RESPONSES TO THE
U.S. NUCLEAR REGULATORY COMMISSION
REQUEST FOR ADDITIONAL INFORMATION
ON THE WEST VALLEY DEMONSTRATION PROJECT
PHASE 1 DECOMMISSIONING PLAN

GROUP 1 RESPONSES

August 14, 2009

Prepared by Washington Safety Management Solutions and
Science Applications International Corporation

for the

U.S. Department of Energy

West Valley, New York

As is the Decommissioning Plan itself, these responses are based on the assumption that the preferred alternative in the Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center (the Decommissioning EIS) will be selected in the Record of Decision. If changes to the Decommissioning EIS occur during the course of the National Environmental Policy Act process that affect the Decommissioning Plan, such as changes to the preferred alternative, or if a different approach is selected in the Record of Decision, the Decommissioning Plan and these responses may need to be revised or replaced in their entirety to reflect the changes.

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CONTENTS

*Copy of calculation package and associated electronic files are being provided with the August RAI responses.

*** Copy of calculation package and associated electronic files are being provided with the September RAI responses.*

CONTENTS

RAI RESPONSES (Responses to be provided in September 2009 are identified as Group 2)

*Copy of calculation package and associated electronic files are being provided with the August RAI responses.

** Copy of calculation package and associated electronic files are being provided with the September RAI responses.

Acronyms and Abbreviations

ALARA	as low as reasonably achievable
CFR	Code of Federal Regulations
DCGL	derived concentration guideline level
$DCGL_W$	derived concentration guideline level, wide
$DCGL_{EMC}$	derived concentration guideline level, elevated measurement concentration
$DCGL_{scan}$	derived concentration guideline level, scan
$DCGL_{scurveyor}$	derived concentration guideline level, surveyor
DEIS	draft environmental impact statement
DOE	Department of Energy
DP	decommissioning plan
DQO	data quality objective
EIS	environmental impact statement
EMC	elevated measurement concentration
EPA	U.S Environmental Protection Agency
FIDLER	Field Instrument for Detecting Low Energy Radiation
HLW	high-level waste
K_d	distribution coefficient
LBGR	lower bound on the grey region
LLW	low-level waste
LTR	License Termination Rule
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
N	north
NDA	NRC-Licensed Disposal Area
NRC	Nuclear Regulatory Commission
NFS	Nuclear Fuel Services, Inc.
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
QA	quality assurance
RAI	request for additional information
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual radioactivity [computer code]
SDA	State-Licensed Disposal Area
WMA	waste management area
WSMS	Washington Safety Management Solutions
WVDP	West Valley Demonstration Project
WVES	West Valley Environmental Services
WVNSCO	West Valley Nuclear Services Company

Units

Ci	curie
cm	centimeter
cm^2	centimeter squared
cm^3	centimeter cubed
cpm	counts per minute
g	gram [mass]
h	hour
kg	kilogram
L	liter
m	meter
millirem	0.001 Roentgen equivalent man
mL	milliliter
mrem	millirem
µCi	0.000001 curie
µR	micro Roentgen
µL	0.000001 liter
pCi	10^{-12} curie
R	Roentgen
rem	Roentgen equivalent man
s	second
y	year

INTRODUCTION

The U.S. Department of Energy (DOE) submitted Revision 0 of the West Valley Demonstration Project (WVDP) Phase 1 Decommissioning Plan to the U.S. Nuclear Regulatory Commission (NRC) for review on December 3, 2009. DOE subsequently submitted Revision 1 of this plan to NRC for review on March 16, 2009. Revision 1 provided additional subsurface soil and groundwater characterization data and the results of additional groundwater modeling, along with several other minor changes.

NRC submitted the Request for Additional Information (RAI) on May 15, 2009 in a letter to Bryan Bower, the Director of the WVDP. This request consisted of 44 separate RAIs on various aspects of the Decommissioning Plan, including dose modeling.

NRC review of the Decommissioning Plan is being performed consistent with the provisions of Public Law 96-368, the WVDP Act of 1980, which provides authority for NRC to consult with DOE informally on matters related to the project. Consistent with the Act, and with a 1981 Memorandum of Understanding between DOE and NRC pertaining to the project, DOE has considered the NRC RAIs and is providing written responses to NRC.

DOE is responding to these RAI in two parts. Responses to the first group of 38 RAIs are provided herein. Responses to the remaining six RAIs will be provided to NRC in September 2009. This two-part response approach is necessary to allow time to factor in the results of additional computer modeling being performed to help resolve some of the RAIs.

It is possible that some of this computer modeling, especially that performed using the STOMP code, might affect one or more of the RAI responses provided herein. If that were to happen, the affected responses would be revised and the revised responses provided to NRC with the second group of RAI responses.

The responses are provided in the following format:

NRC RAI number: The NRC RAI number is specified. DOE has also numbered the RAIs 1 through 44 for reference purposes and these numbers are also identified.

Subject: DOE has added a brief statement of the RAI subject, for clarity.

RAI: A complete copy of the NRC RAI is provided.

Basis: A complete copy of the NRC basis for the RAI is provided.

NRC path forward: A complete copy of the NRC path forward is provided.

DOE response: The DOE response provides requested information and answers NRC questions.

Changes to the plan: Changes to be made are specifically identified with red text and change bars. (The two completely new appendices are not so marked, although they will be in Revision 2.)

References: References are included where appropriate.

For those responses that involve additional dose modeling, copies of the calculation package and the associated electronic files are being provided to enable NRC staff to replicate the modeling. In some cases, a single calculation package applies to more than one RAI response. Note that the three calculation packages included with this submission pertain to:

- Acute dose to the cistern well driller,

- Acute dose to a natural gas well driller, and
- Dose to a recreationist-hiker in an area of deep gullies.

As indicated on the cover sheet, if changes to the Decommissioning EIS occur during the course of the National Environmental Policy Act process that affect the Decommissioning Plan, such as changes to the preferred alternative, or if a different approach is selected in the Record of Decision, the Decommissioning Plan and these responses may need to be revised or replaced in their entirety to reflect the changes.

RAI ESC1 (1)

Subject: Underground lines

RAI: Piping is potentially a significant source of residual activity at the site (page ES-14 states one HLW transfer line may contain 0.4 Ci/ft), but the description of the contamination is limited. (Section ES, Page ES-14)

Basis: The figures (such as Figure 2-3) in the Decommissioning Plan (DP) provide current and previous locations of radionuclides, but do not clearly show the locations, depths, and distributions of piping that will be removed as part of the Phase 1 DP. The description on page ES-8 identifies underground piping generally, but does not provide a complete description of the likely distribution and magnitude of activity, or how the piping inventory estimates were developed.

Path Forward: Provide a description of the locations, depths and distributions of piping as well as estimated radiological inventory associated with the piping.

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DOE Response: DOE will include information on the underground lines in a new appendix to the DP. A copy of this appendix, which is based on the radioisotope inventory report (Luckett, et al. 2004), is attached.

References:

Luckett, et al. 2004, *Radioisotope Inventory Report for Underground Lines and Low Level Waste Tanks at the West Valley Demonstration Project*, WSMS-WVNS-04-0001, Revision 0. Luckett, L., J. Fazio, and S. Marschke, Washington Safety Management Solutions, Aiken, South Carolina, July 6, 2004.

APPENDIX F
ESTIMATED RADIOACTIVITY IN SUBSURFACE PIPING

PURPOSE OF THIS APPENDIX

The purpose of this appendix is to provide conservative estimates of residual radioactivity in underground piping to supplement information on the radiological status of facilties discussed in Section 4.1.

INFORMATION IN THIS APPENDIX

Information in this appendix was drawn from a radioisotope inventory report completed in July 2004. Included are a list of all buried pipelines and estimates for residual activity in pipelines in three areas: (1) beneath the Process Building, (2) west of the Process Building, and (3) east of the Process Building. An estimate is also included for residual radioactivity in the Leachate Transfer Line that runs from the NRC-Licensed Disposal Area (NDA) to Lagoon 2.

RELATIONSHIP TO OTHER PARTS OF THE PLAN

The information in this appendix supplements the information provided in Section 4 and supports the decommissioning activities described in Section 7.

1.0 Introduction

Various underground lines in WMA 1 and WMA 2 carried radioactive liquid during NFS and WVDP operations. All were evaluated and conservative estimates of residual radioactivity were made as described in the radioisotope inventory report (Luckett, et al. 2004). During this evaluation, the sources were divided into categories, including:

- Lines beneath the footprint of the Process Building,
- High-activity lines primarily west of the Process Building,
- Low-activity lines primarily east of the Process Building, and
- The leachate transfer line from the NDA to Lagoon 2.

The evaluation process included the following steps:

- Collection and review of available information and data on pipe design and location;
- Consideration of process history to determine which lines had actually carried radioactive liquid;
- Review of radiological data and inventories generated by the Facility Characterization Project;
- Preparation of activity estimates for indicator radionuclides based on (1) data on fluids carried by the pipes and an empirical relationship between the activity of the HLW fluid and the resulting residual contamination on the pipe interior or (2) the results of surveys of

rooms and systems where the pipe contents originated;

- Application of conservative radionuclide distribution scaling factors from the point of origin of the contamination to produce a conservative estimate of the activity in each line; and
- Combining individual line estimates into conservative curie estimates, that were corrected for decay and ingrowth to 2011, for groups of related lines appropriate to dose modeling.

