DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

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Release Stamp

DATE:
Jul 13, 2020
HANFORD RELEASE

1. **Doc No:** RPP-CALC-63180 **Rev.** 00

2. **Title:**
Calculation of Inhalation Doses from H-3, C-14 and I-129 Originating from Waste Management Area A-AX

3. **Project Number:** T2C25 ☐N/A

4. **Design Verification Required:** ☐Yes ☒No

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6. **PrHA Number** **Rev.** ☒ N/A

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Clearance Review	Raymer, Julia R	*Raymer, Julia R*	07/09/2020
Checker	Lee, Kearn (Pat)	*Lee, Kearn (Pat)*	04/29/2019
Document Control Approval	Alvarez, Efren	*Alvarez, Efren*	07/09/2020
Originator	Watson, David (Dj) J	*Watson, David (Dj) J*	04/29/2019
Quality Assurance	Lungu, Cris C	*Lungu, Cris C*	04/18/2019
Responsible Engineer	Lee, Kearn (Pat)	*Lee, Kearn (Pat)*	04/29/2019
Responsible Manager	Rutland, Paul L	*Rutland, Paul L*	05/21/2019

8. **Description of Change and Justification**

Initial Release

9. **TBDs or Holds** ☒N/A

10. **Related Structures, Systems, and Components**

a. **Related Building/Facilities** ☒N/A	b. **Related Systems** ☒N/A	c. **Related Equipment ID Nos. (EIN)** ☒N/A

11. **Impacted Documents – Engineering** ☒N/A

Document Number	Rev.	Title

12. **Impacted Documents (Outside SPF):**

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13. **Related Documents** ☐N/A

Document Number	Rev.	Title
RPP-ENV-61497	00	Preliminary Performance Assessment of Waste Management Area A-AX, Hanford Site, Washington

14. **Distribution**

Name	Organization
Bergeron, Marcel P	CLOSURE & INTERIM MEASURES
Childress, Ryan D	CLOSURE & INTERIM MEASURES
Lee, Kearn (Pat)	CLOSURE & INTERIM MEASURES
Rutland, Paul L	CLOSURE & INTERIM MEASURES
Singleton, Kristin M	CLOSURE & INTERIM MEASURES

INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part I: Background Information

Title: Calculation of Inhalation Doses from H-3, C-14 and I-129 Originating from Waste Management Area A-AX

Publish to OSTI? ☐ Yes ☑ No

Information Category:
☐ Abstract ☐ Journal Article ☐ Summary
☐ Internet ☐ Visual Aid ☐ Software
☐ Full Paper ☑ Report ☐ Other

Trademark/Copyright "Right to Use" Information or Permission Documentation	Yes	NA
	☐	☑

Document Number: RPP-CALC-63180 Revision 0 Date: June 2020

Author: Watson, David (Dj) J

Part II: External/Public Presentation Information

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Sponsoring Organization(s): DOE-ORP

Date of Conference: Conference Location:

Will Material be Handed Out? ☐ Yes ☑ No Will Information be Published? ☐ Yes ☑ No *(If Yes, attach copy of Conference format instructions/guidance.)*

Part III: WRPS Document Originator Checklist

Description	*Yes*	*N/A*	*Print/Sign/Date*
Information Product meets requirements in TFC-BSM-AD-C-01?	☐	☑	
Document Release Criteria in TFC-ENG-DESIGN-C-25 completed? (Attach checklist)	☐	☑	
If product contains pictures, safety review completed?	☐	☑	

Part IV: WRPS Internal Review

Function	*Organization*	*Date*	*Print Name/Signature/Date*
Subject Matter Expert	WRPS		Watson, David (Dj) J Approved via att. IDMS data file.
Responsible Manager	WRPS		Rutland, Paul L Approved via att. IDMS data file.
Other:			

Part V: IRM Clearance Services Review

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Document Contains Information Restricted by DOE Operational Security Guidelines?	☐	☑	Reviewer Signature: Print Name/Signature/Date
Document is Subject to Release Restrictions? *If the answer is "Yes," please mark category at right and describe limitation or responsible organization below:*	☐	☑	Document contains: ☐ Applied Technology ☐ Protected CRADA ☐ Personal/Private ☐ Export Controlled ☐ Proprietary ☐ Procurement – Sensitive ☐ Patentable Info. ☐ OUO ☐ Predecisional Info. ☐ UCNI ☐ Restricted by Operational Security Guidelines ☐ Other (Specify)
Additional Comments from Information Clearance Specialist Review?	☐	☑	Information Clearance Specialist Approval APPROVED By Julia Raymer at 9:08 am, Jul 07, 2020 Print Name/Signature/Date

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INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

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WRPS Office of Chief Counsel	☑	☐	Approved via att. IDMS data file.
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Other: ORP SME & OCC	☑	☐	Approved via att. IDMS data file.
Other:	☐	☐	

Comments Required for WRPS-Indicate Purpose of Document:

This environmental model calculation file calculates the maximum dose to a receptor at the Hanford Site boundary inhaling radionuclides emitted from the closed Waste Management Area A-AX in 2050. This document is used to screen out the atmospheric pathway from the WMA A-AX PA.

This calculation report is being referenced by the preliminary Waste Management A-AX Performance Assessment (PA), which will be provided to Ecology later this year. In preparation for providing the preliminary PA to Ecology, the documents that support the PA are also be cleared for public release. The analysis was completed in June 2019, but finalization of the document was put on hold until DOE's Low-Level Waste Disposal Facility Federal Review Group (LFRG) reviewed the PA. That review completed last month so finalization of this report is now moving forward.

Safety statement for photographic images: There are no photographic images in this document.

APPROVED
By Julia Raymer at 9:12 am, Jul 07, 2020

Approved for Public Release; Further Dissemination Unlimited

Information Release Station

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Date Information Product Stamped/Marked for Release: 7/7/2020

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RPP-CALC-63180
Revision 0

Calculation of Inhalation Doses from H-3, C-14 and I-129 Originating from Waste Management Area A-AX

Prepared by:

D.J. Watson
Washington River Protection Solutions, LLC

Date Published
June 2020

washington river protection solutions

Prepared for the U.S. Department of Energy
Office of River Protection

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ENVIRONMENTAL MODEL CALCULATION COVER PAGE

SECTION 1: COMPLETED BY RESPONSIBLE MANAGER OR DESIGNEE

Rev. 0
RELEASE/ISSUE

Project: Waste Management Area A-AX Performance Assessment

Date: 4/17/2019

Calculation Title and Description: Calculation of Inhalation Doses from H-3, C-14, I-129 Originating from Waste Management Area A-AX

SECTION 2: COMPLETED BY PREPARER

Calculation No.: RPP-CALC-63180 Revision No.: 0

Revision History

Revision No.	Description	Date	ADD ROW Affected Pages
Rev. 0	Initial issue	4/17/2019	

D

SECTION 3: COMPLETED BY RESPONSIBLE MANAGER OR DESIGNEE

Document Control

1. Is document intended to be controlled within SmartPlant? ☒ Yes ☐ No
2. Does document contain scientific and technical information intended for public use? ☒ Yes ☐ No
3. Does document contain controlled-use information? ☐ Yes ☒ No

