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Office of River Protection, State of Washington Department of Ecology
Tank Waste Retrieval Work Plan/Functions and Requirements Change Notice
(Per Hanford Federal Facility Agreement and Consent Order Section 9.3)

1. Document Title and Number: RPP-22520, Rev. 7, 241-C-101 and 241-C-105 Tanks Waste Retrieval Work Plan		
2. Minor Field Change: (Section 12.4 HFFACO Action Plan) ☐ Yes: (WRPS Signature Only – Attach signed form to Primary Document for record purposes) x No: Proceed to Box 3	**3.** Document Issue Date: 03/21/12 **4.** Document Modification Notice Date: 10/04/12	**5.** Notice Number: 2012-10
6. Do proposed changes require schedule changes? (Would this extend completion of retrieval beyond 12 months from date of initiation?) ☐ Yes x No	**7.** Do proposed changes include specific additions, deletions, or modification to scope and/or requirements which affect the overall intent of the plan? ☐ Yes x No	**8.** (Check only one box) ☐ Significant Modification (Check if the answer to question in either section 6 or 7 is "yes". Significant modifications require revision of the primary document.) Minor Modification x Requires modification of the document x Can be accomplished with Modification Notice.

9. Description and Justification of Change:

Change Description: A change is needed to update the tank C-101 groundwater risk estimates according to Ecology's request in section 11 of Notice Number 2011-09.

Justifications:

- Seciont 7.0, pg 7-9, clarified risk assumptions for tanks C-101 and C-105
- Section 9.0, pg 9-7 to 9-8—updated references
- Appendix A, pg A-1 to A-4—updated reference, deleted old plots and added revised plots
- Appendix A, A-5 to A-6—updated concentration and calculation values, deleted outdated information
- Appendix A, A-8—updated reference

See the attached redline strikeout pages.

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10. Impact of Change:

Provides more accurate estimates of groundwater risk.

11. Additional Requirements and/or Provisions

WMA-C

Office of River Protection, State of Washington Department of Ecology
Tank Waste Retrieval Work Plan/Functions and Requirements Change Notice
(Per Hanford Federal Facility Agreement and Consent Order Section 9.3)

Approvals		
Washington River Protection Solutions, LLC.	Office of River Protection	State of Wash. Dept. of Ecology
☐ Provisional Approval[2] Date	☐ Provisional Approval[2] Date	☐ Provisional Approval[2] Date
☐ Final Approval Date 10/11/12 E. LaRock for D.K. Smith	☒ Final Approval CTK Date 10/11/12	☒ Final Approval Date 10/16/12

Notes

1 - For use by Ecology to identify any additional information needed to make a decision regarding the request for modifications. In addition, Ecology will identify actions, if any, regarding the modification request that DOE may take pending Ecology's final decision

2 – Provisional approval allows DOE and it's contractors to take specific actions identified in section 11, prior to final approval of this modification.

7.1.1.2. Potential Retrieval Leak Inventories. This document presents much of the risk data assuming an 8,000-gal. retrieval leak volume. This quantity is used only as a point of reference, and for consistency and comparison with the volume assumed in the WMA C Closure Plan (RPP-13774, Appendix C) risk assessment. The choice of the reference volume is arbitrary and does not affect how the risk values would be used in the event of a retrieval leak. The 8,000 gal. is a hypothetical volume that represents neither an anticipated leak volume nor a leak detection limit. The WRS design and operational strategy for tanks C-101 and C-105 are designed to minimize the leak potential from the tank structure during waste retrieval. If a leak is detected, however, the risk graphs provided in Appendices A and B will allow the leak impacts to be estimated regardless of leak volume.

The retrieval leak impact graphs provided in the appendices were generated by applying Equation 7-1 over a range of hypothetical retrieval leak inventories for each indicator contaminant (RPP-22521 Rev. 5 and 6). Because potential retrieval leak volumes are uncertain, the inventory range was selected to encompass a small leak on the low end and a large leak on the high end. Points of reference were added to the graphs to show the estimated current tank inventory and the estimated inventory associated with a hypothetical 8,000-gal. retrieval supernate leak. The 8,000-gal. volume was used only for information purposes to provide a point of reference on the graphs.

The indicator contaminant concentrations in RPP-22521, Rev. 5 are high estimates that are intended to be bounding. These bounding estimates were initially used for both C-101 and C-105 prior to installation of the retrieval equipment. Close to the startup of C-101 retrieval, RPP-22521 was revised so that less bounding and more accurate estimates would be available. Appendix A (C-101) is based RPP-22521, Rev. 6A and Appendix B (C-105) is based on RPP-22521, Rev. 5.

An explanation of the bounding assumptions that apply to C-105 and Appendix B are as follows. Prior to retrieval a decant of the DST is conducted reducing the volume of supernate. The estimated volume of water that will be used in the retrieval is not added to the supernate volume thereby minimizing the estimated supernate volume and increasing the estimated concentration. It was assumed that the DST will not be decanted prior to retrieving C-101 and C-105, so all of the mass from SSTs retrieved into the DST prior to C-101 and C-105 remains in the DST supernate. Further, it is assumed that the salt cake shown by the BBI in the DST dissolves increasing the concentration of contaminants.

