WRPS-55821 -FP
Revision 0

Risk and Performance Analyses Supporting Closure of WMA C at the Hanford Site in Southeast Washington

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-08RV14800

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Risk and Performance Analyses Supporting Closure of Waste Management Area C at the Hanford Site in Southeast Washington – 14226

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ABSTRACT

The Office of River Protection under the U.S. Department of Energy (DOE) is pursuing closure of the Single-Shell Tank (SST) Waste Management Area (WMA) C as stipulated by the Hanford Federal Facility Agreement and Consent Order (HFFACO) under federal requirements and work tasks will be done under the State-approved closure plans and permits. An initial step in meeting the regulatory requirements is to develop a baseline risk assessment representing current conditions based on available characterization data and information collected at the WMA C location. The baseline risk assessment will be supporting a *Resource Conservation and Recovery Act of 1976* (RCRA) Field Investigation (RFI)/Corrective Measures Study (CMS) for WMA closure and RCRA corrective action. Complying with the HFFACO conditions also involves developing a long-term closure Performance Assessment (PA) that evaluates human health and environmental impacts resulting from radionuclide inventories in residual wastes remaining in WMA C tanks and ancillary equipment. This PA is being developed to meet the requirements necessary for closure authorization under DOE Order 435.1 and Washington State Hazardous Waste Management Act. To meet the HFFACO conditions, the long-term closure risk analysis will include an evaluation of human health and environmental impacts from hazardous chemical inventories along with other performance Comprehensive Environmental Response, Compensation, and Liability Act Appropriate and Applicable Requirements (CERCLA ARARs) in residual wastes left in WMA C facilities after retrieval and removal. This closure risk analysis is needed to needed to comply with the requirements for permitted closure.

Progress to date in developing a baseline risk assessment of WMA C has involved aspects of an evaluation of soil characterization and groundwater monitoring data collected as a part of the RFI/CMS and RCRA monitoring. Developing the long-term performance assessment aspects has involved the construction of detailed numerical models of WMA C using the Subsurface Transport Over Multiple Phases (STOMP©) computer code, the development of a technical approach for abstraction of a range of representative STOMP© simulations into a system-level model based on the GoldSim© system-level model software. The STOMP©-based models will be used to evaluate local-scale impacts and closed facility performance over a sufficient range of simulations to allow for development of the system-level model of the WMA C. The GoldSim©-based system-level model will be used to evaluate overall sensitivity of modeled parameters and the estimate the uncertainty in potential future impacts from a closed WMA C facility.

INTRODUCTION

The U.S. Department of Energy, Office of River Protection (DOE-ORP) is pursuing closure on the Single-Shell Tank (SST) Waste Management Area (WMA) C under federal requirements and forthcoming State-approved closure plans and permits in accordance with the HFFACO, Action Plan, Appendix I. Current baseline plans at the Hanford Site (Figure 1) call for closure of the WMA C in the year 2019. WMA C is part of the SST system in the 200 East Area of the Hanford Site and is one of the first four of the first tank farm areas built at the Hanford Site in 1944. Environmental releases have occurred in the past to the underlying vadose zone in vicinity of the WMA C. Notable facilities to be addressed in the closure of WMA C include 12 large SSTs each with a capacity of 2 x 10^{+6} L (530,000 gal), four smaller SSTs each with a capacity of 2 x 10^{+5} L (55,000 gal), a catch tank, a vault with 4 tanks, seven diversion boxes, and about seven miles of pipelines (Figure 1). Past releases in previous operational periods include fourteen unplanned releases to the soil have been recorded. To date, eleven of the sixteen single-shell tanks at WMA C have had the previously stored waste removed (retrieved) including 241-C-101, 241-C-103, 241-C-104, 241-C-106, 241-C-108, 241-C-109, 241-C-110, 241-C-201, 241-C-202, 241-C-203, and 241-C-204. Three other tanks (241-C-107, 241-C-111, and 241-C-112 are in varying phases of retrieval, and two remaining tanks (241-C-102 and 241-C-105) are undergoing placement of retrieval equipment in anticipation of starting active retrieval.

In order to close WMA C, both tank and related facility closure activities and corrective actions associated with existing soil contamination must be performed. These actions must meet all applicable or relevant and appropriate laws and regulations including permit conditions. Closure is supported by various types of risk assessments and interim performance assessments (PA). The Richland Operations Office of DOE (DOE-RL) will close other facilities near WMA C and will be responsible for completing a CERCLA Remedial Investigation and Feasibility Study for remediating contaminated groundwater in the areas surrounding and beneath WMA C. DOE-RL also has the responsibility for producing the Hanford Site Composite Analysis, which discusses the impacts from all sources at the Hanford Site.

These risk and performance assessment results will be used to support decisions on the potential use of corrective measures for contaminated soils beneath WMA C and the final design and configuration of the closed WMA C facilities prior to site closure. With respect to WMA C, a baseline risk assessment is required to support *Resource Conservation and Recovery Act of 1976* (RCRA)[1] and *Hazardous Waste Management Act of 1976*[2] decisions associated with non-radiological contamination. The single WMA C HFFACO PA is also required to meet DOE Order 435.1[3, 4, and 5] to support decisions about closure activities at facilities with radioactive waste, as well as waste determination evaluations for waste incidental to reprocessing that will potentially be left in SSTs after closure.

The final WMA C PA will be based on final decisions on a preferred alternative for landfill closure that will follow the issuance of the Record of Decision (ROD) for the final Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS). The final TC&WM EIS [6] was issued in December 2012 and the Record of Decision is anticipated to be forthcoming.