SECTION 4: TRAINING AND SOFTWARE INSTALLATION APPROVAL
(COMPLETED PRIOR TO PERFORMING CALCULATION)

Modeler-Required Training Completed:

Training Coordinator:

Print First and Last Name	Position	Signature	Date
MARCEL BERGERON	Principal Scientist	[signature]	4/25/19

Software Installation and Checkout Certified:

Integration Lead:

Print First and Last Name	Position	Signature	Date
N/A (HAND CALCULATION)			

SECTION 5: DOCUMENT REVIEW AND APPROVAL

	Print First and Last Name	Position	Signature	Date
Preparer:	David J. Watson	Scientist	[signature]	4/17/2019
Checker:	K. Pat Lee	Senior Scientist	[signature]	4/17/2019
Senior Reviewer:	Matt Kozak	Principal Engineer	[signature]	4-23-19
Responsible Manager or Designee:	Bob Hiergesell	Senior Scientist	[signature]	4/23/19

A-6006-716 (REV 1)

Report Number: RPP-CALC-63180 Revision 0

Report Title: Calculation of Inhalation Doses from H-3, C-14 and I-129 Originating from Waste Management
Area A-AX

The following checklists are used in lieu of an appropriate checklist listed in TFC-ESHQ-ENV_FS-C-05 for this environmental model calculation.

Item No.	Yes	No	N/A	Item
				Version/Format
1			X	If revising an existing report, are the changes being made against the current revision in SPF?
2	Y			Is the Document Release and Change Form (DRCF) properly filled out?
3		N		Are all of the pages properly labeled with Report Number, Revision Number, and Sequential Page Number?
4	Y			Are the Subject and Purpose clearly stated and do they meet the end users' needs?
				References
5	Y			Are all References properly documented within the report and can they be easily verified within Document Control, online, or within the library, etc.? If reference documents are not readily available, are they attached?
6	Y			Have the correct design bases documents been identified (e.g., codes, standards, DOE Orders, TOC standards, regulatory requirements, etc.)?
				Open Items/Input
7	Y			Is there a reference/source for each input?
8	Y			Do the identified references/sources fully support the inputs?
9	Y			Are all assumptions used to support the report individually listed and numbered?
10	Y			Is there a justification written for each assumption that includes a technical basis?
11	Y			Do the justifications adequately support the assumptions?
12			X	If the report has open items, TBDs, and/or HOLDs, is there a method identified to track them?
				Results/Conclusion
13	Y			Are the results of the report consistent with the input and assumptions?

14		N		Do the results of the report affect any other technical documents?
15	Y			Do the results substantiate the conclusion?
				Approvals
16	Y			Does the DRCF identify the method of verification and checking and does it have a signature block for the verifier/checker?

Item No.	Comments
3	The checked revision was in the queue for a technical edit, incorrect page numbering in Section 2 will be identified. However, Smart Plant includes sequential page numbering so the resolution will not be back-checked.
NA	All results called out in the report are verified against the calculated values. In puts are verified against the cited source. Hand calculations are independently verified in their entirety using a spreadsheet.
NA	All files used for checking and resolving comments are contained in a zip archive that is attached to the SmartPlant record for this report.

Checker: Kearn Patrick Lee _____ Kearn Patrick Lee _____ 4/18/19
Print Name **Signature** **Date**

On May 26, 2020 an update to the calculation to change the DCF values was performed. The spreadsheet used to calculate the screening dose was re-checked and determined to be correct. In addition, the dose results were updated correctly in the document.

K Pat Lee

Digitally signed by K Pat Lee
Date: 2020.05.27 09:18:59 -07'00'

Calculation Checklist

Yes	No[1]	NA		
☐	☐	☒	a.	The calculation was formatted in accordance with Attachment A of TFC-ENG-DESIGN-C-10.
☒	☐	☐	b.	The objective/purpose of the calculation is clearly stated and the problem is completely defined by the purpose statement.
☒	☐	☐	c.	Analytical and technical approaches and results are reasonable and appropriate.
☒	☐	☐	d.	Input data are adequately described, referenced to their source, and checked for consistency with original source information.
☒	☐	☐	e.	Necessary assumptions are reasonable, explicitly stated, and technically justifiable. Assumptions requiring verification prior to use are clearly stated and identified/tracked using TBD/HOLD numbers.
☐	☐	☒	f.	For both qualitative and quantitative data, uncertainties are recognized and discussed and the data is presented in a manner to minimize design interpretations.
☒	☐	☐	g.	Mathematical derivations were checked, including dimensional consistency of results.
☒	☐	☐	h.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring recourse to the originator.
☒	☐	☐	i.	Calculations were verified, including review that correct input data are used, equations are correctly applied to the problem being analyzed, correct units are used, and results are reasonable and appropriate.
☐	☐	☒	j.	Results produced by Mathcad® were replicated/verified by hand or alternate methods. If results could not be replicated/verified by hand, the utilized Mathcad® feature (e.g. advanced math function, equation, macro, etc.) is verified and registered in HISI.
☐	☐	☒	k.	Software[2] used is identified by the software name, version, HISI ID#, and if applicable the Software Management Plan (SMP).
☐	☐	☒	l.	Software is used in accordance the requirements prescribed by the Software Owner.[3] This includes adherence to limits of use, training requirements, software settings, specific software checklists, usage logs, error report checks, etc.
☐	☐	☒	m.	Software input reports and input files are attached.
☐	☐	☒	n.	The input was correctly entered/modeled in the Software, and consistent with the calculation document.
☐	☐	☒	o.	Software output is consistent with the input and with the results reported in the calculation document.
☐	☐	☒	p.	Multiple-Use spreadsheets are used in accordance with TFC-ENG-DESIGN-C-32, and identified by file name, version, HISI ID#, and as applicable; the SMP or Spreadsheet Verification Form.
☐	☐	☒	q.	Single-Use spreadsheets used in the calculation have adequate explanation of their method, are identified by file name, and checked/verified as part of the calculation.
☒	☐	☐	r.	Data or results presented in tables and graphs have been checked against original source.
☒	☐	☐	s.	The number of significant digits is appropriate and consistent.
☐	☐	☒	t.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
☒	☐	☐	u.	Conclusions are consistent with analytical results and applicable limits.
☒	☐	☐	v.	Results and conclusions address all points in the purpose.
☒	☐	☐	w.	Referenced documents are retrievable or otherwise available and the version or revision of each reference is cited.
☐	☐	☒	x.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
☐	☐	☒	y.	The design media matches the calculations.

Checker: Kearn Patrick Lee 4/18/19

Checkbox Justifications:

A The calculation is formatted correctly for an Environmental Calculation File using TFC-ESHQ-ENV_FS-C-05.

F The analysis is a screening analysis that uses bounding assumptions that don't require justification or a treatment of uncertainty.

[1] If any blocks are checked "No", a justification must be provided here or attached.
[2] Does not apply to non-computational software (e.g. Word®, Visio®).
[3] The Software Owner is responsible for managing software, including requirements, in accordance with TFC-BSM-IRM_HS-C-01.

J Calculation is a hand calculation that was independently replicated by the checker in its entirety using a spreadsheet.

K through Q This is a hand-calculation using simple arithmetic operations. No calculation software is involved.

T Calculation is a screening calculation performed in accordance with Senior Reviewers direction. No limits are reported.