A listing of the underground lines identified in the evaluation is provided in Table F-1. The column "Radionuclide Distribution Surrogate" refers to the distribution of radionuclide ratios assigned to each line, based on process history, the origin and terminus of the line, and the geographic location category. Note that acronyms used in the table are defined in the legend at the end of the table. Residual activity estimated to remain inside the lines is summarized below in Section 2 through 4 of this appendix. Details of the calculations, a discussion of the basis for the assignment of the surrogate radionuclide distribution, and the surface contamination (μCi/m^2) for each radionuclide in each of the distributions are provided in Luckett, et al. 2004.

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet) Below Process Bldg	West of Process Bldg	East of Process Bldg	Radionuclide Distribution Surrogate
1P64-1	1	FRS	MSM Valve Pit	25	0	400	CD Pit
7P19-1	1	Miniature Cell	Tank 7D-14	70.6	0	0	Not Used
7P331a-3	0.25	Tank 7D-13	capped	0	30	0	Tank 7D-13
7P331b-3	0.25	Tank 7D-13	7D-13 Sample station southwest stairwell	0	30	0	Tank 7D-13
7P331c-2	0.50	Tank 7D-13	7D-13 Sample station southwest stairwell	0	30	0	Tank 7D-13
7P63-1	1	Tank 7D-8	Miniature Cell	76.6	0	0	Not Used
7P71-3	3	CPC Floor	59 ft Outside Bldg Capped	70	59	0	Not Used
7P74-3	3	CPC Floor	59 ft Outside Bldg Capped	70	59	0	Not Used
7P90-3	3	CPC Floor	59 ft Outside Bldg Capped	70	59	0	Not Used
7P112-3	3	CPC Floor	Tank 8D-1	65.8	462	0	Not Used
7P113-3	3	Tank 7D-10/ CPC Floor	Tank 8D-2	64.3	462	0	7P113
7P114-3	3	CPC Floor	59 ft Outside Bldg Capped	67.5	59	0	Not Used
7P115-3	3	CPC Floor	59 ft Outside Bldg Capped	67.6	59	0	Not Used
7P116-3	3	CPC Floor	59 ft Outside Bldg Capped	67.7	59	0	Not Used
7P120-3	3	Tank 7D-4/ CPC Floor	THOREX to 8D-4	58.7	462	0	7P120
7P151-3	3	Tank 7D-10	Future HLW Storage Capped 59 ft Outside Bldg	68.2	59	0	Not Used
7P156-2	2	Tank 7D-13 Vent	OGC	35.6	20	0	Tank 7D-13
7P159-2	2	Tank 7D-13 Jet	GP Catch Tank 7C-5	0	60	0	Tank 7D-13

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
7P170-2	2	7C-5 Jet	Tank 8D-1	0	482	0	Tank 8D-1
7P177-12	1.5	7 E-13 GP Evap.	7D-13	0	60	0	Tank 7D-13
7P180-12	1.5	7 E-13 via 7P177	15WW568	0	10	0	WW
7P271-2	2	7D-6 Weak Acid Catch Tank Pump 7G-1	Interceptor	0	10	0	WW
8P11-2	2	Tank 8D-1 8G-4	Lagoon	0	0	825	Vault Drip Pan
8P12-3	3	Waste Tank Off Gas Knockout Drum 8D-6	Tank 8D-1	0	41	0	Tank 8D-1
8P27-3	3	Waste Tank Off Gas Knockout Drum 8D-6	Tank 8D-2	0	52	0	Tank 8D-2
8P29-16	16	Tanks 8D-1 via 8P13; and 8D-2 via 8P28; and PVS	Waste Tank Off Gas Condensers and Relief Knock Out Drum 8D-7	0	52	0	8P29-16
8P34-2	2	Waste Tank O/H Condensate Pump 8G-1	7C-5	0	425	0	Tank 8D-2
8P35-2	2	Waste Tank Cond. Pump 8G-1 via 8P34	8D-2 via 7P170	0	5	0	Tank 8D-2
8P38-2	2	Waste Tank Blowers 8K-1/ 8K-1A VIA 8P-46	Tank 8D-2 via 8P-27	0	5	0	Tank 8D-2
8P46-6 (old)	6	Waste Tank Blowers 8K-1/8K-1A	Stack 15F-1	0	435	0	8P46-6
8P46-6 (new)	6	Waste Tank Blowers 8K-1/8K-1A	To line 6P95-8	0	415	0	8P46-6
8P68-2	2	Equipment shelter Manifold	Lagoon	0	52	0	Vault Drip Pan
8P95-3	3	Con Ed Tank 8C-1 Caustic Scrubber	Tank 8D-6 Off-Gas Knockout Drum	0	52	0	Tank 8D-4
8P120-3	3		Tank 8D-1	0	52	0	Tank 8D-1
4P92-12	1.5	Tank 4D-2 Jet 4H-60	59 ft Outside Bldg Capped	61.8	59	0	Not Used
15CH739-3	3	PMC Floor Drain	GPC Sump via 15CH760-3	13.2	0	0	PMCR
15CH750-3	3	CCR Drain	Tank 35104 via 12CH240-6	40.2	0	0	CCR
15CH752-3	3	Equipment Decon Room	Tank 35104 via 12CH240-6	65.8	0	0	EDR
15CH753-2	2	GPC Sump Jet and Tank 35104 Eductor	1st U Cycle Tank 4D-10	66.8	0	0	GCR
15CH754-12	1.5	From GCR Sump Jet	Tank 7D-2	77	0	0	GCR

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
15CH758-3	3	Mechanical Crane Room	Tank 35104 via 12CH240-6	65.5	0	0	PMCR
15CH760-3	3	PMC Floor Drain	GPC Sump	47.6	0	0	PMCR
15CH763-3	3	Scrap Removal	Tank 35104 via 12CH240-6	57.9	0	0	SRR
15CH773-3	3	Tank 35104 Eductor 15H-1	Tank 7D-2	98.2	0	0	Tank 35104
15CH774-3	3	CPC/EDR Door Slot Drain	Tank 35104 via 12CH240-6	6.6	0	0	CPC
1WW48-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	20	0	0	CD Pit
1WW49-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	20	0	0	CD Pit
1WW50-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW51-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW52-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW53-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW54-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW55-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
1WW56-4	4	FRS Cask Decon Drain	Interceptor via 15WW571-6	6.5	0	0	CD Pit
02WW359-3	3	Lagoon 1	Lagoon 2	0	0	540	WW
02WW360-6	6	LLWTF underslab piping drains	LLWTF Sump	0	0	80	WW
02WW362-6	6	LLWTF underslab piping drains	LLWTF Sump	0	0	40	WW
02WW363-8	8	Sump Manhole, LLWTF	Lagoon 1	0	0	167	WW
02WW364-3	3	LLWTF underslab piping drains	Lagoon 2	0	0	150	WW
15WW533-6	6	Neutralizer	Interceptor	0	0	10	WW
15WW534-6	6	Neutralizer	New Interceptor thru West Valve Pit	0	0	120	WW
15WW536-2	2	West Valve Pit	New Interceptor A	0	0	30	WW
15WW538-4	4	Interceptor B thru E Valve Pit	Lagoon 2 thru new 15WW549-4	0	0	35	WW
15WW539-4	4	New Interceptor A	E Valve Pit	0	0	10	WW
15WW549-4	4	East of Interceptor	Lagoon 1	0	0	200	WW
15WW567-2	2	Tank 7D-13	Interceptor thru 15WW568-2	80	0	0	WW
15WW568-2	2	Tank 7D-13	Interceptor thru 15WW569-6	50	0	0	WW
15WW569-6	6	Trunk Line S side Process Bldg	Interceptor thru 15WW533-6	100	0	110	WW

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
15WW570-4	4	N side Process Bldg / FRS	Interceptor thru 15WW571-6	0	0	200	WW
15WW571-6	6	FRS Cask Decon Drains	Interceptor thru 15WW843-6	60	0	13	CD Pit
15WW841-4	4	N Side of MSM Repair	Interceptor thru 15WW852-3	12	0	25	WW
15WW842-3	3	E Side of MSM Repair	Interceptor thru 15WW570-4	19	0	15	WW
15WW843-6	6	Trunk Line East of Process Bldg	Interceptor thru 15WW569-6	72	0	120	WW
15WW846-3	3	Under Lower Warm Aisle	Interceptor thru 15WW569-6	5	0	0	WW
15WW847-3	3	Under Lower Warm Aisle	Interceptor thru 15WW569-6	5	0	0	WW
15WW848-3	3	Trunk line, upper floors South side Process Bldg	Interceptor thru 15WW569-6	5	0	0	WW
15WW850-4	4	Under Floor RAM Equipment Room	Interceptor thru 15WW843-6	16	0	0	WW
15WW851-3	3	Under Floor CPC	Interceptor thru 15WW895-4	80	0	0	WW
15WW852-3	3	Equipment Decon Room	Interceptor thru 15WW570-4	13.3	0	55	WW
15WW857-3	3	Under Floor PMC	Interceptor thru 15WW851-3	45	0	0	WW
15WW858-3	3	Under Floor RAM Equipment Room	Interceptor thru 15WW895-4	6	0	0	WW
15WW859-3	3	Under Floor RAM Equipment Room	Interceptor thru 15WW895-4	20	0	0	WW
15WW860-3	3	Under Floor Cell Access Aisle	Interceptor thru 15WW851-3	16	0	0	WW
15WW861-3	3	Under Floor W Main Op Aisle	Interceptor thru 15WW895-4	25	0	0	WW
15WW863-3	3	Under Floor W Main Op Aisle	Interceptor thru 15WW895-4	6	0	0	WW
15WW885-2	2	Sink Drains	Tank 7D-13	120	0	0	WW
15WW887-2	2	Sink Drains	Tank 7D-13 via 15WW885-2	25	0	0	WW
15WW892-3	3	Scrap Removal Room	Interceptor thru 15WW852-3	10	0	10	WW
15WW895-4	4	Under Floor RAM Equipment Room	Interceptor thru 15WW843-6	25	0	0	WW
15WW896-3	3	GOA Sump ejector	Interceptor thru 15WW841-4	3	0	0	WW
15WW899-3	3	Floor PPS	Interceptor thru 15WW843-6	3	0	0	WW

