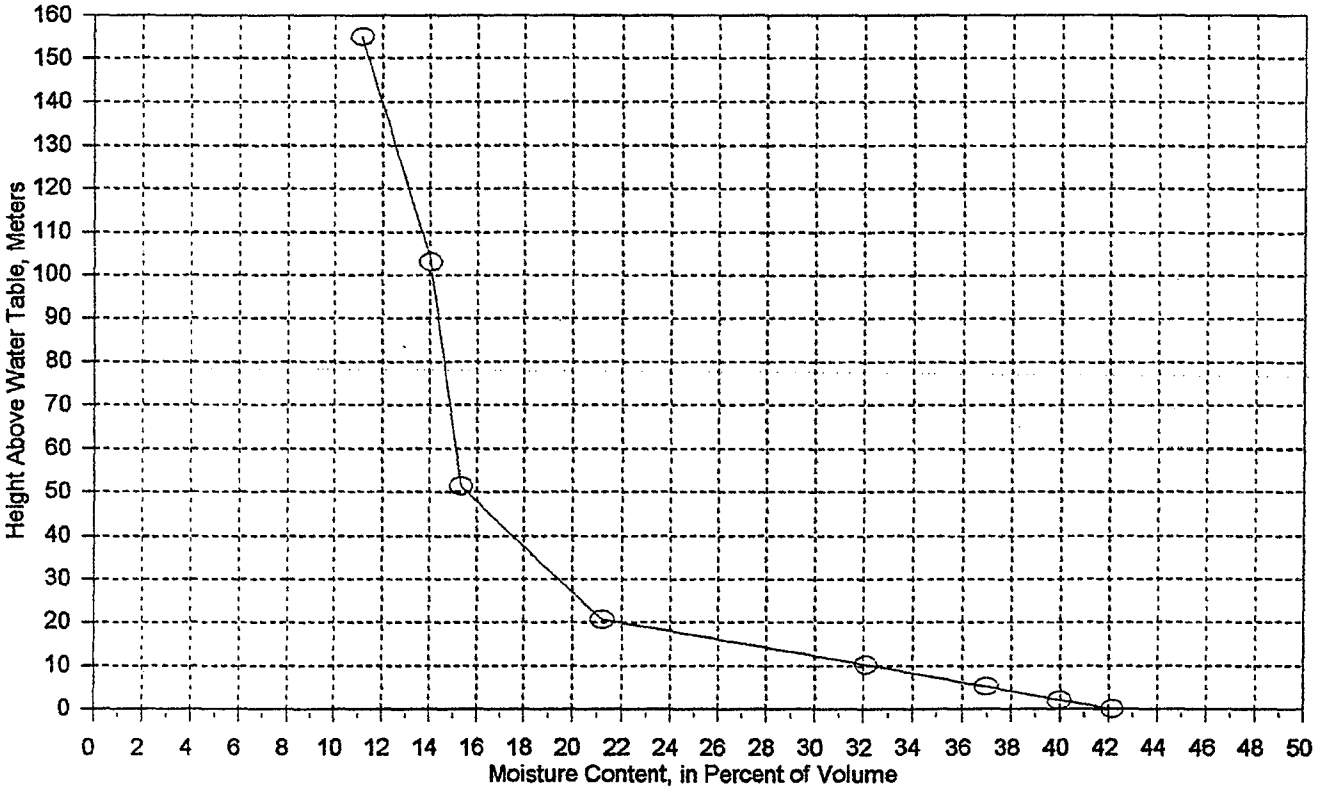


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-1, at 85 % Mdd

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	35.38	39.3	38.85	38.23	37.23	34.98	33.77	33.5	32.91
(5)	4.77	8.69	8.24	7.62	6.62	4.37	3.16	2.89	2.3
(7)	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61
(8)	15.58	28.39	26.92	24.89	21.63	14.28	10.32	9.44	7.51
(9)	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
(10)	23.16	42.19	40.00	36.99	32.14	21.22	15.34	14.03	11.17

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 34

CAPILLARY-MOISTURE RELATIONS

Sample 18-1, at 80 % Mdd w 15 % gravel

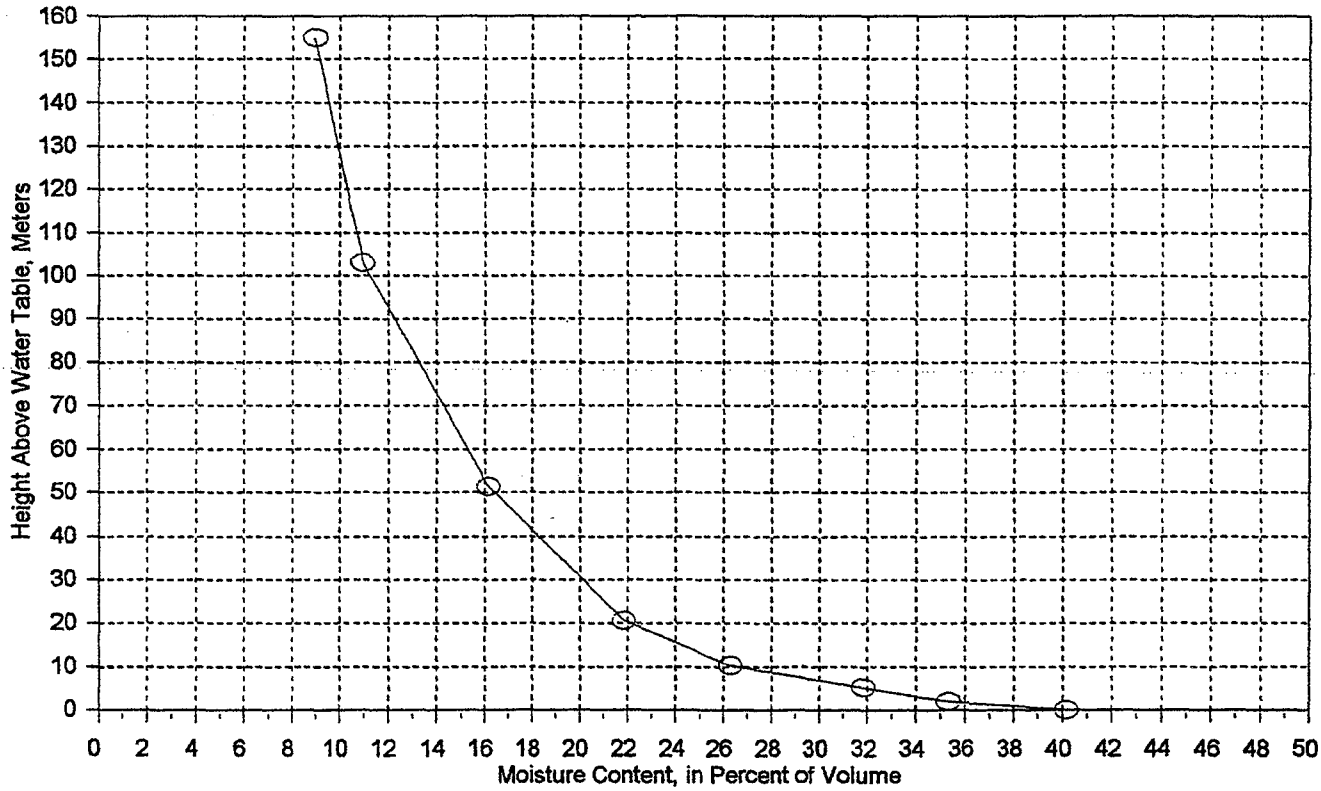


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-1, at 80 % w15% gvl

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	34.18	38.18	37.18	36.46	35.32	34.4	33.23	32.16	31.75
(5)	4.28	8.28	7.28	6.56	5.42	4.5	3.33	2.26	1.85
(7)	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9
(8)	14.31	27.69	24.35	21.94	18.13	15.05	11.14	7.56	6.19
(9)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
(10)	20.78	40.20	35.34	31.85	26.31	21.85	16.17	10.97	8.98

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 35

CAPILLARY-MOISTURE RELATIONS

Sample 18-2, at 80 % Mdd

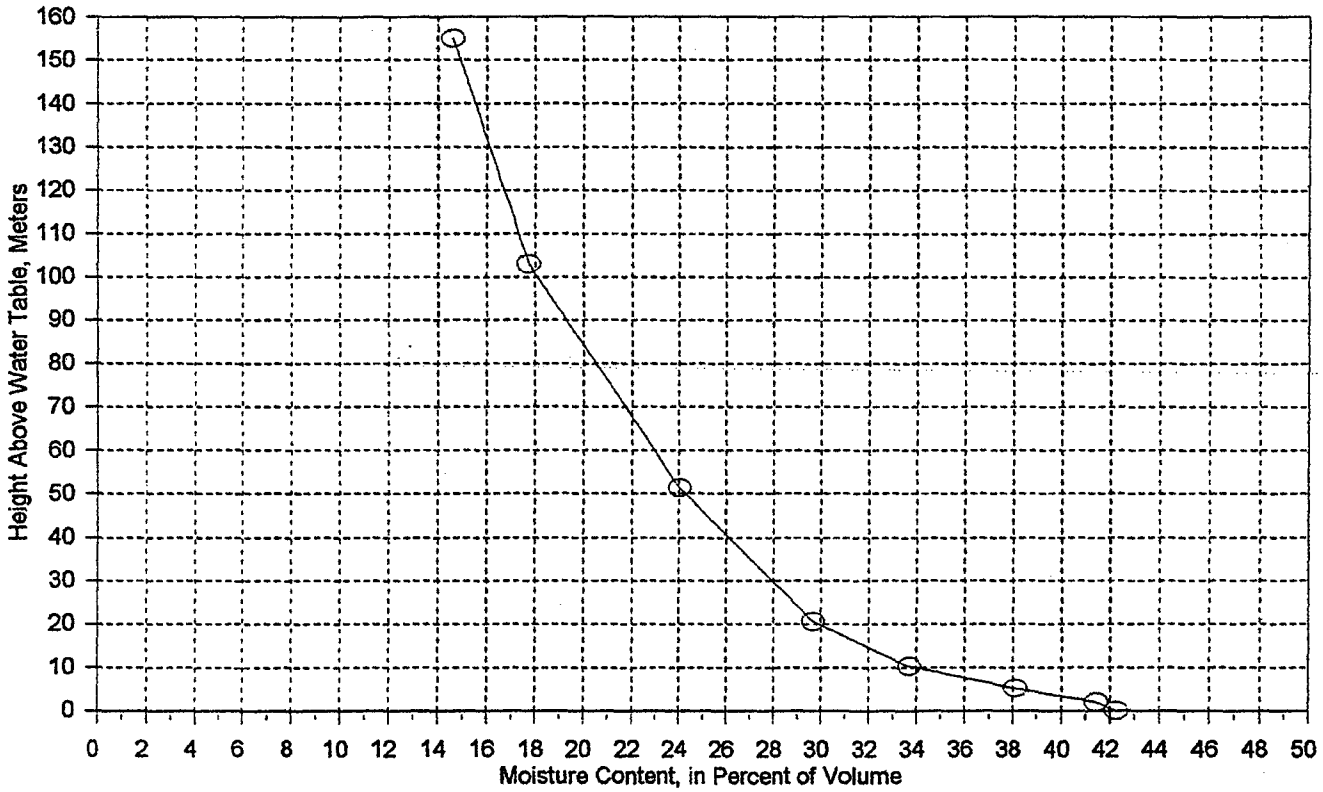


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-2, at 80 %

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	32.24	36.43	36.26	35.57	34.67	33.84	32.67	31.37	30.73
(5)	4.52	8.71	8.54	7.85	6.95	6.12	4.95	3.65	3.01
(7)	27.72	27.72	27.72	27.72	27.72	27.72	27.72	27.72	27.72
(8)	16.31	31.42	30.81	28.32	25.07	22.08	17.86	13.17	10.86
(9)	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
(10)	21.94	42.28	41.46	38.11	33.74	29.71	24.03	17.72	14.61

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 12

CAPILLARY-MOISTURE RELATIONS

Sample 18-2, at 85 % Mdd

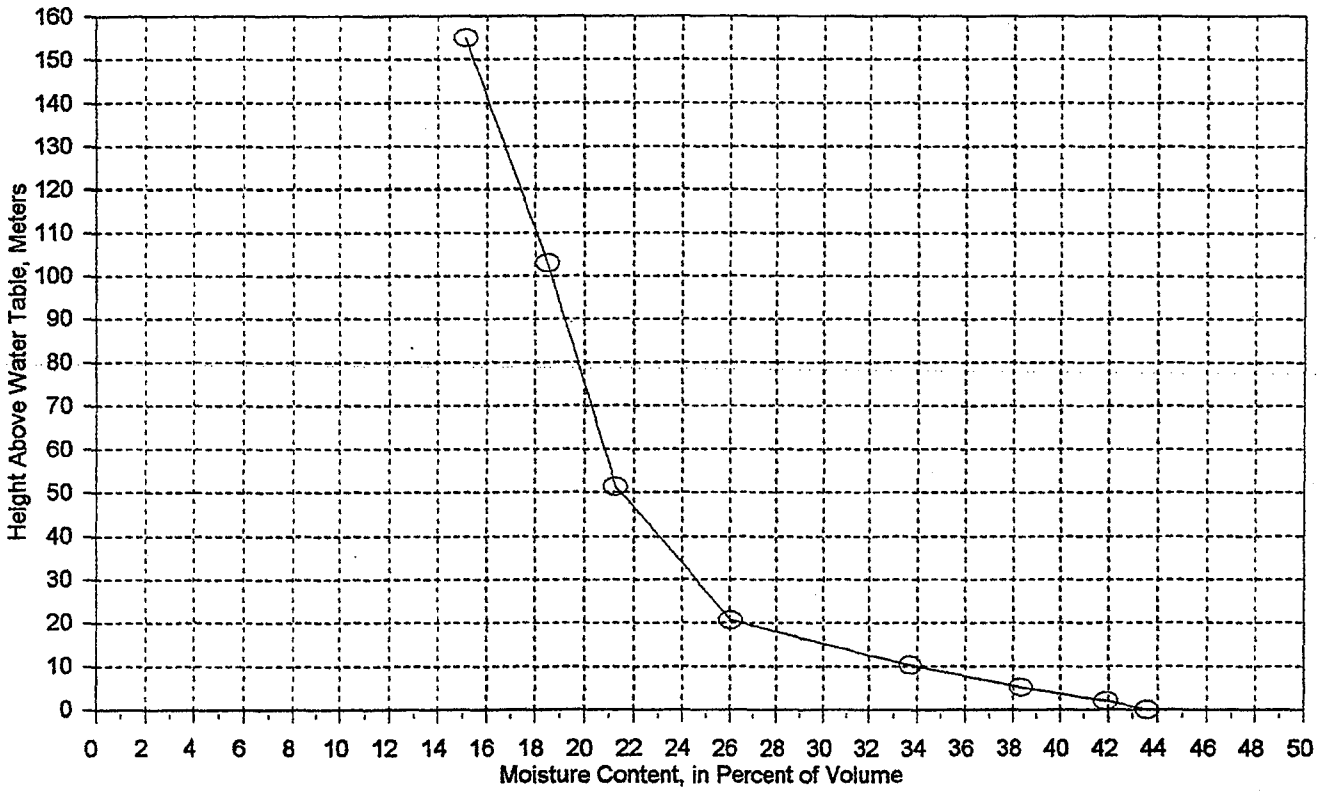


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-2, at 85 %

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	34.19	38.39	38.05	37.31	36.36	34.78	33.79	33.22	32.53
(5)	4.78	8.98	8.64	7.9	6.95	5.37	4.38	3.81	3.12
(7)	29.41	29.41	29.41	29.41	29.41	29.41	29.41	29.41	29.41
(8)	16.25	30.53	29.38	26.86	23.63	18.26	14.89	12.95	10.61
(9)	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
(10)	23.21	43.60	41.95	38.35	33.74	26.07	21.26	18.50	15.15

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 41

CAPILLARY-MOISTURE RELATIONS

Sample 18-2, at 80 % Mdd w gravel

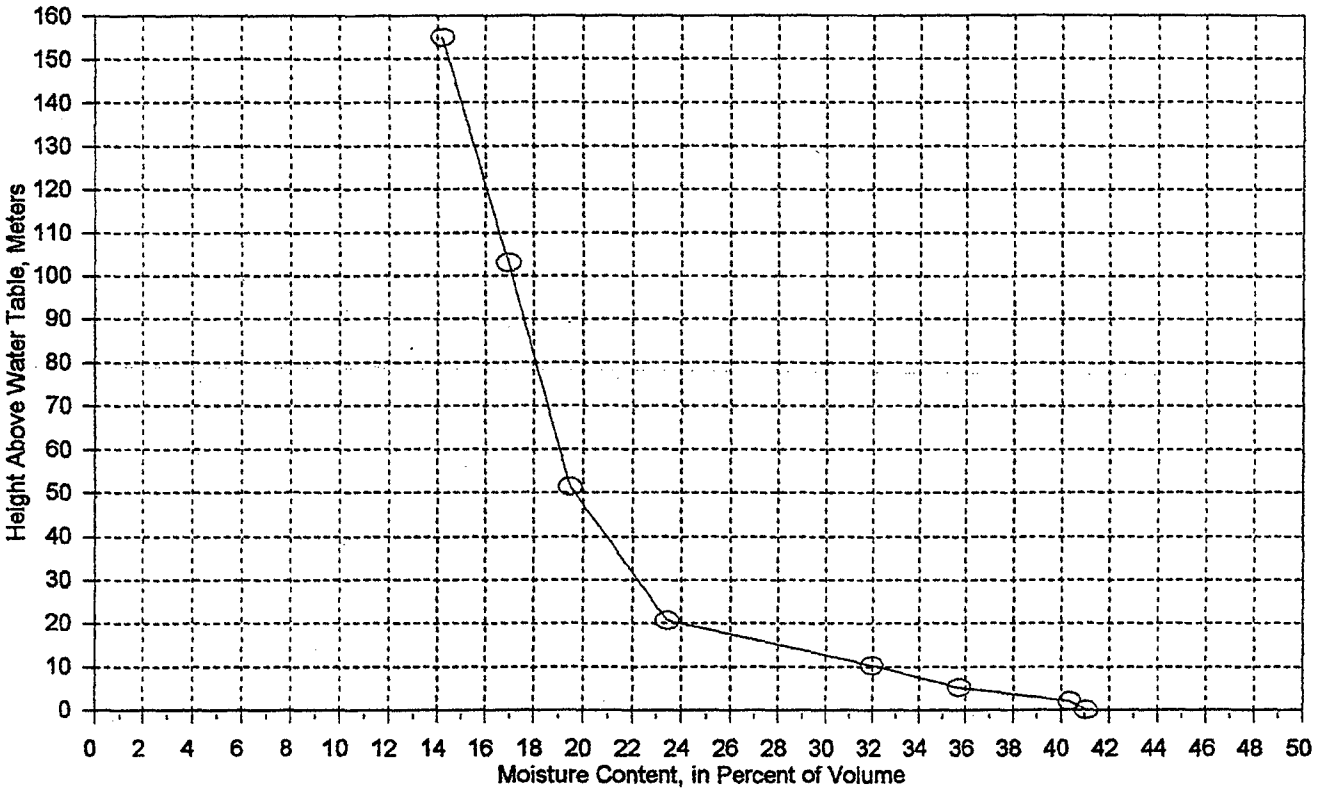


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-2, at 80 % w gravel

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	33.63	38.03	37.89	36.93	36.16	34.4	33.58	33.06	32.5
(5)	4.06	8.46	8.32	7.36	6.59	4.83	4.01	3.49	2.93
(7)	29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57
(8)	13.73	28.61	28.14	24.89	22.29	16.33	13.56	11.80	9.91
(9)	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
(10)	19.71	41.07	40.39	35.73	31.99	23.45	19.47	16.94	14.22

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 3

CAPILLARY-MOISTURE RELATIONS

Sample 18-3, at 80 % Mdd

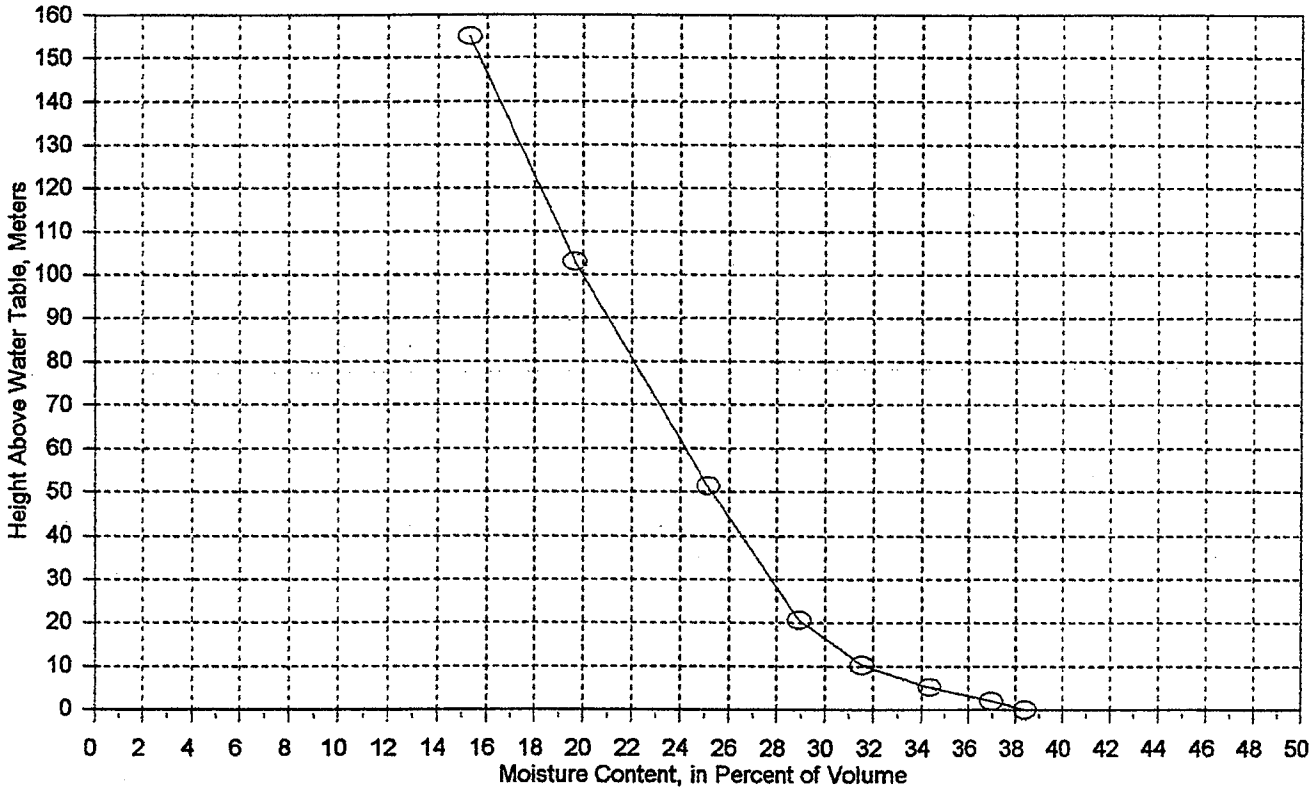


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-3, at 80 %

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	31.23	33.8	33.51	32.97	32.39	31.86	31.07	29.94	29.04
(5)	5.34	7.91	7.62	7.08	6.5	5.97	5.18	4.05	3.15
(7)	25.89	25.89	25.89	25.89	25.89	25.89	25.89	25.89	25.89
(8)	20.63	30.55	29.43	27.35	25.11	23.06	20.01	15.64	12.17
(9)	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
(10)	25.92	38.40	36.99	34.37	31.56	28.98	25.15	19.66	15.29

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 1

CAPILLARY-MOISTURE RELATIONS

Sample 18-3, at 85 % Mdd

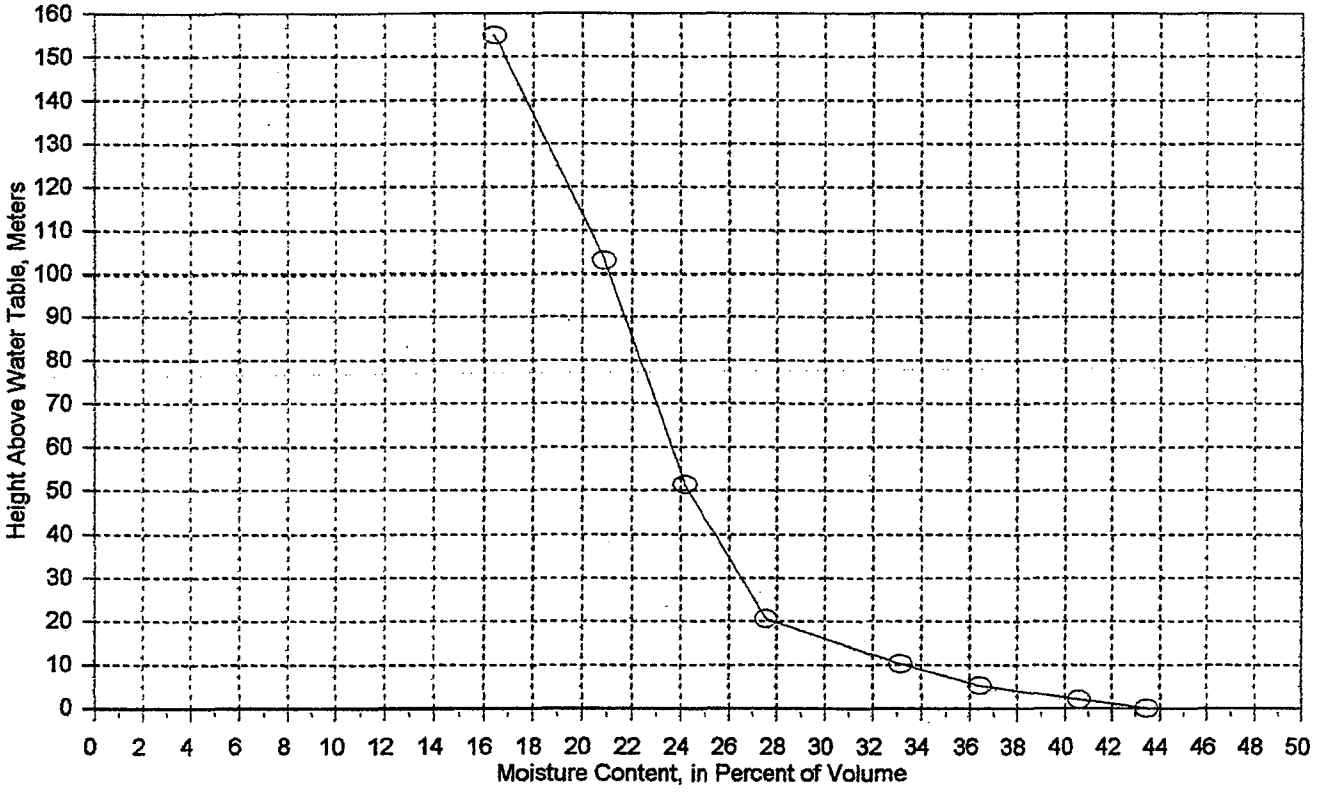


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-3, at 85 % Mdd

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	33.2	36.56	35.97	35.11	34.43	33.28	32.58	31.9	30.98
(5)	5.6	8.96	8.37	7.51	6.83	5.68	4.98	4.3	3.38
(7)	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
(8)	20.29	32.46	30.33	27.21	24.75	20.58	18.04	15.58	12.25
(9)	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34
(10)	27.19	43.50	40.63	36.46	33.16	27.57	24.18	20.88	16.41

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 42

CAPILLARY-MOISTURE RELATIONS

Sample 18-3, at 80 % Mdd with gravel

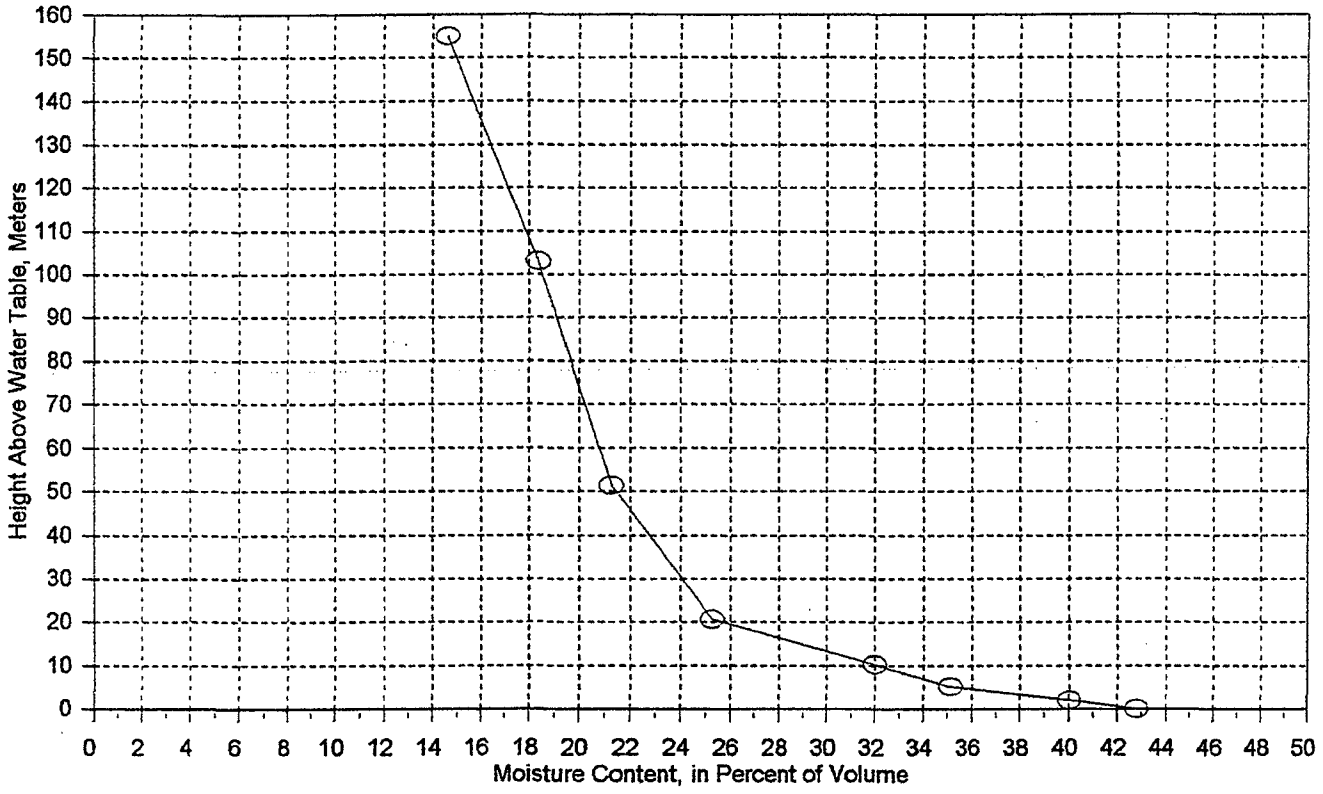


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-3, at 80 % with gravel

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	33.3	37.49	36.92	35.91	35.26	33.88	33.05	32.45	31.68
(5)	4.63	8.82	8.25	7.24	6.59	5.21	4.38	3.78	3.01
(7)	28.67	28.67	28.67	28.67	28.67	28.67	28.67	28.67	28.67
(8)	16.15	30.76	28.78	25.25	22.99	18.17	15.28	13.18	10.50
(9)	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39
(10)	22.48	42.82	40.05	35.15	31.99	25.29	21.26	18.35	14.61

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 39

CAPILLARY-MOISTURE RELATIONS

Sample 18-4, at 80 % Mdd

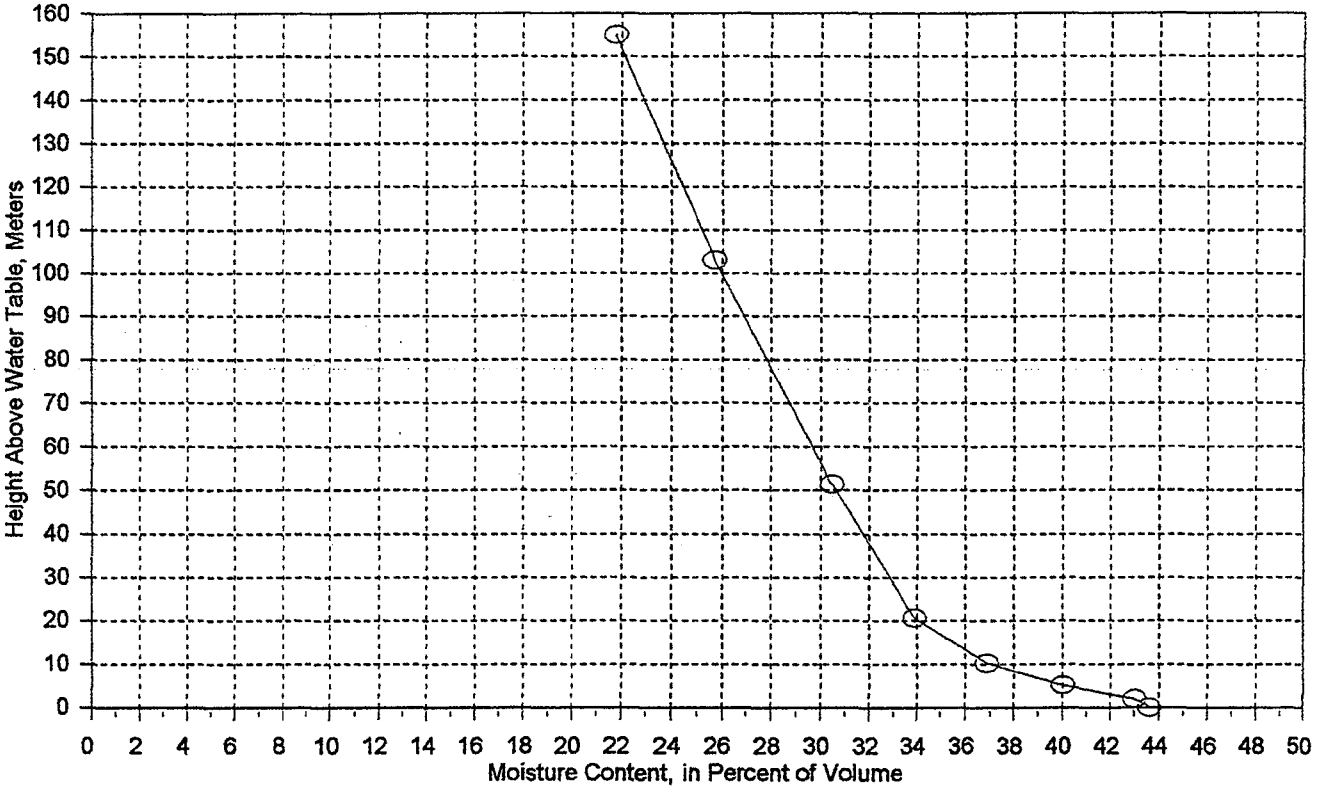


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-4, at 80 % Mdd

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	31.93	35.78	35.65	35.04	34.39	33.78	33.07	32.09	31.28
(5)	5.14	8.99	8.86	8.25	7.6	6.99	6.28	5.3	4.49
(7)	26.79	26.79	26.79	26.79	26.79	26.79	26.79	26.79	26.79
(8)	19.19	33.56	33.07	30.80	28.37	26.09	23.44	19.78	16.76
(9)	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
(10)	24.95	43.64	43.01	40.05	36.90	33.93	30.49	25.73	21.80

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 26

CAPILLARY-MOISTURE RELATIONS

Sample 18-4, at 85 % Mdd

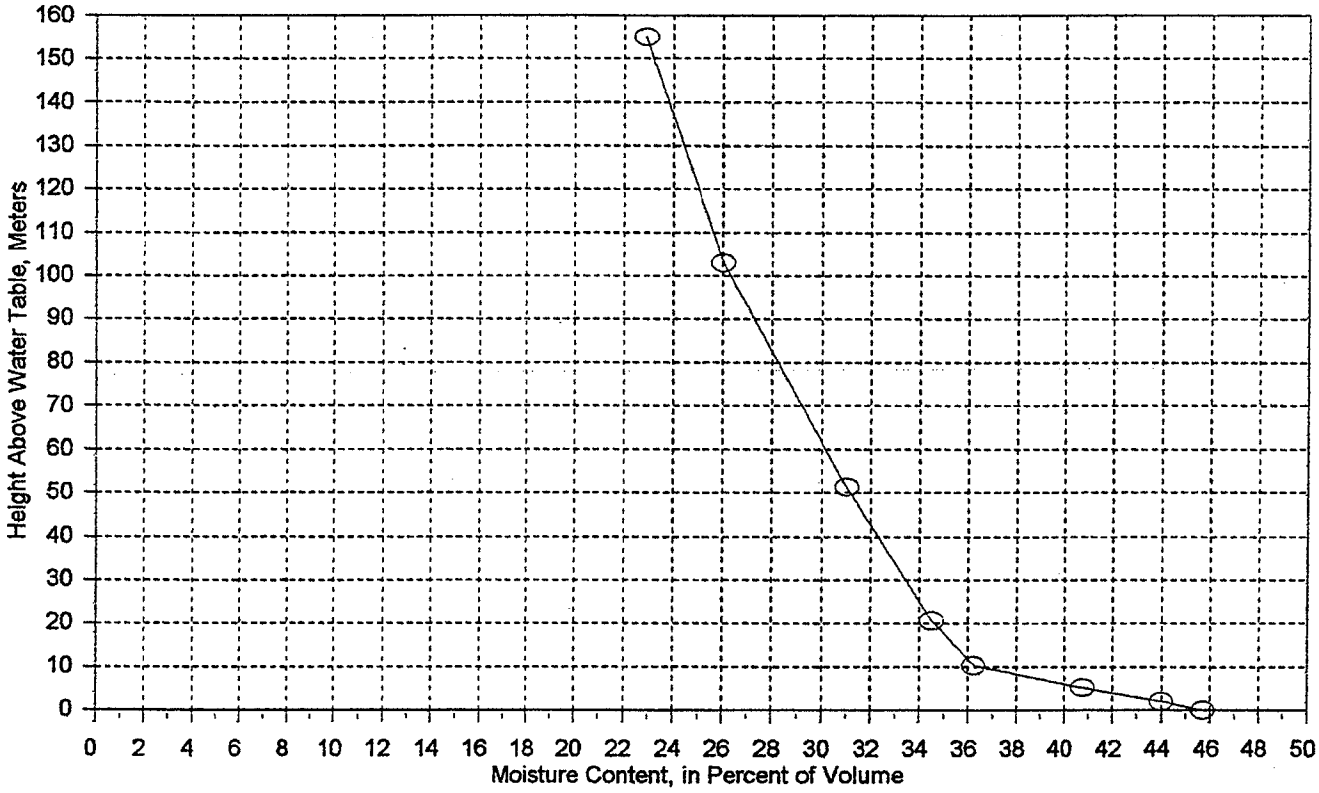


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-4, at 85 % Mdd

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	34.04	37.9	37.55	36.89	35.95	35.59	34.87	33.85	33.2
(5)	5.56	9.42	9.07	8.41	7.47	7.11	6.39	5.37	4.72
(7)	28.48	28.48	28.48	28.48	28.48	28.48	28.48	28.48	28.48
(8)	19.52	33.08	31.85	29.53	26.23	24.96	22.44	18.86	16.57
(9)	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
(10)	26.99	45.73	44.03	40.83	36.26	34.52	31.02	26.07	22.91

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 37

CAPILLARY-MOISTURE RELATIONS

Sample 18-4, at 80 % with gravel

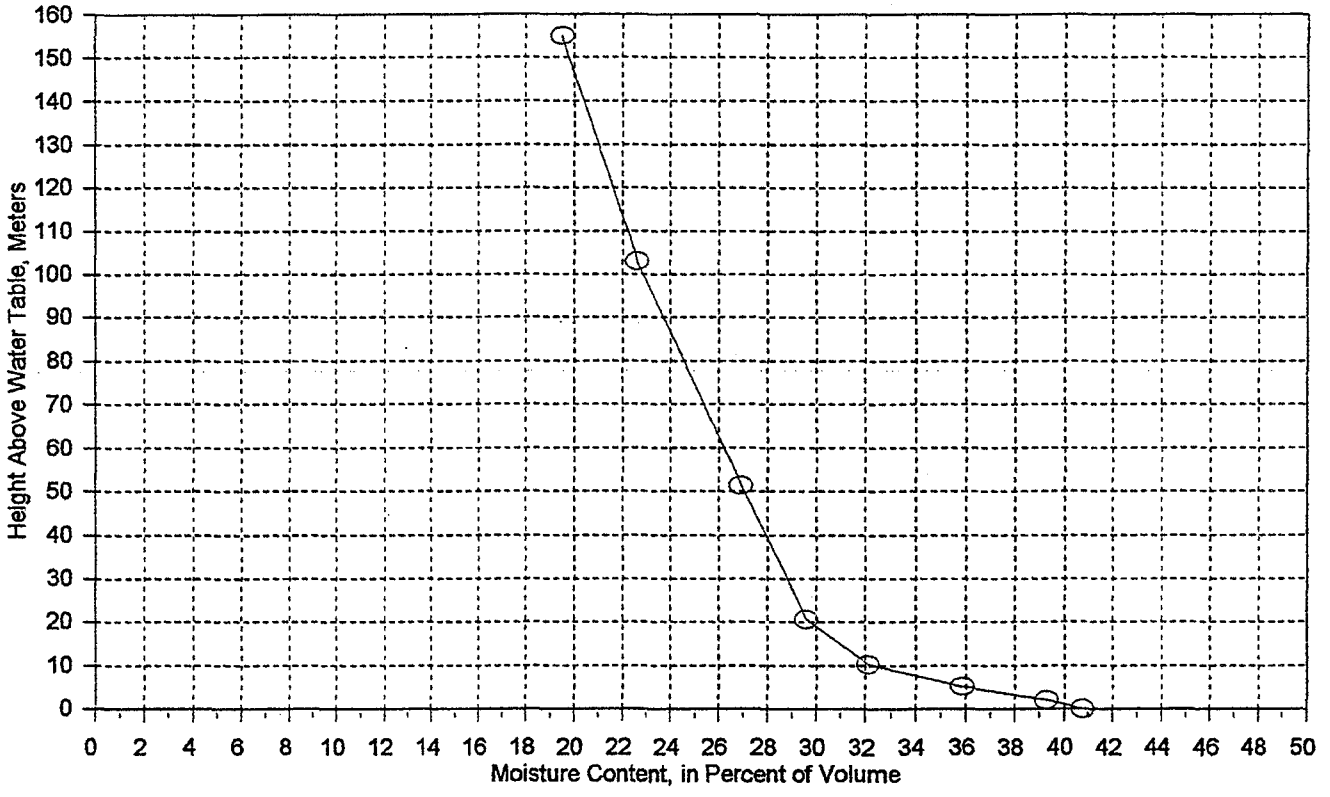


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-4, at 80 % with gravel

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	33.12	36.23	35.92	35.21	34.44	33.92	33.37	32.48	31.84
(5)	5.3	8.41	8.1	7.39	6.62	6.1	5.55	4.66	4.02
(7)	27.82	27.82	27.82	27.82	27.82	27.82	27.82	27.82	27.82
(8)	19.05	30.23	29.12	26.56	23.80	21.93	19.95	16.75	14.45
(9)	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
(10)	25.73	40.83	39.32	35.88	32.14	29.61	26.94	22.62	19.52

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 22

CAPILLARY-MOISTURE RELATIONS

Sample 18-5, at 80 % Mdd

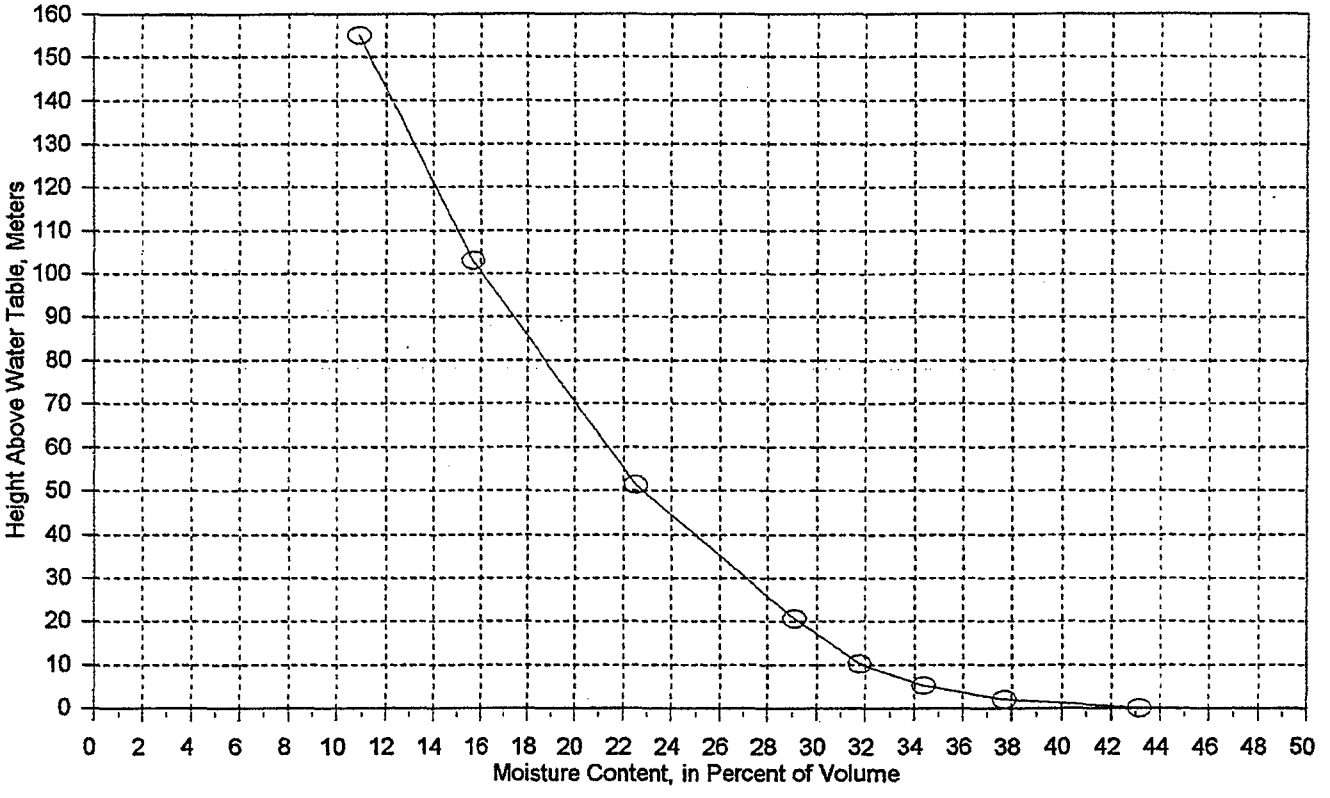


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-5, at 80 % Mdd

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	32.57	36.12	35	34.32	33.78	33.23	31.87	30.46	29.48
(5)	5.34	8.89	7.77	7.09	6.55	6	4.64	3.23	2.25
(7)	27.23	27.23	27.23	27.23	27.23	27.23	27.23	27.23	27.23
(8)	19.61	32.65	28.53	26.04	24.05	22.03	17.04	11.86	8.26
(9)	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32
(10)	25.92	43.16	37.72	34.42	31.80	29.13	22.53	15.68	10.92

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 24

CAPILLARY-MOISTURE RELATIONS

Sample 18-5, at 85 % Mdd

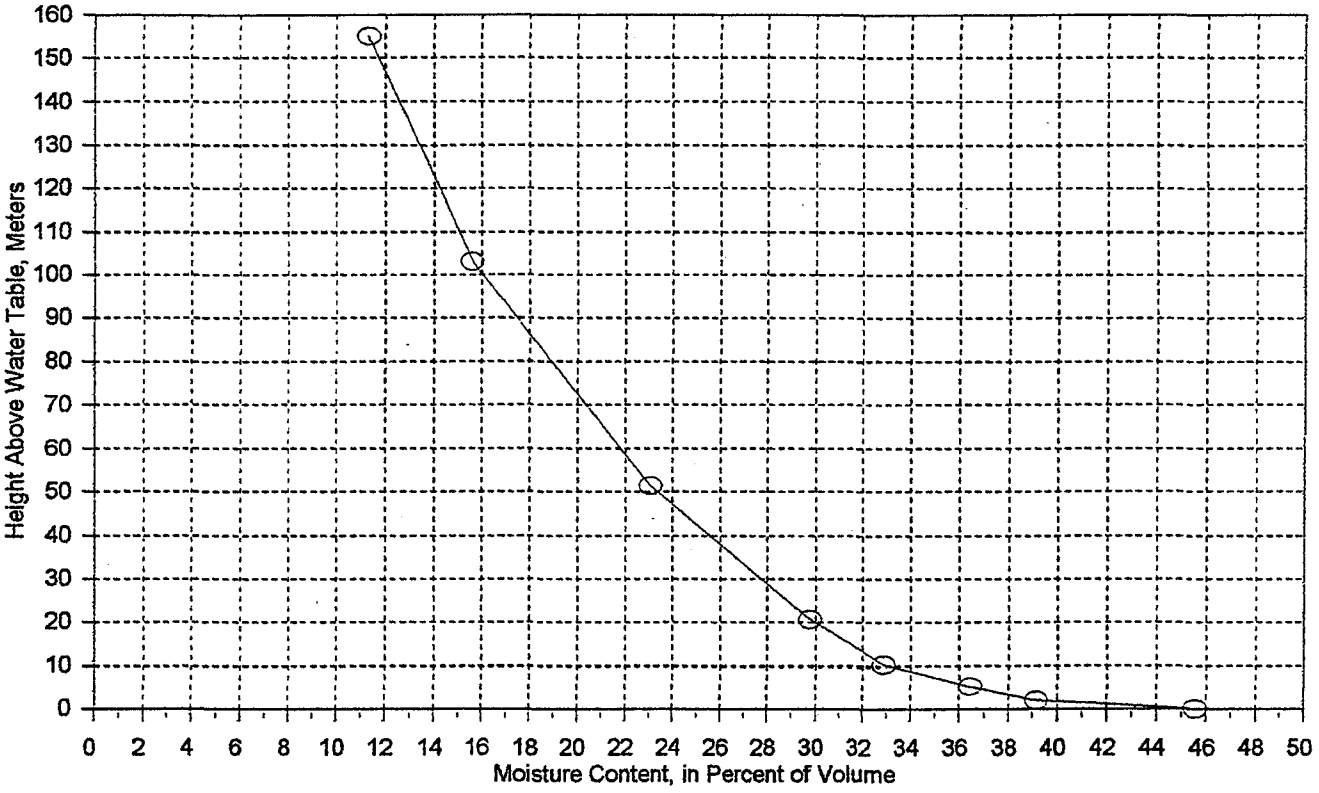


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-5, at 85 % Mdd

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	34.25	38.07	36.75	36.2	35.46	34.82	33.43	31.89	31.02
(5)	5.57	9.39	8.07	7.52	6.78	6.14	4.75	3.21	2.34
(7)	28.68	28.68	28.68	28.68	28.68	28.68	28.68	28.68	28.68
(8)	19.42	32.74	28.14	26.22	23.64	21.41	16.56	11.19	8.16
(9)	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39
(10)	27.04	45.59	39.18	36.51	32.92	29.81	23.06	15.58	11.36

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 21

CAPILLARY-MOISTURE RELATIONS

Sample 18-5, at 80 % with gravel

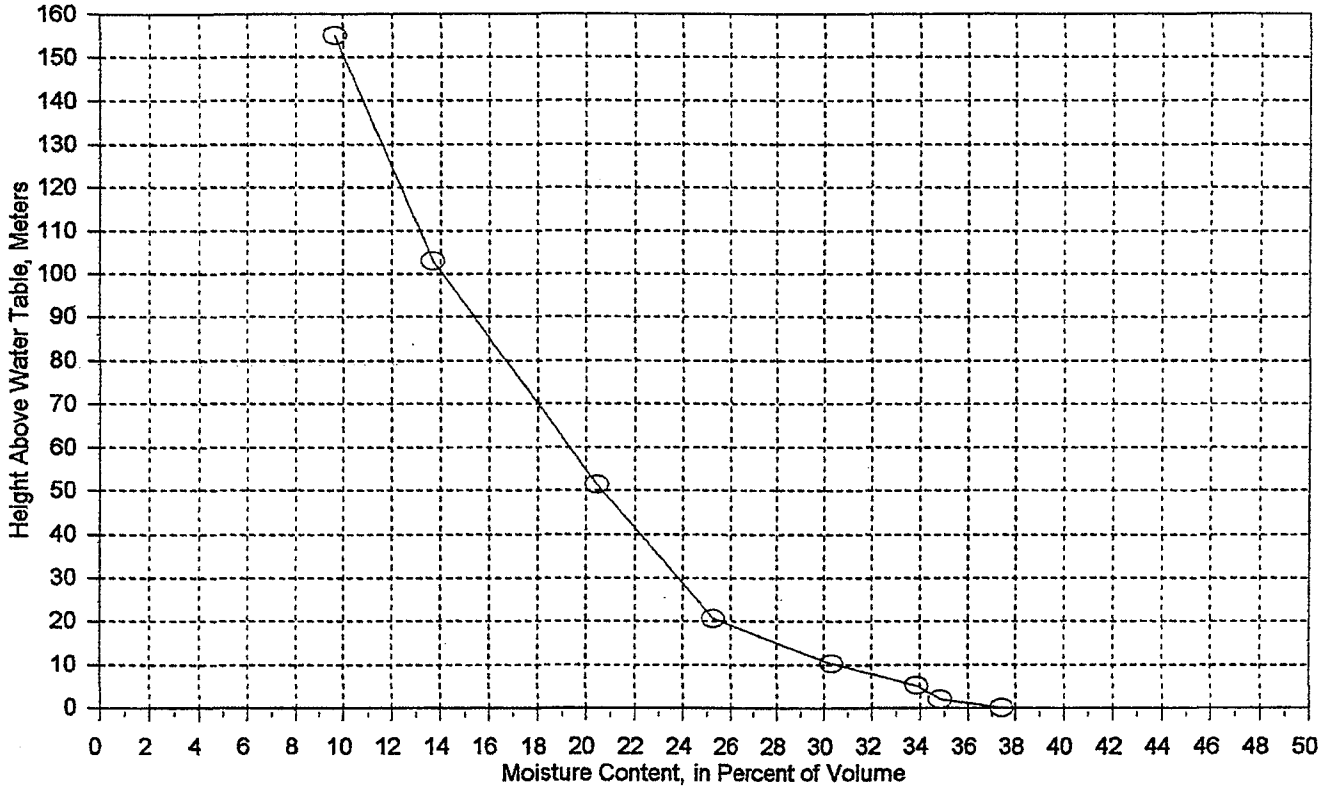


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-5, at 80 % with gravel

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	33.31	37.13	36.6	36.4	35.67	34.63	33.63	32.24	31.41
(5)	3.89	7.71	7.18	6.98	6.25	5.21	4.21	2.82	1.99
(7)	29.42	29.42	29.42	29.42	29.42	29.42	29.42	29.42	29.42
(8)	13.22	26.21	24.41	23.73	21.24	17.71	14.31	9.59	6.76
(9)	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
(10)	18.88	37.43	34.86	33.89	30.34	25.29	20.44	13.69	9.66

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 46

CAPILLARY-MOISTURE RELATIONS

Sample 18-6, at 80 % Mdd

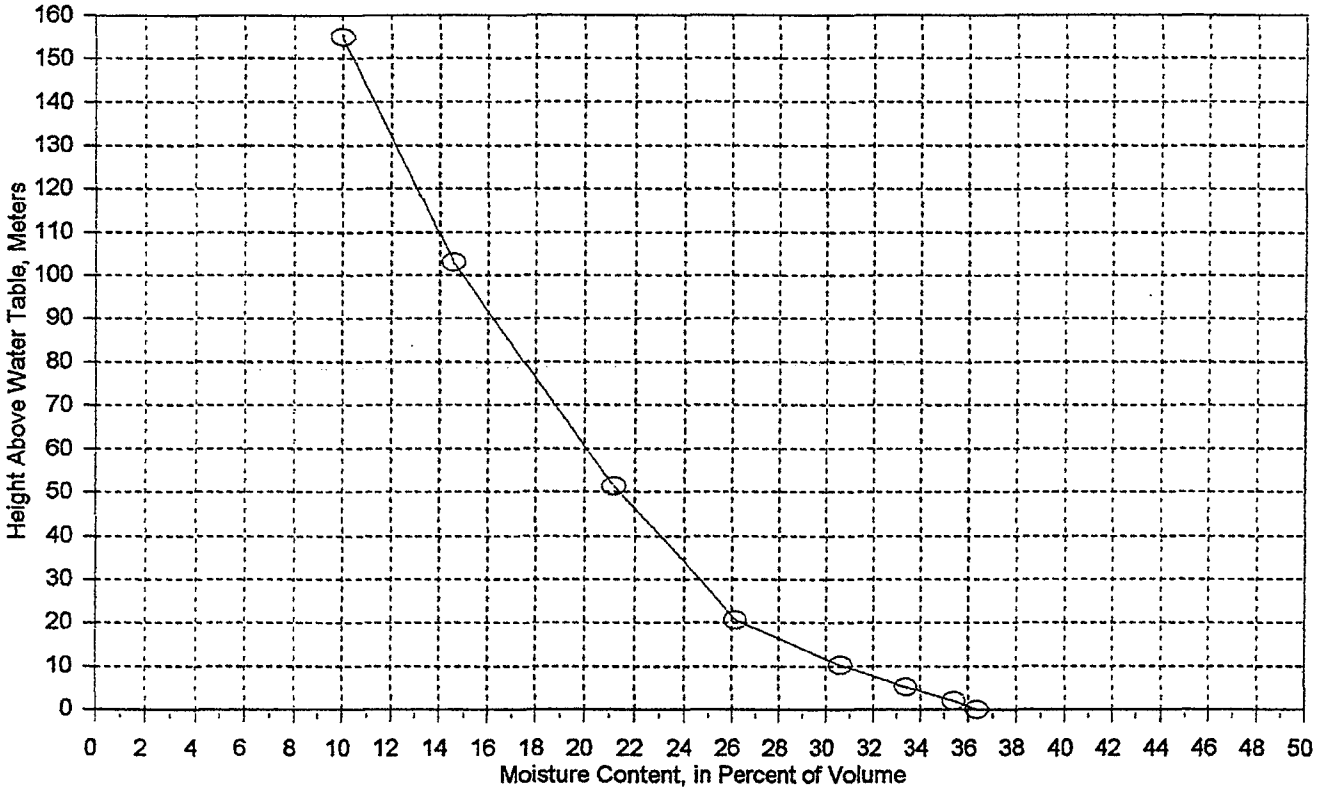


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-6, at 80 % Mdd

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	33.56	37.56	37.36	36.96	36.38	35.46	34.43	33.07	32.13
(5)	3.49	7.49	7.29	6.89	6.31	5.39	4.36	3	2.06
(7)	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07
(8)	11.61	24.91	24.24	22.91	20.98	17.92	14.50	9.98	6.85
(9)	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46
(10)	16.94	36.36	35.39	33.45	30.63	26.17	21.17	14.56	10.00

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 45

CAPILLARY-MOISTURE RELATIONS

Sample 18-6, at 85 % Mdd

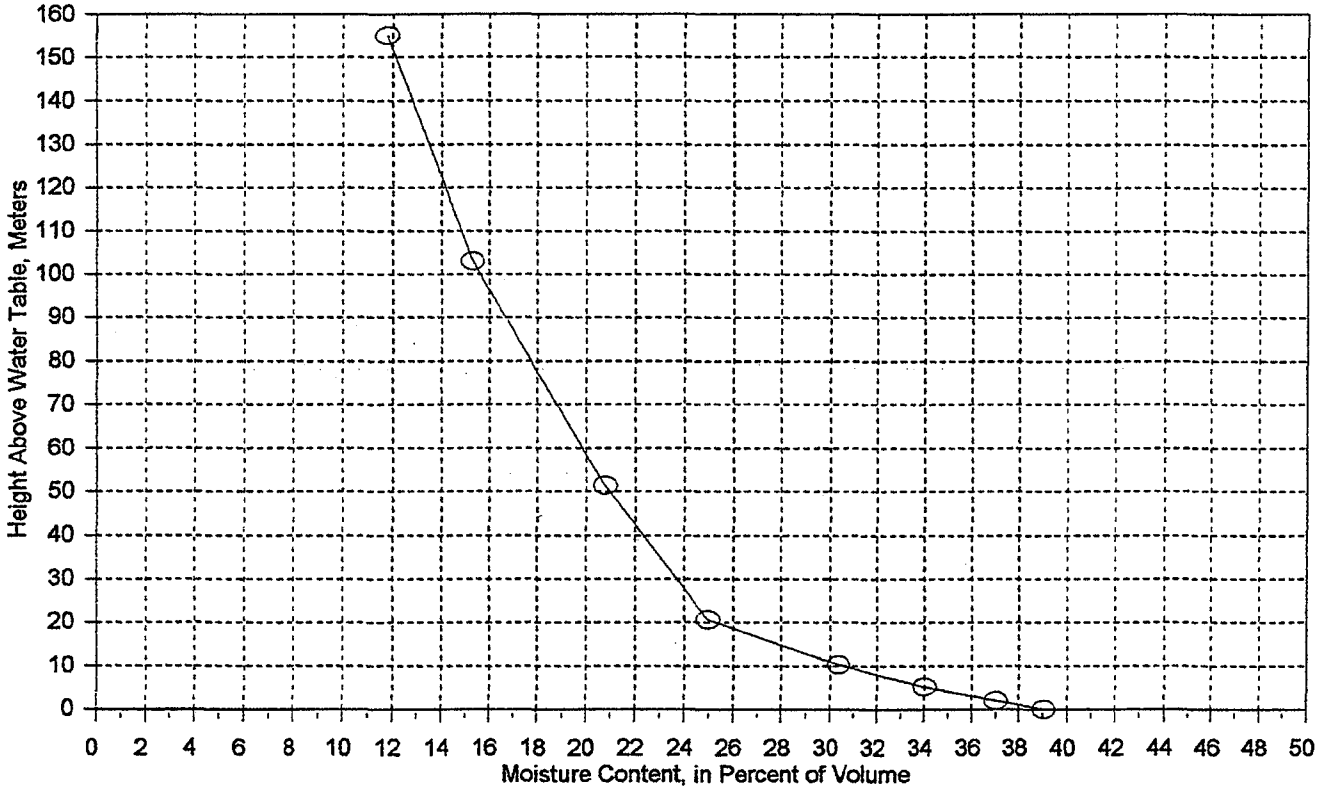


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-6, at 85 % Mdd

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	35.39	39.66	39.24	38.62	37.87	36.76	35.89	34.76	34.04
(5)	3.78	8.05	7.63	7.01	6.26	5.15	4.28	3.15	2.43
(7)	31.61	31.61	31.61	31.61	31.61	31.61	31.61	31.61	31.61
(8)	11.96	25.47	24.14	22.18	19.80	16.29	13.54	9.97	7.69
(9)	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
(10)	18.35	39.08	37.04	34.03	30.39	25.00	20.78	15.29	11.80

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 5

CAPILLARY-MOISTURE RELATIONS

Sample 18-6, at 80 % with gravel

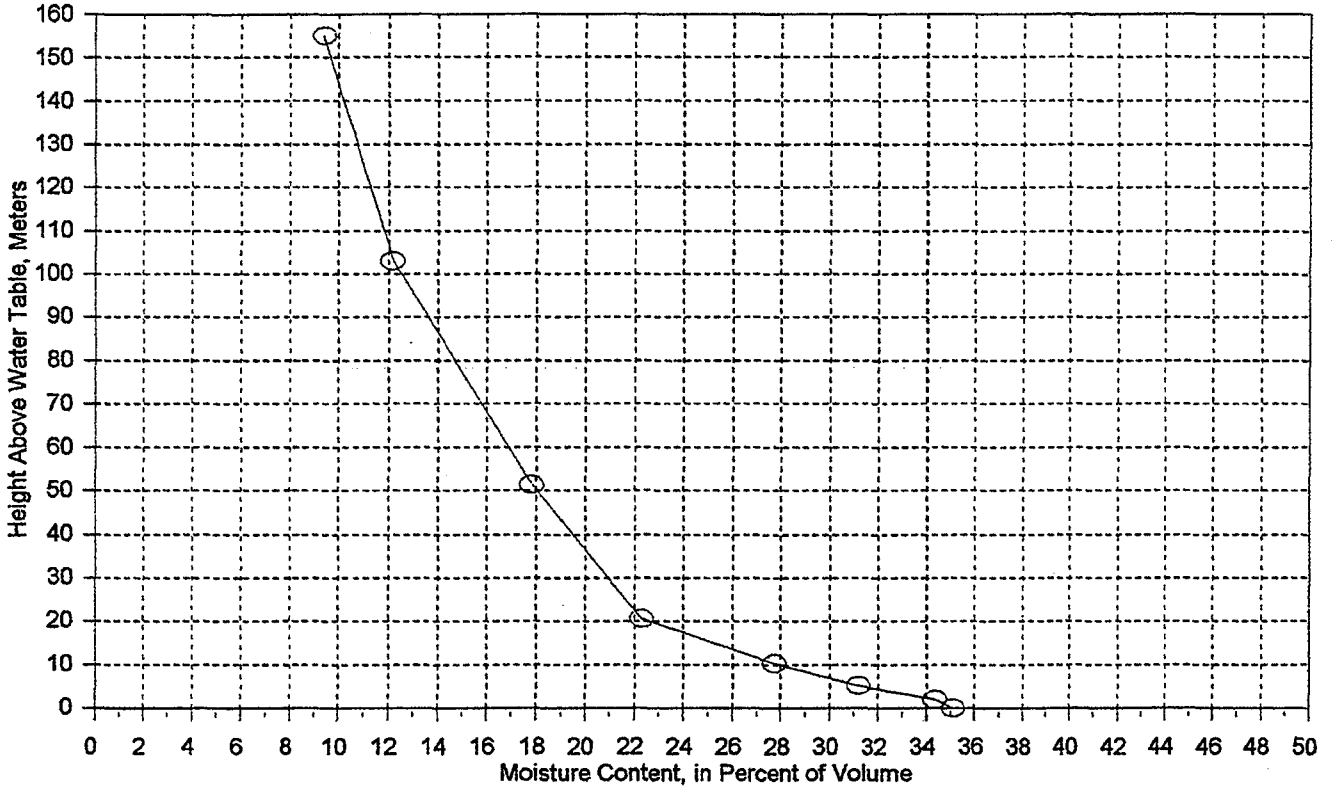


TABLE CAPILLARY-MOISTURE
Strata Inc., FMC Pond Closure
Sample 18-6, at 80 % with gravel

Height m		0	2.06	5.17	10.3	20.6	51.5	103	155
Atm. bar		0	0.2	0.5	1	2	5	10	15
(3)	34.81	39.25	39.1	38.45	37.74	36.61	35.69	34.53	33.96
(5)	2.79	7.23	7.08	6.43	5.72	4.59	3.67	2.51	1.94
(7)	32.02	32.02	32.02	32.02	32.02	32.02	32.02	32.02	32.02
(8)	8.71	22.58	22.11	20.08	17.86	14.33	11.46	7.84	6.06
(9)	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
(10)	13.54	35.10	34.37	31.22	27.77	22.28	17.82	12.19	9.42

KEY:
( ) Refer to ASTM D 3152
(3) Weight of wet sample, g
(5) Weight of moisture, g
(7) Weight of dry sample,g
(8) Moisture content (5/7*100)
(9) Unit weight of dry sample, g/cc
(10) Moisture content volume percent (8*9)
laboratory ref. 28

APPENDIX E

REVISED TECHNICAL REVIEW COMMENTS ON THE JUNE 2004 REMEDIAL INVESTIGATION UPDATE MEMORANDUM FOR THE FMC PLANT OPERABLE UNIT FOR FMC IDAHO LLC IN POCATELLO, IDAHO

RESPONSE TO COMMENTS
FMC IDAHO LLC

Appendix E

Response to Comments

Part 1. Response to General Comments

General Comment #1

The RI Update Memorandum (RI Update Memo) must be revised to include an acronym list.