X There are no specific requirements for screening calculations.

Y There is no design media. This calculation is fully replicated in the calculation document.

EXECUTIVE SUMMARY

This environmental model calculation file calculates the maximum dose to a receptor at the Hanford Site boundary inhaling radionuclides emitted from the closed Waste Management Area A-AX in 2050. The calculation uses the entire inventory of ^{129}I, ^{3}H, and ^{14}C from all sources at Waste Management Area A-AX emanating from the ground surface over the course of a year. The receptor dose is calculated over the same year using atmospheric dispersion coefficients derived from previous work at the Hanford Site. The dispersion coefficient chosen for the calculation corresponds to 24 km, which represents the shortest distance between Waste Management Area A-AX and the Site boundary in the prevailing wind direction. For comparison, the doses at 12 km northeast (representing the shortest distance between Waste Management Area A-AX and the Site boundary regardless of wind direction) and at 0.1 km southeast of the closed tank farm are also calculated.

For the calculation in the prevailing wind direction, the total dose is 1.04×10^{-4} mrem and for the calculation using the shortest distance between Waste Management Area A-AX and the Site boundary, the total dose is 1.40×10^{-4} mrem. When calculated for 0.1 km southeast of the closed tank farm, the total dose is 0.83 mrem. In all three cases, ^{129}I contributes 99.4% of the dose, and ^{14}C and ^{3}H each contributes 0.3% of the dose.

By using highly conservative input parameters, this simple calculation shows that the inhalation dose to a receptor offsite is orders of magnitude lower than the performance objective of 10 mrem/yr. For this reason, the atmospheric dose is screened out and is not developed further in the Waste Management Area A-AX system model.

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LIST OF TERMS, ACRONYMS, AND ABBREVIATIONS

AERMIC	AMS/EPA Regulatory Model Improvement Committee
AMS	American Meteorological Society
DCAL	Dose and Risk Calculation
DCF	dose conversion factor
DOE	U.S. Department of Energy
EMCF	environmental model calculation file
EPA	U.S. Environmental Protection Agency
IAEA	International Atomic Energy Agency
IDF	Integrated Disposal Facility
IMBA	Integrated Modules for Bioassay Assessment
MPR	model package report
NEPA	National Environmental Policy Act
PA	Performance Assessment
PUREX	Plutonium Uranium Extraction
RESRAD	RESidual RADioactive
SST	Single-Shell Tank
STOMP	Subsurface Transport Over Multiple Phases
WMA	Waste Management Area
WRPS	Washington River Protection Solutions, LLC
WTP	Waste Treatment Plant

1.0 PURPOSE

The purpose of this environmental model calculation file (EMCF) is to document a calculation of the dose to a receptor at the Hanford Site boundary inhaling radionuclides emitted from the closed Waste Management Area (WMA) A-AX.

This calculation documents the assumptions and methodology for calculating this dose. Its primary goal is to determine the maximum inhalation dose to a receptor from ^{129}I, ^{3}H, and ^{14}C from all sources at WMA A-AX. These calculations are performed using the entire inventory of these nuclides emanating from the ground surface over the course of a year. The receptor dose is calculated over the same year using a method drawing on previous work on atmospheric dispersion for the Central Plateau in which the annual sector-average atmospheric dispersion coefficients (χ/Q) were estimated for ground level and 60-m releases for the 100-N, 200, 300 and 400 Areas at Hanford [PNNL-6415, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Rev. 18]. These dispersion coefficients are based on meteorological data collected from 1983 through 2006. The dispersion coefficient chosen for the calculation corresponds to 24 km, which is the nearest value in Table A11 of PNNL-6415 to the shortest distance between WMA A-AX and the Site boundary in the prevailing wind direction (20 km, Hanford Geographic Information System, Queried 02/14/2019, [HMAPS Interactive Maps – General Map], http://hmaps.rl.gov/Viewers/index.html?viewer=generalmap#). For comparison, the doses at 12 km northeast (the shortest distance between WMA A-AX and the Site boundary) and 0.1 km southeast of the closed tank farm are also calculated.

1.1 OBJECTIVE

The objective of this calculation is to estimate the dose to a receptor at the Hanford Site boundary by using the entire inventory of ^{129}I, ^{14}C and ^{3}H in all sources at WMA A-AX released over 1 year to determine whether or not further development of the Atmospheric Pathway module of the WMA A-AX system model is necessary. These dose calculations were hand-calculated and support the WMA A-AX performance assessment (PA) focused on radiological impacts to meet the requirements for a closure authorization under DOE O 435.1, *Radioactive Waste Management*.

1.2 SUPPORTING DOCUMENTS

The calculations use conceptual models and mathematical models that are appropriate for the intended use as documented in a series of data package reports, model package reports (MPRs), other environmental calculation reports, and/or other technical literature.

1.2.1 Data Package Reports

Data package reports are reports that are developed for use in the environmental model. Data package reports supporting this calculation support key assumptions and parameterization.

The data package report(s) that support this calculation are:

RPP-CALC-62319, in process	*Residual Waste Source Inventory Term for the Waste Management Area A-AX Performance Assessment Inventory Case 1*
RPP-ENV-58813, Rev. 1	*Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington*

1.2.2 Model Package Reports

Model package reports are reports that describe the conceptual and mathematical models used in the calculation. No model package reports were needed for this calculation.

1.2.3 Other Environmental Model Calculation Files

Environmental model calculation files are reports that describe the conceptual and mathematical models used in the calculation and the result of the calculations, which are potentially used in subsequent calculations or to support a PA conclusion. No other EMCFs were needed to support this calculation.

1.2.4 Other Technical Reports

Other technical reports are reports that describe the conceptual and mathematical models, or supply parameters used in the calculation. Other technical reports supporting this calculation support conceptual model selection, mathematical model selection, and parameterization.

Other technical reports that support this calculation are:

PNNL-6415, Rev. 18	*Hanford Site National Environmental Policy Act (NEPA) Characterization*

1.3 DOCUMENT STRUCTURE

The structure of this environmental calculation report follows the required structure of an EMCF.

- Section 2.0 provides supplemental background for the calculation.
- Section 3.0 describes calculation methodology.
- Section 4.0 describes the assumptions and inputs.
- Section 5.0 describes the computational software.
- Section 6.0 describes the output(s) from the environmental model.
- Section 7.0 provides the calculation results and conclusions.
- Section 8.0 is a list of references cited in this calculation report.

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2.0 BACKGROUND

This section provides background on WMA A-AX, and justifies the methodology used in the calculation.

2.1 HISTORY

WMA A-AX comprises the 241-A and 241-AX Tank Farms and is located within the 200 East Area of the Central Plateau of the Hanford Site. The 241-A Tank Farm (A Farm) and 241-AX Tank Farm (AX Farm) were constructed between 1953 and 1955 and between 1963 and 1965, respectively. The WMA A-AX tank farms are surrounded by several other double-shell tank farms within the A Complex, and Single-Shell Tank (SST) Farm 241-C (C Farm) is located nearby to the northwest (Figure 2-1). WMA A-AX includes catch tanks, diversion boxes, valve pits, pipelines, French drains, and unplanned release sites. Numerous liquid discharge facilities used at various times (cribs, trenches, ditches, septic systems, etc.) surround the WMA.