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
15WW900-3	3	Floor UPC	Interceptor thru 15WW843-6	15	0	0	WW
15WW916-6	6	FRS Resin Wash Pit	Interceptor thru 15WW843-6	5	0	20	WW
15WW917-4	4	Tank 14D-1 and Tank 14D-2	Interceptor thru 15WW920-4	0	0	15	WW
15WW918-4	4	Tank 14D-1 and Tank 14D-2	Interceptor thru 15WW920-4	0	0	15	WW
15WW919-4	4	Tank 14D-1 and Tank 14D-2	Interceptor thru 15WW920-4	0	0	15	WW
15WW920-4	4	Tank 14D-1 and Tank 14D-2	Interceptor thru 15WW569-6	0	0	125	WW
15WW923-6	6	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW924-4	4	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW925-6	6	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW926-2	2	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW927-4	4	Utility Room Floor Drain	Interceptor thru 15WW569-6	30	0	0	WW
15WW929-3	3	Tank 15D-6	New Interceptor East Valve Pit	0	0	660	WW
15WW1231-3	3	Floor Drain PPS	Interceptor via 15WW569-6	15	0	0	WW
15WW1232-3	3	Floor Drain Acid Rec Pump Room	Interceptor via 15WW569-6	15	0	0	WW
15WW1744-2	3	Laundry Sump	New Interceptor A	0	0	175	WW
6-71-6-001	6	6-50-2-015, 6-71-2-019, 6-71-2-675, 6-50-2-015	Tank 35104	0	0	15	WW
6-71-2-003	2	12CH241	Tank 35104 Pump Suction	0	0	15	WW
6-71-1-006	1	Tank 35104 Pump Discharge	LWTS Evaporator	0	0	40	WW
6-71-3-016	3	Floor Drain in 35104 pump niche	General crane Room extension	0	0	30	WW
6-71-2-019	2	Truck Fill	Tank 35104 via 6-71-6-001	0	0	4	WW
6-71-2-020	2	Tank 7D-13 Eductor 7H-19 via 7P159	PPC manifold via 01/14 & Pipe Chase	0	0	45	WW
6-71-2-021	2	Tank 7D-13 Eductor 7H-19 via 7P159	Interceptor via 15WW848	0	0	25	WW
6-71-4-022	4	CSS Drain Header	Tank 7D-13	0	0	70	WW
6-71-2-023	2	Tank 35104 Pump Discharge	6-50-2-153, return to STS	0	0	10	WW

Table F-1. List of Buried Pipelines

Line Number	Pipe Dia. (in)	From	To	Length (feet)			Radionuclide Distribution Surrogate
				Below Process Bldg	West of Process Bldg	East of Process Bldg	
6-71-2-031	2	Drain from 7D-13 valve pit	Tank 7D-13 via 6-71-4-022	0	0	15	WW
6-71-2-032	0.5	Tank 35104 Pump Discharge	35104 Sample Station GPC-CR Lower Air lock	0	0	50	WW
6-71-2-675	0.5	35104 Sample Station GPC-CR Lower Air lock	35104 Waste Catch tank via 6-71-6-001	0	0	50	WW
12CH240-6	6	Drains	Tank 35104	0	0	30	WW
12CH241-3	3	Tank 35104 Eductor	Tank 7D-2 LWC or Tank 35104 Pump Suction	0	0	20	WW
12CH365-1/8	0.125	35104 Pit	Cut and Capped 18"below grade	0	0	10	WW
12CH366-2	0.5	35104 Pit	Cut and Capped 18"below grade	0	0	10	WW
12CH367-1	1	35104 Pit	Cut and Capped 18"below grade	0	0	10	WW
undesignated	2	Tank 15D-6	MSM Valve Pit	0	0	150	Tank 5D-6
undesignated	2	MSM Shop 2 Floor Drains	Tank 15D-6	50	0	50	Tank 15D-6
Leachate Line	2	NDA Hardstand	LLWTF Lagoon 2	0	0	2,000	n/a

LEGEND: Tanks referred to are located within the Process Building, except 15D-6 that is an underground tank located northeast of the Process Building. CCR is the Chemical Process Cell Crane Room. CD Pit is the Cask Decon Pit. CPC is the Chemical Process Cell. CSS is the Cement Solidification System. EDR is the Equipment Decontamination Room. FRS is Fuel Receiving and Storage. GOA is General Purpose Cell Operating Aisle. GP is General Purpose. GPC is General Purpose Cell. GPC-CR is the General Purpose Cell Crane Room. LWC is the Liquid Waste Cell. LWTS is the Liquid Waste Treatment System. MSM is Master-Slave Manipulator. OGC is the Off-Gas Cell. PMCR is the Process Mechanical Cell Crane Room. PPC is the Product Purification Cell. SRR is the Scrap Removal Room. STS is the Supernatant Treatment System. WW is wastewater.

2.0 Lines Beneath the Process Building

Review of drawings and process history established that 57 pipelines or portions of pipelines located beneath the Process Building, Utility Room, or Utility Room Expansion carried radioactive liquid. These include:

- Eleven process drains,
- Two waste transfer lines,
- Eleven Fuel Receiving and Storage Area cask decon lines,
- Thirty-three wastewater drains.

There were 11 lines under the Process Building that were designed to carry radioactive fluids, but were spares that were never used as designed. Their inventory is considered negligible (zero).

Figure F-1 shows the lines that were estimated to contribute more than 98 percent of the total activity in the lines beneath the Process Building. The lines in each category and the estimated source terms are described below.

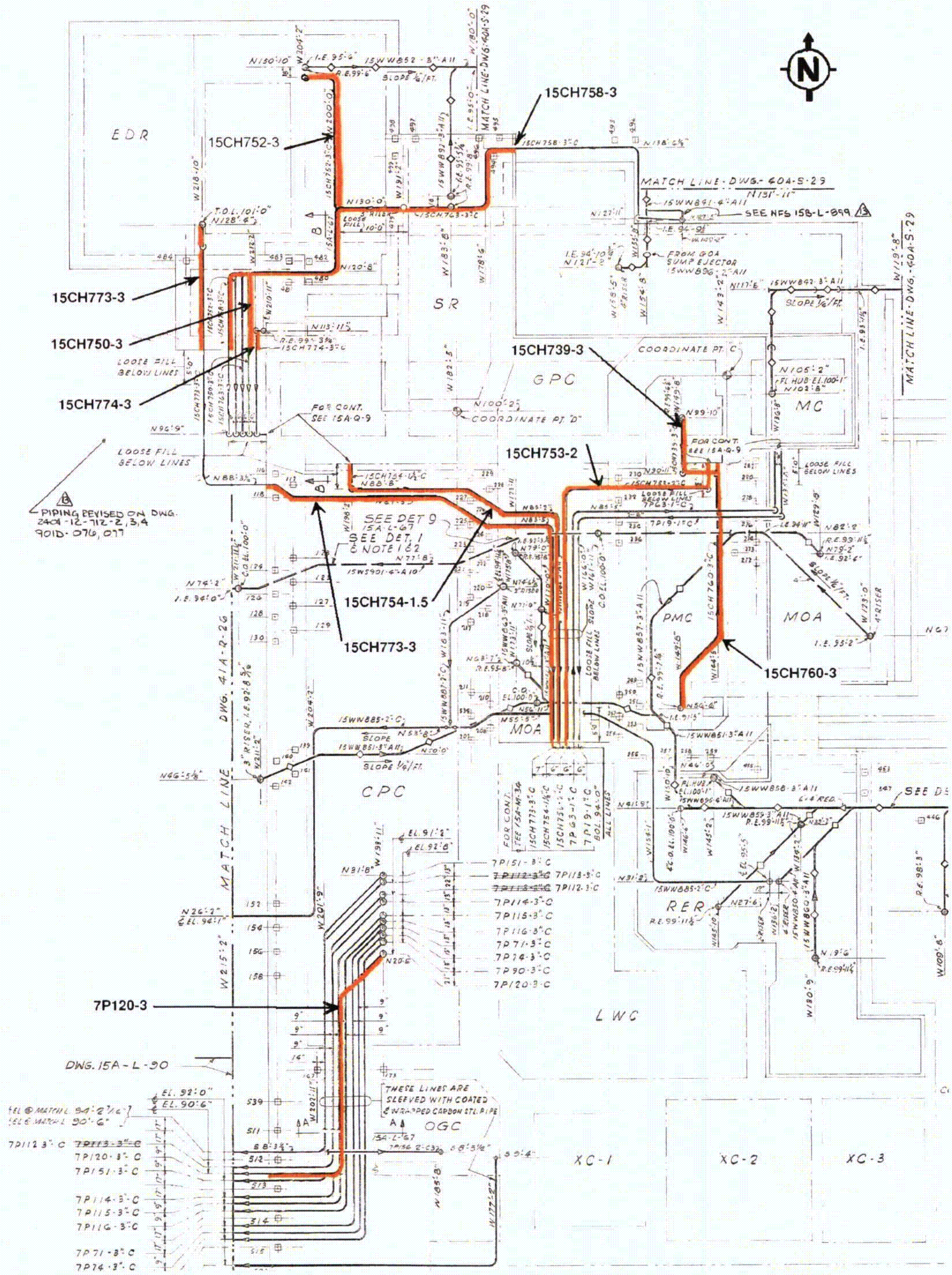

Figure F-1. Location of Pipelines Beneath the Process Building. (Marked lines are estimated to contain more than 98 percent of the activity in piping under the building.)

