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Baseline Risk Assessment Supporting Closure at Waste Management Area C at the Hanford Site Washington - 15332

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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Baseline Risk Assessment Supporting Closure at Waste Management Area C at the Hanford Site Washington – 15332

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ABSTRACT

The Office of River Protection under the U.S. Department of Energy is pursuing closure of the Single-Shell Tank (SST) Waste Management Area (WMA) C under the requirements of the Hanford Federal Facility Agreement and Consent Order (HFFACO). A baseline risk assessment (BRA) of current conditions is based on available characterization data and information collected at WMA C. The baseline risk assessment is being developed as a part of a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/Corrective Measures Study (CMS) at WMA C that is mandatory under Comprehensive Environmental Response, Compensation, and Liability Act and RCRA corrective action. The RFI/CMS is needed to identify and evaluate the hazardous chemical and radiological contamination in the vadose zone from past releases of waste from WMA C.

WMA C will be under Federal ownership and control for the foreseeable future, and managed as an industrial area with restricted access and various institutional controls. The exposure scenarios evaluated under these conditions include Model Toxics Control Act (MTCA) Method C, industrial worker, maintenance and surveillance worker, construction worker, and trespasser scenarios. The BRA evaluates several unrestricted land use scenarios (residential all-pathway, MTCA Method B, and Tribal) to provide additional information for risk management.

Analytical results from 13 shallow zone (0 to 15 ft. below ground surface) sampling locations were collected to evaluate human health impacts at WMA C. In addition, soil analytical data were screened against background concentrations and ecological soil screening levels to determine if soil concentrations have the potential to adversely affect ecological receptors. Analytical data from 12 groundwater monitoring wells were evaluated between 2004 and 2013. A screening of groundwater monitoring data against background concentrations and Federal maximum concentration levels was used to determine vadose zone contamination impacts on groundwater.

Waste Management Area C is the first of the Hanford tank farms to begin the closure planning process. The current baseline risk assessment will provide valuable information for making corrective actions and closure decisions for WMA C, and will also support the planning for future tank farm soil investigation and baseline risk assessments.

INTRODUCTION

The U.S. Department of Energy, Office of River Protection is pursuing closure of the Single-Shell Tank (SST) Waste Management Area (WMA) C under federal requirement of the HHFACO, Appendix I. 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 tank farm areas built at the Hanford Site in 1944. Notable facilities to be addressed in the closure of the WMA C include 12 SSTs each with a capacity of 2×10^6 L, a catch tank, a vault with 4 tanks, 7 diversion

boxes, and about 7 miles of pipelines. Environmental releases have occurred in the past to the underlying vadose zone in the vicinity of WMA C. To date, 13 of 16 SSTs 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-107, 241-C-108, 241-C-109, 241-C-110, 241-C-112, 241-C-201, 241-C-202, 241-C-203, and 241-C-204. Three remaining tanks (241-C-111, 241-C-102 and 241-C-105) are in varying phases of retrieval.

BASELINE RISK ASSESSMENT

Under the HFFACO Action Plan [1] and the Phase 2 work plan [2] soil characterization data was collected in support of the RFI/CMS at WMA C. Analytical data were collected from 13 shallow zone (0 to 15 ft below ground surface) sampling locations during characterization of the vadose zone at WMA C. The 13 locations are identified in Figure 1. For purposes of the BRA, sampling locations were grouped into ten exposure areas based on common Phase 2 characterization objectives. The exposure areas and their general locations within WMA C are identified in Table I.