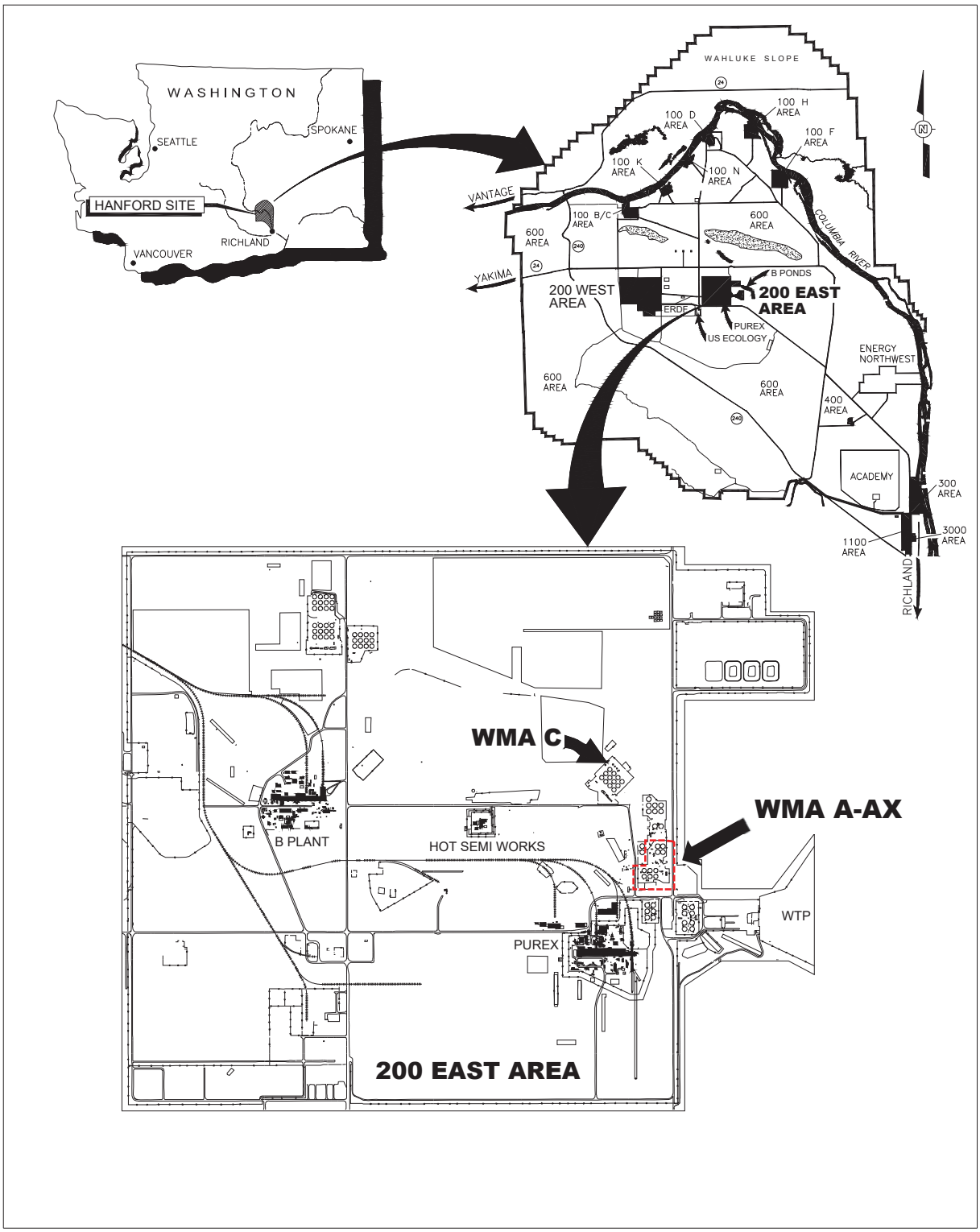
The tanks in both A Farm and AX Farm were designed for the storage of boiling waste generated from irradiated fuel reprocessing at the 202-A Plutonium Uranium Extraction (PUREX) Plant. A Farm contains six 75-ft diameter nominally 1,000,000-gal capacity SSTs that consist of a carbon steel liner inside a concrete tank. AX Farm contains four such SSTs of a later design. A Farm and AX Farm were placed in service in 1955 and 1965, respectively, and both were used to store and transfer waste until mid-1980.

Figure 2-2 illustrates the closure concept for WMA A-AX following tank waste retrieval. Surface facilities will be removed and retrieved SSTs and accessible ancillary equipment with significant void spaces will be filled with grout. Waste transfer pipelines are also expected to be left in place. An engineered surface cover system will be placed over the tank farm and contaminant migration from the closed WMA will be monitored using groundwater wells.

In brief, as of 2018, plans for the future closure of A Farm and AX Farm call for retrieval of wastes remaining in the SSTs (mostly sludge and saltcake solids) to the maximum extent practicable, grouting the residual wastes and interior volume of the SSTs, and construction of a surficial barrier over the tank farms.

Gases or vapors that are released from the residual waste can potentially diffuse upward through the infill grout, the tank shell or ancillary equipment structure, and the closure barrier to the ground surface, where they can subsequently be transported downwind through the atmosphere to a receptor location.

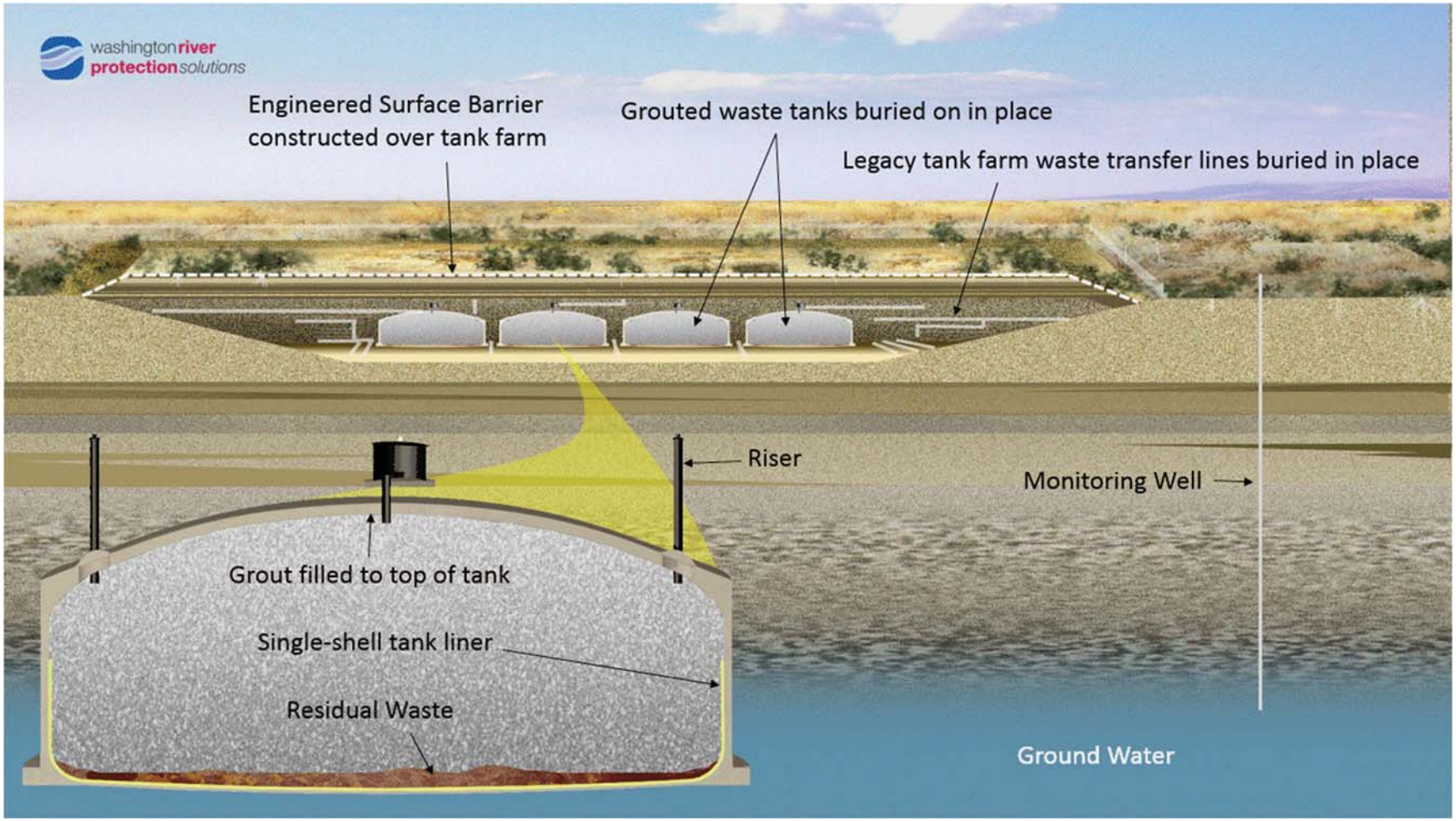
Figure 2-1. Location of Waste Management Area A-AX in Relation to Hanford Site.