2.1 Process Drain Lines

All 11 lines are stainless steel pipe designated for chemical service. Eight are three-inch, two are two-inch, and the other is 1.5-inch in diameter. Each line is encased in an outer carbon steel pipe providing double containment. They are located in side-by-side runs within earth fill beneath the Process Building's reinforced concrete floor slabs.

The lines run typically about 10 feet below grade (reference elevation approximately 90 feet) and are sloped downward in the direction of flow, typically about 0.25 inch per foot. Table F-2 shows conservative estimates of the total activity within all 11 lines.

Table F-2. Estimated Process Drain Line Activity in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	7.5E-02	Np-237	3.7E-05	Tc-99	3.9E-04
C-14	1.3E-04	Pu-238	1.8E-02	U-232	4.4E-05
Cm-243	7.8E-05	Pu-239	1.7E-02	U-233	4.2E-05
Cm-244	1.8E-03	Pu-240	1.1E-02	U-234	1.6E-05
Cs-137	8.0E-01	Pu-241	2.6E-01	U-235	6.8E-05
I-129	2.0E-06	Sr-90	4.6E-01	U-238	2.0E-05

2.2 Waste Transfer Lines

Both lines are three-inch stainless steel pipe; each is encased within an outer six-inch carbon steel pipe. These lines run approximately 10 feet below grade within a concrete pipe trench. The lines are sloped downward in the direction of flow, about 0.25 inch per foot. Estimated activity in the lines is shown in Table D-3 below.

Line 7P120-3 contains much more radioactivity than the other line, 7P113-3. Line 7P120-3, which runs from the Chemical Process Cell to HLW Tank 8D-4, was used by NFS to transfer THOREX process waste during one fuel reprocessing campaign. Line 7P113-3 was used by NFS to transfer PUREX process wastes to Tank 8D-2; this line was flushed with decontamination solutions and with lower level waste solutions after reprocessing operations ended. Table F-3 shows conservative estimates of the total activity within both lines.

Table F-3. Estimated Waste Transfer Line Activity in Curies (as of 2011)

Nuclide/Line	7P113-3	7P120-3	Nuclide/Line	7P113-3	7P120-3
Am-241	1.1E-05	1.0E-02	Pu-240	1.3E-06	3.3E-04
C-14	1.9E-07	5.4E-06	Pu-241	1.7E-05	1.1E-02
Cm-243	3.8E-08	5.3E-06	Sr-90	2.9E-04	1.0E+01
Cm-244	8.9E-07	2.2E-04	Tc-99	2.2E-07	4.3E-03
Cs-137	3.6E-03	1.1E+01	U-232	3.6E-08	8.9E-05
I-129	1.6E-07	7.4E-06	U-233	1.6E-08	8.7E-05

Table F-3. Estimated Waste Transfer Line Activity in Curies (as of 2011)

Nuclide/Line	7P113-3	7P120-3	Nuclide/Line	7P113-3	7P120-3
Np-237	9.9E-09	1.3E-05	U-234	7.9E-09	9.1E-05
Pu-238	2.4E-06	1.6E-02	U-235	6.3E-11	2.1E-07
Pu-239	1.7E-06	6.4E-04	U-238	8.0E-10	2.9E-09

2.3 Cask Decon Lines

Nine lines are four inches in diameter and are associated with floor drains for the Fuel Receiving and Storage Building; these lines connect to the six-inch trunk line (15WW571-6). Line 1P64-1, a one-inch discharge line running toward the Low-Level Waste Treatment Facility (LLWTF) Interceptor, is also grouped with the cask decon lines.

The estimated activity in these lines, based on the assumption that their average interior surface contamination is similar to that remaining on the floor of the Cask Decon Pit, is shown in Table F-4.

Table F-4. Estimated Cask Decon Line Activity in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	1.9E-02	Np-237	2.3E-06	Tc-99	5.2E-05
C-14	2.5E-05	Pu-238	2.8E-03	U-232	2.9E-06
Cm-243	7.4E-06	Pu-239	5.4E-03	U-233	6.9E-06
Cm-244	1.5E-04	Pu-240	2.8E-03	U-234	5.9E-07
Cs-137	1.3E-01	Pu-241	7.6E-02	U-235	8.4E-07
I-129	1.2E-07	Sr-90	1.2E-01	U-238	7.1E-06

2.4 Wastewater Drain Lines

These lines deliver low-level or uncontaminated wash water and spills from various drains in the Process Building to the LLWTF Interceptor. This piping is made of Duriron, a high silicone cast iron, in diameters ranging from two-inch to six-inch. Beneath the Process Building, the runs are encased within concrete of 12-inch-square cross section. They are located eight to 12 feet below grade, sloping about 0.25 inch per foot.

The estimated activity in these lines was based on an empirical relationship between the residual contamination and the radioactivity in the fluid carried by the lines observed in HLW lines. (This relationship is based on WVDP experience with residual contamination measured in other piping where the activity of the liquid that passed through the piping was known.) The LLWTF Interceptor operating limit (0.005 µCi/mL) was used in the calculations for conservatism; many discharges though the lines likely had radioactivity concentrations well below this value. The use of the bounding spent nuclear fuel distribution as the surrogate for the waste water also provides a level of conservatism by assigning the maximum radionuclide ratio observed in any spent fuel batch to the residual in the waste water pipes. The total estimated activity in all the lines is shown in Table F-5.

Table F-5. Estimated Wastewater Drain Line Activity in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	2.1E-06	Np-237	1.3E-09	Tc-99	5.6E-09
C-14	3.2E-11	Pu-238	2.3E-07	U-232	5.8E-10
Cm-243	1.2E-08	Pu-239	7.2E-08	U-233	2.4E-10
Cm-244	2.6E-07	Pu-240	5.2E-08	U-234	9.7E-11
Cs-137	1.4E-04	Pu-241	1.1E-06	U-235	2.5E-12
I-129	2.6E-14	Sr-90	1.3E-04	U-238	2.3E-11

2.5 Total Estimated Inventory in Lines Beneath the Process Building Footprint

As shown in Table F-6 the total estimated residual inventory for all the combined lines beneath the Process Building footprint is approximately 23 Ci, predominantly Sr-90 and Cs-137 activity. The table indicates that Line 7P120-3 and the process drain lines have over 95 percent of the Cs-137 and Sr-90 activity under the Process Building, as well as 71-98 percent of the Pu and U isotopes.

Table F-6. Estimated Total Residual Inventory in Lines Under the Process Building (as of 2011)

Nuclide	Residual Inventory (Ci)			Contribution to Total	
	Total All Lines	Process Drains	Line 7P120-3	Line 7P120-3	Line 7P120-3 and Process Drains
Am-241	1.0E-01	7.5E-02	1.0E-02	10.0%	85.0%
C-14	1.6E-04	1.3E-04	5.4E-06	3.4%	84.6%
Cm-243	9.1E-05	7.8E-05	5.3E-06	5.8%	91.5%
Cm-244	2.2E-03	1.8E-03	2.2E-04	10.0%	91.8%
Cs-137	1.2E+01	8.0E-01	1.1E+01	91.7%	98.3%
I-129	9.7E-06	2.0E-06	7.4E-06	76.3%	96.9%
Np-237	5.2E-05	3.7E-05	1.3E-05	25.0%	96.2%
Pu-238	3.7E-02	1.8E-02	1.6E-02	43.2%	91.9%
Pu-239	2.3E-02	1.7E-02	6.4E-04	2.8%	76.7%
Pu-240	1.4E-02	1.1E-02	3.3E-04	2.4%	80.9%
Pu-241	3.5E-01	2.6E-01	1.1E-02	3.1%	77.4%
Sr-90	1.1E+01	4.6E-01	1.0E+01	90.9%	95.1%
Tc-99	4.7E-03	3.9E-04	4.3E-03	91.5%	99.8%

Table F-6. Estimated Total Residual Inventory in Lines Under the Process Building (as of 2011)

Nuclide	Residual Inventory (Ci)			Contribution to Total	
	Total All Lines	Process Drains	Line 7P120-3	Line 7P120-3	Line 7P120-3 and Process Drains
U-232	1.4E-04	4.4E-05	8.9E-05	63.6%	95.0%
U-233	1.4E-04	4.2E-05	8.7E-05	62.1%	92.1%
U-234	1.1E-04	1.6E-05	9.1E-05	82.7%	97.3%
U-235	6.9E-05	6.8E-05	2.1E-07	0.3%	98.9%
U-238	2.8E-05	2.0E-05	2.9E-09	0.0%	71.4%

3.0 Lines West of the Process Building

The lines west of the Process Building identified in Table F-1 include:

- Four ventilation lines;
- Three waste transfer lines, two of which were used; and
- Twenty-four other lines that carried wastewater or ventilation condensate.

3.1 Lines of Interest

Ventilation Lines

The ventilation lines are:

- 8P29-16, a 16-inch header line that runs from the Permanent Ventilation System to the Equipment Shelter
- 8P34-2, an abandoned and capped two-inch ventilation condensate line from Tank 8D-2,
- 7P170-2, an abandoned and capped two-inch ventilation condensate line from Tank 8D-1, and
- 8P46-6 (old and new), two six-inch lines that connect the Equipment Shelter to the Main Plant Stack.