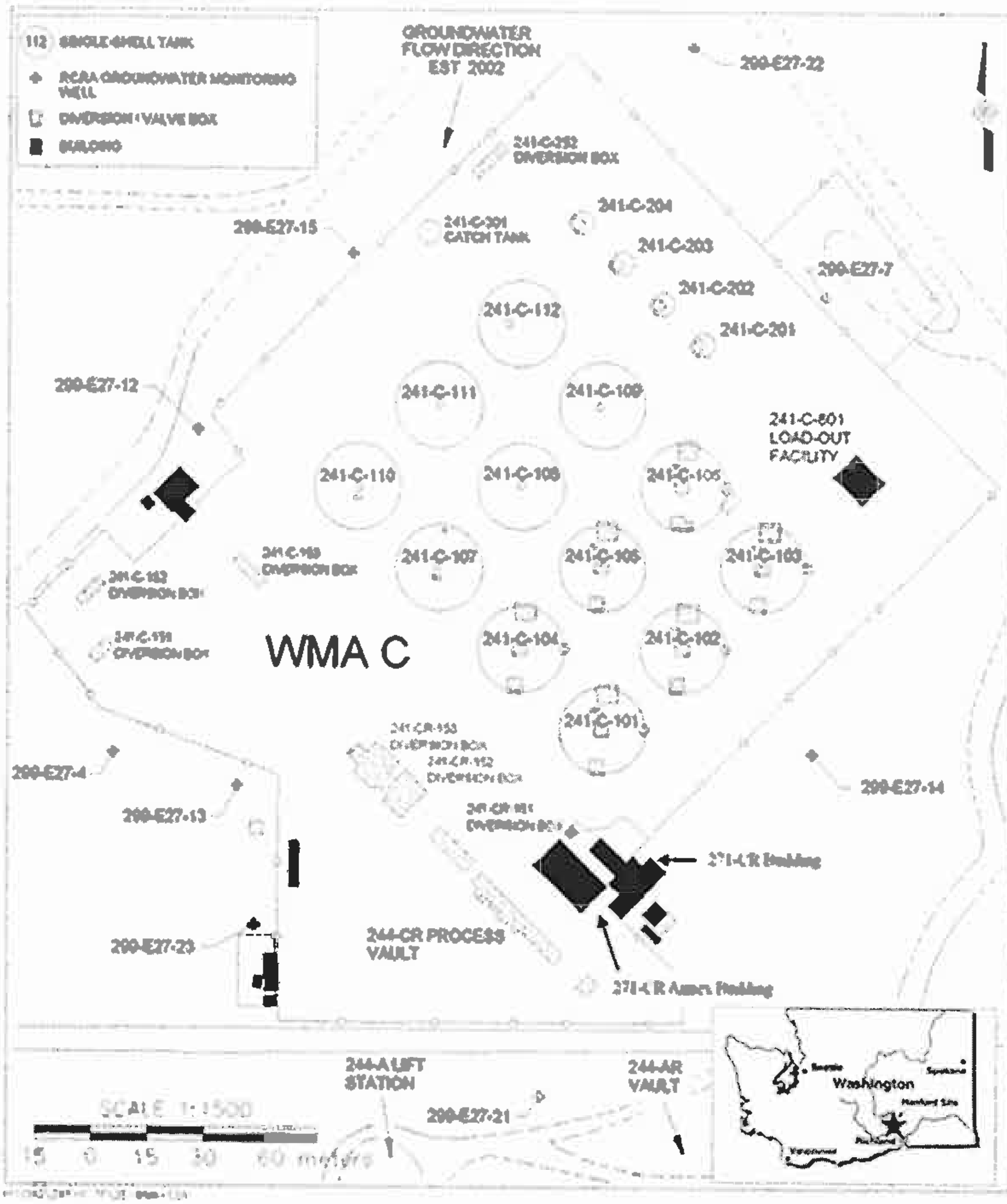

Figure 1. Single-Shell Tanks and Related Facilities in Waste Management Area C in 200 East Area of the Central Plateau of the Hanford Site.

BACKGROUND

The development of the performance assessment was initiated in a scoping process that was sponsored by the U.S. Department of Energy, Office of River Protection (DOE-ORP) and the State of Washington Department of Ecology (Ecology). The scoping process comprised of a series of working sessions attended by regulators and stakeholders to solicit input and to obtain a common understanding. Specifically, input regarding the scope, methods, and data to be used in the planned risk assessments and PAs to support closure of WMA C was obtained. The DOE-ORP and contractors along with Ecology staff held working sessions that included representatives from the U.S. Environmental Protection Agency (EPA), the U.S. Nuclear Regulatory Commission (NRC), Oregon Department of Energy, interested Tribal Nations, other stakeholders groups, and members of the interested public including the Hanford Advisory Board. NRC staff involvement in the working sessions is as a technical resource for required waste determinations by DOE for waste incidental to reprocessing per DOE Order 435.1 since the State of Washington is not a participant in the Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005, Section 3116 [7]. This assessment will need to address whether the waste determinations are based on sound technical assumptions, analyses, and conclusions relative to applicable incidental waste criteria. A summary of topics, dates, and products developed in the working sessions is provided in Table 1.

Table 1. Summary of Working Sessions and Products Completed as a Part of the WMA C PA Scoping Process

Session Number	Working Session Topic	Working Session Dates	Products
1.	**Tank Residual Inventories following Retrieval**	May 5-7, 2009	**RPP-RPT-42323, Rev. 1** Hanford C-Farm RPP-RPT-42323, Rev. 1 Hanford C-Farm tank and Ancillary Equipment Residual Waste Inventory (March 2010)[8]
2.	**Performance Assessment Context and General Conceptual Models**	Sept. 1-3, 2009	**RPP-RPT-41918, Rev. 0** Assessment Context for Performance Assessment for Waste in C Tank Farm Facilities after Closure (March 2010) [9]
3.	**Soil Inventories from Past Releases**	Oct. 27-29, 2009	**RPP-RPT-42294, Rev. 1** Hanford Waste Management Area C Soil Inventory Estimates (May 2010) [10]
4.	**Man-Made System #1** (Detailed conceptual models of recharge, barrier degradation, and tank residual waste release)	Jan. 26-28, 2010	**RPP-RPT-44042, Rev. 0** Recharge and Waste Release within Engineered System in Waste Management Area C (May 2010) [11]
5.	**Review of Conceptual Model(s) and Key Features, Events, and Processes for Man-Made and Natural Systems**	Mar. 30- April 1, 2010	**RPP-RPT-44137, Rev. 0** Process for Identification of Features, Events and Processes (FEPs) Applicable to the Waste Management Area C Performance Assessment (December 2009) [12]
6.	**Natural System** (Detailed conceptual models of near surface	May 25-27, 2010	**RPP-RPT-46088, Rev. 1** Flow and Transport in the Natural System at

	environmental, vadose zone, and groundwater systems)		Waste Management Area C (August 2010) [13]
7.	**Man-Made System #2** (Detailed conceptual models of steel corrosion/degradation, grout degradation for tanks and related facilities)	July 27-29, 2010	**RPP-RPT-46879, Rev. 2** Corrosion and Structural degradation within Engineered System in Waste Management Area C (February 2011) [14]
8.	**Exposure Scenarios** (Detailed conceptual models and data associated with exposure scenarios)	Sept. 28-30, 2010	**RPP-RPT-47479 Rev 1.** Exposure Scenarios for the Waste Management Area C Performance Assessment **(Sept. 2010)** [15]
9.	**Selection and Application of Risk Assessment and Performance Assessment Numerical Codes**	Jan. 25-27, 2011	**RPP-RPT-48490, Rev. 1** Technical Approach and Scope for Flow and Contaminant Transport Analysis in the Initial Performance Assessment of Waste Management Area C (May 2011) [16]
10	**Ecosystem Risk Assessment**	May 17-19, 2011	**RPP-RPT-49425 Rev 1.** Ecological Risk Assessment Approach for Hanford Waste Management Area C (Sept. 2011) [17]

DEVELOPMENT OF BASELINE RISK ASSESSMENT

The objective of WMA C baseline risk assessment is to provide a risk analysis to support an overall determination of whether RCRA corrective actions are warranted for vadose zone soils contaminated by past waste releases from WMA C prior to facility closure. In the baseline Risk Assessment (BRA), soil concentration will be evaluated against soil cleanup levels from the State of Washington Model Toxics Control Act (MTCA) Method B Soil Cleanup Levels ("Unrestricted Land Use Soil Cleanup Standards" [WAC 173-340-740])[18] and EPA's Residential Proposed Remedial Goals (PRGs) for radionuclides (Preliminary Remediation Goals for Radionuclides [EPA, 2000b [19]; ECF-HANFORD-10-0429, REV. 1[20]]) to determine if any action is required. Results from exposure scenarios representing reasonably anticipated future land use will be used to determine potential risks considering DOE access restrictions and institutional controls. Results from additional scenarios (e.g.. Native American Scenarios) are provided to support risk-informed decisions. References for the Native American scenarios include:

- *Exposure Scenario for Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Traditional Subsistence Lifeways* (Harris 2004)[21]
- *Application of the CTUIR Traditional Lifeways Exposure Scenario in Hanford Risk Assessments* (Harris 2008) [22]
- Yakama Nation Exposure Scenario for Hanford Site Risk Assessment (Ridolfi 2007) [23]

Results of screening evaluation of soil concentrations against ecological soil cleanup levels will be used to determine if soil concentrations in the vadose zone at WMA C have the potential to adversely affect ecological receptors. Results from a screening evaluation of local groundwater monitoring data will also be used to determine if vadose zone contamination from past releases at WMA C have impacted groundwater.