H:\CHG\241-C TF\2E-WMA-C1A

WTP = Waste Treatment Plant PUREX = Plutonium Uranium Extraction (Plant) WMA = Waste Management Area

Figure 2-2. Conceptual Model of Closure of Waste Management Area A-AX.



2.2 JUSTIFICATION OF METHODOLOGY

Gases that may be released from WMA A-AX are evaluated against the prescribed performance objectives identified in DOE O 435.1, namely the all-pathways dose limit to humans from both groundwater and air contamination of 25 mrem/yr, and a 10 mrem/yr limit for atmospheric releases. In calculation of these potential doses, it is assumed that institutional control and societal memory is retained for the first 100 years after the year of closure. Therefore, during the first 100 years the nearest potential exposure of a member of the public is at the Hanford Site boundary. At the end of 100 years, it is assumed that both institutional control and societal memory of the Hanford Site is lost, and an individual may move onto the Hanford Site. At times after 100 years, the point of compliance established by DOE O 435.1 is 100 m from the boundary of the facility.

Analyses for atmospheric releases from WMA C (RPP-ENV-58782) indicated that releases of gases from the WMA were projected to occur within the first hundred years after closure. Similar results are anticipated from comparable calculations for WMA A-AX. Therefore, the primary point of exposure considered in this screening calculation is the Hanford Site boundary.

However, PAs contain numerous assumptions that are intended to be conservative by assuming minimal function of engineered features. In particular, in both the WMA C and WMA A-AX PAs, it is assumed that the steel tank shell provides no barrier to contaminant transport starting at the time of closure. In reality, the tank shells are intact, and will likely remain intact for a long time after closure. Consequently, the potential for gas releases to be delayed beyond 100 years after closure should also be considered. For this reason, a secondary screening analysis has been conducted, comparing calculated doses to a receptor at 100 m from the WMA boundary.

The DOE technical standard DOE-STD-5002-2017, *DOE Standard Disposal Authorization Statement and Tank Closure Documentation* states that

> "The exposure scenarios for atmospheric pathways should consider immersion in and direct inhalation of air contaminated with volatile and non-volatile radionuclides. Atmospheric exposure scenarios should also consider external exposure, ingestion of crops, soil, livestock and dairy products from the deposition of contaminated particles, and inhalation of re-suspended contaminated particles."

However, projected releases from WMA A-AX are limited to ^{3}H, ^{14}C, and ^{129}I. Simple inspection of the dose coefficients for these three radionuclides shows that immersion doses are negligible compared to inhalation doses for a given airborne concentration. Furthermore, potential releases from a closed WMA are only envisioned as vapor releases; there is no potential release of particulates, with subsequent redeposition, from a WMA in its post-closure configuration.

However, ^{3}H and ^{14}C have the potential to be incorporated into the food chain directly from airborne concentrations, as tritiated water and $^{14}CO_2$ are components of plant photosynthesis. Consequently, ^{3}H and ^{14}C could potentially contribute to the calculated dose from gaseous

release from a closed WMA. For the current screening calculations, the dose is calculated as an inhalation dose to a person assumed to be standing at the point of maximum concentration at the compliance boundary. Doses from ^{3}H and ^{14}C entering the food chain must be calculated from a wider area-averaged concentration: there must be sufficient area to grow the food to support the exposed person in the dose calculation. Such area-averaged concentrations are dependent on where the crops are grown relative to the source, but generally are substantially below the maximum point concentration used in the inhalation calculation, and associated doses are not likely to be significant compared to inhalation doses. Consequently, the screening calculation presented in this EMCF focuses on inhalation dose as the sole screening criterion.

Calculating inhalation dose to a receptor using annual sector-average atmospheric dispersion coefficients (χ/Q) (PNNL-6415) is a straightforward set of arithmetic operations easily calculated by hand. Using highly conservative input parameters, this simple calculation shows that the inhalation dose to a receptor offsite is orders of magnitude lower than the performance objective of 10 mrem/yr. For this reason, the atmospheric dose is screened out and is not developed further in the WMA A-AX system model.

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3.0 METHODOLOGY

This calculation is performed using the methods described in RPP-ENV-58813, and which are detailed in Section 3.2. Assumptions and inputs used in the calculation are further described in Section 4.0.

3.1 SELECTION OF TECHNICAL STAFF

The responsible manager or a selected delegate is responsible for selecting the technical staff that develops the conceptual and mathematical approach, performs and documents the calculations, checks the work, and reviews the calculation for technical accuracy and completeness.

For the calculations described in this EMCF, the Washington River Protection Solutions, LLC (WRPS) technical lead, as delegated by the responsible manager, has selected the technical staff.

3.1.1 Originators

The originators or preparers of the environmental model calculation develop the methodology; gain early concurrence with the senior reviewers; identify project conditions, assumptions, and inputs; and prepare the calculation and associated calculation report.