Waste Transfer Lines

The two waste transfer lines of interest are the downstream ends of those discussed in Section 2.2, 7P120-3 and 7P113-3.

Other Lines West of the Process Building

The other 24 lines of interest shown in Table F-1 carried process drain fluids, wastewater, and ventilation condensate.

3.2 Estimated Inventory in Lines West of the Process Building

The estimated total inventory of the 31 underground lines west of the Process Building is shown in Table F-7. The total length of all of these lines together is approximately 4,176 feet. The total interior surface area is approximately 3.47E+06 cm^2.

Table F-7. Estimated Total Residual Inventory of Lines West of the Process Building in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	8.3E-02	Np-237	1.0E-04	Tc-99	3.4E-02
C-14	4.6E-05	Pu-238	1.3E-01	U-232	7.1E-04
Cm-243	4.4E-05	Pu-239	5.2E-03	U-233	6.9E-04
Cm-244	1.8E-03	Pu-240	2.7E-03	U-234	7.2E-04
Cs-137	8.5E+01	Pu-241	8.6E-02	U-235	1.8E-06
I-129	6.0E-05	Sr-90	8.1E+01	U-238	1.0E-06

4.0 Lines East of the Process Building

4.1 Lines of Interest

Table F-1 identifies 47 lines east of the Process Building. Most deliver low-level radioactive or uncontaminated wastewater, wash water, or liquid from spills from various drains throughout the Process Building to the Interceptor in WMA 2. From the Interceptor, the water can be sampled, diverted to storage tanks, sent to the LLWTF for treatment, or released to the lagoon system through other lines identified in the table. Other lines in WMA 2 connect various tanks with the LLWTF and the LLWTF to the lagoons. From the lagoons, waters can be discharged to surface streams on the Center.

Various underground lines were realigned from Lagoon 1 to Lagoon 2 and from Lagoon 2 to Lagoon 3 in 1984 when Lagoon 1 was removed from service. At that time, Lagoon 2 became the initial receiving lagoon for the LLWTF. Originally, water treatment was performed in the O2 Building, but it was replaced by the LLWTF. The New Interceptors (A and B) were installed in 1967 to replace the single Old Interceptor.

4.2 Estimated Inventory in Lines East of the Process Building

The estimated total inventory of the 47 underground lines east of the Process Building is shown in Table F-8. The total length of all of these lines together is approximately 4,559 feet. The total interior surface area is approximately 3.40 E+06 cm^2.

Table F-8. Estimated Total Residual Inventory of Lines East of the Process Building in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Am-241	1.3E-02	Np-237	1.5E-06	Tc-99	3.4E-05
C-14	1.6E-05	Pu-238	1.9E-03	U-232	1.9E-06
Cm-243	4.9E-06	Pu-239	3.6E-03	U-233	4.6E-06
Cm-244	9.9E-05	Pu-240	1.9E-03	U-234	3.9E-07

Table F-8. Estimated Total Residual Inventory of Lines East of the Process Building in Curies (as of 2011)

Nuclide	Activity	Nuclide	Activity	Nuclide	Activity
Cs-137	8.5E-02	Pu-241	5.0E-02	U-235	5.6E-07
I-129	7.9E-08	Sr-90	7.9E-02	U-238	4.7E-06

5.0 Leachate Transfer Line

5.1 Description

The Leachate Transfer Line is a buried two-inch polyvinylchloride pipe that originates on the south plateau at the NDA and continues northward across WMA 6 to Lagoon 2 in WMA 2. The line was laid within a five-inch sand layer at the base of a 36-inch wide trench located five feet below the surface.

The line was originally used to transfer fluids originating from the SDA Lagoons to Lagoon 1 in the LLWTF via a pumphouse adjacent to the NDA hardstand. More recently, it has been used to transfer groundwater from the NDA interceptor trench to Lagoon 2. The total length of the line is approximately 2,000 feet. The location of the Leachate Transfer Line is shown on Drawing 40C-S-1057, on which Figure F-2 is based.

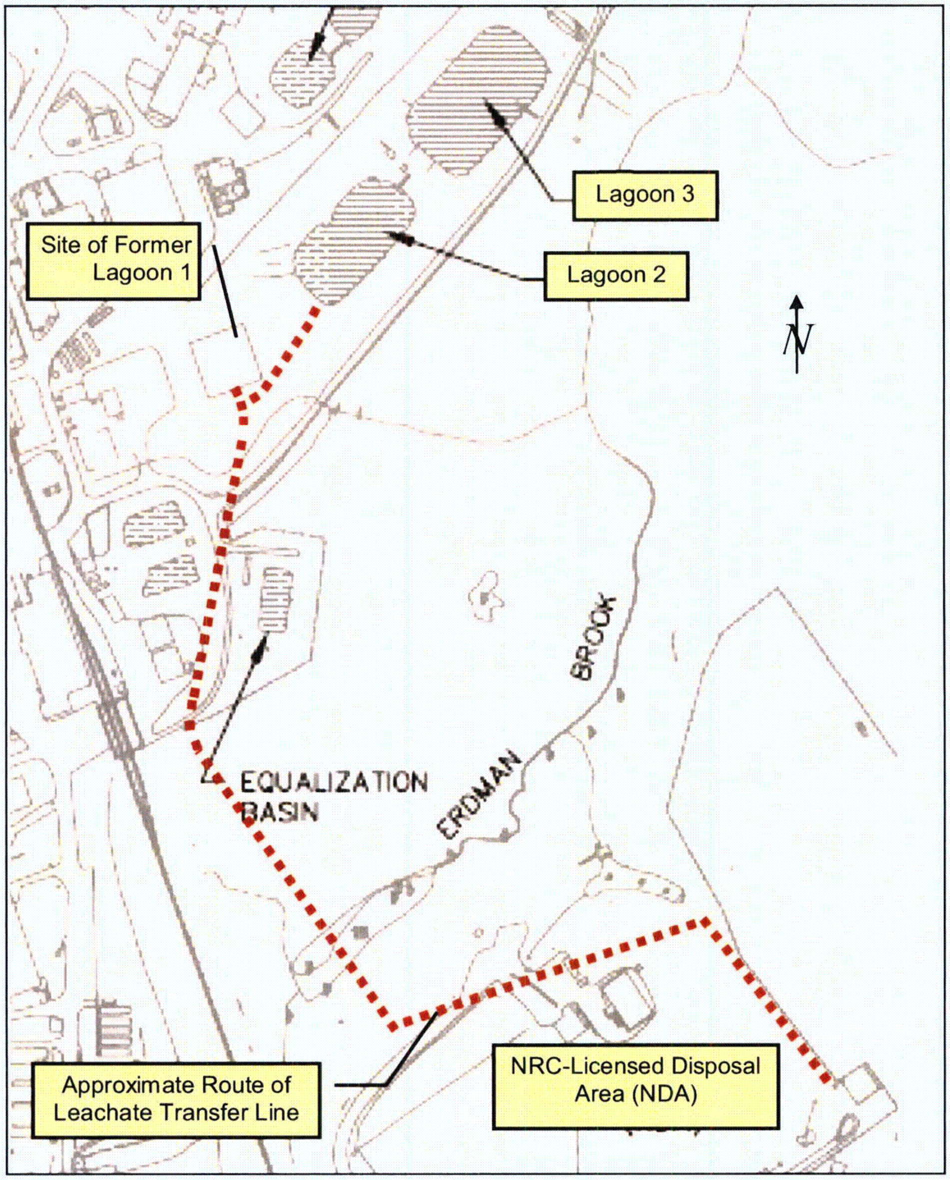

Figure F-2. Leachate Transfer Line Routing From NDA to Lagoon 1 (based on drawing 40C-S-1057)

5.2 Fluids Conveyed by the Line

The use of the Leachate Transfer Line to convey burial trench leachate is described in the RCRA Facility Investigation Report for the NYSERDA-maintained portions of the Center (NYSERDA 1994).

In March 1975 leachate levels in Trenches 4 and 5 of the SDA[1] reached the ground surface and seeped through the earthen covers. NFS began a permitted operation to pump, treat and dispose of leachate[2] from the burial trenches. From 1975 through 1981 NFS pumped over 2,850,000 gals of fluid through the Leachate Transfer Line to Lagoon 1 in WMA 2 for treatment in the LLWTF and eventual discharge to Erdman Brook. Typically, concentrations of radionuclides were in the range of 1 E-03 to 1 E-06 µCi/mL, although in the case of tritium (H-3), concentrations up to ~4 µCi/mL were observed. Before transfer to Lagoon 1 the leachate was chlorinated to destroy biological matter and then treated to reduce water hardness and to precipitate some of the radionuclides. A list of SDA trench-pumping events and volumes is provided in Luckett, et al. 2004. Activity concentrations of radionuclides detected in the leachate are also provided in Luckett, et al. 2004.

The NDA interceptor trench was installed in 1991 on the northeast and northwest boundaries of the NDA to intercept and collect potentially contaminated groundwater migrating from the NDA. The base of the trench extends to a minimum of one foot below the interface of the weathered till with the unweathered till. The trench is drained by a drainpipe that directs accumulated water to a collection sump.

Liquid that collects in the sump is routinely sampled, analyzed, and transferred through the Leachate Transfer Line to Lagoon 2 in WMA 2 for treatment and release. Since its installation, over 3,000,000 gallons of intercepted groundwater have been pumped through the Leachate Transfer Line. Details of fluid volumes pumped through the Leachate Transfer Line from the interceptor trench during the period 1991-2003 are provided in Luckett, et al. 2004.