Development of the tank-specific inventories shown as points of reference on the graphs for the individual tanks is discussed in the appendices. Current inventory values were taken from the BBI by downloading from the Tank Waste Information Network System (TWINS) database. Hypothetical retrieval leak inventory values were calculated from the best available published data source.

RPP-16525, 2004, *C-200 Series Tanks Retrieval Functions and Requirements*, Rev. 6A, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-16666, 2007, *Integrity Assessment for 200 Series Retrieval*, Rev. 0D, CH2M HILL Hanford Group Inc., Richland, Washington.

RPP-16922, *Environmental Specification Requirements*, Latest Revision, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-18629, 2003, *Performance Evaluation for C-106, S-102/112 and C-200 Series Tank Retrieval Activities*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-18811, 2004, *Tanks 241-C-103 and 241-C-105 Waste Retrieval Functions and Requirements*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington

RPP-19822, 2005, *Hanford Defined Waste Model – Revision 5.0*, Rev. 0A, CH2M HILL Hanford Group, Inc., Richland, Washington

RPP-20577, 2004, *Stage II Retrieval Data Report for Single-Shell Tank 241-C-106*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-20820, 2004, *Waste Retrieval Leak Evaluation Report: Single-Shell Tanks*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-20949, *Data Quality Objectives For The Evaluation Of Tank Chemical Emissions For Industrial Hygiene Technical Basis*, Latest Revision, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-21753, 2005, *C Farm 100-Series Tanks, Retrieval Process Flowsheet Description*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-21895, *241-C-103 and 241-C-109 Tanks Waste Retrieval Work Plan*, Latest Revision, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-22393, *241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan*, Latest Revision, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-22491, *Industrial Hygiene Vapor Technical Basis*, Latest Revision, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-22521, ~~2008,~~ *Tanks C-101, C-105, C-110, and C-111 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan*, Rev. ~~3~~5, ~~CH2M HILL~~Washington River Protection Solutions ~~Hanford Group, Inc.~~, LLC, Richland, Washington.

RPP-22521, *Tanks C-101, C-102, C-105, C-110, and C-111 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan*, Rev.6A, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-23403, 2009, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 4, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-23405, 2004, *Tank Farm Vadose Zone Contamination: Volume Estimates for Risk Assessments*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland , Washington.

RPP-23405, 2008, *Tank Farm Vadose Zone Contamination: Volume Estimates for Risk Assessments*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland , Washington.

RPP-27869, *Building Emergency Plan for Tank Farms*, Latest Revision, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-29002, 2006, *Double-Shell Tank Waste Analysis Plan*, Rev 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-30121, 2006, *Tank 241-S-102 High-Resolution Resistivity Leak Detection and Monitoring Test Report,* Rev 0-A, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-32477, *High Resolution Resistivity Leak Detection Data Processing and Evaluation Methods and Requirements*, Latest Revision, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-32681, 2007, *Process to Estimate Tank Farm Vadose Zone Inventories*, Rev 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-33116, *241-C-110 Tank Waste Retrieval Work Plan*, Latest Revision, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-50910, 2011, *Single-Shell Tank Waste Retrieval Limit of Technology Definition for Modified Sluicing*, Rev. 0, Washington River Protection Solutions, LLC., Richland, Washington.

RPP-ASMT-46452, 2010, *Tank 241-C-105 Leak Assessment Completion Report,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-CALC-49671, *Calculation Package for the Installation of a Large Riser on Tank 241-C-105,* Latest Revision, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-CALC-51195, 2011, *An Evaluation of Single-Shell Tank 241-C-105 for the Addition of a Large Penetration in the Tank Dome,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.

A1.0 TANK C-101 PRE-RETRIEVAL RISK ASSESSMENT RESULTS

This appendix provides tank-specific pre-retrieval risk assessment results for 241-C-101 (tank C-101). The information presented was developed using the methodology described in Section 7.0. Groundwater pathway impacts are presented in Section A2.0. Inadvertent intruder impacts are presented in Section A3.0.

