ECF-100BC1-11-0083
Revision 0

Comparison of 100-BC-1 and 100-BC-2 Source Operable Unit Exposure Point Concentrations to Preliminary Remediation Goals Protective of Groundwater and Preliminary Remediation Goals Protective of Surface Water

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Contents

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Terms

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
ECF	environmental calculation file
EPA	Environmental Protection Agency
EPC	exposure point concentration
FS	feasibility study
OU	operable unit
PRG	preliminary remediation goal
RDL	required detection limit
RI	remedial investigation
STOMP	Subsurface Transport Over Multiple Phases
UCL	upper confidence limit

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1 Purpose

This environmental calculation file (ECF) documents the methodology used to identify waste sites in the 100-BC Area where post-remediation soil sample results exceed soil preliminary remediation goals (PRGs) for the protection of groundwater and the protection of surface water. The 100-BC Area is associated with two source operable units (OUs): the 100-BC-1 OU and 100-BC-2 OU. These OUs are referred to collectively herein as the 100-BC Source OU. The exposure point concentrations (EPCs) for identified constituents of potential concern (COPCs) for each waste site decision unit in the 100-BC Source OU are compared to both groundwater protective and surface water protective PRGs for a base case recharge scenario. It should be noted that there were no decision units that required comparison to PRGs developed for protection of surface water. The waste sites where EPCs exceed a PRG will be evaluated through the remedial investigation/feasibility study (RI/FS) process being conducted for the 100 Areas and 300 Area under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA).

This ECF supports DOE/RL-2010-96, *Remedial Investigation/Feasibility Study for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units*. A summary based upon the comparison of EPCs to PRGs described in this ECF will be presented in the RI/FS report.

2 Background

Based on agreements with the Senior Executive Council (DOE/RL-2011-50, *Regulatory Basis and Implementation of a Graded Approach to Evaluation of Groundwater Protection*), modeling with the STOMP simulator (PNNL-15782, *STOMP Subsurface Transport Over Multiple Phases, Version 4.0: User's Guide*) was performed to provide a site-specific basis for estimating PRGs for groundwater protection and surface water protection. PRGs for the protection of groundwater and the protection of surface water were estimated with the STOMP 1D 70:30/100:0 Contaminant Source Model, which is a one-dimensional model that assumes either 70 percent contamination of the vadose zone (upper 70 percent contaminated, lower 30 percent uncontaminated [70:30]) or 100 percent contamination of the vadose zone (zero percent uncontaminated [100:0]) beneath a backfilled waste site. Source distributions are assigned based on analyte distribution coefficients (K_d). A 70:30 source distribution is assumed for analytes with a $K_d \geq 2$ mL/g and a 100:0 source distribution is assumed for analytes with a $K_d < 2$ mL/g. The STOMP 1D 70:30/100:0 Contaminant Source Model is an OU-specific model that assumes all contamination moves downward with no dispersion, volatilization, or credit for mixing with river water. For determination of PRGs, the model was implemented with a base case recharge scenario, which represents a site re-vegetated with a natural (shrub-steppe) land cover with no irrigation of the site.

Comparisons are conducted herein between EPCs and the PRGs for both groundwater protection and surface water protection for the identified COPCs at each waste site decision unit in the 100-BC Source OU. As noted above, this describes the background for development PRGs, there were no decision units that require comparison to PRGs developed for protection of surface water.

3 Methodology

This section describes the methodology used to compare EPCs for identified COPCs at each waste site decision unit to PRGs for groundwater protection and surface water protection.

Overburden and stockpile (staging pile) decision units are not evaluated under this methodology. While sampled, this material does not remain in the same location but is used in backfilling waste sites. The models used as the basis of PRGs for the protection of groundwater and the protection of surface water using the STOMP 1D 70:30/100:0 contaminant source model presume that the sampled concentrations

are present uniformly throughout the upper 70% or 100% of the vadose zone below the backfill. However, this assumption is not applicable to overburden and stockpile (staging pile) material, so derived preliminary remediation goals are not appropriate to apply in these instances.

For all of the COPCs identified at the 100-BC waste site decision units, the following steps are performed:

1. Identify COPCs for each waste site decision unit in the 100-BC Source OU.
2. Obtain unit-length PRGs for the protection of groundwater and for the protection of surface water developed using the the STOMP 1D 70:30/100:0 base case scenario.
3. Obtain representative waste site decision unit dimensions in the general direction of groundwater flow from ECF-100-BC5-15-0019, *Determination of Representative Lineal Dimensions for 100-BC Operable Unit Waste Site Decision Units for Use in Soil Screening Level and Preliminary Remedial Goal Comparisons to Exposure Point Concentrations*. Representative lineal dimensions are provided by two methods in ECF-100BC5-15-0119; equivalent area circle radius and intersecting flow vectors. The intersecting flow vectors method lineal distances are selected for use in this evaluation.
4. Divide the preliminary remediation goal by the waste site decision unit representative lineal dimension to obtain a PRG that is scaled to the waste site decision unit lineal dimension in the general direction of groundwater flow.
5. Obtain EPC values for the COPCs identified for each waste site decision unit in the 100-BC Source OU.
6. Individually compare EPCs for each waste site decision unit in the 100-BC Source OU to soil PRGs for the protection of groundwater and the protection of surface water.