The NDA interceptor trench is sampled as part of the WVDP environmental monitoring program. Radionuclides detected in samples of the fluid are typically in the range of 1 E-07 to 1 E-10 µCi/mL with two exceptions: Tritium (H-3) is observed in the range of 1 E-05 µCi/mL and uranium, attributed to naturally occurring materials, is observed in the range of 3E-03 µg/mL. A summary of radionuclides detected and their concentrations in the samples of the fluid during the period 1993-2003 are provided in Luckett, et al. 2004

5.3 Estimate of Activity Inventory in Leachate Transfer Line

Based on the design, operating history, and radioactivity analyses of fluids conveyed by the line, residual activity remaining in the line is insignificant to the performance assessment. Among the factors which led to this conclusion:

- The line is made of plastic designed to be non-reactive with water-based fluids.
- The leachates were dilute fluids, which had been treated with a precipitant; there would *have been little material in solution to plate out or deposit in the pipe.*

[1] The term "leachate" is used here as a general term for water that has accumulated in a disposal trench and leached constituents from the materials disposed of in the trench. The use of the term does not imply that the water and the associated leached constituents constitute a regulated "leachate" as defined under RCRA or other regulatory regimes.

- The leachate had been chlorinated; there would have been little opportunity for flora or scum to grow in the pipe and filter or trap radioactive materials conveyed in the fluids.
- The major activity in the leachate was tritium which passed through the pipe with the fluid.
- Since the leachate was conveyed in the pipe, the pipe has been flushed with over 2,600,000 gallons of groundwater that is essentially free of radionuclides.
- Measured radionuclide concentrations are detectable only with the most sensitive analysis and are well below the regulatory limits for the LLWTF inflow waters of 5.0E-03 μCi/ml.
- The total uranium observed is typical of uranium occurring naturally in groundwater, and is well below the EPA drinking water standard of 30 μg/L (or 3.0 E-02 μg/mL) for uranium, as specified in Title 10 CFR 40, Part 141.55.

6.0 References

Luckett, et al. 2004, *Radioisotope Inventory Report for Underground Lines and Low Level Waste Tanks at the West Valley Demonstration Project*, WSMS-WVNS-04-0001, Revision 0. Luckett, L., J. Fazio, and S. Marschke, Washington Safety Management Solutions, Aiken, South Carolina, July 6, 2004.

NYSERDA 1994, *RCRA Facility Investigation for NYSERDA-Maintained Portions of the Western New York Nuclear Services Center*, NYSERDA, West Valley, New York, December 1994.

RAI 1C1 (2)

Subject: Potential Phase 1 studies to support Phase 2 actions

RAI: The DP briefly discusses the DEIS preferred alternative (Phased Decision-making). For Phase 2, additional studies and evaluations will be completed to support the selection of Phase 2 activities. The types of studies and evaluations to be completed are not provided in the Phase 1 DP because they are stated as being out of scope. (Section 1.2, Page 1-3)

Basis: A cursory description of the studies and evaluations to be conducted during the ongoing assessment period should be provided to ensure the planned actions of Phase 1 are not likely to alter or limit the ability to complete the Phase 2 studies and evaluations.

NRC Path Forward: Provide a brief description of the planned studies for Phase 2 in the introductory materials of the Phase 1 DP.

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DOE Response: Surface soil, subsurface soil, and stream sediment within the project premises would be characterized during Phase 1 of the phased decision-making alternative. The details of this sampling and data analysis program would be described in the Characterization Sample and Analysis Plan to be prepared in 2009 and provided to NRC for review. The soil data collected during the Phase 1 sampling program would be used to support Phase 1 remediation activities including refining the design of the WMA 1 and WMA 2 excavations and associated hydraulic barrier walls. These data would also support DOE decision-making on potential soil and stream sediment remediation activities that may be performed within the project premises during Phase 1. Soil and sediment data collected during this sampling program would also be considered in future planning and selection of the Phase 2 closure design for the project premises.

The other studies to be performed during Phase 1 are currently being evaluated by DOE and NYSERDA, the joint lead agencies developing the Environmental Impact Statement for *Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (the Decommissioning EIS). Such studies could include:

- Characterization studies, which would include sampling of surface soil and stream sediments and characterization of selected underground piping that would be exposed during other removal activities; and
- Data collection and studies, such as monitoring and evaluating technology developments regarding disposal facilities for orphan waste, underground waste tank cleaning and exhumation, and exhuming buried radioactive waste, along with research related to long-term performance of engineered barriers and work to enhance site erosion and hydrology models.

DOE and NYSERDA would evaluate and consider several factors during Phase 1, including:

- The results of analyses to estimate the impacts of residual radioactivity that would remain after completion of the Phase 1 decommissioning activities;
- The additional information developed in the studies to be carried out in Phase 1; and
- The availability of new technologies that might be applied in Phase 2.

The evaluations would take into account the status of the underground waste tanks and the two waste disposal areas, which would be reviewed at approximately five-year intervals, along with the various decommissioning or long-term management approaches. The final decision on the Phase 2 decommissioning and long-term management approach would be made within 30 years of the date of issue of the Phase 1 Record of Decision.

Changes to the Plan: Revise Subsection 1.2, page 1-3, paragraph 3 as follows:

Phase 2, which this plan does not address, would complete the proposed decommissioning for the Waste Tank Farm, the Construction and Demolition Debris Landfill area, the NDA, the non-source area of the north plateau groundwater plume, and the other remaining impacted areas of the project premises following evaluation and consideration of additional studies, as noted previously. The studies to be performed during Phase 1 are currently being evaluated by DOE and NYSERDA, the joint lead agencies developing the Environmental Impact Statement for *Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (the Decommissioning EIS, which is discussed in Section 1.4.2). Such studies could include:

- Characterization studies, which would include sampling of surface soil, subsurface soil, and stream sediments along with characterization of selected underground piping that would be exposed during other removal activities; and
- Data collection and studies, such as monitoring and evaluating technology developments regarding disposal facilities for orphan waste, underground waste tank cleaning and exhumation, along with research related to long-term performance of engineered barriers and work to enhance site erosion and hydrology models and exhuming buried radioactive waste.

DOE and NYSERDA would evaluate and consider several factors during Phase 1, including:

- The results of analyses to estimate the impacts of residual radioactivity that would remain after completion of the Phase 1 decommissioning activities;
- The additional information developed in the studies to be carried out in Phase 1; and
- The availability of new technologies that might be applied in Phase 2.

The evaluations would take into account the status of the underground waste tanks and the two waste disposal areas, which would be reviewed at approximately five-year intervals, along with the various decommissioning or long-term management approaches. The final decision on the Phase 2 decommissioning and long-term management approach would be made within 30 years of the date of issue of the Phase 1 Record of Decision.

RAI 3C1 (3)

Subject: Groundwater flow and transport numerical analysis

RAI: Section 3.7.7 discusses numerical analysis techniques used to study groundwater flow and transport at the West Valley site. No additional information is provided regarding the results of this analysis and how the results are used in decommissioning planning. (Section 3.7.7, Page 3-72)

Basis: Groundwater modeling and analysis is needed for the Department of Energy (DOE) to demonstrate its understanding of the evolution of groundwater contamination at the site as well as understand the future pathways of exposure to a potential receptor. Modeling and analysis can also assist DOE with assessing the potential cumulative impacts associated with release of contaminants from various source areas at the site.

NRC Path Forward: Clarify the specific purpose and provide results for any numerical modeling conducted to investigate flow and transport at the site as described in Section 3.7.7 of the DP.

****

DOE Response: The dose modeling used to derive the surface and subsurface soil DCGL's in the DP incorporated the results of the three-dimensional far-field and near-field groundwater flow and transport modeling developed to support the preparation of the Decommissioning EIS. These groundwater models supported the evaluation of the EIS alternatives by:

- Evaluating site groundwater flow patterns over the entire project premises and a large area of the Center extending to Buttermilk Creek,
- Evaluating groundwater flow in the surficial sand and gravel unit, underlying glacial geologic units, and the uppermost bedrock units underlying the Center,
- Evaluating local changes in groundwater hydrology resulting from the proposed EIS closure alternatives, and
- Identifying transport parameters required to complete the performance assessments for the closure alternatives.

The DEIS groundwater modeling results were also used to evaluate the potential for overlap of Phase 1 and Phase 2 source areas and the effects of the proposed WMA 1 and WMA 2 hydraulic barriers of the Phased Decision-making alternative on groundwater flow in the sand and gravel unit in the north plateau of the WVDP. Section 3.7.7 of the DP will be revised to summarize the results of the groundwater modeling presented in the DEIS.

Changes to the Plan: Revise Subsection 3.7.7 as follows:

> Three-dimensional far-field and near-field groundwater flow and transport models were developed to support the preparation of the Decommissioning EIS. These models were developed to evaluate site-wide groundwater flow patterns across the project premises and underlying geologic units, evaluate local changes in groundwater hydrology resulting from the proposed EIS closure alternatives, and identify transport parameters required to complete the performance assessments for the closure alternatives.
>
> The three-dimensional site-wide groundwater flow model was the Finite Element Heat and Mass Transfer Code (FEHM), a finite element code developed by the DOE's Los Alamos National Laboratory (LANL 2003). The FEHM model used in the preparation of the Draft EIS was an improvement over earlier models developed for the site which were limited to evaluating groundwater flow in the surficial sand and gravel unit in the north

plateau of the Center. The FEHM model evaluated groundwater flow over a larger lateral and vertical extent of the Center, including the glacial geologic units underlying the surficial sand and gravel unit. The lateral and vertical boundaries of the site-wide FEHM model are as follows:

- Northern Boundary – from Quarry Creek eastward to Franks Creek downstream to its confluence with Buttermilk Creek,
- Western Boundary – follows the 1,450 foot surface elevation contour along Rock Springs Road between Quarry Creek and Franks Creek to the south,
- Southern Boundary – follows Franks Creek along the southern boundary of the South Plateau and continues as an imaginary line to Buttermilk Creek,
- Eastern Boundary – follows Buttermilk Creek from the confluence with Franks Creek to the north, to the intersection of the Southern Boundary with Buttermilk Creek in the south,
- Upper Boundary – the upper surface of the model domain follows the ground surface, and
- Bottom Boundary – the bottom surface of the model domain is at an elevation of 525 feet above sea level.