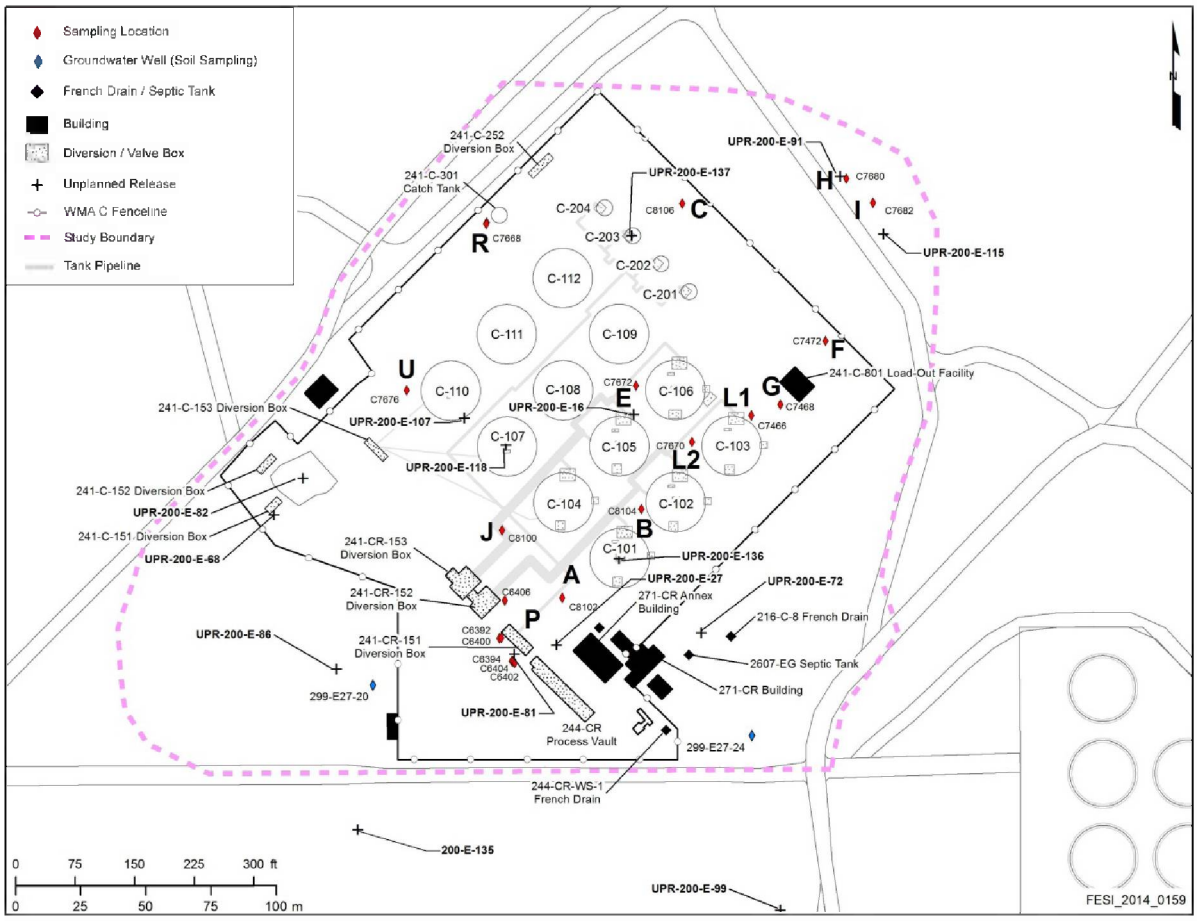

Figure 1. Sampling Location at Waste Management Area C as part of the RCRA Field Investigation/Corrective Measures Study

Two types of data screening processes were performed to identify both radiological and hazardous chemicals for which 95% UCL values are calculated. The data reduction steps and exclusion criteria were applied to the data set and then a weight of evidence screening was performed. The 95% UCL values were

calculated for those analytes that passed both screens. The data screening process is described as follows:

- The data were processed to remove results associated with qualification and validation flags, multiple analytical methods, and duplicates samples.
- Data were processed to remove analytes that meet exclusion criteria.
  - Half-lives less than 3 years
  - Naturally occurring radionuclides
  - Water quality
  - Essential nutrients
  - Analytes with no known toxicity
- Analytes that were not detected in any samples were removed.

Table I. Waste Management Area C Exposure Areas

Exposure Areas	General Location Within Waste Management Area C
A + B	Area near tank 241-C-101
C	Area near 241-C-200 series tanks
E	Area between tanks 241-C-106 and 241-C-109
F + G	Area near tank 241-C-103 and Bldg. C-801, and Bldg. C-801 chemical drain
H + I	Area northeast of UPR-200E-91 and UPR-200E-115
J	Area near tank 241-C-104
L1 + L2	Area between tanks 241-C-103 and 241-C-106
P	Area near UPR-81
R	Area near 241-C-301 catch tank
U	Area near tank 241-C-110

The processing and reduction of the WMA C phase 2 characterization data resulted in 8,288 analytical records and 82 analytes which were used for the calculation of 95% UCLs. EPA guidance document [3] and EPA software, ProUCL 4.00.05 [4] were used in the calculation of the 95% UCL for each analyte from each exposure area. Exposure point concentrations (EPCs) for detected analytes were computed and selected using the logic described in Figure 2.