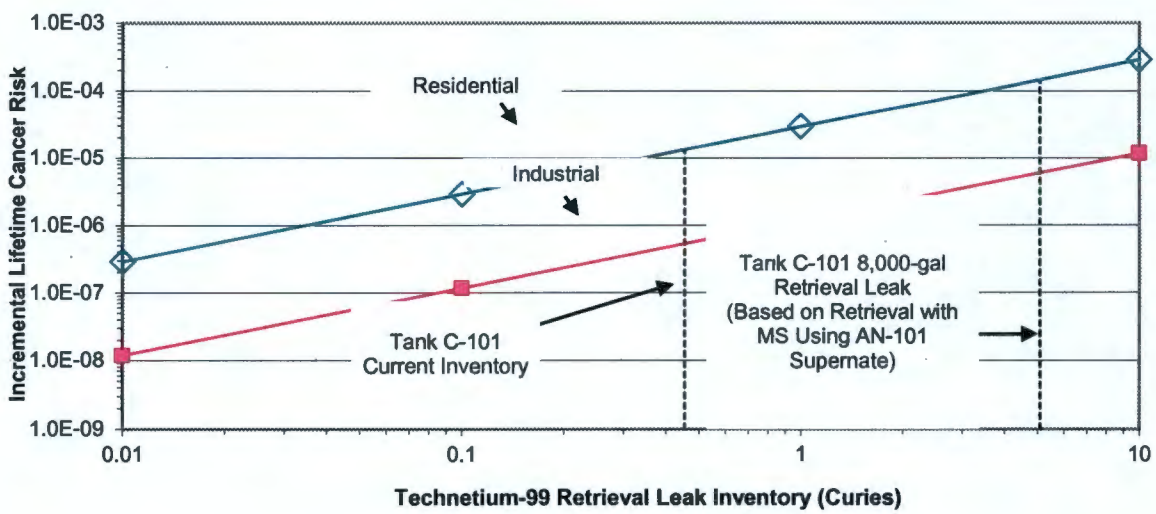
A2.0 GROUNDWATER PATHWAY IMPACTS

The groundwater pathway evaluation involved the development of a set of graphical tools to provide a basis for making informed decisions in the event a leak is detected or unexpected retrieval conditions arise during waste retrieval operations. This section provides and discusses the retrieval leak impact graphs generated for tank C-101. The methodology used to generate the graphs is described in Section 7.1.1. Calculation detail for the