4 Assumptions and Inputs

Assumptions and inputs associated with COPCs, PRGs, and EPCs are described below.

Table 4-1 documents the sources of information for the PRGs.

Table 4-1. Reference Sources

Preliminary Remediation Goal	Pathway	Reference
STOMP 1D 70:30/100:0 Contaminant Source Model – Base Case Scenario	Groundwater	ECF-HANFORD-15-0129
	Surface Water	ECF-HANFORD-15-0129

Notes:

STOMP1-D Modeling for Determination of Unit-Length Soil Screening Levels and Preliminary Remediation Goals for Waste Sites in the 100-BC-1 and 100-BC-2 Source Operable Units. The PRGs provided in this ECF are provided on a unit-length basis, and must be scaled by the representative lineal dimension of the waste site decision unit in the general direction of groundwater flow for evaluation use.

4.1 Identification of COPCs

For the purposes of this ECF, a COPC is defined as an analyte suspected of being associated with site-related activities, which represents a potential threat to human health or the environment, and whose data are of sufficient quality for use in a quantitative baseline risk assessment.

All analytes identified as exceeding background soil concentrations and soil screening levels in a waste site decision unit are identified as COPCs because the soil sample results represent post-remediation conditions. COPCs for the 100-BC Source OU are identified in ECF-100BC1-11-0082, *Comparison of 100-BC-1 and 100-BC-2 Source Operable Unit Exposure Point Concentrations to Soil Screening Levels Protective of Groundwater and Soil Screening Levels Protective of Surface Water*. The COPCs for groundwater protection for each waste site decision unit are presented in Table 4-2. There were no COPCs identified from any waste site decision unit for surface water protection.

4.2 Preliminary Remediation Goals for the Protection of Groundwater

PRGs for the protection of groundwater at and near the 100-BC Source OU have been derived using the following model:

- STOMP 1D 70:30/100:0 Contaminant Source Model, base case scenario

The STOMP 1D 70:30/100:0 Contaminant Source Model assumes that either the upper 70 percent of the vadose zone (for $K_d \geq 2$ mL/g analytes) or the entire vadose zone (for $K_d < 2$ mL/g analytes) is contaminated below a clean fill layer. The recharge rate for the base case scenario represents a site re-vegetated with a natural (shrub steppe) land cover assuming no irrigation of the site. OU-specific PRGs protective of groundwater for the 100-BC Source OU calculated using the STOMP 1D 70:30/100:0 Contaminant Source Model are documented in ECF-HANFORD-15-0129, *STOMP 1-D Modeling for Determination of Unit-Length Soil Screening Levels and Preliminary Remediation Goals for Waste Sites in the 100-BC-1 and 100-BC-2 Source Operable Units*. The STOMP 1D 70:30/100:0 groundwater protective PRGs for identified COPCs at the 100-BC Source OU are presented in Table 4-2.

4.3 Exposure Point Concentrations

OSWER 9285.6-10, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*, states that, "an exposure point concentration (EPC) is a conservative estimate of the average chemical concentration in an exposure medium." OSWER Publication 9285.7-081, *Supplemental Guidance to RAGS: Calculating the Concentration Term,* states that, "because of the uncertainty associated with estimating the true average concentration at a site, the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used for this variable."

The EPCs used for comparison to PRGs are the analyte-specific values computed from the post-remediation soil sample results for each waste site decision unit in the 100-BC Source OU, as described in ECF-100BC1-11-0012, *Computation of Exposure Point Concentrations for the 100-BC-1 and 100-BC-2 Source Operable Units*. The EPCs corresponding to the identified COPCs for each waste site decision unit in the 100-BC Source OU are presented in Table 4-3.

5 Software Applications

Microsoft Excel® was used to tabulate the data in electronic spreadsheets. These spreadsheets are provided as tables in this ECF.

6 Calculation

Comparison of EPCs to PRGs is conducted as described in Section 3 to determine if a COPC exceeds a PRG. Results of the comparisons are presented in the accompanying table, as discussed in Section 7. The tables share a similar format, providing both the values being compared as well as a "Yes/No" column indicating the outcome of the comparison.