FMC Response:

The RI Update Memo has been revised to include an acronym list.

General Comment #2

The phrase "above representative levels" is commonly used in the document. It is unclear if this is referring to background concentrations or some other criteria developed during the Eastern Michaud Flats (EMF) Remedial Investigation (RI). The RI Update Memo must explain what the phrase means and how these levels were derived.

FMC Response:

A description of representative levels and the reference to their derivation has been added to the introduction to Section 6 of the December 2004 RI Update Memo.

The term "representative levels" was used during the EMF RI to acknowledge the fact that there are anthropogenic effects in environmental media (soil, air, surface water, sediment, and groundwater) that are not associated with EMF Site activities.

Representative (background) values were derived by EPA during the course of the EMF RI and were used in the EMF RI Report and in EPA's Human Health Risk Assessment (HHRA) (E&E, 1996) to evaluate site-related impacts. An explanation of how these values were derived can be found in Section 2 of the HHRA.

General Comment #3

The RI Update Memo must be revised to include radionuclides known to be present at the site, including: uranium-238, radium-226, polonium-210, lead-210, potassium-40, as well as gross alpha and gross beta activities. The 1996 RI determined that radionuclides present the largest potential threat to future site workers. However, little data has been collected to date that characterizes the extent of radionuclide contamination within the facility.

Radiation Risk Assessment At CERCLA Sites: Q & A (Luftig & Page, 1999) provides a concise summary of the necessary steps to prepare a CERCLA Risk Assessment on sites with radioactive contaminants including identification and measurement of all radionuclides of concern in environmental media. The initial COPC list must include all radionuclides and decay products based on site history, production methods, and characteristics of the ores. In addition, cancer risks should be evaluated using the most recent isotope-specific cancer slope factors (U.S. Environmental Protection Agency Office of Radiation and Indoor Air, 1999; 2002g).

FMC Response:

Please see response to General Comment #4, and Specific Comments #29, 30 and 31 below.

General Comment #4

The June 2004 RI Update Memo does not identify radionuclide risk based concentrations (RBC), areas where radionuclides are present, or present data gaps related to RBCs. The RI Update Memo must be amended to include the investigation and evaluation of radionuclides.

FMC Response to Comment #3 and #4:

FMC believes there are no data gaps with respect to the ***nature*** of radiological impacts within the FMC Plant OU. Rather, FMC believes that the ***extent*** of radiological impact warrants further characterization for those portions of the FMC Plant OU where no further action is proposed in FMC's remedial action vision (e.g., RU 20), and has identified the need to further characterize the extent of radiological impact as a data gap in the RI Update Memo. As discussed during the September 15, 2004 teleconference between FMC, EPA Region 10, IDEQ and the Shoshone-Bannock Tribes, and documented in Appendices F and G of the December 2004 RI Update Memo, FMC proposes to characterize the extent of potential radiological impacts within these areas in the following two ways:

1. Measuring gamma radiation: The greatest contribution to incremental cancer risks (ICR) associated with worker exposure to all feedstocks and waste streams historically processed at the FMC Plant OU (except phossy wastes) is from external gamma radiation. Risk determinations based on direct gamma measurements are more certain than those calculated from radionuclide activities. Therefore, gamma radiation dose rate measurements will be made in the SRI to provide a direct evaluation of risk associated with external gamma exposure at each RU. The SRI Work Plan will identify sampling locations and analytical protocols for the gamma radiation dose rate measurements.
2. Characterizing lead-210 and polonium-210 activities, in addition to measuring gamma dose rates, in areas containing phossy waste (including precipitator dust): Lead-210 and polonium-210 have been determined to be significant contributors to risk associated with exposure to phossy waste, via pathways other than external gamma radiation. Samples for analysis of lead-210 and polonium-210 will be taken at any gamma radiation dose measurement site at which the potential presence of phossy solids is indicated based on visual characteristics and/or XRF analyses. The lead-210 and polonium-210 data will be used, in conjunction with the gamma dose rate measurements, to evaluate potential risks. The approach to be used to identify the potential presence of phossy waste is described in Appendix H of the December 2004 RI Update Memo. This approach, along with the analytical protocols for Pb-210 and Po-210 speciation, will be comprehensively described in the SRI Workplan.

Additional information on gamma radiation, Pb-210 and Po-210 characterization is provided in FMC's response to Comments #29, #30, and #31.

The EMF RI Report characterizes the nature of radiological constituents in potential source materials, soils, and groundwater within the FMC Plant OU. Other sources of data characterizing the nature of radionuclides at the FMC Plant OU include *Radiological Surveys of Idaho Phosphate Ore Processing – The Thermal Process Plan* (EPA, November 1977). Beginning on page 54, this EPA document describes partitioning of radionuclides in the

uranium-238 and thorium-232 decay series present in industrial feedstocks among byproducts and waste streams (including air) during ore processing.

Also, the EMF RI Report presented an extensive emission characterization and atmospheric dispersion modeling study, as well as the results of an extensive air quality-monitoring program. Emission inventories were presented for uranium-238, uranium-234, uranium-235, thorium-232, thorium-230, radium-228, radium-226, lead-210, and polonium-210 in point (i.e., stack), area (i.e., stockpile, material handling), and line (i.e., road) sources. Radionuclide activities were also analyzed on PM10 high-vol 24-hour filters collected at seven monitoring stations between October 1993 through March 1994, when routine radiological analysis of filters was discontinued with EPA concurrence.

Available radiological data, which typically includes the activities of uranium-238, radium-226, polonium-210, lead-210, and potassium-40 in potential source materials (feedstocks, byproducts, and waste materials), were documented in the conference notes for the September 15, 2004 teleconference, and have been incorporated into Section 3 of the December 2004 RI Update Memo.

EPA's 1997 HHRA identified exposure to external gamma radiation as the primary factor for the incremental cancer risk (ICR) associated with all radionuclides in surficial materials at the FMC Subarea. A more in-depth analysis has shown that, with the exception of phossy wastes (including precipitator slurry), over 95% of the total ICR for all FMC waste materials, ore, co-products and byproducts that pose a risk greater than background is associated with exposure to external gamma radiation. This information, which was discussed during the August 3, 2004 Agency Coordination Meeting and during the September 15, 2004 Agency Coordination Teleconference, has been incorporated into Appendix F of the RI Update Memo.

Radionuclide speciation was not identified as a data gap in areas proposed to be capped for the following reasons:

- The 1998-ROD selected capping/covering the old phossy pond areas where precipitator slurry and phossy water solids were historically managed. EPA selected this remedy as meeting the RAOs for radiological risk management as well as other RAOs.

- Capping additional areas of the FMC Plant OU (e.g., Slag Pile – RU 19), as stated in the RI Update Memo, will meet the radiological risk management RAO specified for the FMC OU in the EMF ROD.

General Comment #5

Additional data must be collected for the undeveloped southern and western portions of the facility. Fluoride samples collected south of the facility property during the RI indicate that EMF contaminants have been deposited on vegetation exceeding the State of Idaho Rule 58.01.01.06 for total fluoride content in vegetation used for forage. Samples collected southwest of the facility property in the vicinity of Residential Area #8 have shown elevated levels of EMF related contaminants. These data suggest that the undeveloped southern and western portions of the facility may be affected by contaminants resulting from air deposition related to facility

operations. The RI Update Memo must include this area as a remediation unit and identify soil concentrations for contaminants of concern as a data gap.

FMC Response:

Existing off-site RI data have proven sufficient to both evaluate ecological risks and to conclude that there is no potential for adverse health effects to future workers within the undeveloped western and southern areas of the FMC Plant OU. Therefore, FMC does not agree that the absence of data from these areas constitutes a data gap, and FMC believes that there is no basis to revise the RI Update Memo to identify the western and southern areas of the FMC Plant OU as a remediation unit.

The Statement of Work (SOW) provides that data associated with the off-site Bannock Hills SW ecological RI sampling station, along with off-site RI surface soil samples collected adjacent to the undeveloped areas of the FMC Plant OU are appropriate to screen on-site ecological risks. The screening assessment performed using the adjacent off-site RI data points was presented in Section 5 of the June 2004 RI Update Memorandum. This conservative assessment of risks in the ERA of the undeveloped portions of the FMC Plant OU determined that no population or community level effects are likely. Furthermore, in the Agencies' specific comments on Section 5 of the June 2004 RI Update Memorandum, no request was made for sampling of the undeveloped western and southern areas of the FMC Plant OU to further support the findings of the ecological assessment. Thus, there are no data gaps with respect to potential ecological impacts in these undeveloped areas of the FMC Plant OU.

As shown in Table 1, the same off-site RI surface soil samples used in the ecological assessment all contain COPC concentrations that are below background and/or commercial/industrial worker SSLs. Thus, it is reasonable to conclude that historical facility emissions have not resulted in surface soil contamination that would pose an unacceptable incremental risk above background to potential future commercial/industrial workers. Moreover, sub-surface soils within the western and southern undeveloped areas of the FMC Plant OU consist of non-impacted native soils, with no potential for adverse health effects to workers above those associated with background exposure. Therefore, further comparison of sub-surface soil concentrations to construction and utility worker SSLs is not warranted. Thus, there is no data gap with respect to evaluating potential worker risks in the western and southern undeveloped areas of the FMC Plant OU.

With respect to fluoride levels in vegetation sampled to the south of the FMC Plant OU exceeding the State of Idaho Rule 58.01.01.06 for total fluoride content in vegetation used for forage, these impacts are not related to activities at the FMC Plant OU. Simplot was the largest source of airborne fluoride emissions (contributing over 90% of the total) during the time of the RI, the period during which the referenced vegetation samples were obtained. Moreover, while the FMC facility ceased operations in December 2001, the Simplot facility is an ongoing source of fluoride emissions. Therefore, any exceedance of the total fluoride forage limits defined in the State of Idaho Rule 58.01.01.06 within vegetation present on the FMC Plant OU is related to ongoing Simplot emissions, an issue that would more appropriately addressed to Simplot representatives.

Table 1
Comparison of RI Surface Soil Data Collected Adjacent to the Undeveloped Western and Southern Areas of the FMC Plant OU to Commercial/Industrial Worker SSLs and Background Levels

COPC	Greater of Commercial/Industrial Worker SSL and Background (mg/kg)	Soil Concentrations at Adjacent RI Sampling Stations (mg/kg)									
		270-2B		248-3B		225-2A		225-2B		180-2B	
Antimony	4.54E+02	7.80E+00	UJ	1.18E+01	J	8.10E+00	U	2.66E+01	J	3.90E+00	UJ
Arsenic	7.70E+00	4.10E+00		3.60E+00		4.50E+00	J	5.40E+00	J	5.10E-01	UJ
Barium	6.76E+04	1.71E+02	J	9.74E+01		1.42E+02		1.36E+02		1.78E+02	J
Beryllium	1.06E+03	8.50E-01		5.90E-01		5.60E-01		8.40E-01		9.10E-01	U
Boron	1.02E+05	1.83E+01		4.70E+00		4.30E+00	J	2.00E+00	J	4.16E+00	
Cadmium	8.94E+02	1.30E+00		3.80E+00		2.62E+01	J	2.81E+01	J	2.90E+00	
Chromium	1.70E+06	2.19E+01		2.20E+01		7.95E+01	J	8.77E+01	J	1.43E+01	
Cobalt	9.08E+02	6.90E+00		4.70E+00		5.90E+00		5.00E+00		5.20E+00	U
Copper	4.20E+04	1.71E+01		9.70E+00		1.77E+01		1.62E+01		1.47E+01	
Fluoride	6.81E+04	5.30E+02		4.63E+02		1.59E+03		1.68E+03		4.33E+02	
Lead	8.00E+02	1.07E+01		1.75E+01	J	1.65E+01	J	1.97E+01	J	2.11E+01	J
Lithium	2.27E+04	1.85E+01		1.03E+01	J	8.70E+00		8.70E+00		1.73E+01	
Manganese	3.53E+04	4.68E+02	J	3.50E+02	J	4.65E+02		4.72E+02		6.82E+02	
Mercury	3.40E+02	6.00E-02	U	8.00E-02		5.00E-02	U	5.00E-02	U	9.00E-02	U
Molybdenum	5.68E+03	1.30E+00	U	1.10E+00	U	4.40E+00	U	8.40E+00	U	1.10E+00	U
Nickel	1.06E+04	1.55E+01		1.05E+01		2.00E+01		2.04E+01		8.40E+00	U
Selenium	5.68E+03	5.90E-01	UJ	4.40E-01		1.10E+00	J	1.30E+00	J	2.60E-01	U
Silver	5.68E+03	4.10E-01	U	9.20E-01		2.30E+00		2.30E+00		3.30E-01	J
Thallium	7.72E+01	1.22E+01	U	1.30E-01	J	1.20E-01	J	1.10E-01	J	1.00E-01	UJ
Vanadium	7.95E+03	3.15E+01		3.55E+01		9.58E+01		9.17E+01		2.61E+01	
Zinc	3.41E+05	7.99E+01		6.19E+01		2.04E+02	J	2.09E+02	J	7.58E+01	

- = No Data.
J = Estimated concentration.
U = Non-detect

General Comment #6

Specific design criteria must be proposed for cap design. It is expected that varying levels of elemental phosphorus (P4), inorganics, and radionuclides, in addition to waste volumes, will have a significant effect on the type of cap for each unit. Since capping has been proposed for a number of areas, characterization to assist with the design must be proposed. Specifically, for areas where levels of elemental phosphorus are encountered at levels which burn a cap similar to the cap at pond 8S would be required, for areas where levels of elemental phosphorus are encountered but do not burn, a cap similar to the cap at pond 9E may be more applicable.

FMC Response:

Specific design criteria for cap design (in effect, Remedial Action Objectives) will be developed during the Supplemental Feasibility Study, rather than in the RI Update Memo. This approach conforms with the AOC and SOW for the SRI/SFS. FMC believes that the issue inherent to EPA's comment is whether additional data are needed to develop and/or evaluate cap design(s) for specific RUs. FMC believes that only limited additional data are needed to evaluate remedial designs for RUs that warrant remediation. The December 2004 RI Update Memo identifies the

following data gaps that will be addressed during the SRI to provide data for cap design during the SFS:

- Leachability testing of calciner solids (RU 16) to support designing a cover that sufficiently minimizes infiltration;
- 44°C isotherm modeling study and confirmatory soil sampling at RU 1 and RU 2 to ensure that the area to be capped has been adequately identified; and,
- Radon flux measurements from the former phossy waste ponds will be obtained for evaluation of the pond covers relative to the UMTRCA guideline of 20 pCi/m^2s.

The remainder of this response provides FMC's rationale for limiting the data gaps to those listed above.

The design of the RCRA pond caps was based first on meeting four primary performance criteria and then took into consideration the volume, moisture content, and P4 level of the sediments to develop a design based on the longevity of the cap deemed appropriate to minimize infiltration and isolate the wastes from direct contact. The primary cap design criteria (RAOs) were developed in the FS Report (1997). The four primary design criteria (or remedial action objectives) for these RCRA closures were:

- Long-term minimization of the migration of liquids through the closed impoundment;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion of the cover; and
- Install a cap with a permeability less than or equal to the permeability of any pond liner or natural subsoils.

Closure of Pond 8S began in 1994 with the concurrent placement of an initial sand and slag fill and drawdown of the free liquids overlying the phossy waste sediments within the pond. The closure plan called for installing a final cover over the initial fill after the settlement rate of the pond sediments and backfill was reduced to design objectives. The initial design for the final cover at RCRA Pond 8S was a 3.5-foot thick multi-layer cap, based on the design recommended in EPA guidance. FMC believed that the combination of initial fill and a multi-layer RCRA cap collectively met RCRA design criteria for pond closure.

Based on FMC's experience and published research, elemental phosphorus (P4) within the pond solids mixed with water, including nearly saturated conditions after removal of free water and placement of the cap, would remain in the covered sediments for some time. EPA was concerned that the synthetic components in the multi-layer cap could not be demonstrated to have sufficient longevity to meet the performance standards over an extended period. Based on EPA's concern, FMC proposed integration of a capillary-barrier cover above the synthetic layers of the originally proposed 3.5-foot multi-layer cap. The capillary barrier was designed exclusively with natural earthen materials to minimize infiltration, withstand erosive forces over an extended period, and ensure that the cap meets the performance standards over the long-term, independent of the longevity of the synthetic layers. In addition, a biointrusion layer (an 18–inch thick layer of coarse slag) was incorporated into the capillary barrier cap to further minimize the potential for intrusion.

The final caps at RCRA Pond 9E and RCRA Pond 8E are similar to the initially proposed Pond 8S final cap with the understanding that the sediments within these ponds did not warrant the added degree of protection afforded by the longer-term design life of the Pond 8S-type cap, because P4 levels remaining in these sediments were much lower. For example, in the case of Pond 9E, the pond had been dredged to remove pond sediments and free liquids to the extent feasible and then the sediments were actively turned to further dry the sediments so the pond could be converted into a drying pad for NOSAP treated precipitator slurry. Although the conversion was not completed, the pond sediments had been dried and oxidized extensively for several years before the initiation of closure. Pond 8E, on the other hand, contained free liquids and saturated phossy wastes, but the waste had been treated by the NOSAP process, which consistently reduced P4 levels in precipitator slurry to below 1,000 ppm (the level determined by FMC where phossy waste sediments were not observed to ignite or smoke).

The following sections review those design criteria and provide a description of additional considerations and criteria that were evaluated for identification of potential SRI data gaps.

(1) Inorganics and Radionuclides as Cap Design Factors

In the FS Report and the ROD, FMC and EPA clearly identified inorganic chemical and radiological constituent levels of the residual sediments in the former phossy waste ponds as cover design factors.

As described in the RI Update Memo, the 1998 ROD specifically identified the old phossy ponds area (RU 22b) as requiring remediation to meet RAOs for preventing external exposure to radionuclides in soils and direct exposure (ingestion/inhalation) to COCs above the stated carcinogenic and non-carcinogenic risks. At Section 10.2.2 of the ROD, EPA specified that, in addition to backfill and grading to prevent ponding and enhance surface drainage, a surface cover of at least 12 inches will be installed at the old phossy ponds. Prior to the ROD, EPA requested that FMC perform an evaluation of the 12-inch soil cover described in the FS Report with respect to shielding gamma emissions from radionuclides in pond solids and/or slag. FMC performed the evaluation and found that a 12-inch layer of soil would shield gamma emissions from the underlying material such that measured gamma exposure at the surface of the soil layer would be essentially equivalent to the gamma emissions for the soil itself (i.e., soil background emissions.)

Radium-226 activity of potential source materials and soils is the primary contributor to radiological risks. Radium-226 decay products generate gamma radiation. As discussed in FMC's response to Specific Comment 31 and elsewhere, FMC has proposed to measure gamma radiation levels at areas where the need for remedial action has not already been identified. Soil covers or other mitigation measures will be evaluated in the SFS for areas exhibiting gamma radiation at levels that pose a risk to future site workers. Standard radiation shielding models such as Microshield™ can be used to evaluate cover designs, with the radium-226 activity of the source material being input to characterize the strength of the gamma radiation to be controlled. FMC believes that sufficient data are available to correlate measured gamma radiation levels with radium-226 activities, and that additional radium-226 characterization data are not needed to support potential radiation modeling studies during the FS.

FMC also believes that radon flux from residual sediments should be considered in developing cover design criteria. As noted previously in this response, radon flux measurements from the former phossy waste ponds will be obtained during the SRI for input to cap design to ensure that radon flux from the cap will be below the UMTRCA guideline of 20 pCi/m^2s.

(2) Elemental Phosphorus Level as a Cap Design Factor

FMC would like to clarify that, although the concentration of elemental phosphorus in pond sediments was a design consideration, elemental phosphorus concentration was not warranted as a primary cap design criterion.

The nature of the residual pond sediments in the old phossy waste ponds within RU 22b is significantly different from the nature of phossy wastes in RCRA Pond 8S at the time of its closure. Phossy wastes were periodically reclaimed from the RU 22b ponds, and the residual sediments lack free liquids that would maintain the phossy wastes in an unoxidized condition. The residual sediments in many ponds have been covered with slag or lie beneath lined RCRA ponds (now closed). In many of the old ponds, the minimal residual volume and dried condition of the solids strongly suggests that the majority of P4 has oxidized to below the 1,000 ppm smoking level.

Specification of either a Pond 8S-type "double cap" or a Pond 9E cap as a design criterion for these former unlined phossy ponds in RU 22b at this time is inappropriate due to the nature (volume, moisture content, and P4 level) of the residual phossy wastes present within these former ponds. Rather, a capillary barrier cap without an underlying synthetic layer may be an appropriate remedial design that ensures that the remedy meets the RAOs. Specific cap designs will be evaluated in the SFS.

(3) Nature of Residual Sediments and P4 in Former Phossy Waste Ponds in RU 22b.

Table G6 provides information on each former phossy waste pond within Remediation Unit 22b. This information includes a summary of pond history from Appendix M of the EMF RI Report, estimated volume of remaining pond sediments, observations on pond sediment properties and P4 occurrence where soil borings or groundwater well borings were advanced within the footprint of the former pond during the EMF RI, and the oxidation/reduction (Eh) potential in groundwater upgradient and downgradient from ponds where wells are closely positioned to detect the residual influence from leakage from the old ponds.

As noted in Table G6:

- Materials were periodically removed from the ponds and P4 was reclaimed from these materials. This material was blended with the ore, processed at either the kiln or calciners, and sent to the furnaces. Additionally, at various times the dried wastes were reclaimed and sold. This history of reclamation of phossy wastes from these former unlined phossy waste ponds is in contrast to the more recent operation of lined RCRA phossy waste ponds, from which phossy wastes have not been reclaimed.

- Soil and well borings demonstrate the absence of P4 over large areas of the old ponds. Of the 31 soil and well borings advanced within the footprint of former unlined phossy waste ponds, all but one (F037B) encountered slag fill over a 1 to 4-foot thick layer of

oxidized pond solids (slightly moist or dry) or slag fill over native soils (suggesting that phossy solids had been removed or had not accumulated). F037B was advanced through 20 feet of slag fill before encountering elemental phosphorus at 23.5 feet bgs.

- Soil and well borings also demonstrate the absence of free liquids within the residual sediments. Former unlined phossy pond sediments have been either exposed or covered with slag (slag is permeable) for decades, except where the former pond is overlain by a newer, lined RCRA phossy waste management pond. Exposed or slag covered phossy wastes would not be expected to contain free liquids and the majority of P4 would have been oxidized to below the 1,000 ppm smoking level.

- Groundwater monitoring data obtained over more than the last 10 years shows that oxidizing conditions (higher Eh levels) are encountered in wells within and downgradient from the former unlined phossy waste ponds (RU 22b). For example, samples from Well Pair 133/134, downgradient from the former unlined phossy waste ponds, consistently exhibit positive Eh values. This indicates that most of the P4 that may have been contained in the pond sediments has been oxidized, and there is not a significant mass of P4, if any, remaining in these sediments. Reducing conditions (strongly negative Eh levels) are encountered only in wells 150, 152, 155, 156 and 157 downgradient from Pond 8S. These strongly reducing conditions are indicative of a reducing leachate flux from reduced conditions in the phossy wastes that have undergone little if any oxidation, including P4 in the pond sediments. In summary, about half of the old phossy ponds have little or no remaining pond sediments, none of the ponds contain free water or even saturated sediments, and P4 levels in residual pond sediments are estimated to be below 1,000 ppm in all of the seven “E-series” ponds, as well as in six of the eleven “S-series” ponds within RU 22b.

See Table G6.

Table G6: OLD PHOSSY WASTE POND INFORMATION

Pond	Material Received/History (from Appendix M of EMF RI Report and RI Update Memo)	Area (acres)	Est. Volume (yd3)	EMF RI soil and GW well borings within pond footprint	Were phossy pond solids encountered in boring/drilling?	Was P4 evidenced during boring/drilling?	Estimated P4 level	Is old pond overlain by a newer, capped RCRA pond?	Closely-spaced GW well Up = upgradient Dn = downgradient	Eh difference in upgradient and downgradient wells
00S	Phossy water and phossy solids. Former unlined pond. Pond location inaccessible; not an engineered structure, dimensions not available; no release controls known. Pond 00S thought to be beneath Mobile Equipment Shop. Characterization of unit expected to be similar to other former unlined S-series ponds.	0.1	No est. available	F060B	Yes (@ 0' to >2' bgs)	No	<1,000 ppm	No	na	na
0S	Phossy water and phossy solids. Former unlined pond. Not an engineered structure; no release controls known. Characterization of unit expected to be similar to other former unlined S-series ponds.	0.7	No est. available	F061B, F073B, F074B	No	No	<1,000 ppm	No	na	na
1S	Phossy water and phossy solids. Former Pond 1S was completed in about 1956, and had a surface area of only about one-half an acre (21,800 ft2). This pond contained slurry material to a depth of about 11 feet. Some P4 was reclaimed from this former pond between 1966 and 1972. Residuals from the reclaim operation were placed in Pond 3S. Pond 1S was dried and capped in 1972. The area was disturbed during the excavation of a power line trench in 1976, and the contents oxidized. In 1991, this area was estimated to contain about 2,850 tons (2,400 yd3) of phossy waste material.	0.5	2,400	na	na	na	>1,000 ppm (based on reported oxidation when sedimentes were exposed in 1976 trenching)	No	na	na
2S	Phossy water and phossy solids. Former Pond 2S was also completed in about 1956, and had a surface area of about 0.8 acre (34,850 ft2). Depth of slurry material was estimated to be similar to that in Pond 1S, or about 11 feet. Some P4 was reclaimed from this former pond between 1966 and 1972. Residuals from the reclaim operation were placed in Pond 3S. This pond was also dried and capped in 1972. In 1991, this area was estimated to contain about 1,050 tons (875 yd3) of phossy waste material.	0.8	875	B-4, B-5, F037B	Yes (B-4 @ 0' to >7 bgs; B-5 @ 0' to >6 bgs, F037B @ 23' to >24 bgs when drilling ceased)	Yes	>1,000 ppm (encountered P2O5 smoke during drilling)	No	na	na
3S	Precipitator slurry solids, slag pit water and solids, phossy water and phossy solids, residual from P4 reclaim operations. Former Pond 3S was constructed in November 1961. It was used from November 1961 until some time in 1965. It was routinely dug out twice a year during the time it was in operation. Between 1972 and 1976, phosphorus was reclaimed from the eastern 100 feet of this former pond, and the area was backfilled with slag. The rest of the pond area was dried between June and December of 1976, and then covered with dirt and slag. Pond 3S had a surface area of about 1.2 acres (52,300 ft2), and was about 20 feet deep. It is estimated to contain about 10,600 tons (8,800 yd3) of phossy wastes, primarily precipitator slurry.	1.2	8,800	na	na	na	>1,000 ppm	No	W133 (Dn); W134 (Dn)	Oxidizing conditions (W133 = 106 mV; W134 = 90 mV)
4S	Precipitator slurry solids. Pond 4S, located south of Pond 3S, was constructed in April 1966. This pond, with an area of 0.8 acre (34,850 ft2) operated for a period of about one year, receiving precipitator slurry. This pond was estimated to contain about 6.4 feet of slurry, or an estimated 7,800 tons (6,500 yd3) of phossy waste material (precipitator slurry). It was isolated for drying in June of 1976, and covered with dirt and slag in the latter part of the year.	0.8	6,500	na	na	na	>1,000 ppm	No	W159 (Up)	Reducing conditions Eh: W159 = -119
5S	Phossy water and phossy solids. Pond 5S received primarily phossy water and phossy solids, creating a residual waste with a very high phosphorus content. This pond had an area of about one acre (43,560 ft2) and contained residual slurry to a depth of about 6.4 feet. This pond was in operation from 1965 through 1967. Closed and dried in 1975-76, it proved difficult to dry due to the high phosphorus content of the waste. It was covered with baghouse dust, dirt, fluid bed drier prills and dust, slag, and a soil cap over the top. It is estimated that about 10,200 tons (8,500 yd3) of phossy waste material remains in this former pond area.	1	8,500	na	na	No	>1,000 ppm	No	W141 (Dn)	Eh in W141 = -17 mV

Table G6: OLD PHOSSY WASTE POND INFORMATION

Pond	Material Received/History (from Appendix M of EMF RI Report and RI Update Memo)	Area (acres)	Est. Volume (yd3)	EMF RI soil and GW well borings within pond footprint	Were phossy pond solids encountered in boring/drilling?	Was P4 evidenced during boring/drilling?	Estimated P4 level	Is old pond overlain by a newer, capped RCRA pond?	Closely-spaced GW well Up = upgradient Dn = downgradient	Eh difference in upgradient and downgradient wells
6S	Precipitator slurry solids, phossy water and phossy solids. Pond 6S was about twice the size of any of the earlier ponds, with a surface area of about 2.3 acres (100,200 ft2), and a depth of about 4 feet. This pond operated from 1967 through 1969 and received primarily precipitator slurry, with some phossy water and phossy solids. The phossy solids were placed in the northeast corner. This pond was dried in 1976, capped with slag and dirt, and a new haul road was constructed over the south end of the area. It is estimated that about 29,500 tons (24,600 yd3) of phossy waste material remains in this former pond area.	2.3	24,600	F055B, F056B, F057B, F058B, F059B, W156	Yes (F056B @ 7' bgs, F057B @ 7' bgs, F058B @ 9' bgs, F059B @ 10' bgs, W156 @ 15' to 25' bgs)	No	<1,000 ppm	RCRA Pond 8S partiall covers south end	W151 (Up), 156 (within)	Eh in W151 = 18, W156 = -182
7S	Precipitator slurry solids with some phossy solids. Constructed in 1969 and in service for about 18 months, Pond 7S, at 3.6 acres (156,800 ft2), was the largest pond placed in service to that date. This pond received primarily precipitator slurry. When closed in 1980, there were some areas where there were high concentrations of phosphorus. These areas were capped with concrete. The entire area was then capped with 6 to 10 feet of slag and three feet of soil placed over the slag. This area is estimated to contain about 21,800 tons (18,200 yd3) of residual phossy wastes.	3.6	18,200	W155	No	No	>1,000 ppm	No	W159 (Dn)	Reducing conditions Eh in W159 = -119 mV
8S[4]	Phossy water and phossy solids, some precipitator slurry solids. Pond 8S was constructed in October 1970 and received phossy water. This pond was also used in a pilot phosphorus recovery project from 1982 through 1990. Pond 8S has a surface area of about 3.1 acres (135,000 ft2) and has about 15 feet of phossy wastes in the bottom. The volume of these wastes is difficult to estimate, as they have not been dried and capped as the other ponds have been. The volume after capping will probably be similar to that of Pond 7S, which is of similar size. The wastes in Pond 8S are high in phosphorus content. Pond 8S has been capped and certified closed under RCRA Interim Status Standards and is in post-closure care.	3.1	90,350	na	na	na	>1,000 ppm	RCRA Pond 8S is capped. Closure has been certified. The unit is in post-closure care.	W150 (Dn), W152 (Dn); B-13 (Dn), W155, W156, W157	Strongly reducing conditions (Eh in downgradient wells approx. -239 mV) W155=6.8, W156=-182, W157=-217
9S	Dried precipitator slurry solids..The four-acre (174,250 ft2) Pond 9S was constructed in 1971 to receive precipitator slurry. The pond operated until about 1974. In October of 1980, the material was dried in place without a cover, and the dried material was excavated and sold during the summer of 1981. This area was used as a storage area for dried precipitator dust between 1981 and July 1991. FMC discontinued the sale of precipitator dust as a product in July 1991. Some small local pockets of precipitator slurry may remain in this area, but in general, the material has been removed and sold.	4	0[1]	B-2, F034B	Yes (B-2 @ 2' to 5' bgs)	No	<1,000 ppm	No	W131 (Up); W132 (Dn)	Eh in W131 = 113 mV; W132 = -15 mV
10S	Fluid bed dryer slurry. A former pond for storage of precipitator slurry before processing in the fluidized bed dryer process, which ceased operation in 1986. Remaining precipitation slurry in pond has dried out and crusted over. No precipitation dust has been piled atop the dried pond 1.7 acres; single lined with no leak detection system.	1	8,050	na	na	na	<1,000 ppm	No	W135 (Dn)	Eh in W135 = 86 mV
1E	Phossy water and carryover fine solids from upstream ponds, precipitator slurry solids and dried slurry. Pond 1E was constructed in April of 1965 and had a variety of uses. This 1.9 acre (82,750 ft2) pond was used as a drying pond for various wastes, and for temporary storage of dried precipitator slurry. The pond was dried in October of 1980, but was used again as a temporary storage and loadout site for dried precipitator slurry dredged from ponds 8E and 9E. This area is estimated to contain about 10,800 tons (9,000 yd3) of residual phossy waste materials.	1.9	9,000	B-1, F033B	Yes (B-1 @ 0' to 4' bgs)	No	<1,000 ppm	RCRA Pond 8E covers north portion	W167 (Up)	Data Not Available
2E	Phossy water and carryover fine solids from upstream ponds. Former Pond 2E was a 3.3 acre (143,750 ft2) pond established in April 1965. It received phossy water and carryover fine solids from upstream ponds until October 1967. The site was also used for fluid bed drier product storage. This pond was excavated in 1984 for the construction of lined Pond 8E. The residual slurry materials were moved to nearby Pond 4E.	3.3	0[1]	na	na	na	<1,000 ppm	RCRA Pond 8E covers entire area	W103 (Dn); W104 (Dn)	Oxidizing conditions Eh: W103 = 209 mV; W104 = 151 mV

Table G6: OLD PHOSSY WASTE POND INFORMATION

Pond	Material Received/History (from Appendix M of EMF RI Report and RI Update Memo)	Area (acres)	Est. Volume (yd3)	EMF RI soil and GW well borings within pond footprint	Were phossy pond solids encountered in boring/drilling?	Was P4 evidenced during boring/drilling?	Estimated P4 level	Is old pond overlain by a newer, capped RCRA pond?	Closely-spaced GW well Up = upgradient Dn = downgradient	Eh difference in upgradient and downgradient wells
3E	Phossy water and carryover fine solids from upstream ponds. Pond 3E was put into service in May 1967 and received phossy wastes until September 1970. With a surface area of 10.4 acres (453,000 ft2), this was the largest unlined pond constructed at the facility. The pond received phossy water and carryover fine solids from upstream ponds. Some of this material was removed and sold. This pond was excavated for the construction of the lined Phase IV Ponds (11S, 12S, 13S and 14S) in 1980.	10.4	0(1)	na	na	na	<1,000 ppm	RCRA Phase IV Ponds cover entire area	W131 (Dn)	Reducing conditions Eh in W131 = -113 mV
4E	Phossy water and carryover fine solids from upstream ponds, precipitator slurry solids overflow. Pond 4E was also put into service in May 1967 and received phossy wastes periodically until 1982. Pond 4E had a surface area of about 1.8 acres (78,400 ft2). The pond received precipitator slurry overflow, residual solids from Pond 2E modifications, carryover fine solids from upstream ponds, and slag-contaminated dried precipitator dust. The site was also used for fluid bed drier product storage. This pond was dried in 1980 and the dried material was sold. As described above, the area was used occasionally for storage of waste materials between 1980 and 1982. This area, adjacent to the southern boundary of the Phase IV ponds (11S-14S), is estimated to contain about 34,850 tons (29,000 yd3) of residual phossy waste materials. The area has not been capped.	1.8	29,000	F024B	No	No	<1,000 ppm	No	na	na
5E	Phossy water and very minor carryover fine solids from upstream ponds. Former Pond 5E was a 6.6 acre (287,500 ft2) pond established in April 1968. This pond received wastes until 1972-1973. The pond received phossy water and minor carryover fine solids from upstream ponds. The pond was dried in October 1980, and 4 to 6 inches of dried gray dirt was removed and placed in the area just south of lined Pond 15S. New pond 15S was constructed in 1982 over former Ponds 5E, 6E, and the eastern portion of Pond 7E.	6.6	0(1)	F025B, W114	Yes (W114 @ 0' to 5' bgs)	No	<1,000 ppm	RCRA Pond 15S covers majority of area	W113 (Dn), W114 (Dn) W115 (Dn), W166 (Dn)	Eh: W113 = 72; W114 = -52; W115 = 23; W166 = Data Not Available
6E	Phossy water and very minor carryover fine solids from upstream ponds. Former Pond 6E was a 6.7 acre (291,800 ft2) pond established in November 1968. This pond operated in the same manner as Pond 5E, receiving wastes until 1972-1973. The pond received phossy water and minor carryover fine solids from upstream ponds. The pond was dried in 1981 and as described above, new lined Pond 15S was constructed in 1982 over former Ponds 5E and 6E.	6.7	0(1)	F026B, F101B, F101R, W129; W130	Yes (F101R @ 0' to 0.5' bgs)	No	<1,000 ppm	RCRA Pond 15S partially covers area	W129 (Dn); W130 (Dn); W137 (Dn), W165 (Up)	Oxidizing conditions Eh: W129 = 188; W130 = 216; W137 = 191; W165 = Data Not Available
7E	Phossy water overflow from upstream ponds. Pond 7E was a 4.3 acre (187,300 ft2) pond constructed in December 1969. This pond received overflow phossy water from upstream ponds. No solids were observed in this pond. In 1982 Pond 7E was partially excavated and the excavated materials were used in the construction of Pond 15S.	4.3	0(2)	F162B, W170, W172, W180, W182	No	No	<1,000 ppm	No	W170 (Dn), W171 (Dn), W172 (Dn), W180 (Dn), W181 (Dn), W182 (Dn)	Data Not Available

(1) Material was removed and placed in another pond,or sold and only thin layer of dried material remained. New ponds were constructed over all or part of the area occupied by this pond.

(2) Pond 7E was an overflow pond. Most of the pond was removed during the construction of Pond 15S.

(3) Area 9S was a former unlined pond that was excavated and used as a storage area for precipitator slurry solids. The volume of dried precipitator slurry solids remaining in the area is shown.

(4) RCRA Waste Management Unit closed under RCRA Interim Status Standards; in RCRA Post-closure Care status. Data included for comparison purposes to illustrate potential influence of unlined S-series pond that recently contained free liquids

General Comment #7

The RI Update Memo should include a discussion regarding how existing groundwater sampling data could be used as part of the focused feasibility study to evaluate the effectiveness of caps that had been installed in areas determined to have been under a sustained hydraulic head. This may have an impact on the groundwater sampling design portion of the supplemental remedial investigation (SRI) and feasibility study.

FMC Response:

Although the data from FMC's on-going groundwater-monitoring program is indicating an improvement in groundwater quality at certain areas of the FMC Plant OU since the EMF Site RI, including downgradient from former unlined Pond 8S, the improvement in groundwater quality is predictable based on elimination of the hydraulic head independent of the type of cap ultimately placed on the pond. The Pond 8S Solute Transport Model (FMC 1993) demonstrated that a substantial period of time will transpire following elimination of sustained head from Pond 8S before the migration of residual COPCs present in deep fine-grained soils above the shallow aquifer diminish to levels at which groundwater quality in the shallow aquifer would reach MCL levels. The cap installed above the wastes has minimal influence on the migration of COPCs from these fine-grained soils into the shallow aquifer, once the major "driving force" (sustained hydraulic head above pond sediments) is removed during the initial phase of pond closure. The primary function of the cap is to act as a barrier to potential exposure to the wastes and prevent/minimize long-term infiltration into the wastes.

Thus, FMC cannot support the proposition that groundwater monitoring and evaluation is a meaningful exercise for the purpose of evaluating cap designs in the SFS as is suggested by the comment. Rather, per the 1998 ROD[1], groundwater monitoring design, evaluations, and conclusions will be developed and performed under the RDRA and post-remedial action monitoring in the context of confirming the effectiveness of implemented remedial actions (i.e., source controls), and, as such, is beyond the scope of the RI Update Memo. No revision of the RI Update Memo is warranted.

General Comment #8

Soil Screening Levels (SSL) were not developed for a number of chemicals of potential concern (COPCs) that have been identified as COPCs for Supplemental RI/FS, including fuel oils, solvents, and polychlorinated biphenyls (PCBs). FMC must develop and present a comprehensive list of SSLs for all identified COPCs in accordance with current EPA guidance.

[1] The EMF ROD states: "Groundwater monitoring will continue and be integrated, to the extent practicable, with the RCRA groundwater monitoring program. EPA will periodically review ground water data with the following goals: (1) insure the source control measures at the old phossy waste ponds, calciner solids, and railroad swale are effective, (2) Insure there are no new sources of contamination from existing or new hazardous waste surface impoundments or landfills, (e.g., Pond 9E, Phase IV Ponds, Pond 15S, Pond 8E and the lined calciner ponds), and (3) confirm eventual achievement of MCLs or RBCs."

FMC Response:

FMC will develop SSLs (RBCs) for PCBs and the organic chemical constituents of fuel oils and solvents that have previously been detected in soil samples obtained from the FMC Plant OU, recognizing that some of these constituents may be within the CERCLA petroleum exclusion. The specific compounds for which SSLs will be developed are: 1,1,1-Trichloroethane, Aroclor 1260, Chloroform, Ethylbenzene, Tetrachloroethene, Toluene, Trichloroethene and Xylenes. These SSLs will serve as a basis for evaluating existing data and to support evaluation of analytical data to be obtained during the supplemental remedial investigation. FMC will provide these SSLs in a subsequent deliverable.

General Comment #9

The text must be revised to include an uncertainty discussion with regards to the development of SSLs for soils. This discussion must include, but not be limited to, uncertainties associated with utilizing site-specific parameters and EPA default parameters to develop SSLs.

FMC Response:

As discussed in greater detail within the response to Specific Comment 42, Section 4 of the December 2004 RI Update Memo has been revised to include a discussion of the uncertainties associated with the assumptions incorporated into the development of soil screening levels (SSLs). This discussion will include, but not be limited to, uncertainties associated with utilizing site-specific and EPA default parameters in the SSL calculations.

General Comment #10

The RI Update Memo must provide a waste characterization based on process knowledge to document the waste characteristics and waste volumes associated with the railcars assumed to be buried beneath the slag pile. The buried rail cars could be a potential source of groundwater contamination. Existing data must be compiled in order to assess groundwater flow direction. If, based on this review, new groundwater monitoring wells are needed they should be installed and sampled for EMF related contaminants for the purpose of monitoring the groundwater beneath the slag pile. Groundwater data gaps must be identified in the RI Update Memo. If new wells are required they must be installed and sampled as part of the SRI.

FMC Response:

The December 2004 RI Update Memo has been revised to include the following discussion on the characterization of plant sludge that was contained in the rail cars:

> "Phosphorus sludge present in the buried railcars is an emulsion of P4, water, and 'dirt.' P4 globules suspended in water will join and form a continuous layer of elemental phosphorus at the bottom of collection sumps and storage tanks. In the presence of high dissolved solids in water, or impurities (i.e., dirt) carried in the furnace gas stream, the P4 globules cannot bind together and form a continuous layer of P4.
>
> Phosphorus sludge formed when the dissolved solids (ions) and suspended dirt "coat" the P4 globules. This coating prevented the coalescing of P4 globules by preventing the globules

from contacting each other. As a result, the globules remained in suspension, forming an emulsion with the water.

Ions and charged dust particles adhere to P4 globules in low pH environments, so sludge formation was more prevalent at pH <3, but would also form at higher pH if there was sufficient dust and ions in the water.

Another factor that influenced sludge occurrence is the rate of cooling in the primary condenser. Faster cooling rates led to smaller P4 globules, which would not coalesce as readily as larger globules.

The sludge buried in the railcars was excess sludge generated in 1962 to 1964 when the FMC furnaces and/or condensers were not operating optimally. There were too many impurities in the process not allowing P4 product to adequately settle out. Instead, a significant quantity of P4 globules was emulsified into sludge. Excess phosphorus sludge was temporarily stored in 30 railroad tank cars, specifically purchased for this storage. After process improvements had been implemented to reprocess phosphorus sludge (e.g., centrifuge) and lower plant sludge production, FMC personnel emptied all 30 railcars to recover P4 product but left the phosphorus sludge in the railcars for expected removal during subsequent railcar cleaning.

After P4 product recovery was completed and the railcars were no longer needed for storage, nine of the 30 railcars were completely cleaned of phosphorus and phosphorus sludge and these cleaned railcars were sold for scrap. However, several "near miss' safety incidents associated with cleaning of these railcars in 1964 resulted in a decision not to attempt to clean but rather to bury the remaining 21 railcars at the south end of the slag pile (per the configuration of the slag pile in 1964). In the late Fall of 1964, the remaining 21 railcars were removed from their trucks, hauled to the slag pile, and buried with clay, then covered by slag. Subsequently, the railcars were further buried under the east slag pile as it advanced south. The location of the buried railcars is currently covered with a minimum of approximately 50 feet and a maximum of over 100 feet of slag.

The location of these buried railcars is documented in an aerial photo taken in June 1965, which shows seventeen identifiable, partially buried railcars. The tank dimensions are 30' in length by 9.5' in diameter. This yields a volume of 1703 cubic feet per rail car. The aggregate volume of all 21 railcars would be 1,325 cubic yards [(21 x 1703) / 27 cubic ft per cubic yd]. Current FMC personnel familiar with phosphorus reprocessing activities believe that the railcars may have contained phosphorus sludge at 50% to 75% of the railcar capacity. Thus, the amount of buried phosphorus sludge may range from 662 cubic yards (if 50% full) to 1,325 cubic yards (if 100% full)."

FMC has conducted groundwater monitoring throughout the FMC Plant OU and RCRA units since 1990. FMC believes that numerous data are available to assess groundwater flow direction associated with the Slag Pile, as noted above. During the past 14 years, wells located downgradient from the slag pile and buried railcars have shown no indication of contamination emanating from this area. Groundwater flow patterns, hydraulic relationships between shallow and deep hydrogeologic units, flow rates, and the nature and extent of contamination have all been characterized and monitored (see Sections 3.3, 4.4, 5 and Appendix K of the EMF RI Report, and "Revisions to RCRA Corrective Action Environmental Indicators" submitted by

FMC to EPA in 2002; and in annual RCRA GW assessment reports submitted since 1993). The 14 years of groundwater monitoring data, coupled with extensive efforts to model and characterize groundwater flow and contaminant transport, indicate no evidence that the buried railcars in the slag pile are a source of contamination to groundwater and there are no data gaps with respect to implementation of the groundwater remedy selected in the 1998 ROD for the FMC OU.

FMC believes that additional characterization of the railcars as a source to groundwater would not alter implementation of the presumptive remedy proposed by FMC.

General Comment #11

Slag Pile Dose Survey. In addition to gross gamma measurements proposed for the slag pile, gross alpha data must also be collected.

FMC Response:

FMC has not revised the RI Update Memo as requested in EPA comment. FMC does not understand how the collection of additional gross alpha measurements of slag or gamma radiation measurements will contribute to remediation design. FMC's remediation vision, as presented in the RI Update Memo, is to cover the Slag Pile to prevent future site workers from exposure to radiation and from potential fugitive dust emissions. The RI Update did not propose to collect additional gross alpha or gamma radiation measurements at the Slag Pile, since existing data already support the proposed remedial action. The gamma radiation measurements made at the Slag Pile were used as input into the MicroShield™ modeling that demonstrated that the 12-inch soil cap design in the 1997 Feasibility Study meets the RAO for controlling gamma radiation exposure.

Part 2. Response to Specific Comments

1. Executive Summary, Page ES-1

Although the 1998 ROD concluded remedial action is necessary for certain units, these remedies were based upon the premise that FMC continued operation of the facility. An evaluation of whether adequate data exists for final remedy design must be included in the RI Update Memorandum.

FMC Response:

The Executive Summary has been revised to note that the assessment of data adequacy reflects the assumption that FMC will not continue to operate the facility. However, this assumption was already embodied in the June 2004 draft of the RI Update Memo. The Conceptual Site Model (Section 2) assumed that the facility property will be reused for a commercial and/or industrial purpose by an entity other than FMC. Data available for each remediation unit were evaluated in Section 6 based on this future land use assumption, and data gaps were identified as input to the scope of the SRI Work Plan.

While the 1998 ROD assumed that FMC would continue to operate the facility, the selected remedies are not restricted by this assumption. Remedies were selected for areas that were not associated with ongoing operations, such as the former phossy waste ponds (designated as RU 22b in the RI Update Memo), and for FMC OU-wide groundwater. Remedies were evaluated at additional areas, such as the slag pile, but were not selected in light of FMC's continued operation of those areas in association with elemental phosphorus production. A notable example is the slag pile (now designated as RU 19), where EPA found that while remediation (i.e., capping) would be appropriate under EPA's default future land use assumptions, FMC's ongoing administrative controls while operating were protective of human health and the environment. The SFS will evaluate methods to ensure that the previously selected remedies, as well as additional remedies at other RUs, are monitored and maintained by FMC in the absence of an on-site industrial manufacturing operations department.

Notwithstanding these observations, FMC believes that the RI Update Memo and the subsequent SRI Work Plan will provide an evaluation of whether adequate data exist for final remedy design. The RI Update Memo identifies two types of data needs: (1) additional site characterization data needed to determine if remedial action is warranted at various RUs, and (2) engineering data needed to develop or refine remedial designs for RU that warrant remediation. Examples of the latter type of data needs are leachability testing of calciner solids (RU 16) to support designing a cover that sufficiently minimizes infiltration, and the 44°C isotherm modeling study and confirmatory soil sampling at RU 1 and RU 2 to ensure that the area to be capped has been conservatively identified.

2. Section 2, Figure 2-10: Conceptual Site Model for Potential Human Exposure to Contaminants at the FMC Operable Unit

The CSM must be updated to include not only slag, but other waste materials such as precipitator dust and calciner fines that have been used as fill.

FMC Response:

Please see the revision to Figure 2-10. Please note, however, that neither precipitator dust nor calciner fines were used as construction fill. Rather, precipitator dust was occasionally spread on internal plant roads during winter conditions as a means to enhance vehicle traction. Calciner fines have been placed in unlined stockpiles south of the Calciner Ponds.

3. Section 2, Figure 2-10: Conceptual Site Model for Potential Human Exposure to Contaminants at the FMC Operable Unit

This figure must be modified to include infiltration/percolation as a possible primary release for areas operated without sustained hydraulic head. As stated in Specific Comment #10, this release mechanism depends on the timing and magnitude of infiltration, the magnitude and extent of the contaminant source term, the nature of the contaminant, and the hydraulic properties of the vadose zone. For many of the sites, this mechanism may be slow given site conditions and the nature of contaminants present, so no adverse impacts to groundwater are likely to occur. These issues must be described in the text.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004. In the proposed revisions, FMC recognized several potential sources to groundwater where a sustained hydraulic head was not applied. These changes are reflected in the CSM and in the text of Section 2 and Appendix A.

4. Section 2, Figure 2-10: Conceptual Site Model for Potential Human Exposure to Contaminants at the FMC Operable Unit

Former plant landfill (RU 19) does not appear to be listed and must be included under Primary Sources in the CSM.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004. The Former Plant Landfill in RU 19 has been added to the CSM as a primary source.

5. Section 2, Figure 2-10: Conceptual Site Model for Potential Human Exposure to Contaminants at the FMC Operable Unit

It is unclear why infiltration/percolation has been removed as a secondary release mechanism for areas operated with sustained hydraulic head. If the CSM has been drawn to take account of the remedial actions already in progress at these sites, data has not been presented to demonstrate that the remedies are fully effective at preventing contaminants in the vadose zone from migrating to the aquifer. The document must be revised to include the potential secondary release mechanism, with a footnote indicating that a remedial action (containment remedy) has been implemented to minimize these releases.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004.

6. Section 2, Figure 2-9: Excerpts from EPA Presumptive Remedy for CERCLA Municipal Landfill Sites

Add a line item to this table that includes an excerpt of the five typical primary response action objectives of the landfill presumptive remedy. These are found listed in Section 4 of the presumptive remedy guidance document (U.S. Environmental Protection Agency, 1993a). Note that the third response action objective is minimizing infiltration and resultant contaminant leaching to groundwater. This is a necessary component of the design for RUs 18 and 19, because of the uncertainties described in Specific Comment #10.

FMC Response:

The following response action objectives from the referenced EPA document have been added to Figure 2-9:

- Preventing direct contact with landfill contents;
- Minimizing infiltration and resulting contaminant leaching to ground water;
- Controlling surface water runoff and erosion;
- Collecting and treating contaminated ground water and leachate to contain the contaminant plume and prevent further migration from source area; and
- Controlling and treating landfill gas.

7. Section 2, Table 2-4, Comment 1, Comment Set 2

A recent study conducted by the Montana Department of Environmental Quality (Montana 2003) on slag from the Rhodia elemental phosphorus plant has shown that approximately half of the gross alpha activity in slag is attributable to radium-226. During the 1992 FMC RI, gross alpha levels at several road and slag fill sites were measured at levels greater than 200 pCi/g. Extrapolating the Montana 2003 results to FMC slag indicates that the radium-226 activity in slag could be in the range of 100 – 175 pCi/g. The RI Update Memo must be revised to identify radionuclide characterization of slag and other waste fill materials as a data gap.

FMC Response:

Please refer to the response to EPA's General Comment 3 and 4, and Specific Comments 30 and 31, which recognize the need to 1) further characterize the extent of radiological impact through gamma radiation measurements and 2) to characterize the extent of lead-210 in roads where precipitator dust may have been used during winter conditions to enhance traction. Revisions have been made to the December 2004 RI Update Memo in the appropriate sections.

However, FMC believes that the extrapolation of Montana data to radium-226 activities in FMC slag is inconsistent with analytical data. In EPA's 1977 study of radionuclides in FMC's

feedstocks, byproducts, and waste materials (cited in the response to EPA General Comment 3 and 4), uranium-238 activities ranged from 18.6 to 29.4 pCi/g, and radium-226 activities ranged from 22.8 to 33.3 pCi/g. Gross alpha activities in slag samples were not determined in EPA's study. However, summation of alpha activities for the alpha-emitting radionuclides in slag samples analyzed by EPA results in gross alpha activities ranging from 162 to 229 pCi/g.

Uranium-238 activities in FMC slag samples analyzed during the EMF RI ranged from 22.1 to 30.7 pCi/g, and gross alpha activities in these slag samples ranged from 179 to 240 pCi/g. The similarity of uranium-238 activities between EPA's data and FMC's data, the actual radium-226 activities detected in EPA study, and the similarity in actual and calculated gross alpha activities indicates that the radium-226 activities extrapolated from the Montana data are not characteristic of FMC's slag. Moreover, it is unlikely that 50% of the gross alpha activity in the Montana slag would be attributable to radium-226. One should ask if the contribution to gross alpha from other alpha-emitting radionuclides in the uranium-238 decay series (such as U-234, Th-230, Po-210) were considered in reaching the cited conclusion. Perhaps some or all of these other radionuclides were not reported in the Montana data.

The decay of a Ra-226 atom would contribute 4 alpha particles (Ra-226 itself plus its short-lived alpha-emitting daughter products Rn-222, Po-218, Po-214) toward a gross alpha measurement. Without knowing the gross alpha activity of the Rhodia slag sample, we cannot estimate the Ra-226 activity. However, given the previous factor, it is more likely that the Ra-226 activity in the Rhodia slag is approximately 25 pCi/g rather than 100+ pCi/g.

8. Section 2, Table 2-4, Comment 5, Comment Set 2

Table 2-4 provides responses to EPA comments on the draft outline for the updated CMS. The response to comment 5 is inadequate because stormwater and sewer pipelines are not included in any RUs or the CSM. The document must be updated to include these items.

FMC Response:

Table 2-4 has been revised to show the storm drain in RU 4 and phossy water piping in RU 2 as potential release points in the CSM.

The RU's with underground process piping and sewer lines were discussed in Section 6 of the RI Update Memo. These features were identified as potential sources and the associated data gaps sections identify the need for additional data to characterize these features. Specifically, RU 1, RU 2, RU 12, RU 13, RU 4 (storm drain), and RU 22b had associated data gaps relating to underground piping. FMC proposed removal or capping the underground piping, depending on the RU. For RU 4, FMC has proposed a video survey of the storm drain.

9. Section 2, Page 2-1, last paragraph

The 1998 Record of Decision (ROD) does not restrict land use in the vicinity of the railroad swale. The ROD did not evaluate or discuss the hazard due to elemental phosphorus. Since elemental phosphorus was encountered in this area during the 1991 RI, the railroad swale must be reassessed in the SRI to ensure the remedy selected in the 1998 ROD is protective for future site uses.

In addition, an evaluation of all areas and remedies identified in the ROD needs to be included in the RI Update Memo to ensure that the remedies identified in 1998 will be protective for future site users.

FMC Response:

Actually, the 1998 ROD does specify that FMC implement legally enforceable land use controls to prevent possibility for future residential use of the FMC plant area including the railroad swale. However, the 1998 ROD did not specify institutional controls to prohibit subsurface intrusion within the lined (or capped) area at the RR Swale. FMC believes that this is the type of land use restriction contemplated in EPA's comment.

FMC believes that subsurface-intrusion prohibitions, which are a common element of land use controls recorded for the RCRA pond closures, are appropriate and consistent with FMC's capping remediation vision for the Railroad Swale (RU 22c). Section 2 of the RI Update Memo has been revised to note this.

FMC believes that the latter part of EPA's comment "…an evaluation of all *areas and remedies* [emph. added] identified in the ROD needs to be included in the RI Update Memo to ensure that the remedies identified in 1998 will be protective for future site users" requires information that is beyond the scope of the RI Update Memo. As noted in item 1.5 of the Statement of Work for the Supplemental Remedial Investigation / Supplemental Feasibility Study for the FMC Plant OU, the scope of the RI Update Memo is to:

1. Compare existing site characterization data to existing RBCs (including a proposed RBC for P4);
2. Identify the rationale for excluding any areas for further evaluation;
3. Identify areas for which data gaps exist and identify data needs for these areas
4. Identify characterization data for areas where adequate data exists to proceed with evaluation in the SFS, and
5. Assess potential ecological risks within the undeveloped areas of the FMC Plant OU for Cd, F, Zn, V, and Cr.

The RI Update Memo already includes evaluation of post-ROD activities and releases that may have influenced the nature and extent of impact at *areas* previously identified in the ROD. This evaluation found, for example, that additional releases of P4 to the Railroad Swale (RU 22c) occurred subsequent to the 1998 ROD, and that additional site characterization is needed to evaluate the scope of a capping remedy at this source area.

An evaluation of the continued protectiveness of the *remedies* identified in the 1998 ROD is an appropriate element of the Supplemental Feasibility Study (SFS). Consequently, FMC has not revised the RI Update Memo to present an evaluation of the protectiveness of remedies identified in the 1998 ROD.

10. Section 2.2.1, Pages 2-7 & 2-8, Areas Operated without Sustained Hydraulic Head

As stated in comments on the Scoping and Planning Memorandum and as we have discussed in subsequent meetings, the contention that all sites grouped under the category of "Areas operated without Sustained Hydraulic Head" could not adversely affect groundwater is not supported by the information available. Infiltration of precipitation through contaminated source areas and site soils in the vadose zone could transport contaminants to the aquifer. The potential for aquifer contamination above risk based concentrations resulting from this release mechanism depends on the timing and magnitude of infiltration, the magnitude and extent of the contaminant source term, the nature of the contaminant, and the hydraulic properties of the vadose zone. Most of the RI sampling consisted of sampling for heavy metals, fluoride, and total phosphorus. These contaminants tend to adsorb to soil particles and not migrate quickly through the vadose zones, unless soil pH is low. However, other contaminants (such as some of the organic compounds) would be much more prone to migration resulting from infiltration.

Few samples were collected for organic analyses in the RI. For example, only one boring was completed in active landfill site RU 18, and there was no sampling conducted at the old landfill in RU 19 because the waste zone is inaccessible. Since a laboratory was operated at the facility and organic constituents were encountered during closure of the RCRA drum storage area organic contaminants are known to be have been present at the facility. At the chemical laboratory seepage pit (in RU 5), toluene was detected at every depth in soil boring F028B (ranging from 31 to 159 ppb), and two of the depth horizons sampled (0 and 20 feet) in the other boring (F029B). Several other organic compounds, including TCA (F028B), xylenes (F029B) and ethylbenzene (F029B) were detected at a depth of 70 feet. Several inorganic contaminants were also detected at elevated concentrations at depth in these two boreholes (EMF RI, pages 4.2-120 through 121). Organic compounds were also detected at various depths in samples collected from the boring completed in the active landfill. Compounds including toluene, xylenes, and ethylbenzene, among others, were detected in soils beneath this landfill. The RI asserted that the organic compounds detected could be laboratory contamination; however, several of these organic compounds were not detected in corresponding blank samples. Although no samples were collected from the former plant landfill, process knowledge suggests that the former plant landfill in RU 19 is likely to contain a greater volume of spent solvents compared to RU 18 (RI Update Memo, Section 6). Hence the contaminant source term that would be prone to leaching could be larger than what exists at RU 18.

Therefore, on the basis of process knowledge and the limited data for organic contaminants collected during the original RI, there appears to be potential for contaminant migration from the waste zones under conditions without sustained hydraulic head. The conceptual site model must be revised to include this. For landfill sites RU 18 and 19, the CERCLA presumptive remedy for municipal landfills, with the response action objective of minimizing infiltration and resulting contaminant leaching to groundwater, must be applied. The long-term remedy must include groundwater monitoring at these sites to assess the effectiveness of the landfill containment remedy. The SRI or SFS should assess whether the existing well network is appropriately located to intercept groundwater flow from the landfills. Additionally, the SRI should evaluate such sites as the chemical laboratory leaching pit, and the disposal area behind the laboratory, to

determine whether there could be adverse impacts to site groundwater from infiltration/leaching of more mobile contaminants at these sites.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004. Revisions were made to the CSM, Section 2 text, and Section 6 text to address this comment. The December 2004 RI Update Memo now reflects the uncertainties relating to potential sources with intermittent applied head and/or potential free liquids, and their potential for being sources to groundwater.

11. Section 2.2.1, Page 2-6

The RI Update Memo must include a discussion of the Industrial Waste Water (IWW) sediments and the former carbon monoxide (CO) flare pit, and other units now buried at the facility.

FMC Response:

Section 2.2.1 of the RI Update Memo presents an update for potential sources that were not described in the original conceptual site model for the EMF Site and changes in the characteristics of several potential sources that were included in the original conceptual site model.

The original conceptual site model identified the IWW Ditch as a primary potential source and surface water and sediment as related exposure media. The IWW discharge to the Portneuf River was terminated in August 2002, as noted in the RI Update Memo. Consequently, the updated CSM does not identify the IWW Discharge as a point source. The updated CSM in the June 2004 RI Update Memo did recognize residual sediments (i.e., soils) within the IWW ditch and IWW Basin as potential sources. However, the discussion of the IWW discharge in the RI Update Memo has been expanded to clarify that residual sediments within the IWW Ditch and IWW Basin are classified as potential (soil) sources in the updated CSM.

FMC believes that the former carbon monoxide flare pit was included within the "Stacks and Vents" source identified in the original conceptual site model (see EMF ROD, Figure 23). However, for clarification, FMC has revised Section 2.2.1 of the RI Update Memo to update information specific to the former CO Flare Pit. The discussion will note that air emissions from this unit terminated in June 2000, and that the slag berm surrounding the former Flare Pit and slag within the perimeter of the pit were removed down to native soil.

FMC is not aware of any units now buried at the facility that were not already identified in the June 2004 draft of the RI Update Memo.

12. Section 2.2.2, Page 2-8, Infiltration/Percolation, Last Sentence

As discussed in comment 3 and 10, it appears that infiltration/percolation is a viable release mechanism for sites operated without a sustained hydraulic head. Inorganic contaminants have also been shown to have migrated from waste sites under conditions without sustained hydraulic head (e.g., RU 16: Calciner Solids Stockpile; RU-5 Chemical Laboratory Seepage Pit). Figure 2-10 must be revised to include, in the list of units, the Slag Pit Wastewater Sump, and areas

within the furnace building and phos dock as having been operated without sustained hydraulic head.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004. Figure 2-10 identifies "seepage/percolation" to groundwater from RU 1 and RU 2 SWMUs and P4 working areas, including the Phos Dock and Furnace Building. Note that the slag pit wastewater sump was operated with an applied head, and including it in the list of units as having been operated without a sustained hydraulic head would be incorrect.

13. Section 2.2.3, Page 2-9

The wastewater currently treated at the Pond Closure Decant Treatment System (PCDT) water treatment system then used for dust suppression is not discussed in the RI Update Memo. The RI Update Memo must be revised to include the areas where the wastewater was used for dust suppression as potential source areas.

FMC Response:

The PCDT water has been applied to roads within the FMC Plant OU. The December 2004 RI Update Memo identifies road segments within RU's and RU 23 as potential source areas, and identifies associated data gaps for all road segments.

Section 6.1.4, RU 23, has been revised to incorporate a discussion on constituent mass loading to FMC Plant OU roadways resulting from the use of PCDT water for dust suppression.

14. Section 2.2.3, Page 2-10, Groundwater

The document must be revised to state that leaching of contaminants from certain sites without sustained hydraulic heads may also impact groundwater quality.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004. These revisions are included in the December 2004 RI Update Memo.