graphs is provided in RPP-22521 Rev. 6, *Tanks C-101, C-102, C-105, C-110, and C-111 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan.*

A2.1 RETRIEVAL LEAK IMPACT GRAPHS

Figures A-1 through A-3 provide the tank C-101 waste retrieval leak impact graphs for the three indicator contaminants (technetium-99, hexavalent chromium, and nitrite) identified in Section 7.1.1.1.

Figure A-1. Tank C-101 Technetium-99 Risk Plot.



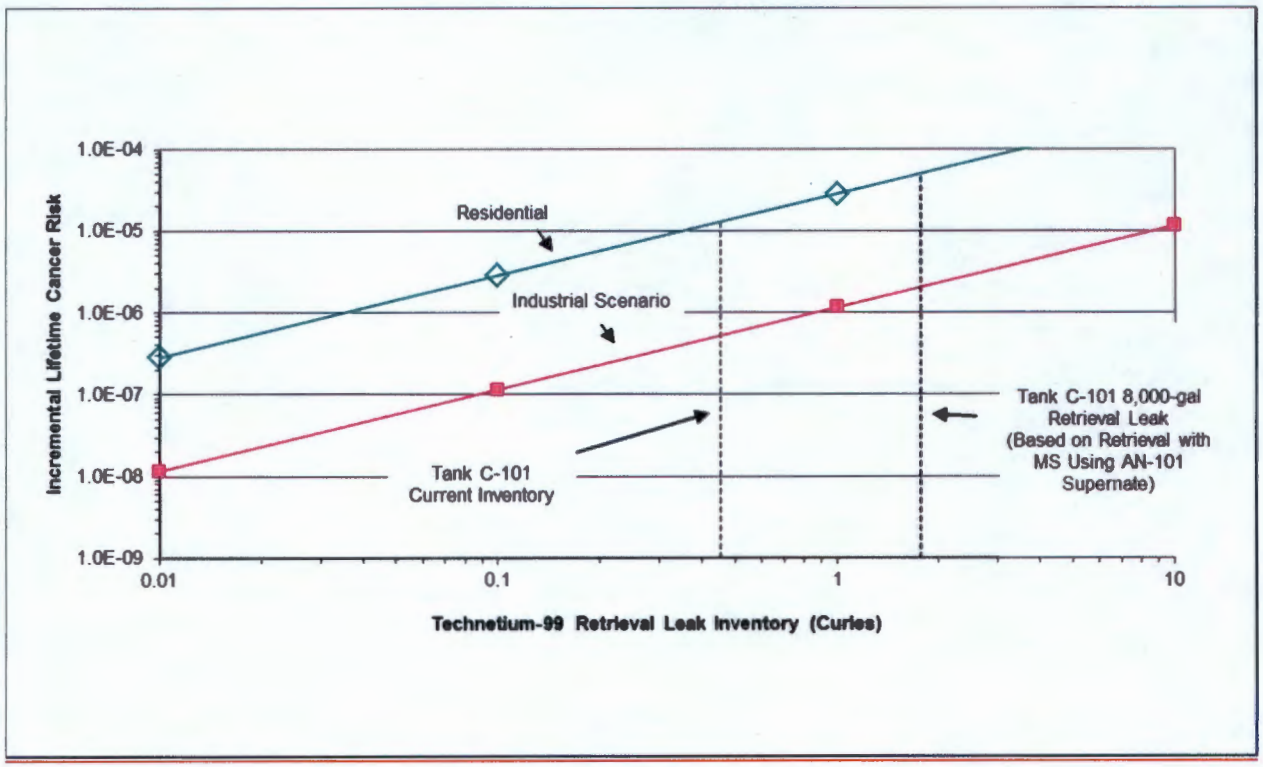
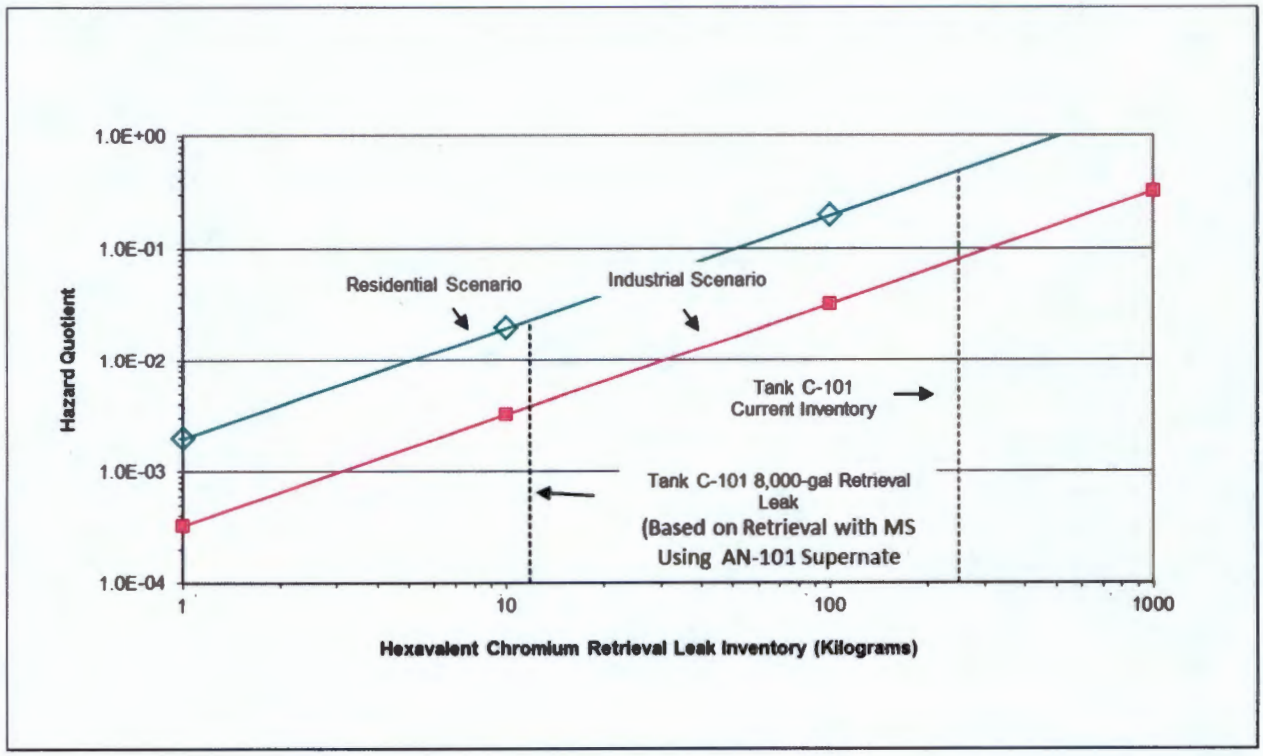