The finite-element grid used in the site-wide model used a total of 955 grid blocks with a uniform dimension of 140 feet in the x-y plane with a node located in the center of each grid block. The model was subdivided vertically into 23 discrete layers to represent the varying thicknesses of the 10 geologic units being modeled (thick-bedded unit, slack-water sequence, weathered Lavery till, unweathered Lavery till, Kent Recessional Sequence, Kent till, Olean Recessional Sequence, Olean till, weathered bedrock, and bedrock). The site-wide model has a total of 21,965 nodes with 955 in each model layer.

The site-wide model was calibrated both manually and with the automated calibration code, Parameter Estimation (PEST) (Doherty 2008). The manual calibration involved the comparison of model predicted heads with the median of observed groundwater level elevations from 56 well locations, and comparison of model predicted seepage flows with actual estimated seepage flows. The model simulated water table contours generated for the thick-bedded unit in the north plateau and the weathered Lavery till in the south plateau are in close agreement in most areas with the observed fourth quarter water table for the north plateau and south plateau. Differences were noted in several areas of the north and south plateaus that are partly attributed to the model grid size.

The site-wide FEHM groundwater flow model was not well suited for evaluating flows associated with the proposed small-scale Close-In-Place and Phased Decision-making engineered structures. A three-dimensional near-field groundwater flow model, the Subsurface Transport Over Multiple Phases Code (STOMP), was developed to evaluate rates and directions of groundwater flow in the surficial sand and gravel unit that would be affected by the proposed engineered barriers associated with the Close-In-Place and Phased Decision-making Alternatives. STOMP is a finite difference code developed by the Pacific Northwest National Laboratory (PNNL 2000). The stratigraphy and boundary conditions used in the FEHM far-field model were incorporated into the STOMP model to the maximum extent. The results of the STOMP near-field groundwater flow modeling associated with the proposed WMA 1 and WMA 2 hydraulic barriers are described in Appendix D, Engineered Barriers and Post Remediation Activities.

References:

Doherty 2004, PEST, Model-Independent Parameter Estimation, User Manual, 5th ed., Doherty, J., July, 2004.

LANL 2003, Software Users Manual (UM) for the FEHM Application, Version 2.2.1, Rev. No. 00. Document ID: 10086-UM-2.21-00, October, 2003.

PNNL 2000. STOMP, Subsurface Transport Over Multiple Phases, Version 2.0 Theory Guide, PNNL-12030, Richland, Washington. March, 2000.

RAI 4C1 (4)

Subject: Average soil concentrations and DCGLs

RAI: Additional information should be provided regarding the process DOE plans to use to average soil concentrations obtained during the final status survey for comparison against Derived Concentration Guideline Levels (DCGLs). Surficial soil contamination is defined as the top 0.15 to 0.3 m of soil in NUREG 1757, "Consolidated Decommissioning Guidance," Vols. 1 and 2 (NRC, 2006). However, in determining the radiological status of the surface soil it was noted on Page 4-28 of the DP that the top 0.6 m of the soil column was used consistent with the depth of borings from a 1993 sampling program, while for the purposes of surface soil DCGLs calculations, a depth of contamination of 1 m was assumed.

Similarly, additional information is also needed if DOE plans to use surface soil DCGLs calculated assuming a thickness of 1 m to guide remediation of areas of the site where surface contamination may be significantly greater than 1 m or where existing groundwater contamination may be present. (Sections 4.2.3, Page 4-28; 5.1.2, Page 5-4; and 5.2.1, Page 5-22; and Chapter 9):

Basis: Surface soil DCGLs were derived assuming a thickness of contamination of 1 m. While derivation of DCGLs assuming a 1 m thickness of contamination for those areas of the site where surface soils are contaminated less than 1 m is conservative, averaging concentrations from the final status survey over 1 m when the thickness of contamination is significantly less than 1 m may underestimate the risk. For example, for those radionuclides where the dose is dominated by the external pathway, the very top of the soil column contributes most significantly to dose. Therefore, the concentration in the upper soil column is most important to dose and should not be diluted over a larger thickness of partially clean soil.

Likewise, use of DCGLs for an assumed thickness of 1 m of contamination in those areas of the site where soils are contaminated over a larger thickness may underestimate the risk for other pathways. For example, for those radionuclides where the plant ingestion pathway or groundwater dependent pathways dominate the dose, the thickness of contamination may be an important parameter value. Comparison of surface soil DCGLs to contamination significantly thicker than 1 m could underestimate the potential risk. In general, DCGLs should be derived consistent with the depth of contamination to avoid significant over- or under-estimates of risk.

NRC Path Forward: Sufficient information should be provided by DOE to determine the distribution (i.e., lateral and vertical extent) of contamination across the site and in saturated sediments to ensure that surface soil DCGLs are appropriately derived and used to demonstrate compliance with License Termination Rule (LTR) criteria. DOE should clarify how soil concentrations will be estimated and compared to surface soil DCGLs in the final status surveys to ensure that doses are not significantly underestimated. DOE should also indicate what criteria will be used to determine the applicability of surface soil DCGLs in Phase 1 should the DP be revised as indicated on Page 5-4 to support remediation of surface soil.

****

DOE Response: The Characterization Sample and Analysis Plan is presently being prepared by Argonne National Laboratory. This plan will provide for measurements to determine the nature and distribution (i.e., lateral and vertical extent) of contamination across the site and in saturated sediments, including sediments in Erdman Brook and the portion of Franks Creek on the project premises.

To help ensure that the characterization program to be described in this plan will be comprehensive, DOE plans to informally solicit input from NRC, NYSERDA, and NYSDEC as the plan is being prepared. DOE will also submit the plan to NRC for review as indicated in the response to RAI 9C1. DOE plans to begin the characterization program, weather permitting, shortly after any NRC comments on the plan are addressed and the plan is issued, so that the resulting data will be available for planning purposes as soon as practicable. The conceptual schedule in Section 7 will be changed to reflect the earlier start of characterization.

DOE has decided not to refine the contamination zone thickness specified in the surface soil conceptual model based on evaluation of additional characterization data and will not recalculate the surface soil DCGLs and cleanup goals based on such a change. This process was provided for in the figure, text, and footnote on page 5-18 of the DP. This information is being changed in Revision 2 so the surface soil DCGLs and cleanup goals will not have to be changed later, since the Phase 1 Final Status Survey Plan design will be based on the cleanup goals in Revision 2 to the DP. Note that the use of surface soil DCGLs has been modified to address the concern expressed by NRC, as discussed below.

Soil sampling associated with the Phase 1 final status surveys will focus on two depth intervals, 0 to 15 cm (six inches) and 0 to 1 m (~3.3 ft). The purpose of samples representative of the 0 to 1 m depth interval is to obtain average results consistent with the Phase 1 surface soil DCGL derivation. The purpose of samples representative of the 0 to 15 cm depth interval is to address contamination that may exist as a thin layer on the surface.

Averages will be calculated separately for the two depth intervals and compared separately to the surface soil $DCGL_W$ values (that is, the Table 5-14 cleanup goals). The Characterization Sample and Analysis Plan will include data collection to confirm that near-surface buried contaminated layers (i.e., thin contaminated layers in the 0 to 1 meter depth interval overlain by un-impacted soils) posing potential dose concerns if exposed do not exist, or if they do, would have been identified by the Phase 1 Final Status Survey Plan sampling protocol. If the Characterization Sample and Analysis Plan data collection identifies areas of the site where these concerns exist, the Phase 1 Final Status Survey Plan sampling protocols would be modified to address those concerns.

Section 9 of the DP will be revised to address this matter, which will be detailed in the Phase 1 Final Status Survey Plan. Note that DOE plans to use a composite sampling approach for these soil samples as part of the final status survey process. This approach has been used effectively with NYSDEC approval in final status surveys for the FUSRAP Rattlesnake Creek remediation project near Buffalo, New York (USACE 2005). It improves decision-making performance and reduces sample analytical costs.

The DP will be revised to indicate that surface soil DCGLs and cleanup goals apply only to areas determined to have no subsurface soil contamination (i.e., contamination extending to depths greater than 1 meter). The characterization program will identify those areas, which will not include those portions of the project premises impacted by the north plateau groundwater plume.

Changes to the Plan: The following changes will be made to the DP:

On page 5-18:

[4]The characterization to be performed as described in Section 9 will provide data that may be useful in better defining source geometry in the conceptual model. For example, if the actual streambed and stream bank source geometry were found to be substantially different from that assumed in the conceptual model, then the conceptual model would be revised accordingly and the DCGLs recalculated. However, there are no plans to recalculate surface soil DCGLs for this reason because the assumed one meter source thickness is conservative and it is important to avoid changes to surface soil DCGLs that would impact the design of the Phase 1 final status surveys. While DCGLs are developed for 18 radionuclides, characterization data may indicate that some radionuclides may be dropped from further consideration. This could be the case, for example, if one or more of the 18 radionuclides do not show up above the minimum detectable concentration in any of the soil or sediment samples.