15. Section 2.2.4, Pages 2-10 & 2-11

For development of SSLs and screening purposes, FMC must use 0-10 ft bgs for the future construction worker scenario. For soil characterization purposes FMC indicates that construction workers engaged in excavations for facility construction projects could be exposed to the upper five to six feet of soil. Justification for this site-specific assumption and deviation from EPA's recommended default exposure parameter soil depth interval for construction worker of zero to ten feet (0-10 ft) below ground surface (bgs) must be provided.

FMC Response:

FMC has revised the Construction Worker Exposure scenario to reflect EPA's default soil exposure depth interval of 0 – 10 feet. Appropriate conforming changes were also made in Sections 4, 6, and Appendix C.

16. Section 2.2.4, Pages 2-11 & 2-13, Footnotes 11 & 13

Footnote 11 on page 2-11 conflicts with Footnote 13 on page 2-13. On 2-11, Footnote 11 states that the potential presence of solvent and petroleum hydrocarbon contamination is believed to be restricted to RU 5, 12, 20, and 22b, whereas Footnote 13 on page 2-13 indicates that the this contamination is restricted to RU 20. This discrepancy must be rectified.

FMC Response:

Agreed. FMC has revised footnote 13 to read as does footnote 11.

17. Section 2.3, Page 2-12

Since groundwater is used for irrigation in the area, an assessment of whether use of groundwater for irrigation would be protective for human health and the environment must be included in the SRI and described in the RI Update Memo and associated CSM.

FMC Response:

FMC does not believe that an assessment of whether use of groundwater for irrigation would be protective for human health and the environment should be included in the SRI or described in the RI Update Memo and associated CSM.

Groundwater within the FMC Plant OU has not been used for crop irrigation and such use in the future is unexpected for several reasons. First, engineered covers either have been, or are expected to be, placed over at least 20% of the area of the FMC Plant OU to minimize water infiltration and exposure to underlying waste materials. Agricultural use of these capped areas (with or without irrigation) would be inconsistent with RCRA Closure Plans, remedies identified in the 1998 ROD and anticipated ROD amendment, and the Remedial Action Plan for the Calciner Ponds. Second, many other portions of the FMC Plant OU either have steep or irregular topography and soil conditions that make them unsuited for agricultural use, are paved or occupied by rail tracks, or are covered with slag, which is unsuited to agricultural use. Finally, future use of the FMC Plant OU is anticipated to be commercial or industrial, as noted in the RI Update Memo. Crop production would be inconsistent with commercial or industrial uses of the property. Therefore, the December 2004 RI Update Memo has not been revised.

18. Section 2.3, Page 2-13, Potential Sources, 2nd, Paragraph, 3rd Sentence

The referenced sentence states that, "the RI also found that potential sources that operated without a sustained hydraulic head did not contribute to contamination of the uppermost aquifer." This sentence is too broad. As discussed in Specific Comment #10, the limited data for organic contaminants collected during the original RI indicates that at some sites there has been contaminant migration from the waste zones under conditions without sustained hydraulic

head. Currently, there may not be monitoring wells located appropriately to intercept potential releases from these sites. In addition, the RI Update Memo describes measured groundwater impacts that are believed to have occurred as a result of infiltration/percolation from sites that are shown Figure 2-19 to have operated without a sustained hydraulic head (Appendix A, Page A-5, second bullet). Modify the sentence to acknowledge this uncertainty.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004.

19. Section 2.3, Page 2-13, Potential Sources, 3rd paragraph

In section 2.3 the text states that contamination of surface soils by deposition of former emissions from the FMC and Simplot facilities will be recognized as a secondary source. However, there appear to be no plans to conduct sampling to evaluate the nature and extent of the deposition. As discussed in comment #5, the southern and western portion of the facility have most likely received contaminants from air deposition. The SRI must include soil concentrations in these areas as a data gap requiring additional investigation.

FMC Response:

Please see response to Comment 5. No revisions have been made to the December 2004 RI Update.

20. Section 2.3, Page 2-13, Potential Sources

In section 2.3, potential source areas must be revised to include roads and areas where waste and slag materials were used for fill.

FMC Response:

As stated in the June 2004 RI Update Memo, the EMF RI and other investigations have shown the following: "Fill within the FMC plant area consists mostly of slag. Some areas have ore and slag mixed in the fill, and in a few areas, precipitator dust was observed in the fill material."

21. Section 2.3, Page 2-14, Potential Release Mechanisms, 5th Bullet

This bullet must be revised to state: " Infiltration and percolation into soils and groundwater from unlined waste management units." Infiltration and percolation into soils and groundwater is a potential release mechanism for waste management units operated without a sustained hydraulic head.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004.

22. Section 2.3, Page 2-15, Exposure Medium Groundwater, 1st Paragraph, 1st Sentence

As discussed in specific comment #10, the text must be revised to acknowledge the uncertainty regarding the impact to groundwater from sites with more mobile COCs in areas that have been operated without sustained hydraulic head.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004.

23. Section 2.3, Page 2-15, Groundwater

The text states that FMC and Simplot industrial activities have contaminated the uppermost aquifer. The 1998 ROD states that EMF operations have contaminated the shallow aquifer and the upper levels of the lower aquifer.

Since the FMC plant closure, groundwater is now extracted at a greatly reduced rate. The RI update should include an evaluation to determine the effect this has on groundwater flow.

The SRI must include groundwater data focusing on the following:

- Continuity and integrity of the American Falls Lake Bed aquitard
- Hydraulic relationship between the shallow and deep aquifers at the source area and downgradient areas.
- Deep aquifer water quality monitoring (groundwater sampling) at selected locations.

If inadequate information exists the SRI must be modified to identify this as a data gap and information must be collected during the SRI to assist with development of a long-term groundwater monitoring strategy.

FMC Response:

The RI Update Memo has been revised to include the following text:

> "The EMF RI identified low levels of site-related contaminants in the deeper aquifer in very limited areas of the FMC Plant OU, and at very low concentrations (below MCLs, and only slightly elevated above background levels). The American Falls Lake Beds were delineated beneath the FMC plant area as well as the old pond area (See Sections 3.3, 4.4, and Appendix K of the EMF RI Report).
>
> Vertical gradients were evaluated during the EMF RI and in subsequent groundwater monitoring events. Monitoring well pairs located near the Simplot and FMC production wells displayed upward vertical gradients while the production wells were pumping, with the exception of slight downward gradients in the Shallow/Deep well pair 126/125 near FMC's production well FMC-3. These wells are located in a portion of the FMC Plant OU that has no indication of impacted groundwater quality. The localized and minor downward gradients were directly a result of deep groundwater extraction and would not induce the downward migration of contamination to the deeper aquifer because the shallow groundwater in this area is not impacted. Overall, there was no inducement of downward

gradients from these production wells that could have affected the deep aquifer within the FMC Plant OU. Sections 3.3 and 4.4 of the EMF RI provide further information.

The EMF RI investigated the future scenario where all groundwater pumping ceased at Simplot and FMC. There was no change in the shallow groundwater flow patterns. Capture zones in the deeper aquifer were eliminated and larger volumes of deep groundwater were available for discharge to the river and springs. FMC's groundwater monitoring data collected since the plant shut down in December 2001 support these conclusions.

Because deeper groundwater was not significantly impacted by FMC sources, and because the deeper aquifer has a significantly greater flux of water, downgradient water quality should improve as a result of decreased pumping from the deeper aquifer. This is because the residual contaminants in the shallow aquifer will be diluted by a much greater flux of clean, deep groundwater in the region near the Portneuf River and Batiste Spring.

While the ROD may have stated that it is unclear what effects there may be from cessation of groundwater pumping at the EMF Site, the EMF RI Report presented a model scenario that simulated groundwater flow patterns with facility wells no longer pumping (FMC and Simplot production wells).

As shown in Section 3.3 (Figures 3.3-16 and 3.3-17) and Appendix K of the EMF RI, the primary difference between the scenarios with groundwater extraction vs. no extraction was a higher flux of deeper (clean) groundwater to the river and springs. It was determined that upward vertical gradients between the deeper and shallow aquifer persisted during the RI period, when FMC and Simplot were pumping the deeper aquifer at a maximum rate (875 gpm for FMC wells, 3,300 to 4,000 gpm for Simplot wells). A reduction in pumping rates will add another level of protection to the deeper aquifer by increasing the upward vertical gradients (reducing drawdown in the deeper aquifer)."

The EPA-approved Scoping and Planning Memorandum (FMC, 2004) states that the primary focus of the SRI/SFS is the shallow (<=10 feet) soil or fill. EPA also acknowledges this as the focus of the SFS in the SRI/SFS Consent Order SOW. The comment may not have been written with an understanding of the Statement of Work (SOW) for the SRI/SFS (EPA, 2003), or the approved Scoping and Planning Memorandum (FMC, 2004). The SOW notes: "It is anticipated that the SFS will focus on the Soils/Solids Media, including the soils/solids to groundwater pathway, because the air and groundwater pathways were evaluated on a site-wide basis in the 1997 feasibility study." [Footnote 2 in the RI Update notes that FMC provided EPA a summary of post-RI groundwater monitoring data collected by FMC (Bechtel 2002). These data were consistent with the data presented in the RI Report.]

24. Section 2.3, Page 2-16, 1st paragraph

The text states that worker exposure to contaminated surface and subsurface soils is currently minimized by administrative controls, physical barriers and security systems and states further that the updated CMS assumes the potential exposure pathways applicable to current workers are applicable to future workers. Physical barriers and security systems can not be assumed to be in place for future industrial/worker scenarios. If these measures are necessary to ensure protection of future workers, these measures need to be included as a component to the remedy.

FMC Response:

The need for these measures will be considered in the evaluation of remedial action alternatives in the Supplemental Feasibility Study. No revisions were made to the December 2004 RI Update.

25. Section 2.3, page 2-16, last paragraph

The 1998 ROD does not distinguish between the upper and lower aquifer, while the RI Update Memo implies that the deep aquifer meets MCLs and use of the deep aquifer is not restricted. The ROD requires that use of "the aquifer" be restricted. The ROD needs to be revised to specifically state that the shallow aquifer does not meet MCLs and it's use is restricted if the RI update memo makes this distinction, otherwise the RI update must be revised to be consistent with ROD.

FMC Response:

Section 2 of the RI Update memo has been revised to clarify that the restrictions on groundwater use specified in the 1998 ROD are applicable to both the upper and lower aquifers. FMC did not intend to imply in the June 2004 draft of the RI Update Memo that restrictions were applicable only to the upper aquifer.

26. Section 3.4, Page 3-7

This section does not include a comprehensive summary of waste materials characterization data at the EMF facility. Studies which are missing include the Toluene Insoluble work, the Zimpro pilot studies completed as part of the LDR Treatment Plant project, calciner solids studies, waste water (PCDT) treatment studies. All existing data that would help understand wastes managed at the site and identify contaminants of concern must be referenced.

FMC Response:

Descriptions of the Toluene Insolubles study, the ZIMPRO pilot study, the calciner solids studies, and the PCDT treatment studies have been added to Section 3. The radionuclide speciation data discussed during the 9/15/04 teleconference have also been added.

27. Section 3.3, Page 3-7, SWMU 63

Since no analytical data exists to confirm the clean closure of this unit, soil samples must be taken in the vicinity of the tanks to demonstrate that elemental phosphorus and contaminants of concern associated with product are at levels are below the RBC. In addition, the fill should also be characterized for inorganic and radionuclides.

FMC Response:

Please refer to the discussion of data gaps for RU 6 in Section 6 of the RI Update Memo. Data gaps include a lack of inorganic characterization in shallow (0-10') soils, gamma radiation, and elemental phosphorus.

28. Section 3.4, Page 3-8, Coke Analyses

The text must explain why the TCLP samples of coke from the Kemmerer, Wyoming facility are representative of materials that would be present at FMC in Pocatello.

FMC Response:

In Section 3.3, the intent was to present new or additional data that was not presented in the EMF RI, it was not intended to justify whether or not additional data are needed to characterize certain materials/soils. A more detailed discussion of available data is provided in Section 6 (see below).

In the discussion of data gaps in RU 20, the RI Update Memo identifies the following data gap:

"Characterization of residual coke is needed to support a decision to either forward RU 20 to the SFS or determine that no further action is needed."

Related to RU 7 Coke Handling:

"Coke has not been characterized at RU 7, and the nature of coke used by FMC will be characterized to evaluate a decision of no further action. The vertical extent of the coke will be assessed to determine if mechanical mixing with shallow soils has occurred."

29. Section 4

Exposure to specific radionuclides must be included in the SRI and discussed in the RI Update Memo. The "Soil Screening Guidance for Radionuclides: User's Guide" October 2000, OSWER No. 9355.4-16A, NTIS Order Number (PB2000 963307), and "Soil Screening Guidance for Radionuclides: Technical Background Document" October 2000, OSWER 9355.4-16, NTIS Order Number (PB2000 963306) provide information on soil screening for radionuclides when setting remediation goals at CERCLA sites with radioactive contamination. The "Soil Screening Guidance for Radionuclides: User's Guide" presents standardized exposure parameters and equations for calculating radionuclide preliminary remediation goals (PRGs) for residential land use exposures. These documents have been recently superseded with revised spreadsheets posted on the web. While many areas of the guidance remain unchanged, it is advisable to use the most recent guidance.

Preliminary Remediation Goals for Radionuclides Excel Spreadsheets can be used as a starting point for PRGs. Additional analyses may consider site-specific exposure modifications or comparisons with natural background levels of COPCs (U.S. Environmental Protection Agency, 2002c). The radionuclide PRG guidance and spreadsheets are available from the following web site:

http://epa-prgs.ornl.gov/radionuclides/prg_guide.shtml

FMC Response:

As discussed during both the August 3 and September 15, 2004 teleconferences, and documented within Appendix F of the December 2004 RI Update Memo, FMC has analyzed available radionuclide-specific data that characterize the content of the various feedstocks and waste materials that comprise the contaminant sources at the FMC Plant OU. These analyses have

determined that external exposure to gamma radiation comprises the majority of the risk to future workers for all source materials, except phossy solids.

Consequently, external gamma dose rate measurements will be collected during the SRI, in lieu of radionuclide-specific analyses, in all areas except those found to contain phossy solids. For phossy solids, exposure to lead-210 and polonium-210 via incidental soil ingestion and inhalation of fugitive dusts contributes as significantly to overall worker risk as exposure to external gamma radiation. Consequently, in addition to external gamma dose rate measurements, analyses of lead-210 and polonium-210 will be performed in areas found to contain phossy solids during the SRI.

As also discussed during the September 15, 2004 teleconference, background radiological cancer risk in the EMF study area is greater than 1 in ten thousand ($1x10^{-4}$). Consequently, using the guidance documents referenced in the comment to develop radionuclide-specific soil screening levels (SSLs) at EPA's default target risk threshold of 1 in a million ($1x10^{-6}$) will not help in interpreting the significance of the SRI findings. Instead, as discussed during the September 15, 2004 teleconference and documented in the December 2004 RI Update Memo, the radiological data collected during the SRI will be used to compare potential worker exposure to a target dose threshold of 15 mrem/year above background (equivalent to an incremental cancer risk of $3x10^{-4}$); the same radiological remedial action objective (RAO) established for off-site soils at the Monsanto Soda Springs elemental phosphorus production CERCLA site.

30. Section 4, Page 4-2, 2nd paragraph

The rationale for excluding radionuclides from the RI Update Memo and SRI and relying only on gamma emission data to assess risks at the site is not consistent with EPA guidance. EPA guidance documents should be used as a guideline to develop a RBC for radium-226 and other radionuclides. The SRI must be revised to identify radionuclide concentrations as a data gap and propose data collection for COPCs and an evaluation of radionuclide levels believed to be present at the facility.

It is stated that because the human health risk assessment (HHRA) determined that external exposure to gamma radiation contributed 95% of the total risk from outdoor exposure to radionuclides by future workers in the FMC subarea, gamma radiation dose measurements will be used for screening purposes. This appears to be a modification of the concentration-toxicity screen detailed in RAGS, except that types of radioactive decay (beta, alpha) and exposure routes (particulate inhalation, soil ingestion) rather than COPCs are being screened. This approach regards risk from exposure routes such as inhalation and soil ingestion as insignificant. The RI Update Memo does not demonstrate that this method is appropriate for all areas of the site and types of materials (e.g., slag versus calciner solids stockpile) that might contain different ratios or types of isotopes. Additionally, the HHRA was based on estimated levels of radionuclides as no samples of radionuclides were collected during the 1996 RI. Risks calculated in the HHRA may not be accurate due since radionuclide levels were only estimated and no sampling has been conducted to determine whether the assumptions made at that time are accurate. The RI Update Memo must identify radionuclide specific concentrations/activities as a data gap and identify that data will be collected so risks posed by these COPCs and exposure pathways can be evaluated in the RI Report.

FMC Response:

FMC agrees that the June 2004 RI Update Memo did not identify lead-210 and polonium-210 in phossy solids as a data gap; the December 2004 RI Update Memo has incorporated appropriate revisions. Because exposure to external gamma radiation contributes the vast majority of potential radionuclide risk to future workers for all source materials (except phossy solids) at the FMC Plant OU, comparing direct exposure measurements of gamma radiation to a dose-based target (e.g., 15 mrem/yr above background as used at Monsanto) will effectively ensure the protection of these potential receptors. For areas that may contain phossy solids, the collection of lead-210 and polonium-210 data will characterize the potential risks associated with the ingestion and inhalation pathways. These radionuclide-specific investigations will be used in conjunction with gamma measurements to determine whether worker exposures exceed the 15 mrem/yr above background threshold.

The methodology, assumptions and findings of the analyses performed to support FMC's position are fully documented in Section 4 and Appendices F, G, and H of the December 2004 RI Update Memo.

As discussed during both the August 3 and September 15, 2004 teleconferences, FMC acknowledges that EPA's Superfund guidance for evaluating radionuclides generally does recommend the collection of radionuclide-specific data. However, the proposed approach of using gamma radiation dose rate measurements to evaluate radionuclides during the SRI/FS of the FMC OU is not unprecedented, and several EPA guidance documents specifically identify circumstances under which it is desirable to collect direct exposure rate measurements of gamma radiation.

EPA's *Radiation Risk Assessment at CERCLA Sites: Q and A* (EPA, 1999) (http://www.epa.gov/oerrpage/superfund/resources/radiation/radrisk.htm), identifies the merits of collecting gamma radiation dose rate measurements, and deriving cancer risk estimates directly from these data (see response to question 33 in EPA, 1999). EPA (1999) notes that this approach eliminates potential modeling uncertainties associated with estimating external gamma radiation exposure and concerns about the shape of the source (e.g., slag pile on FMC OU). EPA (1999) also cautions that such data only reflect a sub-set of the radionuclides and exposure pathways of potential concern (e.g., only external exposure from gamma-emitting radionuclides in near-surface soil), and may present an incomplete picture of overall radionuclide-related site risks. EPA (1999) indicates that, in most cases, more accurate estimation of radiation risks will require additional site characterization data, including concentrations of all radionuclides of concern in all pertinent environmental media because of the potential for other pathways to contribute to overall risk. However, as discussed further below and provided in Appendix F of the December 2004 RI Update Memo, radionuclide-specific data characterizing the content of the various feedstocks and waste materials historically processed at the FMC Plant OU are available. Moreover, analyses of these data demonstrate that exposure pathways other than external exposure to gamma radiation do not contribute significantly to overall worker risk for all source materials, except phossy solids.

Further support for FMC's proposed approach is presented in the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),* which was developed by the Departments of

Defense and Energy, EPA, and the Nuclear Regulatory Commission to provide detailed guidance for planning, implementing, and evaluating environmental and facility radiological surveys conducted to demonstrate compliance with a dose- or risk-based regulations (http://www.epa.gov/radiation/marssim/index.html). Specifically, page 4-7 of MARSSIM (EPA et al., 2000) states that measurement of exposure rates may be used as a surrogate for surface or volume activity concentrations for radionuclides that deliver the majority of their dose through the direct radiation pathway. That is, instead of demonstrating compliance with radionuclide-specific soil or surface contamination derived concentration guideline levels (DCGLs) (i.e., cleanup goals) derived from the direct radiation pathway, compliance is demonstrated by direct measurement of exposure rates.

Furthermore, MARSSIM indicates that this surrogate approach may still be possible for sites that contain radionuclides that do not deliver the majority of their dose through the direct radiation pathway, provided that a consistent relative ratio for the radionuclides that do deliver the majority of their dose through the direct radiation pathway can be established. As stated in FMC's August 3 and September 15, 2004 presentations, the HHRA identified the external exposure to gamma radiation pathway as contributing over 95% of the total radionuclide cancer risk to a potential future worker. As documented in Appendix F of the RI Update Memo, radionuclide-specific data characterizing the composition of historical feedstocks and waste streams at the FMC OU confirm that, with the exception of phossy wastes, external exposure to gamma radiation contributes approximately 96 to 98.5% of the total radionuclide cancer risk to a potential future commercial/industrial worker exposed to any source material that poses a risk greater than that associated with exposure to background native soils (ore, calcined nodules, slag, and calciner pond sediment). Similarly, as also documented in Appendix F, with the exception of phossy wastes, external exposure to gamma radiation contributes 81 to over 89% of the total radiological risk to a potential future construction worker exposed to any subsurface source material that poses a risk greater than that associated with exposure to background native soils. Therefore, given both the high degree to which external gamma radiation contributes to total risk, and the relatively consistent ratio of external gamma radiation risk to total risk for each source material of potential concern, it is reasonable to conclude that, per the approach described in MARSSIM (EPA et al., 2000), direct gamma radiation measurements can be used during the SRI as a surrogate for radionuclide-specific activity data for areas of the FMC Plant OU that do not contain significant quantities of phossy solids.

With respect to areas containing significant quantities of phossy solid fill material, exposure to lead-210 and polonium-210 through the incidental soil ingestion and fugitive dust inhalation pathways would contribute as significantly as exposure external gamma radiation to total radiological risk to future workers. With respect to phossy solids, incidental soil ingestion and fugitive dust inhalation of lead-210 and polonium-210, in conjunction with exposure to external gamma radiation, accounts for over 98% of the total risk to any future worker exposed to this media. Thus, a supplemental remedial investigation strategy targeted on analysis of lead-210, polonium-210 and gamma dose rate measurements can be developed to ensure acceptable residual radiation risk in phossy waste-containing RUs where no further remedial action is contemplated in FMC's remediation vision. Appendix H of the RI Update Memo describes the approach that will be taken to confirm the presence of phossy waste during the SRI.

Finally, despite guidance indicating that dose assessments should generally not be performed to assess risk or to establish cleanup levels, this approach has been applied at sites comparable to the FMC Plant OU. Specifically, one of the RAOs established for off-site soils (property surrounding the plant) at the Monsanto elemental phosphorus production site located in Soda Springs, Idaho is to prevent exposure to radionuclides in soils at levels that pose cumulative estimated risks of $3x10^{-4}$, by meeting a radiation effective dose equivalent of 15 mrem/year above background (EPA, 1997; EPA, 2003).

31. Section 4.3, Page 4-2, 3rd Paragraph

Dose rate surveys may be useful for estimating dose and risk. If background levels are exceeded, risks above background may be estimated. It is not necessarily the case, however, that background readings correspond to acceptable risk levels.

The proposal is made to screen gamma risk using gamma radiation dose rate measurements. The ability of this approach to detect risk-based screen levels of gamma radiation must be evaluated in the RI Update Memo. The dose rate that correspond to risk-based screening levels is likely to be small compared with the variability in background dose rates and the detection capability of the instrument in the background. As is the case with laboratory radioanalyses, detection capabilities will largely be determined by the variability of the background measurements. If the total gamma background (i.e. 13 uR/hr) is used as the basis for background comparisons, then the variability will be significant. It is not clear that the proposed method will be able to detect gamma dose rates corresponding to risk-based screening levels (e.g. 1E-4 risk). A data quality evaluation must be provided to demonstrate that the proposed screening method can meet the risk-based decision criteria for the site.

FMC Response:

The ability of gamma dose rate measurement instruments to detect worker risk-based screening levels of gamma radiation (approximately 8 μR/hr) is documented in Appendix G of the December 2004 RI Update Memo. Specifically, EPA's Data Quality Objectives (DQO) process was applied to confirm that a Pressured Ionization Chamber (PIC) is capable of reliably quantifying gamma radiation rates at the levels needed to assess risks to potential future site workers. Additionally, information was provided to demonstrate that a Bicron NaI instrument can be coupled with a PIC to increase coverage and to determine the variability in gamma radiation intensity across the site. In accordance with the comment and Action Item #30 identified during the September 15, 2004 Agency Coordination Meeting teleconference, the confirmatory data quality evaluation will be further documented in the SRI Work Plan

32. Section 4, Page 4-1, 1st paragraph

RBCs for Elemental Phosphorus and Other COPCs, Page 4-1. The text and RBC calculations should be updated to apply the most updated toxicological criteria provided in USEPA's HEAST 2001. Currently, the document references HEAST 1997, and the radiological slope factors in HEAST 1997 have been comprehensively updated in HEAST 2001. The RBCs should be updated in accordance with the updated guidance.

The text must be revised to list web sites, date accessed, and revision dates for cited online toxicity references.

Example:

U.S. Environmental Protection Agency. (1992). IRIS Toxicity Profile for Zinc and Compounds. Accessed: August, 12, 2003. Revised: October, 1992. http://www.epa.gov/iris/subst/0426.htm

FMC Response:

In accordance with the comment, the RI Update Memo has been revised to list the web address and date of access of online toxicity references. In addition, the latest revision date provided on the web site is documented.

As stated in the comment, radiological cancer slope factors were updated in the 2001 version of EPA's Health Effects Assessment Summary Tables (HEAST); however, RBCs are not developed for radiological constituents in the RI Update Memo. Instead, the RI Update Memo develops RBCs, otherwise known as soil screening levels (SSLs), for elemental phosphorus and other chemical COPCs. The 2001 HEAST publication does not contain updated toxicological criteria for chemicals. The most recent version of HEAST that provides toxicological criteria for chemicals was published in 1997. In summary, the 2001 version of HEAST does not contain any information relevant to the derivation of the chemical RBCs presented in the RI Update Memo and is not referenced in Section 4 of the December 2004 RI Update Memo.

33. Section 4, Page 4-2, 3rd paragraph, 2nd sentence

The text refers to gamma radiation as a radiation-related COPC. Strictly speaking, gamma radiation is not a COPC; rather, the radionuclide, which emits the radiation, is the COPC. The document should be revised to clarify this.

FMC Response:

It is agreed that specific radionuclides, rather than gamma radiation, constitute the COPCs. While this distinction is made in the December 2004 RI Update Memo, and gamma radiation dose rate measurements are identified as a surrogate to be used to evaluate radiation-related risk from exposure to gamma emitting COPCs within the SRI/SFS.

34. Section 4.2.1, Page 4-5, 2nd paragraph

In the last sentence there is a reference to ground water containing COPCs in excess of MCLs or SSLs. Since the latter acronym stands for Soil Screening Level, it is not appropriate for ground water and must be changed.

FMC Response:

Agreed. The last sentence of the cited paragraph has been revised to read "… FMC will record land use restrictions to prevent future workers from being exposed to groundwater containing COPC concentrations in excess of Maximum Contaminant Levels (MCLs) or risk-based screening levels."

35. Section 4.2.2, Page 4-7, Exposure via Soil Ingestion and Dermal Absorption, 5th paragraph

The first sentence begins: "By contrast to cancer slope factors, the following hierarchy was used to select noncancer toxicity values:" However, the hierarchy for cancer and noncancer toxicity

values is essentially the same. The text should be revised to state that the same hierarchies were used.

FMC Response:

The hierarchy for cancer and chronic non-cancer toxicity values is the same. The first sentence of the cited paragraph has been changed to "The same hierarchy for developing cancer slope factors was used to select chronic noncancer toxicity values:"

36. Section 4.4.3.2, Page 4-21, Equation 4-26

Equation 4-26 does not match the Equation E-21 in EPA's Supplemental Soil Screening Guidance (U.S. Environmental Protection Agency, 2002e). The conversion factor from kilograms to grams appears to be incorrect. The equation should be revised using a conversion factor of 1,000 g/kg.

FMC Response:

A value of 4×10^3 g/kg, rather than 1×10^3 g/kg, was an inadvertent typographical error. The equation will be corrected as requested; however, it should be noted that the SSL calculations were correctly performed using a conversion factor of 1,000 g/kg.

37. Section 4, Table 4-1

Table 4-1 must be revised to include the following chemicals and radionuclides:

Chemical	**Risk Based Concentration**	**Source**
Cobalt	1,900 mg/kg	(Smucker, 2004)
Lead	800 mg/kg	(U.S. Environmental Protection Agency Technical Review Workgroup for Lead (TRW), 2002h)
Lead-210	1.23 pCi/g	(U.S. Environmental Protection Agency, 2002c)
Phosphorous (elemental)	20 mg/kg	(Smucker, 2004)
Radium-226	0.0258 pCi/g	(U.S. Environmental Protection Agency, 2002c)
Uranium (total, noncancer)	200 mg/kg	(Smucker, 2004)
Uranium-238	1.8 pCi/g	(U.S. Environmental Protection Agency, 2002c)

FMC Response:

As discussed on page 4-1 of the RI Update Memo, the purpose of Table 4-1 is to present the original EPA calculated worker RBCs documented in the 1997 Feasibility Study (FS) Report of the FMC Subarea. The information provided in the comment is not relevant to the 1997 FS Report and, consequently, has not been incorporated into Table 4-1. However, Table 4-1 has

been renamed "EPA Calculated Worker Risk-Based Concentrations (RBCs) for the FMC Subarea[1]". The reference at the end of the title refers to a footnote that identifies the 1997 FS Report as the source of the information presented in the table.

38. Section 4, Table 4-4

The soil adherence factor for the utility worker must be revised to 0.9 mg/cm2 (U.S. Environmental Protection Agency, 2004). The EPA Dermal Exposure Guidance (RAGS-E) has been revised and finalized (U.S. Environmental Protection Agency, 2001b; 2004), must be reviewed for changes which may impact the exposure assessment and PRG development.

FMC Response:

The soil adherence factor for the utility worker has been revised to 0.9 mg/cm^2 in accordance with the recommendation contained within Exhibit 3-3 of EPA's recently finalized *Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (July, 2004). The remainder of the final guidance document has been reviewed and there is no additional information in that document that affects the dermal absorption assumptions incorporated into the SSL calculations within the June 2004 RI Update Memo.

In the SSL calculations, dermal exposure was taken into account only for arsenic and cadmium. Although a chemical-specific or default gastro-intestinal absorption factor is available for all of the COPCs in the final dermal guidance document, allowing for the derivation of dermal toxicity values for all substances for which an oral toxicity value is available, a chemical-specific dermal absorption factor is still only available for arsenic and cadmium (EPA does not recommend a default dermal absorption factor for inorganics). In the absence of a dermal absorption factor for a chemical, the dermal exposure route cannot be incorporated into the calculation of the SSL for that chemical. The gastro-intestinal and dermal absorption factors for arsenic and cadmium presented in the final dermal guidance are the same as those used in the June 2004 RI Update Memo SSL calculations.

In summary, outside of the soil adherence factor for the utility worker, there is no additional information presented in the revised dermal guidance that affects the SSL calculations.

39. Section 4, Table 4-5

Cancer Slope Factors (CSFs) and Unit Risk Factors (URFs). Toxicity criteria for elemental phosphorus was not provided on this table. This comment also applies to Table 4-6, Chronic Reference Doses (RFDs) and References Concentrations (RFCs). The tables must be revised accordingly.

FMC Response:

While the structure of Table 4-6 has been revised, no changes to the characterization of elemental phosphorus toxicity within either Table 4-5 or Table 4-6 are necessary.

Cancer slope factors (CSFs) and Unit Risk Factors (URFs) are developed for constituents for which sufficient data are available to conclude that exposure may result in an increased potential for carcinogenic health effects. As discussed in the text, only those chemicals classified by EPA as a known or potential human carcinogen (Group A, B, or C) are included in Table 4-5. EPA has classified elemental phosphorus (as white phosphorous) in Group D (not classifiable as to human carcinogenicity based on no data in humans and animals). Consequently, elemental phosphorus is not included within Table 4-5.

With respect to characterizing potential non-cancer health effects associated with chronic exposure to elemental phosphorus, both an oral reference dose (RfD) and an inhalation reference concentration (RfC) are presented in Table 4-6. However, the table has been revised to present the chronic toxicity factors for each COPC in alphabetical order. "Phosphorus (elemental)" appears after nickel and before selenium in the revised version of Table 4-6.

40. Section 4, Table 4-9

Since the QCwind values were derived using regional-specific climatic parameters, the PEF must be calculated using regional-specific climatic parameters.

The rationale for assuming that the site area is 50 acres must be provided (e.g., mean size of the source area).

FMC Response:

Outside of the QC_{wind} parameter, the particulate emission factor (PEF) is a function of the fraction of vegetative cover at the site (V), the mean annual wind speed at the site (U_m), the equivalent threshold value of wind speed at a height of 7 m (U_t), and a function dependent upon both U_m and U_t. Of these latter four parameters, only the mean annual wind speed (U_m) is a climatic parameter. In accordance with the comment, this parameter is characterized in the December 2004 RI Update Memo by the regional-specific mean annual wind speed for Pocatello, ID (4.6 m/s), as cited in Table 4-1 of Cowherd et al. (1985).

With respect to the site area assumed in the PEF-related calculations, it is considered most likely that any future commercial/industrial redevelopment on the FMC plant OU will be concentrated around existing infrastructure (e.g., railroad line), and be limited in size. However, to ensure conservatism in the assessment, the size of the largest RU not already slated for capping (RU 20 ~ 57.1 acres) was used as the basis for selecting a 50-acre source area in calculating the fugitive dust emission factor. This explanation has been incorporated into the December 2004 RI Update Memo.

While unfeasibly large, it should be noted that an assumed site area of 500 acres (i.e., the maximum allowable in the default EPA SSL equation) would result in no substantive changes to the findings of the RI Update Memo. The SSLs for most constituents would remain essentially unchanged because the contribution of the fugitive dust inhalation pathway to the final SSL for most COPCs is negligible. The SSLs for the maximally affected constituents (beryllium, cobalt, manganese and nickel) would be approximately 25% lower than the levels projected in the RI Update Memo. However, none of these SSLs would be exceeded by any of the historical data collected at the FMC Plant OU.

41. Section 4, Table 4-12

Table 4-12 incorrectly lists the oral RfD for elemental phosphorous as 0.0002 (mg/kg-day), based on ATSDR. The correct value is 0.00002 (mg/kg-day) based on IRIS, the preferred source for CERCLA toxicity values (U.S. Environmental Protection Agency, 1993b; Cook, 2003).

The oral RfD for uranium is incorrectly listed as 0.002 mg/kg-day. The table must be revised with the correct value of 0.0006 mg/kg-day (U.S. Environmental Protection Agency, 2000b; a).

FMC Response:

The values listed in Table 4-12 are subchronic RfDs and RfCs, intended to evaluate shorter-term (i.e., subchronic) exposures. As discussed in the text, the preferential sources of subchronic toxicity values were PPRTVs (EPA), HEAST (EPA), and ATSDR Minimal Risk Levels (MRLs). The hierarchy is generally in accordance with EPA guidance for developing soil screening levels for subchronic exposures (EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Office of Solid Waste and Emergency Response. OSWER 9355.4-24). IRIS does not develop subchronic toxicity values; the values listed in IRIS are chronic toxicity values intended to evaluate long-term exposures. Only if a subchronic value was not available, was a chronic toxicity value used, by default, to characterize subchronic exposure to a chemical.

Subchronic toxicity values (i.e., intermediate MRLs developed by ATSDR for the evaluation of exposures >14-364 days) were available for both elemental phosphorus and uranium. Therefore, these values were used as the subchronic toxicity values for these chemicals in preference to available chronic RfDs. The IRIS RfD for phosphorus and the Federal Register RfD for uranium are both chronic RfDs.

42. Section 4, Table 4-13

Assumptions used in the default particulate emission factor (PEF) equation for fugitive dust generation from wind blown soil should be evaluated. Specifically, the vegetative cover and the threshold value for wind may not be protective at FMC. The default fraction for vegetative cover is 50%. This default is not appropriate for much of the facility area.

Parameter Values Used to Calculate the Subchronic PEF for the construction worker exposed to fugitive dust generated by unpaved road must be reassessed. For a number of parameters listed on this table, FMC cites assumptions within the Supplemental Soil Screening Guidance, Appendix E, Case Example but did not explain or provide a rationale for the application of these assumptions to the FMC facility. A discussion regarding the assumptions and the associated uncertainties must be included.

FMC Response:

Revisions to address this comment have been made in the December 2004 RI Update Memo, as detailed below. The 50% vegetative cover (V) assumption and the equivalent threshold value of wind speed at 7 m (U_t) parameters are not relevant to Table 4-13, which is specific to estimating construction worker exposure to fugitive dust generated by unpaved road traffic. Instead, the V and U_t parameters are relevant to commercial/industrial worker exposure to wind generated

fugitive dust (Table 4-9). Nonetheless, the EPA default assumption of 50% vegetative cover for evaluating commercial/industrial worker exposure to wind generated fugitive dust has been revised to 0% to reflect the fact that much of developed FMC Plant OU area is not vegetated. By contrast, the EPA default equivalent threshold value of wind speed at 7 m (U_t) used in the June 2004 RI Update Memo calculations is considered highly conservative (i.e., protective) for the FMC site, and has not been altered. The technical rationale for this conclusion is provided in the December 2004 RI Update Memo.

With respect to the parameter values used to calculate the subchronic PEF for the construction worker exposed to fugitive dust generated by unpaved road construction traffic, site-specific measurements are not available to characterize many of the parameters within EPA's default construction-related SSL equations (which were also assumed to apply to a utility worker). In the absence of such information, the assumptions within the Case Example presented within Appendix E of EPA's Supplemental Soil Screening Guidance were used to characterize the parameters. These values were used because, upon review, they appeared to either reasonably characterize or potentially overestimate the degree to which construction and utility-related work would result in fugitive dust emissions. Another factor considered in the selection of these values is the fact that EPA typically incorporates conservative (i.e., health protective) assumptions into its analyses. However, in accordance with the comment, parameter values used to calculate the subchronic PEF for the construction worker exposed to fugitive dust generated by unpaved road traffic have been reassessed based on available site-specific data. Moreover, FMC has incorporated further discussion in the December 2004 RI Update Memo regarding the basis for the use of site-specific or EPA Case Example assumptions to characterize the parameters used to derive construction and utility worker SSLs. In addition, potential uncertainties associated with making these assumptions are discussed.

43. Section 5, Ecological Risk Assessment Comments

The derivation of toxicity reference values for use in the screening evaluation of risks to terrestrial plants requires further clarification. There is a high uncertainty in using soil pore water estimations and soil solution TRVs as proposed in the RI Update Memo. The risks to plants should be assessed using bulk soil values. This analysis could be supplemented with soil pore water estimations and soil solution TRVs.

FMC Response:

For three of the COPCs (cadmium, fluoride and zinc) in the draft RI Update Memorandum, neither soil solution nor bulk soil concentration TRVs were developed to assess potential affects to terrestrial plants. Plant tissue-based TRVs were used because of the availability of plant tissue concentrations for these three constituents from the Bannock Hills SW RI ecological sampling station. This approach to evaluating potential cadmium, fluoride and zinc impacts to plants, which was also adopted in the Baseline ERA, was made feasible by the plant tissue sampling and analyses performed per the EPA-approved Baseline ERA work plan. The approach eliminates uncertainties associated with plant uptake from soil and soil solution, particularly as it is influenced by soil geochemistry. Because vanadium and chromium were not COPCs during the Baseline ERA, their concentrations were not analyzed in sampled plant tissue.

To perform the screening level ERA for the undeveloped portions of the FMC Plant OU, vanadium and chromium phytotoxicity had to be evaluated via the use of either the bulk soil or soil pore-water plant TRVs contained within Efroymson et al. (1997).

Efroymson et al. (1997) gives a low confidence level to the bulk soil toxicological benchmarks for chromium and vanadium. The soil pore-water TRVs were given a moderate confidence level for chromium and a low confidence level for vanadium. (Note that Table 5-5b of the June 2004 RI Update Memo erroneously reported a low confidence level for the pore-water TRV for chromium.) The high degree of uncertainty associated with use of the bulk soil plant TRVs is further highlighted by the fact that the Efroymson et al. (1997) chromium and vanadium bulk soil TRVs are both more than twenty-fold lower than background chromium and vanadium levels in the EMF study area. As stated in Efroymson et al. (1997), "…if a benchmark is exceeded by background soil concentrations, it is generally safe to assume that the benchmark is a poor measure of risk to the plant community at that site". Consequently, while the reviewer suggests that there is a high uncertainty in using soil pore water based screening benchmarks, Efroymson et al. (1997) concludes that the bulk soils TRVs would not be appropriate indicators of risk since they exceed background concentrations for the area.

The non-applicability of the Efroymson et al. (1997) bulk soil TRVs to the FMC Plant OU is a result of the local soil geochemistry, e.g. high pH and mineral content generally associated with arid west soils, that tends to limit the dissolution and bioavailability of metals. In recognition of the influence of local soil geochemistry on metal bioavailability, EPA specifically requested in their July 2003 document entitled "Recommendations for Terrestrial Ecological Risk Assessment Activities Regarding the FMC OU" that "FMC derive TRVs applicable to arid west systems and screen these against measured or estimated concentrations in the south and west ecological areas of the FMC OU". Indicative of the emphasis of geochemical determinants on bioavailability, Efroymson et al. (1997) note that "the presence of soil in test systems reduces the experimenter's degree of control over exposure" and that plant exposure is via soil pore-water. Therefore, particularly in the absence of bulk soil TRVs developed in similar soil types, use of pore-water TRVs is considered best suited to ascertaining potential risks to terrestrial plants since modeled pore-water concentrations provide the means to incorporate values for local geochemical parameters, e.g. pH.

Since the June 2004 RI Update Memorandum, FMC has undertaken an extensive search in the primary literature to determine whether bulk soil toxicity data are available for a similar soil type as present at the FMC Plant OU. While inadequate information was available for vanadium, several chromium III bulk soil toxicity studies, the predominant form of chromium at the FMC Plant OU (see response to comment #44), were found to have been performed in high pH soils similar to those of the EMF area.

In a study using native soils in China at a pH of 7.98-8.25, slightly higher than those of regional soils (EMF average pH is 7.8 based on ten soil samples [E&E, 1995]), no apparent toxicity or effects on biomass were observed in wheat seedlings at chromium III soil concentrations of up to approximately 216 mg/kg, the maximum measured soil concentration (Ma et al., 2003). In another study, no changes in biomass were observed in Indian mustard and sunflower seedling

plants at a chromium III soil concentration of 100 mg/kg; at a soil concentration of 300 mg/kg, biomass was decreased by approximately 35% and 45% in mustard and sunflower, respectively (Shahandeh and Hossner, 2000). In a third study, a slight effect on biomass (approximately 15%) was observed when chromium III was added to soil (pH 7-8) at a concentration of 300 mg/kg (lowest concentration tested) (Bolan and Thiagarajan, 2001). These studies therefore confirm that no negative effect on the local plant population would be expected at the soil concentration of 76 mg/kg, the 95% UCL chromium concentration used to characterize the undeveloped portions of the FMC Plant OU, because of the high alkalinity of the local soils. Consequently, the use of the Efroymson et al. (1997) 1 mg/kg bulk soil TRV for chromium would be inappropriate for characterizing the potential toxicity of chromium at the FMC Plant OU. The pore-water approach to defining plant TRVs is therefore considered to be most suited to a determination of potential risks associated with the alkaline arid soils of the study area.

In summary, the soil pore-water TRVs for vanadium and chromium were developed to be representative of potential plant toxicity in the soils of the arid west, per EPA's recommendations. Furthermore, adopting a non site-specific bulk soil TRV would not eliminate uncertainty, but would rather add to the uncertainty since it would not address the significant influence that soil geochemistry has on the bioavailability of inorganics. Furthermore, as recommended by Efroymson et al. (1997), because background soil levels of vanadium and chromium are significantly lower that the benchmark (by 20-fold), the bulk soil TRVs are considered poor measures of risk. An intensive search for more recent data regarding bulk soil TRVs confirmed that the Efroymson et al. (1997) bulk soil TRV for chromium is at least two orders of magnitude too low in comparison to studies performed in soils of a similar pH to those of the study area. Consequently, the plant pore-water TRVs for vanadium and chromium, which are associated with either equal or higher confidence limits in comparison to the bulk soil TRVs, are the appropriate values to be used in the evaluation of potential impacts to terrestrial plants of the study area; the approach used in the June 2004 RI Update Memorandum did not require revision.

44. Section 5, Table 5-12

Provide the justification for sampling for total chromium rather than for Cr^{3+} and Cr^{6+}.

<u>FMC Response:</u>

During the EMF RI analyses were performed to evaluate the proportion of Cr(VI) in FMC process emissions. Appendix C of the Human Health Risk Assessment (HHRA) and Appendix AK of the RI report state that the most reliable data indicate that Cr(VI) accounts for less than 1% of the total chromium in historical air emissions from processes at the FMC plant that had the greatest potential to favor chromium oxidation. Furthermore, Cr(VI) is a strong oxidizing agent and tends to be reduced to Cr(III) in the environment as a result of reactions with organic matter and some inorganic chemicals such as iron and sulfides. Consequently, as indicated by the evaluation in the RI report, it is likely that a significant portion of any Cr(VI) historically released from the FMC facility has subsequently been reduced to Cr(III) within FMC Plant OU soils. In summary, total chromium and Cr(III) concentrations are nearly equivalent.

Consequently, collection of speciated chromium data was considered unnecessary during the RI, as remains the case today.

45. Section 5.3, Page 5-2

Although the text states that EPA approved the use of specific data reported in the 1996 RI as surrogate data to represent the undeveloped southern and western portions of the FMC OU, the use of those data entails a high level of uncertainty, and the data may not be appropriate as surrogate. The primary rationale for use of the Bannock Hills SW data on plant and small mammal tissues as surrogate for data from the FMC OU was based on a comparison of soil data in the Bannock Hills SW with soil data collected at stations off-site but immediately adjacent to the undeveloped areas. However, review of the station locations in Figure 5-1, and the data in Table 5-2, leaves substantial uncertainty as to the appropriateness of that comparison. The off-site data are from five stations, but only two of which (Stations 225-2A and 225-2B) are adjacent to the undeveloped areas and in line with the predominant source of contaminant transport. The data in Table 5-2 suggest that only Stations 225-2A and 225-2B are contaminated with metals; the other three stations are not properly located to be surrogates, and their metals concentrations are closer to background levels. These considerations suggest that only the two stations at 225 would be appropriate surrogates for the undeveloped areas. The reliance on data from only two stations does not follow recommendations in EPA guidance for the number of samples to evaluate risks to terrestrial receptors at Superfund sites. The risks, based on the maximum values, must be calculated and presented in an uncertainty assessment.

FMC Response:

This comment appears to be based only on the limited discussion of the data provided in the June 2004 RI Update Memorandum, suggesting that the reviewer may not have been aware of FMC's *Evaluation of Potential Ecological Risks Within the FMC OU* "white paper", which included a detailed evaluation of the adequacy of off-site RI data to characterize conditions within the undeveloped areas of the FMC Plant OU. Furthermore, the remark, 'Although the text states that EPA approved the use of specific data", appears to have been written without knowledge of EPA's follow-up recommendations to the white paper, which indicated that the only outstanding issues to be evaluated in the RI Update Memorandum were related to updating the TRVs for cadmium, zinc and fluoride and the addition of vanadium and chromium as COPCs. Moreover, EPA specifically agreed in the final SOW that data collected at the Bannock Hills SW sampling station be used to evaluate potential on-site ecological risks for cadmium, fluoride and zinc. This was in large measure due to the findings of FMC's analysis of the RI surface soil data associated with samples collected along the 225 degree radial from the EMF facilities, which indicated that the maximum concentrations associated with deposition of historical emissions were located in the vicinity of the Bannock Hills SW sampling station. EPA also indicated that the RI data collected adjacent to the undeveloped areas, as identified in the white paper, could be used to estimate exposures and evaluate potential on-site ecological risks associated with chromium and vanadium. These Agency agreements were embodied into the scope of the ecological assessment task presented in the final SOW for the Supplemental RI/FS.

FMC also does not agree with the reviewer's technical basis for critiquing the use of all five adjacent off-site RI surface soil data points to characterize the chromium and vanadium exposure point concentrations carried forward into the ecological assessment of the undeveloped southern and western portions of the FMC Plant OU. The suggested use of the maximum off-site concentration to characterize conditions on over 500 acres of undeveloped land on the FMC Plant OU is unrealistically conservative. This conclusion is supported by figures within the RI report that depict vanadium and chromium surface soil concentration isopleths.

Figure 5-2 of the December 2004 RI Update Memorandum (amended RI Figure 4.3-23) shows that vanadium surface soil concentrations within much of the undeveloped areas of the FMC Plant OU are likely below the regional background level (45.4 mg/kg) derived by EPA during the RI. As also shown in Figure 5-2, while portions of the undeveloped areas located adjacent to disturbed areas (e.g., slag pile) may exhibit higher levels, none are likely to exceed background by more than a factor of two. Similarly, as shown in Figure 5-3 of the December 2004 RI Update Memorandum (amended RI Figure 4.3-20), the undeveloped areas of the FMC Plant OU are likely to contain chromium ranging from below background (27.5 mg/kg) to approximately two-times this level at locations adjacent to disturbed areas of the FMC Plant OU. Therefore, the 95% UCL of the adjacent, offsite RI samples, several of which (i.e., Stations 225A and 225B) are located near historic fugitive sources that only affect a limited portion of the undeveloped areas, are likely to overestimate exposures across the entire undeveloped portions of the FMC Plant OU.

In summary, FMC believes that all five of the off-site RI data points located immediately adjacent to the undeveloped areas are highly relevant to the characterization of potential chromium and vanadium exposures. Moreover, use of the 95% UCL on the mean of these data points to characterize potential exposures is consistent with EPA guidance and likely results in a conservative (i.e., health protective) estimate of potential risks. Nonetheless, chromium and vanadium ecological risks estimated using only the maximum adjacent RI surface soil concentrations are presented and discussed within the uncertainty section of the December 2004 RI Update Memorandum. This effort was not extended to cadmium, fluoride and zinc which, consistent with the Baseline ERA, are most appropriately (and conservatively) characterized by the Bannock Hills SW data.

46. Section 5.4.1, Page 5-4

Although air emissions are no longer a source of contamination to the undeveloped portions of the OU from the FMC facility, the adjacent Simplot facility continues to act as an air emission source. In addition, air transport of fugitive dusts from contaminated soils and subsequent deposition onto soil and above-ground vegetation is also a relevant transport pathway. Consequently, exposure to COPCs transported in air, and deposited onto soil and plants, by ingestion of soil and plants are relevant exposure pathways and must be included in the conceptual site model.

FMC Response:

Section 5.4 presents the sources and potential exposure pathways that were identified in the Conceptual Site Model developed in the Baseline ERA. Because the CSM from the Baseline

ERA is not directly relevant to the current assessment, it will not be updated to identify exposure pathways related to potential fugitive dust emissions on the FMC Plant OU. The text in Section 5.4.1 identifies the potential sources and receiving media evaluated in the current assessment of potential ecological risks within undeveloped areas of the FMC Plant OU. This text will be modified to reflect the fact that fugitive dust emissions could potentially contribute to aboveground vegetative concentrations.

It should be noted that this comment does not affect the findings of the ecological assessment. The Bannock Hills SW unwashed vegetation data used in the current assessment accounted for both the deposition of process emissions from the FMC and Simplot facilities and fugitive dust deposition. Since FMC process emissions ceased in 2001, these data likely overestimate current plant concentrations of cadmium, fluoride, and zinc. However, a qualifying statement has been added to note that deposition of ongoing Simplot facility and fugitive dust emissions onto soil and aboveground vegetation may result in exposure to chromium and vanadium plant concentrations greater than those modeled through uptake alone.

47. Section 5.5, Page 5-5

The sources cited for the toxicity benchmarks are not primary sources but secondary sources. None of the sources listed provides original research to develop a toxicity benchmark, but instead are compilations of data from other publications that are subsequently used to develop benchmarks. In addition, the citation of Kabata-Pendias and Pendias, 2000 is incorrect. The correct citation is either Kabata-Pendias and Pendias, 1984, or Kabata-Pendias, 2000. The text must be revised to identify the secondary sources and to include the correct citation.

FMC Response:

The RI Update Memo will be amended to acknowledge that the cited toxicity benchmarks are from secondary sources that provide compilations of data from primary publications.

The correct reference is Kabata-Pendias, 2000, and is the 3rd edition of the book. The text will be revised to include the correct citation.

48. Section 5.5.1, Page 5-5, and Table 5-5a

The development of toxicity reference values (TRVs) for exposure of terrestrial plants to cadmium, fluoride and zinc is described for two types of TRVs: for comparison with plant tissue COPCs and with concentrations of COPCs in soil solution. TRVs based on plant tissue concentrations are identified as being taken from Kabata-Pendias and Pendias, 2000 (see above Specific Comment #48 regarding the incorrect citation). In general, critical values are provided for concentrations of chemicals in soil, not in plant tissue. Provide confirmation that the TRVs selected from the reference source are for application to plant tissue concentrations and not to soil concentrations. The TRVs selected are very similar to soil-based toxicity benchmarks compiled in Efroymson et al. 1997 for terrestrial plants, which brings into question whether the TRVs selected from the reference source are applicable to soil or to plant tissue. Because of the uncertainty with this method, the risk evaluation for terrestrial plant exposure to cadmium,

fluoride, and zinc must also be performed by comparison of concentrations in bulk soil with the soil benchmarks provided in Efroymson et al. 1997.

FMC Response:

No revisions have been made to the December 2004 RI Update Memorandum. FMC does not believe that comparing bulk soil cadmium, fluoride and zinc concentrations to soil benchmarks provided in Efroymson et al. (1997) would reduce uncertainties in the assessment of potential effects to terrestrial plants. In fact, use of bulk soil benchmarks would considerably increase the degree of uncertainty compared to previous EPA and FMC evaluations. Furthermore, use of the Efroymson et al. (1997) bulk soil benchmarks is not technically justified based on a comparison to background soil concentrations. Specifically, the background soil concentrations for four of the five COPCs exceed the bulk soil benchmarks reported in Efroymson et al. (1997). In the case of vanadium and chromium, bulk soil benchmarks are more than 20-fold lower than the background concentrations. Additionally, the Efroymson et al. (1997) benchmarks are lower than the background soil concentrations for fluoride and zinc by nearly 50% and 85%, respectively. As noted in the response to Comment #43, Efroymson et al. (1997) considers bulk soil benchmarks to be poor measures of risk when background soil concentrations are higher than the benchmarks.

As described in the response to Comment #43, the potential for adverse effects to result from exposure of terrestrial plants to cadmium, fluoride, and zinc was evaluated by comparing measured plant tissue concentrations at the Baseline ERA Bannock Hills SW sampling station to plant tissue-based TRVs for these three constituents. Thus, contrary to the comment, soil pore-water TRVs were not developed to evaluate potential effects to terrestrial plants associated with cadmium, fluoride, and zinc exposure. Instead, this latter approach was restricted to the evaluation of chromium and vanadium, for which no plant tissue data were collected at the Baseline ERA Bannock Hills SW sampling station.

Plant tissue concentration-based TRVs for cadmium, fluoride, and zinc were obtained from Table 36 of Kabata-Pendias (2000). Plant tissue-based TRVs, rather than bulk soil or soil pore-water TRVs, were used to evaluate potential effects to terrestrial plants for cadmium, fluoride and zinc because this approach involves the direct comparison of measured plant tissue concentrations in sagebrush and thickspike wheatgrass to plant tissue concentration benchmarks known to cause toxic effects. Because soil chemistry plays a significant role in determining the extent to which chemicals (particularly inorganics) are taken up by plants, use of bulk soil benchmarks would be unjustified as stated by Efroymson et al. (1997). Moreover, the adopted approach (i.e., use of plant tissue-based TRVs) is identical to that used by EPA's contractor in performing the Baseline ERA of terrestrial habitats in the EMF study area.

49. Section 5.5.1, Page 5-5, and Table 5-5b.

The risk evaluation for terrestrial plant exposure to chromium and vanadium should be performed by comparison of concentrations in bulk soil with the soil benchmarks provided in Efroymson et al. 1997.

FMC Response:

See response to Comment #43.

50. Section 5.5, Page 5-5

The discussion of the development of TRVs for wildlife should come under a new subsection heading of 5.5.2.

FMC Response:

Agreed. The RI Update memo has been revised in accordance with this comment.

51. Section 5.5, Pages 5-5 & 5-6 and Table 5-8

The derivation of benchmarks for wildlife includes the extrapolation from laboratory test species to the assessment receptors. The method for the extrapolation is shown in Equation 5-1 and the basis is cited as Opresko et al. 1994. The updated compilation of wildlife toxicity benchmarks by Opresko (found in Sample et al. 1996) uses a different version of the equation. The extrapolations should have been based on the updated equation. However, Sample et al. (1996) also points out the high uncertainty in such an extrapolation, and essentially dissuades readers from using the extrapolation procedure. Sample et al. (1996) illustrates the high uncertainty with the procedure by showing that the smaller the receptor in comparison with the test species, the higher the toxicity benchmark will be, which would appear to indicate less toxicity of the chemical on a body weight basis. However, comparison of laboratory toxicity data for mice and rats in Sample et al. (1996) shows that a given chemical is not necessarily less toxic to smaller animals, and can be of greater, not lesser, toxicity on a body weight basis. For this reason, the TRVs must be derived without the extrapolation (i.e., without the scaling factors listed in Table 5-8), using the values and general approach in Sample et al. (1996). The ecological risk must be calculated without the use of scaling factors and be presented in an uncertainty sections.

FMC Response:

While it is recognized that some methods will change with the passage of time, the scaling methodology has not been called out as a concern in previous Agency comments that were drafted post-publication of the Sample et al. (1996) article. During the April 20, 2004 meeting at which the ecological risk assessment approach was presented, FMC indicated that this wildlife TRV extrapolation methodology would be employed to retain consistency with the Baseline ERA. Nonetheless, FMC recognizes that any method of extrapolating toxicity benchmarks developed for laboratory test species to assessment receptors has inherent uncertainties. Similarly, not extrapolating the benchmarks also has inherent uncertainties. Within the uncertainty section of the December 2004 RI Update Memo, a discussion of the extrapolation uncertainties has been added, including an estimation of risks without scaling the benchmarks to adjust for size differences amongst the species.

However, FMC disputes EPA's conclusion that Sample et al. (1996) dissuades readers from using any extrapolation procedure. In fact, in a more recent manuscript by the same main author

(Sample and Arenal 1999), Sample summarizes his 1996 manuscript as having recommended an extrapolation procedure using a scaling factor (the power to which body weight is scaled) of 0.25 for mammals, although the scaling factor recommended for birds was zero. Additionally, in the Sample and Arenal manuscript (1999), analysis of acute toxicity data across all chemical classes led the authors to recommend scaling factors of -0.2 for birds and 0.06 for mammals, which have subsequently been used to evaluate chronic wildlife risks (e.g., Sample and Suter, [2002]).

Furthermore, Sample and Arenal (1999) suggest utilizing their chemical class-specific results where appropriate. An analysis of the inorganic data contained in Table 1 of their manuscript would result in scaling factors of 0.05 for birds and 0.2 for mammals. Potential risks associated with these chemical class-specific scaling factors are evaluated in the uncertainty section of Section 5 of the December 2004 RI Update Memo. Finally, it is important to note that per Table 2 of Sample and Arenal (1999) the mammalian and avian scaling factors derived for the majority of the chemicals evaluated are not statistically significantly different from the scaling factor used in the Baseline ERA.

52. Section 5.6.2, Page 5-9, Wildlife EPCs for Vanadium and Chromium, 3rd Equation

The term BCF_s should be revised to BCF_f, since it is the food-to-deer mouse bioconcentration factor.

FMC Response:

Agreed. The RI Update memo has been revised in accordance with this comment.

53. Section 5.6.2, Table 5-11

The source of the exposure point concentrations in soil, plants, and small mammals is identified as Table 4-3 of the baseline ERA. Although the text states that these are 95 upper confidence limits (UCL) on the mean, Table 4-3 does not state the statistical basis of the values. A reference to the calculation of the 95 UCL must be provided.

FMC Response:

As discussed within Section 4.3.1.2 and noted in Table 4-3 of the BERA, the 95% UCL on the arithmetic mean was used to characterize cadmium, fluoride and zinc exposure point concentrations in soil, plants, and small mammals, with the following exceptions:

Cadmium

Sagebrush (unwashed); background location – Non-outlier maximum concentration

Thickspike wheatgrass; background location – Average of detected concentrations

Fluoride

Thickspike wheatgrass; background location – One-half detection limit

Thickspike wheatgrass; undeveloped areas of FMC OU – Third quartile (75th percentile)

Deer mouse (whole body); background location – One-half detection limit

Zinc

Sagebrush (unwashed); background location – 95% UCL of lognormal distribution

The text and table within the December 2004 RI Update Memo has been modified to reflect the above.

54. Section 5.6.2, Table 5-12

Only two stations (Stations 225A & B) should have been considered appropriate surrogates, and the exposure point concentrations derived in Table 5-12 should have been derived from those two stations as the maximum values. However, chemistry data from only two soil stations are insufficient to develop exposure point concentrations or to characterize risks to ecological terrestrial receptors. The RI Update Memo must be revised to a discussion of this in an uncertainty section.

FMC Response:

This comment has already been addressed in the response to Comment #45. In summary, while FMC does not concur with the conclusion that only Stations 225A and 225B are appropriate surrogates, the uncertainty section has been revised to include a recharacterization of potential chromium and vanadium risks using only the maximum concentrations from the off-site RI surface soil samples collected from areas adjacent to the undeveloped portions of the FMC Plant OU. This effort has not been extended to cadmium, fluoride and zinc, which, consistent with the BERA, are most appropriately and conservatively characterized by the Bannock Hills SW data.

55. Section 5, Table 5-17

The value for the soil pore water concentration for chromium in the undeveloped areas of the FMC OU should be expressed in scientific notation for the table to read properly.

FMC Response:

Agreed. The RI Update memo has been revised in accordance with this comment.

56. Section 5.7.1 & Table 5-19

As discussed in Specific Comment #48, the derivation of the TRVs for cadmium, fluoride, and zinc needs further explanation to ensure that they are correctly applicable as tissue-based values. The exposure estimate (EE) values for chromium and vanadium are in units of mg/L, not mg/kg, as are the TRVs derived for those metals. The table must be revised by adding a footnote that these values are calculated for soil pore-water and used for soil solution.

FMC Response:

As discussed in FMC's response to Specific Comment #48, the cadmium, fluoride, and zinc TRVs are plant tissue-based values obtained from Table 36 of Kabata-Pendias (2000).

The comment correctly states that the EE and TRV values for chromium and vanadium in Table 5-19 should be identified as being in units of mg/L, not mg/kg. The table has been corrected and a footnote added as suggested.

57. Section 5.7.1 & Table 5-20

Risk calculations must be recomputed for TRVs that are expressed per body weight but derived without extrapolation. Of specific concern are the TRVs for receptors smaller than the test species, including the deer mouse, Townsend's big-eared bat, and horned lark. For those species, TRVs may have been overestimated, with consequent risks underestimated, possibly by factors of 2- to 3-fold for the deer mouse, 3-fold for the bat, and 3-fold for the horned lark. Corrections to the TRVs, and consequent HQs in Table 5-20, suggest that risks from vanadium could exceed HQ of 1 for the deer mouse and bat. The risk calculations must also be recomputed using the maximum EPC instead of the 95 UCL from the surrogate stations.

FMC Response:

Comments concerning the suitability of the off-site RI data used to characterize exposure point concentrations (i.e., 95% UCL on the mean versus maximum) were previously addressed (responses to Comment #s 45 and 54) from the perspective of how they contradict prior direction from EPA. These responses are not repeated here.

The remainder of the comment is similar in content to Comment # 51 above. The reviewer in this comment is, however, more specific in stating the concern that the vanadium TRVs may increase by 2 to 3-fold and, consequently, result in a risk potentially exceeding an HQ of one for some receptors.

With regard to the significance of the extrapolation approach on the risk assessment findings, it should be noted that a HQ above one does not specifically indicate potential risks. In fact, as was discussed for other COPCs elevated above one (some of which would be below one if the TRV extrapolation methodology was changed to that proposed by the reviewer), there was sufficient conservatism in the BERA methodology to suggest that there is only a marginal exceedance and that there are unlikely to be any population or community level effects. Moreover, due to the high degree of conservatism inherent within the evaluation of potential vanadium risks (as described in Section 5.7 of the RI Update Memorandum), it is unlikely that any individual receptor would experience an adverse health effect associated with exposure to this constituent.

FMC concludes that changing the TRV extrapolation approach and using the maximum rather than the 95% UCL on the mean concentration are both contrary to previous discussions and add little to the ecological risk assessment. Nonetheless, FMC has included in the uncertainty section a recharacterization of the risks estimated using the maximum concentrations from the adjacent areas (for chromium and vanadium only) as well as eliminating the TRV extrapolation that was performed to account for species differences.

58. Section 5.7.1, Page 5-12, Terrestrial HQs, 1st Paragraph

Comment #47 also applies to this section.

FMC Response:

The comment most likely should refer to Comment #46. FMC agrees that there remains the potential for re-suspended soils to deposit on vegetation. However, as discussed in the response to Comment #46, the degree to which contaminants within re-suspended soil particles are deposited on plant surfaces at this time is certainly lower than the extent to which contaminants were deposited on plant surfaces when the facility was operating and releasing air emissions prior to 2001.

Hence FMC's statement within the text indicating that use of cadmium, fluoride, and zinc data associated with unwashed vegetation samples "adds a measure of conservatism to the current assessment" is appropriate given that the FMC facility was still operational at the time that the unwashed samples were collected. However, as discussed in the response to Comment #46, a qualifying statement has been added to note that deposition of ongoing Simplot facility and fugitive dust emissions onto soil and aboveground vegetation may result in exposure to chromium and vanadium plant concentrations greater than those modeled through uptake alone.

59. Section 6 (Text and Tables), General Comment

Section 6 must be revised to identify COPCs for each RU. The COPCs for each RU must be added to Table 7-1.

FMC Response:

The December 2004 RI Update Memo has been revised and contains a listing of COCs and COPCs for each RU, based on data from the EMF RI, other data sources, and process knowledge. This information is provided in Table 6-1, at the beginning of Section 6 in the final RI Update Memo.