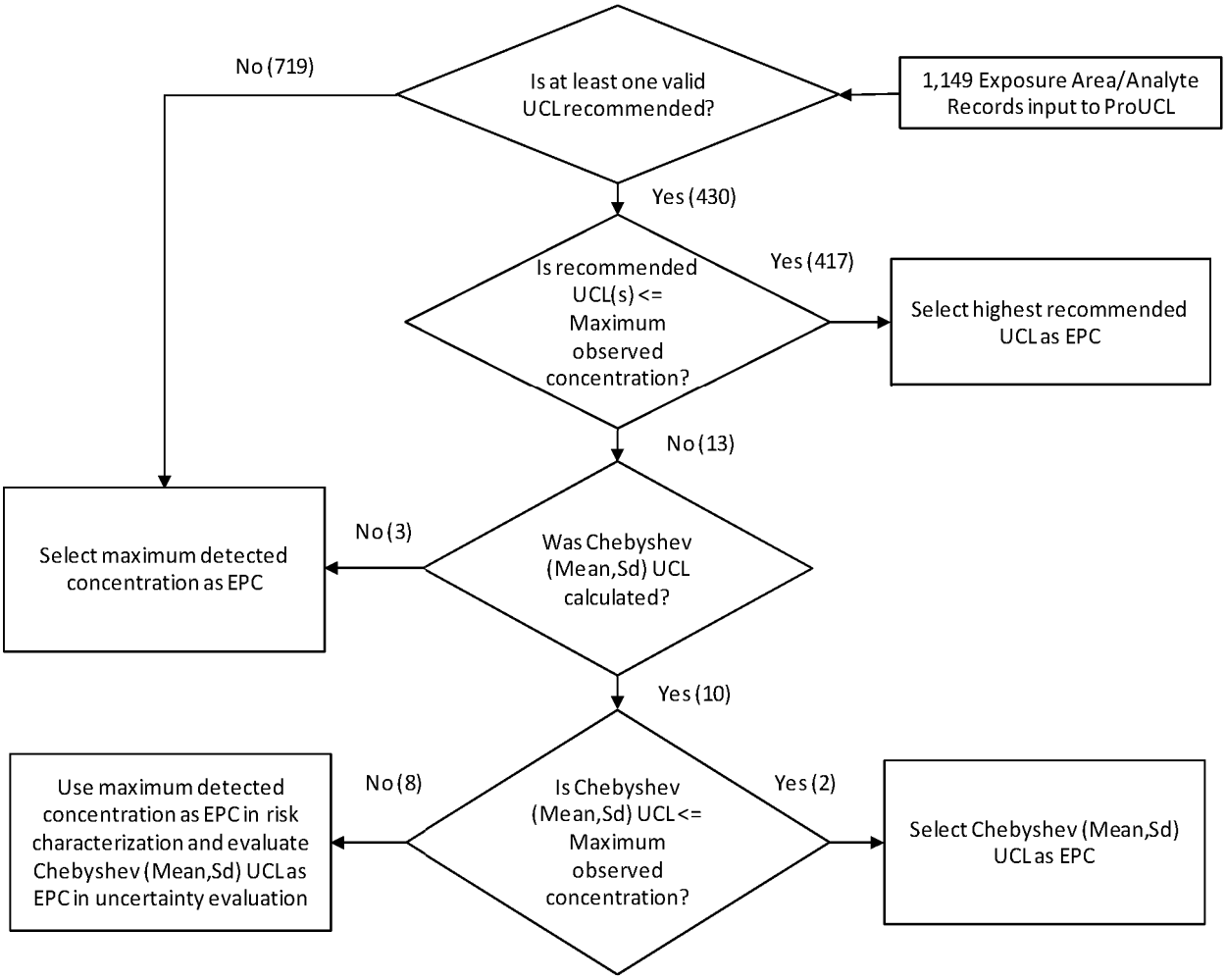

Figure 2. Decision Logic for Exposure Point Concentration Selection

Human Health Risk Assessment

The WMA C baseline risk assessment will provide a risk analysis based on current conditions and will support an overall determination of whether RCRA corrective actions are warranted for vadose zone soils contaminated by past waste releases at WMA C prior to facility closure. In the baseline risk assessment, soil concentrations were evaluated using reasonably anticipated future land used scenarios.

The WMA C will be under Federal ownership for the foreseeable future, and managed as an industrial area with restricted access and various institutional controls. Reasonably anticipated future land used scenarios include the following scenarios:

- Industrial Worker
- Industrial Worker under MTCA Method C
- Construction Worker
- Maintenance/Surveillance Worker
- Trespasser (Adult/Youth)

The BRA provides additional information for risk management through the evaluation of a residential scenario and the evaluation of a resident under MTCA Method B. Additionally, Native American Scenarios [5], [6], [7] are included to support risk-informed decisions.