In preparation for performing the baseline risk assessment, a preliminary evaluation of analytical results for samples collected in the vadose zone and groundwater has been conducted. A description of this evaluation is provided in the following sections.

Preliminary Evaluation of Vadose Zone Characterization Data

The data assessment and screening report follows regulatory guidance from the U.S. Environmental Protection Agency (EPA) (*Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) : Interim Final* (RAGS) [EPA/540/1-89/002] [23]; U.S. Environmental Protection Agency (EPA), *Pro UCL Version 4.00.05 Technical Guide*, [EPA/600/R-07/041] [25]; and Washington State Department of Ecology (Ecology) "Model Toxics Control Act—Cleanup," (MTCA) (WAC 173-340) [26].

The methodology used to process and reduce the data set, the tools used to calculate the 95% UCL for each analyte detected in each sample location grouping, and the logic used to determine the final exposure point concentrations (EPC) for each analyte within each sample location grouping in the WMA C are as follows:

- Obtain the data set of analytical results collected during the characterization of the vadose zone sediments as a part of the RFI/CMS. The location of the 14 boreholes where vadose zone samples were collected as a part of this study is provided in Figure 2.
- Identify the unique sample numbers within the data set associated with each set of vadose zone sample location groupings within the WMA C based a shared purpose for characterization. The vadose zone sample location groupings and their purposes are summarized in Table 2. For the purpose of this assessment, these groupings were also further grouped in a shallow vadose zone group represented by samples collected from 0 to 4.6 m (0 to 15 ft) belowground surface (bgs) and a deep vadose zone group represented by samples collected from depths greater than 4.6 m (15 ft) bgs.
- Process the data set to remove results meeting specific exclusion criteria.
- Process the data set to remove results associated with redundant analytical methods.
- Process parent and duplicate results within the data set to a single set of results per sample location.
- Process the data set to remove those analytes that were not detected in any of the samples from the WMA C.
- Process specific results in the data set by each decision unit, and running specific results through ProUCL 4.00.05 and obtaining the UCL and raw statistics output files.
- Summarize the ProUCL 4.00.05 statistical results for detected analytes by sample location grouping.
- Determine the EPC for each detected analyte for each sample location groupings.

This approach was selected to help maximize the available soil concentration data for conservatively estimating exposure point concentrations (EPC) based on all applicable soil data for use in the data processing and initial risk evaluations. The data processing effort was focused on obtaining a comprehensive set of soil contamination data for the purposes of establishing summary statistics, calculating EPCs, and conducting initial risk screening.

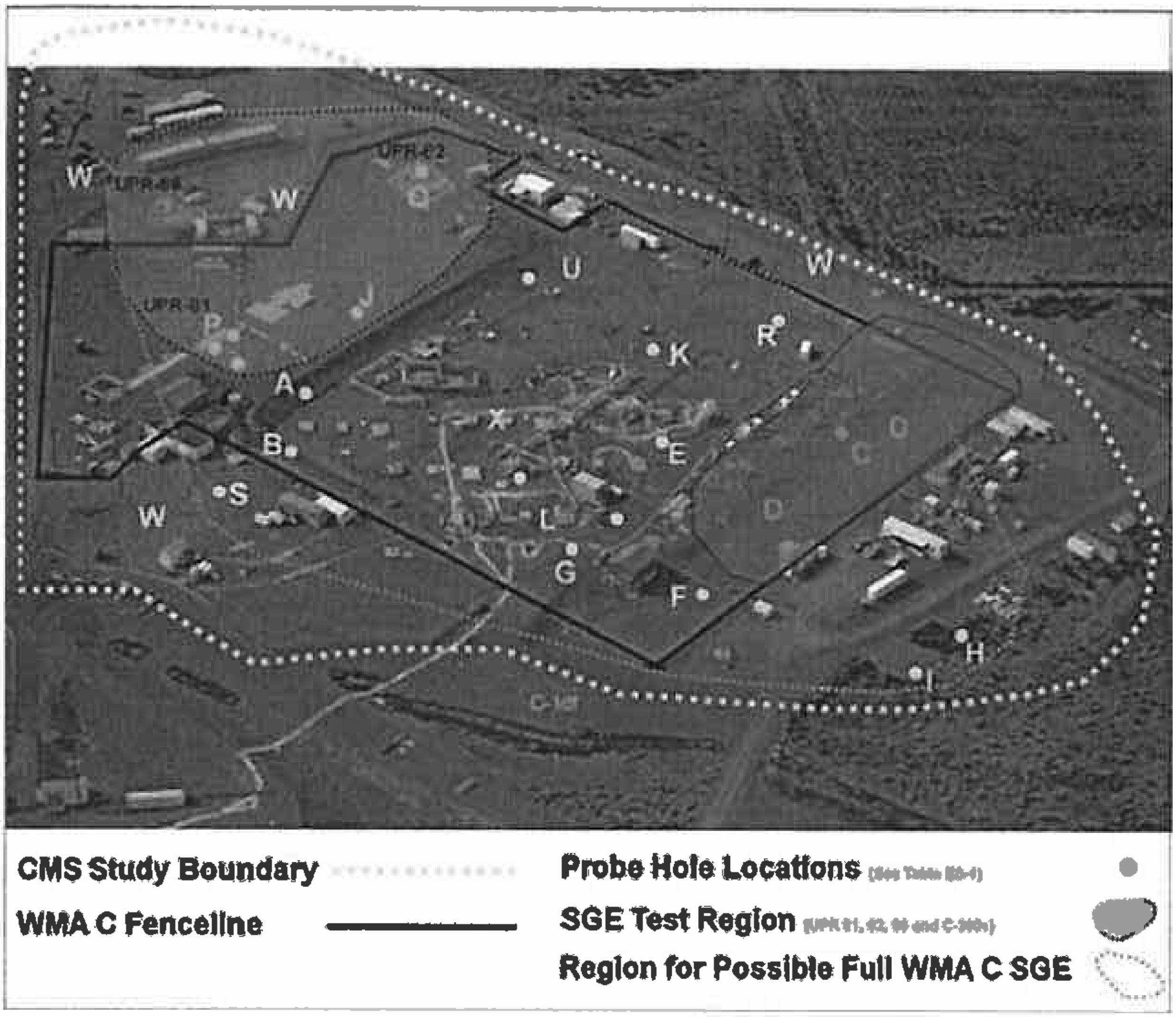

Figure 2. Locations at Waste Management Area C where Vadose Zone was sampled as a Part of the RCRA Field Investigation/Corrective Measures Study (adapted from RPP-PLAN-39114, Rev. 2) [27]