David J. (DJ) Watson (Washington River Protection Solutions), Scientist
MS 2009, Environmental Science, Washington State University
BS 1996, Geology, Washington State University

DJ Watson has over 16 years of human health risk assessment and PA experience. He has over 13 years of environmental modeling experience, including: subsurface contaminant transport using STOMP©[1], pflotran[2], and TOUGH2[3]; air dispersion with AERMOD[4]; internal and external

[1] Subsurface Transport Over Multiple Phases (STOMP)© is copyrighted by Battelle Memorial Institute, 1996.
[2] PFLOTRAN is open-source software and can be redistributed and/or modified under the terms of the GNU Lesser General Public License as published by the Free Software Foundation.
[3] TOUGH2 software was developed by Lawrence Berkeley National Laboratory, University of California, Berkeley, California with support from the Office of Science, Office of Basic Energy Sciences, Materials Sciences and Engineering Division of the U.S. Department of Energy.
[4] AERMOD atmospheric dispersion modeling system was developed by the AERMIC (American Meteorological Society [AMS]/U.S. Environmental Protection Agency [EPA] Regulatory Model Improvement Committee), a collaborative working group of scientists from the AMS and the EPA.

radiological dosimetry using IMBA®[5], DCAL[6], OLINDA[7], and RESRAD[8]; and system modeling using GoldSim©. He has worked in the areas of underground tank waste retrieval and tank closure, radiation dosimetry from both internally-deposited radionuclides and external exposure, nuclear fuel fabrication and transport, and geologic carbon dioxide sequestration. His work has supported the U.S. Department of Energy (DOE), U.S. Nuclear Regulatory Commission, International Atomic Energy Agency (IAEA), Joint Global Change Research Institute and other industrial and research organizations.

3.1.2 Checkers

The checker reviews the environmental model calculation to verify that it is clearly developed and that the calculation was performed as described and without error. Checking includes ensuring that all the inputs are consistent with the original referenced material. The checker documents the review of the calculation on an appropriate Checker Log.

Kearn Patrick (Pat) Lee (Orano Federal Services) Advisory Engineer
MCE, 1996, Civil and Environmental Engineering, University of Delaware
BChE, 1993, Chemical Engineering, University of Delaware

Pat Lee has over 18 years of modeling experience using the GoldSim© RT Module to perform PAs for DOE. He was a lead analyst on the high-level waste PA for Yucca Mountain from 2001 to 2010 and has been the technical lead for the Hanford Integrated Disposal Facility (IDF) PA since 2015. He has presented models he developed for the Yucca Mountain Project at several GoldSim© user's conferences and he also developed Yucca Mountain Project training modules to provide an overview of the Yucca Mountain high-level waste PA model. He has developed and checked several models for the IDF PA. He has checked several other models for the WMA A-AX PA.

3.1.3 Senior Reviewers

The senior reviewer(s) review(s) the calculation methodology, assumptions, and criteria and verifies they are appropriate for the intended use and that the calculation was developed correctly.

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[5] Integrated Modules for Bioassay Assessment (IMBA)® is a registered trademark of Public Health England, London, United Kingdom; IMBA Expert™ DOE-Edition is a trademark of ACJ & Associates, Richland, Washington and U.K. Health Protection Agency, Oxfordshire, United Kingdom.

[6] DCAL (Dose and Risk Calculation) software was developed by the Dosimetry Research Group (now the Biosystems Modeling Team in the Advanced Biomedical Science and Technology Group) at Oak Ridge National Laboratory under the sponsorship of the U.S. Environmental Protection Agency.

[7] OLINDA code was written by Michael Stabin, PhD, CHP, Department of Radiology and Radiological Sciences, Vanderbilt University, Nashville, Tennessee.

[8] The RESRAD (RESidual RADioactive) family of codes is developed at Argonne National Laboratory, Lemont, Illinois, managed by UChicago Argonne, LLC, for the U.S. Department of Energy's Office of Science.

Matthew W. Kozak (INTERA, Inc.)

PhD, 1988, Chemical Engineering, University of Washington
BS, 1981, Chemical Engineering, Cleveland State University

Dr. Kozak has more than 27 years of experience in the areas of performance assessment of near-surface and geological radioactive waste repositories, regulatory development, dose assessment for residual contamination of soils and buildings, toxic materials risk assessment, and mixed waste issues. He is the author of over 100 publications on these topics. He has supported national programs in the U.S. and countries in Europe, Asia, and Africa to site, develop, construct, and analyze facilities for disposal of radioactive waste.

He has participated in a number of international research programs, including the IAEA's Coordinated Research Program on Improvement of Safety Assessment Methodologies, and its successor programs: Application of Safety Assessment Methodologies, Practical Illustration and Use of the Safety Case Concept in the Management of Near-Surface Disposal, and most recently Modelling and Data for Radiological Impact Assessments.

He is a principle investigator for the WMA A-AX PA.

3.2 CONCEPTUAL MODEL

Of the radionuclides contained in residual inventory at closure, three could potentially originate as gas, and need to be considered as potential contributors to doses associated with the atmospheric pathway:[9]

- Carbon-14
- Hydrogen-3 (tritium)
- Iodine-129.

The conceptual model is a simple dose calculation that converts each radionuclide's inventory to an emission rate, which is then converted to a concentration in air at the receptor's site through the use of atmospheric dispersion coefficients. The concentrations are converted to dose by accounting for the receptor's indoor inhalation rate, fraction of time spent indoors, outdoor inhalation rate, fraction of time spent outdoors and radionuclide-specific dose conversion factors. The sum of these doses is the total inhalation dose to the receptor. Lesser exposure pathways, e.g., ingestion of foods contaminated by the airborne plume, are neglected in this screening calculation.

[9] The dose performance objective in DOE O 435.1 excludes the contribution from radon.

3.3 MATHEMATICAL MODEL

The concentration of gaseous constituents of potential concern at the receptor location is calculated by (PNNL-6415):

$$\chi = \frac{\chi}{Q'} \times Q \tag{3-1}$$

Where:

χ	=	Air concentration (Ci/m^3)
$\frac{\chi}{Q'}$	=	factor – concentration at receptor location per unit release from source (s/m^3)
Q	=	Emission rate (Ci/s) – in this screening calculation the emission rate is calculated by dividing the inventory by 31,557,600 (seconds in a year).

The resulting concentration in air (χ) was used to calculate the inhalation dose to receptor using the following equation:

$$D_{inh,i} = C_{air,i} \times (INH_{in} \times t_{in} + INH_{out} \times t_{out}) \times DCF_{inh,i} \tag{3-2}$$

Where:

$D_{inh,i}$	=	Dose of radionuclide *i* in air (mrem)
$C_{air,i}$	=	Concentration of radionuclide *i* in air (pCi/m^3) ($C_{air,i}$ = χ × Unit Conversion Factor)
INH_{in}	=	Indoor inhalation rate (m^3/yr)
t_{in}	=	Fraction of time spent indoors (unitless)
INH_{out}	=	Outdoor inhalation rate (m^3/yr)
t_{out}	=	Fraction of time spent outdoors (unitless)
$DCF_{inh,i}$	=	Dose conversion factor of radionuclide *i* (mrem/pCi).

3.4 CALCULATION PROCEDURE

The inventory source data was obtained from RPP-CALC-62319 in spreadsheet format.