60. Section 6, Page 6-1, Step 1, State the Problem

The text must be amended to address the fact that previous investigations did not determine the nature and extent of radionuclide contamination at the FMC OU. This data gap affects the ability to make remedial decisions at some of the FMC RUs. Selection of appropriate COPCs is a necessary step in the DQO process. Previous comments recommending collection and analysis of individual radioactive uranium decay products are applicable to this section. Gamma readings, without concurrent individual radionuclide concentrations of surface and sub-surface materials, are insufficient to characterize site conditions to make "no further action" determinations (Luftig & Page, 1999).

FMC Response:

The EMF RI (BEI, 1996) characterized the nature of radionuclide activities in the various materials stored at the FMC Plant OU. Thirty-one samples of potential source material and 95 native soil samples within the FMC Plant OU were analyzed for radiological parameters during the course of the EMF RI. In addition, a gamma radiation survey of the FMC plant area was conducted as part of the EMF RI (see Appendix O-2 of the EMF RI Report).

However, FMC agrees that further characterization of the extent of radiological impact is warranted. Supplemental characterization of gamma radiation and lead-210 will be performed at RUs identified as candidates for no further action during the SRI, and all data collection will be subject to the DQO Process, as noted in the response to EPA Specific Comment 31. Please also see the responses to General Comments 3 and 4 and Specific Comment 30.

61. Section 6, Page 6-4, Step 6, 4th paragraph

Decision 4 Error is not complete in that the Δ value and the σ value are not specified. There must be a reference to Section 6.1.4 and the appropriate page number where the notion of Δ is discussed. In addition, the formula used for the calculation of the number of samples, n, needs to be specified along with the assumptions applicable to the formula in question.

FMC Response:

Regarding the discussion of Δ, this change will be made by adding a reference to Section 6.1.4. The appropriate formulae for calculating the number of samples are now included in the discussion of Step 6.

62. Section 6.1.1, Pages 6-5 & 6-6, RU 22b – Old Ponds & Figure 6-2

The RI Update Memo must be revised to propose additional investigation of the solid waste management units (SWMUs) within remediation unit (RU) 22b. Elemental phosphorus levels are a data gap and need to be assessed in order to proceed with cap design to ensure that the final cap will be protective of human health and the environment.

FMC Response:

Please refer to FMC's response to General Comment 6, regarding the issue of further characterization of SWMUs within RU 22b.

63. Section 6.1.1, Page 6-7, RU 8, 1st Paragraph, Last Sentence & Figure 6-8

This sentence states that the pond sediments are covered by concrete slabs as a result of calciner construction in the late 1960's. Please clarify in the text whether concrete slabs cover the entirety of the three former kiln scrubber ponds, or whether the concrete slabs are limited to the rectangular footprints shown in the middle and eastern ponds in Figure 6-8. The rectangles are not labeled on the figure, so it is unclear whether they are buildings.

FMC Response:

Figure 6-8 has been revised to show the pond footprints. The calciner foundations do not cover the entire extent of the former kiln scrubber ponds. Clarifying text has been added to the document.

64. Section 6.1.1, Page 6-8, RU 16, 4th Paragraph

Identify the "remediation vision" for this site that is referenced in this paragraph.

FMC Response:

In the discussion for each RU, the Remediation Vision will be reiterated in the introductory paragraphs. Specific to RU 16:

"The remediation vision for this RU is capping/soil cover to reduce the potential for direct exposure."

Please also see the proposed changes to text in section 6 submitted to EPA on September 7, 2004. This provides proposed changes to the text to address a data gap on the potential leachability of the calciner pond solids. These revisions are shown in Section 6.1.1, RU 16.

65. Section 6.1.1, Page 6-8, RU 16, 3rd paragraph

The referenced text states contaminants migrated to a depth of at least 10 feet beneath the pile. This is inconsistent with the description found in Table 6-9 which states *that "soil borings show very little if any migration of metals or other EMF-related constituents into native soils beneath the calciner solids."* Provide or reference the actual data (including sample depths and analytes).

FMC Response:

The detailed discussion of the data and findings are provided in the EMF RI Report, page 4.2-164 and Table 4.2.3-33 (BEI, 1996). These pages of the EMF RI are cited in the text of the December 2004 RI Update Memo.

66. Section 6.1.1, Page 6-8, RU 16, 3rd Paragraph

The text states that soil data from stockpile borings show that some contaminants have migrated up to 10 feet into the soils beneath the pile. However, neither the text nor Table 6-9 identify the COPCs. Revise the text to provide this information.

FMC Response:

This information has been added at the beginning of Section 6 (see Table 6-1). Please also see response to Specific Comment 59 above.

67. Section 6, Figure 6-10

The text does not describe the differences between SWMU 17 (Storage Area B) and SWMU 1 (Calciner Solids Stockpile) identified in the figure. The text must be revised to describe SWMU 17. The existing data appears to have been taken from roadway areas. It is not clear this existing data adequately characterizes the unit. The results of samples collected in the roadways may not be representative of conditions found within the stockpile, where the source term (i.e., stockpile) is presumably thicker. The document must be revised to discuss the adequacy of the existing data for remedy selection.

The text must describe what is meant by *"above representative levels."* It is unclear if this is referring to background concentrations or some other criteria. See general comment #2.

FMC Response:

Please see the response to General Comment 2 and Specific Comment 66. Also see FMC's submittal to EPA dated September 7, 2004 and revisions found in Section 6.1.1, RU 16 of the December 2004 RI Update Memo.

68. Section 6.1.1, Page 6-8, RU 16

Provide a reference for the EMF RI table containing the analytical results for boring F160B. This information can not be located in existing files.

FMC Response:

Boring F160B was drilled to install a groundwater monitoring well. Bedrock was encountered at a depth of 107 feet, no groundwater was encountered in the boring, and the borehole was backfilled with cement grout. No soil samples were submitted for chemical analysis from this boring. Please see Appendix B of the EMF RI for the boring log.

69. Section 6.1.1, Page 6-8, RU 8, Last 2 Paragraphs in Section

The statement is made that the selected remedy of RU 16 *"could be effectively applied at RU 8."* It is unclear whether this indicates the intention to apply said remedy. The text must specify the remedial action anticipated for this site.

FMC Response:

As with all RU's, the remediation vision was stated in the accompanying summary figures. The December 2004 RI Update Memo includes a clear statement of the remediation vision for each RU in Section 6 text, as well as on the summary figures.

Specific to RU 8, FMC's remediation vision is to "Leave existing concrete slabs in-place, grade to design subgrade elevation and construct soil cover (cap) over entire footprint of these areas." This statement will be reiterated in the text discussing RU 8. Please see revised text in Section 6.1.1, RU 8.

70. Section 6.1.1, Pages 6-6 to 6-7, RU 22C, 1st Sentence in section

Based on this discussion, it appears that the liner required by the 1998 ROD has not been installed, and that the only liner present at this site was one installed over a portion of the swale in 1993. The lateral extent of the 1993 liner must be depicted on Figure 6-5. It is not possible to evaluate the results of the EMF RI soil borings without knowing where they were collected with respect to the existing liner. Additionally, the "Data Gaps" identified in Figure 6-4 states, *"Potential for P4 above the liner."* It is not possible to evaluate this statement about data gaps without the information regarding the locations of the existing liner and the previous EMF RI sample locations.

In addition, since FMC will no longer control use and access in the vicinity of the railroad swale, the remedy needs to be designed to ensure that the site does not pose a significant risk to future users of the site. Since the phos dock overflowed into this area, samples must be collected to

determine the lateral and vertical extent of contamination and to characterize wastes present at the site. This information will be required to design a final cap that contains the waste and is protective.

FMC Response:

The liner extent will be illustrated on Figure 6-5, along with the storm drain outfall location (i.e., location where P4 was potentially introduced into the RR Swale.) Please see revised text in Section 6.1.1, RU 22c.

71. Section 6.1.1, Pages 6-7 to 6-8, RU 8, General Comment

Clarify in the text whether the kiln scrubber overflow pond and the ditch leading to it are considered part of RU 8 or RU 9. Figures 6-8 and 6-31 are confusing on this point. Based on process knowledge, the kiln scrubber overflow pond and ditch should be included in RU 8.

FMC Response:

Based on process knowledge and EMF RI data, it appears the kiln scrubber overflow pond and ditch were used for transporting/storing clarified kiln scrubber water. The kiln scrubber solids were deposited in the kiln scrubber ponds, so there is likely to be significantly less of an accumulation of kiln scrubber solids in RU 9. FMC's remediation vision for RU 8 is capping, while the remediation vision for RU 9 is no further action, pending the results of the SRI/SFS. Please see revised text in Section 6.1.1, RU 8 and Figure 6-8.

72. Section 6.1.1, Page 6-7, RU 8, Last Sentence in Section

Revise the text to discuss whether or not the silt aquifer overlying the uppermost aquifer has been shown to be laterally extensive, whether or not it is a horizontal aquitard or is sloped, and whether tests have been performed to determine the leakage factor.

In addition, since the precise location of the kiln scrubber ponds is not known, and because the levels of radionuclides and inorganics in the waste is not known, the RI Update Memo must be revised to indicate this is a data gap. To address this data gap samples should be collected to determine the lateral and vertical extent of contamination and to obtain data to be used for the cap design.

FMC Response:

The silt aquifer is laterally extensive, it is nearly horizontal in this area, and vertical permeability tests have been conducted on the silt aquitard overlying the shallow aquifer at the EMF Site. Please see Sections 3-3, 4-4, and Appendix K of the EMF RI for a more complete presentation of the site hydrogeologic characterization data. Section 6.1.1 (RU 8) discussion has been revised, and a reference to the appropriate sections of the EMF RI Report has been included in the document.

The location of the kiln scrubber ponds is well known and is shown in the 1965 air photo in Figure 6-8. Process knowledge and extensive characterization of calciner pond solids is sufficient for supporting decisions regarding the cap design for RU 8. FMC agrees that

confirmation borings or trenching should be conducted along the exterior boundaries of the ponds, where accessible, to define the lateral extent of the cap. This is now recognized as a data gap in the discussion of RU 8.

Delineating the vertical distribution of the contaminants is not necessary when the data and process knowledge all indicate these former unlined ponds leaked to groundwater. The 1998 ROD selected a remedy for groundwater and the cap will reduce the potential for future contaminant loading to groundwater. The RI Update memo has not been revised to identify this issue as a data gap.

73. Section 6.1.2, Pages 6-9 & 6-10

The 44˚C isotherm study should not be the only parameter considered in determining the migration of P4 and other contaminants at the various RUs. The potential value in the 44 ˚C Isotherm Study is that it could potentially help determine where soil sampling would begin as part of the effort to determine the lateral dimensions of the cap. The 44 ˚C Isotherm Study alone will not provide the necessary data to determine the dimensions of the cap.

While P4 may migrate due to the higher temperatures, other COPCs such as cadmium and arsenic, which have a higher solubility, could be distributed beyond the model boundaries identified for P4 and its oxidation product. A proposal to assess the distribution of metals that may have migrated beyond the model boundaries must be included. While the model may delineate the cap boundary, sampling must be conducted to ensure the lateral extent of the cap is sufficient to reduce infiltration and be protective of human health and the environment.

FMC Response:

The primary factors affecting the migration of P4 are the bulk thermal conductivity of the underlying porous media. This variable is influenced by soil moisture, permeability and porosity. All these variables will be investigated in the thermal modeling study.

Solubility and pH are not considered in the thermal modeling effort because these factors do not affect the thermal properties of the soils and will not affect the distribution of elemental phosphorus in the subsurface, particularly at the levels of interest for this study.

The solubility limit of elemental phosphorus is 3.0 mg/l, the RBC for elemental phosphorus is 22.7 mg/kg, while the concentration at which elemental phosphorus can smoke is 1,000 mg/kg. Given these figures, the solubility of P4 does not play a significant role in transporting elemental phosphorus in the subsurface when compared to heating the porous media above 44 C. In other words, where the soils were heated above 44 C, over 10% of the mass could be elemental phosphorus, assuming that one-half of the pore spaces are occupied by P4. Where soils are below 44 C, and fully saturated with water transporting dissolved elemental phosphorus, approximately 0.00006% of the mass could be elemental phosphorus (assumes 20% porosity of soil is occupied by water with 3 mg/l of P4).

The modeling effort will be used to assess metal transport in the vadose zone to determine if the lateral extent of transport of metals in the dissolved phase could significantly exceed the lateral distribution of the P4. Decisions for analyzing confirmation soil samples for metals will be made after reviewing the modeling results.

74. Section 6.1.2, Page 6-9, 4th Paragraph

It is premature to determine in this document whether the process piping in RU 1 and RU 2 should be removed. Information must be presented identifying the extent of subsurface piping in these RUs, the size and material of construction, depths of burial, and any process knowledge regarding the residuals expected to be remaining in the pipes. The RI Update Memo must be revised to include this information and identify any data gaps regarding the process piping.

FMC Response:

The RI Update Memo concluded that within RU 1 and RU 2 boundaries, subgrade piping will be emptied, plugged and abandoned in place. The envisioned cap will cover the subgrade piping within these RU boundaries.

For the subgrade piping that lies between RU 22b (Former Ponds), and the final cap extent at RU 2, the RI Update Memo does not draw a conclusion regarding removal of this piping. the RI Update Memo states:

"FMC will evaluate the feasibility of removing the subgrade piping in areas between the former P4 working areas and the old ponds in RU 22a and RU 22b. The underground P4 process piping outside of RU 1 and RU 2 is the only potential P4 source outside RU 1 and RU 2 (there are no process vessels outside these RU's). Any potential P4 releases from this piping would be immobile because the ambient soil temperatures along the pipeline route are below 44°C."

Any proposed actions to remove underground piping will be evaluated in the Supplemental Feasibility Study.

Underground piping in the RU 1 and RU 2 is primarily mild steel pipe, with diameters of 4 to 6 inches. These pipes carried phossy water and sludge to the ponds. Within RU 1 and RU 2, if there were leaks in these pipes, the heated soils may have allowed migration of P4 away from the leak. Therefore, removal of piping in RU 1 and RU 2 would pose a greater risk to site workers, and would only achieve removal of a small potential source of P4. Further away from the heat sources, the P4 would not migrate (soil temperatures would remain below 44°C near the piping), and in the area outside the RU 1 and RU 2 boundaries, FMC may be able to remove soils containing P4 concentrations above the RBCs.

No revisions to the RI Update Memo have been made to address this comment.

75. Section 6.1.2, Pages 6-9 & 6-10, 5th Paragraph, 1st Sentence

The document should clarify whether RU 1 and RU 2 are being addressed under CERCLA or RCRA authority. The first sentence is confusing regarding this point. Later in Section 6.1.2.1, the text appears to indicate that RU 2 is being addressed under RCRA. These sections should be revised to clarify the program authority.

FMC Response:

The RI Update Memo has been revised to clarify that RU 1 and RU 2 are being addressed under CERCLA. The Slag Pit Wastewater Collection Sump is a small RCRA WMU within the boundaries of RU 2, and FMC will close this unit under RCRA.

76. Section 6.1.2.1, Page 6-12, Existing Cover Assessment, 2nd Paragraph, Last Sentence

This paragraph describes building foundations with some unstated number of sumps (of unstated sizes) present, piping that is proposed to be cut and capped, and depressions that will be backfilled with some unstated material. The description provided does not suggest that the decommissioning activities will result in a *"monolithic slab of concrete surrounded by paved areas."* Instead, these activities suggest that the pre-RD site would have vastly differing hydraulic properties (e.g., concrete structures versus backfill), and the potential for conduits to channel infiltration (along process piping, and sumps filled with unspecified backfill materials). The document must be revised to describe the area. The text must be clarified. Additionally, information must be provided to support the statement that the concrete slab foundation is *"impermeable over large areas."*

FMC Response:

The text has been revised to describe the furnace building foundation after decommissioning activities are complete. The following text has been used:

> "The furnace building foundation is primarily a level concrete slab with below grade sumps and launders. After demolition of the superstructure is completed, the sumps and below grade features will be backfilled and the fill material will be graded to manage run-on/run-off and prevent water accumulation in these areas. Below grade piping will be plugged and abandoned in place. If capping is selected as the remedy, the concrete foundation will be integrated into the final contouring of RU 1 and RU 2 during the RD phase. Cap design will be RCRA-equivalent, and will not rely on the concrete slab to minimize infiltration."

77. Section 6.1.2.1, Page 6-12, *Existing Cover Assessment,* 1st Paragraph

Summarize in the text what closure activities are required by the closure plan, and where the closure plan is in the approval process. Providing this information will enable and facilitate the CERCLA efforts to be integrated efficiently.

FMC Response:

The Slag Pit Sump Closure Plan calls for construction of a RCRA cap over the slag pit sump area. The Closure Plan was submitted to EPA in September 2001, and FMC is awaiting EPA's approval. FMC will provide the appropriate cap design information for evaluating capping RU 1 and RU 2 in the SFS, and, assuming capping is selected as the remedy for RU 1 and RU 2, the detailed cap design will be developed during the RD/RA.

78. Section 6.1.2.1, Page 6-13, Statistical Comparison of Site Data with RBCs, 2nd Paragraph

An explanation of why only inorganic constituents were statistically analyzed is needed. A discussion of the data that are available for organic contaminants and statistical evaluation, if appropriate, should be included.

FMC Response:

There were no organic contaminants identified in the EMF RI and HHRA that were considered a COC or risk-driver in shallow soils. Therefore, these were not analyzed statistically.

Organic contaminants within the FMC Plant OU were discussed in the EMF RI, Section 4.2.3. SSLs for the organic compounds detected in shallow soils will be developed by FMC.

79. Section 6.1.2.1, Pages 6-14 & 6-15, RU 6 – Long-term Phos Storage Facilities, RU 6

The railroad track adjacent to the long-term phosphorus storage tanks (former) and the railcar loading overflow tank must be sampled for P4 as this is an area likely to have had operating units and releases occur. The RI Update Memo must be revised to identify this as a data gap and propose data collection to address.

FMC Response:

Agreed. FMC believes this was discussed in the June 2004 RI Update Memo in the "Data Gaps" summary for RU 6: "There is a potential that spills may have occurred during the loading and unloading of railcars with P4. Shallow soil samples near the spur line are needed to evaluate the potential for P4 in the 0-10' depth interval." No revisions have been made to the December 2004 RI Update Memo.

80. Section 6.1.3, Page 6-15, 2nd Paragraph, 4th Bullet

As discussed in Specific Comment #10, infiltration controls will be a necessary component of the landfill remedies. There is insufficient information regarding the source terms at RU 18 and RU 19 (former plant landfill or buried railcar areas) to conclude that these controls are not needed. In the absence of specific information regarding the nature of the wastes disposed, the presumptive remedy includes measures to minimize infiltration. Please revise the text to indicate that the presumptive remedy for sites RU18 and 19 will include the remedial action objective to minimize infiltration. As stated in previous comments, this may be achieved by the design and construction of an evapotranspirative cover, with an adequate infiltration storage layer.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004. The text now includes the remedial action objective for minimizing infiltration for RU 18 and the two areas of interest in RU 19 (Former Plant Landfill and buried sludge-containing railcars).

81. Section 6.1.3, Page 6-16, 2nd Paragraph, & Page 6-19, Technical Area 6

Although geotechnical data from a proposed borrow area are found in Appendix D, these raw data cannot be evaluated for suitability as cover material until we are provided with a cover design.

FMC Response:

Comment noted. However, we must point out that the data included in Appendix D was obtained specifically to demonstrate that the soil from the borrow area is suitable for use with the "capillary-barrier enhanced" RCRA cap (a.k.a. Pond 8S cap) that have been constructed at the property.

82. Section 6.1.3, Page 6-17, Technical Area 1, 2nd Paragraph in Section, Last Sentence

The RI Update Memorandum must include more information regarding the types of materials that are being proposed for disposal at the area in between RU17 and 18. Information should include both the potential for contamination and the physical properties of the wastes in order to design an adequate cap. The waste zone must not have void spaces that could compromise the integrity of the final cover.

FMC Response:

FMC assumes that the comment refers to the type of materials being managed in the Recyclable Material Landfill (RU 17) and the Plant Landfill (RU 18). There are no waste disposal sites in the area "in between RU 17 and 18" as stated in the comment.

The materials managed in the Recyclable Material Landfill (RU 17) are described in Table 6-3 and in the description of SWMU 89 in Table A-17 in Appendix A of the RI Update Memo. FMC does not plan to add any additional materials to the Recyclable Material Landfill during facility decommissioning and demolition.

The materials managed in the Plant Landfill (RU 18) are described in Table 6-3 and in the description of SWMU 45 in Table A-18 in Appendix A of the RI Update Memo. The Plant Landfill will continue in use for management these types of nonhazardous wastes during facility decommissioning and demolition.

All the wastes managed in the landfills are nonhazardous and generated on-site. The landfill is managed to minimize void space and interim cover is applied periodically with a bulldozer or loader. These RCRA Subtitle D industrial landfills are not subject to permitting requirements. As noted in Section 6, FMC's remediation vision for RU 17 and RU 18 is to install a cover consistent with EPA's presumptive remedy guidelines for municipal landfills.

83. Section 6.1.3, Page 6-19, Technical Area 4, 3rd Paragraph in Section, Last Sentence

It is reasonable to assume that slag will become a component of the engineered covers. However, note that the covers over RU 18 and 19 must also minimize infiltration. The last sentence must be revised to read, "The final cover design will integrate the slag into the landfill cover and be designed to minimize infiltration through the waste."

FMC Response:

The RI Update Memo has been revised in accordance with the comment.

84. Section 6.1.4, Page 6-23, RU 20 – Former Bannock Paving Area

The source causing elevated nitrogen levels in monitoring well #139 must be identified.

FMC Response:

In the discussion of RU 20, FMC will add the following:

> "During the EMF RI, elevated levels of nitrate were detected in groundwater samples from Well 139, located approximately 450 feet west of the coke drying scrubber basin. The source of this nitrate was not confirmed during the EMF RI. Subsequently, a potential source has been identified. Wet coke was stockpiled in the area of Well 139 before the coke was dried and used in the elemental phosphorus production process. Coke production is a major source of ammonia sulfate, a fertilizer compound, and wet coke can contain a significant amount of ammonia because it has not been fully dried. The wet coke stockpile was not covered or lined, so precipitation could infiltrate the wet coke, oxidize and leach ammonia, and ultimately transport it to the uppermost aquifer. The Eh in the vadose zone would also allow mobilized ammonia to oxidize to nitrate as it was transported through the vadose zone."

The RI Update data gaps discussion for RU 20 now states that the residual coke characterization will include leachability testing for ammonia and nitrate to confirm the source of elevated nitrate in Well 139.

85. Section 6.1.4, 6-25, RU 5 – Lab and Old Drain Field

Additional VOC and semi-VOC samples must be collected to complete the characterization at this RU.

FMC Response:

The following text was improperly inserted in the discussion for RU 4. The RI Update Memo has been revised, and the following discussion will apply to RU 5:

> "Although the EMF RI did not identify the disposal area behind the lab as a potential source to groundwater, additional characterization is needed for VOCs in the shallow soils in order to reach a no further action decision or if the area should be evaluated in the SFS. If VOCs are detected, limited hotspot remediation will be evaluated in the SFS."

86. Section 6.1.4, Page 6-20, Methods, 2nd Paragraph, 4th Item

It is not appropriate to exclude site data indicating contamination has migrated below 10 feet. Even though there may be no current or future exposure risk pathway, the remedy may require measures to protect the aquifer from degradation consistent with USEPA's Groundwater Protection Strategy and Idaho's Groundwater Quality Rule. Therefore, all data must be included in the evaluation.

FMC Response:

As set forth in the SOW, the focus of the SRI is to delineate areas where surface and subsoils could potentially pose risks under future worker scenarios. Some utility work may occur to depths of 10 feet, therefore, this maximum depth was selected as the cut-off for the statistical analysis.

Deeper soils data and fate and transport of COPCs to groundwater were evaluated and results were presented in the EMF RI Report. The RI Update Memo was not intended to re-evaluate the fate and transport of COPCs in groundwater at the EMF Site.

87. Section 6.1.4, Page 6-20, Methods, 2nd Paragraph, 2nd Item

This item states that, *"there were no "R" flagged data in the dataset."* This statement is not correct. Tables C-14 and C-24 indicate R flagged data for thallium. The text should be revised to address this inconsistency.

FMC Response:

The commenter apparently misunderstood the context of the text referred to in the comment, which is a generic discussion of the methodology rather than a statement of fact. The entire description of this step states:

"Analytical data were also reviewed for data quality to determine:

1. The detection limits were lower than levels of concern (RBCs, background, etc.)
2. There were no "R" flagged data in the dataset, "R" = analytical results rejected during the QA process. The "R" flagged data were not used in the statistical analyses."

FMC believes the text is clear and that no revisions are necessary.

88. Section 6.1.4, Page 6-21, Methods Comments of Shapiro-Wilk Test & Nondetects

There are a number of constituents that have small data sets with greater than 15% nondetected values. For samples with nondetects, the normal distribution assumption is invalid and should be removed. The following tables indicate those RUs and constituents that have between 15% and 50% nondetects, and greater than 50% nondetects. Until a new data analysis related to censored data is performed, the conclusions regarding the comparison to action levels are not valid.

Constituents with between 15% and 50% censored data (U and UJ) in analysis:

RU	Site Worker RBC	Construction Worker RBC	Utility Worker RBC	Background
RU 1		Be, Se		
RU 4		As, Be	As, Be, Pb, Hg	As, Be, Pb, Hg
RU 7	Li, Se	B, Cd, Li	B, Cd	B, Cd
RU 9		Be, B, Co, Pb, Hg, Se,		Pb, Li
RU 12		B, Cd, Pb	Cd, Pb, Li	Cd, Cu, Pb
RU 13			B, Hg, Se	B, Hg, Se
RU 20	Se	B, Co, Ag	Co, Li	Co, Li

Constituents with > 50% censored data (U and UJ) in analysis:

RU	Site Worker RBC	Construction Worker RBC	Utility Worker RBC	Background
RU 1		Sb, B, Cd, Mo, Ag, Tl	Sb, Be, B, Cd, Mo, Se, Ag, Tl	Sb, Be, B, Cd, Mo, Se, Ag, Tl
RU 4		Sb, B, Cd, Mo, Se, Ag, Tl	Sb, B, Cd, Mo, Se, Ag, Tl	Sb, B, Cd, Mo, Se, Ag, Tl
RU 7	Sb, Pb, Hg, Mo, Ag, Tl	Sb, Pb, Hg, Mo, Se, Ag, Tl	Sb, Pb, Hg, Mo, Se, Ag, Tl	Sb, Pb, Hg, Mo, Se, Ag, Tl
RU 9		Sb, Mo, Ag, Tl		Sb, B, Hg, Mo, Se, Ag, Tl
RU 12		Sb, As, Hg, Mo, Se, Ag, Tl	Sb, As, B, Hg, Mo, Se, Ag, Tl	Sb, As, B, Li, Hg, Mo, Se, Ag, Tl
RU 13			Sb, Mo, Ag, Tl	Sb, Mo, Ag, Tl
RU 20	Sb, As, Cd, Co, Pb, Li, Hg, Mo	Sb, As, Cd, Pb, Li, Hg, Mo, Se, Tl	Sb, As, B, Cd, Pb, Hg. Mo, Se, Ag, Tl	Sb, As, B, Cd, Pb, Hg. Mo, Se, Ag, Tl

For samples where > 50% of the data are nondetects, nonparametric methods are appropriate.

FMC Response:

As discussed with the agencies during the August 3rd coordination meeting, the following approach has been adopted in the December 2004 RI Update Memo:

1. For sample sizes >4 but <10, the 95% UCL of the mean will be calculated using a non-parametric technique. This will negate any underlying distribution assumption, and no tests for distribution will be performed or presented. Where non-detects are included in the dataset, the procedures outlined in "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites" Appendix A (EPA, 2002), will be applied.

2. No testing of sample size sufficiency will be conducted where the 95% UCL of the mean is less than 1/10 the lowest RBC value This is because checks on sample size sufficiency are meant to determine if the desired power (i.e., ability to reject the null hypothesis when it is false) in a test has been achieved. When the test rejects the null hypothesis, then power is not an issue.

3. If the 95% UCL is within a factor of 10 of the lowest RBC value, the appropriate estimation of the variance will be made and the sample size sufficiency will be analyzed.

4. For depth intervals and RU's where there are <4 samples available, no statistical tests will be performed, and a data gap will be identified (the DQO process will be used to determine the number of samples needed, and this will be documented in the SRI Work Plan).

5. Regarding the issue of correlation, the geologic conditions at the FMC Plant OU and the spacing of the borings argue against correlation, either horizontal or vertical. Native soils at the FMC Plant OU are loess, a wind-blown silt. These soils were the first encountered in most of the borings that penetrated native soils. Given the geologic processes that affected the deposition and sorting of the loess, there is no reason to assume samples would be correlated (i.e., concentrations from one sample would be directly dependent on a nearby sample). Furthermore, the descriptions on the boring logs indicate the shallow soils are reasonably homogeneous. (Appendix B of the EMF RI Report).

Regarding the combining of datasets, the RI Update Memo will separately evaluate the slag data, ferrophos data, and the native soils data at various RU's, rather than combining data. The 95% UCL for the fill materials and the native soils will be compared to the RBCs as distinct populations. This approach should also address the issue of bimodal distribution and provide a more defensible decision when determining exposure point concentrations.

89. Section 6.1.4, Page 6-21, Methods

Given the limitation of the Shapiro-Wilk test for small sample sizes as discussed in the previous comment, the tables in Appendix C are inadequate. The calculated W value for each data analysis must be included and additional methods must be assessed for determination of distribution. As skewness is an important assumption in the distribution calculation, the tables in

Appendix C should include the calculated skewness of the data population. It should be noted that taking ½ of the censored data alters the skewness of the true, unknown, population, again raises the question of the appropriateness of the test. The correlation coefficient from a Q-Q plot can give another indication of the normality of the data set.

FMC Response:

Please refer to the response to Specific Comment 88.

90. Section 6.1.4, Page 6-21, Methods, Comments on Sample Size & CLT

The sample size equation is not included in the document, but the use of the EPA DQO process implies that the following formula may have been used:

$$n = \frac{\left(z_{1-\alpha} + z_{1-\beta}\right)^2 s^2}{\Delta^2} + \frac{z_{1-\alpha}^2}{2}$$

If this is, in fact, the formula that was used, then the following comments apply. If another equation was used, then the formula must be included along with a discussion of the assumptions used in the derivation of the equation and how those assumptions relate to the calculated n value.

First, it is assumed that data are drawn from an approximately normal distribution. Second, it is assumed the data are uncorrelated. It is not clear that the data are uncorrelated. The document must be revised to discuss sample depth and sample location in order to assess the appropriateness of assuming the data are uncorrelated.

FMC Response:

Please refer to the response to Specific Comment 88. The appropriate equations and discussion are now incorporated into Section 6.1.4, Step 4.

91. Section 6.1.4, Page 6-21, Methods

For a number of RUs the number of samples used for a statistical analysis is not large enough. Gibbons (2003) indicates that a minimum of 20 samples is needed to provide the best confidence limit result having adequate power. The following tables indicate those situations where decisions were made with insufficient data based on the assumptions inherent for a statistical approach.

RU	**Site Worker RBC**	**Construction Worker RBC**	**Utility Worker RBC**	***Background***
RU 1		4	5	9
RU 4		6	10	14
RU 7	7	14	17	17
RU 9		4		17

RU 12		17 or 12	29 or 22	42 or 35
RU 13			4	4
RU 20	7	13	17	17

Decisions based on statistics without an adequate data set are not valid. Either the RI Update Memo needs to describe how an adequate number of samples will be collected, or an alternate approach must be proposed to evaluate the data.

FMC Response:

Please refer to the response to Specific Comment 88.

92. Section 6.1.4, Page 6-21, Methods

For each RU where data has been combined from various types of sampling, an evaluation needs to be done to show whether the data sets can be combined into one data set. The same analyses must assess whether soil samples from < 10 feet are from the same population as data from > 10 feet.

It is statistically inappropriate to combine data sets without first demonstrating that the data comes from the same populations. As an example, the 17 data for RU 20 are composed of ten soil samples, six slag composite samples, and one ferrophos composite sample. If the separate data sets have a normal distribution, then the F-test can be used to test whether the standard deviation are the same and the t-test can be used to test whether the means are the same. If the separate data sets are nonparametric, then other tests can be used to check whether the data sets can be combined (e.g. Levene's test, Kruskal-Wallis test).

FMC Response:

Please refer to the response to Specific Comment 88.

93. Section 6.1.4, Page 6-21, Methods

The document states that the ProUCL software was used to calculate the 95% UCL. Appendix C of the current document has chosen methods that do not conform to the ProUCL guidance documentation. These methods must be corrected or explained.

Specific deviations for constituents with log-normal distributions but where different methods were chosen methods as compared to ProUCL guidance Table A.2 include:

RU	Site Worker RBC	Construction Worker RBC	Utility Worker RBC	Background
RU 1			Ni	F
RU 4		As, Co, Hg, Mo, V, Zn	B, Hg, Ni, Se, V	Al, B, Li, P, K
RU 7	As	As, Pb, Li, Hg	Ba, Mn, Hg	Al, Ba, Mg, Mn, Hg
RU 9				Li

RU	Site Worker RBC	Construction Worker RBC	Utility Worker RBC	Background
RU 12		Ba	Ba	
RU 13				Al, Ca
RU 20		Mn, Se		

FMC Response:

Please refer to the response to Specific Comment 88.

94. Section 6.1.4, Page 6-24, RU 4, 4th Paragraph

It is unclear why the laboratory seepage pit and the disposal area behind the laboratory are discussed in the section for RU 4, as Figure 6-25 suggests that these SWMUs are located in RU 5. Clarify this inconsistency.

FMC Response:

The discussion of the laboratory drainfield and the disposal area behind the laboratory is now included in RU 5, not RU 4.

95. Section 6.1.4, Page 6-24, RU 4, 4th Paragraph

The EMF RI data suggests that there has been migration of organic contaminants to depth from this disposal pit. It is unclear whether groundwater has been impacted at this site. Based on review of the limited existing data, the conclusions that there is no source of organic compounds to groundwater from this site or that no soil impacts have occurred is not supported. The RI Update Memo must be revised to indicate that that some contaminant migration has occurred but that the existing groundwater monitoring network does not indicate a contaminant plume emanating from these sites.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004. The text has been revised to state:

"The remediation vision for RU 4 is "no further action anticipated to be necessary". However, during the EMF RI, toluene was detected in boring F028B in low levels in all sampled soil horizons. The VOCs detected in F028B are thought to be associated with the Chem Lab Seepage Pit (SWMU 39). Although the EMF RI concluded that there were was no indication of a VOC source to groundwater, there is some uncertainty and additional characterization will be needed."

96. Section 6.1.4, Page 6-25, RU 4, Last Paragraph

Since no samples have previously been collected from the disposal area behind the laboratory, it is premature to conclude that this site could not be a potential source of groundwater contamination. Organic compounds were detected at depths of up to 70 feet beneath the

laboratory seepage pit. The SRI must investigate the nature and extent of contamination (including contaminant migration) in this area and at RU 5.

FMC Response:

This comment was addressed in the proposed RI Update Memo revisions submitted to EPA on September 7, 2004. In these revisions, FMC noted that there is a potential for groundwater impact at this area that will be investigated during the SRI.

97. Section 6.1.4, Page 6-26, RU 9, 1st Paragraph, Last Sentence

A description of the "silica" that was used to backfill the kiln scrubber overflow pond (e.g., was this material a coarse siliceous sand or a fine-grained, manmade product) must be provided.

FMC Response:

The RI Update Memo has been revised to note: "Silica was formerly a process feedstock and is a naturally-occurring weathered quartzite that was mined at the Wells Cargo Mine, approximately 7 miles south of the FMC facility. Silica was crushed and screened at the mine then stockpiled on the plant site. Silica used in the elemental phosphorus process had a typical diameter ranging from 0.5 to 1.5 inches."

98. Section 6.1.4, Pages 6-26 & 6-27, RU 9

This section appears to include the kiln scrubber overflow pond, although the text is not clear regarding the ditch leading to it. It would seem more appropriate to include the kiln scrubber overflow pond and ditch with RU 8 based on process knowledge.

FMC Response:

Please see response to Specific Comment 71. The portion of the ditch within the boundaries of RU 9 are considered part of RU 9, the portion of the ditch that falls within the boundaries of RU 8 is considered part of RU 8. Please see Figures 6-8 and 6-31.

99. Section 6.1.4, Page 6-28, RU 12, 1st Paragraph

The document must state whether the EMF RI sampled for TPH in this RU. The sample depths and results for this data must be provided.

FMC Response:

The RI Update Memo has been revised to note that twelve samples were collected and analyzed for TPH in RU 12 during the EMF RI, recognizing that TPH is within the CERCLA petroleum exclusion. Sample depths ranged from 0.5 to 3 feet, and the reported TPH concentrations ranged from 30.1 mg/kg to 9025.2 mg/kg. Nine of the twelve samples had reported concentrations less than 200 mg/kg. Results are discussed in Section 4.2.3 of the RI Report (pages 4.2-122, 123, 131-135, and 138).

100. Section 6.1.4, Page 6-28, RU 12, 2nd Paragraph, 3rd Sentence

Additional information must be provided regarding the evidence suggesting the underground pipes leaked. Indicate what contaminants were detected, what contaminants were expected based on process knowledge of wastes carried through those pipes, whether the EMF RI looked for the entire suite of contaminants expected to be present in releases from the pipes, and the depths of contamination investigated and found.

FMC Response:

The RI Update Memo has been revised to note: "The EMF RI investigated the pipeline cleanouts located in RU 12. These pipelines transported phossy water to the ponds, where the solids were allowed to settle. Cleanouts were placed to access these pipes in the event they became clogged with phossy solids.

Inorganics and radionuclides were analyzed from soil samples collected around the pipeline cleanouts. The typical suite of phossy water constituents were detected in the shallow soil samples (cadmium, fluoride, zinc in addition to orthophosphate, arsenic, and several trace metals). Borings were drilled to depths ranging from 7 to 25 feet from grade. A detailed review of the results of this investigation is presented in the EMF RI Report, Section 4.2, pages 97-106."

101. Section 6.1.4, Page 6-29, RU 12, Last Paragraph

The document must discuss process knowledge regarding PCB use in this RU. It is unclear why PCB hotspots are a concern. Figure 6-36 identifies the location of a PCB storage shed. Clarify whether this is the only potential PCB source in this area, or if there is any indication that PCBs may have been stored or disposed elsewhere in this RU.

FMC Response:

The potential for PCB hotspots is a concern because PCB transformer oils were stored in the PCB Storage Shed. The EMF RI analyzed shallow soil samples for PCB's in this area. However, FMC believes that additional sampling is needed to support a decision at the appropriate confidence levels regarding the presence/absence of PCBs in isolated areas (i.e., "hotspots"). The PCB Storage Shed is the only area where PCBs were stored in this area. The PCB Storage Shed was a concrete block structure with a concrete floor; there was no visible staining of the floor or walls prior to its demolition. The PCB Storage Shed no longer exists; it was removed during construction of the LDR Treatment System in 2000 and the area was regraded.

102. Section 6.1.4, Page 6-30, RU 15 & Figure 6-40

Based on review of Figure 6-40, it appears that only one boring, F127B, was completed within the RU boundaries. Boring F108B was completed to a depth of only 2.5 feet in the roadway to the west of this RU, and would not be expected to be representative of site conditions in RU-15. Based on the figure, this boring was located east of the RU boundaries also in a roadway. Provide a reference to an EMF RI table containing information regarding boring F163B.

FMC Response:

The December 2004 RI Update Memo has been revised to note: "Boring 163B was initially drilled to install a groundwater monitoring well. However, water-yielding material was not encountered. A single sample from a depth of 21 feet was analyzed for selenium. Results for this analysis were ND (1.4 mg/kg UJ). This information was not discussed in the RI Report, but was submitted to EPA during the RI."

Shallow samples from Boring F108B are representative of shallow materials at RU 15.

103. Section 6.1.4, Page 6-30, RU 15 & Figure 6-40

Based on the RU description presented in Figure 6-39, wastes at this site are heterogeneous consisting of mounds of reject ore, baghouse dusts from multiple sources, and pieces of carbon electrodes. No information is presented to indicate the type of wastes present in the immediate vicinity of boring F127B. A characterization of these wastes must be provided.

FMC Response:

The December 2004 RI Update Memo has been revised to note: "A characterization of the wastes around boring F127B was presented in the EMF RI Report, page 4.2-166. The boring encountered calciner pond sediments at a depth of 5 feet, and native soils below that interval. See also Table 4.2.3-33 of the EMF RI Report for the data from boring F127B."

104. Section 6.1.4, Page 6-30, RU 15 & Figure 6-40

A discussion regarding the depth of contaminant migration observed in Boring F127B, and whether it would be reasonable to expect this depth of migration throughout this RU, given the heterogeneous waste materials present must be provided. This information will be required for cap design.

FMC Response:

The RI Update Memo has been revised to note: "As noted in the EMF RI (Section 4.2, page 4.2-166), only orthophosphate and potassium were detected at concentrations significantly exceeding background levels in samples from 15', 25', and 35' in boring F127B. Metals were near or below background levels in these samples.

A sample collected from a depth of 5 feet in the native soils showed concentrations of potassium, orthophosphate, total phosphorus, boron, thallium, and zinc that were above background levels (however, all were significantly below the updated RBCs).

Given the location of F127B, it is reasonable to expect similar depths of migration in other locations of RU 15 because the materials stored in RU 15 were dry (no free liquids), and data associated with ore and calciner solids indicate constituents of concern are not mobile. Coke dust was from coke that was received dry and handled within RU 7 before entering the furnaces, so the presence of soluble ammonia is not expected at RU 15."

105. Section 6.1.4, Page 6-30, RU 15

This RU discussion is confusing. The remediation vision presented in the fourth paragraph suggests that the RU poses an unacceptable risk. However, this does not appear to be supported by the data that are briefly mentioned in the sixth paragraph. Although there are insufficient samples to compare statistically to RBCs or background concentrations, the last paragraph concludes that there are no data gaps. It is unclear whether an unacceptable risk has been identified at this RU, or whether an unacceptable risk is simply presumed based on process knowledge of waste materials present. The text must be modified to clarify these issues.

FMC Response:

Based on data collected during the EMF RI, ore exceeds the Site Worker RBC for arsenic, and ore is the primary material stored within RU 15. Therefore, it was concluded that RU 15 poses an unacceptable risk to future site workers via direct exposure. The text has been revised to reflect this.

106. Section 6.1.4, Pages 6-31 & 6-32, RU 23, 1st Paragraph

The document must be revised to clarify which road segments are included in this RU. The text states that Figure 3-1 identifies the road segments in this RU, but roadway borings are shown both inside and outside of the RUs on this Figure. Additionally, the legend in the upper right corner of Figure 3-1 states that RU 23 road segments are "not shown." This is especially confusing because individual RU Figures (e.g., Figure 6-40) also depict roadway borings that appear to be outside of the RU boundaries. For example, it is unclear whether borings F108B and F163B are intended to be included as data for RU 15 or RU 23.

FMC Response:

All road segments that are not within the other RU boundaries, but within the FMC Plant OU area, are considered part of RU 23. All plant roadways are shown in Figure 3-1, and the note has been revised, as noted above.

Borings F108B and F163B are included in the dataset for RU 15, not RU 23.

107. Section 6.1.4, Pages 6-31 & 6-32, RU 23, 1st Paragraph

The rationale for separating the road segments into various RUs should be explained. It may be more appropriate to include all shallow roadway borings under RU 23, since the same road construction materials were probably used throughout the facility.

FMC Response:

The RU boundaries were primarily developed based on similarity of use and contaminants within the RU, but FMC also considered establishing the RUs as logical parcels for redevelopment. The decision to include road segments within the RU itself is logical, because redevelopment projects would not likely use the existing roads, particularly if the road falls in or near the middle of new parcels/lots. Road materials sampled within the RU boundaries are part of the dataset

that characterize future worker (site workers, construction workers, and utility workers) exposure to COCs and COPCs.

The rationale was presented in the Scoping and Planning Memorandum (FMC, 2003).

108. Section 6.1.4, Pages 6-31 & 6-32, RU 23 - Statistical Summary and Data Gaps

The text states that statistical analyses were not performed for inorganic constituents within RU 23 because there were insufficient data, but instead refers to the analysis conducted under RU 20. However, review of EMF RI table 4.2.3-20 and EMF RI text (pages 4.2-125 though 4.2-138) indicates that numerous borings were completed in and just beneath the roadways, and included inorganic analyses, radionuclides, and occasionally TPH and PCBs. It is not clear why these data are not used. The document must include this information.

FMC Response:

The RI Update Memo has been revised to note: "Most of the road samples were collected on road segments that are within the boundaries of other RU's. The practice adopted for the RI Update Memo was to evaluate the data only within the boundaries of an RU (with the exception of slag composite samples). Therefore, all of the road characterization data are used in the RI Update but there were insufficient data to evaluate road segments that are outside the boundaries of RUs 1 through 22."

109. Section 6.1.4, Pages 6-31 & 6-32, RU 23 - Statistical Summary and Data Gaps

Under the "Data Gaps" subsection, the only data gap identified is gamma radiation. However, review of the above-referenced EMF RI data indicates that inorganic constituents were commonly found in excess of comparison criteria in these shallow roadway borings. All COPCs must be compared to RBCs and those exceeding the RBCs must be sampled for unless a presumptive containment remedy is being proposed.

FMC Response:

The RI Update Memo has been revised to note:

"Because the roads are made of a slag road base, FMC believes the inorganics on roadways require no further characterization. However, gamma radiation from slag has not been adequately characterized for individual road segments."

In addition, the RI Update Memo has been revised to show that precipitator dust was applied to FMC roads in the past to provide traction in winter months. Lead-210, the primary COC in precipitator dust will be characterized on roads to support the SFS.

110. Section 6.1.4, Pages 6-31 & 6-32, RU 23 - Statistical Summary and Data Gaps

Since previous roadway sampling did not include analyses of surficial materials, all COCs present in the roadway materials have not been taken into account, and the results are not representative of site risks. As indicated above, inorganic constituents were commonly detected above EMF RI comparison criteria, and radionuclide samples were not collected and analyzed.

The text must be modified to identify radionuclides and other COPCs as data gaps that require additional sampling.

FMC Response:

During the EMF RI, 48 samples of surficial materials were collected and analyzed for inorganics (48 samples), organic compounds and/or TPH (17 samples), PCBs (17 samples), and radiological parameters (32 samples). These samples are representative of the surficial roadbed material because of frequent road maintenance and constant heavy equipment traffic on plant roadways would have mixed material deposited on the surfaces into the upper 6 to 12 inches of road base. FMC had a road grader dedicated to maintaining unpaved roads.

As described in the response to General Comments #3 and #4, FMC will characterize radionuclides in roadbed materials. Specifically, Pb-210 and Po-210 associated with the past use of precipitator dust in winter months.

Please see the revised discussion of data gaps for RU 23 in Section 6.1.4.

111. Section 7, Page 7-1, Summary and Next Steps

This summary must take into account radionuclides known to be present at the site. Currently, descriptions of risks associated with radionuclides are limited to gamma measurements. Risks from individual radioactive constituents in facility wastes (including slag, precipitator dust, calciner wastes, ferrophos, and other fill and wastes at the facility) need to be characterized. Radionuclide analyses needs to be discussed as a data gap and additional sampling needs to be conducted.

FMC Response:

The summary includes a review of radionuclides known to be present at the site. FMC disagrees with the position that risks associated with radionuclides in facility feedstocks, by-products, and waste materials require further characterization. Please refer to FMC's response to General Comments 3 and 4 with respect to this issue and the balance of this comment.

112. Appendix A, All Tables, General Comment Regarding Roadways within RUs

The following text appears under the "Post-RI releases that might have impacted environmental media" column. "Water withdrawn from the RCRA ponds during closure and treated in the waste water treatment unit (PCDT) system to meet the Universal Treatment Standards (UTS) applied to the roads in 2004 and 2005 for dust control. No documented post-RI releases to roads." The two sentences are somewhat confusing and appear to be inconsistent with one another. This issue must be discussed in more detail in this document. For example, it is unclear whether the pond liquids contain radionuclides that would increase cumulative risks in the application areas. Likewise, it is unclear whether repeated applications of fluids with hazardous constituents at UTS concentrations could appreciably add to the CERCLA cumulative risks determined for the roads. Information must be provided regarding the application rates, volumes, and frequency of application. A demonstration that the application process is

protective and not inconsistent with the CERCLA SRI, and will not enhance contaminant migration should be included. The document should reference or include this evaluation.

FMC Response:

The December 2004 RI Update Memo has been revised to note: "An evaluation of the application process was performed and the results submitted to EPA in a transmittal dated November 21, 2003. There was no indication that use of treated pond water for dust suppression would adversely impact the road materials. The mass of applied constituents was calculated, and the estimated increase in concentrations/activities was well below the 1998 RBCs."

Water application rates are intended to only wet the road surface, which will not provide a mechanism for deeper migration of dissolved constituents. For example, the water applied to roads over an eight-month period from March through October will be approximately 13 inches. Evaporation potential in this area of Idaho exceeds 40 inches per year while the Mean Annual Precipitation is 11 inches per year.

Water is not applied to roads after rain events. It is only applied when dust abatement is required. This practice further reduces the potential for mobilizing constituents in the roadbeds.

113. Appendix A, Section A.2, Page A-2, Figure A-3: FMC Facility Summary (Actual figure located in Section 4.2.3.1 EMF RI Report), Fourth Bullet

A review of the Roads subsection of the EMF RI (RI pages 4.2-125 through –138, and Tables 4.2.3-20 and 4.2.3-6) indicates that contamination was commonly detected as deep as sampled. In such instances where the deepest sample collected was from a depth of approximately two feet, and analyte concentrations in that sample exceed comparison criteria, it should not be concluded that the soil beneath that depth was not impacted. In some cases, samples were collected below 2 feet, and some of the analytes detected at those deeper depths exceed comparison criteria in the RI. The existing data should be compared to the new RBCs to ensure that the existing sample concentrations do not exceed RBCs. If additional data is necessary the RI Update Memo must be revised to indicate this is a data gap.

FMC Response:

The comment refers to a quotation of a summary bullet reprinted from the EMF RI Report. The EMF RI Report was approved by EPA in 1996. It is not within the scope of the RI Update Memo to revise the EMF RI Report.

114. Appendix A, Section A.3.1, Page A-4, 5th and 6th Bullets

Although the IWW discharges and stacks/vents/other plant air emissions have ceased with plant shutdown, it is not clear how contamination resulting from historic releases from these SWMUs is being addressed. The document must be revised to address these sources.

The RI Update Memo must include a discussion of the IWW sediment that is buried at the site, the buried former CO flare pit, and other areas now buried at the facility.

FMC Response:

The EMF RI, HHRA, and Ecological Risk Assessment (BERA) evaluated historic releases from these SWMUs that may have impacted areas outside the FMC Plant OU. Section 6 of the RI Update Memo identifies data gaps associated with characterization of IWW sediments remaining within the FMC Plant OU. The slag berm surrounding the former CO Flare Pit and slag within the perimeter of the Flare Pit were removed during construction of the Excess CO Combustor. FMC believes that no residual contamination remains within the footprint of the former CO Flare Pit. FMC is not aware of any units now buried at the facility that were not already identified in the June 2004 draft of the RI Update Memo.

115. Appendix A, Section A.2, Page A-2, Figure A-3: FMC Facility Summary (Actual figure located in sec. 4.2.3.1 EMF RI Report), Sixth Bullet

A review of the Roads subsection of the EMF RI (RI pages 4.2-125 through –138) indicates that TPH contamination was sometimes detected as deep as sampled. In these instances, it should not be concluded that TPH is not detected at depth in these locations. This must be discussed in the RU summary and additional data collection proposed.

FMC Response:

Please see response to Specific Comment 113.

116. Appendix A, Section A.2, Page A-2, Figure A-3: FMC Facility Summary (Actual figure located in sec. 4.2.3.1 EMF RI Report), Last Paragraph, Last Sentence

The limited data for organic contaminants collected during the original RI indicates contaminant migration from the waste zones under conditions without sustained hydraulic head. Additionally, some inorganic contaminants appear to have migrated out of the waste zone at some sites that do not have sustained hydraulic heads (e.g., RU 16). Discussion in other sections of this document needs to make it clear that the conclusions in the 1991 RI Report may not be supported by the existing data.

FMC Response:

Please see response to Specific Comment 113.

117. Appendix A, Section A.3, Page A-2, Table A-16, SWMU-17, Storage Area B

It appears that some of the borings described under the "EMF RI Findings" column were actually drilled in RU's 14 or 15 (i.e., F128B, F050B, and F127B). Please delete references to these two borings from the RU17 line item, and move to the appropriate RU descriptions.

FMC Response:

The appropriate revisions have been made in the December 2004 RI Update Memo.

118. Appendix A, Section A.3, Page A-2, Table A-16, SWMU-17, Storage Area B

The information presented in the "Current Status" column indicates that a soil cap was installed over this portion of RU 16 in 1993. This information must be discussed in the RU 16, Section 6 of RI Update, since it will be important for remedial design. Section 6 must be revised to describe the extent of the 1993 remediation effort, including cover materials, lateral extent, cover thickness.

FMC Response:

Agreed. Information regarding the partial cover is presented in Section 6.

119. Appendix A, Section A.3.1, Page A-4, 4th Bullet

The limited data for organic contaminants collected during the original RI suggests that at some sites there appears to be, or the potential exists for, contaminant migration from the waste zones under conditions without sustained hydraulic head. Currently, there may not be monitoring wells located appropriately to intercept potential releases from these sites. Please delete this bullet and modify the conceptual site model to depict this potential release mechanism.

FMC Response:

Please see the proposed document revisions submitted to EPA on September 7, 2004. SWMUs where materials containing free liquids may have been managed are identified in Appendix A.

120. Appendix C, Title page, Appendix C

The Statistical Analysis Site Data Comparisons With: 1998 RBC's, Updated Site Worker RBC's, Construction Worker RBC's Utility Worker RBC's, and Background, must be updated to include RBCs for radionuclides as discussed in other comments.

FMC Response:

Please refer to FMC's response to Specific Comment 31 and related comments regarding radionuclide characterization.

121. Appendix C, Section RU 1, Page C-2, Table C-3

A brief review of Table C-3 reveals the fifth number listed under the column labeled Antimony is 8.15. This value implies there should be a 16.3 ppm in Table C-1 under the Antimony column, but there is not. More thorough QA/QC procedures need to be used to address possible transcription errors that could affect data analysis.

FMC Response:

Agreed. A detailed check will be made of all data used in the statistical analyses.

122. Appendix C, Section RU 20, Page C-4, Table C-26, All Data Columns

It is not clear how the 13th data point was chosen for this RU. In all previous tables, the Construction Worker RBC was based on the combined data from 0-2 feet and 2-6 feet. For RU 20, those two data sets would be composed of a total of 12 data points. It is not clear why sample #F084B, obtained from a 7-foot depth, was added to each of these data sets.

FMC Response:

Agreed. An error occurred in the data manipulation, and this has been rectified in the December 2004 RI Update Memo.

123. Appendix D, General Comment

Note that although geotechnical data from a proposed borrow area are presented in this Appendix, these data cannot be evaluated for suitability as cover material until cap design is provided for review.

FMC Response:

Comment noted.

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Table G6: OLD PHOSSY WASTE POND INFORMATION

Pond	Material Received/History (from Appendix M of EMF RI Report and RI Update Memo)	Area (acres)	Est. Volume (yd3)	EMF RI soil and GW well borings within pond footprint	Were phossy pond solids encountered in boring/drilling?	Was P4 evidenced during boring/drilling?	Estimated P4 level	Is old pond overlain by a newer, capped RCRA pond?	Closely-spaced GW well Up = upgradient Dn = downgradient	Eh difference in upgradient and downgradient wells
00S	Phossy water and phossy solids. Former unlined pond. Pond location inaccessible; not an engineered structure, dimensions not available; no release controls known. Pond 00S thought to be beneath Mobile Equipment Shop. Characterization of unit expected to be similar to other former unlined S-series ponds.	0.1	No est. available	F060B	Yes (@ 0' to >2' bgs)	No	<1,000 ppm	No	na	na
0S	Phossy water and phossy solids. Former unlined pond. Not an engineered structure; no release controls known. Characterization of unit expected to be similar to other former unlined S-series ponds.	0.7	No est. available	F061B, F073B, F074B	No	No	<1,000 ppm	No	na	na
1S	Phossy water and phossy solids. Former Pond 1S was completed in about 1956, and had a surface area of only about one-half an acre (21,800 ft2). This pond contained slurry material to a depth of about 11 feet. Some P4 was reclaimed from this former pond between 1966 and 1972. Residuals from the reclaim operation were placed in Pond 3S. Pond 1S was dried and capped in 1972. The area was disturbed during the excavation of a power line trench in 1976, and the contents oxidized. In 1991, this area was estimated to contain about 2,850 tons (2,400 yd3) of phossy waste material.	0.5	2,400	na	na	na	>1,000 ppm (based on reported oxidation when sedimentes were exposed in 1976 trenching)	No	na	na
2S	Phossy water and phossy solids. Former Pond 2S was also completed in about 1956, and had a surface area of about 0.8 acre (34,850 ft2). Depth of slurry material was estimated to be similar to that in Pond 1S, or about 11 feet. Some P4 was reclaimed from this former pond between 1966 and 1972. Residuals from the reclaim operation were placed in Pond 3S. This pond was also dried and capped in 1972. In 1991, this area was estimated to contain about 1,050 tons (875 yd3) of phossy waste material.	0.8	875	B-4, B-5, F037B	Yes (B-4 @ 0' to >7 bgs; B-5 @ 0' to >6 bgs, F037B @ 23' to >24 bgs when drilling ceased)	Yes	>1,000 ppm (encountered P2O5 smoke during drilling)	No	na	na
3S	Precipitator slurry solids, slag pit water and solids, phossy water and phossy solids, residual from P4 reclaim operations. Former Pond 3S was constructed in November 1961. It was used from November 1961 until some time in 1965. It was routinely dug out twice a year during the time it was in operation. Between 1972 and 1976, phosphorus was reclaimed from the eastern 100 feet of this former pond, and the area was backfilled with slag. The rest of the pond area was dried between June and December of 1976, and then covered with dirt and slag. Pond 3S had a surface area of about 1.2 acres (52,300 ft2), and was about 20 feet deep. It is estimated to contain about 10,600 tons (8,800 yd3) of phossy wastes, primarily precipitator slurry.	1.2	8,800	na	na	na	>1,000 ppm	No	W133 (Dn); W134 (Dn)	Oxidizing conditions (W133 = 106 mV; W134 = 90 mV)
4S	Precipitator slurry solids. Pond 4S, located south of Pond 3S, was constructed in April 1966. This pond, with an area of 0.8 acre (34,850 ft2) operated for a period of about one year, receiving precipitator slurry. This pond was estimated to contain about 6.4 feet of slurry, or an estimated 7,800 tons (6,500 yd3) of phossy waste material (precipitator slurry). It was isolated for drying in June of 1976, and covered with dirt and slag in the latter part of the year.	0.8	6,500	na	na	na	>1,000 ppm	No	W159 (Up)	Reducing conditions Eh: W159 = -119
5S	Phossy water and phossy solids. Pond 5S received primarily phossy water and phossy solids, creating a residual waste with a very high phosphorus content. This pond had an area of about one acre (43,560 ft2) and contained residual slurry to a depth of about 6.4 feet. This pond was in operation from 1965 through 1967. Closed and dried in 1975-76, it proved difficult to dry due to the high phosphorus content of the waste. It was covered with baghouse dust, dirt, fluid bed drier prills and dust, slag, and a soil cap over the top. It is estimated that about 10,200 tons (8,500 yd3) of phossy waste material remains in this former pond area.	1	8,500	na	na	No	>1,000 ppm	No	W141 (Dn)	Eh in W141 = -17 mV

Table G6: OLD PHOSSY WASTE POND INFORMATION

Pond	Material Received/History (from Appendix M of EMF RI Report and RI Update Memo)	Area (acres)	Est. Volume (yd3)	EMF RI soil and GW well borings within pond footprint	Were phossy pond solids encountered in boring/drilling?	Was P4 evidenced during boring/drilling?	Estimated P4 level	Is old pond overlain by a newer, capped RCRA pond?	Closely-spaced GW well Up = upgradient Dn = downgradient	Eh difference in upgradient and downgradient wells
6S	Precipitator slurry solids, phossy water and phossy solids. Pond 6S was about twice the size of any of the earlier ponds, with a surface area of about 2.3 acres (100,200 ft2), and a depth of about 4 feet. This pond operated from 1967 through 1969 and received primarily precipitator slurry, with some phossy water and phossy solids. The phossy solids were placed in the northeast corner. This pond was dried in 1976, capped with slag and dirt, and a new haul road was constructed over the south end of the area. It is estimated that about 29,500 tons (24,600 yd3) of phossy waste material remains in this former pond area.	2.3	24,600	F055B, F056B, F057B, F058B, F059B, W156	Yes (F056B @ 7' bgs, F057B @ 7' bgs, F058B @ 9' bgs, F059B @ 10' bgs, W156 @ 15' to 25' bgs)	No	<1,000 ppm	RCRA Pond 8S partiall covers south end	W151 (Up), 156 (within)	Eh in W151 = 18, W156 = -182
7S	Precipitator slurry solids with some phossy solids. Constructed in 1969 and in service for about 18 months, Pond 7S, at 3.6 acres (156,800 ft2), was the largest pond placed in service to that date. This pond received primarily precipitator slurry. When closed in 1980, there were some areas where there were high concentrations of phosphorus. These areas were capped with concrete. The entire area was then capped with 6 to 10 feet of slag and three feet of soil placed over the slag. This area is estimated to contain about 21,800 tons (18,200 yd3) of residual phossy wastes.	3.6	18,200	W155	No	No	>1,000 ppm	No	W159 (Dn)	Reducing conditions Eh in W159 = -119 mV
8S[4]	Phossy water and phossy solids, some precipitator slurry solids. Pond 8S was constructed in October 1970 and received phossy water. This pond was also used in a pilot phosphorus recovery project from 1982 through 1990. Pond 8S has a surface area of about 3.1 acres (135,000 ft2) and has about 15 feet of phossy wastes in the bottom. The volume of these wastes is difficult to estimate, as they have not been dried and capped as the other ponds have been. The volume after capping will probably be similar to that of Pond 7S, which is of similar size. The wastes in Pond 8S are high in phosphorus content. Pond 8S has been capped and certified closed under RCRA Interim Status Standards and is in post-closure care.	3.1	90,350	na	na	na	>1,000 ppm	RCRA Pond 8S is capped. Closure has been certified. The unit is in post-closure care.	W150 (Dn), W152 (Dn); B-13 (Dn), W155, W156, W157	Strongly reducing conditions (Eh in downgradient wells approx. -239 mV) W155=6.8, W156=-182, W157=-217
9S	Dried precipitator slurry solids..The four-acre (174,250 ft2) Pond 9S was constructed in 1971 to receive precipitator slurry. The pond operated until about 1974. In October of 1980, the material was dried in place without a cover, and the dried material was excavated and sold during the summer of 1981. This area was used as a storage area for dried precipitator dust between 1981 and July 1991. FMC discontinued the sale of precipitator dust as a product in July 1991. Some small local pockets of precipitator slurry may remain in this area, but in general, the material has been removed and sold.	4	0[1]	B-2, F034B	Yes (B-2 @ 2' to 5' bgs)	No	<1,000 ppm	No	W131 (Up); W132 (Dn)	Eh in W131 = 113 mV; W132 = -15 mV
10S	Fluid bed dryer slurry. A former pond for storage of precipitator slurry before processing in the fluidized bed dryer process, which ceased operation in 1986. Remaining precipitation slurry in pond has dried out and crusted over. No precipitation dust has been piled atop the dried pond 1.7 acres; single lined with no leak detection system.	1	8,050	na	na	na	<1,000 ppm	No	W135 (Dn)	Eh in W135 = 86 mV
1E	Phossy water and carryover fine solids from upstream ponds, precipitator slurry solids and dried slurry. Pond 1E was constructed in April of 1965 and had a variety of uses. This 1.9 acre (82,750 ft2) pond was used as a drying pond for various wastes, and for temporary storage of dried precipitator slurry. The pond was dried in October of 1980, but was used again as a temporary storage and loadout site for dried precipitator slurry dredged from ponds 8E and 9E. This area is estimated to contain about 10,800 tons (9,000 yd3) of residual phossy waste materials.	1.9	9,000	B-1, F033B	Yes (B-1 @ 0' to 4' bgs)	No	<1,000 ppm	RCRA Pond 8E covers north portion	W167 (Up)	Data Not Available
2E	Phossy water and carryover fine solids from upstream ponds. Former Pond 2E was a 3.3 acre (143,750 ft2) pond established in April 1965. It received phossy water and carryover fine solids from upstream ponds until October 1967. The site was also used for fluid bed drier product storage. This pond was excavated in 1984 for the construction of lined Pond 8E. The residual slurry materials were moved to nearby Pond 4E.	3.3	0[1]	na	na	na	<1,000 ppm	RCRA Pond 8E covers entire area	W103 (Dn); W104 (Dn)	Oxidizing conditions Eh: W103 = 209 mV; W104 = 151 mV

Table G6: OLD PHOSSY WASTE POND INFORMATION

Pond	Material Received/History (from Appendix M of EMF RI Report and RI Update Memo)	Area (acres)	Est. Volume (yd3)	EMF RI soil and GW well borings within pond footprint	Were phossy pond solids encountered in boring/drilling?	Was P4 evidenced during boring/drilling?	Estimated P4 level	Is old pond overlain by a newer, capped RCRA pond?	Closely-spaced GW well Up = upgradient Dn = downgradient	Eh difference in upgradient and downgradient wells
3E	Phossy water and carryover fine solids from upstream ponds. Pond 3E was put into service in May 1967 and received phossy wastes until September 1970. With a surface area of 10.4 acres (453,000 ft2), this was the largest unlined pond constructed at the facility. The pond received phossy water and carryover fine solids from upstream ponds. Some of this material was removed and sold. This pond was excavated for the construction of the lined Phase IV Ponds (11S, 12S, 13S and 14S) in 1980.	10.4	0(1)	na	na	na	<1,000 ppm	RCRA Phase IV Ponds cover entire area	W131 (Dn)	Reducing conditions Eh in W131 = -113 mV
4E	Phossy water and carryover fine solids from upstream ponds, precipitator slurry solids overflow. Pond 4E was also put into service in May 1967 and received phossy wastes periodically until 1982. Pond 4E had a surface area of about 1.8 acres (78,400 ft2). The pond received precipitator slurry overflow, residual solids from Pond 2E modifications, carryover fine solids from upstream ponds, and slag-contaminated dried precipitator dust. The site was also used for fluid bed drier product storage. This pond was dried in 1980 and the dried material was sold. As described above, the area was used occasionally for storage of waste materials between 1980 and 1982. This area, adjacent to the southern boundary of the Phase IV ponds (11S-14S), is estimated to contain about 34,850 tons (29,000 yd3) of residual phossy waste materials. The area has not been capped.	1.8	29,000	F024B	No	No	<1,000 ppm	No	na	na
5E	Phossy water and very minor carryover fine solids from upstream ponds. Former Pond 5E was a 6.6 acre (287,500 ft2) pond established in April 1968. This pond received wastes until 1972-1973. The pond received phossy water and minor carryover fine solids from upstream ponds. The pond was dried in October 1980, and 4 to 6 inches of dried gray dirt was removed and placed in the area just south of lined Pond 15S. New pond 15S was constructed in 1982 over former Ponds 5E, 6E, and the eastern portion of Pond 7E.	6.6	0(1)	F025B, W114	Yes (W114 @ 0' to 5' bgs)	No	<1,000 ppm	RCRA Pond 15S covers majority of area	W113 (Dn), W114 (Dn) W115 (Dn), W166 (Dn)	Eh: W113 = 72; W114 = -52; W115 = 23; W166 = Data Not Available
6E	Phossy water and very minor carryover fine solids from upstream ponds. Former Pond 6E was a 6.7 acre (291,800 ft2) pond established in November 1968. This pond operated in the same manner as Pond 5E, receiving wastes until 1972-1973. The pond received phossy water and minor carryover fine solids from upstream ponds. The pond was dried in 1981 and as described above, new lined Pond 15S was constructed in 1982 over former Ponds 5E and 6E.	6.7	0(1)	F026B, F101B, F101R, W129; W130	Yes (F101R @ 0' to 0.5' bgs)	No	<1,000 ppm	RCRA Pond 15S partially covers area	W129 (Dn); W130 (Dn); W137 (Dn), W165 (Up)	Oxidizing conditions Eh: W129 = 188; W130 = 216; W137 = 191; W165 = Data Not Available
7E	Phossy water overflow from upstream ponds. Pond 7E was a 4.3 acre (187,300 ft2) pond constructed in December 1969. This pond received overflow phossy water from upstream ponds. No solids were observed in this pond. In 1982 Pond 7E was partially excavated and the excavated materials were used in the construction of Pond 15S.	4.3	0(2)	F162B, W170, W172, W180, W182	No	No	<1,000 ppm	No	W170 (Dn), W171 (Dn), W172 (Dn), W180 (Dn), W181 (Dn), W182 (Dn)	Data Not Available

(1) Material was removed and placed in another pond,or sold and only thin layer of dried material remained. New ponds were constructed over all or part of the area occupied by this pond.