Analyte specific toxicity values were determined using the reference hierarchy as described in "Human Health Toxicity Values in Superfund Risk Assessments" [8]. Tier 1 – The EPA Integrated Risk Information System (IRIS), Tier 2 – The EPA Provisional Peer Reviewed Toxicity Values, and Tier 3 – Other Toxicity Values (California Environmental Protection Agency, the Agency for Toxic Substances and Disease Registry, Health Effects Assessment Summary Tables). When Tier 1, Tier 2, or Tier 3 toxicity values were not available for a COPC, the toxicity values from the National Center for Environmental Assessment were used. These values can be found in the Risk Assessment Information System [9]. The human health radiological dose and risk assessment for radiological analytes were conducted utilizing the RESidual RADioactivity computer code (RESRAD) Version 6.5 [10].

Groundwater Protection

The evaluation of groundwater protection for nonradiological contaminants in the vadose zone was performed using the WAC 173-340-747(4) fixed-parameter three-phase partitioning model [11] (hereinafter referred to as the 3-phase model) cleanup levels.

The evaluation of soil concentrations protective of groundwater compares maximum detected concentrations and EPCs for each nonradiological analyte to corresponding soil cleanup level based on the 3-phase model. Nonradiological analytes for which maximum detected concentrations were greater than the cleanup levels were then evaluated against Hanford Site background concentrations [12].

Protection of groundwater at WMA C will be evaluated in the future using a more representative site-specific model developed to support the WMA C Performance Assessment. This will be performed for both nonradiological and radiological contaminants.

Screening Level Ecological Risk Assessment

The screening level ecological risk assessment (SLERA) was developed based on EPA guidance [13] and MTCA. Contaminants of Potential Ecological Concern (COPECs) were identified using the soil characterization results collected from 13 sampling location within the 10 exposure areas identified as part of the human health risk assessment. A tiered based risk assessment was conducted using generic screening and Tier 1 screening [14]. This tiered process allows the incorporation of more sophisticated ERA methods and increasing levels of ecological site-specific and site relevant information to provide soil screening levels (SSLs) that are more representative of Hanford Site conditions.

All WMAs in the tank farm system are actively managed to prevent vegetation, insects, and wildlife from using the WMA as habitat, including WMA C. Herbicides and pesticides are used on a regular basis and fences are placed around the perimeter to keep larger animals out. Without a source of food within the WMA, smaller animals are less likely to enter. No species that regularly frequent the Hanford Site are listed as threatened or endangered under the *Endangered Species Act of 1973*.

Generic screening levels represent initial, conservative screening values from readily available published literature and agency sources. These readily-available SSLs for terrestrial plants, soil invertebrates, birds, and mammals are not specific to the Hanford Site; rather, they represent conservative, literature-based screening values. Those SSLs are obtained from following existing published and accepted sources:

- EPA (Ecological Soil Screening Levels [EcoSSLs]),

- Washington State Department of Ecology (Ecological Indicator Soil Concentrations), found in Ecology Publication 94-06, *Model Toxics Control Act Regulation and Statute*, Table 749-3, Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals,
- Oak Ridge National Laboratory Screening-Level Benchmarks, and
- DOE Biota Concentration Guides for radionuclides that are presented in DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*

Tier 1 assessment was performed for COPECs that were retained during the generic screening. Tier 1 SSLs for plants and soil invertebrates are not developed. Tier I SSLs were calculated specifically for bird and mammal species present at the Hanford Site. Exposures were calculated based on intake of soil and food/prey by the following receptors:

- Herbivorous birds—California quail (*Callipepla californica*)
- Herbivorous mammals—Great Basin pocket mouse (*Perognathus parvus*)
- Insectivorous birds—killdeer (*Charadrius vociferus*)
- Insectivorous mammals—northern grasshopper mouse (*Onychomys leucogaster*)
- Omnivorous birds—western meadowlark (*Sturnella neglecta*)
- Omnivorous mammals—deer mouse (*Peromyscus maniculatus*)
- Carnivorous birds (raptors)—red-tailed hawk (*Buteo jamaicensis*)
- Carnivorous mammals—badger (*Taxidea taxus*).