Table 2 Summary of Vadose Zone Sample Location Groupings and the Purpose for the Sampling at these Locations

Vadose Zone Sample Location Groupings	Purpose of Sampling
A + B	Characterize suspected past releases from C-101single-shell tank
C	Characterize suspected past releases from C-200 Series single-shell tanks
E	Characterize suspected past releases in areas between C-106 & C-109 single-shell tanks
F + G	Characterize suspected past releases of PUREX waste near building C-801and associated chemical drain and C-103 single shell tank
H + I	Characterize near surface unplanned releases from UPR- 91 and UPR-115
J	Characterize suspected past releases near C-104single-shell tank
L1 + L2	Characterize suspected past line leak and tank overfill releases between C-103 and C-106 single-shell tanks
P	Characterize suspected past unplanned release near UPR-81
R	Assess potential past release near C-301catch tank
U	Characterize suspected past releases near C-110 single-shell tank

Results of the soil concentration data processing and reduction of the WMA C vadose zone characterization data set is summarized in Figure 3. Processing the initial WMA C data set of soil concentration that contained 29,166 records for 371 analytes, resulted in final data set of 12,234 records of 208 analytes used for the EPC calculations.

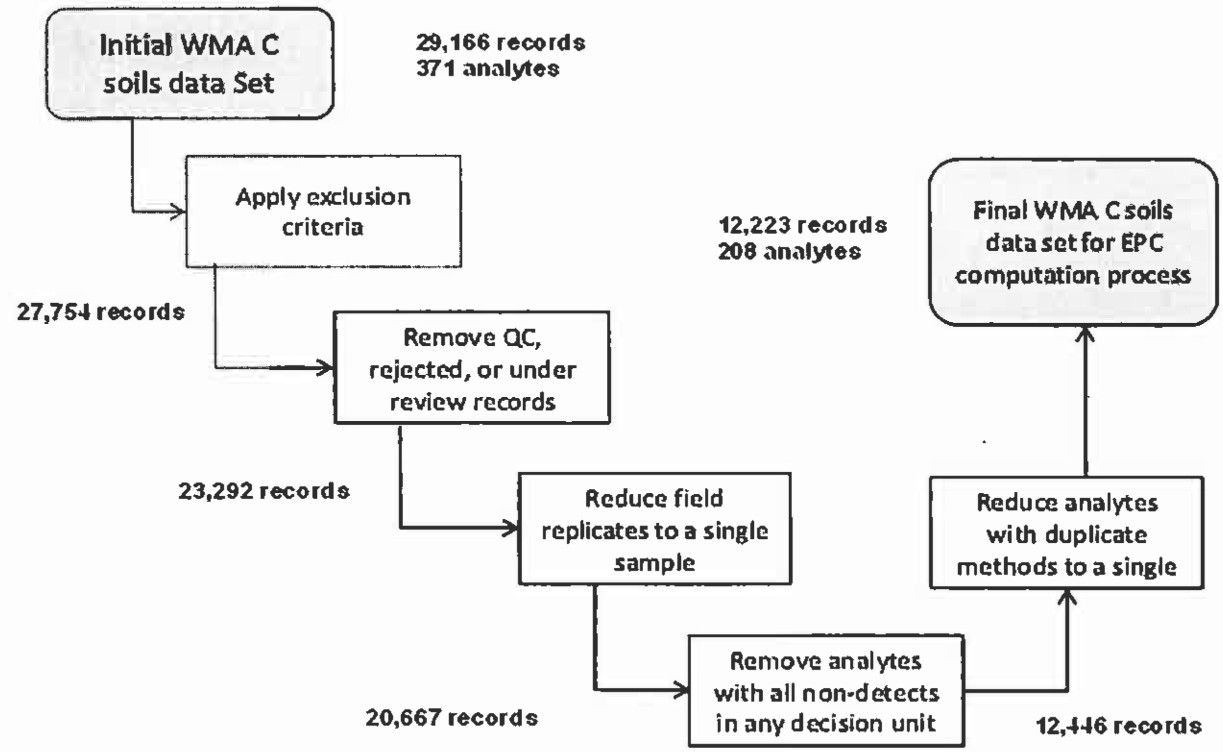

Figure 3. Results of Data Processing of Soil Characterization Data Collected at Waste Management Area C

Exposure Point Concentration Calculation Methodology

In the final set of soil concentrations for each the vadose zone sample location groupings, 95% UCL values of exposure point concentrations (EPCs) were calculated using OSWER Publication 9285.7-081[28], which only addresses data distributions that are either normal or lognormal. OSWER 9285.6-10[29] provides alternative methods for calculating the UCLs; these methods can be used, subject to the discretion of the regulatory agencies and programs involved. OSWER 9285.6-10 is the most recent EPA guidance for UCL calculation, and ProUCL 4.00.05 serves as the companion software package for this guidance. ProUCL 4.00.05 contains rigorous parametric and nonparametric statistical methods (including bootstrap methods) that can be used on data sets of soil concentration without non-detect results and on data sets of soil concentrations with non-detect results (results reported below detection limits). Both ProUCL and OSWER 9285.6-10 were used to calculate UCLs for the WMA C.

Comparison of Calculated EPCs with Natural Background Concentrations

The methodology used for comparing background soil concentrations is consistent with EPA (EPA/600/R-07/041[30]; OSWER Directive 9285.6-07P[31], and EPA/540/R-01/003) [32] and Ecology guidance documents (WAC 173-340-709) [33].

Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (EPA 540-R-01-003) [34] defines background constituents as the following: anthropogenic—natural and artificial substances present in the environment as a result of human activities (not specifically related to the CERCLA release in question), and naturally occurring—substances present in the environment in forms that have not been influenced by human activity.

Background concentration data in soil are available for a variety of analytes (both for metals and radionuclides). For most analytes, background values will be selected from a Hanford Site-specific background data set. Where Hanford Site-specific background data are not available, a data set of background soil concentrations for Washington will be used. *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites* (EPA 540-R-01-003) [34] provides national policy considerations for application of background data in risk assessment and remedy selection. This policy recommends an approach that addresses site-specific background issues in the risk characterization.

Key references for Hanford soil background concentrations for chemical and radionuclides include the following;

- *Soil Background Data for Interim Use at the Hanford Site* (ECF-HANFORD-11-0038), [35]
- *A Review of Metal Concentrations Measured in Surface Soil Samples Collected on and Around the Hanford Site* (hereinafter called Review of Metal Concentrations [PNNL-18577]). [36]
- Non-radionuclide Soil Background document (DOE/RL-92-24) [37]
- Radionuclide Soil Background document (DOE/RL-96-12) [38]
- *Natural Background Soil Metals Concentrations in Washington State* (Ecology Publication 94-115) [39]
- *Soil Background Data for Interim Use at the Hanford Site* (ECF-HANFORD-11-0038) [40]

Background soil concentrations for selected constituents for the Hanford Site are provided in Table 3.