(2) Pond 7E was an overflow pond. Most of the pond was removed during the construction of Pond 15S.

(3) Area 9S was a former unlined pond that was excavated and used as a storage area for precipitator slurry solids. The volume of dried precipitator slurry solids remaining in the area is shown.

(4) RCRA Waste Management Unit closed under RCRA Interim Status Standards; in RCRA Post-closure Care status. Data included for comparison purposes to illustrate potential influence of unlined S-series pond that recently contained free liquids

APPENDIX F

RISK-BASED JUSTIFICATION FOR FMC'S PROPOSED APPROACH TO EVALUATING RADIONUCLIDES DURING THE SUPPLEMENTAL RI/FS

Appendix F
Risk-Based Justification for FMC's Proposed Approach to Evaluating Radionuclides During the Supplemental RI/FS

F1 Introduction

During teleconferences held between FMC, EPA, IDEQ and the Tribes on August 3 and September 15, 2004, FMC provided the results of technical analyses performed to support its case that gamma radiation dose rate measurements, in conjunction with targeted radionuclide-specific analyses, are sufficient to evaluate potential radiological risks associated with commercial/industrial worker exposure to surface soils within the Supplemental Remedial Investigation/Feasibility Study (SRI/SFS) of the FMC Plant OU. The Agencies subsequently requested that the methods, assumptions and findings of these analyses be documented in the revised RI Update Memorandum. Amongst other requests, the Agencies also asked that additional analyses be performed to confirm that the proposed approach is appropriate for evaluating potential risks to workers exposed to subsurface soils. The purpose of this appendix is to document the relevant radionuclide data, and the methods, assumptions and findings of the risk analyses. In addition, based on the findings of the risk analyses, an outline of the SRI approach that will be taken to collect data sufficient to evaluate RU-specific radiological risks to potential receptors is also provided. A comprehensive description of the approach will be provided in the SRI Workplan.

The information presented within this appendix is presented as follows: For background informational purposes, Section F2 summarizes the dialogue-to-date between FMC, EPA Region 10, IDEQ and the Tribes concerning the evaluation of radionuclides in the SRI/SFS. Available radionuclide data characterizing the various feedstock and waste stream source materials historically processed at the FMC Plant OU are presented in Section F3. Analyses performed to estimate radionuclide- and exposure pathway-specific contributions to total radiological risk to the receptor most highly exposed to surface contamination (future commercial/industrial worker) from exposure to each potential source material are presented in Section F4. Similarly, analyses performed to document the radionuclide- and exposure pathway-specific contributions to total radiological risk for the receptor most highly exposed to subsurface contamination (construction worker) from exposure to each potential source material are presented in Section F5. Based on the findings of the analyses presented in Sections F4 and F5, Section F6 provides an overview of the approach that will be taken to collect data sufficient to evaluate RU-specific radiological risks to potential receptors during the SRI. The references cited in this appendix are provided in Section F7.

F2 Background

In the June 2004 RI Update Memorandum (FMC, 2004), gamma radiation was identified as the sole measure of radiation-related risk to be considered in the SRI/SFS. This approach was proposed on the basis that the Human Health Risk Assessment (HHRA) of the EMF Site (E&E, 1996) concluded that external gamma radiation contributes the vast majority (over 95%) of the total potential risk associated with radionuclide exposure of future workers in the FMC Subarea (excluding indoor exposure to radon because, per the EMF ROD, future office buildings are to be constructed using radon control measures).

Preliminary EPA, IDEQ and Tribe comments on the draft RI Update Memorandum noted that the HHRA evaluation of radiological risks to future workers in the FMC Subarea was not based on actual measurements of specific radionuclide activities, and that radionuclide data should be obtained during the SRI to identify key risk driving constituents and pathways. Moreover, the Agencies commented that the approach of using gamma radiation dose rate measurements to evaluate radionuclide-related risks is not consistent with EPA guidance, and that radionuclide-specific measurements were necessary to fully characterize risks.

In response to the preliminary draft comments, FMC provided EPA, IDEQ and the Tribes with information regarding the available radionuclide-specific data for the various feedstocks and waste streams historically processed at the FMC Plant OU and how these data support the conclusion that external exposure to gamma radiation drives risks to commercial/industrial workers for all source materials (except phossy solids) at the FMC Plant OU. Moreover, information was provided to demonstrate that the proposed approach of primarily relying upon gamma radiation dose rate measurements to evaluate radiological risks during the SRI/SFS is not unprecedented. Specifically, this information, summarized below, was provided during two teleconferences between technical and managerial representatives of FMC, EPA Region 10, IDEQ and the Tribes that were held on August 3 and September 15, 2004.
During the teleconferences, FMC highlighted several EPA guidance documents that expressly identify circumstances under which it is desirable to collect direct exposure rate measurements of gamma radiation. Specifically, EPA's *Radiation Risk Assessment at CERCLA Sites: Q and A* (EPA, 1999) identifies the merits of collecting gamma radiation dose rate measurements, and deriving cancer risk estimates directly from these data (as discussed in the response to question 33 in EPA, 1999). EPA (1999) notes that this approach eliminates potential modeling uncertainties associated with estimating external gamma radiation exposure and concerns about the shape of the source (e.g., slag pile on the FMC Plant OU).

Illustrative of the Agencies' concerns raised in the preliminary comments on the June 2004 RI Update Memorandum, EPA (1999) also cautions that such data only reflect a sub-set of the radionuclides and exposure pathways of potential concern (e.g., only external exposure from gamma-emitting radionuclides in near-surface soil), and may present an incomplete picture of overall radionuclide-related site risks. EPA (1999) indicates that, in most cases, more accurate estimation of radiation risks will require additional site characterization data, including concentrations of all radionuclides of concern in all pertinent environmental media because of the potential for other pathways to contribute to overall risk. However, as discussed during the teleconferences and documented in Section F3, radionuclide-specific data characterizing the content of the various feedstocks and waste materials historically processed at the FMC Plant

OU are available. Moreover, as discussed during the teleconferences and presented in Sections F4 and F5, analyses of these data demonstrate that exposure pathways other than external exposure to gamma radiation do not contribute significantly to overall worker risk for all source materials of potential concern, with the exception of phossy solids. With respect to phossy solids, incidental ingestion and fugitive dust inhalation of lead-210 and polonium-210, together with external exposure to gamma radiation, contribute virtually all of the risk to workers exposed to this source material. Therefore, analyzing samples for lead-210 and polonium-210, in conjunction with taking gamma dose rate measurements, would adequately address radiological risks in areas found to contain phossy solids.

Further support for FMC's proposed approach is presented in the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),* which was developed by the Departments of Defense and Energy, EPA, and the Nuclear Regulatory Commission to provide detailed guidance for planning, implementing, and evaluating environmental and facility radiological surveys conducted to demonstrate compliance with a dose- or risk-based regulations (http://www.epa.gov/radiation/marssim/index.html). Specifically, page 4-7 of MARSSIM (EPA et al., 2000) states that measurement of exposure rates may be used as a surrogate for surface or volume activity concentrations for radionuclides that deliver the majority of their dose through the direct radiation pathway. That is, instead of demonstrating compliance with radionuclide-specific soil or surface contamination derived concentration guideline levels (DCGLs) (i.e., cleanup goals) for the direct radiation pathway, compliance is demonstrated by direct measurement of exposure rates. Furthermore, MARSSIM indicates that this surrogate approach may still be possible for sites that contain radionuclides that do not deliver the majority of their dose through the direct radiation pathway, provided that a consistent relative ratio for the radionuclides that do deliver the majority of their dose through the direct radiation pathway can be established. This approach, as described in Section F6, has been adopted for the SRI.

Finally, despite some guidance indicating that dose assessments should generally not be performed to assess risk or to establish cleanup levels, this approach has been applied at sites comparable to the FMC Plant OU. Specifically, one of the remedial action objectives (RAOs) established for off-site soils (property surrounding the plant) at the Monsanto elemental phosphorus production site located in Soda Springs, Idaho is to prevent exposure to radionuclides in soils at levels that pose cumulative estimated risks of 3E-04, by meeting a radiation effective dose equivalent of 15 mrem/year above background (EPA, 1997; EPA, 2003). Consequently, FMC proposed during the teleconferences to use the same target dose threshold in the SRI evaluation of radiological impacts at the FMC Plant OU.

As a result of FMC's August 3 and September 15, 2004 presentations, it was agreed that FMC's proposed approach to evaluating radionuclides in the SRI/SFS could be adopted provided that each of the following issues were satisfactorily addressed:

1. Documentation of the methods and assumptions used in FMC's August and September analyses that found that gamma radiation dose rate measurements could be used to evaluate risks from exposure to surficial deposits of all source materials of potential concern (except phossy solids) in the SRI/SFS, and that gamma dose rate measurements in conjunction with lead-210 analyses could be used to evaluate risks for areas found to contain surficial phossy solids;

2. Documentation of the basis for evaluating potential radiological risks associated with exposure to subsurface materials (i.e., construction worker, utility worker) during the SRI (Action Item 31 from the September 15 teleconference);
3. Documentation confirming that the sensitivity of gamma survey instruments (e.g., pressurized ionization chamber) is sufficient to observe an increased dose rate of 15 mrem/year above background for the commercial/industrial, construction and utility worker receptors (Action Item 30 from the September 15 teleconference); and
4. Development of an approach to ensure that risks (chemical and radiological) associated with potential redistribution of fill excavated during future site construction or utility trenching will be addressed in the SRI (Action Item 32 from the September 15 teleconference).

The purpose of this appendix is to address the first two followup issues described above (i.e., delineate and provide the technical justification for FMC's proposed approach to evaluating radionuclide risks from exposure to surface and subsurface fill in the SRI/SFS). Documentation of item 3 is provided in Appendix G of this report. Item 4 will be addressed in the SRI Workplan.

F3 Radionuclide-Specific Data

Radionuclide-specific data are available for all of the primary feedstock and waste stream source materials historically handled at the FMC facility. The sources of these data, along with methods and assumptions used to derive exposure point activities for each potential source material for use in the risk evaluation, are described below.

F3.1 Data Sources

The available radionuclide-specific data for the FMC Plant OU, which are presented for both background soils and each potential source material in Table F-1, were developed from the following sources:

EPA's Radiological Surveys of Idaho Phosphate Ore Processing -- The Thermal Process Plant Report (1977)

As part of a radiological survey of the FMC facility (EPA, 1977), EPA collected and analyzed samples of materials input to FMC's thermal process (phosphate ore, calcined nodules, silica, coke and coke supplement) and the products and by-products of the process (phosphorus product, ferrophos, fluid bed prills, and slag). Each of the collected samples was analyzed for radionuclides in the uranium-238 and thorium-232 decay chains. The results of these analyses are presented in Tables 3 and 4 of EPA (1977).

The reported values for phosphate ore, calcined nodules and slag in Tables 3 and 4 of EPA (1977) represent averages of the results of analyses performed on a larger number of individual samples of these materials. Specifically, six samples of phosphate ore, calcined nodules and slag were collected and analyzed as part of the survey. Moreover, as discussed within Appendix C of EPA (1977), each of these samples was split, with one set analyzed at EPA's Environmental Monitoring and Support Laboratory (EMSL), and the other set analyzed at EPA's Eastern Environmental Research Facility (EERF) laboratory. Table C-1 of EPA (1977) provides analytical results for the phosphate ore samples, Table C-2 provides results for the calcined nodule samples, and Table C-3 provides results for the slag samples. It is also noted in Appendix C of EPA (1977) that the lead-210 results for ore, calcined nodules and slag reported by EMSL are erroneous, being found to underestimate actual levels by up to a factor of five for this constituent.

Remedial Investigation for the Eastern Michaud Flats Site (Bechtel, 1996)

Data characterizing the radiological composition of slag, ferrophos, phosphate ore, IWW Ditch discharge and sediment, water and sediment in the railroad swale, phossy pond discharge and sediment, calciner pond discharge and sediment, and coke settling pond sediment were collected during the RI (Bechtel, 1996). Gross alpha and gross beta levels were measured in each of the samples. Uranium-238, lead-210, and potassium-40 analyses were performed on each of the slag, ferrophos, phosphate ore, phossy pond sediment, calciner pond sediment and coke settling pond sediment samples. By contrast, radium-226 and radium-228 analyses were performed on the liquid IWW Ditch discharge, railroad swale water, phossy pond discharge, and calciner pond discharge samples. No data, outside of the gross alpha and gross beta measurements, were developed from the IWW Ditch and railroad swale sediment samples. These data are discussed in Section 4.2.3.1 and presented in Tables 4.2.3-2 and 4.2.3-3 of the RI report (Bechtel, 1996).

In addition to the radiological data developed from potential source materials at the FMC Subarea, potassium-40, uranium-238, lead-210 and polonium-210 analyses were performed on offsite, subsurface soil samples that were collected from a depth of 2 feet at nearly 100 locations situated along radials extending from the EMF facilities. These data are presented in Table 4.3-1 of the RI report (Bechtel, 1996). EPA subsequently used these data to develop the representative background activities of potassium-40, uranium-238, lead-210, and polonium-210 that are presented in Table 4.2.1-1 of the RI report. These background levels represent the 95th percentile of the offsite, subsurface soil RI data set. The precise approach taken to derive these background levels is described in Section 2.2.4 of EPA's Baseline Human Health Risk Assessment (HHRA) (E&E, 1996).

Rather than present each offsite, subsurface soil RI data point, Table F-1 provides the 95th percentile representative (background) levels developed by EPA for potassium-40, uranium-238, lead-210, and polonium-210.

Astaris' Pre-Start Up LDR Radionuclides Study (2001)
Data characterizing the content of phossy solids were developed by Astaris during the *Pre-Start Up LDR Radionuclides Study* (Astaris, 2001). Specifically, Astaris collected samples of Tank V-3600, V-3700, and V-3800 discharges, and composited these in the proportion expected to be fed to the LDR Waste Treatment System that was under construction in 2001 (V-3600 = 17.6%, V-3700 = 73.8%, and V-3800 = 8.6%). The samples were then dryed and subsequently submitted to Hazen Research, Inc., Golden, Colorado for analysis of potassium-40, radionuclides in the uranium-238 and thorium-232 decay chains, and gross alpha and gross beta.

In total, two sets of grab samples from Tank V-3600, V-3700, and V-3800 discharges were collected within a two week period in February 2001. An additional 2 sets of samples were collected within a two week period in April 2001.

Hazen Report of Analysis for Calciner Sample 2-C 03/12/2003 (2003)
Hazen Research, Inc., Golden, Colorado was contracted to analyze a sample of Pond 2C liquid in March 2003. The sample was analyzed for potassium-40, radionuclides in the uranium-238 and thorium-232 decay chains, and gross alpha and gross beta.

F3.2 Data Treatment

The data for solid matrix samples discussed in Section F3.1 and presented in Table F-1 were treated in accordance with EPA guidance (EPA, 1992) to develop exposure point activities for use in the risk evaluation. Initially, one-half of the detection limit was used to characterize the activity of radionuclides in samples that did not contain levels above the detection limit. However, if one-half of the detection limit for a non-detect sample was found to exceed the maximum detected activity of a radionuclide in a source material, then that non-detect sample was removed from the exposure point activity calculation.

As discussed in Section F3.1, the EMSL results for lead-210 in phosphate ore, calcined nodules and slag were found to be in error by up to a factor of 5 too low in EPA's *Radiological Surveys of Idaho Phosphate Ore Processing -- The Thermal Process Plant* Report (EPA, 1977). Therefore, none of the EMSL results for lead-210 were included in the exposure point activity calculations. Also, while there is no documentation critiquing the validity of the Bechtel (1996)

phosphate ore lead-210 sample result, this data point was also removed from the evaluation because it corresponds closely to the low-biased levels seen in the EMSL data set. Finally, Table F-1 includes the EPA (1977) calculated average activity of each radionuclide in the 6 individual phosphate ore, calcined nodule, and slag samples analyzed in the study. These average activities were removed from the evaluation (i.e., only the results for the six individual samples were retained).

The exposure point activity of each radionuclide within each source material of potential concern was then derived by calculating the 95% upper confidence limit (UCL) on the arithmetic mean of the remaining data points. In the event that the calculated 95% UCL on the arithmetic mean was found to exceed the maximum reported activity in a potential source material (e.g., radium-226 in coke), the maximum activity was used to characterize potential exposures. Also, when only one data point was available for a radionuclide in a source material (e.g., radium-226 in ferrophos), the result for that sample was used to characterize potential exposure.

Data are not available to characterize uranium-234, thorium-230, radium-226, and polonium-210 (i.e., uranium-238 decay series) in calciner pond sediment. For this source material, the exposure point activities of uranium-234, thorium-230, and radium-226 were characterized by the calculated exposure activity of uranium-238 (i.e., secular equilibrium was assumed). Similarly, the exposure point activity of polonium-210 was characterized by the calculated exposure activity of lead-210.

As discussed in Section F3.1, the 95th percentiles of the potassium-40, uranium-238, lead-210 and polonium-210 activities measured in offsite, subsurface soil RI samples were developed by EPA to characterize representative background levels of these constituents. The precise approach taken to derive these background levels is described in Section 2.2.4 of EPA's Baseline Human Health Risk Assessment (HHRA) (E&E, 1996). These values were also used to characterize background exposures and risks in the current evaluation. Additionally, in the absence of data for uranium-234, thorium-230 and radium-226, the background activity of uranium-238 was used to characterize the background levels of these constituents (i.e., secular equilibrium was assumed). Finally, in the absence of data for thorium-232 and radium-228 (thorium-232 decay series), background levels were not assigned to these constituents.

The resulting exposure point activities in background soils and each of the source materials of potential concern at the FMC Plant OU are summarized in Table F-2.

F4 Evaluation of Radiological Risk Drivers for Receptors Exposed to Surface Soil/Fill at the FMC Plant OU

As discussed in greater detail within Section 4 of the RI Update Memorandum, the following receptors have the potential to be exposed to site-related contamination at the FMC Plant OU:

- Outdoor commercial/industrial workers
- Indoor commercial/industrial workers
- Construction workers
- Utility workers
- Nearby off-site residents

From the soil screening level (SSL) calculations performed for inorganic constituents of potential concern in Section 4, the outdoor commercial/industrial worker is identified as the most highly exposed receptor to surface contamination. This finding corresponds with EPA guidance (EPA, 2002), which identifies the outdoor worker as likely to be the most highly exposed receptor in the outdoor environment under commercial/industrial conditions. Thus, identifying the radiological constituents and exposure pathways that drive risks to this chronically exposed (i.e., > 1 year) receptor for each potential source material at the FMC Plant OU is the most relevant approach to determining the appropriate surface radiological data for collection during the SRI.

F4.1 Potential Exposure Pathways of Concern

As defined by EPA (2002), the outdoor commercial/industrial worker is a long-term receptor exposed during the work day who is a full time employee of the company operating on-site and who spends most of the workday conducting maintenance activities outdoors. The activities for this receptor (e.g., moderate digging, landscaping) typically involve on-site exposures to surface and shallow subsurface soils (at depths of zero to two feet).

Under current EPA guidance for deriving preliminary remediation goals (PRGs) for radionuclides (EPA, 2004), the following exposure pathways are identified as being relevant to outdoor workers:

- Incidental ingestion of soil,
- Inhalation of fugitive dust, and
- External exposure to gamma (ionizing) radiation.

With respect to evaluating potential risks to outdoor commercial/industrial workers at the FMC Plant OU, each of the above exposure pathways is considered relevant. No radiological exposure pathways outside of those listed above are considered plausible for potential future outdoor commercial/industrial workers at the FMC Plant OU.

F4.2 Exposure via Soil Ingestion

For the purposes of evaluating the contribution of incidental soil ingestion to the total radiological risk to future outdoor commercial/industrial workers at the FMC Plant OU, the portion of EPA's PRG equation for outdoor workers relevant to the soil ingestion pathway, as presented in Section 4.2 of EPA (2004), was re-arranged to develop a commercial/industrial worker risk estimate (i.e., rather than a PRG) from ingestion of radionuclides for each source material, as follows:

Equation F-1

$$Risk_{si,x,y} = \frac{A_{x,y} \times (1 - e^{[-\lambda_x \times t_w]}) \times EF_{ow} \times ED_{ow} \times SF_{si-x} \times IR_{sow} \times 1E-03}{t_w \times \lambda_x}$$

Where:

$Risk_{si,x,y}$	=	Soil ingestion cancer risk for radionuclide x in source material y (unitless),
$A_{x,y}$	=	Exposure point activity of radionuclide x in source material y (pCi/g),
t_w	=	Time – worker (years),
λ_x	=	Decay constant for radionuclide x (years^{-1})
EF_{ow}	=	Exposure frequency (days/year),
ED_{ow}	=	Exposure duration (years),
SF_{si-x}	=	Soil ingestion slope factor for radionuclide x (risk/pCi),
IR_{sow}	=	Soil ingestion rate (mg/day), and
1E-03	=	Conversion factor (g/mg).

The radionuclide-specific exposure point activities associated with each potential source material at the FMC Plant OU, along with corresponding background levels in native soils, are presented in Table F-2. The radionuclide-specific soil ingestion cancer slope factors are presented in Tables F-3. Per EPA (2004), these slope factors were obtained from EPA's current Health Effects Assessment Summary Tables (HEAST) for radionuclides (EPA, 2001). The radionuclide-specific decay constants, along with their corresponding half-lives, were also obtained from HEAST EPA (2001), and are provided in Table F-4. Finally, the values and reference sources used to characterize each of the non radionuclide-specific exposure parameters within Equation F-1 are presented in Table F-5. It should be noted that the values assigned to these parameters are consistent with both the values incorporated into the inorganic SSL calculations within Section 4 of the RI Update Memorandum and the recommended, default values provided in EPA (2004).

The total radiological risk to outdoor commercial/industrial workers at the FMC Plant OU from incidental soil ingestion was calculated for each potential source material by summing the risk estimate for each radionuclide, as follows:

Equation F- 2

$$Risk_{si,totaly} = \sum Risk_{si,x,y}$$

Where:

$Risk_{si,total,y}$	=	Total radiological cancer risk from incidental soil ingestion of source material y (unitless), and
$Risk_{si,x,y}$	=	Soil ingestion cancer risk for radionuclide x in source material y (unitless).

The radionuclide-specific and total radiological risk estimates to outdoor commercial/industrial workers at the FMC Plant OU from incidental soil ingestion are presented in Tables F-6, F-7, F-8, F-9, F-10, F-11, F-12, F-13, and F-14 for phosphate ore, calcined nodules, silica, coke, ferrophos, slag, calciner pond sediments, phossy solids (including precipitator slurry), and background soils, respectively.

F4.3 Exposure via Inhalation of Fugitive Dusts

Similar to the approach used to evaluate risks associated with incidental soil ingestion, the portion of EPA's PRG equation for outdoor workers relevant to the fugitive dust inhalation pathway, as presented in Section 4.2 of EPA (2004), was re-arranged to develop a commercial/industrial worker risk estimate from inhalation of radionuclides for each source material, as follows:

Equation F-3

$$Risk_{fdi,x,y} = \frac{A_{x,y} \times (1 - e^{[-\lambda_x \times t_w]}) \times EF_{ow} \times ED_{ow} \times SF_{i-x} \times IR_{iw} \times \frac{1E-03}{PEF} \times \left[ET_{owo} + \left(ET_{owi} \times DF_i\right)\right]}{t_w \times \lambda_x}$$

Where:

$Risk_{fdi,x,y}$	=	Fugitive dust inhalation cancer risk for radionuclide x in source material y (unitless),
$A_{x,y}$	=	Exposure point activity of radionuclide x in source material y (pCi/g),
t_w	=	Time – worker (years),
λ_x	=	Decay constant for radionuclide x (years^{-1})
EF_{ow}	=	Exposure frequency (days/year),
ED_{ow}	=	Exposure duration (years),
SF_{i-x}	=	Inhalation slope factor for radionuclide x (risk/pCi),
IR_{ow}	=	Inhalation rate (m^3/day),
ET_{owo}	=	Exposure time outdoors (hour/hour),
ET_{owi}	=	Exposure time indoors (hour/hour),
DF_i	=	Indoor dilution factor (unitless),
PEF	=	Particulate emission factor (m^3/kg), and
1E+03	=	Conversion factor (g/kg).

The radionuclide-specific exposure point activities associated with each potential source material at the FMC Plant OU, along with corresponding background levels in native soils, are presented in Table F-2. The radionuclide-specific inhalation cancer slope factors are presented in Tables F-3, and the radionuclide-specific decay constants are provided in Table F-4. Finally, the values and reference sources used to characterize each of the non radionuclide-specific exposure parameters within Equation F-3 are presented in Table F-5. With the exception of the particulate emission factor (PEF), the values assigned to the non radionuclide-specific exposure parameters are consistent with both the values incorporated into the inorganic SSL calculations within Section 4 of the RI Update Memorandum and the recommended, default values provided in EPA (2004). Because regional-specific meteorological data were used to develop the PEF in the Section 4 SSL calculations, this value was used in preference to the non site-specific default PEF presented in EPA (2004).

The total radiological risk to outdoor commercial/industrial workers at the FMC Plant OU from fugitive dust inhalation was calculated for each potential source material by summing the risk estimate for each radionuclide, as follows:

Equation F- 4

$$Risk_{fdi,totaly} = \sum Risk_{fdi,x,y}$$

Where:

$Risk_{fdi,total,y}$	=	Total radiological cancer risk from fugitive dust inhalation of source material y (unitless), and
$Risk_{fdi,x,y}$	=	Fugitive dust inhalation cancer risk for radionuclide x in source material y (unitless).

The radionuclide-specific and total radiological risk estimates to outdoor commercial/industrial workers at the FMC Plant OU from fugitive dust inhalation are presented in Tables F-6, F-7, F-8, F-9, F-10, F-11, F-12, F-13, and F-14 for phosphate ore, calcined nodules, silica, coke, ferrophos, slag, calciner pond sediments, phossy solids (including precipitator slurry), and background soils, respectively.

F4.4 Exposure via External Gamma Radiation

Similar to the approach used to evaluate risks associated with incidental soil ingestion and fugitive dust inhalation, the portion of EPA's PRG equation for outdoor workers relevant to the external gamma radiation exposure pathway, as presented in Section 4.2 of EPA (2004), was re-arranged to develop a commercial/industrial worker risk estimate from external gamma emitting radionuclides within each source material, as follows:

Equation F-5

$$Risk_{ee,x,y} = \frac{A_{x,y} \times (1 - e^{[-\lambda_x \times t_w]}) \times EF_{ow} \times ED_{ow} \times SF_{e-x} \times \frac{1}{365} \times ACF \times \left[ET_{owo} + \left(ET_{owi} \times GSF\right)\right]}{t_w \times \lambda_x}$$

Where:

$Risk_{ee,x,y}$	=	External gamma cancer risk for radionuclide x in source material y (unitless),
$A_{x,y}$	=	Exposure point activity of radionuclide x in source material y (pCi/g),
t_w	=	Time – worker (years),
λ_x	=	Decay constant for radionuclide x (years^{-1})
EF_{ow}	=	Exposure frequency (days/year),
ED_{ow}	=	Exposure duration (years),
SF_{e-x}	=	External exposure slope factor for radionuclide x (risk/year per pCi/g),
ACF	=	Area correction factor (unitless),
GSF	=	Gamma shielding factor (unitless),
ET_{owo}	=	Exposure time outdoors (hour/hour),
ET_{owi}	=	Exposure time indoors (hour/hour), and
365	=	Conversion factor (days/year).

The radionuclide-specific exposure point activities associated with each potential source material at the FMC Plant OU, along with corresponding background levels in native soils, are presented in Table F-2. The radionuclide-specific external exposure cancer slope factors are presented in Tables F-3, and the radionuclide-specific decay constants are provided in Table F-4. Finally, the values and reference sources used to characterize each of the non radionuclide-specific exposure parameters within Equation F-5 are presented in Table F-5. With the exception of the area correction factor (ACF), the values assigned to the non radionuclide-specific exposure parameters are consistent with the recommended, default values provided in EPA (2004). The EPA default ACF (0.9) lowers the assumed extent to which receptors are presumed to be exposed to external gamma radiation to account for the fact that the assumption of an infinitely thick slab is overly conservative. However, due to the large spatial extent of the FMC Plant OU, the most conservative (i.e., health protective) value (1) was assigned to the ACF parameter.

The total radiological risk to outdoor commercial/industrial workers at the FMC Plant OU from external exposure to gamma radiation was calculated for each potential source material by summing the risk estimate for each radionuclide, as follows:

Equation F- 6

$$Risk_{ee,totaly} = \sum Risk_{ee,x,y}$$

Where:

$Risk_{ee,total,y}$	=	Total radiological cancer risk from external exposure to gamma radiation from source material y (unitless), and
$Risk_{ee,x,y}$	=	External gamma cancer risk for radionuclide x in source material y (unitless).

The radionuclide-specific and total radiological risk estimates to outdoor commercial/industrial workers at the FMC Plant OU from external exposure to gamma radiation are presented in

Tables F-6, F-7, F-8, F-9, F-10, F-11, F-12, F-13, and F-14 for phosphate ore, calcined nodules, silica, coke, ferrophos, slag, calciner pond sediments, phossy solids (including precipitator slurry), and background soils, respectively.

F4.5 Summary of Risk Estimates: Commercial/Industrial Workers

Table F-15 summarizes both the pathway-specific and total risk estimates for commercial/industrial workers exposed to potential source materials at the FMC Plant OU and background soils. As shown in this table, total cancer risks associated with commercial/industrial worker exposure to silica (8E-05), coke (4.45E-05) and ferrophos (4.45E-5) are 3 to 6 times lower than the corresponding total risk associated with exposure to background soils (2.61E-04) over the same working timeframe (i.e., a worker exposed to background soils for 1,800 hours/year for 25 years would have a higher level of cancer risk than a worker exposed to silica, coke or ferrophos over the same timeframe). Because exposure of future commercial/industrial workers to these silica, coke and ferrophos would pose a lower risk than that associated with exposure to natural background levels, there is no potential for residual, surficial deposits of these materials to result in unacceptable levels of risk to any receptor at the FMC Plant OU. Therefore, there is no need to identify an SRI radiological sampling strategy for these source materials. However, it is still worth noting that, as shown in Table F-15, external gamma radiation is the principal risk driver for all three source materials, contributing between 87 to over 97% of the total radiological risk.

With the exception of phossy wastes, external exposure to gamma radiation contributes approximately 96 to 98.5% of the total radionuclide cancer risk to a potential future commercial/industrial worker exposed to any of the remaining source materials (ore, calcined nodules, slag, and calciner pond sediment). Given both the high degree to which external gamma radiation contributes to total risk, and the relatively consistent ratio of external gamma radiation risk to total risk for each of these source materials, it is reasonable to conclude that, per the approach described in MARSSIM (EPA et al., 2000), direct gamma radiation measurements are sufficient to characterize commercial/industrial worker risks associated with exposure to surficial source materials at the FMC Plant OU that do not contain significant quantities of phossy solids.

With respect to phossy solids, Table F-13 indicates that incidental soil ingestion of lead-210 would contribute approximately 48% of the total risk to commercial/industrial workers exposed to this media. Additionally, external exposure to gamma radiation would contribute a further 51% of the total risk. Thus, given that lead-210 and external gamma radiation contribute a combined total of approximately 99% of the total risk associated with commercial/industrial worker exposure to phossy solids, it is reasonable to conclude that a supplemental remedial investigation strategy targeted on both gamma dose rate measurements and analysis of lead-210 can be implemented in the SRI to evaluate radiological risk in RUs found to contain surficial phossy solids.

F5 Evaluation of Radiological Risk Drivers for Receptors Exposed to Subsurface Soil/Fill at the FMC Plant OU

As discussed in greater detail within Section 4, the following receptors have the potential to be exposed to subsurface site-related contamination at the FMC Plant OU:

- Construction workers
- Utility workers

From the soil screening level (SSL) calculations performed for inorganic constituents of potential concern in Section 4 of the RI Update Memorandum, the construction worker is identified as the most highly exposed receptor to subsurface contamination, a finding which corresponds with EPA guidance (EPA, 2002). Thus, identifying the radiological constituents and exposure pathways that drive risks to this sub-chronically exposed (i.e., <= 1 year) receptor for each feedstock and waste stream source material historically processed at the FMC Plant OU is the most relevant approach to determining the appropriate radiological data to collect from subsurface fill during the SRI.

F5.1 Potential Exposure Pathways of Concern

Current EPA guidance (EPA, 2002) recognizes that construction is likely to occur as part of the redevelopment process at many NPL sites, regardless of the anticipated future land use. Although construction is typically of relatively short duration (a year or less), it may lead to significant exposures to construction workers as a result of soil-disturbing activities that include excavation and vehicle traffic on unpaved roads. EPA's approach to deriving construction worker SSLs is to assume that a short-term adult receptor is exposed to soil contaminants during the work day for the duration of a single construction project (typically a year or less). If multiple non-concurrent construction projects are anticipated, it is assumed that different workers will be employed for each project (EPA, 2002). Construction worker activities typically assume substantial on-site exposures to surface and subsurface soils, particularly with respect to soil ingestion rates.

While the exact nature of any future redevelopment of the FMC OU is unknown, it is reasonable to conclude that building construction would likely be an integral part of any such effort. During construction, workers may be exposed to residual soil contamination to a depth of 4-6 feet (the depth at which building footers have historically been placed at the FMC OU), though exposure to a maximum depth of 10 feet is considered possible on a short-term basis. Consistent with the approach outlined in EPA (2002) and Section 4 of the RI Update Memorandum, potential risks to construction workers are developed herein assuming that a period of six months would be required to complete construction work.

Current EPA guidance for developing PRGs for radionuclides (EPA, 2004) does not identify a construction worker scenario. However, the same exposure pathways by which a future commercial/industrial worker could be exposed to surface fill material are considered relevant to potential exposure of construction workers to surface and subsurface fill material:

- Incidental ingestion of soil,
- Inhalation of fugitive dust, and
- External exposure to gamma (ionizing) radiation.

No radiological exposure pathways outside of those listed above are considered plausible for potential future construction workers at the FMC Plant OU.

F5.2 Exposure via Soil Ingestion

For the purposes of evaluating the contribution of incidental soil ingestion to the total radiological risk to future construction workers at the FMC Plant OU, the portion of EPA's PRG equation for outdoor workers relevant to the soil ingestion pathway was re-arranged to develop a risk estimate from ingestion of radionuclides for each source material. This approach was previously presented in Equation F-1 within Section F4.2.

To characterize construction worker exposures from incidental soil ingestion, the radionuclide-specific exposure point activities associated with each potential source material at the FMC Plant OU were used, along with corresponding background levels in native soils, as previously presented in Table F-2. Similarly, the radionuclide-specific soil ingestion cancer slope factors were presented in Tables F-3, and the radionuclide-specific decay constants were provided in Table F-4. Finally, the values and reference sources used to characterize each of the non radionuclide-specific exposure parameters within Equation F-1 are presented in Table F-16. In the absence of default values for a construction worker in EPA's radionuclide PRG guidance, the exposure parameters were assigned to be consistent with the values incorporated into the inorganic construction worker SSL calculations within Section 4 of the RI Update Memorandum.

The total radiological risk to construction workers at the FMC Plant OU from incidental soil ingestion was calculated for each potential source material using Equation F-2. The resulting radionuclide-specific and total radiological risk estimates to future construction workers at the FMC Plant OU from incidental soil ingestion are presented in Tables F-17, F-18, F-19, F-20, F-21, F-22, F-23, F-24, and F-25 for phosphate ore, calcined nodules, silica, coke, ferrophos, slag, calciner pond sediments, phossy solids (including precipitator slurry), and background soils, respectively.

F5.3 Exposure via Fugitive Dust Inhalation

For the purposes of evaluating the contribution of fugitive dust inhalation exposure to the total radiological risk to future construction workers at the FMC Plant OU, the portion of EPA's PRG equation for outdoor workers relevant to the fugitive dust inhalation pathway was re-arranged to develop a risk estimate from inhalation of radionuclides for each source material. This approach was previously presented in Equation F-3 within Section F4.3.

Construction worker exposure via fugitive dust inhalation was calculated using the radionuclide-specific exposure point activities associated with each potential source material at the FMC Plant OU, as well as the radionuclide-specific activities associated with background levels in native soils. These exposure point activities were previously presented in Table F-2. Estimates of risk relied on the radionuclide-specific inhalation cancer slope factors presented in Tables F-3, and the radionuclide-specific decay constants provided in Table F-4. Finally, the values and

reference sources used to characterize each of the non radionuclide-specific exposure parameters within Equation F-3 are presented in Table F-16. In the absence of default values for a construction worker in EPA's radionuclide PRG guidance, the values assigned to these parameters were chosen to be consistent with the values incorporated into the inorganic SSL calculations within Section 4 of the RI Update Memorandum.

The total radiological risk to construction workers at the FMC Plant OU from fugitive dust inhalation was calculated for each potential source material using Equation F-4. The resulting radionuclide-specific and total radiological risk estimates to future construction workers at the FMC Plant OU from fugitive dust inhalation are presented in Tables F-17, F-18, F-19, F-20, F-21, F-22, F-23, F-24, and F-25 for phosphate ore, calcined nodules, silica, coke, ferrophos, slag, calciner pond sediments, phossy solids (including precipitator slurry), and background soils, respectively.

F5.4 Exposure via External Gamma Radiation

For the purposes of evaluating the contribution of external gamma radiation to the total radiological risk to future construction workers at the FMC Plant OU, the portion of EPA's PRG equation for outdoor workers relevant to the external gamma radiation pathway was re-arranged to develop a risk estimate from external gamma emitting radionuclides within each source material. This approach was previously presented in Equation F-5 within Section F4.4.

Additionally, a correction factor was applied to account for the increased external gamma radiation exposure that would occur when a worker is surrounded by the walls of an excavated trench. The correction factor was derived by applying the MICROSHIELD 5.05 model to estimate the increased dose rate to a worker standing in a trench excavated from slag. Specifically, the increased dose rate associated with a worker standing in a 1.5 m (5 ft) or 2.75 m (9 ft) deep, 5 m long and 2 m wide trench was modeled for various assumed thicknesses of steel shoring (0, 0.25, 0.5, and 1 inch). As shown in Table F-26, an upperbound correction factor of 1.57 was derived for a 2.75 m (9 ft) deep trench with 0.25 inch steel shoring. This factor was applied to account for the increased risk a worker would experience from external gamma radiation exposure while standing in a trench. A complete discussion of the assumptions and findings of the MICROSHIELD 5.05 modeling is presented in Attachment 1 to this appendix.

Characterization of construction worker risk from external gamma radiation exposure to the various fill materials as well as native soils relied on the radionuclide-specific exposure point activities associated with each potential source material at the FMC Plant OU, along with corresponding background levels in native soils, as previously presented in Table F-2. Similarly, the radionuclide-specific external gamma radiation cancer slope factors were presented in Tables F-3, and the radionuclide-specific decay constants were provided in Table F-4. Finally, the parameter values and reference sources used to characterize each of the non radionuclide-specific exposure parameters within Equation F-5 are presented in Table F-16. In the absence of default values for a construction worker in EPA's radionuclide PRG guidance, the exposure parameters were chosen to be consistent with the values incorporated into the inorganic SSL calculations within Section 4.

The total radiological risk to construction workers at the FMC Plant OU from external gamma radiation exposure was calculated for each potential source material using Equation F-6. The

resulting radionuclide-specific and total radiological risk estimates to future construction workers at the FMC Plant OU from fugitive dust inhalation are presented in Tables F-17, F-18, F-19, F-20, F-21, F-22, F-23, F-24, and F-25 for phosphate ore, calcined nodules, silica, coke, ferrophos, slag, calciner pond sediments, phossy solids (including precipitator slurry), and background soils, respectively.

F5.5 Summary of Risk Estimates: Construction Workers

Table F-27 summarizes both the pathway-specific and total risk estimates for construction workers exposed to potential source materials at the FMC Plant OU and background soils. As shown in this table, total cancer risks associated with construction worker exposure to silica (3.81E-06), coke (2.54E-06) and ferrophos (4.03E-06) are 3 to 4 times lower than the corresponding total risk associated with exposure to background soils (1.10E-05) over the same working timeframe (i.e., a construction worker exposed to subsurface background soils for 1,040 hours over the course of a construction project would experience a higher level of cancer risk than a worker exposed to silica, coke or ferrophos over the same timeframe). Because exposure of future construction workers to silica, coke and ferrophos would pose a lower risk than that associated with exposure to natural background levels, there is no potential for residual, subsurface deposits of these materials to result in unacceptable levels of risk to any receptor at the FMC Plant OU. Consequently, there is no need to develop an SRI radiological sampling strategy for these materials.

Considering the remaining source materials, i.e. those where total risks are above background, external gamma radiation is the principal risk driver, contributing between 80 to over 88.5% of the total radiological risk, with the exception of phossy solids (Table F-27). Given both the high degree to which external gamma radiation contributes to total risk, and the relatively consistent ratio of external gamma radiation risk to total risk for each of these sources materials, it is reasonable to conclude that, per the approach described in MARSSIM (EPA et al., 2000), direct gamma radiation measurements can be used during the SRI as a surrogate for radionuclide-specific activity data for subsurface areas of the FMC Plant OU that do not contain significant quantities of phossy solids.

With respect to phossy solids, Table F-24 indicates that incidental soil ingestion of lead-210 and polonium-210 would contribute approximately 54% of the total risk to construction workers exposed to this media in the subsurface, with approximately 49% of the total risk attributable to lead-210 and a further 5% attributable to polonium-210. Additionally, inhalation of fugitive dusts contributes another 26% of the total risk, with nearly 21% of the total risk attributable to lead-210 and an additional 5% attributable to polonium-210. External exposure to gamma radiation would contribute a further 18% of the total risk. Thus, lead-210 and polonium-210 determine nearly 80% of the total risk which, when combined with measures of external gamma radiation, captures 98% of the total risk associated with construction worker exposure to phossy solids. Therefore, it is reasonable to conclude that an SRI strategy targeted on gamma dose rate measurements and analyses of lead-210 and polonium-210 can be implemented to evaluate radiological risk in RUs found to contain subsurface phossy waste solid fill.

F6 Overview of FMC's Proposed Approach to Radiological Data Collection and Evaluation During the SRI

As discussed within the summaries to Sections F4 and F5, radiological risks associated with future worker exposure to surface and subsurface fill at the FMC Plant OU will be driven by external gamma radiation for all potential receptors and source materials, except phossy solids. Risks associated with future worker exposure to phossy solid fill material will be driven by incidental ingestion and fugitive dust inhalation of lead-210 (and polonium-210 in the case of subsurface soils) in addition to external gamma radiation.

Based on the above findings, FMC proposes to evaluate radiological risks during the SRI/SFS of the FMC Plant OU through the collection of gamma dose rate measurements, in conjunction with radionuclide-specific analyses targeted on samples collected from areas identified as containing residual phossy solids. The resulting data will be used to develop dose rate estimates above background. These incremental dose rate estimates will subsequently be compared to a target threshold of 15 mrem/year for each receptor. This threshold is equivalent to the remedial action objective (RAO) established for offsite soils at the Monsanto, Soda Springs elemental phosphorus production plant in Soda Springs, Idaho (EPA, 1997; EPA, 2003). The remainder of this section provides an overview of the approach FMC proposes to implement with respect to the collection and evaluation of radiological data within the SRI. A comprehensive presentation of this approach will be provided in the SRI Workplan.

As discussed in the main body of this report, a remedial vision of capping has already been developed for many RUs within the FMC Plant OU. This remedial approach, in conjunction with accompanying land-use restrictions, will prevent future workers at the site from being exposed to source materials of radiological concern via any pathway (including external gamma radiation) at capped RUs. Thus, collection of radiological data during the SRI will be restricted to RUs for which a remedial vision of capping is not currently envisioned (i.e., RUs # 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 20, 21, and 23)Gamma dose rate measurements will be collected at each of the above-referenced RUs using instrumentation described in Appendix G. Surface samples will be collected 3 feet above the ground (i.e., coincident with the mid-point of an exposed worker's body). Subsurface samples will be collected 3 feet above the base of test pits/trenches. The maximum depth of these test pits/trenches will be 5 feet (maximum allowable under OSHA regulations for worker entry without sloping or shoring). The DQO process that will be used to identify both a sampling grid and the total number of surface and subsurface measurements to be made at each RU is discussed in Appendix G, and will be implemented during the SRI.

The potential for phossy solids to be present within the surface and subsurface fill material at each gamma measurement site will be determined based on both visual observation (phossy waste has distinctive visual characteristics) and the use of a portable XRF analyzer to confirm elevated cadmium, zinc and, possibly lead levels (i.e., phossy solid indicator parameters) (see Appendix H). A sample will be taken at each area suspected to contain phossy solid fill material, based on a visual assessment or XRF analytical result, and analyzed for Pb-210 and Po-210 activities. In addition, for RUs in which the presence of phossy solid fill is not identified at any sampling point, an RU-wide composite sample will be analyzed for Pb-210 and Po-210 to confirm that risk levels associated with exposure to these constituents are low relative to the risk

from exposure to gamma radiation (i.e., consistent with the findings of the risk evaluations performed in Sections F4 and F5). The SRI Work Plan will identify sampling locations and analytical protocols for Pb-210 and Po-210 speciation.

Existing background gamma dose rate data for the EMF area (Bechtel, 1996) will be used to account for background within the SRI surface and subsurface gamma dose rate measurements taken within each RU. The incremental dose rate estimates will then be compared to a target threshold of 15 mrem/year for each potential receptor. For locations at which the presence of phossy solids is confirmed, the dose associated with incidental ingestion and fugitive dust inhalation of the measured lead-210 and polonium-210 activities (minus background) will be calculated, combined with the incremental gamma dose rate measurement results and compared to the 15 mrem/yr threshold for each receptor. A comprehensive description of this approach will be provided in the SRI Workplan.

F7 References

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Table F-1
Radionuclide Activities in Background Native Soils and Potential Source Materials at the FMC OU

Material	Sample	Data Source	Sample Type[a]	Sample ID	Units	Assoc. with Potassium			<- parents -- Uranium-238 Decay Series -- daughters ->															Thorium-232 Decay Series					
						Potassium-40			Uranium-238			Uranium-234			Thorium-230			Radium-226			Lead-210			Polonium-210			Thorium-232			Radium-228		
						actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual
Background Soil	Native subsurface soils [h]	Bechtel 1996			pCi/g	20.5			3.88												3.03			3.58								
Phosphate Ore	FMC Ore	Bechtel 1996	PSW	FOSFPO01	pCi/g	10.9	2.46		24.2	6.92											1.7	0	U									
	Phosphate Rock (ore) [c]	EPA 1977			pCi/g				22	3.2		22	2		22	4.1		26	19		27	12		22	3		0.43	0.12		0.89	0.28	
	Phosphate Rock (ore) sample #1[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				22.3	3.35		22	3.3		21.4	0.641		24.3	0.243		27.7	0.9		21.5	3.2		0.483	0.0676		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				22	5.5		21	5.2		23	1.1		26	0.93		2.7	0.69		24	2.4		0.3	0.11		0.78	0.76	
	Phosphate Rock (ore) sample #2[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				21.0	3.05		20.6	2.99		24.1	0.723		24.0	0.24		31.8	1.9		22.8	3.3		0.516	0.0722		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				20	2.2		22	2.4		24	1.00		27	0.94		6.4	0.83		22	1.3		0.37	0.13		0.74	0.66	
	Phosphate Rock (ore) sample #3[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				22.2	3.11		21.4	2.99		22.2	0.666		21.3	0.213		29.4	1.5		25.2	3.7		0.439	0.0636		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				23	2.3		23	2.3		19	0.96		14	0.68		4.7	0.76		21	1.7		0.49	0.16		0.98	0.68	
	Phosphate Rock (ore) sample #4[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				21.8	3.15		21.7	3.15		22.8	0.648		19.4	0.194		27.7	1		19.4	1.5		0.441	0.0639		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				26	4.7		22	4.7		23	0.99		30	1		5.8	0.8		22	1.7		0.42	0.14		0.67	0.65	
	Phosphate Rock (ore) sample #5[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				21.9	3.07		21.8	3.05		22.1	0.662		21.1	0.211		15.4	1.3		21.5	1.5		0.454	0.0635		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				24	4.0		24	3.9		23	1.0		29	0.98		6.5	0.82		23	1.6		0.46	0.15		<0.65		U
	Phosphate Rock (ore) sample #6[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				20.5	2.97		20.7	3.00		22.0	0.66		20.8	0.208		31.9	1.8		22.4	0.9		0.479	0.0646		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				22	3.2		21	3.0		17	0.87		53	1.3		7.2	1		21	2.4		0.36	0.13		<0.81		U
Nodules (Calcined Briquettes)	Calcined Rock (aka nodules) [c]	EPA 1977			pCi/g				24	1.8		23	2.2		23	2		25	8.6		18	8.6		<2.65		U	0.47	0.1		0.97	0.48	
	Calcined Briquettes (aka nodules) sample #1[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.5	3.53		23.8	3.56		21.6	0.648		24.2	0.242		19.1	0.3		ND		U	0.479	0.0574		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				24	2.0		22	2.0		23	1.00		28	0.97		8.1	0.9		9.2	1.1		0.5	0.15		1.3	0.84	
	Calcined Briquettes (aka nodules) sample #2[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.0	3.22		22.3	3.12		23.0	0.689		21.8	0.218		20.5	0.3		ND		U	0.404	0.8606		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				22	1.8		22	1.7		23	0.98		20	0.82		6.5	0.85		8.5	0.88		0.52	0.15		<0.73		U
	Calcined Briquettes (aka nodules) sample #3[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				22.3	3.23		21.9	3.18		22.7	0.68		22.4	0.224		25.1	0.6		ND		U	0.575	0.0719		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				24	1.9		22	2.0		23	1.0		31	1.0		8.7	0.93		11	1.2		0.44	0.14		1.5	0.83	
	Calcined Briquettes (aka nodules) sample #4[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.6	3.3		23.2	3.25		23.8	0.713		20.3	0.203		17.4	0.6		ND		U	0.410	0.0636		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				23	1.6		23	1.5		23	0.95		25	0.91		5.2	0.77		9.3	0.86		0.49	0.14		<0.74		U
	Calcined Briquettes (aka nodules) sample #5[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.7	3.32		23.1	3.23		21.4	0.641		20.7	0.207		12.8	1.3		<2.65		U	0.465	0.0674		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				25	2.4		26	2.5		24	1.0		29	0.98		5	0.77		11	1.1		0.42	0.14		<0.78		U
	Calcined Briquettes (aka nodules) sample #6[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				23.9	3.7		23.0	3.56		20.9	0.627		21.6	0.216		15.2	1.5		ND		U	0.522	0.0705		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				25	2.5		23	2.3		24	1.0		32	1.0		9.7	0.94		9.0	0.89		0.42	0.13		<0.63		U
Silica	Silica [c]	EPA 1977			pCi/g				1.5	1.4		<0.86		U	1.6	0.53		1.7	0.24		0.67	0.55		2.6	0.9		0.69	0.37		<0.89		U
Coke	Coke [c]	EPA 1977			pCi/g				<0.51		U	<0.44		U	<0.23		U	0.78	0.17		2.4	0.62		<1.3		U	<0.69		U	<0.95		U
	Coke Supplement [c]	EPA 1977			pCi/g				<0.59		U	<0.95		U	<0.20		U	0.7	0.16		0.61	0.54		0.98	0.11		<0.22		U	<0.91		U
	Coke Settling Sediment Pond	Bechtel 1996	PSW	FWSCSP01	pCi/g	0.926	0.48	UJ	3.11	0	U										6.64	0	U									
Ferrophos	Ferrophosphorus [c]	EPA 1977			pCi/g				19	4.9		21	5.2		0.42	0.27		0.27	0.11		1.1	0.58		<0.57		U	0.26	0.2		0.99	0.94	
	Ferrophos	Bechtel 1996	PSW	FWSFSA01	pCi/g	2.3	0.77		4.68	1.85	UJ										1.26	0	U									
	Ferrophos	Bechtel 1996	PSW	FWSFSA02	pCi/g	0.794	0.33	UJ	9.69	1.9											1.34	0	U									
	Ferrophos	Bechtel 1996	PSW	FWSFSA03	pCi/g	2.04	0.71		12.3	2.68											1.39	0	U									
Slag	Slag [c]	EPA 1977			pCi/g				25	7		25	6.7		26	11		32	13		11	7.9		<16		U	0.59	0.29		0.96	0.46	
	Slag sample #1[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				29.4	4.41		28.4	4.25		25.5	0.764		22.8	0.228		11.6	1.0		8.27	2.86		0.648	0.081		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				25	4.2		27	4.4		29	1.4		37	1.1		2.3	0.67		8.3	1.3		0.52	0.19		<0.80		U
	Slag sample #2[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				22.2	3.1		21.2	2.96		25.8	0.774		23.2	0.232		11.1	1.7		ND		U	0.632	0.0789		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				26	2.4		27	2.4		11	0.40		40	1.2		0.86	0.61		2.4	0.50		0.20	0.055		<0.76		U
	Slag sample #3[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				21.6	2.92		21.6	2.91		26.3	0.789		24.8	0.248		6.6	0.6		23.7	5.85		0.533	0.0693		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				29	2.6		27	2.5		28	1.1		36	1.1		2.1	0.68		11	1.1		0.47	0.15		1.6	0.86	
	Slag sample #4[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				27.7	3.88		27.2	3.81		26.6	0.797		32.5	0.325		7.8	0.7	.	ND		U	0.672	0.084		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				25	2.3		29	2.4		23	0.95		37	1.1		0.69	0.62		3.3	0.45		0.66	0.16		<0.76		U
	Slag sample #5[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				18.6	2.32		19.7	2.46		28.1	0.843		32.3	0.323					ND		U	0.627	0.0783		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				24	3.3		24	3.3		33	1.5		37	1.1		1.4	0.66		11	0.95		0.73	0.22		<0.80		U
	Slag sample #6[g]	EPA 1977																														
	EERF Laboratory results	EPA 1977			pCi/g				20.3	2.64		20.4	2.65		27.3	0.819		33.3	0.333		16.7	2.8		ND		U	0.683	0.0854		<1.0		U
	EMSL Laboratory results	EPA 1977			pCi/g				28	2.0		27	2.0		31	1.2		23	0.87		4.2	0.82		8.0	0.72		0.70	0.18		<0.76		U

Table F-1
Radionuclide Activities in Background Native Soils and Potential Source Materials at the FMC OU

Material	Sample	Data Source	Sample Type[a]	Sample ID	Units	Assoc. with Potassium			<- parents -- Uranium-238 Decay Series -- daughters ->															Thorium-232 Decay Series					
						Potassium-40			Uranium-238			Uranium-234			Thorium-230			Radium-226			Lead-210			Polonium-210			Thorium-232			Radium-228		
						actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual	actual value	uncertainty	qual
	FMC Slag	Bechtel 1996	PSW	FWSSSA01	pCi/g	8.48	2.09		24.4	7.22											4.66	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA02	pCi/g	7.38	2.18		28.1	7.14											4.55	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA03	pCi/g	8.09	1.85		26.3	7.52											4.52	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA04	pCi/g	9.22	1.91		22.1	6.34											3.7	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA05	pCi/g	10.9	2.16		30.7	8.90											4.35	0	U									
	FMC Slag	Bechtel 1996	PSW	FWSSSA06	pCi/g	9.05	2.61		26.5	8.34											4.58	0	U									
Calciner Pond Wastes	Calciner Pond 2C - Liquid	Bechtel 1996	PSL	CALPOND2	pCi/L													0.62	0.16	U										-0.5	0.40	U
	Calciner Pond 2C - Liquid (3/12/03 sample)	Hazen 2003	PSL	C351/03-1	pCi/L	44,400 [f]			<1[b]						0	0.6	U	0.9	1		8.4	4.2		18	4		0	0.6		1	1.7	U
	Water Discharged to Calciner Ponds - time composite	Bechtel 1996	PSL	FSWCPW01	pCi/L													0.34	0.11	UJ										-0.4	0.70	U
	Sediment in Calciner Ponds	Bechtel 1996	PSW	FSDCPW01	pCi/g	70.4	8.34		17.5	7.96											1.7	0	U									
Precipitator Slurry/Phossy Wastes	Precipitator Slurry Discharged to Pond 8E - time composite	Bechtel 1996	PSL	FSWPS88E	pCi/L													103	4.48											-2.7	1.00	U
	Precipitator Slurry Discharged to Phase IV Ponds - time composite	Bechtel 1996	PSL	FSWPWSIV	pCi/L													1.9	0.56	J										-2.4	1.10	U
	Fluid Bed Dryer Prills (dried precipitator dust) [c]	EPA 1977			pCi/g				<71		U	<91		U	<24		U	13	0.65		52	1.8		440	27		<17		U	1.9	1	
	Sediments from Pond 11S	Bechtel 1996	PSW	FWSP1101	pCi/g	25.9	3.16		4.46	0	U										352	89.4										
	Sediments from Pond 12S	Bechtel 1996	PSW	FWSP1201	pCi/g	27.4	3.5		4.98	0	U										465	117										
	Sediments from Pond 15S	Bechtel 1996	PSW	FWSP5S01	pCi/g	22	3.32		3.93	4.14	UJ										204	53.8										
	Sediments from Pond 8S	Bechtel 1996	PSW	FWSP8S01	pCi/g	13.1	2.28		0.694	3.28	UJ										230	60.4										
	Sediments from Pond 9E	Bechtel 1996	PSW	FWSP9E01	pCi/g	50.7	5.78		8.36	5.32											0.782	0	U									
	Phossy Waste (V-3600/V-3700/V-3800 composite)	Astaris 2001	PSW	G-0620 115-1	pCi/g	163[f]			<3[e]						2.2	0.9		10	2		1,240	17		510	8		0.3	0.4		0	1.5	U
	Phossy Waste (V-3600/V-3700/V-3800 composite)	Astaris 2001	PSW	G-0620 115-2	pCi/g	176f			<3[e]						1.5	0.7		10	2		1,240	17		540	8		0	0.2	U	0.6	1.5	U
	Phossy Waste (V-3600/V-3700/V-3800 composite)	Astaris 2001	PSW	G-0620 118-1	pCi/g	157f			<1[e]						13	5		7.5	1.7		1,340	40		750	20		0	1.2	U	0.3	1.2	U
	Phossy Waste (V-3600/V-3700/V-3800 composite)	Astaris 2001	PSW	G-0620 118-2	pCi/g	157f			<19[e]						3.4	2.6		11	2		1,370	40		720	20		0.4	1.4	U	0	1.2	U
IWW System	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWA	pCi/L													0.89	0.15	U										-0.30	0.80	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWD	pCi/L													0.31	0.10	U										-2.90	0.30	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWE	pCi/L													0.46	0.10	U										-1.50	0.60	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWF	pCi/L													0.79	0.13	U										-0.30	0.40	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWG	pCi/L													0.18	0.08	U										6.50	0.80	
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWH	pCi/L													0.63	0.12	U										-1.10	0.40	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWN	pCi/L													0.00	0.1	U										0.00	0.30	U
	IWW Ditch Discharge (July 1993)	Bechtel 1996	PSL	O307IWP	pCi/L													0.18	0.08	U										-0.70	0.30	U
	IWW Ditch Discharge (Sept. 1992) - time composite	Bechtel 1996	PSL	FSWIWW01	pCi/L													0.72	0.17	UJ										-0.2	0.60	U
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW01	pCi/g																											
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW02	pCi/g																											
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW03	pCi/g																											
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW04	pCi/g																											
	IWW Ditch Sediments	Bechtel 1996	PSW	FSDIWW05	pCi/g																											
	IWW Ditch Sediments (composite)	Bechtel 1996	PSW	FSDIWW06	pCi/g																											
Railroad Swale	Water in Railroad Swale - location composite	Bechtel 1996	PSL	FWWRRS01	pCi/L													1.59	0.23											-0.3	0.50	U
	Sediment in Railroad Swale	Bechtel 1996	PSW	FSDRRS01	pCi/g																											

Notes:

Blank result cells - radionuclide not analyzed

J = Estimated value.

U = Not detected.

[a] Station location code used in EMF Site remedial investigation

[b] Uranium as U (pCi/g) calculated from total uranium; U-238 not reported, but is < U (pCi/g)

[c] As stated in EPA report Table 3, data are average results from both EMSL and EERF laboratories except for lead-210 and polonium-210 (corrected) which are average of EERF values only from Appendix C, Tables C-1, C-2 and C-3 of EPA report.

[e] Uranium as U (pCi/g) calculated from total uranium; U-238 not reported, but is < U (pCi/g)

[f] K-40 calculated from total potassium assuming natural abundance of K-40 is 0.0118%

[g] EPA collected 6 samples of phosphate ore, 6 samples of calcined briquettes, and 6 samples of slag in December 1976 from the FMC facility. These samples were split. One set was analyzed at EPA's EMSL laboratory and the other set was analyzed at EPA's EERF laboratory. Table C-1 provides analytical results for phosphate ore samples, Table C-2 provides results of calcined briquettes

[h] Data are 95th percentile representative background levels developed by EPA and reported in Table 4.2.1-1 of the RI Report (Bechtel, 1996).

Astaris 2001:Pre-Start Up LDR Radionuclides Study

Bechtel 1996: EMF Site Remedial Investigation Report

EPA 1977: Radiological Surveys of Idaho Phosphate Ore Processing -- The Thermal Process Plant

Hazen 2003: Report of Analysis for Sample Calciner 2-C 03/12/2003

Table F-2
Exposure Point Activities for Background Soils and Potential Source Materials at the FMC Plant OU

		Associated with Potassium		<- parents -- **Uranium-238 Decay Series** -- daughters ->										Thorium-232 Decay Series			
Media	**Units**	**Potassium-40**		**Uranium-238**	**Uranium-234**		**Thorium-230**		**Radium-226**		**Lead-210**		**Polonium-210**		**Thorium-232**		**Radium-228**
Background (1)																	
Native Subsurface Soils	pCi/g	20.50		3.88	3.88	(2)	3.88	(2)	3.88	(2)	3.03		3.58		-		-
Potential Source Materials																	
Phosphate Ore	pCi/g	10.90	(3)	23.28	22.32		23.13		31.28		32.22		23.00		0.47		0.68
Calcined Nodules	pCi/g	-		24.10	23.59		23.35		27.10		21.79		10.92		0.50		0.82
Silica (3)	pCi/g	-		1.50	0.43		1.60		1.70		0.67		2.60		0.69		0.45
Coke	pCi/g	0.46	(3)	1.54	0.48	(4)	0.12	(4)	0.78	(4)	3.32	(4)	0.98	(4)	0.35	(4)	0.48	(4)
Ferrophos	pCi/g	2.30	(4)	17.58	21.00	(3)	0.42	(3)	0.27	(3)	0.99		0.29	(3)	0.26	(3)	0.99	(3)
Slag	pCi/g	9.82		26.81	26.86		29.30		35.19		9.12		14.03		0.67		0.74
Calciner Pond Sediment	pCi/g	70.40		17.50	17.50	(5)	17.50	(5)	17.50	(5)	0.85		0.85	(6)	-		-
Phossy Solids	pCi/g	135.22		13.03	45.50		11.33		12.04		1005.30		711.12		5.08		1.18
IWW Ditch Sediments	pCi/g	-		-	-		-		-		-		-		-		-
Sediment in Railroad Swale	pCi/g	-		-	-		-		-		-		-		-		-

- = No data available.

1) Unless otherwise noted, background activities obtained from Table 2-8 of the EMF HHRA (E&E, 1996).

2) Background activity characterized assuming constituent in secular equilibrium with U-238.

3) Due to the availability of only one sample, exposure point concentration characterized by the maximum data point.

4) 95% UCL on the mean exceeds the maximum activity reported; exposure point concentration characterized by maximum data point.

5) In the absence of data, constituent activity characterized assuming secular equilibrium with U-238.

6) In the absence of data, constituent activity characterized assuming secular equilibrium with Pb-210.