For this screening calculation, the concentration for each radionuclide and source was then calculated by dividing the inventory (in Curies) by the number of seconds in a year (31,557,600) to obtain an air emission rate at the surface in Ci/s. The resulting rate was then converted to an air concentration 24 km away by multiplying the air emission rate (in Ci/s) by the $\frac{\chi}{Q'}$ value for 24 km (in s/m^3). These two calculations comprise Equation 3-1. For example, the concentration for ^{14}C from tank 241-A-101 in air 24 km away from WMA A-AX would be:

$$\frac{(6.43\times10^{-2}\ Ci\ ^{14}C)}{1\ yr} \times \frac{yr}{31557600\ s} = 2.04 \times 10^{-9}\ Ci/s \tag{3-3}$$

$$(2.04 \times 10^{-9}\,\frac{Ci}{s}) \times (4.90 \times 10^{-8}\,\frac{s}{m^3}) = 9.98 \times 10^{-17}\,\frac{Ci}{m^3} \tag{3-4}$$

The resulting air concentrations were then converted to inhalation doses for each source and each radionuclide using Equation 3-2. For example, the inhalation dose from the ^{14}C in tank 241-A-101 to a receptor 24 km away from WMA A-AX would be:

$$\left(9.98 \times 10^{-17}\,\frac{Ci}{m^3}\right) \times \left(1 \times 10^{12}\,\frac{pCi}{Ci}\right) \times \left(7300\,\frac{m^3}{yr} \times 0.4 + 12775\,\frac{m^3}{yr} \times 0.486\right) \times \left(8.21 \times 10^{-6}\,\frac{mrem}{pCi}\right) = 7.48 \times 10^{-6} mrem/yr \tag{3-5}$$

Once the inhalation doses to the receptor were calculated for all radionuclides from all sources in WMA A-AX, they were summed to arrive at the total inhalation dose to the receptor assuming all the inventory in the WMA is released to the atmosphere in one year.

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4.0 ASSUMPTIONS AND INPUTS

4.1 KEY ASSUMPTIONS

Assumption	Basis
All inventory is released over a year	Most conservative assumption without complicating the model.
Constant emission rate	Simplifying assumption.
Receptor exposure is over a year	Most conservative assumption without complicating the model.
Constant exposure rate	Simplifying assumption.
Full inventory of each source at year 2050	Using the inventory at the closure year is the most conservative assumption.
Full inventory is placed on the surface	This creates the most conservative situation by eliminating time delay and concentration dilution caused by upward diffusion of gas through the soil over the tank.
Institutional controls are in place	This is the expected condition at the year of closure.
Receptor is 24 km away from source	Closest point at the Site boundary to WMA A-AX in the direction of the prevailing wind (southeast) is approximately 20 km away. The nearest distance for which a χ/Q value is available in PNNL-6415 is 24 km.
Receptor is 12 km away from source	Closest point at the Site boundary to WMA A-AX regardless of wind direction is approximately 12 km away. This point lies northeast of WMA A-AX and has a χ/Q value in PNNL-6415.
Receptor is 0.1 km away from source	Closest point to WMA A-AX for which there is a χ/Q value in PNNL-6415. This distance corresponds to the point of compliance after institutional control. This is not the anticipated time period in which the peak dose from the atmospheric pathway is expected to occur, but has been included for completeness.
The prevailing wind direction is fixed for the analysis	Simplifying assumption.

4.2 INPUTS

Table 4-1. Inputs Used in the Screening Calculations.

Variable	Value	Units
$\frac{\chi}{Q'}$ [a]	4.9E-8	s/m^3
$\frac{\chi}{Q'}$ [b]	6.6E-8	s/m^3
$\frac{\chi}{Q'}$ [c]	3.9E-4	s/m^3
Inh_{in} [d]	7,300	m^3/yr
t_{in} [d]	0.4	unitless
Inh_{out} [d]	12,775	m^3/yr
T_{out} [d]	0.486	unitless
^{14}C DCF [e]	2.48E-8	mrem/pCi
^{3}H DCF [e]	7.14E-8	mrem/pCi
^{129}I DCF [e]	4.00E-4	mrem/pCi

[a]PNNL-6415, Table A11, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, 24 km away from Waste Management Area (WMA) A-AX; prevailing wind direction is to the southeast.

[b]PNNL-6415, Table A11. Using closest point on Site boundary to WMA A-AX regardless of wind direction (12 km); wind direction is to the northeast).

[c]PNNL-6415, Table A11. Using closest point to WMA A-AX (0.1 km); prevailing wind direction is to the southeast.

[d]RPP-ENV-58813, *Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington*, Rev. 1, Table Q-1.

[e]DOE-STD-1196-2011, Table A-2.

DCF = dose conversion factor

Table 4-2. Source Inventories Used in the Screening Calculation (Curies).

Source	Carbon-14	Hydrogen-3	Iodine-129
Tank 241-A-101	6.43E-02	1.45E-02	2.29E-03
Tank 241-A-102	1.72E-02	1.14E-02	1.34E-03
Tank 241-A-103	3.18E-02	8.52E-03	3.35E-04
Tank 241-A-104	3.24E-01	1.13E-01	6.36E-03
Tank 241-A-105	2.75E-01	6.96E-02	9.47E-04
Tank 241-A-106	1.39E-02	8.63E-03	1.33E-03
Tank 241-AX-101	5.71E-02	1.29E-02	2.12E-03
Tank 241-AX-102	5.96E-03	1.26E-02	1.52E-03
Tank 241-AX-103	4.35E-02	9.86E-03	1.71E-03
Tank 241-AX-104	3.87E-02	9.84E-03	1.34E-04
A Ancillary	7.98E-07	2.63E-07	7.89E-05
AX Ancillary	1.17E-07	3.12E-08	4.59E-09
A Pipeline	4.14E-07	1.37E-07	4.10E-05
AX Pipeline	2.82E-07	7.52E-08	1.11E-08

Source: RPP-CALC-62319, *Residual Waste Source Inventory Term for the Waste Management Area A-AX Performance Assessment Inventory Case 1*.

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5.0 SOFTWARE APPLICATIONS

The inhalation dose calculations are straightforward arithmetic operations and are hand-calculated.

5.1 SOFTWARE IDENTIFICATION

Since these are hand calculations this section is not applicable.

5.2 SOFTWARE QUALITY ASSURANCE

Since these are hand calculations this section is not applicable.

5.3 SOFTWARE INSTALLATION AND CHECKOUT

Since these are hand calculations this section is not applicable.

5.4 STATEMENT OF VALID SOFTWARE APPLICATION

Since these are hand calculations this section is not applicable.

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6.0 CALCULATION

6.1 DESCRIPTION OF MODEL CHANGES

There are no changes to describe as this is a newly created calculation.

6.1.1 Model Configuration Control

Since this is a hand calculation, any necessary revisions will be recorded by revising this EMCF.

6.1.2 Model Checking

The hand calculations are checked using the procedure found in Section 4.2.2 of TFC-ESHQ-ENV_FS-C-05, "Preparation and Issuance of Model Package Reports and Environmental Model Calculation Files." The model checker was provided with a draft copy of this EMCF.

The checker made comments and all comments were resolved as indicated by a signed checker's log.

6.2 DESCRIPTION OF CALCULATED OUTPUT

The calculated output is displayed in tables in Section 7.1.

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7.0 RESULTS AND CONCLUSIONS

7.1 RESULTS

When the inhalation dose from the combined inventory of ^{129}I, ^{3}H and ^{14}C from all sources in WMA A-AX released from the ground surface in 2050 is calculated in the prevailing wind direction (southeast), the receptor is 24 km away. The total dose in this case is 1.04×10^{-4} mrem.