Comparison of EPCs with selected Risk Based Screening Levels

For identifying contaminants that may pose an adverse effect for human health and to be consistent with EPA RAGS (EPA/540/1-89/002) [41], data will be compared to EPA Residential PRGs for radionuclides (Preliminary Remediation Goals for Radionuclides [EPA, 2000b [42]; ECF-HANFORD-10-0429, REV. 1] [43]). For radiological screening, the rural residential scenario evaluates radiological contaminants through direct contact and food chain pathways. Food chain pathways include the consumption of fruits and vegetables grown in a backyard garden, and consumption of meat and milk from livestock raised around the site. Consistent with other risk assessments at the Hanford Site, the RESRAD code was used to evaluate exposure to radiological contaminants in vadose zone material. A detailed description of this exposure scenario is published in the 100 Area RDR/RAWP (DOE/RL-96-17) [44].

Table 3. Background Data for Selected Constituents for the Hanford Site.

Analyte Name	Analyte Symbol	Analyte Class	Units	Lognormal 90th Percentile Background Value	Maximum Background Value	Source of Background Value
Cesium-137	Cs-137	RAD	pCi/g	1.1	1.6	DOE/RL-96-12, Rev. 0
Strontium-90	Sr-90	RAD	pCi/g	0.18	0.37	DOE/RL-96-12, Rev. 0
Arsenic*	Ar	Metal	μg/kg	6,470	27,700	DOE/RL-92-24, Vol. 1, Rev. 4
Cadmium*	Cd	Metal	μg/kg	563	2,900	ECF-HANFORD-11-0038
Chromium	Cr	Metal	μg/kg	18,500	320,000	DOE/RL-92-24, Vol. 1, Rev. 4
Uranium	U	Metal	μg/kg	3,210	4,042	Isotopic Activity Conversion based on DOE/RL-96-12 values
Nitrate	NO_3	Anion	μg/kg	52,000	906,000	DOE/RL-92-24, Vol. 1, Rev. 4

* Dangerous waste constituent per *Washington Administrative Code* 173-303-9905, "Dangerous Waste Constituents List."

References:

DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analyte*, Rev. 4, Volume 1.
DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, Rev. 0.
ECF-HANFORD-11-0038, *Soil Background Data for Interim Use at the Hanford Site.*
Ecology Publication #94-115, *Natural Background Soil Metals Concentrations in Washington State.*

For chemicals and metals, results will be assessed using the MTCA Method B Soil Cleanup Levels ("Unrestricted Land Use Soil Cleanup Standards" [WAC 173-340-740]) [17]. The MTCA (WAC 173-340) Method B levels are based solely on incidental soil ingestion. This exposure scenario is developed for protection of human health and is based on the MTCA "Method B Soil Cleanup Levels for Unrestricted Land Use" (WAC 173-340-740(3)) and Standard "Cleanup Standards to Protect Air Quality," "Method B Air Cleanup Levels" (WAC 173-340-750(3)) [44]. These MTCA soil cleanup levels are based on exposure to a child receptor that includes incidental ingestion, and use residential exposure frequency and duration assumptions. The MTCA air cleanup levels are based on exposure to a child and adult receptor, include inhalation of vapors and dust in ambient air, and assume residential exposure frequency and duration assumptions.

For carcinogens, the screening value will equal the RSL at 10^{-6} target risk and for non-carcinogens the screening values will equal the RSL divided by 10 in order to address potential cumulative health effects at sites with multiple contaminants.

For chemicals and metals, EPCs are also compared soil screening levels protective of groundwater based on the use of the Fixed Parameter Three-Phase Partitioning Model, as defined in regulations promulgated under the State of Washington Model Toxics Control Act (MTCA) (Washington Administrative Code [WAC] Chapter 173-340-747, "Deriving Soil Concentrations for Groundwater Protection") [46]. This model is used to calculate a set of soil cleanup or screening levels protective of groundwater.

Preliminary Evaluation of Groundwater Monitoring Data

A similar evaluation of groundwater concentration results from groundwater monitoring data collected in 15 wells between 2003 and 2013 in vicinity of WMA C (See Figure 4) between 2003 and 2013 has also been undertaken. The methodology that was followed to process and reduce the data set was the similar to what was done for the vadose characterization. However, once the data processing and reduction was completed, EPCs were not determined for each well. In lieu of using calculated EPCs, each of the individual monitoring well analyte results were compared to background concentration levels and established maximum concentration limits established for groundwater protection.

Hanford Soil background concentrations for chemical and radionuclides in groundwater were taken from *Hanford Site Background: Part 3, Groundwater Background,* DOE/RL-96-61 Rev.0 [47].Background groundwater concentrations for selected constituents for the Hanford Site are provided in Table 4.

Results of the data processing and reduction of the WMA C groundwater monitoring data set is summarized in Figure 5. Processing the initial WMA C data set that contained 42,209 records for 310 analytes, resulted in final data set 19,760 records of 81 analytes used for used in the comparisons with background and established maximum concentration limits.