Tier 1 values are based on agency developed or accepted methods, that have been calculated specifically for bird and mammal species present at the Hanford Site. Tier 1 screening based on (TRVs), two types of screening were performed during Tier 1 screening.

For nonradiological COPECs, both No-Observed-Adverse-Effect-Level (NOAEL) and Lowest-Observed-Adverse-Effect-Level (LOAEL) based toxicity reference values (TRVs) for birds and mammals were obtained from various sources and focus was given to the most recent sources and those derived or endorsed by EPA [15] and Ecology. For radiological COPECs, more receptor-specific SSLs for wildlife (animals) were developed using RESRAD-BIOTA. Values were established for eight species representing feeding guilds at the site.

Maximum detected concentration of each COPEC was compared to its corresponding screening benchmark based on NOAEL. The COPECs with maximum concentrations less than the NOAELs were considered to pose negligible risk and therefore, were eliminated from further consideration. COPECs with maximum concentrations equal or greater than the NOAEL were compared to its corresponding screening bench mark based on LOAEL. When the HQs for the COPECs are greater than 1, scientific management decision points (SMDPs) were considered before retaining them.

The identification of specific receptors that have the potential for adverse health effects (proportion of receptors affected, likelihood of population-or-community-level effects, home range of the receptors at risk relative to the area exceeding risk-based thresholds) were considered to interpret the results of the risk characterization and determine if the site requires further evaluation in the CMS.

Groundwater Screening Evaluation

The groundwater screening evaluation provides support to ongoing investigations into potential contributions to current and future groundwater contamination from sources in the vadose zone at WMAC. This groundwater screening is considered a high-level evaluation and is intended to provide an initial basis

of information that can be used in conjunction with additional groundwater evaluations. Protectiveness of human health is evaluated by comparing groundwater concentrations to existing federal or state MCLs or nonzero MCLGs.

The groundwater data set used for the identification of analytes of interest consists of sampling and analysis data collected over a 10-year period, between January 2004 and December 2013, from 12 monitoring wells located in the vicinity of WMA C. A total of 40,505 records were obtained from the Hanford Environmental Information System database. A list of the wells is provided in Table II.

Table II. Groundwater Monitoring Wells Used for Identification of Analytes of Interest at Waste Management Area C

Well Name			
299-E27-12	299-E27-15	299-E27-22	299-E27-25
299-E27-13	299-E27-155	299-E27-23	299-E27-4
299-E27-14	299-E27-21	299-E27-24	299-E27-7

The data screening processes was performed to identify both radiological and radiological analytes to be evaluated against groundwater comparison values. The data screening process is described as follows:

- The data were processed to remove results associated with qualification and validation flags, multiple analytical methods, and duplicates samples.
- Process data to removed analytes that meet exclusion criteria.
  - Half-lives less than 3 years
  - Background radionuclides
  - Water quality
  - Essential nutrients
  - Analytes with no known toxicity
- Remove analytes that were not detected in any samples.

For purposes of identifying groundwater analytes of interest, maximum groundwater concentrations were evaluated against groundwater comparison values and background concentrations. Groundwater comparison values are screening levels derived from chemical-specific applicable or relevant and appropriate requirements (ARARs) and/or risk-based concentrations calculated using default exposure assumptions. The following are the sources of federal and Washington State groundwater comparison values.

- 40 CFR 141, "National Primary Drinking Water Regulations", MCLs, Secondary MCLs, and nonzero MCLGs established under the *Safe Drinking Water Act of 1974* [16].
- Washington Administrative Code (WAC) 173-340-720, "Groundwater Cleanup Standards." [11]
- WAC 246-290-310, "Group A Public Water Supplies," "Maximum Contaminant Levels (MCLs) and Maximum Residual Disinfectant Levels (MRDLs)." [17]

Derivation of groundwater cleanup levels in accordance with the 2007 Washington State Model Toxics Control Act (MTCA) cleanup regulations. For this evaluation, Method B groundwater screening levels

represent the 1×10^{-6} target cancer risk value and a hazard quotient (HQ) of 0.1. The noncancer HQ of 0.1 values are used for this evaluation because multiple analytes are present and this approach identifies analytes that may have a common mechanism of action and target organ.

The evaluation of background composition was done on a site wide basis to provide a consistent, technically defensible definition of background, as opposed to determining local background compositions at each waste management unit. Historical Hanford Site groundwater data (and new data collected specifically for the study) were screened to eliminate samples and/or constituents that may have been affected by Hanford Site activities [18].