Iodine-129 accounts for 99.4% of the dose (1.03×10^{-4} mrem) with ^{14}C (3.06×10^{-7} mrem) and ^{3}H (2.74×10^{-7} mrem) each contributing 0.3% of the total inhalation dose. Table 7-1 provides the detailed results for this scenario.

Table 7-1. Dose to a Receptor 24 kilometers Southeast from Waste Management Area A-AX (millirems/year).

Source	Carbon-14	Hydrogen-3	Iodine-129	Total
Tank 241-A-101	2.26E-08	1.47E-08	1.30E-05	1.30E-05
Tank 241-A-102	6.04E-09	1.15E-08	7.59E-06	7.61E-06
Tank 241-A-103	1.12E-08	8.62E-09	1.90E-06	1.92E-06
Tank 241-A-104	1.14E-07	1.14E-07	3.60E-05	3.63E-05
Tank 241-A-105	9.66E-08	7.04E-08	5.36E-06	5.53E-06
Tank 241-A-106	4.88E-09	8.74E-09	7.53E-06	7.55E-06
Tank 241-AX-101	2.01E-08	1.31E-08	1.20E-05	1.20E-05
Tank 241-AX-102	2.09E-09	1.28E-08	8.61E-06	8.62E-06
Tank 241-AX-103	1.53E-08	9.98E-09	9.69E-06	9.71E-06
Tank 241-AX-104	1.36E-08	9.96E-09	7.59E-07	7.83E-07
A Ancillary	2.79E-13	2.65E-13	4.44E-07	4.44E-07
AX Ancillary	4.11E-14	3.16E-14	2.60E-11	2.60E-11
A Pipeline	1.45E-13	1.39E-13	2.32E-07	2.32E-07
AX Pipeline	9.91E-14	7.61E-14	6.29E-11	6.30E-11
Total	3.06E-07	2.74E-07	1.03E-04	1.04E-04
	0.3%	0.3%	99.4%	

When the inhalation dose from the combined inventory of ^{129}I, ^{3}H and ^{14}C from all sources in WMA A-AX released from the ground surface in 2050 is calculated for a receptor at the Hanford Site boundary the shortest distance away from WMA A-AX, the receptor is 12 km away in the northeast direction. The total dose in this case is 1.40×10^{-4} mrem.

Iodine-129 accounts for 99.4% of the dose (1.39×10^{-4} mrem) with ^{14}C (4.12×10^{-7} mrem) and ^{3}H (3.69×10^{-7} mrem) each contributing 0.3% of the total inhalation dose. Table 7-2 provides the detailed results for this scenario.

Table 7-2. Dose to a Receptor 12 kilometers Northeast from Waste Management Area A-AX (millirems/year).

Source	Carbon-14	Hydrogen-3	Iodine-129	Total
Tank 241-A-101	3.04E-08	1.98E-08	1.75E-05	1.75E-05
Tank 241-A-102	8.14E-09	1.55E-08	1.02E-05	1.02E-05
Tank 241-A-103	1.51E-08	1.16E-08	2.56E-06	2.58E-06
Tank 241-A-104	1.53E-07	1.54E-07	4.85E-05	4.88E-05
Tank 241-A-105	1.30E-07	9.49E-08	7.22E-06	7.45E-06
Tank 241-A-106	6.58E-09	1.18E-08	1.01E-05	1.02E-05
Tank 241-AX-101	2.70E-08	1.76E-08	1.62E-05	1.62E-05
Tank 241-AX-102	2.82E-09	1.72E-08	1.16E-05	1.16E-05
Tank 241-AX-103	2.06E-08	1.34E-08	1.30E-05	1.31E-05
Tank 241-AX-104	1.83E-08	1.34E-08	1.02E-06	1.05E-06
A Ancillary	3.75E-13	3.56E-13	5.98E-07	5.98E-07
AX Ancillary	5.53E-14	4.25E-14	3.50E-11	3.51E-11
A Pipeline	1.96E-13	1.87E-13	3.13E-07	3.13E-07
AX Pipeline	1.33E-13	1.03E-13	8.47E-11	8.49E-11
Total	4.12E-07	3.69E-07	1.39E-04	1.40E-04
	0.3%	0.3%	99.4%	

When the inhalation dose from the combined inventory of ^{129}I, ^{3}H and ^{14}C from all sources in WMA A-AX released from the ground surface in 2050 is calculated for a receptor 0.1 km away to the southeast from WMA A-AX, the total dose is 0.83 mrem. This estimate is an approximation of the dose when the inventory does not rapidly diffuse to the atmosphere until after the assumed lapse in institutional controls. At that time, the ^{14}C dose would decrease slightly and the ^{3}H dose would decrease significantly due to radionuclide decay, depending on the assumed time at which the releases occur. Despite the conservatism of the release assumption (the release of the entire WMA inventory over one year) the dose remains about an order of magnitude below the DOE performance objective.

Iodine-129 accounts for 99.4% of the dose (8.21×10^{-1} mrem) with ^{14}C (2.44×10^{-3} mrem) and ^{3}H (2.18×10^{-3} mrem) each contributing 0.3% of the total inhalation dose. Table 7-3 provides the detailed results for this scenario.

Table 7-3. Dose to a Receptor 0.1 kilometers Southeast from Waste Management Area A-AX (millirems/year).

Source	Carbon-14	Hydrogen-3	Iodine-129	Total
Tank 241-A-101	1.80E-04	1.17E-04	1.03E-01	1.04E-01
Tank 241-A-102	4.81E-05	9.18E-05	6.04E-02	6.05E-02
Tank 241-A-103	8.89E-05	6.86E-05	1.51E-02	1.53E-02
Tank 241-A-104	9.06E-04	9.10E-04	2.87E-01	2.89E-01
Tank 241-A-105	7.69E-04	5.61E-04	4.27E-02	4.40E-02
Tank 241-A-106	3.89E-05	6.95E-05	6.00E-02	6.01E-02
Tank 241-AX-101	1.60E-04	1.04E-04	9.56E-02	9.58E-02
Tank 241-AX-102	1.67E-05	1.02E-04	6.85E-02	6.86E-02
Tank 241-AX-103	1.22E-04	7.94E-05	7.71E-02	7.73E-02
Tank 241-AX-104	1.08E-04	7.93E-05	6.04E-03	6.23E-03
A Ancillary	2.22E-09	2.11E-09	3.53E-03	3.53E-03
AX Ancillary	3.27E-10	2.51E-10	2.07E-07	2.07E-07
A Pipeline	1.16E-09	1.10E-09	1.85E-03	1.85E-03
AX Pipeline	7.89E-10	6.06E-10	5.00E-07	5.02E-07
Total	**2.44E-03**	**2.18E-03**	**8.21E-01**	**8.25E-01**
	0.3%	**0.3%**	**99.4%**	

7.2 CONCLUSIONS

By using highly conservative input parameters, this simple calculation shows that the inhalation dose to a receptor offsite is orders of magnitude lower than the performance objective of 10 mrem/yr. Because the inhalation dose is expected to be the largest dose contributor through the air pathway, the atmospheric dose is screened out and is not developed further in the WMA A-AX system model.

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