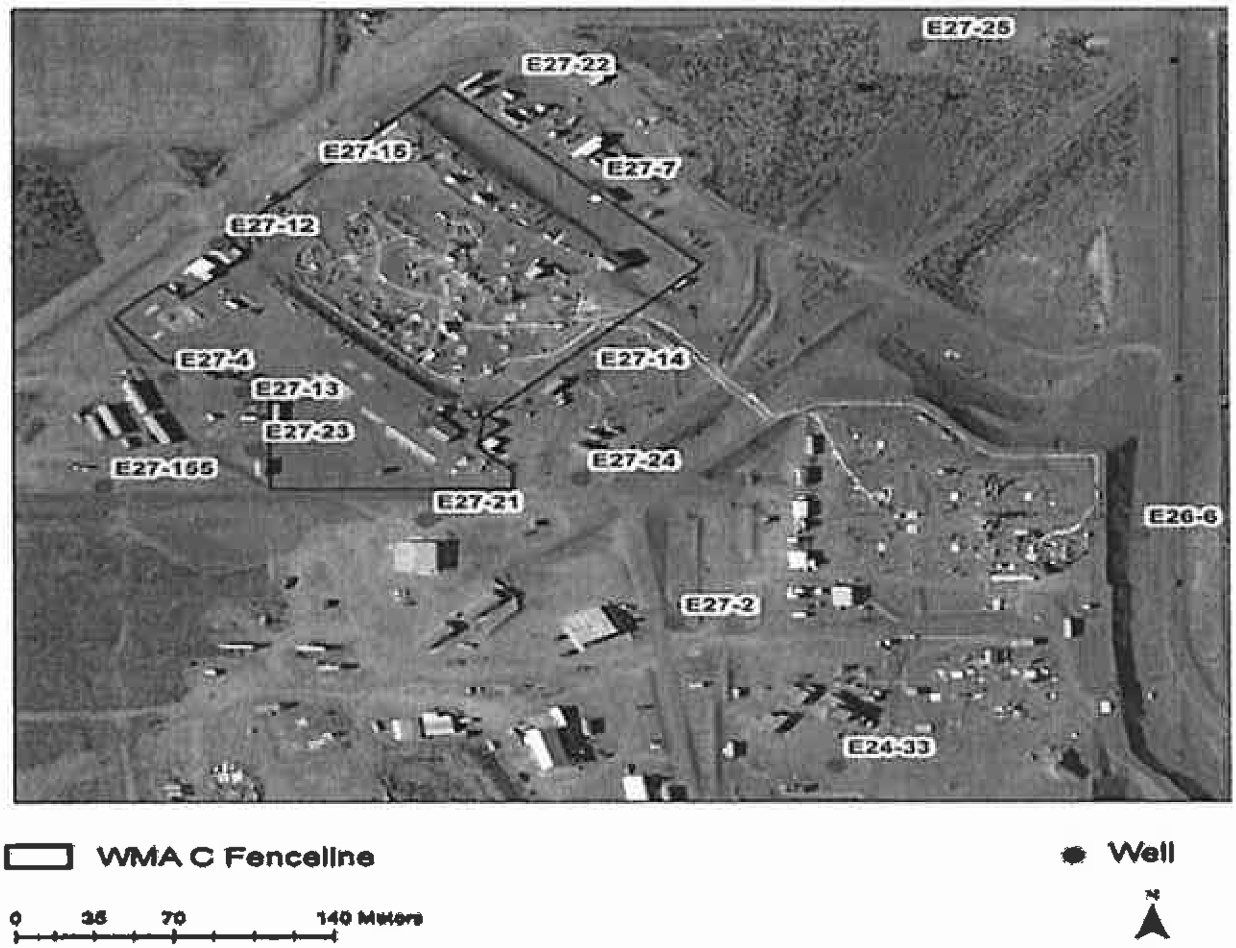

Figure 4. Location of Groundwater Monitoring Wells in Vicinity of Waste Management Area C

Table 4. Background Groundwater Concentrations for Selected Constituents for the Hanford Site

Analyte Name	Analyte Class	Units	Lognormal 90th Percentile Background Value	Source of Background Value
Americium-241	RAD	pCi/L	0.000077	DOE/RL-96-61 Rev.0, Table ES-1
Cesium-137	RAD	pCi/L	8.576	DOE/RL-96-61 Rev.0, Table ES-1
Iodine-129	RAD	pCi/L	0.0000009	DOE/RL-96-61 Rev.0, Table ES-1
Strontium-90	RAD	pCi/L	0.00103	DOE/RL-96-61 Rev.0, Table ES-1

Analyte Name	Analyte Class	Units	Lognormal 90th Percentile Background Value	Source of Background Value
Technetium-99	RAD	pCi/L	0.83	DOE/RL-96-61 Rev.0, Table ES-1
Arsenic	METAL	ug/L	7.85	DOE/RL-96-61 Rev.0, Table ES-1
Cadmium	METAL	ug/L	0.916	DOE/RL-96-61 Rev.0, Table ES-1
Cyanide	Inorganic	ug/L	8.41	DOE/RL-96-61 Rev.0, Table ES-1
Lithium	METAL	ug/L	11.321	DOE/RL-96-61 Rev.0, Table 5-2 (Table ES-1 off by 1E+03 for lithium)
Nitrate	Inorganic	ug/L	26871	DOE/RL-96-61 Rev.0, Table ES-1
Oxalate	Non-RAD	ug/L	287	DOE/RL-96-61 Rev.0, Table ES-1
Sulfate	Inorganic	ug/L	47014	DOE/RL-96-61 Rev.0, Table ES-1
Tritium	METAL	pCi/L	119	DOE/RL-96-61 Rev.0, Table ES-1
Uranium	METAL	ug/L	9.85	DOE/RL-96-61 Rev.0, Table ES-1
Sodium	METAL	ug/L	26,998	DOE/RL-96-61 Rev.0, Table ES-1

Reference

DOE/RL-96-61, Rev. 0, *Hanford Site Background: Part 3, Groundwater Background.*

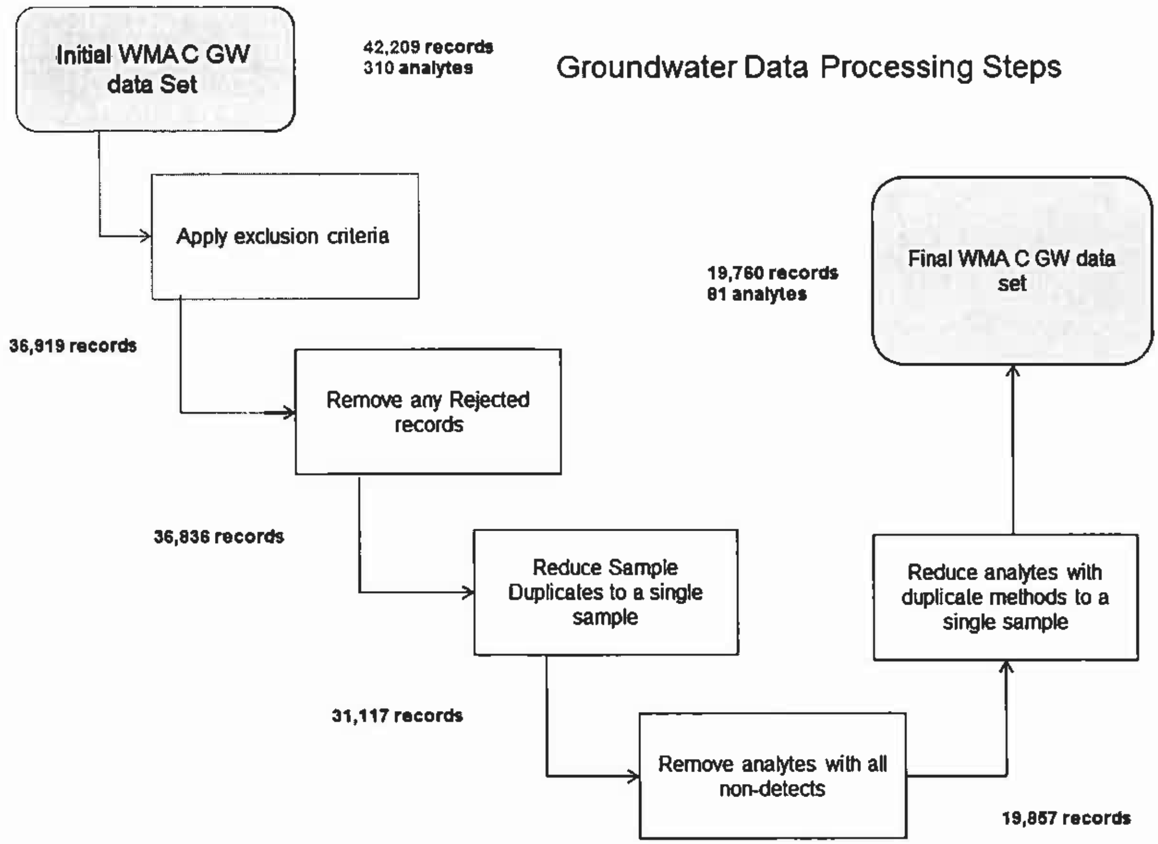

Figure 5. Results of Data Screening Evaluation of Groundwater Monitoring Data at Waste Management Area C