Table F-3
Radionuclide Carcinogenicity Slope Factors (1)

Decay Series	Isotope (2)	Radioactive Carcinogenicity - Slope Factors (1)		
		Soil Ingestion (risk/pCi)	Inhalation (risk/pCi)	External Exposure (risk/yr per pCi/g)
Potassium	Potassium-40	6.18E-11	1.03E-11	7.97E-07
Uranium- 238	Uranium-238+D	2.10E-10	9.35E-09	1.14E-07
	Uranium-234	1.58E-10	1.14E-08	2.52E-10
	Thorium-230	2.02E-10	2.85E-08	8.19E-10
	Radium-226+D	7.30E-10	1.16E-08	8.49E-06
	Lead-210 + D	2.66E-09	1.39E-08	4.21E-09
	Polonium-210	7.96E-10	1.08E-08	3.95E-11
Thorium-232	Thorium-232	2.31E-10	4.33E-08	3.42E-10
	Radium-228+D	2.29E-09	5.23E-09	4.53E-06

(1) Slope factors obtained from HEAST (EPA, 2001).

(2) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-4
Radionuclide Half-Lives and Decay Constants

Decay Series	Isotope (1)	Half-Life (years) (2)	Decay Constant (years^{-1}) (3)
Potassium	Potassium-40	1.28E+09	5.42E-10
Uranium- 238	Uranium-238+D	4.47E+09	1.55E-10
	Uranium-234	2.45E+05	2.83E-06
	Thorium-230	7.70E+04	9.00E-06
	Radium-226+D	1.60E+03	4.33E-04
	Lead-210 + D	2.23E+01	3.11E-02
	Polonium-210	3.78E-01	1.83E+00
Thorium-232	Thorium-232	1.41E+10	4.92E-11
	Radium-228+D	5.75E+00	1.21E-01

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

(2) Half-lives obtained from HEAST (EPA, 2001).

(3) Decay constant calculated as ln(2)/half-life for each radionuclide.

Table F-5
Parameter Values Used to Estimate Radiological Risk to Future Commercial/Industrial Workers Exposed to Potential Source Materials at the FMC Plant OU

Parameter	Units	Value	Source
Equation F-1: Incidental Soil Ingestion			
t_w - Time worker	years	25	Default value (EPA, 2004)
EF_{ow} - Outdoor worker exposure frequency	days/year	225	Default value (EPA, 2004)
ED_{ow} - Outdoor worker exposure duration	years	25	Default value (EPA, 2004)
IR_{sow} - Outdoor worker soil ingestion rate	mg/day	100	Default value (EPA, 2004)
Equation F-3: Inhalation of Fugitive Dust			
t_w - Time worker	years	25	Default value (EPA, 2004)
EF_{ow} - Outdoor worker exposure frequency	days/year	225	Default value (EPA, 2004)
ED_{ow} - Outdoor worker exposure duration	years	25	Default value (EPA, 2004)
IR_{ow} - Outdoor worker inhalation rate	m^3/day	60	Default value (EPA, 2004)
ETowo - Outdoor worker exposure time outdoors	hour/hour	0.33	Default value (EPA, 2004): Equivalent to 8 hours/work day
ETowi - Outdoor worker exposure time indoors	hour/hour	0	Default value (EPA, 2004)
DF_i - Indoor dilution factor	unitless	0.4	Default value (EPA, 2004)
PEF - Particulate emission factor	m^3/kg	3.41E+08	Derived for outdoor commercial/industrial workers at the FMC Plant OU in Section 4.2.3
Equation F-5: External Exposure to Gamma Radiation			
t_w - Time worker	years	25	Default value (EPA, 2004)
EF_{ow} - Outdoor worker exposure frequency	days/year	225	Default value (EPA, 2004)
ED_{ow} - Outdoor worker exposure duration	years	25	Default value (EPA, 2004)
ACF - Area correction factor	unitless	1	Due to the spatial extent of the FMC Plant OU no area correction factor applied
GSF - Gamma shielding factor	unitless	0.4	Default value (EPA, 2004)
ET_{owo} - Outdoor worker exposure time outdoors	hour/hour	0.33	Default value (EPA, 2004): Equivalent to 8 hours/work day
ET_{owi} - Outdoor worker exposure time indoors	hour/hour	0	Default value (EPA, 2004)

Table F-6

Radionuclide- and Pathway-Specific Contributions to Total Risk for Commercial/Industrial Workers Exposed to Phosphate Ore

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	10.90	3.79E-07	0.03%	3.71E-11	0.00%	4.46E-05	3.02%
Uranium- 238	Uranium-238 + D	23.28	2.75E-06	0.19%	7.19E-08	0.00%	1.36E-05	0.92%
	Uranium-234	22.32	1.98E-06	0.13%	8.40E-08	0.01%	2.89E-08	0.00%
	Thorium-230	23.13	2.63E-06	0.18%	2.18E-07	0.01%	9.73E-08	0.01%
	Radium-226 + D	31.28	1.28E-05	0.87%	1.19E-07	0.01%	1.36E-03	91.93%
	Lead-210 + D	32.22	3.35E-05	2.27%	1.03E-07	0.01%	4.84E-07	0.03%
	Polonium-210	23.00	2.25E-07	0.02%	1.79E-09	0.00%	1.02E-10	0.00%
Thorium-232	Thorium-232	0.47	6.10E-08	0.00%	6.72E-09	0.00%	8.25E-10	0.00%
	Radium-228 + D	0.68	2.76E-07	0.02%	3.70E-10	0.00%	4.98E-06	0.34%
		Total	**5.46E-05**	**3.70%**	**6.05E-07**	**0.04%**	**1.42E-03**	**96.26%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-7

Radionuclide- and Pathway-Specific Contributions to Total Risk for Commercial/Industrial Workers Exposed to Calcined Nodules

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	NA	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
Uranium- 238	Uranium-238 + D	24.10	2.85E-06	0.23%	7.44E-08	0.01%	1.41E-05	1.14%
	Uranium-234	23.59	2.10E-06	0.17%	8.88E-08	0.01%	3.05E-08	0.00%
	Thorium-230	23.35	2.65E-06	0.21%	2.20E-07	0.02%	9.82E-08	0.01%
	Radium-226 + D	27.10	1.11E-05	0.89%	1.03E-07	0.01%	1.18E-03	94.91%
	Lead-210 + D	21.79	2.27E-05	1.83%	6.95E-08	0.01%	3.28E-07	0.03%
	Polonium-210	10.92	1.07E-07	0.01%	8.50E-10	0.00%	4.83E-11	0.00%
Thorium-232	Thorium-232	0.50	6.51E-08	0.01%	7.16E-09	0.00%	8.80E-10	0.00%
	Radium-228 + D	0.82	3.33E-07	0.03%	4.46E-10	0.00%	6.01E-06	0.49%
		Total	**4.18E-05**	**3.38%**	**5.64E-07**	**0.05%**	**1.20E-03**	**96.58%**

NA = No data available for this constituent.

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-8
Radionuclide- and Pathway-Specific Contributions to Total Risk for Commercial/Industrial Workers Exposed to Silica

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	NA	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
Uranium- 238	Uranium-238 + D	1.50	1.77E-07	0.22%	4.63E-09	0.01%	8.78E-07	1.10%
	Uranium-234	0.43	3.82E-08	0.05%	1.62E-09	0.00%	5.57E-10	0.00%
	Thorium-230	1.60	1.82E-07	0.23%	1.51E-08	0.02%	6.73E-09	0.01%
	Radium-226 + D	1.70	6.94E-07	0.87%	6.48E-09	0.01%	7.37E-05	92.14%
	Lead-210 + D	0.67	6.97E-07	0.87%	2.14E-09	0.00%	1.01E-08	0.01%
	Polonium-210	2.60	2.54E-08	0.03%	2.02E-10	0.00%	1.15E-11	0.00%
Thorium-232	Thorium-232	0.69	8.97E-08	0.11%	9.87E-09	0.01%	1.21E-09	0.00%
	Radium-228 + D	0.45	1.81E-07	0.23%	2.43E-10	0.00%	3.27E-06	4.08%
		Total	**2.08E-06**	**2.60%**	**4.02E-08**	**0.05%**	**7.79E-05**	**97.35%**

NA = No data available for this constituent.

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-9
Radionuclide and Pathway-Specific Contributions to Total Risk for Commercial/Industrial Workers Exposed to Coke

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	0.46	1.61E-08	0.04%	1.58E-12	0.00%	1.90E-06	4.26%
Uranium- 238	Uranium-238 + D	1.54	1.82E-07	0.41%	4.75E-09	0.01%	9.01E-07	2.03%
	Uranium-234	0.48	4.22E-08	0.09%	1.79E-09	0.00%	6.15E-10	0.00%
	Thorium-230	0.12	1.31E-08	0.03%	1.08E-09	0.00%	4.84E-10	0.00%
	Radium-226 + D	0.78	3.19E-07	0.72%	2.97E-09	0.01%	3.38E-05	76.08%
	Lead-210 + D	3.32	3.45E-06	7.77%	1.06E-08	0.02%	4.99E-08	0.11%
	Polonium-210	0.98	9.57E-09	0.02%	7.63E-11	0.00%	4.34E-12	0.00%
Thorium-232	Thorium-232	0.35	4.48E-08	0.10%	4.93E-09	0.01%	6.06E-10	0.00%
	Radium-228 + D	0.48	1.93E-07	0.43%	2.59E-10	0.00%	3.49E-06	7.84%
		Total	**4.27E-06**	**9.61%**	**2.65E-08**	**0.06%**	**4.02E-05**	**90.33%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-10

Radionuclide- and Pathway-Specific Contributions to Total Risk for Commercial/Industrial Workers Exposed to Ferrophos

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	2.30	8.00E-08	0.18%	7.82E-12	0.00%	9.42E-06	21.15%
Uranium- 238	Uranium-238 + D	17.58	2.08E-06	4.66%	5.43E-08	0.12%	1.03E-05	23.12%
	Uranium-234	21.00	1.87E-06	4.19%	7.91E-08	0.18%	2.72E-08	0.06%
	Thorium-230	0.42	4.77E-08	0.11%	3.95E-09	0.01%	1.77E-09	0.00%
	Radium-226 + D	0.27	1.10E-07	0.25%	1.03E-09	0.00%	1.17E-05	26.30%
	Lead-210 + D	0.99	1.03E-06	2.31%	3.16E-09	0.01%	1.49E-08	0.03%
	Polonium-210	0.29	2.78E-09	0.01%	2.22E-11	0.00%	1.26E-12	0.00%
Thorium-232	Thorium-232	0.26	3.38E-08	0.08%	3.72E-09	0.01%	4.57E-10	0.00%
	Radium-228 + D	0.99	4.02E-07	0.90%	5.40E-10	0.00%	7.27E-06	16.32%
		Total	**5.65E-06**	**12.68%**	**1.46E-07**	**0.33%**	**3.87E-05**	**86.99%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-11
Radionuclide- and Pathway-Specific Contributions to Total Risk for Commercial/Industrial Workers Exposed to Slag

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	9.82	3.41E-07	0.02%	3.34E-11	0.00%	4.02E-05	2.48%
Uranium- 238	Uranium-238 + D	26.81	3.17E-06	0.20%	8.28E-08	0.01%	1.57E-05	0.97%
	Uranium-234	26.86	2.39E-06	0.15%	1.01E-07	0.01%	3.48E-08	0.00%
	Thorium-230	29.30	3.33E-06	0.21%	2.76E-07	0.02%	1.23E-07	0.01%
	Radium-226 + D	35.19	1.44E-05	0.89%	1.34E-07	0.01%	1.53E-03	94.09%
	Lead-210 + D	9.12	9.48E-06	0.58%	2.91E-08	0.00%	1.37E-07	0.01%
	Polonium-210	14.03	1.37E-07	0.01%	1.09E-09	0.00%	6.21E-11	0.00%
Thorium-232	Thorium-232	0.67	8.73E-08	0.01%	9.61E-09	0.00%	1.18E-09	0.00%
	Radium-228 + D	0.74	2.99E-07	0.02%	4.01E-10	0.00%	5.40E-06	0.33%
		Total	**3.36E-05**	**2.07%**	**6.34E-07**	**0.04%**	**1.59E-03**	**97.89%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-12

Radionuclide- and Pathway-Specific Contributions to Total Risk for Commercial/Industrial Workers Exposed to Calciner Pond Sediment

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	70.40	2.45E-06	0.23%	2.39E-10	0.00%	2.88E-04	26.83%
Uranium- 238	Uranium-238 + D	17.50	2.07E-06	0.19%	5.40E-08	0.01%	1.02E-05	0.95%
	Uranium-234	17.50	1.56E-06	0.14%	6.59E-08	0.01%	2.27E-08	0.00%
	Thorium-230	17.50	1.99E-06	0.19%	1.65E-07	0.02%	7.36E-08	0.01%
	Radium-226 + D	17.50	7.15E-06	0.67%	6.67E-08	0.01%	7.59E-04	70.67%
	Lead-210 + D	0.85	8.84E-07	0.08%	2.71E-09	0.00%	1.28E-08	0.00%
	Polonium-210	0.85	8.30E-09	0.00%	6.62E-11	0.00%	3.76E-12	0.00%
Thorium-232	Thorium-232	NA	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
	Radium-228 + D	NA	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
		Total	**1.61E-05**	**1.50%**	**3.54E-07**	**0.03%**	**1.06E-03**	**98.47%**

NA = No data available for this constituent.

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-13

Radionuclide- and Pathway-Specific Contributions to Total Risk for Commercial/Industrial Workers Exposed to Phossy Solids

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	135.22	4.70E-06	0.22%	4.60E-10	0.00%	5.54E-04	25.38%
Uranium- 238	Uranium-238 + D	13.03	1.54E-06	0.07%	4.02E-08	0.00%	7.63E-06	0.35%
	Uranium-234	45.50	4.04E-06	0.19%	1.71E-07	0.01%	5.89E-08	0.00%
	Thorium-230	11.33	1.29E-06	0.06%	1.07E-07	0.00%	4.77E-08	0.00%
	Radium-226 + D	12.04	4.92E-06	0.23%	4.59E-08	0.00%	5.22E-04	23.94%
	Lead-210 + D	1005.30	1.05E-03	47.94%	3.21E-06	0.15%	1.51E-05	0.69%
	Polonium-210	711.12	6.95E-06	0.32%	5.53E-08	0.00%	3.15E-09	0.00%
Thorium-232	Thorium-232	5.08	6.61E-07	0.03%	7.27E-08	0.00%	8.93E-09	0.00%
	Radium-228 + D	1.18	4.79E-07	0.02%	6.43E-10	0.00%	8.66E-06	0.40%
		Total	**1.07E-03**	**49.06%**	**3.70E-06**	**0.17%**	**1.11E-03**	**50.77%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-14

Radionuclide- and Pathway-Specific Contributions to Total Risk for Commercial/Industrial Workers Exposed to Background Soil

Decay Series	Isotope (1)	Background Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	20.50	7.13E-07	0.27%	6.97E-11	0.00%	8.39E-05	32.11%
Uranium- 238	Uranium-238 + D	3.88	4.58E-07	0.18%	1.20E-08	0.00%	2.27E-06	0.87%
	Uranium-234	3.88	3.45E-07	0.13%	1.46E-08	0.01%	5.02E-09	0.00%
	Thorium-230	3.88	4.41E-07	0.17%	3.65E-08	0.01%	1.63E-08	0.01%
	Radium-226 + D	3.88	1.58E-06	0.61%	1.48E-08	0.01%	1.68E-04	64.39%
	Lead-210 + D	3.03	3.15E-06	1.21%	9.67E-09	0.00%	4.56E-08	0.02%
	Polonium-210	3.58	3.50E-08	0.01%	2.79E-10	0.00%	1.58E-11	0.00%
Thorium-232	Thorium-232	- (2)	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
	Radium-228 + D	- (2)	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
		Total	**6.73E-06**	**2.57%**	**8.79E-08**	**0.03%**	**2.55E-04**	**97.39%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

(2) Data sufficient to characterize background activity are unavailable for this constituent.

Table F-15
Summary of Total Risk for Commercial/Industrial Workers Exposed to Background Soils and Potential Source Materials

Potential Source Material	Exposure Pathway						All Pathways	
	Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation			
	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Background								
Subsurface soil	6.73E-06	2.57E-02	8.79E-08	3.36E-04	2.55E-04	9.74E-01	2.61E-04	100.00%
Potential Source Material								
Phosphate Ore	5.46E-05	3.70%	6.05E-07	0.04%	1.42E-03	96.26%	1.48E-03	100.00%
Calcined Nodules	4.18E-05	3.38%	5.64E-07	0.05%	1.20E-03	96.58%	1.24E-03	100.00%
Silica	2.08E-06	2.60%	4.02E-08	0.05%	7.79E-05	97.35%	8.00E-05	100.00%
Coke	4.27E-06	9.61%	2.65E-08	0.06%	4.02E-05	90.33%	4.45E-05	100.00%
Ferrophos	5.65E-06	12.68%	1.46E-07	0.33%	3.87E-05	86.99%	4.45E-05	100.00%
Slag	3.36E-05	2.07%	6.34E-07	0.04%	1.59E-03	97.89%	1.62E-03	100.00%
Calciner Pond Sediment	1.61E-05	1.50%	3.54E-07	0.03%	1.06E-03	98.47%	1.07E-03	100.00%
Phossy Solids	1.07E-03	49.06%	3.70E-06	0.17%	1.11E-03	50.77%	2.18E-03	100.00%

= Total risk from commercial/industrial worker exposure to this potential source material is lower than the risk associated with exposure to background soils over the same time duration.

Table F-16

Parameter Values Used to Estimate Radiological Risk to Future Construction Workers Exposed to Potential Source Materials at the FMC Plant OU

Parameter	Units	Value	Source
Equation F-1: Incidental Soil Ingestion			
t_w - Time worker	years	1	Section 4 construction worker SSL calculations
EF_{ow} - Outdoor worker exposure frequency	days/year	130	Section 4 construction worker SSL calculations
ED_{ow} - Outdoor worker exposure duration	years	1	Section 4 construction worker SSL calculations
IR_{sow} - Outdoor worker soil ingestion rate	mg/day	330	Section 4 construction worker SSL calculations
Equation F-3: Inhalation of Fugitive Dust			
t_w - Time worker	years	1	Section 4 construction worker SSL calculations
EF_{ow} - Outdoor worker exposure frequency	days/year	130	Section 4 construction worker SSL calculations
ED_{ow} - Outdoor worker exposure duration	years	1	Section 4 construction worker SSL calculations
IR_{ow} - Outdoor worker inhalation rate	m^3/day	60	Default value (EPA, 2004)
ETowo - Outdoor worker exposure time outdoors	hour/hour	0.33	Default value (EPA, 2004): Equivalent to 8 hours/work day
ETowi - Outdoor worker exposure time indoors	hour/hour	0	Default value (EPA, 2004)
DF_i - Indoor dilution factor	unitless	0.4	Default value (EPA, 2004)
PEF - Particulate emission factor	m^3/kg	7.44E+05	Derived for construction worker at the FMC Plant OU in Section 4.4.3
Equation F-5: External Exposure to Gamma Radiation			
t_w - Time worker	years	1	Section 4 construction worker SSL calculations
EF_{ow} - Outdoor worker exposure frequency	days/year	130	Section 4 construction worker SSL calculations
ED_{ow} - Outdoor worker exposure duration	years	1	Section 4 construction worker SSL calculations
ACF - Area correction factor	unitless	1	Due to the spatial extent of the FMC Plant OU no area correction factor applied
GSF - Gamma shielding factor	unitless	0.4	Default value (EPA, 2004)
ET_{owo} - Outdoor worker exposure time outdoors	hour/hour	0.33	Default value (EPA, 2004): Equivalent to 8 hours/work day
ET_{owi} - Outdoor worker exposure time indoors	hour/hour	0	Default value (EPA, 2004)

Table F-17
Radionuclide- and Pathway-Specific Contributions to Total Risk for Construction Workers Exposed to Phosphate Ore

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	10.90	2.89E-08	0.04%	3.92E-10	0.00%	1.62E-06	2.49%
Uranium- 238	Uranium-238 + D	23.28	2.10E-07	0.32%	7.60E-07	1.17%	4.95E-07	0.76%
	Uranium-234	22.32	1.51E-07	0.23%	8.89E-07	1.37%	1.05E-09	0.00%
	Thorium-230	23.13	2.00E-07	0.31%	2.30E-06	3.54%	3.53E-09	0.01%
	Radium-226 + D	31.28	9.79E-07	1.51%	1.27E-06	1.95%	4.95E-05	76.10%
	Lead-210 + D	32.22	3.62E-06	5.57%	1.54E-06	2.37%	2.49E-08	0.04%
	Polonium-210	23.00	3.60E-07	0.55%	3.98E-07	0.61%	7.76E-11	0.00%
Thorium-232	Thorium-232	0.47	4.66E-09	0.01%	7.11E-08	0.11%	2.99E-11	0.00%
	Radium-228 + D	0.68	6.28E-08	0.10%	1.17E-08	0.02%	5.40E-07	0.83%
		Total	**5.62E-06**	**8.64%**	**7.24E-06**	**11.13%**	**5.22E-05**	**80.23%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-18

Radionuclide- and Pathway-Specific Contributions to Total Risk for Construction Workers Exposed to Calciner Nodules

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	NA	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
Uranium- 238	Uranium-238 + D	24.10	2.17E-07	0.40%	7.87E-07	1.44%	5.12E-07	0.94%
	Uranium-234	23.59	1.60E-07	0.29%	9.39E-07	1.72%	1.11E-09	0.00%
	Thorium-230	23.35	2.02E-07	0.37%	2.32E-06	4.25%	3.56E-09	0.01%
	Radium-226 + D	27.10	8.49E-07	1.55%	1.10E-06	2.01%	4.29E-05	78.44%
	Lead-210 + D	21.79	2.45E-06	4.48%	1.04E-06	1.91%	1.68E-08	0.03%
	Polonium-210	10.92	1.71E-07	0.31%	1.89E-07	0.35%	3.68E-11	0.00%
Thorium-232	Thorium-232	0.50	4.96E-09	0.01%	7.57E-08	0.14%	3.19E-11	0.00%
	Radium-228 + D	0.82	7.58E-08	0.14%	1.41E-08	0.03%	6.51E-07	1.19%
		Total	**4.13E-06**	**7.55%**	**6.47E-06**	**11.84%**	**4.41E-05**	**80.61%**

NA = No data available for this constituent.

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-19
Radionuclide- and Pathway-Specific Contributions to Total Risk for Construction Workers Exposed to Silica

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	NA	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
Uranium- 238	Uranium-238 + D	1.50	1.35E-08	0.35%	4.90E-08	1.29%	3.19E-08	0.84%
	Uranium-234	0.43	2.91E-09	0.08%	1.71E-08	0.45%	2.02E-11	0.00%
	Thorium-230	1.60	1.39E-08	0.36%	1.59E-07	4.18%	2.44E-10	0.01%
	Radium-226 + D	1.70	5.32E-08	1.40%	6.89E-08	1.81%	2.69E-06	70.65%
	Lead-210 + D	0.67	7.53E-08	1.98%	3.20E-08	0.84%	5.18E-10	0.01%
	Polonium-210	2.60	4.07E-08	1.07%	4.49E-08	1.18%	8.77E-12	0.00%
Thorium-232	Thorium-232	0.69	6.84E-09	0.18%	1.04E-07	2.74%	4.40E-11	0.00%
	Radium-228 + D	0.45	4.12E-08	1.08%	7.66E-09	0.20%	3.54E-07	9.30%
		Total	**2.48E-07**	**6.50%**	**4.83E-07**	**12.69%**	**3.08E-06**	**80.80%**

NA = No data available for this constituent.

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-20
Radionuclide- and Pathway-Specific Contributions to Total Risk for Construction Workers Exposed to Coke

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	0.46	1.23E-09	0.05%	1.67E-11	0.00%	6.88E-08	2.70%
Uranium- 238	Uranium-238 + D	1.54	1.39E-08	0.54%	5.02E-08	1.98%	3.27E-08	1.28%
	Uranium-234	0.48	3.22E-09	0.13%	1.89E-08	0.74%	2.23E-11	0.00%
	Thorium-230	0.12	9.97E-10	0.04%	1.14E-08	0.45%	1.76E-11	0.00%
	Radium-226 + D	0.78	2.44E-08	0.96%	3.16E-08	1.24%	1.23E-06	48.51%
	Lead-210 + D	3.32	3.73E-07	14.66%	1.59E-07	6.24%	2.57E-09	0.10%
	Polonium-210	0.98	1.53E-08	0.60%	1.69E-08	0.67%	3.31E-12	0.00%
Thorium-232	Thorium-232	0.35	3.42E-09	0.13%	5.22E-08	2.05%	2.20E-11	0.00%
	Radium-228 + D	0.48	4.40E-08	1.73%	8.17E-09	0.32%	3.78E-07	14.85%
		Total	**4.79E-07**	**18.85%**	**3.48E-07**	**13.69%**	**1.72E-06**	**67.46%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-21
Radionuclide- and Pathway-Specific Contributions to Total Risk for Construction Workers Exposed to Ferrophos

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	2.30	6.10E-09	0.15%	8.28E-11	0.00%	3.42E-07	8.47%
Uranium- 238	Uranium-238 + D	17.58	1.58E-07	3.93%	5.74E-07	14.24%	3.74E-07	9.26%
	Uranium-234	21.00	1.42E-07	3.53%	8.36E-07	20.74%	9.86E-10	0.02%
	Thorium-230	0.42	3.64E-09	0.09%	4.18E-08	1.04%	6.41E-11	0.00%
	Radium-226 + D	0.27	8.45E-09	0.21%	1.09E-08	0.27%	4.27E-07	10.59%
	Lead-210 + D	0.99	1.11E-07	2.75%	4.73E-08	1.17%	7.64E-10	0.02%
	Polonium-210	0.29	4.46E-09	0.11%	4.93E-09	0.12%	9.62E-13	0.00%
Thorium-232	Thorium-232	0.26	2.58E-09	0.06%	3.93E-08	0.98%	1.66E-11	0.00%
	Radium-228 + D	0.99	9.16E-08	2.27%	1.70E-08	0.42%	7.87E-07	19.53%
		Total	**5.29E-07**	**13.11%**	**1.57E-06**	**38.98%**	**1.93E-06**	**47.91%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-22
Radionuclide- and Pathway-Specific Contributions to Total Risk for Construction Workers Exposed to Slag

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	9.82	2.60E-08	0.04%	3.53E-10	0.00%	1.46E-06	2.13%
Uranium- 238	Uranium-238 + D	26.81	2.42E-07	0.35%	8.76E-07	1.28%	5.70E-07	0.83%
	Uranium-234	26.86	1.82E-07	0.27%	1.07E-06	1.56%	1.26E-09	0.00%
	Thorium-230	29.30	2.54E-07	0.37%	2.92E-06	4.26%	4.47E-09	0.01%
	Radium-226 + D	35.19	1.10E-06	1.61%	1.43E-06	2.08%	5.57E-05	81.27%
	Lead-210 + D	9.12	1.02E-06	1.49%	4.36E-07	0.64%	7.04E-09	0.01%
	Polonium-210	14.03	2.20E-07	0.32%	2.43E-07	0.35%	4.73E-11	0.00%
Thorium-232	Thorium-232	0.67	6.66E-09	0.01%	1.02E-07	0.15%	4.28E-11	0.00%
	Radium-228 + D	0.74	6.81E-08	0.10%	1.27E-08	0.02%	5.85E-07	0.85%
		Total	**3.12E-06**	**4.56%**	**7.08E-06**	**10.34%**	**5.83E-05**	**85.10%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-23

Radionuclide- and Pathway-Specific Contributions to Total Risk for Construction Workers Exposed to Calciner Pond Sediment

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	70.40	1.87E-07	0.43%	2.53E-09	0.01%	1.05E-05	24.00%
Uranium- 238	Uranium-238 + D	17.50	1.58E-07	0.36%	5.72E-07	1.31%	3.72E-07	0.85%
	Uranium-234	17.50	1.19E-07	0.27%	6.97E-07	1.60%	8.22E-10	0.00%
	Thorium-230	17.50	1.52E-07	0.35%	1.74E-06	4.00%	2.67E-09	0.01%
	Radium-226 + D	17.50	5.48E-07	1.26%	7.09E-07	1.63%	2.77E-05	63.55%
	Lead-210 + D	0.85	9.55E-08	0.22%	4.06E-08	0.09%	6.57E-10	0.00%
	Polonium-210	0.85	1.33E-08	0.03%	1.47E-08	0.03%	2.87E-12	0.00%
Thorium-232	Thorium-232	NA	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
	Radium-228 + D	NA	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
		Total	**1.27E-06**	**2.92%**	**3.78E-06**	**8.67%**	**3.85E-05**	**88.41%**

NA = No data available for this constituent.

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-24
Radionuclide- and Pathway-Specific Contributions to Total Risk for Construction Workers Exposed to Phossy Solids

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	135.22	3.59E-07	0.15%	4.87E-09	0.00%	2.01E-05	8.67%
Uranium- 238	Uranium-238 + D	13.03	1.17E-07	0.05%	4.25E-07	0.18%	2.77E-07	0.12%
	Uranium-234	45.50	3.08E-07	0.13%	1.81E-06	0.78%	2.14E-09	0.00%
	Thorium-230	11.33	9.82E-08	0.04%	1.13E-06	0.49%	1.73E-09	0.00%
	Radium-226 + D	12.04	3.77E-07	0.16%	4.88E-07	0.21%	1.91E-05	8.22%
	Lead-210 + D	1005.30	1.13E-04	48.76%	4.81E-05	20.75%	7.77E-07	0.34%
	Polonium-210	711.12	1.11E-05	4.80%	1.23E-05	5.31%	2.40E-09	0.00%
Thorium-232	Thorium-232	5.08	5.04E-08	0.02%	7.69E-07	0.33%	3.24E-10	0.00%
	Radium-228 + D	1.18	1.09E-07	0.05%	2.03E-08	0.01%	9.38E-07	0.40%
		Total	**1.26E-04**	**54.18%**	**6.50E-05**	**28.06%**	**4.11E-05**	**17.76%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

Table F-25

Radionuclide- and Pathway-Specific Contributions to Total Risk for Construction Workers Exposed to Background Soils

Decay Series	Isotope (1)	Exposure Point Activity (pCi/g)	Exposure Pathway					
			Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation	
			Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Potassium	Potassium-40	20.50	5.44E-08	0.50%	7.38E-10	0.01%	3.05E-06	27.76%
Uranium- 238	Uranium-238 + D	3.88	3.50E-08	0.32%	1.27E-07	1.16%	8.24E-08	0.75%
	Uranium-234	3.88	2.63E-08	0.24%	1.55E-07	1.41%	1.82E-10	0.00%
	Thorium-230	3.88	3.36E-08	0.31%	3.86E-07	3.52%	5.92E-10	0.01%
	Radium-226 + D	3.88	1.21E-07	1.11%	1.57E-07	1.43%	6.14E-06	55.96%
	Lead-210 + D	3.03	3.40E-07	3.10%	1.45E-07	1.32%	2.34E-09	0.02%
	Polonium-210	3.58	5.60E-08	0.51%	6.19E-08	0.56%	1.21E-11	0.00%
Thorium-232	Thorium-232	- (2)	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
	Radium-228 + D	- (2)	0.00E+00	0.00%	0.00E+00	0.00%	0.00E+00	0.00%
		Total	**6.67E-07**	**6.08%**	**1.03E-06**	**9.41%**	**9.27E-06**	**84.51%**

(1) For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included.

(2) Data sufficient to characterize background activity are unavailable for this constituent.

Table F-26
Summary of MICROSHIELD 5.05 Model Results

Model Scenario	Trench Floor Dose (uR/hr)	Trench Wall Dose (uR/hr)	Total Exposure Rate (uR/hr)	Fractional Increase from Trench Walls
5' deep trench with no shield	54	26	80	1.48
5' deep trench with 0.25" steel shield	54	21	75	1.39
5' deep trench with 0.5" steel shield	54	17	71	1.31
5' deep trench with 1" steel shield	54	11	65	1.20
9' deep trench with 0.25" steel shield	54	31	85	1.57
9' deep trench with 0.5" steel shield	54	24	78	1.44
9' deep trench with 1" steel shield	54	15	69	1.28

Table F-27
Summary of Total Risk for Construction Workers Exposed to Background Soils and Potential Source Materials

Potential Source Material	Exposure Pathway						All Pathways	
	Incidental Soil Ingestion		Fugitive Dust Inhalation		External Gamma Radiation			
	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk	Cancer Risk	% of Total Risk
Background								
Subsurface soil	6.67E-07	6.08E-02	1.03E-06	9.41E-02	9.27E-06	8.45E-01	1.10E-05	100.00%
Potential Source Material								
Phosphate Ore	5.62E-06	8.64%	7.24E-06	11.13%	5.22E-05	80.23%	6.50E-05	100.00%
Calcined Nodules	4.13E-06	7.55%	6.47E-06	11.84%	4.41E-05	80.61%	5.47E-05	100.00%
Silica	2.48E-07	6.50%	4.83E-07	12.69%	3.08E-06	80.80%	3.81E-06	100.00%
Coke	4.79E-07	18.85%	3.48E-07	13.69%	1.72E-06	67.46%	2.54E-06	100.00%
Ferrophos	5.29E-07	13.11%	1.57E-06	38.98%	1.93E-06	47.91%	4.03E-06	100.00%
Slag	3.12E-06	4.56%	7.08E-06	10.34%	5.83E-05	85.10%	6.85E-05	100.00%
Calciner Pond Sediment	1.27E-06	2.92%	3.78E-06	8.67%	3.85E-05	88.41%	4.36E-05	100.00%
Phossy Solids	1.26E-04	54.18%	6.50E-05	28.06%	4.11E-05	17.76%	2.32E-04	100.00%

= Total risk from commercial/industrial worker exposure to this potential source material is lower than the risk associated with exposure to background soils over the same time duration.

ATTACHMENT 1

MICROSHIELD 5.05 MODELING ANALYSIS

Appendix F – Attachment 1
Microshield 5.05 Modeling Analysis

Calculation of Dose Increase by Walls of a Trench

MICROSHIELD 5.05 was used to calculate the increased dose rate from slag if a person were to stand in a trench. The first case was a trench assumed to be 2.0 meters wide, at least 5.0 meters long, and a depth of approximately 1.5 meters (5 feet). The dose rate was calculated at a height of 1 m above the trench floor. The second case was a trench assumed to be 2.0 meters wide, at least 5.0 meters long, and a depth of approximately 2.75 meters (9 feet). The dose rate was calculated at a height of 1 m above the trench floor. Both cases were then repeated with 3 thicknesses of steel shoring (shields) along the trench wall.

The conditions were simulated by first determining the dose rate at 1 meter from an infinitely thick slab[1] of infinite extent for the floor of the trench. One trench wall was calculated for an infinitely thick wall, 5 m long and at the two heights (depths). The dose rate point was 1 meter from the wall and 1 meter above the base. The total dose rate was assumed to be the sum of the trench floor and two walls. The material of the floor and walls was assumed to be 20 pCi/g of radium-226, lead-214, and bismuth-214 and of a density of 1.6 g/cm^3.

Three repetitions of the trench wall dose rate were made for each case with a steel shield against the face as a shoring device. The thicknesses used were 0.635 cm (0.25 inch), 1.27 cm (0.5 inch), and 2.54 cm (1.0 inch). The summed results are show in the following table and the MICROSHIELD results on the following pages.

Scenario	Trench Floor (μR/hr)	Trench Wall (μR/hr)	Total Exposure Rate (μR/hr)	Fractional increase from Trench Walls
Trench w/ No shield (5 ft)	54	26	80	1.48
Trench w/ 0.64 shield (5 ft)	54	21	75	1.39
Trench w/ 1.3 shield (5 ft)	54	17	71	1.32
Trench w/ 2.5 shield (5 ft)	54	11	65	1.20
Trench w/ 0.64 shield (9 ft)	54	31	85	1.57
Trench w/ 1.3 shield (9 ft)	54	24	78	1.45
Trench w/ 2.5 shield (9 ft)	54	15	69	1.27

[1] Infinite thickness was determined by a succession of calculations that showed that there was no increase in dose rate for thicknesses greater than 60 cm. The cases were run for 60 cm depth or thickness.

MicroShield v5.05 (5.05-00134)
Auxier & Associates
Case Title: Case 1, Infinite Slab, soil 60 cm thick Ra-226, Pb-214, and Bi-214 at 20 pCi/g with a density of 1.6 g/cm^3, dose at height of 1 meter from center.

Results With Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	1.309e-002	6.495e-002	3.247e-003	8.651e-006
7	0.08	2.730e-001	4.803e+000	3.842e-001	6.080e-004
8	0.1	1.607e-003	3.533e-002	3.533e-003	5.405e-006
10	0.2	1.275e-001	2.618e+000	5.236e-001	9.242e-004
11	0.3	2.443e-001	4.773e+000	1.432e+000	2.716e-003
12	0.4	4.531e-001	7.867e+000	3.147e+000	6.131e-003
13	0.5	2.025e-002	3.303e-001	1.651e-001	3.242e-004
14	0.6	5.709e-001	8.620e+000	5.172e+000	1.009e-002
15	0.8	1.118e-001	1.608e+000	1.286e+000	2.447e-003
16	1.0	3.707e-001	5.134e+000	5.134e+000	9.464e-003
17	1.5	2.254e-001	3.026e+000	4.539e+000	7.636e-003
18	2.0	3.169e-001	4.364e+000	8.729e+000	1.350e-002
	TOTALS:	2.728e+000	4.324e+001	3.052e+001	5.386e-002

Results Without Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	1.309e-002	1.009e-002	5.045e-004	1.344e-006
7	0.08	2.730e-001	3.897e-001	3.118e-002	4.933e-005
8	0.1	1.607e-003	2.710e-003	2.710e-004	4.146e-007
10	0.2	1.275e-001	2.970e-001	5.940e-002	1.048e-004
11	0.3	2.443e-001	6.682e-001	2.004e-001	3.802e-004
12	0.4	4.531e-001	1.395e+000	5.581e-001	1.087e-003
13	0.5	2.025e-002	6.868e-002	3.434e-002	6.740e-005
14	0.6	5.709e-001	2.101e+000	1.261e+000	2.460e-003
15	0.8	1.118e-001	4.709e-001	3.767e-001	7.165e-004
16	1.0	3.707e-001	1.744e+000	1.744e+000	3.215e-003
17	1.5	2.254e-001	1.310e+000	1.964e+000	3.305e-003
18	2.0	3.169e-001	2.142e+000	4.283e+000	6.623e-003
	TOTALS:	2.728e+000	1.060e+001	1.051e+001	1.801e-002

Attenuation Coefficients for Shield Materials

Source	Air Gap
5.838e-01	2.396e-04
3.202e-01	1.969e-04
2.723e-01	1.841e-04
1.998e-01	1.495e-04
1.715e-01	1.297e-04
1.532e-01	1.162e-04
1.396e-01	1.061e-04
1.291e-01	9.810e-05
1.134e-01	8.619e-05
1.019e-01	7.746e-05
8.299e-02	6.305e-05
7.155e-02	5.417e-05

Conversion of calculated exposure in air to dose
Results (Summed over energies)

	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	1.060e+001	4.324e+001
Photon Energy Fluence Rate	MeV/cm²/sec	1.051e+001	3.052e+001
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	1.801e-002	5.386e-002
Absorbed Dose Rate in Air	mGy/hr	1.572e-004	4.702e-004
	mrad/hr	1.572e-002	4.702e-002

Deep Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	1.822e-004	5.562e-004
Opposed		1.541e-004	4.552e-004
Rotational		1.541e-004	4.551e-004
Isotropic		1.379e-004	4.068e-004

Shallow Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	1.918e-004	5.840e-004
Opposed		1.842e-004	5.563e-004
Rotational		1.842e-004	5.563e-004
Isotropic		1.453e-004	4.303e-004

Effective Dose Equivalent Rate(ICRP 51 - 1987)

Anterior/Posterior Geometry	mSv/hr	1.629e 004	4.941e 004
Posterior/Anterior		1.487e-004	4.437e-004
Lateral		1.175e-004	3.416e-004
Rotational		1.339e-004	3.977e-004
Isotropic		1.180e-004	3.462e-004

MicroShield v5.05 (5.05-00134)
Auxier & Associates

Case Title: Case 2, Rectangular volume, 5m x 1.5m x 0.6m volume of soil 60 cm thick Ra-226, Pb-214, and Bi-214 at 20 pCi/g with a density of 1.6 g/cm^3, no shielding, dose at height of 1 meter from center.

Results With Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	5.984e+004	6.744e-003	3.372e-004	8.982e-007
7	0.08	1.248e+006	3.805e-001	3.044e-002	4.817e-005
8	0.1	7.347e+003	2.943e-003	2.943e-004	4.502e-007
10	0.2	5.831e+005	3.366e-001	6.733e-002	1.188e-004
11	0.3	1.117e+006	6.986e-001	2.096e-001	3.975e-004
12	0.4	2.071e+006	1.352e+000	5.407e-001	1.053e-003
13	0.5	9.259e+004	6.248e-002	3.124e-002	6.132e-005
14	0.6	2.610e+006	1.807e+000	1.084e+000	2.116e-003
15	0.8	5.110e+005	3.718e-001	2.974e-001	5.657e-004
16	1.0	1.695e+006	1.291e+000	1.291e+000	2.379e-003
17	1.5	1.031e+006	8.617e-001	1.293e+000	2.175e-003
18	2.0	1.449e+006	1.307e+000	2.614e+000	4.042e-003
	TOTALS:	1.247e+007	8.478e+000	7.459e+000	1.296e-002

Results Without Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	5.984e+004	3.953e-003	1.977e-004	5.266e-007
7	0.08	1.248e+006	1.509e-001	1.208e-002	1.911e-005
8	0.1	7.347e+003	1.044e-003	1.044e-004	1.597e-007
10	0.2	5.831e+005	1.126e-001	2.253e-002	3.976e-005
11	0.3	1.117e+006	2.510e-001	7.531e-002	1.429e-004
12	0.4	2.071e+006	5.204e-001	2.082e-001	4.056e-004
13	0.5	9.259e+004	2.546e-002	1.273e-002	2.499e-005
14	0.6	2.610e+006	7.748e-001	4.649e-001	9.074e-004
15	0.8	5.110e+005	1.721e-001	1.377e-001	2.618e-004
16	1.0	1.695e+006	6.324e-001	6.324e-001	1.166e-003
17	1.5	1.031e+006	4.671e-001	7.006e-001	1.179e-003
18	2.0	1.449e+006	7.533e-001	1.507e+000	2.330e-003
	TOTALS:	1.247e+007	3.865e+000	3.773e+000	6.477e-003

Attenuation Coefficients for Shield Materials

Source	Air Gap
5.838e-01	2.396e-04
3.202e-01	1.969e-04
2.723e-01	1.841e-04
1.998e-01	1.495e-04
1.715e-01	1.297e-04
1.532e-01	1.162e-04
1.396e-01	1.061e-04
1.291e-01	9.810e-05
1.134e-01	8.619e-05
1.019e-01	7.746e-05
8.299e-02	6.305e-05
7.155e-02	5.417e-05

Conversion of calculated exposure in air to dose
Results (Summed over energies)

	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	3.865e+000	8.478e+000
Photon Energy Fluence Rate	MeV/cm²/sec	3.773e+000	7.459e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	6.477e-003	1.296e-002
Absorbed Dose Rate in Air	mGy/hr	5.654e-005	1.131e-004
	mrad/hr	5.654e-003	1.131e-002

Deep Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	6.558e-005	1.320e-004
Opposed		5.538e-005	1.103e-004
Rotational		5.537e-005	1.103e-004
Isotropic		4.954e-005	9.861e-005

Shallow Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	6.901e-005	1.389e-004
Opposed		6.627e-005	1.331e-004
Rotational		6.627e-005	1.331e-004
Isotropic		5.221e-005	1.041e-004

Effective Dose Equivalent Rate(ICRP 51 - 1987)

Anterior/Posterior Geometry	mSv/hr	5.862e-005	1.178e-004
Posterior/Anterior		5.346e-005	1.068e-004
Lateral		4.219e-005	8.354e-005
Rotational		4.814e-005	9.603e-005
Isotropic		4.237e-005	8.418e-005

Case Title: Case 3 Rectangular volume, 5m x 1.5m x 0.6m volume of soil 60 cm thick Ra-226, Pb-214, and Bi-214 at 20 pCi/g with a density of 1.6 g/cm^3, with 0.635 cm thick steel shield, dose at height of 1 meter from center.

Results With Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	5.984e+004	4.232e-007	2.116e-008	5.637e-011
7	0.08	1.248e+006	3.416e-002	2.733e-003	4.325e-006
8	0.1	7.347e+003	8.049e-004	8.049e-005	1.231e-007
10	0.2	5.831e+005	2.290e-001	4.580e-002	8.083e-005
11	0.3	1.117e+006	5.221e-001	1.566e-001	2.971e-004
12	0.4	2.071e+006	1.044e+000	4.177e-001	8.139e-004
13	0.5	9.259e+004	4.914e-002	2.457e-002	4.823e-005
14	0.6	2.610e+006	1.439e+000	8.633e-001	1.685e-003
15	0.8	5.110e+005	3.014e-001	2.411e-001	4.586e-004
16	1.0	1.695e+006	1.061e+000	1.061e+000	1.955e-003
17	1.5	1.031e+006	7.253e-001	1.088e+000	1.830e-003
18	2.0	1.449e+006	1.116e+000	2.232e+000	3.452e-003
	TOTALS:	1.247e+007	6.522e+000	6.133e+000	1.063e-002

Results Without Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	5.984e+004	8.935e-008	4.467e-009	1.190e-011
7	0.08	1.248e+006	4.845e-003	3.876e-004	6.134e-007
8	0.1	7.347e+003	1.164e-004	1.164e-005	1.781e-008
10	0.2	5.831e+005	4.505e-002	9.011e-003	1.590e-005
11	0.3	1.117e+006	1.235e-001	3.706e-002	7.029e-005
12	0.4	2.071e+006	2.814e-001	1.126e-001	2.193e-004
13	0.5	9.259e+004	1.463e-002	7.314e-003	1.436e-005
14	0.6	2.610e+006	4.653e-001	2.792e-001	5.449e-004
15	0.8	5.110e+005	1.102e-001	8.815e-002	1.677e-004
16	1.0	1.695e+006	4.239e-001	4.239e-001	7.814e-004
17	1.5	1.031e+006	3.368e-001	5.053e-001	8.501e-004
18	2.0	1.449e+006	5.661e-001	1.132e+000	1.751e-003
	TOTALS:	1.247e+007	2.372e+000	2.595e+000	4.415e-003

Attenuation Coefficients for Shield Materials

Source	Shield 1	Air Gap
5.838e-01	1.457e+01	2.396e-04
3.202e-01	4.331e+00	1.969e-04
2.723e-01	2.692e+00	1.841e-04
1.998e-01	1.087e+00	1.495e-04
1.715e-01	8.363e-01	1.297e-04
1.532e-01	7.231e-01	1.162e-04
1.396e-01	6.510e-01	1.061e-04
1.291e-01	5.982e-01	9.810e-05
1.134e-01	5.222e-01	8.619e-05
1.019e-01	4.682e-01	7.746e-05
8.299e-02	3.822e-01	6.305e-05
7.155e-02	3.341e-01	5.417e-05

Conversion of calculated exposure in air to dose
Results (Summed over energies)

	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	2.372e+000	6.522e+000
Photon Energy Fluence Rate	MeV/cm²/sec	2.595e+000	6.133e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	4.415e-003	1.063e-002
Absorbed Dose Rate in Air	mGy/hr	3.855e-005	9.276e-005
	mrad/hr	3.855e-003	9.276e-003

Deep Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	4.446e-005	1.079e-004
Opposed		3.788e-005	9.057e-005
Rotational		3.788e-005	9.057e-005
Isotropic		3.391e-005	8.096e-005

Shallow Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	4.681e-005	1.135e-004
Opposed		4.506e-005	1.090e-004
Rotational		4.506e-005	1.090e-004
Isotropic		3.569e-005	8.543e-005

Effective Dose Equivalent Rate(ICRP 51 - 1987)

Anterior/Posterior Geometry	mSv/hr	3.981e-005	9.631e-005
Posterior/Anterior		3.648e-005	8.756e-005
Lateral		2.899e-005	6.870e-005
Rotational		3.289e-005	7.877e-005
Isotropic		2.904e-005	6.914e-005

Case Title: Case 3a Rectangular volume, 5m x 2.75m x 0.6m volume of soil 60 cm thick Ra-226, Pb-214, and Bi-214 at 20 pCi/g with a density of 1.6 g/cm^3, with 0.635 cm thick steel shield, dose at height of 1 meter from center.

Results With Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	1.077e+005	4.471e-007	2.236e-008	5.955e-011
7	0.08	2.246e+006	4.165e-002	3.332e-003	5.272e-006
8	0.1	1.322e+004	1.040e-003	1.040e-004	1.592e-007
10	0.2	1.050e+006	3.187e-001	6.374e-002	1.125e-004
11	0.3	2.011e+006	7.356e-001	2.207e-001	4.186e-004
12	0.4	3.729e+006	1.479e+000	5.918e-001	1.153e-003
13	0.5	1.667e+005	6.985e-002	3.493e-002	6.856e-005
14	0.6	4.698e+006	2.051e+000	1.231e+000	2.402e-003
15	0.8	9.197e+005	4.314e-001	3.451e-001	6.564e-004
16	1.0	3.051e+006	1.523e+000	1.523e+000	2.808e-003
17	1.5	1.855e+006	1.049e+000	1.573e+000	2.647e-003
18	2.0	2.608e+006	1.622e+000	3.244e+000	5.016e-003
	TOTALS:	2.245e+007	9.322e+000	8.830e+000	1.529e-002

Results Without Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	1.077e+005	9.404e-008	4.702e-009	1.253e-011
7	0.08	2.246e+006	5.773e-003	4.619e-004	7.309e-007
8	0.1	1.322e+004	1.457e-004	1.457e-005	2.229e-008
10	0.2	1.050e+006	6.053e-002	1.211e-002	2.137e-005
11	0.3	2.011e+006	1.684e-001	5.052e-002	9.584e-005
12	0.4	3.729e+006	3.866e-001	1.546e-001	3.013e-004
13	0.5	1.667e+005	2.020e-002	1.010e-002	1.983e-005
14	0.6	4.698e+006	6.453e-001	3.872e-001	7.557e-004
15	0.8	9.197e+005	1.538e-001	1.230e-001	2.340e-004
16	1.0	3.051e+006	5.947e-001	5.947e-001	1.096e-003
17	1.5	1.855e+006	4.769e-001	7.153e-001	1.203e-003
18	2.0	2.608e+006	8.064e-001	1.613e+000	2.494e-003
	TOTALS:	2.245e+007	3.319e+000	3.661e+000	6.223e-003

Attenuation Coefficients for Shield Materials

Source	Shield 1	Air Gap
5.838e-01	1.457e+01	2.396e-04
3.202e-01	4.331e+00	1.969e-04
2.723e-01	2.692e+00	1.841e-04
1.998e-01	1.087e+00	1.495e-04
1.715e-01	8.363e-01	1.297e-04
1.532e-01	7.231e-01	1.162e-04
1.396e-01	6.510e-01	1.061e-04
1.291e-01	5.982e-01	9.810e-05
1.134e-01	5.222e-01	8.619e-05
1.019e-01	4.682e-01	7.746e-05
8.299e-02	3.822e-01	6.305e-05
7.155e-02	3.341e-01	5.417e-05

Conversion of calculated exposure in air to dose
Results (Summed over energies)

	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	3.319e+000	9.322e+000
Photon Energy Fluence Rate	MeV/cm²/sec	3.661e+000	8.830e+000

Exposure and Dose Rates:

Exposure Rate in Air	mR/hr	6.223e-003	1.529e-002
Absorbed Dose Rate in Air	mGy/hr	5.432e-005	1.335e-004
	mrad/hr	5.432e-003	1.335e-002

Deep Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	6.263e-005	1.551e-004
Opposed		5.340e-005	1.303e-004
Rotational		5.340e-005	1.303e-004
Isotropic		4.780e-005	1.165e-004

Shallow Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	6.594e-005	1.633e-004
Opposed		6.349e-005	1.567e-004
Rotational		6.349e-005	1.567e-004
Isotropic		5.031e-005	1.229e-004

Effective Dose Equivalent Rate(ICRP 51 - 1987)

Anterior/Posterior Geometry	mSv/hr	5.610e-005	1.385e-004
Posterior/Anterior		5.141e-005	1.260e-004
Lateral		4.089e-005	9.891e-005
Rotational		4.636e-005	1.133e-004
Isotropic		4.095e-005	9.952e-005

Case Title: Case 4 Rectangular volume, 5m x 1.5m x 0.6m volume of soil 60 cm thick Ra-226, Pb-214, and Bi-214 at 20 pCi/g with a density of 1.6 g/cm^3, with 1.27 cm thick steel shield, dose at height of 1 meter from center.

Results With Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	5.984e+004	3.192e-011	1.596e-012	4.252e-015
7	0.08	1.248e+006	2.349e-003	1.879e-004	2.974e-007
8	0.1	7.347e+003	1.703e-004	1.703e-005	2.605e-008
10	0.2	5.831e+005	1.389e-001	2.777e-002	4.902e-005
11	0.3	1.117e+006	3.621e-001	1.086e-001	2.061e-004
12	0.4	2.071e+006	7.621e-001	3.048e-001	5.940e-004
13	0.5	9.259e+004	3.685e-002	1.842e-002	3.616e-005
14	0.6	2.610e+006	1.100e+000	6.600e-001	1.288e-003
15	0.8	5.110e+005	2.365e-001	1.892e-001	3.599e-004
16	1.0	1.695e+006	8.477e-001	8.477e-001	1.562e-003
17	1.5	1.031e+006	5.977e-001	8.965e-001	1.508e-003
18	2.0	1.449e+006	9.350e-001	1.870e+000	2.892e-003
	TOTALS:	1.247e+007	5.019e+000	4.923e+000	8.496e-003

Results Without Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	5.984e+004	4.844e-012	2.422e-013	6.452e-016
7	0.08	1.248e+006	2.086e-004	1.669e-005	2.641e-008
8	0.1	7.347e+003	1.530e-005	1.530e-006	2.340e-009
10	0.2	5.831e+005	1.870e-002	3.741e-003	6.602e-006
11	0.3	1.117e+006	6.205e-002	1.862e-002	3.531e-005
12	0.4	2.071e+006	1.543e-001	6.173e-002	1.203e-004
13	0.5	9.259e+004	8.487e-003	4.244e-003	8.330e-006
14	0.6	2.610e+006	2.815e-001	1.689e-001	3.296e-004
15	0.8	5.110e+005	7.081e-002	5.664e-002	1.077e-004
16	1.0	1.695e+006	2.845e-001	2.845e-001	5.244e-004
17	1.5	1.031e+006	2.423e-001	3.635e-001	6.116e-004
18	2.0	1.449e+006	4.236e-001	8.472e-001	1.310e-003
	TOTALS:	1.247e+007	1.546e+000	1.809e+000	3.054e-003

Attenuation Coefficients for Shield Materials

Source	Shield 1	Air Gap
5.838e-01	1.457e+01	2.396e-04
3.202e-01	4.331e+00	1.969e-04
2.723e-01	2.692e+00	1.841e-04
1.998e-01	1.087e+00	1.495e-04
1.715e-01	8.363e-01	1.297e-04
1.532e-01	7.231e-01	1.162e-04
1.396e-01	6.510e-01	1.061e-04
1.291e-01	5.982e-01	9.810e-05
1.134e-01	5.222e-01	8.619e-05
1.019e-01	4.682e-01	7.746e-05
8.299e-02	3.822e-01	6.305e-05
7.155e-02	3.341e-01	5.417e-05

Conversion of calculated exposure in air to dose
Results (Summed over energies)

	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	1.546e+000	5.019e+000
Photon Energy Fluence Rate	MeV/cm²/sec	1.809e+000	4.923e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	3.054e-003	8.496e-003
Absorbed Dose Rate in Air	mGy/hr	2.666e-005	7.417e-005
	mrad/hr	2.666e-003	7.417e-003

Deep Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	3.065e-005	8.605e-005
Opposed		2.627e-005	7.253e-005
Rotational		2.627e-005	7.253e-005
Isotropic		2.353e-005	6.485e-005

Shallow Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	3.227e-005	9.059e-005
Opposed		3.110e-005	8.702e-005
Rotational		3.110e-005	8.702e-005
Isotropic		2.474e-005	6.839e-005

Effective Dose Equivalent Rate(ICRP 51 - 1987)

Anterior/Posterior Geometry	mSv/hr	2.748e-005	7.689e-005
Posterior/Anterior		2.526e-005	7.004e-005
Lateral		2.018e-005	5.513e-005
Rotational		2.279e-005	6.305e-005
Isotropic		2.018e-005	5.542e-005

Case Title: Case 4a, Rectangular volume, 5m x 2.75m x 0.6m volume of soil 60 cm thick Ra-226, Pb-214, and Bi-214 at 20 pCi/g with a density of 1.6 g/cm^3, with 1.27 cm thick steel shield, dose at height of 1 meter from center.

Results With Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	1.077e+005	3.238e-011	1.619e-012	4.313e-015
7	0.08	2.246e+006	2.647e-003	2.118e-004	3.351e-007
8	0.1	1.322e+004	2.047e-004	2.047e-005	3.131e-008
10	0.2	1.050e+006	1.867e-001	3.733e-002	6.589e-005
11	0.3	2.011e+006	4.976e-001	1.493e-001	2.832e-004
12	0.4	3.729e+006	1.058e+000	4.231e-001	8.243e-004
13	0.5	1.667e+005	5.145e-002	2.573e-002	5.050e-005
14	0.6	4.698e+006	1.543e+000	9.259e-001	1.807e-003
15	0.8	9.197e+005	3.341e-001	2.673e-001	5.084e-004
16	1.0	3.051e+006	1.204e+000	1.204e+000	2.219e-003
17	1.5	1.855e+006	8.568e-001	1.285e+000	2.162e-003
18	2.0	2.608e+006	1.349e+000	2.698e+000	4.172e-003
	TOTALS:	2.245e+007	7.083e+000	7.016e+000	1.209e-002

Results Without Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	1.077e+005	4.909e-012	2.455e-013	6.539e-016
7	0.08	2.246e+006	2.316e-004	1.853e-005	2.932e-008
8	0.1	1.322e+004	1.790e-005	1.790e-006	2.739e-009
10	0.2	1.050e+006	2.408e-002	4.816e-003	8.499e-006
11	0.3	2.011e+006	8.173e-002	2.452e-002	4.651e-005
12	0.4	3.729e+006	2.057e-001	8.227e-002	1.603e-004
13	0.5	1.667e+005	1.141e-002	5.703e-003	1.119e-005
14	0.6	4.698e+006	3.807e-001	2.284e-001	4.458e-004
15	0.8	9.197e+005	9.671e-002	7.737e-002	1.472e-004
16	1.0	3.051e+006	3.915e-001	3.915e-001	7.216e-004
17	1.5	1.855e+006	3.380e-001	5.071e-001	8.531e-004
18	2.0	2.608e+006	5.961e-001	1.192e+000	1.844e-003
	TOTALS:	2.245e+007	2.126e+000	2.514e+000	4.238e-003

Attenuation Coefficients for Shield Materials

Source	Shield 1	Air Gap
5.838e-01	1.457e+01	2.396e-04
3.202e-01	4.331e+00	1.969e-04
2.723e-01	2.692e+00	1.841e-04
1.998e-01	1.087e+00	1.495e-04
1.715e-01	8.363e-01	1.297e-04
1.532e-01	7.231e-01	1.162e-04
1.396e-01	6.510e-01	1.061e-04
1.291e-01	5.982e-01	9.810e-05
1.134e-01	5.222e-01	8.619e-05
1.019e-01	4.682e-01	7.746e-05
8.299e-02	3.822e-01	6.305e-05
7.155e-02	3.341e-01	5.417e-05

Conversion of calculated exposure in air to dose
Results (Summed over energies)

	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	2.126e+000	7.083e+000
Photon Energy Fluence Rate	MeV/cm²/sec	2.514e+000	7.016e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	4.238e-003	1.209e-002
Absorbed Dose Rate in Air	mGy/hr	3.700e-005	1.056e-004
	mrad/hr	3.700e-003	1.056e-002

Deep Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	4.251e-005	1.224e-004
Opposed		3.648e-005	1.033e-004
Rotational		3.648e-005	1.033e-004
Isotropic		3.267e-005	9.235e-005

Shallow Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	4.475e-005	1.289e-004
Opposed		4.315e-005	1.238e-004
Rotational		4.315e-005	1.238e-004
Isotropic		3.435e-005	9.738e-005

Effective Dose Equivalent Rate(ICRP 51 - 1987)

Anterior/Posterior Geometry	mSv/hr	3.812e-005	1.094e-004
Posterior/Anterior		3.506e-005	9.971e-005
Lateral		2.803e-005	7.855e-005
Rotational		3.164e-005	8.976e-005
Isotropic		2.802e-005	7.894e-005

MicroShield v5.05 (5.05-00134)
Auxier & Associates
Results With Buildup

Case Title: Case 5, Rectangular volume, 5m x 1.5m x 0.6m volume of soil 60 cm thick Ra-226, Pb-214, and Bi-214 at 20 pCi/g with a density of 1.6 g/cm^3, with 2.54 cm thick steel shield, dose at height of 1 meter from center.

Dose Point # 1 - (162.54100250) cm

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	5.984e+004	2.200e-019	1.100e-020	2.931e-023
7	0.08	1.248e+006	1.059e-005	8.473e-007	1.341e-009
8	0.1	7.347e+003	6.858e-006	6.858e-007	1.049e-009
10	0.2	5.831e+005	4.603e-002	9.207e-003	1.625e-005
11	0.3	1.117e+006	1.607e-001	4.821e-002	9.144e-005
12	0.4	2.071e+006	3.800e-001	1.520e-001	2.962e-004
13	0.5	9.259e+004	1.964e-002	9.819e-003	1.927e-005
14	0.6	2.610e+006	6.145e-001	3.687e-001	7.196e-004
15	0.8	5.110e+005	1.409e-001	1.128e-001	2.145e-004
16	1.0	1.695e+006	5.280e-001	5.280e-001	9.732e-004
17	1.5	1.031e+006	3.997e-001	5.995e-001	1.009e-003
18	2.0	1.449e+006	6.508e-001	1.302e+000	2.013e-003
	TOTALS:	1.247e+007	2.940e+000	3.130e+000	5.352e-003

Results Without Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	5.984e+004	2.360e-020	1.180e-021	3.143e-024
7	0.08	1.248e+006	5.176e-007	4.141e-008	6.553e-011
8	0.1	7.347e+003	3.268e-007	3.268e-008	5.000e-011
10	0.2	5.831e+005	3.539e-003	7.078e-004	1.249e-006
11	0.3	1.117e+006	1.679e-002	5.036e-003	9.553e-006
12	0.4	2.071e+006	4.922e-002	1.969e-002	3.836e-005
13	0.5	9.259e+004	3.010e-003	1.505e-003	2.954e-006
14	0.6	2.610e+006	1.080e-001	6.477e-002	1.264e-004
15	0.8	5.110e+005	3.044e-002	2.435e-002	4.632e-005
16	1.0	1.695e+006	1.327e-001	1.327e-001	2.447e-004
17	1.5	1.031e+006	1.291e-001	1.936e-001	3.258e-004
18	2.0	1.449e+006	2.432e-001	4.864e-001	7.522e-004
	TOTALS:	1.247e+007	7.160e-001	9.288e-001	1.547e-003

Attenuation Coefficients for Shield Materials

Source	Shield 1	Air Gap
5.838e-01	1.457e+01	2.396e-04
3.202e-01	4.331e+00	1.969e-04
2.723e-01	2.692e+00	1.841e-04
1.998e-01	1.087e+00	1.495e-04
1.715e-01	8.363e-01	1.297e-04
1.532e-01	7.231e-01	1.162e-04
1.396e-01	6.510e-01	1.061e-04
1.291e-01	5.982e-01	9.810e-05
1.134e-01	5.222e-01	8.619e-05
1.019e-01	4.682e-01	7.746e-05
8.299e-02	3.822e-01	6.305e-05
7.155e-02	3.341e-01	5.417e-05

Conversion of calculated exposure in air to dose
Results (Summed over energies)

	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	7.160e-001	2.940e+000
Photon Energy Fluence Rate	MeV/cm²/sec	9.288e-001	3.130e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	1.547e-003	5.352e-003
Absorbed Dose Rate in Air	mGy/hr	1.351e-005	4.672e-005
	mrad/hr	1.351e-003	4.672e-003

Deep Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	1.546e-005	5.396e-005
Opposed		1.337e-005	4.585e-005
Rotational		1.337e-005	4.585e-005
Isotropic		1.199e-005	4.102e-005

Shallow Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	1.627e-005	5.683e-005
Opposed		1.571e-005	5.467e-005
Rotational		1.571e-005	5.467e-005
Isotropic		1.258e-005	4.320e-005

Effective Dose Equivalent Rate(ICRP 51 - 1987)

Anterior/Posterior Geometry	mSv/hr	1.389e-005	4.830e-005
Posterior/Anterior		1.282e-005	4.417e-005
Lateral		1.033e-005	3.501e-005
Rotational		1.159e-005	3.981e-005
Isotropic		1.030e-005	3.511e-005

Case Title: Case 5A, Rectangular volume, 5m x 2.75m x 0.6m volume of soil 60 cm thick Ra-226, Pb-214, and Bi-214 at 20 pCi/g with a density of 2.54 g/cm^3, with 2.54 cm thick steel shield, dose at height of 1 meter from center.