7 Results/Conclusions

The comparison of EPCs to PRGs protective of groundwater for the 100-BC Source OU waste site decision units is provided in Table 7-1. The strontium-90 EPCs for both decision units (116-C-1 deep and 116-C-1 deep focused) were less than the PRGs protective of groundwater.

8 References

DOE/RL-2010-96, 2012, *Remedial Investigation/Feasibility Study for the 100-BC-1, 100-BC-2, and 100-BC-5 Operable Units*, Decisional Draft, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2011-50, 2012, *Regulatory Basis and Implementation of a Graded Approach to Evaluation of Groundwater Protection*, Rev. 1, United States Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093361.

ECF-100BC1-11-0012, 2012, *Computation of Exposure Point Concentrations for the 100-BC-1 and 100-BC-2 Source Operable Units*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

ECF-100BC1-11-0082, 2012, *Comparison of 100-BC-1 and 100-BC-2 Source Operable Unit Exposure Point Concentrations to Soil Screening Levels Protective of Groundwater and Soil Screening Levels Protective of Surface Water,* Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

ECF-100BC5-15-0119, 2015, *Determination of Representative Lineal Dimensions for 1000BC Operable Unit Waste Site Decision Units for Use in Soil Screening Level and Preliminary Remedial Goal Comparisons to Exposure Point Concentrations,* Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

ECF-HANFORD-15-0129, 2012, *STOMP 1-D Modeling for Determination of Unit-Length Soil Screening Levels and Preliminary Remediation Goals for Waste Sites in the 100-BC-1 and 100-BC-2 Source Operable Units*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

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OSWER 9285.6-10, 2002, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://epa.gov/oswer/riskassessment/pdf/ucl.pdf.

OSWER Publication 9285.7-081, 1992, *Supplemental Guidance to RAGS: Calculating the Concentration Term*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.deq.state.or.us/lq/pubs/forms/tanks/UCLsEPASupGuidance.pdf.

PNNL-15782, 2006, *STOMP Subsurface Transport Over Multiple Phases, Version 4.0: User's Guide*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://stomp.pnnl.gov/.

Table 4-2. STOMP 1D 70:30/100:0 Contaminant Source Model Base Case Preliminary Remediation Goals for Groundwater Protection for Identified COPCs at the 100-BC Source Operable Unit

COPC	CAS No.	70:30/100:0 Contaminant Source Model Base Case Preliminary Remediation Goal for Groundwater Protection[a]
Radionuclides (pCi/g)		
Total beta radiostrontium	SR-RAD	92

Notes:

a. ECF-HANFORD-15-0129, *STOMP 1-D Modeling for Determination of Soil Screening Levels and Preliminary Remediation Goals for Waste Sites in the 100-BC-1 and 100-BC-2 Source Operable Units.*

Table 4-3. Summary of COPCs and EPCs for Groundwater Protection for the 100-BC Source Operable Unit

Waste Site/Decision Unit	Analyte Group	COPC	CAS No.	Units	Exposure Point Concentration[a]
116-C-1_Deep	Rad	Total beta radiostrontium	SR-RAD	pCi/g	64
116-C-1_Deep_Focused	Rad	Total beta radiostrontium	SR-RAD	pCi/g	88

Notes:

a. ECF-100BC1-11-0012, *Computation of Exposure Point Concentrations for the 100-BC-1 and 100-BC-2 Source Operable Units.*

Table 7-1. Comparison of EPCs from 100-BC Operable Unit Waste Site Decision Unit COPCs to STOMP 1D 70:30/100:0 Contaminant Source Base Case Preliminary Remediation Goals Protective of Groundwater

Waste Site/Decision Unit	Analyte Group	Analyte Name	CAS No.	Units	Exposure Point Concentration (pCi/g)	STOMP 1D 70:30/100:0 Contaminant Source Model Preliminary Remediation Goal for Groundwater Protection[a] $\left(\frac{pCi}{g} \cdot m\right)$	Site Width in Direction of Groundwater Flow[b] (m)	STOMP 1D 70:30/100:0 Contaminant Source Model Preliminary Remediation Goal for Groundwater Protection Scaled to Site Length in Direction of GW Flow (pCi/g)	Is EPC > Soil Screening Level Protective of Groundwater?
116-C-1_Deep	Rad	Total beta radiostrontium	SR-RAD	pCi/g	64	5,296	58	92	No
116-C-1_Deep_Focused	Rad	Total beta radiostrontium	SR-RAD	pCi/g	88	5,296	58	92	No

Notes:

a. ECF-HANFORD-15-0129. A 70:30 source distribtuion is used for analytes with Kd ≥ 2 mL/g; a 100:0 source distribution is used for analytes with Kd

b. ECF-100-BC5-15-0119, *Determination of Representative Lineal Dimensions for 100-BC Operable Unit Waste Site Decision Units for Use in Soil Screening Level and Preliminary Remedial Goal Comparisons to Exposure*