DEVELOPMENT OF WMA C PERFORMANCE ASSESSMENT

The Initial PA of WMA C at Hanford will assess the fate and transport of radionuclides and hazardous chemicals within residual wastes left in tanks and ancillary equipment and facilities in their assumed closed configuration, and the subsequent risks to humans into the far future. The assumed closure configuration must meet the requirements defined in WAC 173-303-610 and 173-303-665, "Landfills" [48] and DOE O 435.1 (RPP-RPT-41918, Rev 0) [8]. Given hypotheses about the natural and engineered materials that exist in the subsurface at WMA C, and about future scenarios for the infiltration of water, calculations can be made to estimate contaminant fate and transport. The PA will be used to produce estimates of concentrations and a variety of performance metrics, which include radiological doses and risk from hazardous chemicals. The end result of these fate and transport calculations is to produce time-dependent estimates of contaminant concentrations in media to which humans may be exposed. From that point, a performance or a risk assessment will apply various human exposure scenarios in order to arrive at estimates of potential future risks.

The Initial PA of WMA C at Hanford will be supported by a variety of modeling approaches. These will include process-specific models that address particular transport mechanisms and an integrative system-level model that will summarize the entire system, from environmental transport to dose or risk. While the modeling that will support the PA considers a wide range of processes contributing to contaminant transport and exposure pathways, this description of the proposed technical approach is focused on the hydrogeological aspects of flow and contaminant transport. That includes transport in porous media at the site, including consideration of air, water, and solid phases of engineered media such as grout and environmental media such as unsaturated and saturated geologic strata.

The PA model analysis will make use of a combination of process and systems models depicted in Figure 6. The STOMP©[1] [49, 50]-based process model will be used in the analysis of post-closure flow for both the unsaturated and saturated systems. The groundwater part of analyses in the Initial PA will be focused on the local-scale impacts at WMA C and not for a regional scale. The groundwater impacts will be evaluated at either the WMA C fence line or within 100 m down gradient of WMA C. The STOMP©-based will be uses deterministically to examine a range of model parameters through sensitivity analyses.

The flow field from the STOMP© process-level model will then be extracted and abstracted to the system-level model based on the GoldSim© software[2]. The STOMP©-based model will be used to characterize the flow for two periods of time: when the engineered barrier system at closure is intact and when it is degraded. The model will be run for a number of sensitivity cases that will allow full characterization of the parameter uncertainties during each of those time periods. The sensitivity cases will be chosen to allow the development of a response surface that characterizes the response of the flow field to changes in input parameters. This response surface will then be used as an input to the probabilistic application of the system- model.

The broad range of process-level flow models will be integrated into a system-level model that considers them collectively, and will ultimately include other processes as well. The system model, populated with uncertain inputs, will eventually run in probabilistic fashion exploring the space of uncertainty through a large number (perhaps thousands) of independent realizations. By running the system-level model in this fashion, a great deal can be learned about the system. The most significant input parameters can be identified, which, in turn, would reveal the parts of the model that are the most uncertain and the most important. With this information, studies can be directed to reduce uncertainty, if it is unacceptable, and the model can be updated and rerun.

As a starting point, the PA effort will make use of local-scale three-dimensional model(s) of the WMA C area that were developed to support the Tank Closure Waste Management Environmental Impact Statement (TC-WM EIS) [6]. These sub models have undergone a thorough evaluation and will be adapted and modified to meet the needs of PA requirements as defined in Appendix I of HFFACO and DOE Order 453.1. These adaptations and modifications will include:

- To satisfy the objectives of the PA for a local-scale impact analysis, the EIS model domain will be necessary will be extended into saturated zone beneath the WMA C. Model domain of the EIS model of WMA C is only extended the top of the local water table and loads simulated contaminated from this local-scale model of WMA C to a regional groundwater flow and transport model to calculate groundwater impacts.

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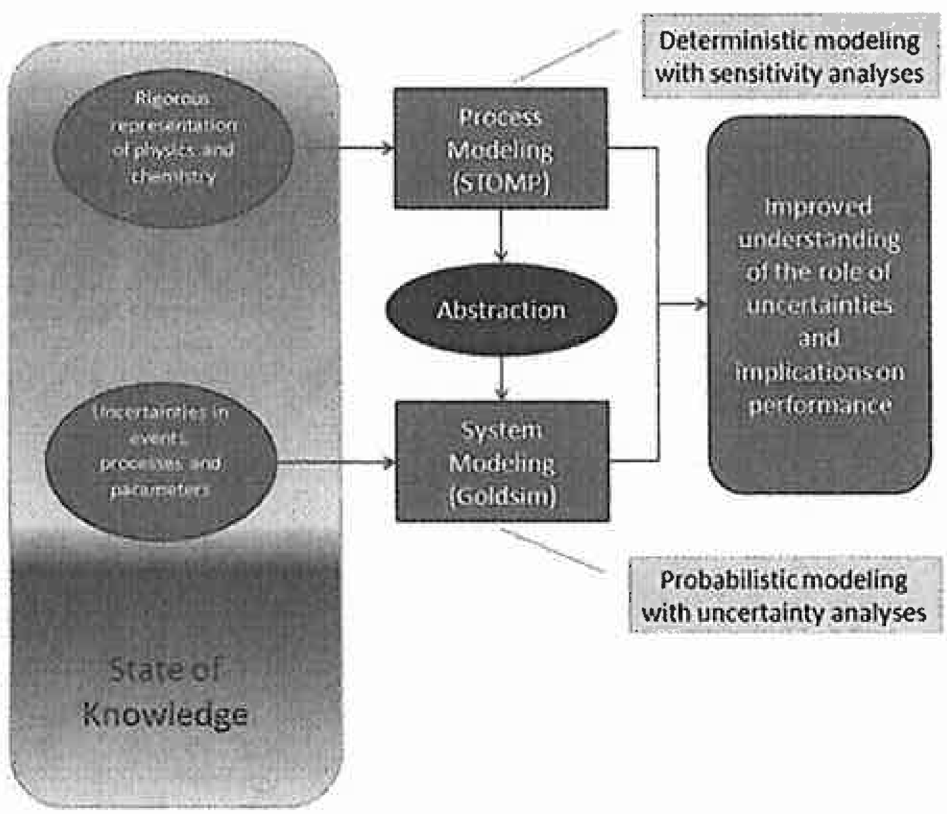
[1] Subsurface Transport Over Multiple Phases (STOMP) is copyrighted by Battelle Memorial Institute, 1996.