Results With Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	1.077e+005	2.203e-019	1.101e-020	2.934e-023
7	0.08	2.246e+006	1.115e-005	8.916e-007	1.411e-009
8	0.1	1.322e+004	7.599e-006	7.599e-007	1.163e-009
10	0.2	1.050e+006	5.786e-002	1.157e-002	2.042e-005
11	0.3	2.011e+006	2.089e-001	6.268e-002	1.189e-004
12	0.4	3.729e+006	5.021e-001	2.009e-001	3.913e-004
13	0.5	1.667e+005	2.622e-002	1.311e-002	2.573e-005
14	0.6	4.698e+006	8.268e-001	4.961e-001	9.683e-004
15	0.8	9.197e+005	1.919e-001	1.535e-001	2.920e-004
16	1.0	3.051e+006	7.249e-001	7.249e-001	1.336e-003
17	1.5	1.855e+006	5.571e-001	8.356e-001	1.406e-003
18	2.0	2.608e+006	9.161e-001	1.832e+000	2.833e-003
	TOTALS:	2.245e+007	4.012e+000	4.330e+000	7.392e-003

Results Without Buildup

Group #	Energy (MeV)	Activity photons/sec	Fluence Rate photons/cm²/sec	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
5	0.05	1.077e+005	2.363e-020	1.181e-021	3.147e-024
7	0.08	2.246e+006	5.411e-007	4.329e-008	6.850e-011
8	0.1	1.322e+004	3.563e-007	3.563e-008	5.451e-011
10	0.2	1.050e+006	4.268e-003	8.536e-004	1.507e-006
11	0.3	2.011e+006	2.086e-002	6.258e-003	1.187e-005
12	0.4	3.729e+006	6.216e-002	2.486e-002	4.844e-005
13	0.5	1.667e+005	3.846e-003	1.923e-003	3.774e-006
14	0.6	4.698e+006	1.392e-001	8.350e-002	1.630e-004
15	0.8	9.197e+005	3.980e-002	3.184e-002	6.056e-005
16	1.0	3.051e+006	1.755e-001	1.755e-001	3.234e-004
17	1.5	1.855e+006	1.740e-001	2.610e-001	4.391e-004
18	2.0	2.608e+006	3.320e-001	6.640e-001	1.027e-003
	TOTALS:	2.245e+007	9.516e-001	1.250e+000	2.078e-003

Attenuation Coefficients for Shield Materials

Source	Shield 1	Air Gap
5.838e-01	1.457e+01	2.396e-04
3.202e-01	4.331e+00	1.969e-04
2.723e-01	2.692e+00	1.841e-04
1.998e-01	1.087e+00	1.495e-04
1.715e-01	8.363e-01	1.297e-04
1.532e-01	7.231e-01	1.162e-04
1.396e-01	6.510e-01	1.061e-04
1.291e-01	5.982e-01	9.810e-05
1.134e-01	5.222e-01	8.619e-05
1.019e-01	4.682e-01	7.746e-05
8.299e-02	3.822e-01	6.305e-05
7.155e-02	3.341e-01	5.417e-05

Conversion of calculated exposure in air to dose
Results (Summed over energies)

	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm²/sec	9.516e-001	4.012e+000
Photon Energy Fluence Rate	MeV/cm²/sec	1.250e+000	4.330e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	2.078e-003	7.392e-003
Absorbed Dose Rate in Air	mGy/hr	1.815e-005	6.453e-005
	mrad/hr	1.815e-003	6.453e-003

Deep Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	2.075e-005	7.448e-005
Opposed		1.797e-005	6.336e-005
Rotational		1.797e-005	6.336e-005
Isotropic		1.611e-005	5.669e-005

Shallow Dose Equivalent Rate(ICRP 51 - 1987)

Parallel Geometry	mSv/hr	2.184e-005	7.843e-005
Opposed		2.110e-005	7.548e-005
Rotational		2.110e-005	7.548e-005
Isotropic		1.691e-005	5.970e-005

Effective Dose Equivalent Rate(ICRP 51 - 1987)

Anterior/Posterior Geometry	mSv/hr	1.865e-005	6.668e-005
Posterior/Anterior		1.723e-005	6.103e-005
Lateral		1.389e-005	4.842e-005
Rotational		1.557e-005	5.501e-005
Isotropic		1.385e-005	4.854e-005

APPENDIX G

EVALUATION OF THE SENSITIVITY OF GAMMA SURVEY INSTRUMENTS NEEDED TO DETERMINE IF RADIONUCLIDES IN FILL MATERIALS AND SOILS POSE AN INCREASED DOSE RATE OF 15 MREM/YR ABOVE BACKGROUND FOR THE OUTDOOR INDUSTRIAL/COMMERCIAL WORKER, CONSTRUCTION WORKER, AND UTILITY WORKER EXPOSURE SCENARIOS

Appendix G
Evaluation of the Sensitivity of Gamma Survey

G1 Introduction

A teleconference was held with EPA, Tribal, and IDEQ personnel on September 15, 2004 to discuss a preliminary EPA comment on the June 2004 draft RI Update Memo. During the teleconference, FMC explained the basis for its proposal to measure gamma radiation levels, in lieu of collecting soil samples for radionuclide speciation, to further evaluate risk at areas of the FMC Plant OU that are not proposed for capping. Presentation materials reviewed during the teleconference, and notes, conclusions, and action items arising from the teleconference are documented in FMC's September 23, 2004 letter to EPA. Further detail on the information presented during the teleconference is discussed in Appendix F.

Conclusions arising from the teleconference included the following:

- The instrument used to measure gamma radiation levels (e.g., a Pressured Ionization Chamber) during the supplemental remedial investigation must have sufficient sensitivity to distinguish site-related gamma radiation from background, such that an increased dose rate of 15 mrem/yr above background can be reliably identified to evaluate the Commercial/Industrial Worker, Utility Worker, and Construction Worker exposure scenarios.
- EPA's Data Quality Objective (DQO) process should be followed in the SRI Work Plan to determine the needed instrument sensitivity.
- Assuming the sensitivity of the gamma radiation measurement instrument is acceptable to EPA, measuring gamma radiation (in lieu of radionuclide speciation) to further evaluate risk is acceptable, except where soils that are not to be capped may have been impacted by precipitator dust. Both gamma radiation and lead-210 activities should be used to characterize radiation risks at areas potentially impacted by precipitator dust (e.g., roadbeds) that will not be capped per FMC's remediation vision.

Appendix G presents an outline of an evaluation of the sensitivity of gamma survey instruments needed to determine if radionuclides in fill materials and soils pose an increased dose rate of 15 mrem/yr above background for the Commercial / Industrial Worker, Utility Worker, and Construction Worker exposure scenarios. A complete DQO-based evaluation will be presented in the SRI Work Plan.

This evaluation is also presented in response to Action Item #30, which was recorded during the September 15, 2004 teleconference. Action items are recorded by FMC during periodic Agency Coordination Meetings held to facilitate the SRI/SFS process for the FMC Plant OU.

G2. Application of the DQO Process

An initial evaluation of the required gamma radiation measurement instrumentation needed to characterize the site has been performed using EPA's seven-step Data Quality Objective (DQO) process. The DQO process is a U.S. EPA-endorsed strategic planning tool based on the scientific method (U.S. EPA 2000a, 2002b). A complete DQO-based evaluation will be presented in the SRI Work Plan.

The DQO process comprises the following seven steps, each of which is described in the following sections. A brief description of each step from the U.S. EPA guidance (U.S. EPA 2000a) is presented after each step.

1. State the problem. *Concisely describe the problem to be studied. Review prior studies and existing information to gain a sufficient understanding to define the problem. Identify the planning team members, including the decision-makers.*
2. Identify the decision. *Identify what questions the study will attempt to resolve and what actions may result from each decision. Develop a decision statement.*
3. Identify the decision inputs. *Identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement.*
4. Define the study boundaries. *Specify the time periods and spatial boundaries to which decisions will apply. Determine when and where data should be collected. Define the target population of interest.*
5. Develop the decision rules. *Define the statistical parameter of interest, specify the action level, and integrate the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions. Define an "if. . . then. . ." statement.*
6. Specify tolerance limits on decision errors. *Define the decision-makers' tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.*
7. Optimize the sampling design. *Evaluate information from the previous steps and generate alternative data collection designs. Choose the most resource-effective design that meets all DQOs.*

G2.1 Step 1 - State The Problem

The problem to be addressed is:

> Do standard gamma radiation survey instruments, such as the Pressurized Ionization Chamber or Sodium Iodide Detector, have sufficient sensitivity to determine if radionuclides (predominantly radium-226) in fill materials (i.e., slag, ore) and soils pose an increased dose rate of 15 mrem/yr above background for the Commercial/Industrial Worker, Utility Worker, and Construction Worker exposure scenarios?

A separate approach will be developed to characterize lead-210 in areas where precipitator dust may have been used as fill (i.e., roadways). This effort is not addressed in this action item response.

G2.2 Step 2 – Identify The Decision

The second step in the DQO process is to identify the questions the study is to resolve and what actions may result from each decision.

Gamma radiation survey instruments output measurements in units of μR/hr, where R (roentgen) is a measure of radiation intensity. The roentgen is defined as the amount of gamma or X radiation that will produce in one cubic centimeter of dry air, at 0ºC and 760 mm pressure, one electrostatic unit of electricity. This is equivalent to 1.61×10^{12} ion pairs per gram of air and corresponds to the absorption of 83.8 ergs of energy. (Sawyer et al, 1994) A rem (for roentgen-equivalent-man) corresponds to the amount of radiation that will produce an energy dissipation in the human body that is biologically equivalent to one roentgen of radiation of X rays, or approximately 100 erg/g. (Sawyer et al, 1994)

Given this, the first decision to be made in addressing the problem presented in Step 1 is:

1. What is the minimum gamma radiation level (in μR/hr) in excess of background that corresponds to an increased dose of 15 mrem/yr to an Outdoor Industrial/Commercial Worker, Construction Worker, and Utility Worker?

Having determined the minimum gamma detection level necessary for the survey, the second decision is:

2. What gamma radiation survey instruments (or survey protocols) have the required sensitivity (in μR/hr) to identify whether site conditions at the FMC Plant OU exceed these radiation levels?

G2.3 Step 3 – Identify The Decision Inputs

The third step in the DQO process is to identify the information that needs to be obtained and measurements that are needed to resolve the decision statements developed in Step 2.

Inputs to the decision include the following elements:

- Gamma survey instrument sensitivities
- Agency comments on selection criteria for gamma survey instruments.
- Available gamma radiation survey data for the FMC Plant OU (e.g., background, point measurements; EPA aerial survey).
- Exposure frequencies for the Outdoor Industrial/Commercial Worker, Construction Worker, and Utility Worker exposure scenarios for the FMC Plant OU in the RI Update Memo.
- Gamma radiation levels (in μR/hr) that correspond to a dose of 15 mrem/yr above background for each exposure scenario.

G2.3.1 Decision Inputs – Gamma Survey Instruments

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) provides guidance on planning, conducting, evaluating, and documenting building surface and surface soil final status radiological surveys for demonstrating compliance with dose or risk-based regulations or standards. MARSSIM is a multi-agency consensus document that was developed collaboratively by four Federal agencies having authority and control over radioactive materials: Department of Defense (DOD), Department of Energy (DOE), Environmental Protection Agency (EPA), and Nuclear Regulatory Commission (NRC). MARSSIM's objective is to describe a consistent approach for planning, performing, and assessing building surface and surface soil final status surveys to meet established dose or risk-based release criteria, while at the same time encouraging an effective use of resources.

Appendix H of MARSSIM presents information on various field and laboratory equipment used to measure radiation levels and radioactive material concentrations. The descriptions provide general guidance, and MARSSIM notes that those interested in purchasing or using the equipment are encouraged to contact vendors and users of the equipment for specific information and recommendations.

Appendix H of MARSSIM was reviewed to identify candidate gamma radiation measurement instruments for use during the supplemental remedial investigation. In addition, Dr. Joseph Alvarez[1] was contacted for expert guidance on potential instument selection and operation. This review identified the Pressurized Ionization Chamber (PIC) as having the best overall capability for the gamma radiation survey. The Sodium Iodide (NaI) Detector also appears to offer utility. Dr. Alvarez, who is a Health Physicist with over 30 years experience, is familiar with the radiological properties of the feedstocks, by-products, and waste materials historically managed at the FMC facility and performed a gamma radiation survey of the facility in 1995 that is reported in Appendix O-2 of the EMF RI Report (Bechtel 1996).

Figure G2-1 presents excerpts from MARSSIM, Appendix H on the applicability of the PIC to site surveys and the sensistivity of the instument. Figure G2-2 is a reproduction of a short brochure from a leading PIC vendor. Figure G2-3 presents excerpts from MARSSIM, Appendix H on the applicability of the NaI Detector to site surveys and the sensistivity of the instument.

G2.3.1.1 PIC Sensitivity Study Results

The minimum detectable change in dose rate determined by an industry-standard PIC was evaluated by Dr. Alvarez using Reuter-Stokes RSS-112 PIC. The PIC was used in the average and integrate modes at 2 dose rates. Table G2-1 shows the lower dose rate results.

The higher dose rate location results are shown in Table G2-2.

The standard deviation is about 10% of the dose rate in the low dose rate case and about 4% in the higher dose rate case. The PIC measures the chamber response every second and reports the average every 5 seconds. The standard deviation for the average over time remains the same as the above table shows, but the standard error of the average reduces with time. The time for each

[1] Auxier & Associates, Inc , 9821 Cogdill Rd., Suite 1; Knoxville, TN 37932

measurement can be adjusted to obtain the necessary sensitivity to measure the difference from the background dose rate with acceptable confidence.

The 95% minimum detectable dose rate (MDD) is the standard error times 4.66. The MDD for various times is shown in Table G2-3. The MDDs are acceptable for measuring the increased dose rate above background of 7.5 μR/hr.

G2.3.2 Decision Inputs – Agency Comments

Recommendations on selection criteria for gamma survey instruments were received from Dr. Luke Paulus, IDEQ, by e-mail on September 16, 2004. Dr. Paulus participated in the September 15, 2004 teleconference. Dr. Paulus' comments are presented verbatim, following by FMC's preliminary response.

Comment #1: Survey instrument should be calibrated to radionuclide(s) of concern to compensate for variations in instrument response due to variations in gamma energy. This is important if using a detector that does not have a flat energy-response over range associated with the gamma emissions.

FMC response to Comment #1: The radionuclide of concern for gamma radiation is Ra-226, as demonstrated during 9/15/04 teleconference. (See "Radiation Risk Driver" slides for data reviewed during 9/15/04 teleconference and Appendix F of the RI Update Memo.) The PIC has a flat dose-rate response over the energies of concern.

Comment #2: Natural fluctuation of survey instrument (due to inherent properties of detector) should be considered. Fluctuation should not exceed required detection level above background.

FMC response to Comment #2: Agreed. The natural fluctuation of the survey instrument should not exceed required detection level above background.

Comment #3: It could be difficult to quantify gamma radiation from Ra-226 if an instrument such as an NaI(Tl) detector is used in the Multi-Channel Analyzer mode. It is also inadvisable to shield cosmic radiation if this method is used.

FMC Response to Comment #3: Multi-channel analysis can identify Ra-226 activity. However, this must be input to a model to calculate a dose rate, which introduces uncertainty. The PIC measures exposure rates <u>directly</u> and can be operated in the integration mode to obtain a detection level of 1 μrem/hr. FMC agrees that it would be inadvisable to shield cosmic radiation.

Comment #4: Recommend a large-area plastic scintillator in conjunction with GPS to create contour map of relative exposure rates. At areas of elevated exposure rate, use a non-destructive method (e.g., NaI(Tl) detector with MCA capability) to assay radionuclides of concern.

FMC Response to Comment #4: This is a good method to evaluate a site with unknown radionuclides and potentially highly variable (and localized) radiological impacts. However, the radionuclides of concern at the FMC Plant OU have already been identified. Previous surveys show large areas of uniform radiation levels (e.g., areas with slag and ore at surface).

G2.3.3 Decision Inputs - Gamma Radiation Data

Gamma radiation survey data for the FMC Plant OU are available in two references.

2.3.3.1 EPA Aerial Radiation Survey Data

The first reference, US EPA 1987 "An Aerial Radiological Survey of Pocatello and Soda Springs, Idaho and Surrounding Area," includes an aerial radiological survey of the area of the FMC Plant OU and surrounding areas. The aerial survey was performed in June and July of 1986.

These EPA survey data were used in EPA's Baseline Human Health Risk Assessment (BHHRA) for the EMF Superfund Site (E&E 1996). Figure G2-4 is a reproduction of "Terrestrial Gamma Radiation Exposure Rate Contours derived from Aerial Data obtained in June-July 1986 over Area 1 of Pocatello, Idaho and Surrounding Area," which appears as Figure 3-6 of the BHHRA.

The BHHRA (pages 3-35 – 3-36) states:

> "In the survey, gamma radiation measurements were made using a detector array mounted on a helicopter. The survey was conducted by flying a series of parallel paths across the area, spaced 250 feet apart, at an average altitude of 150 feet above ground surface. As noted in the report, this procedure tends to 'blur' the exposure levels for small hot spots, but it should provide reliable average exposure rate estimates for the relatively large exposure areas being used to estimate worker exposures. The survey results are presented in a series of aerial photographs overlaid by contour lines outlining areas in which the gamma radiation exposure at 1 meter above ground fall within specified ranges. Figure 3 from the survey report covers the EMF facilities [i.e., the FMC and Simplot facilities] and has been included in this document as Figure 3-6. Areas outlined by the contour lines are labeled with letter codes corresponding to various gamma exposure rate ranges, and a key is provided in the figure. The slag pile at the FMC facility (and the one at Bannock Paving) is labeled 'H', which corresponds to an exposure rate of 50 to 100 μR/hr. Most of the rest of the operational area of the FMC facility is labeled 'G', which corresponds to an exposure rate of 30 to 50 μR/hr. The gypstacks at the Simplot facility are labeled 'G'. The rest of the Simplot facility includes areas labeled 'E', 'F', and 'G', but appears to average 'F', which corresponds to an exposure rate of 22 to 30 μR/hr. The survey report notes that background exposure rates in the Pocatello area range from 11 to 17 μR/hr (C-D levels); however, a review of the maps included in the survey report shows that the background levels in the flats and valley floor areas, where most people live and work, is predominantly 'C'. A greater proportion of 'D' levels occur in upland background areas, but the background levels residents of the Pocatello area typically experience fall predominantly in the 'C' range, which corresponds to exposures from 11 to 14.5 μR/hr. …. The gamma radiation measurements collected during the 1986 aerial survey include an estimated background cosmic ray contribution of 5.4 μR/hr."

As noted in EPA 1987[2] (page 4), gamma radiation measurements were obtained using a sodium iodide (thallium-activated) (NaI(Tl)) scintillation detector. However, this data reported in EPA 1987 (and used in the BHHRA) were not corrected for instrument over-response from terrestrial radiation. These measurements can be corrected for instrument over-response using the equation:

[2] EPA 1987 is reproduced in large part as Appendix H of the BHHRA (E&E 1996).

M_c = 5.4 μR/hr + (M_o μR/hr * 0.58),

where Mc is the corrected measurement and

M_o is the reported, uncorrected gamma radiation measurement.

Using this correction factor, the corrected background gamma levels inferred in E&E 1996 are 11.3 to 13.2 μR/hr; this includes a cosmic radiation background level of 5.4 μR/hr. Similarly, the corrected gamma radiation levels within operational and waste management areas of the FMC Plant OU would be 13.3 to 55 μR/hr.

G2.3.3.2 EMF RI Report

A gamma radiation survey of portions of the area of the FMC Plant OU was performed in 1995 in support of the EMF Site remedial investigation. Appendix O-2 of the EMF RI Report (BEI 1996) describes survey methods and results.

This survey, which was performed by Dr. J. Alvarez, found that background gamma radiation (including cosmic radiation) was 13 μrem/hr (or 13.7 μR/hr, assuming that radium-226 was the contributing radionuclide). The survey also found that unshielded levels within FMC Plant OU area ranged from 10 μrem/hr (10.5 μR/hr) at various locations, including the silica pile, the former Kiln Bldg., and the east end of Furnace Bldg, to 52 μrem/hr (55 μR/hr) at the Slag Pile. Lower rates were observed in paved areas and at material handling areas with low U-238 series radionuclides. Higher rates were observed at material handling and storage areas where feedstock, by-products, and waste materials containing U-238 series radionuclides were managed.

G2.3.4 Decision Inputs - Exposure Frequencies

The conceptual site model (CSM) for the FMC Plant OU identifies three future exposure scenarios. The CSM is presented in Section 2 of the RI Update Memo.

Outdoor Industrial/Commercial Worker: The CSM assumes that an outdoor industrial/commercial worker will be exposed to site conditions 225 days per year (or 1,800 hours per year), using default EPA exposure assessment guidelines. Further information on exposure frequencies is available in Section 4 of the RI Update Memo.

Construction Worker: The CSM assumes that a Construction Worker will be exposed to site conditions 130 days per year (or 1,040 hours per year), using default EPA exposure assessment guidelines. Further information on exposure frequencies is available in Section 4 of the RI Update Memo.

Utility Worker: The CSM assumes that a Utility Worker will be exposed to site conditions 10 days per year (or 80 hours per year). Further information on exposure frequencies is available in Section 4 of the RI Update Memo.

G2.3.5 Decision Inputs – 15 mrem/yr above background for each exposure scenario

The minimum gamma radiation level (in units of μR/hr) in excess of background that corresponds to an increased dose of 15 mrem/yr to an Outdoor Industrial/Commercial Worker, Construction Worker, and Utility Worker is presented in this section.

Exposure rates (in units of μR/hr) corresponding to 15 mrem/yr were determined for each exposure scenario, using a Ra-226 quality factor of 0.95 μR/μrem.

Outdoor Industrial/Commercial Worker Scenario Exposure Rate:

- 7.9 μR/hr = (15 mrem/y x 0.95 μR/μrem x 1000 μrem/mrem) ÷ 1800 hr/y

Construction Worker Scenario Exposure Rate:

- 13.7 μR/hr = (15 mrem/y x 0.95 μR/μrem x 1000 μrem/mrem) ÷ 1040 hr/y

Utility Worker Scenario Exposure Rate:

- 178 μR/hr = (15 mrem/y x 0.95 μR/μrem x 1000 μrem/mrem) ÷ 80 hr/y

The background gamma exposure rate was conservatively assumed as 13.2 μR/hr. This is the upper range of the background gamma radiation level reported in E&E 1996 (after correction for NaI (Tl) detector over-response. Using this background level, 15 mrem/yr above background corresponds to 13.2 + 7.9 = 21.1 μR/hr for the most conservative exposure scenario, which is the Outdoor Industrial/Commercial Worker at an exposure frequency of 1,800 hr/yr.

G2.3.6 Decision Inputs – Instrument Measurement Objectives

The precision in the PIC measurements must be small enough so that a difference between background and (background + 15 mrem/yr) can be determined at an acceptable level of confidence.

FMC's preliminary determination is that the PIC has sufficient sensitivity to meet this objective, based on the sensitivity study test data reported in Section 2.1.1:

- The 95% minimum detectable dose rate (MDD) of the PIC is approximately 0.8 μR/hr when operated in the integration mode for 5 minutes
- The MDD is 0.4 μR/hr when operated in the integration mode for 20 minutes
- The standard deviation of unshielded measurements within the FMC Plant OU (using data reported in Appendix O-2 of the EMF RI Report) is 5.3. This is approximately 9 times the instrument MDD when operated in the 10-minute integration mode (0.59 μR/hr).

Thus it appears that the PIC, when operated in an integration mode of at least 5 minutes, has the precision needed to detect a difference in gamma radiation levels between background and (background + 15 mrem/yr) at an acceptable level of confidence for the worse case exposure scenario (the Outdoor Industrial/Commercial Worker).

G2.4 Step 4 – Define the Study Boundaries

The fourth step of the DQO process defines the spatial and temporal boundaries of the survey.

The study boundaries of the gamma radiation survey are Remediation Units (RUs) within the FMC Plant OU that are not proposed to be capped per FMC's Remediation Vision. These are RUs #3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 20, 21, and 23. Available gamma radiation level data from Appendix O-2 of the EMF RI Report range from 10.5 to 55 μR/hr.

RUs that FMC proposes to cap, per its Remediation Vision, are by definition areas where the need for remediation is already established. Hence, there is no need to evaluate these areas to determine if gamma radiation levels exceed 15 mrem/yr in excess of background.

The study boundary for the Outdoor Industrial/Commercial Worker exposure scenario is the ground surface of these RUs. The study boundary for the Construction Worker and Utility Worker exposure scenarios is from the ground surface to a depth of 10 feet below ground surface.

G2.5 Step 5 – Develop Decision Rules: RU 20 Example

The fifth step in the DQO process is to define the statistical parameter of interest, specify the action level, and integrate previous DQO outputs into a single statement that describes the logical basis for choosing among alternatives.

RU 20 (Former Bannock Paving Area, including rail spurs) is used in as a model of how such decision rules will be developed on an RU-specific basis in the SRI Work Plan.

The null hypothesis (Ho) and alternate hypothesis (Ha) are:

Ho: RU 20 average > 21.1 μR/hr

Ha: RU 20 average < 21.1 μR/hr

The null hypothesis is that the mean gamma radiation level (including background contribution) at an elevation of one meter above the ground surface within RU 20 is greater than or equal to 21.1 μR/hr. The alternate hypothesis is that the mean gamma radiation level (including background contribution) at an elevation of one meter above the ground surface within RU 20 is less than 21.1 μR/hr

G2.6 Step 6 – Specify Tolerance Limits on Decision Errors

The sixth step in the DQO process specifies the level of error the decision makers can tolerate. Tolerable error limits are generally based on a consideration of the consequences of making an incorrect decision. In this case, the tolerance error limits are expressed as the confidence level for a statistical test, which is defined as 100 percent minus alpha (α). As the confidence level is lowered (i.e., as α is increased), the likelihood of committing a Type I error increases. The power of a statistical test is defined as 100 percent minus beta (β). As the power is lowered (i.e., as β is increased), the likelihood of committing a Type II error increases.

RU 20 is used as a model of how tolerance limits on decision rules will be developed on an RU-specific basis in the SRI Work Plan.

$\alpha = 0.1$ (probability of rejecting the null hypothesis when it should be accepted; site is classified as not exceeding 21.1 μR/hr when it does exceed.)

$\beta = 0.1$ (probability of classifying the site as exceeding the 21.1 μR/hr threshold when it does not exceed.)

$s = 5.3$

Delta (gray region) = 4

G2.7 Step 7 – Optimize the Sampling Design

The final step in the DQO process is optimizing the data collection program. The purpose of this step is to develop a resource-effective program.

RU 20 is used in Step 7 as a model of how the sampling design will be optimized on an RU-specific basis in the SRI Work Plan.

The MARSSIM Sign Test was selected to determine the number of measurements needed to evaluate the gamma radiation intensity within RU 20. The Sign Test was selected based on the MARSSIM guidance (MARSSIM, 2000). It should be noted that the final comparison between site conditions and background may utilize different statistical tests, depending on the distribution of site-specific data, variance, and skewness. These parameters will be calculated and assumptions verified during the data collection process. Methods will be specified in detail in the SRI Work Plan.

Because there was insufficient data to determine the distribution of the gamma radiation within RU 20, the MARSSIM Sign Test was applied with the assumption that a normal distribution is not required.

Using the values described in Step 6, above, the MARSSIM Sign Test results indicate that 22 measurements ($n = 22$) are needed to characterize gamma radiation within RU 20. MARSSIM guidance also recommends that the number of readings be increased by 20% as an added level of confidence. Applying this additional 20% "confidence" factor yields $n = 27$.

Figure G2-5 illustrates one example of a sample grid within RU 20 for collecting 27 gamma measurements. This grid was generated using Visual Sampling Plan (VSP) software, with a random starting point and a triangular grid pattern. Numerous other grid schemes can be implemented to collect the 27 measurements, and Figure G2-5 is only a single example.

Characterizing exposure to construction workers/utility workers will entail measuring gamma exposure rates in test trenches/pits. The trenches will be no more than 5 feet deep (maximum allowable under OSHA for worker entry without sloping or shoring the walls [e.g., trench box]). The overall number of trench measurements will depend on the results of the surface survey. For example, if the surface survey shows gamma radiation levels are homogeneous across RU 20, then two or three trench measurements may be needed. If gamma radiation levels are highly

variable across RU 20, more measurements will be required. The number of trench measurements will be determined through the application of the DQO Process.

G3 Summary

Preliminary evaluation and sensitivity study test data indicate that the PIC, when operated in an integration mode of at least 5 minutes, has the precision needed to detect a difference in gamma radiation levels between background and (background + 15 mrem/yr) at an acceptable level of confidence for the worse case exposure scenario (the Outdoor Industrial/Commercial Worker).

The SRI Work Plan will document the approach for using the PIC to meet the DQOs.

G4 References

BEI 1996. EMF Site Remedial Investigation Report.

E&E 1996. Baseline Human Health Risk Assessment for the EMF Superfund Site.

EPA 1987. An Aerial Radiological Survey of Pocatello and Soda Springs, Idaho and Surrounding Area. Department of Energy Remote Sensing Laboratory, operated for the USDOE by EG&G Energy Measurements, Inc. Las Vegas, Nevada. EPA-8613, February 1987.

EPA 2000a. Guidance for the Data Quality Objectives Process, QA/G-4. EPA/600/R-96/055. August.

EPA 2000b. Guidance for Data Quality Assessment: Practical Methods for Data Analysis, EPA QA/G-9. EPA/600/R-96/084. July. United States Environmental Protection Agency (EPA) (2001). EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. Quality Assurance Management Staff, QA/R-5. March.

MARSSIM 2000 – Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Revision 1. US Department of Defense, US Department of Energy, US Environmental Protection Agency, US Nuclear Regulatory Commission. Washington D.C. NUREG-1575, Rev.1; EPA-402-R-97-016, Rev. 1; DOE/EH-0624, Rev. 1. August 2000.

Sawyer, CL, McCarty, P.L, and Parkin, G.F. 1994. Chemistry for Environmental Engineering. 4th Edition. McGraw Hill, Inc. New York.

Applicability to Site Surveys: The PIC is a highly accurate ionization chamber for measuring gamma exposure rate in air, and for correcting for the energy dependence of other instruments due to their energy sensitivities. It is excellent for characterizing and evaluating the effectiveness of remediation of contaminated sites based on exposure rate. However, most sites also require nuclide-specific identification of the contributing radionuclides. Under these circumstances, PICs must be used in conjunction with other soil sampling or spectrometry techniques to evaluate the success of remediation efforts.

Specificity/Sensitivity: The PIC measures gamma or x-radiation and cosmic radiation. It is highly stable, relatively energy independent, and serves as an excellent tool to calibrate (in the field) other survey equipment to measure exposure rate. Since the PIC is normally uncollimated, it measures cosmic, terrestrial, and foreign source contributions without discrimination. Its rugged and stable behavior makes it an excellent choice for an unattended sensor where area monitors for gamma emitters are needed. PICs are highly sensitive, precise, and accurate to vast changes in exposure rate (1 µR/ hr up to 10 R/hr). PICs lack any ability to distinguish either energy spectral characteristics or source type. If sufficient background information is obtained , the data can be processed using algorithms that employ time and frequency domain analysis of the recorded systems to effectively separate terrestrial, cosmic, and "foreign" source contributions. One major advantage of PIC systems is that they can record exposure rate over ranges of 1 to 10,000,000 µR per hour (i.e., µR/hr to 10 R/hr) with good precision and accuracy.

Figure G2-1
MARSSIM Appendix H Excerpts on the Pressurized Ionization Chamber

GE Energy

Reuter-Stokes 131

Environmental Radiation Monitor

Benefits

- Able to identify increases above background radiation levels not detectable with GM technologies
- Omni-directional – spherical HPIC is not subject to inherent GM tube limitations
- Reliable operation in extreme climates
- Many units in service over 20 years
- Simplified repair and maintenance

Solid Performance

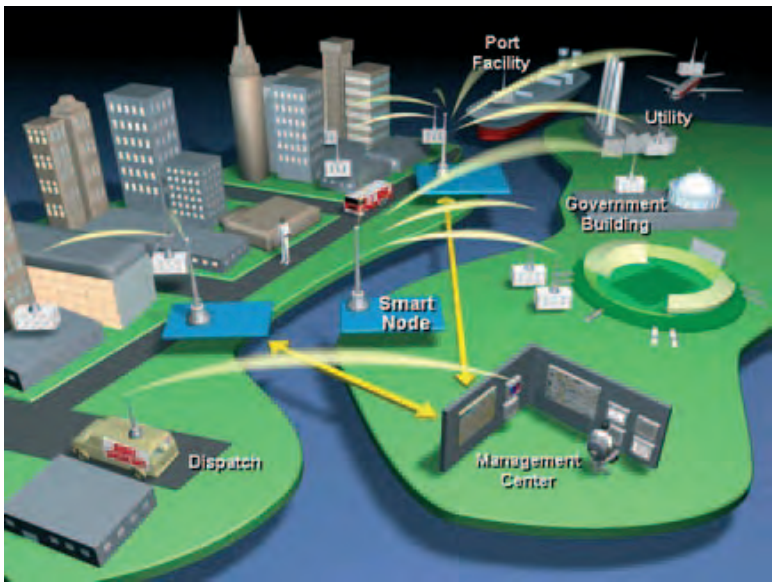
Designed to measure low-level airborne gamma radiation, this Environmental Radiation Monitor (RSS 131) is the latest High Pressure Ionization Chamber (HPIC) from GE Energy. With over 30 years of service in multiple utility and environmental radiation monitoring applications around the world, Reuter-Stokes Environmental Radiation Monitors continue to provide reliable operation in extreme climates. Versatile, robust and reliable, the RSS 131 is ideally suited for use in Homeland Security applications.

A Full Package

Features typically required for a fully functional system are packaged "in the box." The system is equipped with three weatherproof RS-232 ports and an optional dial-up modem. Although units are often operated as stand-alone systems, many have been incorporated into environmental monitoring stations and may be used in Homeland Security monitoring applications. GE Energy offers meteorological monitoring options, including wind speed/direction, a rain gauge, and barometric pressure.

Customer Configurable

The user has the option to specify parameters such as alarm limits, unit address, and data recording interval (1 sec – 9 hours). This is accomplished via one of the serial interface ports using a PC – there is no need to open the weatherproof enclosure to make these adjustments, enabling straightforward customization.



Applicability to Site Surveys: Sodium iodide survey meters can be response checked against a pressurized ionization chamber (PIC) and then used in its place so readings can be taken more quickly.

Specificity/Sensitivity: Sodium iodide survey meters measure gamma radiation in µR/hr or cpm with a minimum sensitivity of around 1-5 µR per hour, or 200-1,000 cpm, or lower in digital integrate mode. The reading error of 50% can occur at low count rates because of a large needle swing, but this decreases with increased count rate. The instrument is quite energy sensitive,with the greatest response around 100-120 keV and decreasing in either direction. Measuring the radiation level at a location with both a PIC and the survey meter gives a factor for converting subsequent readings to actual exposure rates. This ratio can change with location.

Figure G2-3
MARSSIM Appendix H Excerpts on the Sodium Iodide Survey Meter

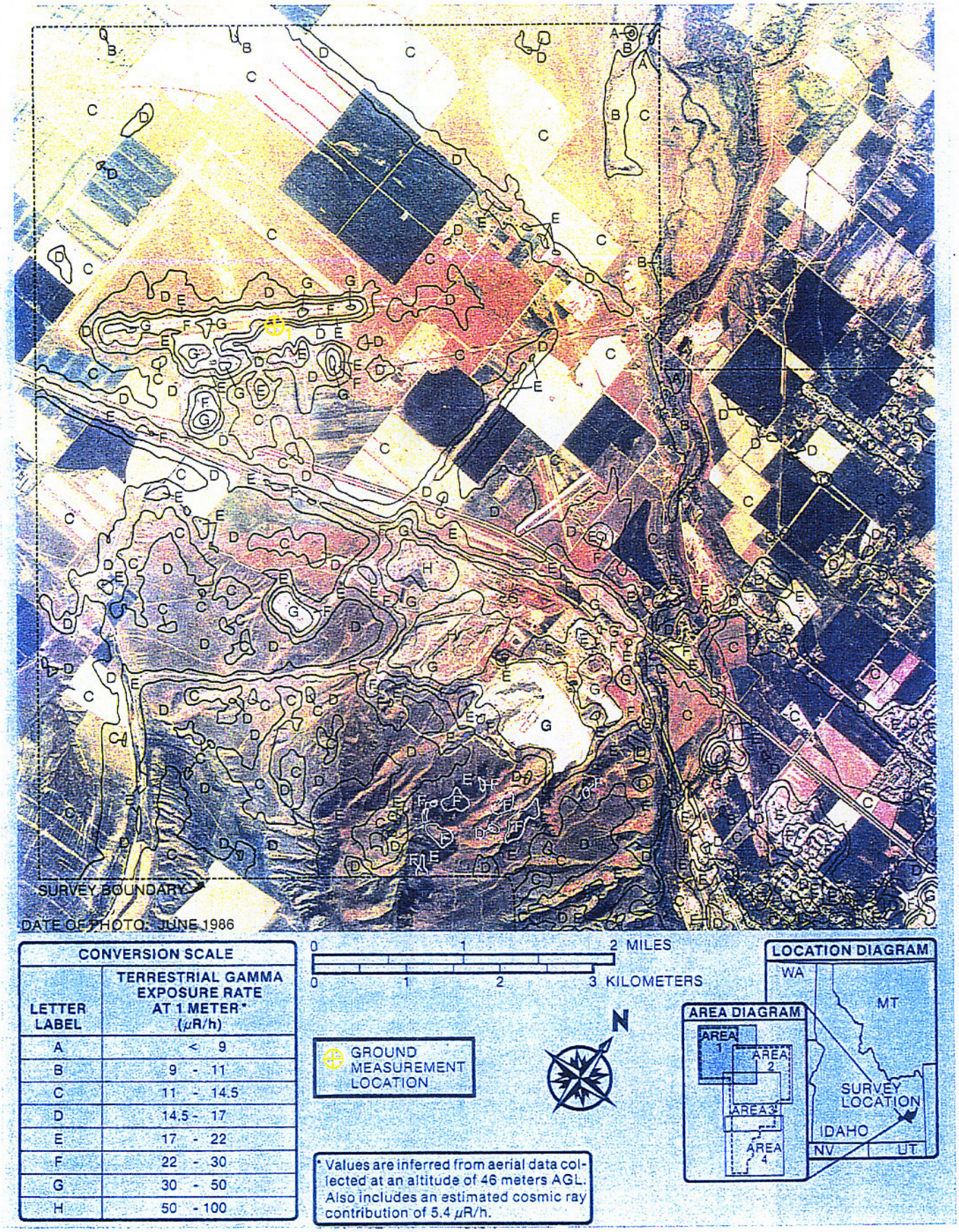
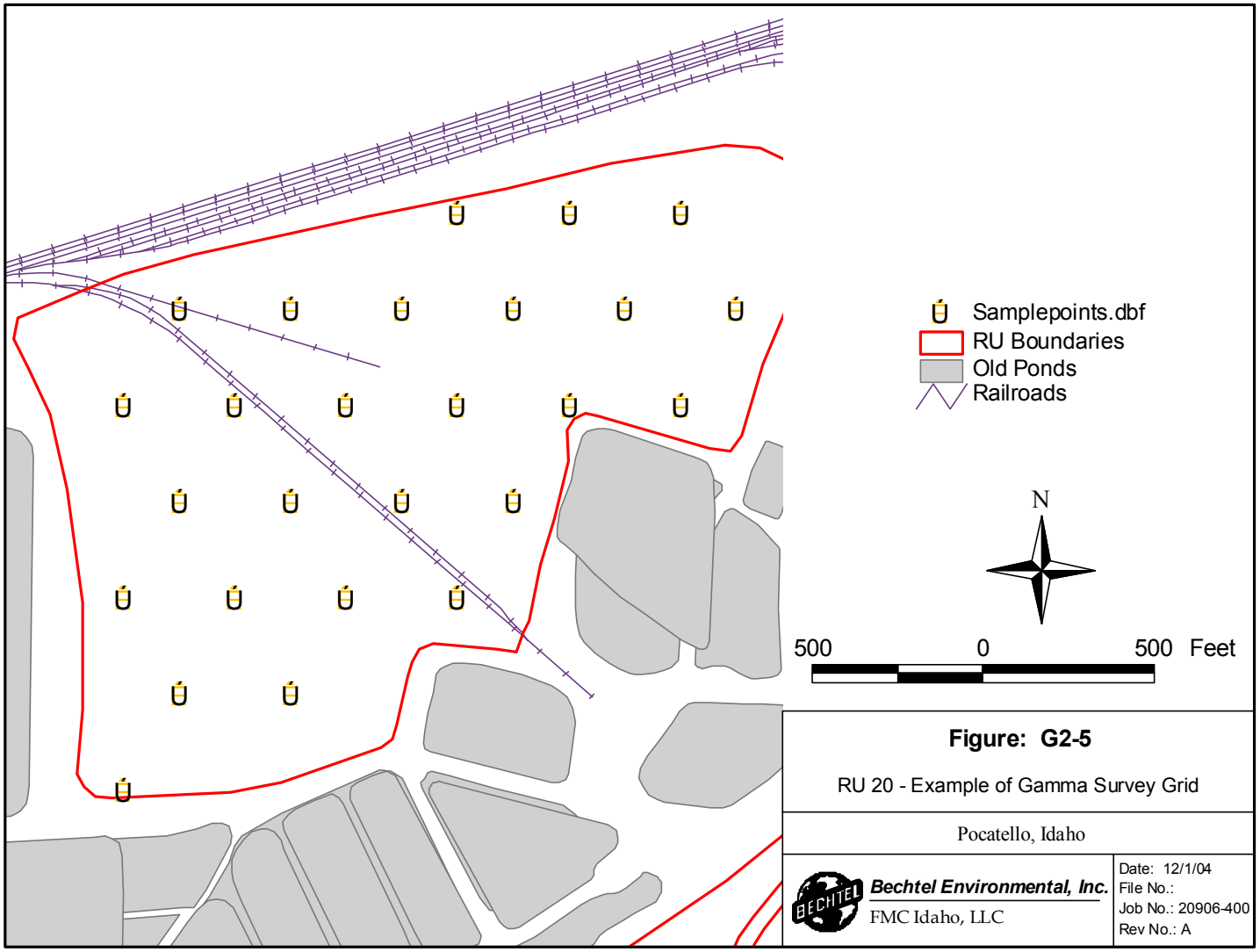


FIGURE 3-6 ***TERRESTRIAL GAMMA RADIATION EXPOSURE RATE CONTOURS DERIVED FROM AERIAL DATA OBTAINED IN JUNE-JULY 1986 OVER AREA 1 OF POCATELLO, IDAHO AND SURROUNDING AREA***

Figure G2-4



Document

Figure G2-5
Example Gamma Radiation Measurement Sampling Grid at RU 20

Table G2-1
PIC Lower Dose Rate Results

Time (min)	Average (μR/hr)	Maximum (μR/hr)	Minimum (μR/hr)	Standard Deviation
0.5	8.3	8.5	8.2	0.1
1	8.4	10.2	7	0.9
5	8.1	9.4	7.2	0.5
10	8.2	10.2	6.7	0.6
20	8.4	14	6.2	0.9
30	8.3	10.7	6.7	0.7

Table G2-2
PIC Higher Dose Rate Results

Time (min)	Average (μR/hr)	Maximum (μR/hr)	Minimum (μR/hr)	Standard Deviation
0.5	22.3	24.2	21	1.1
1	22.5	23.2	21.2	0.6
5	21.8	24	19.7	0.9
10	21.8	25.7	19.5	0.9
20	21.7	24.4	18.9	0.9
30	21.8	24.2	18.7	0.9

Table G2-3
Minimum Detectable Dose Rates

Time (min)	Average (μR/hr)	Standard Deviation	Standard Error	MDD (μR/hr)
0.5	22.3	1.1	0.70	3.24
1	22.5	0.6	0.27	1.25
5	21.8	0.9	0.18	0.84
10	21.8	0.9	0.13	0.59
20	21.7	0.9	0.09	0.42
30	21.8	0.9	0.07	0.34

Appendix H

XRF Screening for Phossy Solids

As documented in Appendix F of this report, analysis of available radionuclide-specific data for the various feedstocks and waste streams historically processed at the FMC Plant OU demonstrates that external exposure to gamma radiation drives risks to potential future workers for all source materials (except phossy solids) at the FMC Plant OU. With respect to phossy solids (including precipitator dust), incidental ingestion and fugitive dust inhalation of lead-210 and polonium-210, together with external exposure to gamma radiation, contribute virtually all of the risk to workers exposed to this source material. Therefore, analyzing samples for lead-210 and polonium-210, in conjunction with taking gamma dose rate measurements, is proposed to address radiological risks in areas that may contain phossy solids. The purpose of this appendix is to provide an outline of the approach that will be used identify the presence of phossy solids at gamma dose rate measurement sites during the SRI.

Phossy solids (including precipitator dust) are characterized by relatively high concentrations of arsenic, cadmium, lead, silver, and zinc when compared to the concentrations of these same metals in ore, ferrophos, and slag. These metals can be detected via field portable x-ray fluorescence (XRF) spectroscopy. Table H-1 presents the concentrations of metals in phosphate ore and ferrophos. Table H-2 presents the concentrations of metals in pond sediment (i.e., precipitator slurry) and Table H-3 presents the concentration of metals in slag. The ratios of the concentrations in precipitator dust and the concentrations in ore, slag and background are presented in Table H-4. These ratios were calculated by dividing the average concentrations in precipitator dust by the average concentrations in ore and slag. For the ratios between precipitator dust and background concentrations, the EMF RI background levels were used. As shown in Table H-4, the higher values indicate the relative enrichment of the metal in the precipitator dust when compared other materials that might be mixed with precipitator dust.

Column 5 of Table H-4 highlights, in bold text, metals with concentrations in pond sediments that are greater than approximately twenty times the concentrations found in slag. While the ratios of arsenic and silver concentrations are high, the actual concentrations are near the XRF detection levels for these metals. Arsenic and silver are therefore not considered good candidates as indicators for phossy solids. Table H4 does however indicate that cadmium, zinc and possibly lead may be used to indicate the presence of phossy solids.

H1 Conceptual Sampling Approach

Details of the sampling approach will be provided in the supplemental remedial investigation work plan. The conceptual framework for the proposed work includes collecting samples from a sub-set of the locations at which gamma dose rate measurements are taken during the SRI, and screening these samples for the presence of phossy solids in an on-site laboratory using a field portable x-ray fluorescence spectrometer. In addition, any location containing fill material that exhibits the visual characteristics of phossy solids will be sampled and screened. Consistent with the approach being taken to collect gamma dose rate measurements, XRF screening during the SRI will be restricted to RUs for which a remedial vision of capping is not currently envisioned (i.e., RUs # 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 20, 21, and 23). Although there is no evidence of past

releases of phossy solids in RUs 3, 4, 5, 7, 9, 11, 20, and 21, confirmation sampling for lead-210 and polonium-210 is needed to fully characterize the 0-10' depth interval.

To optimize detection levels the samples will be ground and screened to assure a consistent matrix. It is anticipated that samples will be obtained from the surface to approximately 2 feet bgs to evaluate the outdoor industrial/commercial worker exposure scenario. In addition, samples will be obtained from the base of test pits/trenches to evaluate the construction and utility worker exposure scenarios. Samples with concentrations of cadmium, zinc, and possibly lead indicating the potential presence of precipitator slurry will be shipped to a fixed laboratory for conventional metals and lead-210 analyses. The fixed laboratory will also analyze a fraction of the samples that are not suspected of having been impacted by phossy solids.

H2 Conceptual Analytical Approach

U.S. EPA, SW-846, Method 6200 will be used to perform the field measurements of cadmium and zinc. Using Method 6200, inorganic analytes of interest are identified and quantified with a field portable energy-dispersive x-ray fluorescence spectrometer. Radiation from one or more radioisotope sources or an electrically excited x-ray tube is used to generate characteristic emissions from elements in a sample. Method 6200 uses a sealed radioisotope source to irradiate samples with x-rays. When an atom absorbs the source x-rays, the incident radiation dislodges electrons from the innermost shells of the atom, creating vacancies. The electron vacancies are filled by electrons cascading in from outer electron shells. The outer shell electrons give off energy in the form of an x-ray as they cascade down into the inner shell vacancies. This rearrangement of electrons is termed x-ray fluorescence and the emitted x-ray intensities and energies are characteristic of specific atoms making identification and quantification possible.

Each characteristic x-ray line is defined with the letter K, L, or M, which signifies which shell had the original vacancy and by a subscript alpha (α) or beta (β), which indicates the higher shell from which electrons fell to fill the vacancy and produce the x-ray. For example, a $K\alpha$ line is produced by a vacancy in the K shell filled by an L shell electron, whereas a $K\beta$ line is produced by a vacancy in the K shell filled by an M shell electron. The $K\alpha$ transition is on average 6 to 7 times more probable than the $K\beta$ transition; therefore, the $K\alpha$ line is approximately 7 times more intense than the $K\beta$ line for a given element, making the $K\alpha$ line the choice for quantitation purposes.

The SRI Work Plan will describe the necessary cadmium and zinc detection levels, detail how the XRF analyzer will be used, and identify how soil samples will be selected for analysis using fixed-base laboratory methods. The fixed laboratory will use standard EPA methods for determining the total concentrations of metals in samples. It is anticipated that Method 6010B will be used for metals and Method 901.1 will be used for lead-210.

H3 Verification of the Conceptual Approach

Prior to implementing the proposed approach during the supplemental remedial investigation, a verification study will be performed to demonstrate that cadmium, zinc and possibly lead can be reliably used as indicator parameters for the potential presence of phossy solids/precipitator slurry. This verification study will involve analysis of approximately twenty-five composite samples of slag and precipitator slurry combined in several weight percentages from 100-percent slag to approximately 75-percent slag and 25-percent precipitator slurry. Each sample will be

analyzed by field portable XRF and by a fixed laboratory for, at a minimum, lead-210, total lead, total cadmium and total zinc. The results of this verification study will be used to establish site-specific correlations between the field XRF measurements and fixed laboratory measurements and to identify any potential interferences that may limit the utility of the field XRF instrument as a screening tool.

Table H-1
Metals and Fluoride in Phosphate Ore and Ferrophos

	Phosphate Ore		Ferrophos Composite					
Parameter	FOSFPO01		FWSFSA01		FWSFSA02		FWSFSA03	
Antimony	16.8	UJ	61.4	J	42.3	J	28.5	J
Arsenic	14.6	J	0.52	UJ	1.8	UJ	3.7	UJ
Barium	105		23.6		14.5		23.4	
Beryllium	1.9		4.1		1.7		1.8	
Boron	74.3		4.8		7.6		6.1	
Cadmium	77.8	J	0.98	UJ	0.99	UJ	2.8	UJ
Chromium	822		6320		2550		2370	
Cobalt	0.87	U	29.1		14.7		12.6	
Copper	104		851		453		404	
Fluoride	13200		1790		1890		3370	
Lead	12.1	UJ	6.1	U	6.1	U	6	U
Lithium	11.8	UJ	1.2	UJ	1.1	UJ	2.2	UJ
Manganese	122		307		264		190	
Mercury	0.36	UJ	0.11	UJ	0.08	UJ	0.24	UJ
Molybdenum	15	U	151		93.2		90.6	
Nickel	126		1150		727		535	
Selenium	6.1	J	2.6	UJ	0.24	UJ	1.1	UJ
Silver	5.1		47		27		26.7	
Thallium	26.2	R	23.6	R	23.8	R	23.1	R
Vanadium	996		6330		2610		2630	
Zinc	991	J	97.3	J	70.3	J	169	J

Concentrations in milligrams per kilogram

Acronyms/Abbreviations:

J – Estimated Value
R – Rejected Value
U – Not Detected

Table H-2
Metals and Fluoride in Pond Sediment (precipitator slurry)

	Pond 11S Sediment		Pond 12S Sediment		Pond 15S Sediment		Pond 8S Sediment		Pond 9E Sediment	
Parameter	FWSP1101		FWSP1201		FWSP5S01		FWSP8S01		FWSP9E01	
Antimony	37.2	J	47	J	54.4	J	189	J	54.6	J
Arsenic	36.1	J	20.4	J	90.9	J	256	J	17.1	J
Barium	48.2		48.8		30.6		18.7		50.8	
Beryllium	0.29		0.35		0.2	U	0.19	U	0.37	
Boron	55.9	J	79.6	J	34.9	J	30.4	J	136	J
Cadmium	2040		2030		1100		1360		2410	
Chromium	107		133		116		71.6		192	
Cobalt	3.1		1.8		0.79	U	0.74	U	6.6	
Copper	68	J	74.9	J	42.2	J	41.7	J	75.4	J
Fluoride	17100		15900		8850		8600		16100	
Lead	332	J	386	J	185	J	201	J	338	J
Lithium	9.5	U	8.7	U	9.9	U	9.3	U	9	U
Manganese	80.8		49.4		53.2		37.9		52	
Mercury	0.24		0.46		0.23		0.74		0.82	
Molybdenum	7.1		6.7		4.5		3.7	U	6.6	
Nickel	16.2		16.4		17.6		16.2		26.5	
Selenium	49.6		16.5		13.3		10.8		45.3	
Silver	199		198		106		116		218	
Thallium	26		9.4	J	16.63	J	22.9		39.4	
Vanadium	68.5		93.4		84.1		42.9		169	
Zinc	26600		20200		11400		10400		21400	

Concentrations in milligrams per kilogram

Acronyms/Abbreviations:

J – Estimated Value
U – Not Detected

Table H-3
Metals and Fluoride in Slag

	Slag Samples													
Parameter	FWSSSA01		FWSSSA02		FWSSSA03		FWSSSA04		FWSSSA05		Furnace Slag		FWSSSA06	
Antimony	14.9	UJ	14.5	UJ	14.2	UJ	14.6	UJ	14.1	UJ	10	U	14	UJ
Arsenic	0.51	UJ	0.48	UJ	0.52	UJ	0.5	UJ	0.48	UJ	3	U	0.58	UJ
Barium	223		229		254		214		251		159		233	
Beryllium	1.9		2.1		2		1.8		1.9		1.69		1.9	
Boron	97.8		67.5		88.9		68.6		88				83.9	
Cadmium	2.8	UJ	1.2	UJ	13	J	32.4	J	103	J	0.4	U	4.3	UJ
Chromium	238		230		290		172		280		245		273	
Cobalt	1.2	U	1.6	U	1.6	U	1.6	U	1.4				1.6	
Copper	15.8		10.9		17.9		11.9		17.7				17	
Fluoride	14400		17800		17300		12400		16500				16200	
Lead	6	U	5.8	U	5.7	U	5.9	U	5.7	U	4	U	5.6	U
Lithium	16.5	UJ	17.2	UJ	19.5	UJ	17.9	UJ	18.9	UJ			18	UJ
Manganese	114		127		169		205		168				126	
Mercury	0.17	UJ	0.05	UJ	0.12	UJ	0.05	UJ	0.05	UJ	0.05	U	0.39	UJ
Molybdenum	2.5	U	2.5	U	2.4	U	2.5	U	2.4	U			2.4	U
Nickel	8.8		3.8	U	8.8		6.5		11.9		3	U	7.9	
Selenium	4.5	J	4.6	J	2.8	UJ	4.3	J	6.9	J	46.5		4.9	J
Silver	2.6		2.3		4.8		4.9		3.7		0.6	U	4.3	
Thallium	23.2	R	22.6	R	22.2	R	22.8	R	22	R	0.1	U	21.8	R
Vanadium	215		183		243		150		249		218		250	
Zinc	52.5	J	36.4	J	194	J	450	J	136	J	95.2		85.5	J

Concentrations in milligrams per kilogram

Acronyms/Abbreviations:

J – Estimated Value
R – Rejected Value
U – Not Detected

Table H-4
Ratios of Metals and Fluoride Concentrations[a]

Parameter[b]	Ferrophos/ore	Pond Sediment[c]/ore	Slag/ore	Pond Sediment[c]/slag	Ore/background
Antimony	2.6	4.6	0.8	5.6	7.6
Arsenic	0.1	5.8	0.1	**97**	1.9
Barium	0.2	0.4	2.1	0.2	0.6
Beryllium	1.3	0.1	1.0	0.1	1.9
Boron	0.1	0.9	1.1	0.8	5.8
Cadmium	0.02	**23**	0.3	**80**	**41**
Chromium	4.6	0.2	0.3	0.5	**30**
Cobalt	**22**	3.0	1.7	1.7	0.1
Copper	5.5	0.6	0.1	4.0	8.3
Fluoride	0.2	1.0	1.2	0.8	**22**
Lead	0.5	**24**	0.5	**52**	0.4
Lithium	0.1	0.8	1.5	0.5	0.7
Manganese	2.1	0.4	1.2	0.4	0.3
Mercury	0.4	1.4	0.3	4.0	2.3
Molybdenum	7.4	0.4	0.2	2.3	7
Nickel	6.4	0.1	0.1	2.6	8.1
Selenium	0.2	4.4	1.7	2.5	4.5
Silver	6.6	**33**	0.6	**51**	2.7
Thallium[d]					
Vanadium	3.9	0.1	0.2	0.4	**22**
Zinc	0.1	**18**	0.2	**120**	**19**

Notes:

[a] Ratios greater than approximately 20 are highlighted by **bold** text.

[b] Parameters highlighted by **bold** text are potential candidates for measurement using field XRF spectrometry.

[c] The metals composition of pond sediment is considered to be generally consistent with the metals content of precipitator slurry.

[d] Thallium ratios were not calculated because the thallium data associated with ore, ferrophos and slag have been flagged with an ”R” indicating the data are rejected.

APPENDIX I

PCDT / ROAD DUST SUPPRESSION INFORMATION

NOVEMBER 21, 2003
FMC LETTER

FMC Corporation

FMC Idaho LLC
PO Box 4111
Pocatello Idaho 83205-4111
(208) 236-8200

FMC Idaho LLC

November 21, 2003

Ms. Linda Meyer
MS WCM-121
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, WA 98101

Subject: Information in support of FMC's proposed on-site water treatment and use for dust control

Dear Ms. Meyer:

During the October 9, 2003 meeting between FMC, EPA, and the Shoshone Bannock Tribes, FMC presented information regarding our extensive efforts to identify and evaluate options for management of the remaining RCRA pond wastewater. As we described, FMC has evaluated over 20 options and, at this time, recommend an option that will treat all of the water through the on-site water treatment system (originally designed and built to treat the water for discharge to the Pocatello POTW) for subsequent use to provide dust control during the upcoming pond closure construction work in 2004 and 2005. This letter and attachments provide additional information that EPA requested regarding FMC's proposal as follows:

- Provide an estimate of the residual levels of treated water constituents in soil at those areas where water is applied, particularly naturally-occurring radioactive materials (NORM);
- Provide a description of the treatment process and management of water for dust control;
- Provide the results of bench testing to treat Pond 17 decant water to meet Universal Treatment Standards (UTS); and,
- Provide a copy of the Tom Gesell evaluation of NORM constituents, prepared for the original proposal to discharge to the Pocatello POTW.

Attachments 1-4 provide the basis for the evaluation of potential residual concentrations of metals and NORM in soil at those locations where treated wastewater would be used for dust control. Attachment 1 provides a summary of the influent and treated effluent water quality for the "Other Ponds" (Ponds 8E, 15S, 16S, 18 and the Phase IV ponds) and Pond 17 water. The influent and effluent water quality information presented on the attachment

summarizes extensive analyses of pond decant water and bench testing and analyses of the proposed treatment process. As discussed during the October meeting, the Pond 17 water will be treated separately for the other source waters. Consistent with the original proposal to discharge treated effluent to the Pocatello POTW, calciner pond water is excluded from this proposed option.

Attachment 2 provides the schedule for pond pumping (dewatering), water treatment and application using 2 to 3 water trucks during the construction season. Attachment 3 provides the application rate per unit area over the 2004 and 2005 construction areas. Note that the highest application areas are the general construction areas (roads) and thus the 2004 and 2005 construction season water volumes were added cumulatively to these areas to create a "maximum" application. As shown on the attachment, the incremental metals and NORM concentrations in the upper 2-inches of soil are negligible compared to the risk-based concentrations (worker RBC for the FMC plant OU) or background, if higher than the RBC.

Attachment 4 compares the incremental metals and NORM from the water application on the roads (maximum application) to the concentrations already present based on the Remedial Investigation roadway surface soil samples. As shown on the attachment, the 95-percent upper confidence limit of the roadway surface soil concentrations already exceeds the RBCs for arsenic, beryllium and uranium-238. After the proposed dust control water application, these constituents still exceed the RBCs, but no other constituents exceed their respective RBCs. As shown in the far right column, constituent increases above the existing concentrations in roadway samples are generally well below 5 percent.

Attachment 5 provides a Process Description and Sequence of Operations for the Pond Decant Treatment System (PCDT). As discussed during the October 9 meeting, FMC has identified the Universal Treatment Standards (UTS) as a treatment goal. In the case of the Other Pond water (Ponds 8E, Phase IV ponds, 15S, 16S and 18) that FMC has characterized as non-hazardous, the UTS are being considered as appropriate or relevant requirements. In the case of the Pond 17 water that will be treated separately from the other pond water, FMC has characterized this water as hazardous and the UTS are applicable.

Attachment 6 summarizes the bench testing related to separate treatment of the Pond 17 water. As indicated in the attachment, for the purposes of the bench testing, the treatment goal for cyanide was 20 mg/l since at that level the UV/oxidation system would be able to

further treat the water to below the UTS limits for amenable and total cyanide of 0.86 mg/l and 1.2 mg/l respectively. Additional bench testing to confirm that the UV/oxidation system can reliably meet the UTS with treated Pond 17 water is scheduled during December.

Attachment 7 provides a copy of the Tom Gesell evaluation of NORM under the originally planned PCDT treatment and discharge to the Pocatello POTW.

FMC believes these attachments provide further support to our position that on-site water treatment and use for dust control is an acceptable option. This option meets applicable or relevant and appropriate requirements, does not significantly add incrementally to metals or NORM already in soils at the site, and conserves clean water that would otherwise need to be pumped from the aquifer.

Please feel free to contact me at (208) 236-8216 should you have questions regarding this information.