Maximum detected concentrations in the combined (12-well) groundwater data set were evaluated against respective groundwater comparison values. An analyte-specific evaluation was performed to distinguish analytes with results that are indicative of natural groundwater background conditions or those analytes that were reported on a nonrecurring basis (concentrations that are not reproducible or consistent with the remainder of the data set).

RESULTS

Soil Human Health Risk Assessment

Five exposure areas (A+B, C, E, L1+L2, and P) reported an exceedance of 1×10^{-4} based on the industrial worker expousre scenario and maintenance worker scenario. Two exposure areas (A+B and C) reported an exceedance of 1×10^{-4} based on the youth trespasser exposure scenario. The two major contributors, cesium-137 and tin-126 were retained as radiological COPCs for further evaluation in the CMS.

Based on the residential exposure scenarios, nine exposure areas (A + B, C, E, F + G, H + I, J, L1 + L2, P, and U) are greater than the upper risk threshold 1×10^{-4}. Cesium-137, cobalt-60, nickel-63, selenium-79, strontium-90 and tin-126 were identified as major risk contributors.

Protection of Groundwater

Five analytes (arsenic, cadmium, nitrate, beta-BHC, and lindane) were identified as exceeding their corresponding 3-phase model soil cleanup levels and background levels.

Screening Level Ecological Risk Assessment

The values used to calculate SSLs are based on the assumption that the size of the waste site inhabited by a receptor is the same size as the area used by the animal. The SSLs assume that a wildlife receptor is exposed 100 percent of the time to the contaminants in a waste site. This ratio of the area of contamination to the home range is known as an AUF. Assuming that the AUF is 1 in development of SSLs may considerably overstate ecological risks.

The size of WMA C is around 0.04 km^2. That means, a killdeer will utilize less than 1% for its food sources from WMA C. SSLs based on AUF of 1% will result in much higher SSL for killdeer as compared to their maximum detected concentrations. Therefore, none of the COPECs were retained for further evaluation.

The results of Tier 1 assessment for radiological COPECs identified elevated ecological risk levels at exposure area P. The results of human health risk characterization also identified unacceptable radiological risk at exposure area P for industrial worker, maintenance/ surveillance worker and residential receptors. Results of this HHRA will be considered in the evaluation of potential corrective measures for soil contamination.

Groundwater Screening Evaluation

Based on an analyte specific evaluation, a total of seven analytes were identified as groundwater analytes of interest. These analytes are sulfate, vanadium, nickel, nitrate, iodine-129, technetium-99, and cyanide. Three of these analytes (vanadium, nickel, and iodine-129) were not found to be related to a release from WMA C.

REFERENCES

1. Hanford Federal Facility Agreement and Consent Order

2. RPP-PLAN-39114, 2012, Phase 2 RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C, Rev. 2, Washington River Protection Solutions, LLC, Richland, Washington.

3. OSWER Publication 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

4. EPA/600R-07/038, 2010, ProUCL Version 4.00.05 User Guide, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

5. Harris, 2008, Application of the CTUIR Traditional Lifeways Exposure Scenario in Hanford Risk Assessments

6. Harris, 2004, Exposure Scenario for Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Traditional Subsistence Lifeways

7. Ridolfi, 2007, Yakama Nation Exposure Scenario for Hanford Site Risk Assessment

8. OSWER Directive 9285.7-53, 2003, Human Health Toxicity Values in Superfund Risk Assessments, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington D.C. 20460.

9. ORNL, 2010, Risk Assessment Information System, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

10. ANL, 2009a, RESRAD, Version 6.5, Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

11. WAC 173-340, "Model Toxics Control Act—Cleanup," *Washington Administrative Code*, Olympia, Washington.

12. DOE/RL-92-24, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, Rev. 4, 2 vols., U.S. Department of Energy, Richland Operations Office, Richland, Washington.

13. EPA 540-R-97-006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments: Interim Final*

14. CHPRC-00784, 2011, *Tier 1 Risk-Based Soil Concentrations Protective of Ecological Receptors at the Hanford Site*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

15. OSWER Directive 9285.7-55, 2007, *Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs)*, Attachment 4-1, *Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs*, U.S. Environmental Protection Agency, Washington, D.C., revised April 2007

16. 40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended

17. WAC 246-290-310, "Maximum Contaminant Levels (MCLs) and Maximum Residual Disinfectant Levels (MRDLs)," *Washington Administrative Code*

18. DOE/RL-96-61, 1997, *Hanford Site Background: Part 3, Groundwater Background*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.