Figure A-2. Tank C-101 Hexavalent Chromium Hazard Quotient Plot.



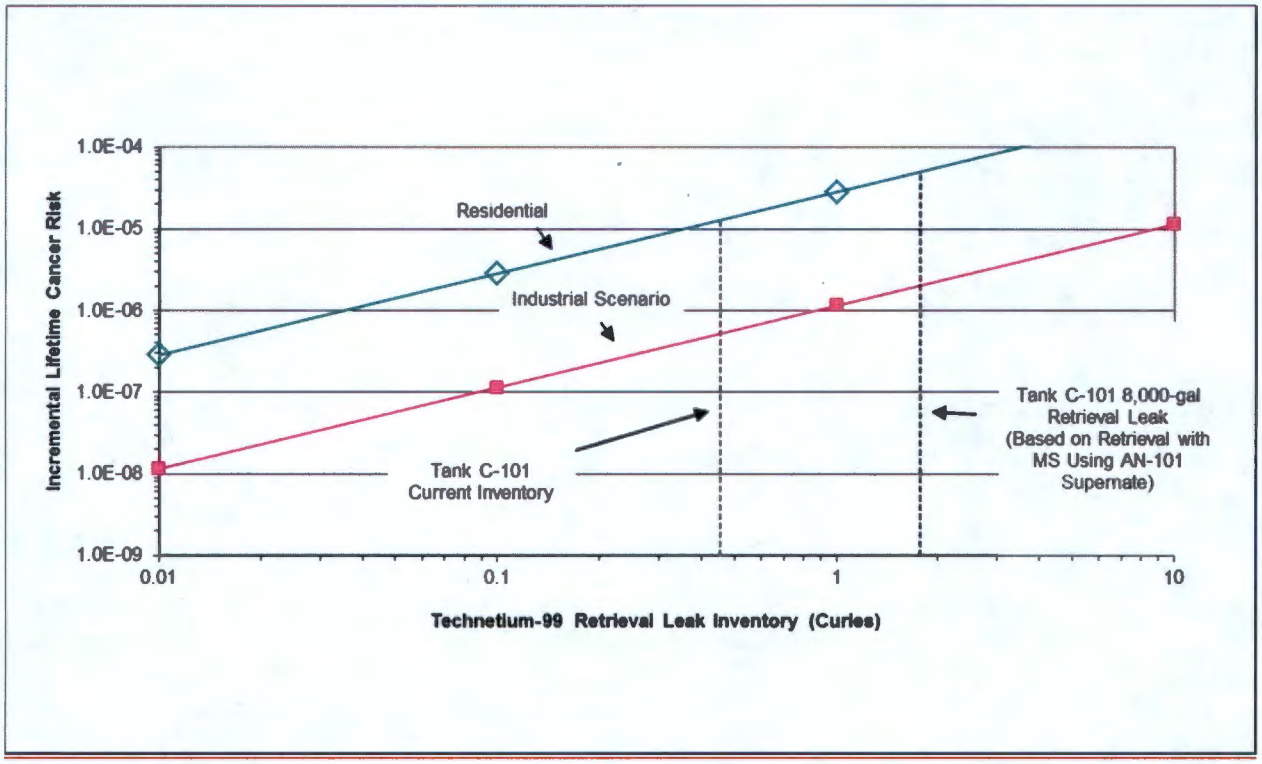
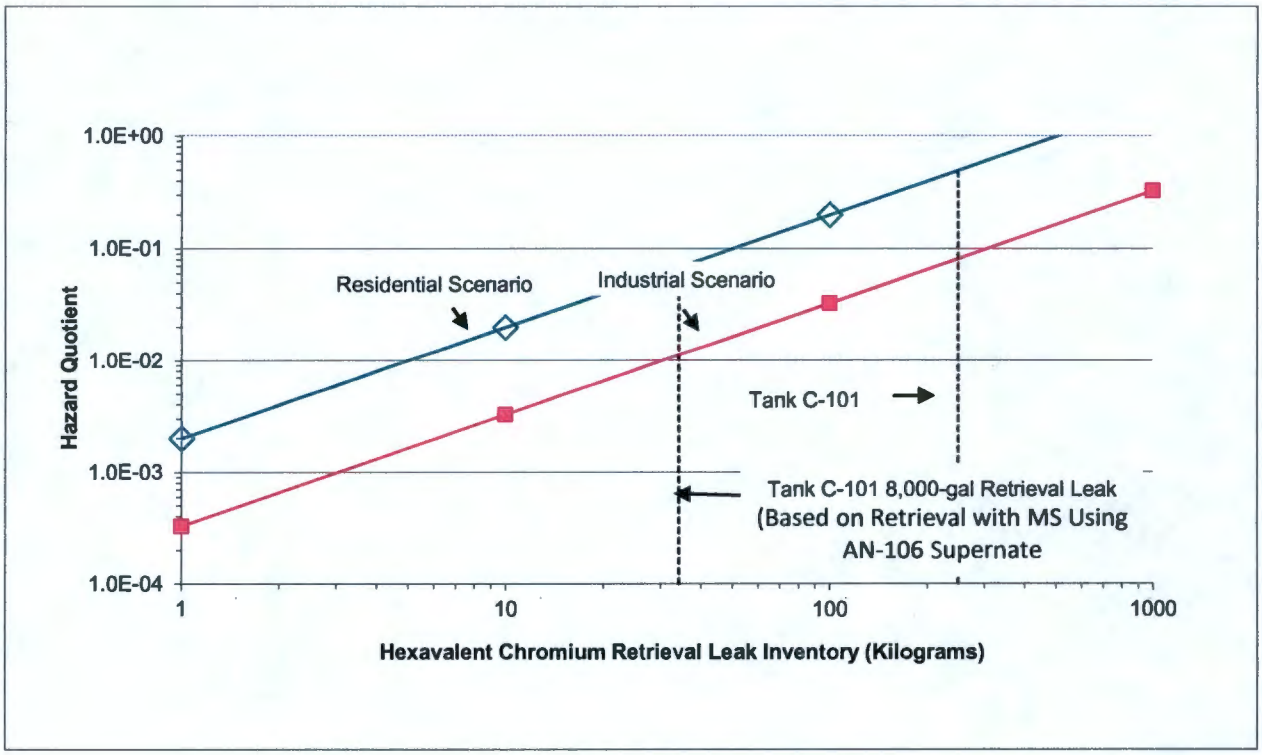


Figure A-2. Tank C-101 Hexavalent Chromium Hazard Quotient Plot.