[2] GoldSim simulation software is copyrighted by GoldSim Technology Group LLC of Issaquah, Washington (see http://www.goldsim.com

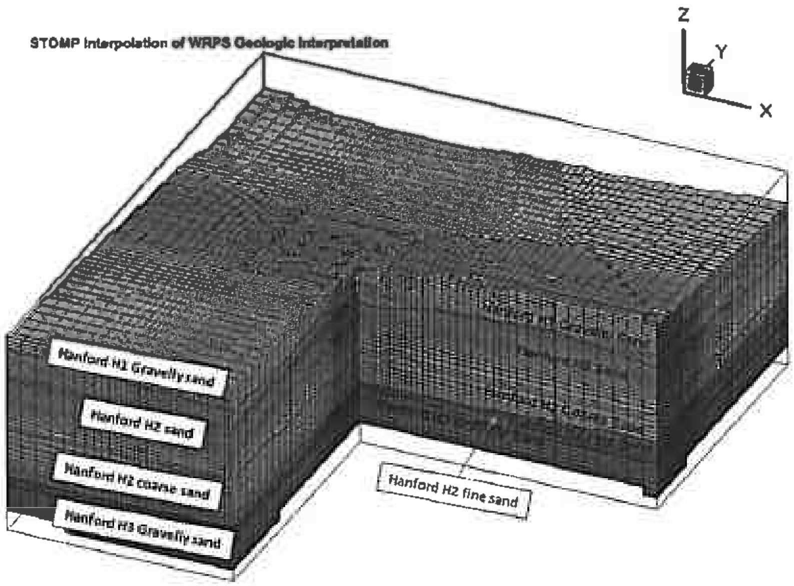
- Discretization of the EIS models of WMA C may require some grid resolution enhancement (i.e. smaller grid blocks) as necessary to minimize the effects of numerical dispersion, to maximize numerical convergence, and to represent smaller system features within WMA C.
- Stratigraphy and related hydraulic properties will be updated to reflect RFI/CMS information collected and recent re-interpretations of the hydrogeological framework of the WMA C area.
- Tank residual inventories will need to be updated to reflect the current status of tank waste retrievals and will be simulated at greater detail than the EIS with each tank and its related inventory represented separately.
- Evaluation of several contaminant release mechanisms; including partition limited advection, solubility, and diffusional release

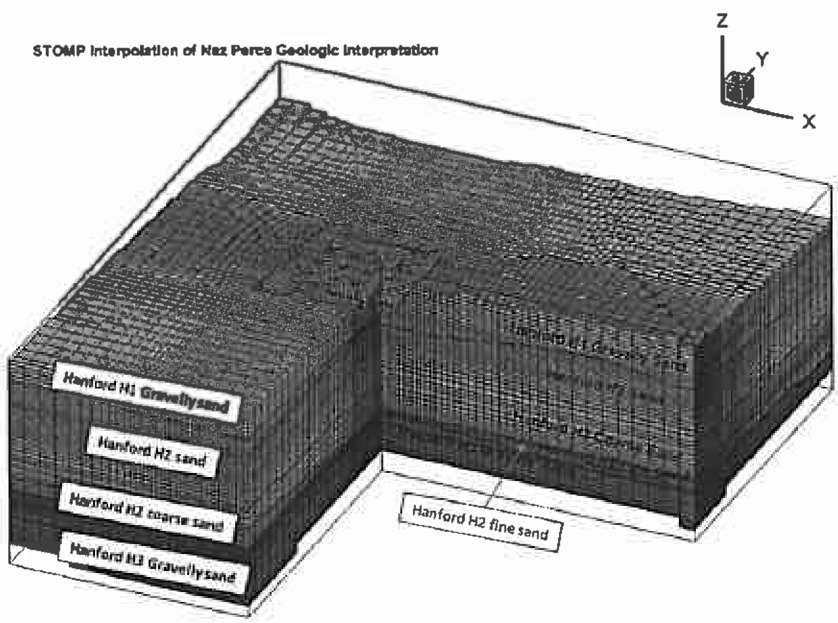
Figure 6. The integration of process modeling and systems modeling to address uncertainties.



Work is currently underway to make the necessary adaptations and modification to the EIS model and model domain for use in the PA effort. Two alternative conceptual models of the hydrogeologic framework are being considered: 1) an alternative that has been by Washington River Protection Solutions and subcontractor staff and 2) another alternative developed by Dr. Stan Sobcyzk of the Nez Perce Tribal nation. A preliminary view of these two alternative models as implemented in three-dimensional models of WMA C for the PA effort is provided in Figure 7.

Figure 7. Current version of the three-dimensional model of WMA C based on hydrogeologic conceptual models developed by WRPS and the Nez Perce Tribe.





CONCLUSIONS

The objective of the WMA C baseline risk assessment is to provide a risk analysis support an overall determination of whether RCRA corrective actions are warranted for vadose zone soils contaminated by past waste releases from WMA C. In the BRA, soil contaminant concentrations will be evaluated against soil cleanup levels from the MTCA Method B and the residential (all-pathways) scenarios, representing unrestricted land use, to determine if any action is required. Results from exposure scenarios representing reasonably anticipated future land use will be used to determine potential risks considering DOE access restrictions and institutional controls. Results from additional scenarios (e.g. Native American Scenarios) are provided to support risk-informed decisions

Results from a screening evaluation of soil concentrations against ecological soil cleanup levels will be used to determine if soil concentrations in the vadose zone at WMA C have the potential to adversely affect ecological receptors. Results from a screening evaluation of local groundwater monitoring data will also be used to determine if vadose zone contamination from past releases at WMA C have impacted groundwater'

In preparation for performing the baseline risk assessment, a preliminary evaluation of analytical results for samples collected in the vadose zone and groundwater monitoring results has been conducted. This data processing effort was focused on obtaining a comprehensive data set for the purposes of establishing summary statistics, calculating EPCs and conducting initial risk screening to identify characterization and monitoring data that would be suitable for use in the risk assessment.

The PA model analysis will make use of a combination of process and systems models depicted in Figure 7. The STOMP© process model will be used in the analysis of post-closure flow for both the unsaturated and saturated systems. The groundwater part of analyses in the Initial PA will be focused on the local-scale impacts at WMA C and not for a regional scale. The groundwater impacts will be evaluated at either the WMA C fence line or within 100 m down gradient of WMA C. The STOMP©-based model will be used deterministically to examine a range of model parameters through sensitivity analyses.

The flow field from the STOMP© process-level model will then be extracted and abstracted to the system-level model based on the GoldSim© software The STOMP© model will be used to characterize the flow for two periods of time: when the engineered barrier system at closure is intact and when it is degraded. The model will be run for a number of sensitivity cases that will allow full characterization of the parameter uncertainties during each of those time periods. The sensitivity cases will be chosen to allow the development of a response surface that characterizes the response of the flow field to changes in input parameters. This response surface will then be used as an input to the probabilistic application of the system- model.

The broad range of process-level flow models will be integrated into a system-level model that considers them collectively, and will ultimately include other processes as well. The system model, populated with uncertain inputs, will eventually run in probabilistic fashion exploring the space of uncertainty through a large number (perhaps thousands) of independent realizations. By running the system-level model in this fashion, a great deal can be learned about the system.

The most significant input parameters can be identified, which, in turn, would reveal the parts of the model that are the most uncertain and the most important.

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