Very truly yours,

Rob J. Hartman

Rob J. Hartman
FMC Corporation

Attachments

cc: Mark Masarik, EPA - IOO
Scott Youree, Shoshone-Bannock Tribes w/ enclosure

ATTACHMENT 1: Summary of Other Pond (Ponds 8E, Phase IV, 15S, 16S and 18) and Decon Water Influent and Treated Effluent Concentrations

Constituent	Abbr.	Unit	UTS Wastewater Limit	Other Ponds Influent Approx. Range (mg/L)	Other Ponds Treated Effluent Avg Value (mg/L)
Oxygen Demand:					
Biochemical Oxygen Demand	BOD	mg/L	-	NA	NA
Chemical Oxygen Demand	COD	mg/L	-	2000 - 4000	4000
Nutrients:					
Total Phosphorus	TP	mg/L	-	4000 - 6000	3500
Ortho-phosphate as P	PO_4-P	mg/L	-	1000 - 2000	200
Elemental Phosphorus	P_4	mg/L	-	<1.0	<1.0
Total Kjeldahl Nitrogen	TKN	mg/L	-	50 -100	100
Ammonia-N	NH_3-N	mg/L	-	20 - 50	50
Nitrate-N	NO_3^--N	mg/L	-	5 - 15	15
Metals:					
Antimony	Sb	mg/L	1.90	0.05 - 1.0	0.10
Arsenic	As	mg/L	1.40	0.05 - 1.0	0.10
Barium	Ba	mg/L	1.2	0.05 - 0.2	0.10
Beryllium	Be	mg/L	0.82	0.002 - 0.01	0.005
Cadmium	Cd	mg/L	0.69	0.01 - 0.1	0.050
Chromium, Total	Cr	mg/L	2.80	0.05 - 0.5	0.30
Copper	Cu	mg/L	N/A	0.05 - 0.2	0.50
Lead	Pb	mg/L	0.69	0.04 - 0.1	0.05
Mercury	Hg	mg/L	0.1500	0.0006 - 0.001	0.0006
Nickel	Ni	mg/L	4.00	0.05 - 0.1	0.05
Selenium	Se	mg/L	0.82	0.05 - 0.1	0.05
Silver	Ag	mg/L	0.43	0.02 - 0.1	0.02
Thallium	Tl	mg/L	1.40	0.05 - 0.5	0.10
Vanadium	V	mg/L	4.3***	0.03 - 0.2	0.05
Zinc	Zn	mg/L	2.61***	0.5 - 50	1.00
Cations:					
Calcium	Ca^{2+}	mg/L	-	10 - 50	50
Magnesium	Mg^{2+}	mg/L	-	1 - 20	20
Potassium	K^+	mg/L	-	8000 - 13000	13000
Sodium	Na^+	mg/L	-	2000 - 3000	3000
Anions:					
Fluoride	F^-	mg/L	35***	300 - 1000	50-100
Chloride	Cl^-	mg/L	-	1000 - 2000	2000
Sulfide, Total	S^{2-}	mg/L	14***	<50	<50
Sulfate	SO_4^{2-}	mg/L	-	500 - 2000	2000
Cyanide, Total	CN^-	mg/L	1.2	1 - 50	0.5
Cyanide, WAD	WAD CN^-	mg/L	0.86	0.5 - 10	0.2

ATTACHMENT 1. Summary of Other Pond (Ponds 8E, Phase IV, 15S, 16S and 18) and Decon Water Influent and Treated Effluent Concentrations

Constituent	Abbr.	Unit	UTS Wastewater Limit	Other Ponds Influent Approx. Range (mg/L)	Other Ponds Treated Effluent Avg Value (mg/L)
Solids:					
Total Dissolved Solids	TDS	mg/L	-	15,000 - 45,000	30,000
Total Suspended Solids	TSS	mg/L	-	50 -500	100
pH	pH		2.0 <--> 12.45	7 - 10	7 - 10
Temperature (winter)	T	deg C	-	5.0	5.0
Temperature (summer)	T	deg C	-	20.0	20.0

NOTES:

*** These constituents are not "underlying hazardous constituents" in characteristic wastes, according to the definition in 268.2(i)

NORM Constituent	Abbr.	Unit	Other Ponds Influent Approx. Range (mg/L)	Other Ponds Avg Month Effluent (mg/L)
Radium 226	^{226}Ra	pCi/L	0 - 10	2.6
Radium 228	^{228}Ra	pCi/L	0 - 1.5	0.5
Radium 226+228	$^{226}Ra + ^{228}Ra$	pCi/L	0 - 12	3.1
Potassium 40[J]	^{40}K	pCi/L	3,000 - 12,000	12,000
Polonium 210	^{210}Po	pCi/L	10 - 500	1.8
Lead 210	^{210}Pb	pCi/L	10 - 300	12.0
Thorium 228	^{228}Th	pCi/L	0.5 - 5	1.0
Thorium 230	^{230}Th	pCi/L	0.5 - 5	1.0
Thorium 232	^{232}Th	pCi/L	0.5 - 5	1.0
Uranium (as U238)	U	mg/L	<0.5	0.20

ATTACHMENT 1. (Cont.) Summary of Pond 17 Influent and Treated Effluent Concentrations

Constituent	Abbr.	Unit	UTS Wastewater Limit	Pond 17 Influent Approx. Range (mg/L)	Pond 17 Treated Effluent Average Value (mg/L)
Oxygen Demand:					
Biochemical Oxygen Demand	BOD	mg/L	-	NA	NA
Chemical Oxygen Demand	COD	mg/L	-	8000-10000	10,000
Nutrients:					
Total Phosphorus	TP	mg/L	-	10,000-15,000	15,000
Ortho-phosphate as P	PO_4-P	mg/L	-	2,000-4,000	400
Elemental Phosphorus	P_4	mg/L	-	<1.0	<1.0
Total Kjeldahl Nitrogen	TKN	mg/L	-	150-215	215
Ammonia-N	NH_3-N	mg/L	-	100-200	200
Nitrate-N	NO_3^--N	mg/L	-	5 - 15	15
Metals:					
Antimony	Sb	mg/L	1.90	1.0 - 1.5	1.3
Arsenic	As	mg/L	1.40	3.5 - 4.5	0.50
Barium	Ba	mg/L	1.2	0.2 - 0.4	0.3
Beryllium	Be	mg/L	0.82	0.001 - 0.005	0.003
Cadmium	Cd	mg/L	0.69	0.1 -1.0	0.002
Chromium, Total	Cr	mg/L	2.80	0.05 - 0.1	0.1
Copper	Cu	mg/L	N/A	0.05- 0.5	0.75
Lead	Pb	mg/L	0.69	0.1-0.5	0.5
Mercury	Hg	mg/L	0.1500	0.0006 - 0.001	0.001
Nickel	Ni	mg/L	4.00	0.5 - 1.0	1.0
Selenium	Se	mg/L	0.82	0.1 - 0.5	0.25
Silver	Ag	mg/L	0.43	0.01 - 0.05	0.025
Thallium	Tl	mg/L	1.40	0.05 - 0.2	0.1
Vanadium	V	mg/L	4.3***	0.5 - 1.0	0.75
Zinc	Zn	mg/L	2.61***	50 - 200	1.0
Cations:					
Calcium	Ca^{2+}	mg/L	-	10 - 50	200
Magnesium	Mg^{2+}	mg/L	-	1.0 - 20	1.0
Potassium	K^+	mg/L	-	30,000 - 40,000	40,000
Sodium	Na^+	mg/L	-	5000 - 7000	7000
Anions:					
Fluoride	F^-	mg/L	35***	2000 - 3000	50 - 100
Chloride	Cl^-	mg/L	-	3000 - 4000	3000 - 4000
Sulfide, Total	S^{2-}	mg/L	14***	< 50	< 50
Sulfate	SO_4^{2-}	mg/L	-	3000 - 4000	12,000 - 15,000
Cyanide, Total	CN^-	mg/L	1.2	350 - 400	0.5 - 1.0
Cyanide, WAD	WAD CN^-	mg/L	0.86	20-30	0.1 - 0.5

ATTACHMENT 1. (Cont.) Summary of Pond 17 Influent and Treated Effluent Concentrations

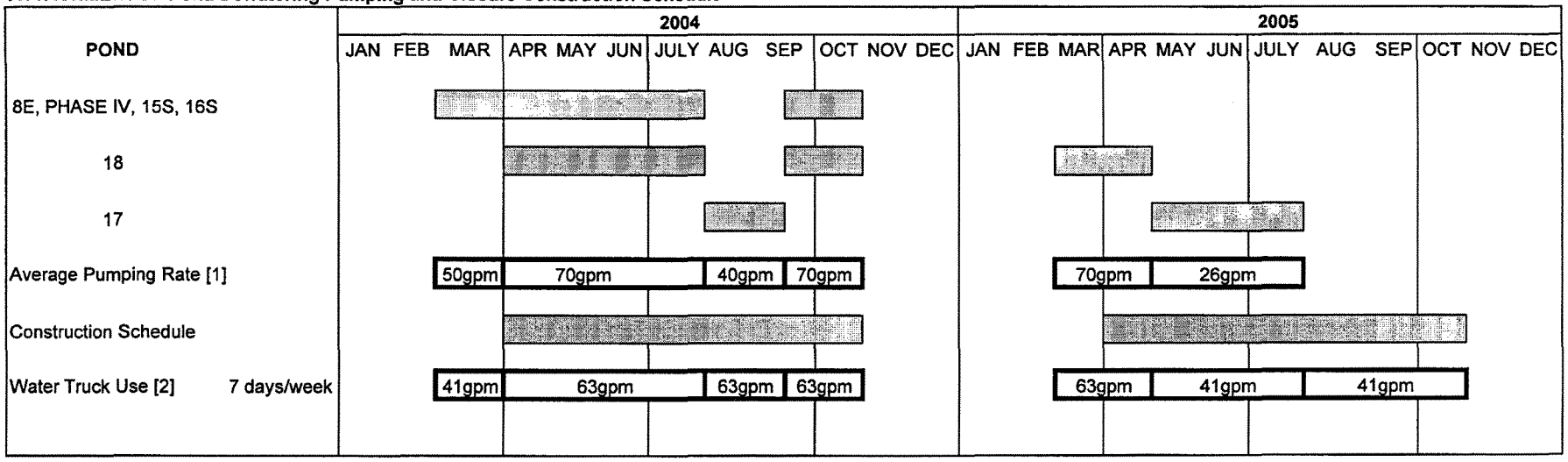
Constituent	Abbr.	Unit	UTS Wastewater Limit	Pond 17 Influent Approx. Range (mg/L)	Pond 17 Treated Effluent Average Value (mg/L)
Solids:					
Total Dissolved Solids	TDS	mg/L	-	80,000 - 100,000	80,000 - 100,000
Total Suspended Solids	TSS	mg/L	-	50 - 500	50
pH	pH		2.0 <--> 12.45	10 - 11	10 - 12
Temperature (winter)	T	deg C	-	5.0	5.0
Temperature (summer)	T	deg C	-	20.0	20.0

NOTES:

*** These constituents are not "underlying hazardous constituents" in characteristic wastes, according to the definition in 268.2(i)

NORM Constituent	Abbr.	Unit	Pond 17 Influent Approx. Range (mg/L)	Pond17 Avg Month Effluent (mg/L)
Radium 226	^{226}Ra	pCi/L	0 - 10	2.6
Radium 228	^{228}Ra	pCi/L	0 - 1.5	0.5
Radium 226+228	$^{226}Ra + ^{228}Ra$	pCi/L	0 - 12	3.1
Potassium 40[J]	^{40}K	pCi/L	3,000 - 12,000	12,000
Polonium 210	^{210}Po	pCi/L	10 - 500	1.8
Lead 210	^{210}Pb	pCi/L	10 - 300	12.0
Thorium 228	^{228}Th	pCi/L	0.5 - 5	1.0
Thorium 230	^{230}Th	pCi/L	0.5 - 5	1.0
Thorium 232	^{232}Th	pCi/L	0.5 - 5	1.0
Uranium (as U238)	U	mg/L	<0.5	0.20

ATTACHMENT 2. Pond Dewatering Pumping and Closure Construction Schedule



Notes:
1. Each water truck use 20.8 gpm @ 10 hrs/day, 7 days/week
2. A water truck operating 10 hours/day, 7 days/week will use an average of 20.8 gpm of water (on a 24 hours/day, 7 days/week basis)

ATTACHMENT 3. FMC On-Site Water Treatment and Use Option - Incremental Loading to Surface Soil Evaluation

2004 Construction		
Pond closure construction area (sf)	Water Volume applied (Mgals)	Total water applied (L/sf)
1,998,457	16.63	31.49
General dust control area (sf)		
525,400	4.37	31.49
2005 Construction		
Pond closure construction area (sf)	Water Voume applied (Mgals)	Total water applied (L/sf)
2,212,629	6.87	11.75
General dust control area (sf)		
525,400	1.63	11.75

Pond closure construction area assumes that water applied to pond surface area only 2 of 7 months.

Constituent	Treated Other and Pond 17 Water Average Concentration (mg/L)	2004 Incremental mass applied (mg/sf)	2004 Incremental soil concentration (mg/cf)	2004 Construction and General dust control areas Incremental soil concentration (mg/kg)	2005 Construction and General dust control areas Incremental soil concentration (mg/kg)	2004 plus 2005 Loading on General dust control areas Incremental soil concentration (mg/kg)	Worker RBC or Background (mg/kg)
Antimony	0.10	3.15	18.90	0.36	0.14	0.50	359.0
Arsenic	0.10	3.15	18.90	0.36	0.14	0.50	**7.7**
Barium	0.10	3.15	18.90	0.36	0.14	0.50	61,612.0
Beryllium	0.005	0.16	0.94	0.02	0.01	0.02	**1.0**
Cadmium	0.050	1.57	9.45	0.18	0.07	0.25	448.0
Chromium, Total	0.30	9.45	56.69	1.09	0.41	1.49	896,457.0
Copper	0.50	15.75	94.48	1.81	0.68	2.49	33,259.0
Lead	0.05	1.57	9.45	0.18	0.07	0.25	**29.1**
Mercury	0.0006	0.02	0.11	0.002	0.001	0.003	269.0
Nickel	0.05	1.57	9.45	0.18	0.07	0.25	17,929.0
Selenium	0.05	1.57	9.45	0.18	0.07	0.25	4,482.0
Silver	0.02	0.63	3.78	0.07	0.03	0.10	4,482.0
Thallium	0.10	3.15	18.90	0.36	0.14	0.50	71.7
Vanadium	0.05	1.57	9.45	0.18	0.07	0.25	6,275.0
Zinc	1.00	31.49	188.96	3.62	1.35	4.98	268,937.0
Cyanide, total	0.50	15.75	94.48	1.81	0.68	2.49	NC
Fluoride	100.00	3,149.35	18,896.08	362.32	135.18	497.51	53,787.0
NORM	(pCi/L)	(pCi/sf)	(pCi/cf)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
Radium 226	2.6	81.88	491.30	0.01	0.00	0.01	NC
Radium 228	0.5	15.75	94.48	0.00	0.00	0.00	NC
Radium 226+228	3.1	97.63	585.78	0.01	0.00	0.02	NC
Polonium 210	1.8	56.69	340.13	0.01	0.00	0.01	21.22
Lead 210	12.0	377.92	2,267.53	0.04	0.02	0.06	6.24
Thorium 228	1.0	31.49	188.96	0.00	0.00	0.00	NC
Thorium 230	1.0	31.49	188.96	0.00	0.00	0.00	NC
Thorium 232	1.0	31.49	188.96	0.00	0.00	0.00	NC
	(mg/L)	(mg/sf)	(mg/cf)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Uranium (as U238)	0.20	6.30	37.79	0.72	0.27	1.00	4.42

*Assumes upper 2-inches of soil

*Assumes 115 pcf soil density

*Bold values = background

ATTACHMENT 4. FMC On-Site Water Treatment and Use Option - Incremental Increase in Constituents on Maximally Impacted Area (Roadways)

FMC Plant OU - Remedial Investigation, Plant Roads - Surface Soil Sample Summary								General dust control areas (Roads) - Surface Soil plus Incremental mass load				
Constituent	Number of Existing Samples	Minimum Conc. (mg/kg) (1)	Maximum Conc. (mg/kg) (1)	Mean (mg/kg)	95% UCL (mg/kg)	Worker RBC (mg/kg) (2)	95%UCL > RBC?	2004 Construction Area (mg/kg)	95%UCL+2004 Construction Area Data (mg/kg)	2005 General Dust Control Area (mg/kg)	95%UCL + 2004 Construction Area Data + 2005 General Dust Control Area Data (mg/kg)	Percent Increase above current 95% UCL
Antimony	11	7.45	8.5	7.82	7.99	359	No	0.36	8.35	0.14	8.49	6.2
Arsenic	11	0.85	25.6	6.29	**18.51**	**7.7**	**Yes**	0.36	**18.87**	0.14	**19.01**	2.7
Barium	11	107	232	176.55	200.81	61,612	No	0.36	201.17	0.14	201.31	0.2
Beryllium	11	0.82	2.7	1.94	**2.26**	**1**	**Yes**	0.02	**2.28**	0.01	**2.28**	1.1
Cadmium	11	6	340	80.23	407.25	448	No	0.18	407.43	0.07	407.50	0.1
Chromium	11	42.6	820	368.24	504.41	896,457	No	1.09	505.50	0.41	505.90	0.3
Copper	11	14	101	41.68	70.25	33,259	No	1.81	72.06	0.68	72.74	3.5
Fluoride	11	1,250	19,020	13,465	16,011	53,787	No	362.32	16,373	135.18	16,508	3.1
Lead	11	3	69.9	11.05	21.87	29.1	No	0.18	22.05	0.07	22.12	1.1
Mercury	11	0.025	0.53	0.16	0.27	269	No	0.00	0.27	0.00	0.27	1.1
Nickel	11	9.2	139	54.67	127.91	17,929	No	0.18	128.09	0.07	128.16	0.2
Selenium	11	0.7	10.1	4.96	6.7	4,482	No	0.18	6.88	0.07	6.95	3.7
Silver	11	0.43	35.2	7.67	12.76	4,482	No	0.07	12.83	0.03	12.86	0.8
Thallium	11	11.6	13.3	12.2	12.48	71.7	No	0.36	12.84	0.14	12.98	4.0
Vandium	11	54.3	917	389.12	543.97	6275	No	0.18	544.15	0.07	544.22	0.0
Zinc	11	127	8,020	1,156	3,156	268,937	No	3.62	3,160	1.35	3,161	0.2
U-238	11	23.15	202.4	91.51	**127.78**	**4.42**	**Yes**	0.72	**128.50**	0.27	**128.78**	0.8

Notes:
(1) 1/2 detection limits are used for samples with "U" or "UJ".
(2) Arsenic, beryllium, and lead values are background.

ATTACHMENT 5

Process Description and Sequence of Operations

TECHNICAL MEMORANDUM

November 7, 2003

To: Rob Hartman, FMC
Jay Brummer, FMC
Jerry Keely, FMC

From: Jason Rushing, Parsons
Charles Bott, Parsons

Subject: FMC Pond Closure Decant Treatment System (PCDT)
Treatment of Pond Water to Universal Treatment Standards (UTS)
Process Description & Sequence of Operation

1. INTRODUCTION

The FMC Pocatello plant ceased operations in December 2001. Decommissioning activities include closure of waste management ponds and decontamination of plant facilities. In order to complete the EPA-required pond closures and proceed with decommissioning the plant, a treatment system design has been developed to manage pond closure decant water derived from dewatering of "Other Ponds" (Ponds 8E, 15S, 16S, the Phase IV ponds and Pond 18) and Pond 17. The design criteria are based on treatment of Pond water to meet Universal Treatment Standards (UTS) before use for dust suppression during construction activities related to pond closure. The Pond 17 water will be treated as a separate influent source and the Other Ponds will be treated as a combined influent source.

The previous onsite LDR facility was modified to accomplish the above treatment objective when it was modified to treat the pond water for discharge to the Pocatello POTW. All process tankage with the exception of the Million Gallon (MG) Tank (T-8141) was constructed with secondary containment. The basic process is as follows, with details included in later sections:

- Pump pond water to Pond Dewatering Tank (or directly to MG Tank for Pond 18)
- Add 1500 - 2500 mg/L H2O2 to pond decant in Pond Dewatering Tank
- Pump contents from Pond Dewatering Tank to Million Gallon Tank (or directly to Batch Reactor for Pond 17)
- Fill Batch Reactor
- Adjust pH with sulfuric acid to pH 7-8 (Pond 17 only)
- Add 5-40 g/L H2O2 and 50-300 mg/L Cu to batch reactor. Purpose: to oxidize WAD CN and precipitate iron-complexed CN presumably as a $Cu_3[Fe(CN)_6]_2$ solid or other Fe containing solids. Potentially add 50-100 mg/L Fe (using $FeCl_3$) to improve precipitation.
- Add cationic polyelectrolyte (polymer) to coagulate Fe-CN precipitate
- Settle CN Sludge and pump to sludge storage/thickening tank – Dewater as needed (1 or 2 times/month) using Filter Press
- Transfer settled decant from Batch Reactor to Filter Feed Tank

- Add 10 – 40 g/L Lime (as $Ca(OH)_2$) to precipitate heavy metals (As, Cd, Sb, and Zn) and fluoride
- Filter and dewater lime sludge using Filter Press
- Adjust pH to 10-11 in pH Adjust Tank
- Oxidize residual iron-complexed CN using the existing UV/H_2O_2 unit system
- Transfer to storage tank(s) prior to loading into water trucks for dust control

2. INFLUENT SOURCES

2.1 "Other Ponds" - 8E, 15S, 16S, Phase IV and 18

Other Pond sources (pond 8E, 15S, 16S, and Phase IV) will be pumped to the existing Pond Dewatering Tank (T-8511) for preliminary H_2O_2 treatment (dose of 1500-2500 mg/L). The Other Pond water will then be transferred to the Million Gallon Tank (T-8141) at LDR from where it will be managed in the batch treatment process. Pond 18 decant will be pumped directly to the Million Gallon Tank (T-8141) at LDR.

2.2 Pond 17

Pond 17 decant will be pumped to the existing Pond Dewatering Tank (T-8511) for preliminary H_2O_2 treatment (approximate dose of 2500 mg/L). The Pond 17 water will then be transferred directly to one of two Batch Reactor Tanks (T-8201 & T-8202) at LDR for treatment.

Untreated Pond 17 decant will not be added to the Million Gallon Tank under any conditions because it was not designed with secondary containment.

3. TREATMENT STANDARDS

FMC has characterized the Pond 17 water as hazardous due to cadmium exceeding the TCLP limit. The applicable treatment standard for Pond 17 will therefore be the Universal Treatment Standards (UTS), as required by the Land Disposal Regulations (40CFR268).

FMC has characterized the "Other Ponds" water as nonhazardous and, thus, the UTS are not applicable; however, FMC has applied the UTS as a relevant and appropriate treatment objective for these sources.

4. EXISTING POND 17 DEWATERING TANK - H_2O_2 ADDITION (T-8511)

The Pond Dewatering Tank (T-8511) exists in the vicinity of Pond 17 and has been used previously for Pond 17 dewatering operations. The purpose of the existing 21,600 gallon tank (T-8511) is to oxidize a majority of the WAD cyanide and dissolved phosphine in Pond 17 decant and, to a lesser extent, in the Other Pond water with moderate H_2O_2 dosing. This will be performed to minimize the potential for emissions of HCN and PH_3 in the batch reactor tanks. Pretreatment of these sources in the Pond 17 Dewatering Tank will eliminate the need for collecting and treating tank headspace in downstream

processes and will minimize the potential for any operator exposure to HCN and PH_3 in the vicinity of LDR-located treatment equipment.

This system is currently configured to add 50% H_2O_2 at a dose of 2500 mg/L (100% basis), which is approximately 4.2 gallons of 50% H_2O_2 per 1000 gallons of pond decant. The H2O2 dose may be reduced to 1500 mg/L for "Other Ponds" depending on the outcome of bench-scale testing, scheduled for December 2003. Peroxide addition is controlled using a flow meter on the influent Pond 17/Other Pond decant line, and the signal is used to adjust the speed of the H_2O_2 dosing pump (P-8111). H_2O_2 is added directly from a supply truck to the Pond Dewatering Tank.

Other Pond decant will be pumped continuously into a common header and into the Pond Dewatering Tank (T-8511). The influent flow meter will be used to control H_2O_2 addition directly into the tank. When a high level in the tank is signaled, the effluent pump (P-3701A/B) will be started and operated until reaching a low level in the tank. For Other Pond dewatering, the effluent from the tank will be pumped to the 1 MG Storage Tank (T-8141). For Pond 17 dewatering, the effluent will be pumped directly to the Batch Reactors.

5. MILLION GALLON TANK (T-8141)

The Million Gallon Tank (T-8141) will be used for influent flow and load equalization and will serve to blend "Other Pond" sources and supply Pond 18 decant to the treatment system. The 1 MG Storage Tank will be used to supply water to the batch reactor tanks (T-8201/T-8202) using pumps rated at approximately 900 gpm (P-8143A/B). This is beneficial because reactor fill time from the 1 MG Storage Tank will be minimized (i.e. reactor tanks filled quickly).

6. BATCH REACTOR TANKS (2 in parallel)

The batch reactors (T-8201/T-8202) will be used to perform 2 primary treatment objectives: 1) Oxidize WAD and non-WAD cyanide, and 2) precipitate Fe-complexed CN with copper and ferric iron for removal by subsequent coagulation and sedimentation. It is possible that the UTS limit for CN will be met with H2O2 oxidation (with or without copper catalysis) alone for Other Ponds and Pond 18 sources. If this is the case, the precipitation step will not be required. Additional bench testing is scheduled for December 2003 to finalize the requirements for this process step. Bench testing already completed confirmed that a CN precipitation step will be required for treatment of Pond 17 water.

To accomplish the 2 primary objectives, the following treatment actions will be performed in the batch reactors:

- Hydrogen Peroxide Addition – oxidizing agent
- Copper Addition (added as cupric sulfate pentahydrate) – catalyst for H_2O_2 oxidation and for precipitation of presumed $Cu_3[Fe(CN)_6]_2$ solids.
- Addition of Fe^{3+} as FeCl3 – for improved precipitation of presumed $Cu_3[Fe(CN)_6]_2$ and other Fe-containing CN solids
- Addition of cationic polyelectrolyte – to coagulate CN precipitate for subsequent filtration.

The following sequence of operation is specified for the batch reactors.

- **Fill** reactor from 1 MG Storage Tank (T-8141) (or directly from Pond Dewatering Tank). The Reactor Tanks should be filled to a volume of 23,000-25,000 gallons
- **Adjust pH** to pH 7 - 8 using concentrated sulfuric acid (Pond 17 only)
- **Add Cu** in dry powder or granular form by manually weighing quantities specified in the Process Design Calculations. The operator should add the dry chemical directly into the batch reactor tank through a top opening.
- **Add H_2O_2** by manually starting the peroxide feed pump (P-8200B) and metering the required dose. The H2O2 feed pump will be a 55 gpm centrifugal pump configured with an automatic batch dose controller (integral flow meter and totalizer).
- **React**. The reactor contents will be allowed to mix for approximately 3-10 hours or until the H2O2 reaction is complete.
- **Add $FeCl_3$** $FeCl_3$ may be added if needed to improve CN precipitation.
- **Coagulate**. Add cationic polyelectrolyte to coagulate presumed $Cu_3[Fe(CN)_6]_2$ solids
- **Settle**. Allow $Cu_3[Fe(CN)_6]_2$ sludge to settle to bottom of batch reactor, and pump solids to sludge storage tank
- **Empty** the reactor to the Filter Feed Tank

If it is determined that CN precipitation is not needed for the Other Ponds and Pond 18 sources, the $FeCl_3$ addition, coagulation, and settling steps described above will not be required for these sources.

7. FILTER FEED TANK

The Filter Feed Tank (T-8203) will be operated under variable volume conditions to supply the dewatering/filtration process on a semi-continuous basis while accepting the entire contents of a batch reactor at 600 gpm. Lime addition will also be performed in the Filter Feed Tank (T-8203). This will be accomplished by manually adding lime from the Lime Feed Tank (T-8216) during the reactor decant period (i.e. add lime to Filter Feed Tank when adding decant from a Batch Reactor). To allow sufficient time for lime addition and reaction, it will be necessary to temporarily stop feeding the filtration/dewatering system during the times when the Filter Feed Tank is being filled and lime slurry is being added.

The Filter Feed Tank (T-8203) will be used to precipitate/adsorb arsenic, antimony, cadmium, copper, zinc, other heavy metals, and fluoride. To accomplish these objectives, the following treatment action will be performed in the Filter Feed Tank:

- Lime Addition (added as 20wt% slurry of slaked CaO) – precipitate fluoride; increase pH to promote cationic heavy metal precipitation as (oxy)hydroxide or carbonate solid.

The following sequence of operation is specified for the filter feed tank.

- **Stop** effluent withdrawal to the filtration/dewatering process immediately before transferring the contents of a Batch Reactor into the Filter Feed Tank.
- **Fill** the Filter Feed Tank rapidly from one of the batch reactors.
- **Add Lime** simultaneously with influent addition from the batch reactors by manually opening the control valve on the lime recycle line from the Lime Feed Tank (T-8216) until the required volume of 20wt% CaO has been transferred. Lime dosages (as 20wt% slurry) are estimated in the Process Design Calculations between 2,500-3,500 gallons per batch depending on the influent source. This dose will be refined based on operator experience and ongoing bench-scale laboratory reactor simulations. Given the size of the Lime Feed Tank (12,000 gallons), the entire lime dose can be added rapidly from the feed tank at up to 150 gpm. The lime slaker and associated equipment would be operated manually to maintain an appropriate volume of slaked lime in the Lime Feed Tank.
- **pH Measurement** by manual sampling from the Filter Feed Tank should be performed approximately 30 minutes after completing lime addition to verify that a pH of 11-12.5 (depending on pond source) was achieved. Otherwise, a supplemental lime addition will be performed.
- **Resume Dewatering.** The dewatering/filtration process will be restarted immediately after the lime reaction period.

8. IRON-CYANIDE SLUDGE STORAGE TANK

Iron-Cyanide sludge generated during the Batch Reactor precipitation step (at a minimum required for Pond 17 water) will be pumped from the bottom of the batch reactor into the Sludge Storage Tank. The purpose of the Sludge Storage Tank is to gravity thicken Fe-CN sludge and collect a sufficient quantity to dewater using the Filter Press. Once the tank contains a sufficient quantity of thickened sludge, the entire contents of the tank will be dewatered using the Filter Press. Decant from the tank and filtrate from the Filter Press will be recycled to the 1 MG Storage Tank or Batch Reactors for further treatment.

8. DEWATERING & FILTRATION PROCESS

A recessed plate filter press has been selected to perform the function of dewatering the lime and Fe-CN sludges and filtering the effluent. The filter press has been sized at roughly 120-130 ft^3 with 1500 mm plates. The influent stream from the Filter Feed Tank (T-8203) will contain roughly 4-5% solids after lime precipitation, and the dewatered cake should be roughly 50% solids. The filtrate will flow by gravity to the Hold Tank (T-8550) where it will be collected and pumped (P-8002) to the pH Adjust Tank. The influent stream from the Fe-CN Sludge Storage Tank will contain roughly 2-4% solids and the dewatered cake will contain approximately 25-30% solids. The filtrate will flow from the Hold Tank where it will be collected and pumped to the Filter Feed Tank.

9. pH ADJUST TANK

Filtrate will be pumped from the Hold Tank to the 30,000 gallon pH Adjust Tank (T-8000). During the filling and neutralization operation, a recycle loop equipped with pH probes will be operated to

provide continuous pH measurement. In the event of an improperly treated batch, the contents of the pH Adjust Tank can be diverted back to the Million Gallon Tank.

After the pH Adjust Tank is full, sulfuric acid will be added at a known flow rate (1-20 gpm) from a gear pump equipped with a manual timer, speed control, and manual switch. The operator will manually direct the addition of known volumes of acid based on readings from a pH probe located in the recycle loop. After the pH Adjust Tank is full, the operator will make a final pH adjustment to the range of about 10-11.5, and then immediately empty the tank to the Equalization Tanks (T-8140 & T-8001A) at roughly 500 gpm by turning two valves on the recycle loop.

10. EQUALIZATION TANKS

The Equalization Tanks (T-8140 & T-8001A) will consist of a 25,000 gallon and a 30,000 gallon tank piped together for an available surge/storage volume of approximately 55,000 gallons. Valves will be supplied in the influent and effluent lines so that each tank can be operated independently. These tanks will be used to ensure a continuous flow is provided to the UV Irradiation/H_2O_2 Process.

11. UV IRRADIATION/H_2O_2 PROCESS

Depending on the effectiveness of oxidation and precipitation of CN in the batch reactors, it may be necessary to oxidize remaining iron-complexed cyanide to meet the treatment objective for total cyanide of less than 1.2 mg/L. This will be accomplished using a continuous flow UV-H_2O_2 system as the final process.

Irradiation with ultraviolet light promotes the dissociation (photolysis) of the iron cyanide complex, and a relatively low dose of H_2O_2 (typically about 100 mg/L) is added to the influent of the UV contact reactor to promote oxidation of cyanide. The UV light simply makes the cyanide more available to be oxidized by H_2O_2 (or hydroxyl radical given UV irradiation). The cyanide is oxidized to cyanate, which subsequently hydrolyzes to carbonate and ammonia.

A Perox-pure UV oxidation reactor (Model CW600/540) will be used for iron-complexed cyanide oxidation when required. Water will be pumped from the Equalization Tanks through the UV system continuously at 60-90 gpm. To promote cyanide oxidation, 50% H_2O_2 will be injected into the influent pipe at 50-250 mg/L which is equivalent to 0.25-3.75 gallons per hour using a 0-4 gph infinite-turndown diaphragm metering pump (on/off hand switch). The UV system is rated for a maximum power output of 360 KW using 15 KW lamps and a maximum volumetric throughput of 200 gpm at 7 psi. The exact UV and H_2O_2 dose requirements will be determined using a bench-scale UV apparatus if subsequent treatability testing demonstrates that UV/H_2O_2 oxidation is required.

12. WATER USE FOR DUST CONTROL

Treated effluent will be pumped to a storage tank(s) for later transfer to water trucks during pond closure construction activities.

The years 1999, 2000 and 2002 were major RCRA pond closure construction years. During these construction periods, 2 full time water trucks were required for project dust control during most of the construction season. Typically the closure contractor mobilizes and starts work in March and completes/demobilizes the projects in mid to late October. In addition to the project construction dust control, day to day plant operations dust control requires 1 water truck for the plant decommissioning activities, including dust control on plant roadways. Both 2004 and 2005 are planned as major pond closure construction years, similar to 1999, 2000 and 2002 and will require a minimum of 2 project water trucks. During the construction schedule, fugitive emissions will be monitored and additional controls and water trucks will be added as necessary. Routinely, the construction work schedule is based on 10 hours per day, 6 or 7 days per week. However, water trucks will be operated whenever construction is going on. With final covers being installed on 4 RCRA waste management units (7 ponds), during the 2004 construction season, it is possible that an additional water truck will be required. If an additional water truck is necessary, 4 water trucks will be in operation at the plant during a portion of the 2004 construction season. During the 2005 construction season, 3 water trucks will likely provide adequate dust control.

It is estimated that each water truck applies 30,000 gallons per day, based on one 10 hour shift per day (normal construction schedule), or an average of 20.8 gallons per minute (gpm). It takes approximately 10-15 minutes to fill the water truck with water and 39 minutes to apply per load or cycle. FMC has developed a pond pumping and pond closure schedule that essentially matches the pumped and treated volume of water with the needed water for construction dust control.

ATTACHMENT 6. Summary Results of Pond 17 UTS Bench Testing Experiments

													Experimental Conditions						
Notebook Page #	Sample # [1][2]	Total CN (mg/L)	WAD CN (mg/L)	TP (mg/L)	PO4 (mg/L)	PO3 (mg/L)	F by ISE (mg/L)	As (mg/L)	Cd (mg/L)	Cu (mg/L)	Fe (mg/L)	Zn (mg/L)	Initial pH Adjust	Cu Dose (mg/L)	H2O2 (g/L)	FeCl3 Dose (mg/L as Fe)	FeSO4 Dose (mg/L as Fe)	Lime Dose (g/L Ca(OH)2)	Notes [4]
Raw P17	P17-09/02/03	321						3.02	0.039	0.45	137	29.4							
Initial H2O2	P17-H2O2-091503	298	0.4	13770	3618	2430	2758	3.34	0.59	0.14	90.3	27.3							
Treatment Target (UTS)		1.2 [3]	0.86 [3]	NA	NA	NA	NA	1.4	0.69	NA	NA	NA							
37	E37-FILTRATE-0917	4.0	0.34	12920	3104	5942	2649	2.90	0.231	245	28.6	18.1	7	400	40	0	0	5	
	E37-LIME-0917	4.9	0.46	12027	4154	7197	509	2.64	0.014	167	4.9	3.3							
38	E38-LIME-0917	6.8	0.15	11466	3736	5523	1233	2.67	<0.002	25.8	2.4	0.81	7	400	40	0	0	7	assume filtrate characteristics are same as exp 37
39	E39-LIME-0917	7.3	0.08	10641	2853	5095	761	2.66	<0.002	12.5	2.5	1.3	7	400	40	0	0	11	assume filtrate characteristics are same as exp 37
40	E40-LIME-0917	5.4	0.44	6332	49	3522	74	0.05	<0.002	0.34	1.7	0.28	7	400	40	1000	0	60	Added lime and Fe to filtrate from exp 38 and 39.
41	E41-LIME-0917	7.2	0.43	8644	52	4579	80	0.34	<0.002	0.63	1.8	0.54	7	400	40	200	0	40	Added lime and Fe to filtrate from exp 38 and 39.
42	E42A-LIME-0919	302	3.10	10094	601	4639	135	0.93	0.007	0.53	104	1.52	none	0	2.5	200	200	40	Add Fe before lime
	E42B-LIME-0919	306	2.80	9687	585	4612	135	0.76	0.007	0.55	103	1.23	none	0	2.5	200	300	40	Add 100 ppm of FeSO4 after lime add'n
43	E43-LIME-0919	73.6	0.98	9605	316	4960	77	0.27	<0.002	4.10	28.0	0.95	7	400	10	400	400	40	Add 200 ppm of FeCl3 after lime add'n
44	E44-FILTRATE-0919	15.4	0.53	14048	4975	4559	2871	-	-	-	-	-	7	200	10	0	20	0	Filtrate sample after copper/H2O2/FeSO4 add'n
	E44A-LIME-0919	24.2	1.12	9112	360	6227	80	0.34	<0.002	0.39	7.3	0.56	7	200	10	0	20	40	Add lime to filtrate
	E44B-LIME-0919	23.3	1.4	9168	220	4644	74	0.25	<0.002	0.48	7.2	0.34	7	200	10	200	20	40	Add lime and FeCl3 to filtrate
45	E45A-LIME-0919	295	3.1	9614	331	4404	98	0.47	<0.002	0.15	31.2	0.49	7	0	2.5	200	200	40	Add FeCl3 and FeSO4 before lime
	E45B-LIME-0919	302	2.6	9774	348	4552	94	0.4	<0.002	0.09	29.0	0.36	7	0	2.5	200	300	40	Add 100 ppm of FeSO4 after lime add'n

Notes:

[1] "Filtrate" samples refer to filtrate collected after precipitation of CN with copper.

[2] "Lime" samples refer to filtrate collected after lime precipitation.

[3] Primary treatment target is UTS limit, with the exception of CN, which was targeted for 20 mg/L so that UV oxidation could reasonably polish to below total and WAD UTS of 1.2 mg/L and 0.86 mg/L respectively.

[4] Highlighted lines show successful treatment in terms of low CN and UTS compliant As and Cd levels which are the key treatment parameters in the raw Pond 17 water.

ATTACHMENT 7

Tom Gesell Evaluation

May 28, 2003

Mr. Jim Rice
FMC Corporation
Phosphate Chemicals Division

Dear Mr. Rice:

This letter reports my review of potential impacts of proposed aqueous discharges to the Pocatello publically owned treatment works (POTW) of potassium and uranium. Naturally-occurring potassium has one radioactive isotope and uranium has three naturally-occurring isotopes, all of which are radioactive. Estimated discharges and consequent concentrations expected in water and biosolids were taken from documents supplied by FMC (2003).

Potential concerns about any radionuclide in the environment center around 1) ingestion through drinking water or food, 2) inhalation of airborne material, and 3) direct radiation exposure from radionuclides in soil. There are two general approaches to understanding the potential impact of natural radionuclides that are redistributed by industrial activities: 1) estimating radiation doses through use of models and 2) comparisons with existing levels of these natural radionuclides, their normal variations, and variations caused by other industrial practices. In this letter the second approach, comparisons, is used.

It is important to recognize that exposures to radionuclides in the environment at the levels discussed here do not present acute risks.

Potassium

Natural potassium includes a long-lived radioactive isotope, potassium-40, which occurs as 0.0117% of elemental potassium. As a consequence, all natural potassium is slightly radioactive. Potassium is also an essential human nutrient with a recommended intake (Daily Reference Value) of 3.5 grams per day. Potassium chloride, sold as a table salt substitute for persons who must restrict sodium intake, is marketed freely without regulation of its radioactive content.

Water

The potassium content of the human body is under strict homeostatic control and is not influenced by amount of intake, which varies from 1.4 to 6.5 grams per day and averages 3.3 grams per day. Because of the homeostatic control, the radiation dose from potassium-40 within the body is independent of normal variations in potassium intake. Consequently there is no need for regulatory limits on potassium or its natural radioactive isotope, potassium-40, in drinking water or food, and none exist.

From the FMC application (FMC, 2003), the concentration of potassium in water discharged from the Pocatello POTW would average 0.3 grams per liter if the proposed FMC effluent was included. If this discharge were somehow to be consumed as drinking water at the standard assumed rate of 2 liters per day, the intake would be about 0.6 grams per day, a fraction of the normal variation of 1.4 to 6.5 grams per day. As discussed above, this would have no radiological consequences.

Direct radiation

Potassium-40 emits gamma radiation. On average, gamma radiation from potassium-40 in rocks and soil contributes about 3% of the average annual radiation dose to Americans from natural sources. However the potassium-40 content of rocks and soil is variable which leads to variation in the dose. In addition to natural variations, it has been estimated that about 4 million tons of potassium are added annually to the soils of the United States in the form of fertilizer (Guimond, 1978).

Table 1 lists the potassium concentrations in the current Pocatello POTW biosolids and the concentration expected in the biosolids if the proposed FMC waste stream is introduced. Potassium concentrations in rocks and soils, in POTW biosolids from a national survey, and in high grade fertilizer are listed for comparison. As can be seen in the table, introduction of the proposed waste stream from FMC would increase the potassium concentration in Pocatello POTW biosolids from 1.1% to 1.8%. However the concentration of 1.8% is less than several other comparable materials including the average concentration in the earth's crust. Furthermore, the duration of the FMC discharge is limited to 2 ½ years, so the total amount of FMC potassium that would be discharged is also limited. Thus land application of the biosolids would not markedly alter the potassium content of the soil and would in fact serve as a nutrient in a manner similar to fertilizer application.

Table 1. Concentration of potassium in earthen materials and POTW biosolids

Material	Potassium concentration in material (%)	Reference
Lower concentration: natural rock	0.3	NCRP, 1987
Median concentration: national survey of POTW biosolids	0.5	AMSA Survey
Current concentration: Pocatello POTW biosolids	1.1	FMC, 2003
Average concentration: soil	1.5	NCRP, 1987
Concentration with FMC wastes: Pocatello POTW biosolids	1.8	FMC, 2003
Average concentration: earth's crust	2.8	NCRP, 1987
Upper concentration: in natural rock	4.5	NCRP, 1987
Upper concentration: national survey of POTW biosolids	7.4	AMSA Survey
Concentration in high grade fertilizer	20	Mahler, 2002

Food

Food or fodder crops grown on land to which biosolids have been applied should simply benefit from the potassium as a fertilizer and would not be expected to contain more potassium than food or fodder grown under normal agricultural conditions. Even if the potassium content in food were to be increased, homeostatic control within the human body would prevent any increase in dose.

Inhalation

Inhalation is not considered to be an important route for human intake of potassium. However, since soil contains a small percentage of potassium, any retention in the human body of inhaled, resuspended soil particles of respirable size would contribute to intake of potassium. However the amount would be small in comparison to the normal ingestion (1.4 to 6.5 grams per day with an average of 3.3 grams per day). In any case the concentration of potassium in soil augmented with Pocatello POTW biosolids would be little different whether or not the proposed FMC discharges were present.

Uranium

Uranium is an element that has three natural isotopes, all of which are radioactive. As these isotopes undergo radioactive decay, they transform into series of radioactive isotopes of different elements referred to as daughter products. Uranium and its daughters, together with thorium and its daughters and potassium-40, endow the earth's crust with its natural radioactivity. Uranium and its daughters are taken up by plants and dissolved in water to some extent, forming pathways for human intake.

Water

Unlike potassium, uranium is neither an essential human nutrient nor under homeostatic control. Increased intake will result in increased amounts of uranium in the human body, and a standard for drinking water of 30 micrograms per liter has been established by the US EPA. The current influent to the Pocatello PTOW is estimated to have an average monthly concentration of 2 micrograms per liter of uranium. The FMC effluent is expected to have an average monthly concentration of 200 micrograms per liter (500 micrograms per liter maximum daily concentration). If the current and proposed FMC influent streams are combined, the resulting influent stream is expected to have a concentration of 5.4 micrograms per liter. A removal of 85% is assumed, leading to an estimated average monthly concentration in the Pocatello POTW liquid effluent of 0.8 micrograms per liter. Thus the effluent directly from the Pocatello POTW would be less than 3% of the US EPA drinking water maximum concentration limit of 30 micrograms per liter. Thus uranium in the effluent from the Pocatello POTW would not be a problem.

Direct radiation

The uranium isotopes themselves do not emit any significant gamma radiation. The daughter products that do emit gamma radiation are separated from uranium in the decay series by intervening isotopes with very long half lives. As a consequence, it takes thousands of years for the gamma-emitting uranium daughter products to approach the concentrations of the parent uranium. Based on the data in the spreadsheets, the uranium in the FMC effluent has been separated from its daughters. Thus in the "short term" (less than thousands of years) external radiation from uranium in the FMC effluent is not an issue. Eventually, however, the concentration of the daughters will equal that of the parent uranium and direct radiation levels would be the same as for an equal concentration of uranium found in nature.

Table 2 lists the uranium concentrations in the current Pocatello POTW biosolids and the concentrations expected in the biosolids if the proposed FMC waste stream is introduced. For comparison, uranium concentrations in rocks, soils and phosphate fertilizer are also listed. As can be seen in the table, introduction of the proposed waste stream from FMC would increase the uranium concentration in Pocatello POTW biosolids from 1.4 ppm to 23.5 ppm. Thus as POTW biosolids are land disposed, the concentration of uranium in soil can be expected to increase. As for the potassium, however, the duration of the FMC discharge is limited, as is the total amount of FMC uranium that would be discharged. The amount of increase and resulting concentration in soil depends on several factors, and a quantitative estimate is beyond the scope of this discussion. However it is worth noting that the estimated uranium concentration in the biosolids is only 14% of the corresponding concentration in phosphate fertilizer. Phosphate fertilizer is widely used and is not regulated with respect to its uranium concentration. I am unaware of any plans to regulate phosphate fertilizer with respect to its uranium concentration.

Table 2. Concentration of uranium in earthen materials and POTW biosolids

Material	Uranium concentration in material (ppm)	Reference
Lower concentration: natural rock	0.5	NCRP, 1987
Current concentration: Pocatello POTW biosolids	1.4	FMC, 2003
Average concentration: natural soil	1.8	NCRP, 1987
Average concentration: earth's crust	2.8	NCRP, 1987
Upper concentration: natural rock	4.7	NCRP, 1987
Concentration with FMC wastes: Pocatello POTW biosolids	23.5	FMC, 2003
Concentration in phosphate fertilizer	165	EPA, 1993

Food

Food or fodder crops grown on land to which biosolids (or phosphate fertilizer) have been applied can be expected to have an increased concentration of uranium in direct proportion to the increased uranium concentration is soil. However the contribution from all pathways of uranium intake (food, water, air) is about 0.3 percent of the total US average natural radiation dose (NCRP, 1987). Thus even if the uranium concentration of soil were to be increased by several factors, the increment in human radiation dose due to intake would be small.

Inhalation

Soil contains uranium, so any uptake and retention in the human body of inhaled, resuspended soil particles of respirable size would contribute to intake of uranium. However, inhalation is not an important route for human intake of uranium. The average concentration in air is about 0.00003 micrograms per cubic meter (NCRP, 1987). This includes uranium from resuspended soil as well as any man-made contributions. Humans breath about 1 cubic meter of air per hour (ICRP, 1991) so the daily average intake is about 0.0007 micrograms. This amount is very small in comparison to the normal intake through ingestion of food and water, which averages about 1.5 micro grams of uranium per day (NCRP, 1987). Thus while increased soil concentration of uranium could result in a corresponding increase in air concentration due to resuspension, the effect on total intake of uranium is likely to be small.

Conclusions

The radiological impact of potassium in the FMC effluent that is proposed to be discharged to the Pocatello POTW is inconsequential because the concentrations are small, the discharge period (2 ½ years) and the total amount of potassium contributed by FMC are limited, and potassium taken into the human body is under homeostatic control.

Based on comparisons, the impact of the uranium appears to be inconsequential for potential water or air intakes. The impact of land disposal of uranium-contaminated biosolids appears to be small based on comparisons with uranium concentrations in earthen materials and phosphate fertilizer and the fact the discharge period (2 ½ years) and the total amount of uranium contributed by FMC are limited. However, the buildup of uranium in soil due to the limited discharge and any consequent radiation dose were not estimated quantitatively.
Sincerely,

Thomas F. Gesell

References

AMSA Survey. A survey of constituents of biosolids conducted by the Association of Metropolitan Sewerage Agencies. Referenced from FMC, 2003.

EPA (1993) Environmental Protection Agency. Diffuse NORM Wastes: Waste Characterization and Preliminary Risk Assessment. RAE-9232/1-2, Draft report, US Environmental Protection Agency, Washington, DC.

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Guimond, R. J. (1978) The radiological aspects of fertilizer utilization. *in* Radioactivity in Consumer Products (A. A. Moghissi, P. Paras, M. W. Carter, and R. F. Barker, eds), U.S. Nuclear Regulatory Commission Rep. NUREG/CPOOO3, pp. 31-393, NTIS, Springfield, VA.

ICRP (1991) International Commission on Radiological Protection. 1990 Recommendations of the International Commission on Radiological Protection, Annals of the ICRP Vol. 21/1-3.
Mahler, R. L. (2002) Fertilizer Primer, SIS 863, University of Idaho Extension, Moscow, Idaho.

NCRP (1987) National Council on Radiation Protection and Measurements. Exposure of the Population in the United States and Canada from Natural Background Radiation, Report 94, NCRP, Bethesda, MD.

DECEMBER 30, 2003
FMC LETTER

FMC Corporation

FMC Idaho LLC
PO Box [illegible]
Pocatello, Idaho [illegible]
208 [illegible]

FMC Idaho LLC

December 30, 2003

Ms. Linda Meyer
MS WCM-121
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, WA 98101

Subject: Information in response to the December 23 conference call

Dear Ms. Meyer:

In follow-up to the December 23, 2003 conference call between FMC, EPA, IDEQ, and the Shoshone Bannock Tribes regarding FMC's on-site water treatment and use options, this letter and attachments provide the following information that EPA requested regarding this proposal:

- A map showing the construction areas and general areas that will be watered for dust control during 2004 and 2005; and,
- The EPA Preliminary Remediation Goals (PRGs) for radium-226 and radium-228.

There are two "Facility/Resource Locations" maps attached, each map is in 2 parts – the western half (left sheet) and eastern half (right sheet) of the plant. The first set shows the 2004 Envirocon Operations (construction) areas and the second set shows the 2005 construction areas. A legend is provided on the right sheet that indicates paved and non-paved roads, (to be) capped areas, topsoil borrow areas and slag recovery/screening and handling areas for which dust control will be necessary. Note that the 2005 construction areas map incorrectly identifies the Pond 18 Cell B area as a "cap area" however, dust control will be required in this area during "deconstruction" of Pond 18 Cell B during the closure by removal. As we discussed during the conference call, the vast majority of these areas are within Remediation Units/Solid Waste Management Units already identified in the Scoping and Planning Memorandum for the Supplemental Remedial Investigation for the FMC Operable Unit.

The EPA Preliminary Remediation Goals (PRGs) for radium-226 and -228, and thorium-228, -230 and –232, and the EPA Region 9 PRG for cyanide have been inserted into the attached revised version of Attachment 3. As indicated in the footnote, the EPA PRGs for the specified radionuclides are Outdoor Worker Soil exposure values in picoCuries per gram (pCi/g), and the EPA Region 9 PRG for cyanide is the Industrial Soil exposure value

in milligrams per kilogram. The EPA PRGs provide useful reference points that further illustrate the minimal nature of the incremental loading of constituents to soil at the dust control areas.

In addition to the EPA-calculated RBCs for polonium-210, lead-210 and uranium-238 included in the original Attachment 3, the EPA-calculated background soil concentrations for these radionuclides have been added to the revised Attachment 3. As discussed during the conference call, secular equilibrium can logically be assumed for natural soils and thus the uranium-238 soil background concentration of 3.88 pCi/g can be used as a reasonable approximation for the radium-226 soil background concentration.

Finally, Attachment 3 has been revised to convert the total uranium concentration from milligrams per liter (as originally analyzed and reported) to uranium-238 in picoCuries per liter. As discussed, we conservatively assumed that all of the uranium is present as uranium-238. Thus, the incremental soil concentrations (2004, 2005, and 2004 plus 2005) for uranium-238 are now in picoCuries per gram (pCi/g) and thus can now be directly compared to the EPA calculated RBC of 4.42 pCi/g for uranium-238 in surface soil for worker exposure. All of the above-described revisions to Attachment 3 are shown as shaded cells to highlight these revisions.

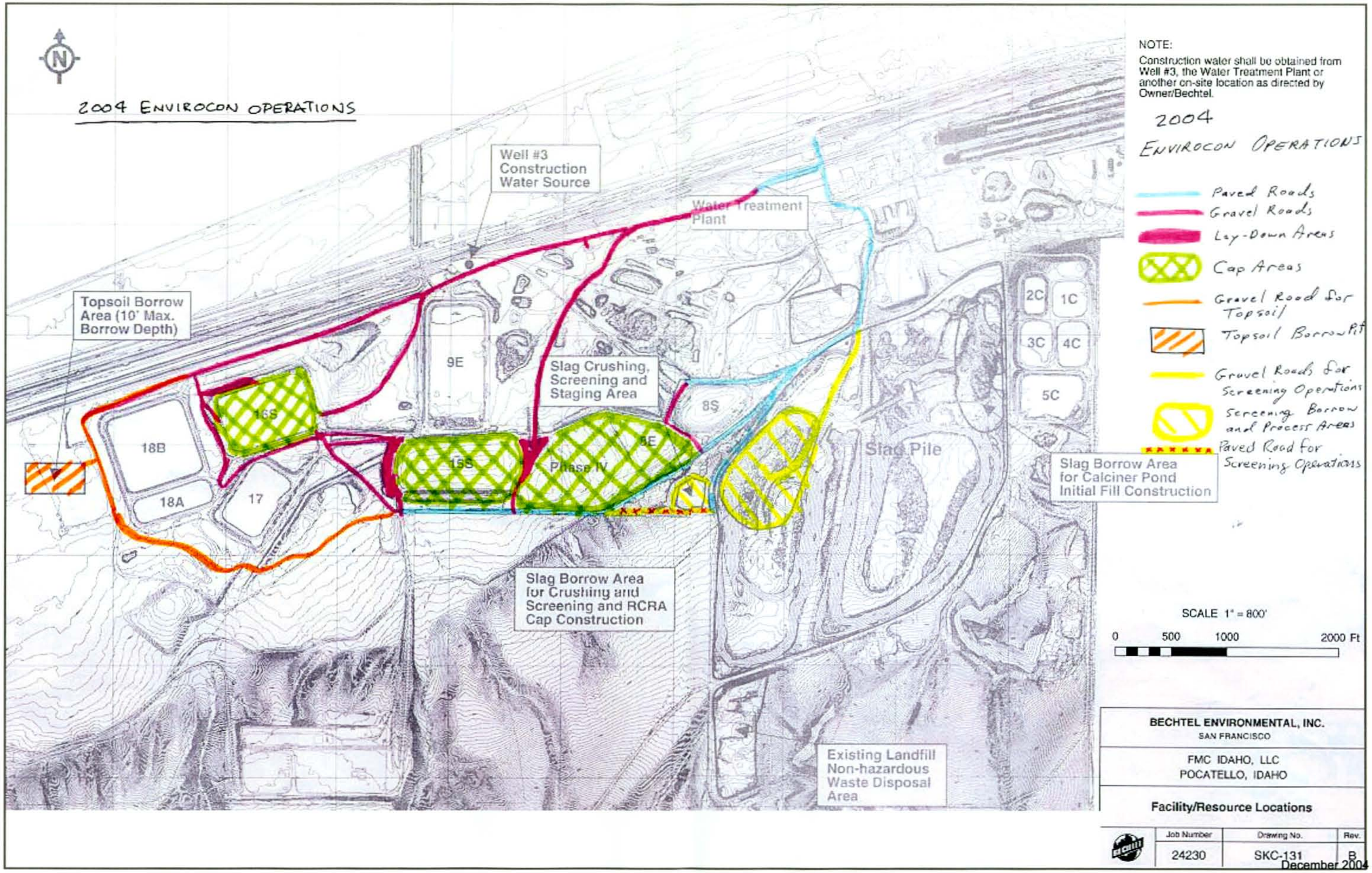
FMC believes the additional details and clarifications provided during the December 23 conference call and in these attachments continue to support our position that on-site water treatment and use for dust control is an acceptable option. Please feel free to contact me at (208) 236-8216 should you have questions regarding this information.

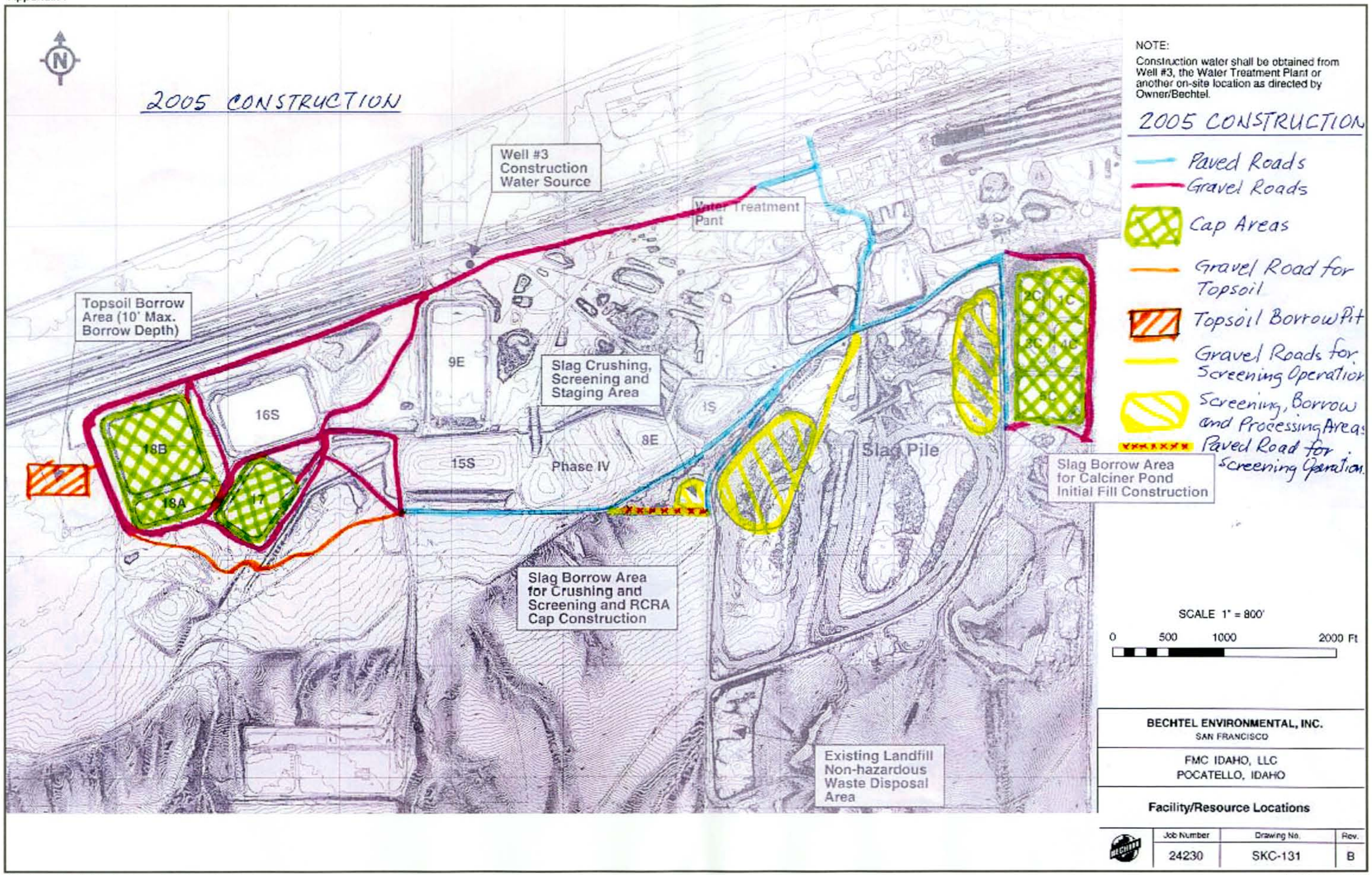
Sincerely,

Rob J. Hartman
FMC Corporation

Attachments

cc: Mark Masarik, EPA
Doug Tanner, IDEQ
Roger Turner, Shoshone-Bannock Tribes
Scott Youree, Shoshone-Bannock Tribes


2004 ENVIROCON OPERATIONS
Well #3 Construction Water Source
Water Treatment Plant
Topsoil Borrow Area (10' Max. Borrow Depth)
9E
Slag Crushing, Screening and Staging Area
8S
16S
18B
18A
17
15S
5E
Phase IV
Slag Pile
2C
1C
3C
4C
5C
Slag Borrow Area for Calciner Pond Initial Fill Construction
Slag Borrow Area for Crushing and Screening and RCRA Cap Construction
Existing Landfill Non-hazardous Waste Disposal Area
NOTE:
Construction water shall be obtained from Well #3, the Water Treatment Plant or another on-site location as directed by Owner/Bechtel.
2004
ENVIROCON OPERATIONS
Paved Roads
Gravel Roads
Lay-Down Areas
Cap Areas
Gravel Road for Topsoil
Topsoil Borrow Pit
Gravel Roads for Screening Operations
Screening Borrow and Process Areas
Paved Road for Screening Operations
SCALE 1" = 800'
0
500
1000
2000 Ft
BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO
FMC IDAHO, LLC
POCATELLO, IDAHO
Facility/Resource Locations
Job Number
24230
Drawing No.
SKC-131
Rev.
B
December 2004


2005 CONSTRUCTION
Well #3 Construction Water Source
Water Treatment Plant
Topsoil Borrow Area (10' Max. Borrow Depth)
9E
16S
18B
18A
17
15S
Phase IV
Slag Crushing, Screening and Staging Area
8E
1S
Slag Pile
2C
1C
Slag Borrow Area for Calciner Pond Initial Fill Construction
Slag Borrow Area for Crushing and Screening and RCRA Cap Construction
Existing Landfill Non-hazardous Waste Disposal Area
NOTE:
Construction water shall be obtained from Well #3, the Water Treatment Plant or another on-site location as directed by Owner/Bechtel.
2005 CONSTRUCTION
Paved Roads
Gravel Roads
Cap Areas
Gravel Road for Topsoil
Topsoil Borrow Pit
Gravel Roads for Screening Operation
Screening, Borrow and Processing Areas
Paved Road for Screening Operation
SCALE 1" = 800'
0 500 1000 2000 Ft
BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO
FMC IDAHO, LLC
POCATELLO, IDAHO
Facility/Resource Locations
Job Number 24230
Drawing No. SKC-131
Rev. B

ATTACHMENT 3. FMC On-Site Water Treatment and Use Option - Incremental Loading to Surface Soil Evaluation

2004 Construction		
Pond closure construction area (sf)	Water Volume applied (Mgals)	Total water applied (L/sf)
1,998,457	16.63	31.49
General dust control area (sf)		
525,400	4.37	31.49
2005 Construction		
Pond closure construction area (sf)	Water Voume applied (Mgals)	Total water applied (L/sf)
2,212,629	6.87	11.75
General dust control area (sf)		
525,400	1.63	11.75

Pond closure construction area assumes that water applied to pond surface area only 2 of 7 months.

Constituent	Treated Other and Pond 17 Water Average Concentration (mg/L)	2004 Incremental mass applied (mg/sf)	2004 Incremental soil concentration (mg/cf)	2004 Construction and General dust control areas Incremental soil concentration (mg/kg)	2005 Construction and General dust control areas Incremental soil concentration (mg/kg)	2004 plus 2005 Loading on General dust control areas Incremental soil concentration (mg/kg)	Worker RBC or Background (mg/kg)	
Antimony	0.10	3.15	18.90	0.36	0.14	0.50	359.0	
Arsenic	0.10	3.15	18.90	0.36	0.14	0.50	**7.7**	
Barium	0.10	3.15	18.90	0.36	0.14	0.50	61,612.0	
Beryllium	0.005	0.16	0.94	0.02	0.01	0.02	**1.0**	
Cadmium	0.050	1.57	9.45	0.18	0.07	0.25	448.0	
Chromium, Total	0.30	9.45	56.69	1.09	0.41	1.49	896,457.0	
Copper	0.50	15.75	94.48	1.81	0.68	2.49	33,259.0	
Lead	0.05	1.57	9.45	0.18	0.07	0.25	**29.1**	
Mercury	0.0006	0.02	0.11	0.002	0.001	0.003	269.0	
Nickel	0.05	1.57	9.45	0.18	0.07	0.25	17,929.0	
Selenium	0.05	1.57	9.45	0.18	0.07	0.25	4,482.0	
Silver	0.02	0.63	3.78	0.07	0.03	0.10	4,482.0	
Thallium	0.10	3.15	18.90	0.36	0.14	0.50	71.7	
Vanadium	0.05	1.57	9.45	0.18	0.07	0.25	6,275.0	
Zinc	1.00	31.49	188.96	3.62	1.35	4.98	268,937.0	
Cyanide, Total	0.50	15.75	94.48	1.81	0.68	2.49	35 (EPA 9 PRG)	
Fluoride	100.00	3,149.35	18,896.08	362.32	135.18	497.51	53,787.0	
NORM	(pCi/L)	(pCi/sf)	(pCi/cf)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	Background (pCi/g)
Radium 226	2.6	81.88	491.30	0.01	0.00	0.01	3.69 (EPA PRG)	NC
Radium 228	0.5	15.75	94.48	0.00	0.00	0.00	8.40 (EPA PRG)	NC
Radium 226+228	3.1	97.63	585.78	0.01	0.00	0.02	NC	NC
Polonium 210	1.8	56.69	340.13	0.01	0.00	0.01	21.22	3.58
Lead 210	12.0	377.92	2,267.53	0.04	0.02	0.06	6.24	3.03
Thorium 228	1.0	31.49	188.96	0.00	0.00	0.00	139 (EPA PRG)	NC
Thorium 230	1.0	31.49	188.96	0.00	0.00	0.00	20.8 (EPA PRG)	NC
Thorium 232	1.0	31.49	188.96	0.00	0.00	0.00	19.8 (EPA PRG)	NC
Uranium (as U238)	66.60	2,097.46	12,584.79	0.24	0.09	0.33	4.42	3.88

*Total uranium value of 0.20 mg/L equals 66.6 pCi/L (assumes all total U is U-238)

*Assumes upper 2-inches of soil

*Assumes 115 pcf soil density

*Bold values = background; EPA 9 PRG is for Industrial Soil (mg/kg) and EPA PRGs are for Outdoor Worker Soil (pCi/g)

*EPA calculated background, EMF Site HHRA

ROB HARTMAN

12/05/2003 09:21 AM

To: Burges.Sylvia@epamail.epa.gov
cc: Meyer.Linda@epamail.epa.gov
cc: Meyer.Linda@epamail.epa.gov
Subject: Re: On-site water treatment and use option information

Sylvia: A revised Attachment 2 that shows the average monthly water application rate for dust control and the average monthly evaporation rate in inches is attached to this memo.

The formula for converting from gpm to inches per month is gpm x 60min/hr x 24hrs/day x 30(or 31) days/month = gallons/month x 1cubic foot/7.48 gallons x 1/application area for 2004 (or 2005) in square feet = feet water/unit application area x 12inches/1 foot = inches water/unit area per month. We added a footnote to Attachment 2 that states "Conversions of application rates from gpm to inches are based on application areas as shown on Attachment 3 (2,524,000 sq. ft. for 2004 and 2,738,000 sq. ft. for 2005)".

As you requested, we added monthly evaporation data to the Attachment. The values are based on a formula normally used to calculate evaporation from open water & use (e.g., irrigation), and data from the HELP files (used for HELP infiltration modelling for caps at the site) plus an assumed wind speed. The nearest historical pan evaporation data is from the Aberdeen Station (about 25 miles away), but the evaporation rate there appears to be significantly higher than we would expect for Pocatello. Thus, we used the more conservative site-specific evaporation rates.

As you can see the evaporation rate exceeds the application rate in all months except March 2005 when the application rate slightly exceeds the evaporation rate (0.46 inches). During May - September, the monthly evaporation rates far exceeds the application rates for dust control. Contact me if you have further questions.

Attach 2 Pumping Schedule PCDT - Rev12
Burges.Sylvia@epamail.epa.gov

Burges.Sylvia@epamail.epa.gov

12/03/2003 12:44 PM

To: rob_hartman@fmc.com
cc: Meyer.Linda@epamail.epa.gov
Subject: On-site water treatment and use option information

Rob, It's not clear to me how your water application rates compare to the expected evaporation rates. Can you provide a conversion factor from gpm to inches applied to your roads and other areas? [published pan evaporation data are generally available in inches] Thanks.

Sylvia Burges
RCRA Compliance Unit
(206) 553-1254 phone
(206) 553-2909 fax

ATTACHMENT 2. Pond Dewatering Pumping and Closure Construction Schedule (Revised 12/5/03)

POND	2004												2005											
	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
8E, PHASE IV, 15S, 16S																								
18																								
17																								
Average Pumping Rate [1]			50gpm	70gpm				40gpm	70gpm						70gpm		26gpm							
Construction Schedule																								
Water Truck Use [2] 7 days/week			41gpm	63gpm				63gpm	63gpm						63gpm		41gpm			41gpm				
Average Application (Inches/month) [3]			1.16	1.73	1.79	1.73	1.79	1.79	1.73	1.79					1.65	1.59	1.07	1.04	1.07	1.07	1.04	1.07		
																	Only ~3/4 treated water			Essentially all well water				
Average Evaporation (Inches/month) [4]			1.19	2.02	3.30	4.92	7.13	6.98	4.47	2.61					1.19	2.02	3.30	4.92	7.13	6.98	4.47	2.61		

Notes:

1. Each water truck use 20.8 gpm @ 10 hrs/day, 7 days/week.
2. A water truck operating 10 hours/day, 7 days/week will use an average of 20.8 gpm of water (on a 24 hours/day, 7 days/week basis).
3. Conversions of application rates from gpm to inches are based on application areas as shown on Attachment 3 (2,524,000 sq. ft. for 2004 and 2,738,000 sq. ft. for 2005).
4. The values are based on a formula normally used to calculate evaporation from open water & use, and data from the HELP files plus an assumed wind speed. The nearest historical pan evaporation data is from the Aberdeen Station (about 25 miles away), but the evaporation rate there appears to be significantly higher than we would expect for Pocatello.