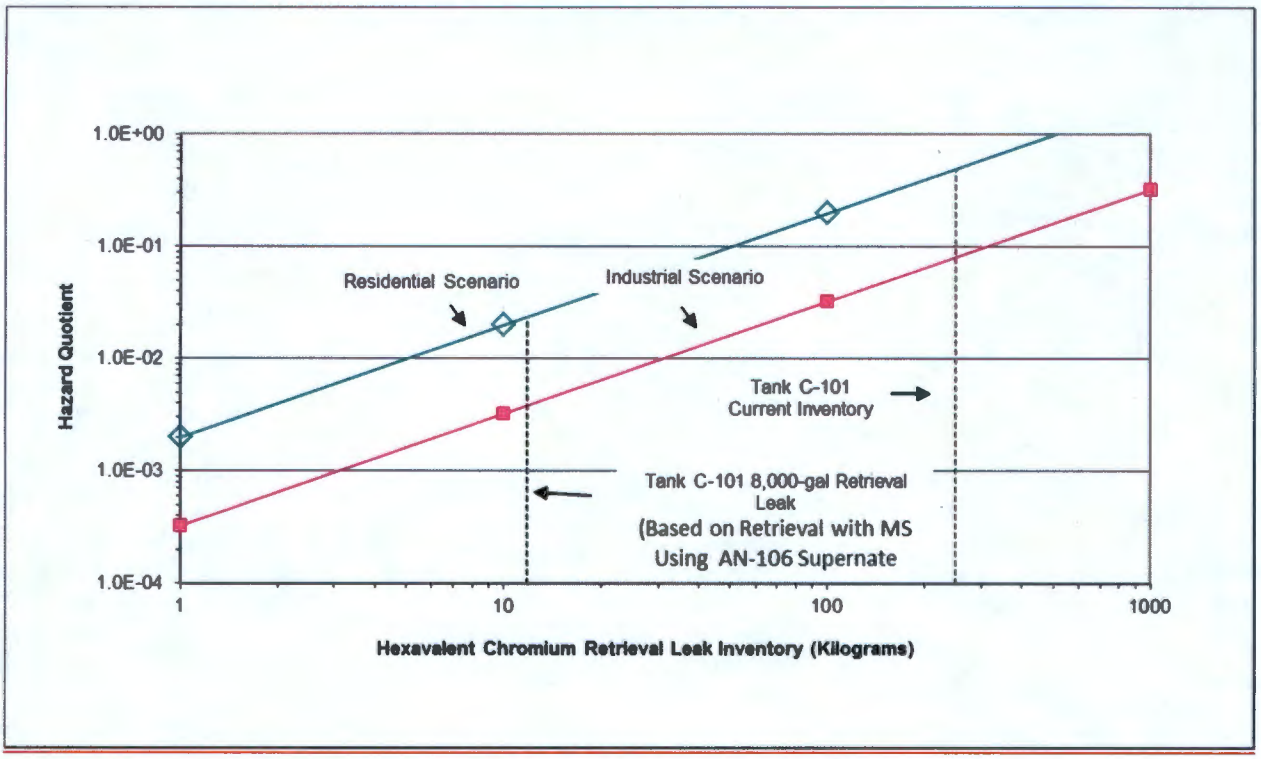
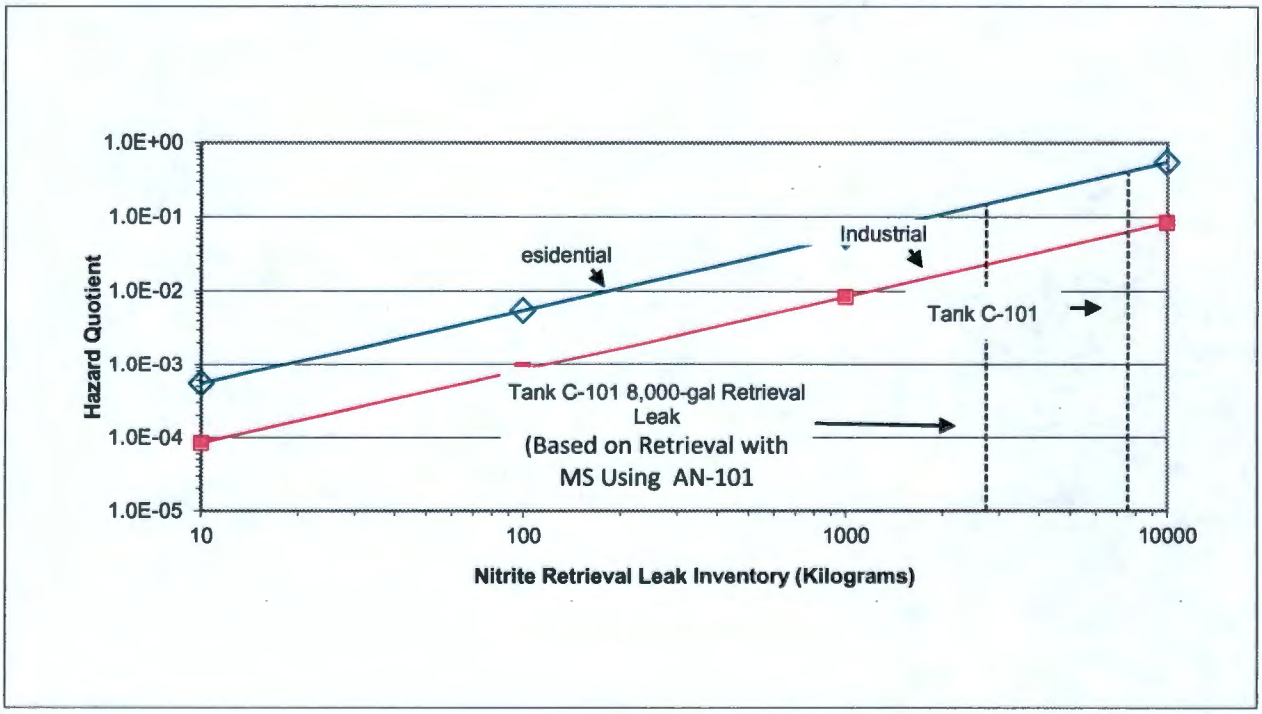


Figure A-3. Tank C-101 Nitrite Hazard Quotient Plot.



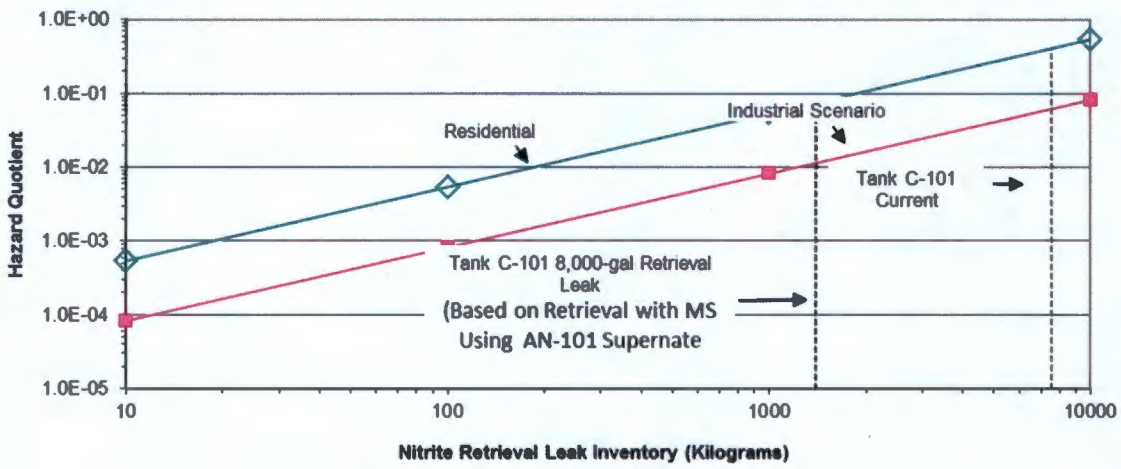


Figure A-1 shows the peak groundwater pathway incremental lifetime cancer risk (ILCR) from technetium-99 as a function of the amount of technetium-99 leaked from tank C-101 during waste retrieval. Figures A-2 and A-3 show the peak groundwater pathway hazard quotient (HQ) from hexavalent chromium and nitrite, respectively, as a function of the amount of hexavalent chromium and nitrite leaked from tank C-101 during waste retrieval.

The ILCR and HQ values shown on the graphs were based on the predicted peak groundwater concentrations at the waste management area (WMA) C downgradient fenceline. As discussed in Section 7.1.1.3, the projected arrival time of the peaks is approximately the year 2082 based on the supporting contaminant transport analysis in RPP-13774, *Single-Shell Tank System Closure Plan*. The graphs provide a retrieval leak risk picture for tank C-101 but do not include contributions from other WMA C sources. Projected impacts from other WMA C sources are discussed in Section 7.1.3.

Two sloped lines representing the industrial and residential scenarios were plotted on each graph. The data points for these lines were calculated as described in Section 7.1.1 over a range of technetium-99, hexavalent chromium, and nitrite values. Because potential retrieval leak volumes are uncertain, the inventory range was selected to encompass a small leak on the low end and a large leak on the high end.

Vertical dashed lines were added to each graph as points of reference to show the estimated current tank C-101 inventory and the inventory associated with a potential 8,000 gal. retrieval leak. The 8,000-gal. volume was a hypothetical volume used only as a point of reference and for consistency with previous analyses. It was not intended to represent anticipated retrieval leak volumes or leak detection limits for tank C-101.

In the event a leak is detected during waste retrieval, the leak monitoring system would be used to estimate the leak volume. The potential human health impacts from the leak could then be evaluated from the leak volume and estimated contaminant concentrations in the leak along with the graphs shown in Figures A-1 through A-3. Using the graphs, the impacts from leak inventories greater or lesser than those shown for the 8,000-gal. reference volume can be estimated rapidly by extrapolating from the impacts shown for the reference volume.

A2.2 INVENTORY

The reference lines shown in Figures A-1 through A-3 to indicate current inventory and retrieval leak inventory were developed from the best available data and information. Current inventories were taken from the best-basis inventory (BBI) by downloading from the Tank Waste Information Network System (TWINS) database (http://twinsweb.pnl.gov/twins.htm). Retrieval leak inventories were calculated by multiplying the hypothetical retrieval leak volume (8,000 gal.) by the estimated retrieval leak fluid concentration. Waste was assumed to be retrieved from tank C-101 with ~~the mobile retrieval system (MRS) using~~modified sluicing using AN-101 supernate~~ water~~. The retrieval leak fluid concentrations for this retrieval scenario were developed using data from RPP-~~21753~~22521~~,~~; the concentrations are shown in Table A-1.~~C-Farm 100 Series Tanks, Retrieval Process Flowsheet Description. The RPP-21753 flowsheet description provides representative contaminant concentrations for the fluids inside the SST, the MRS batch vessel, and the receiver double-shell tank (DST) during retrieval with the MRS. Retrieval leak inventories were developed from the representative SST fluid concentrations from RPP-21753 (Table A-1).~~

Table A-1. Tank C-101 Retrieval Leak Inventory Estimate.

Contaminant	Leak Fluid Concentration *	Inventory in 8,000-gal. Retrieval Leak
Technetium-99	~~1.68E-4~~5.84E-05 Ci/L	~~5.09~~1.77E+00 Ci
Hexavalent Chromium	~~1.13E-3~~3.9E-04 kg/L	~~3.42~~1.18E+01 kg
Nitrite	~~9.03~~4.59E-02 kg/L	~~2.73~~1.39E+03 kg

* Concentrations from Table ~~C-27~~D-9 of RPP-22521, *Tanks C-101, C-102, C-105, C-110, and C-111 Long Term Waste Retrieval Work Plan*

A2.3 SUMMARY OF IMPACTS FROM HYPOTHETICAL 8,000-GALLON RETRIEVAL LEAK

The technetium-99 inventory associated with a hypothetical 8,000 gal. retrieval leak from tank C-101 was estimated to be approximately ~~5.09~~1.77 curie (RPP-22521). As shown in Figure A-1, this corresponds to an ILCR of approximately ~~5.90~~2.05 × 10^{-6} for the industrial scenario and ~~1.44~~4.99 × 10^{-4}~~-5~~ for the residential scenario. The peak technetium-99 groundwater concentration at the WMA C fenceline from this retrieval leak would be approximately ~~427~~ 149 pCi/L.

The hexavalent chromium inventory associated with a hypothetical 8,000 gal. retrieval leak from tank C-101 was estimated to be approximately ~~34.2~~11.8 kg (RPP-22521). As shown in Figure A-2, this corresponds to an HQ of approximately ~~1.12~~3.85 × $10^{\cancel{-2}\,-3}$ for the industrial scenario and ~~6.73~~2.32 × 10^{-2} for the residential scenario. The peak hexavalent chromium groundwater concentration at the WMA C fenceline from this retrieval leak would be approximately ~~2.87~~9.92 × $10^{\cancel{-3}\,-4}$ mg/L.

The nitrite inventory associated with an 8,000 gal. retrieval leak from tank C-101 was estimated to be approximately ~~2730~~ 1390 kg (RPP-22521). As shown in Figure A-3, this corresponds to an HQ of approximately ~~2.27~~1.15 × 10^{-2} for the industrial scenario and ~~1.46~~7.34 × $10^{\cancel{-1}\,-2}$ for the residential scenario. The peak nitrite groundwater concentration at the WMA C fenceline from this retrieval leak would be approximately ~~2.30~~1.17 × 10^{-1} mg/L.

A2.4 EXAMPLE CALCULATION

To illustrate the calculation method used for the retrieval leak impact graphs, the following example is provided. The example uses the industrial scenario ILCR result of ~~5.9~~2.05 × 10^{-6}. Using Equation 7-1 from Section 7.1.1, the industrial scenario ILCR was calculated as the product of the technetium-99 inventory (Table A-1), the technetium-99 retrieval leak unit groundwater concentration factor (Table 7-2), and the technetium-99 industrial scenario unit risk factor (Table 7-3), as follows:

$$\text{ILCR} = (\cancel{5.09}1.77\ \text{Ci}) \cdot (8.4 \times 10^{1}\ \text{pCi/L per Ci}) \cdot (1.38 \times 10^{-8}\ \text{ILCR per pCi/L}) = \cancel{5.90}2.05 \times 10^{-6}$$

Complete calculation details are provided in RPP-22521.

A3.0 INADVERTANT INTRUDER IMPACTS

The starting inventories for the tank C-101 intruder calculation were the estimated radionuclide inventories remaining in the tank following retrieval to the Ecology et al. (1989), *Hanford Federal Facility Agreement and Consent Order* (HFFACO) interim retrieval goal of 360 ft^3 (2,700 gal.) of residual waste. These inventories were taken from RPP-15317, *241-C Waste Management Area Inventory Data Package* and are based on the selective phase removal inventory estimation method. Inventories for all 46 radionuclides reported in the BBI are provided in RPP-15317 and were used in the calculation (RPP-22521). Inventories for the subset of BBI radionuclides that were shown in DOE/ORP-2003-11, *Preliminary Performance Assessment for Waste Management Area C at the Hanford Site, Washington* to dominate intruder doses at 500 years after closure are shown in Table A-2.

Table A-3. Tank C-101 Intruder Dose.

Radionuclide	Well Driller (mrem EDE)	Suburban Resident with a Garden (mrem/yr EDE)	Rural Farmer with a Dairy Cow (mrem/yr EDE)
Strontium-90	0.000	0.007	0.001
Technetium-99	0.000	0.001	0.000
Tin-126	0.000	0.000	0.000
Cesium-137	0.002	0.002	0.000
Plutonium-239	0.105	0.592	0.027
Plutonium-240	0.017	0.095	0.004
Americium-241	0.001	0.005	0.000
Other Radionuclides	0.001	0.002	0.000
TOTAL	0.126	0.704	0.032

Note: The number of significant digits shown in Table A-3 is not intended to imply a level of accuracy greater than the input values.
EDE = effective dose equivalent.

A4.0 REFERENCES

DOE/ORP-2003-11, 2003, *Preliminary Performance Assessment for Waste Management Area C at the Hanford Site, Washington*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

RPP-13774, 2004, *Single-Shell Tank System Closure Plan*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-15317, 2003, *241-C Waste Management Area Inventory Data Package*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-21753, 2005, *C-Farm 100 Series Tanks, Retrieval Process Flowsheet Description*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

~~RPP-22521, *Tanks C-101, C-105, C-110, and C-111 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan*, Latest Revision, Washington River Protection Solutions, LLC., Richland, Washington.~~

RPP-22521, *Tanks C-101, C-102, C-105, C-110, and C-111 Long-Term Human Health Risk Calculations to Support Tank Waste Retrieval Work Plan*, Rev. 6A, Washington River Protection Solutions, LLC., Richland, Washington.