On page 5-23:

"Key features of this conceptual model and key assumptions include:

- The areal extent of surface soil contamination, which has not yet been well defined, can be represented by a distributed source spread over a relatively large area (10,000 square meters or approximately 2.5 acres);
- The average depth of contamination (contamination zone thickness) is approximately 3.3 feet (one meter), a conservative assumption for the site;
- Because the model considers only surface contamination, the resulting DCGLs and cleanup goals are applicable only to portions of the project premises where there is no subsurface contamination (i.e., contamination does not extend beyond a depth of 1 meter);"

On page 5-33,

"5.2.3 Summary of Results

Table 5-8 provides the calculated individual radionuclide DCGLs for surface soil, subsurface soil, and streambed sediment which assure that the dose to the average member of the critical group would not exceed 25 mrem per year when considering the dose contribution from each radionuclide individually. Note that the surface soil DCGLs apply only to areas of the project premises where there is no subsurface soil contamination and that the subsurface soil DCGLs apply only to the bottoms and lower sides (extending from a depth of three feet and greater) of the large excavations in WMA 1 and WMA 2."

On page 5-48:

"Consideration of such factors led to DOE establishing in this plan the cleanup goals shown in Table 5-14. Note that the surface soil cleanup goals apply only to areas of the project premises where there is no subsurface soil contamination and that the subsurface soil cleanup goals apply only to the bottoms and lower sides (extending from a depth of three feet and greater) of the large excavations in WMA 1 and WMA 2."

The following changes will be made to Figure 7-15 on page 7-49:

Change activity 2 to read "Characterize soil and sediment."

Add a label note to activity 2 as follows:

The soil and sediment characterization program may begin before Phase 1 starts.

The following changes will be made to Section 9.6 on page 9-19:

"Sample Collection and Handling

A brief description of how samples are to be collected, controlled, and handled would be provided, with reference to the detailed procedure(s) to be used for this purpose. Soil samples are to be taken from the surface representative of two different depth intervals: 0 to 15 cm (6 in) and 0 to 1 m (3.3 ft). This protocol will provide average results consistent with DCGL derivation and will prevent contamination near the surface from being diluted with less contaminated underlying material. It will also identify cases where thin contaminated layers in the 0 to 1 m interval are overlain by uncontaminated soil. The Phase 1 Final Status Survey Plan will also detail how composite samples will be consolidated for analysis."

The response to RAI 5C7 describes additional changes to be made to clarify the applicability of the subsurface soil DCGLs (cleanup goals).

References:

USACE 2005, *Rattlesnake Creek Final Status Survey Plan, Tonawanda, New York*, Revision 1. U.S. Army Corps of Engineers, Buffalo District, Buffalo, New York, September, 2005.

RAI 4C2 (5)

Subject: Characterization of contamination in Process Building area

RAI: It is not clear that the extent of contamination potentially associated with previous releases in the area of the process building has been adequately characterized. (Section 4)

Basis: The process building rests on approximately 480 H-piles that were driven into the Lavery Till. The H-piles and other discrete features such as piping, utility conduits, and wells may have acted as discrete pathways for contamination of deep groundwater.

NRC Path Forward: Provide a description of the areal and vertical extent of sampling for contamination that has been completed associated with the H-piles and other discrete engineered features relative to past major spills, leaks, or known large sources of activity.

****

DOE Response: Section 4 of Revision 1 summarizes existing radiological data from the Process Building area, including data on radioactivity in subsurface soil and groundwater collected in 2008. No data are available on contamination that may be present around the Process Building foundation H pilings and data around discrete engineering features are limited. Limited sampling data exist for the major spills in WMA 1 described in Section 2, except for the 1994, 1998, and 2008 Geoprobe® studies beneath the Process Building that investigated the source area of the north plateau groundwater plume.

Data related to the foundation H pilings will be important to understanding conditions below the bottom of the excavation. Figure 4C2-1 shows typical foundation pilings during installation. Additional historical photographs of foundation pilings are included in the response to RAI DC1. Figure 4C2-2 shows the locations of the foundation pilings.

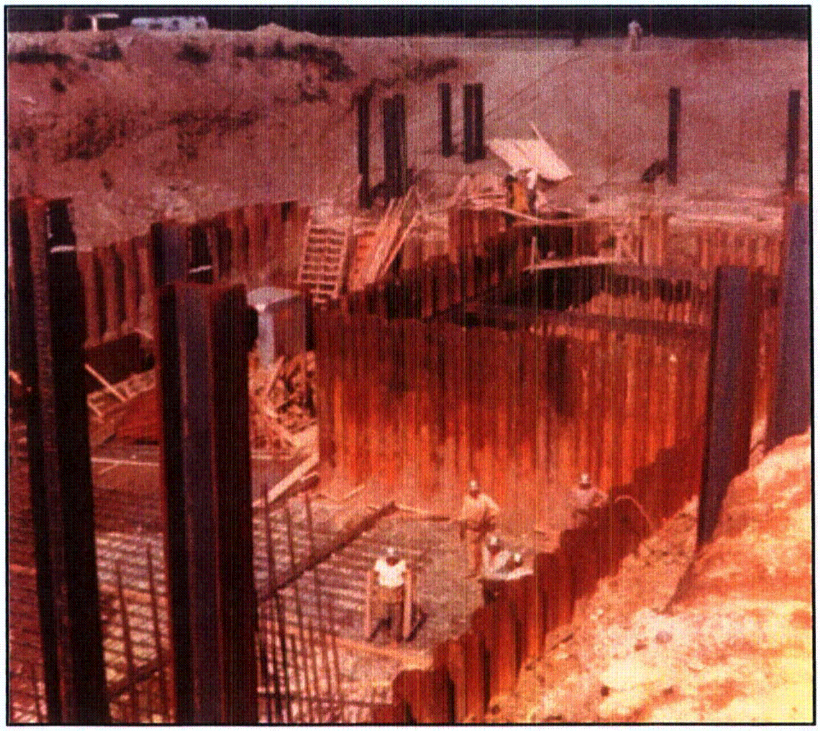

Figure 4C2-1. Construction Photograph Showing Foundation Pilings

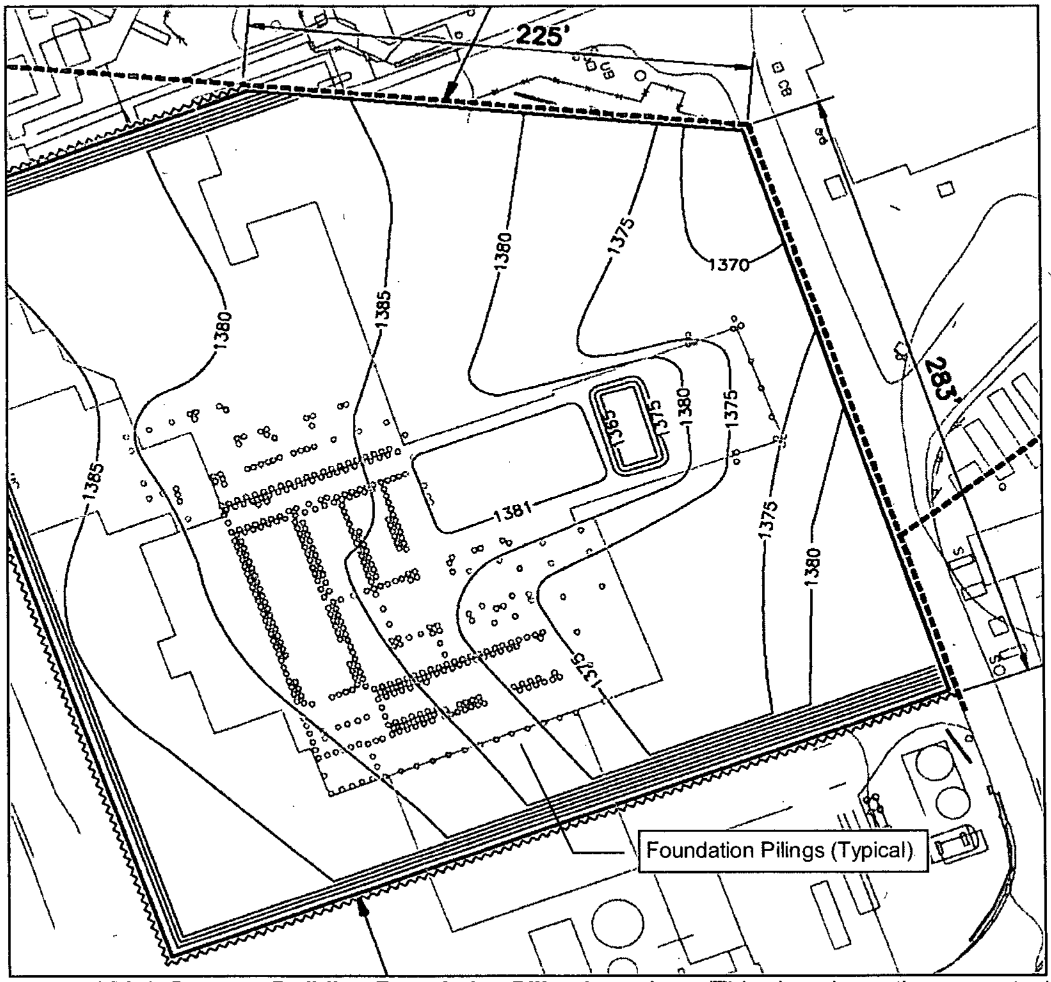

Figure 4C2-2. Process Building Foundation Piling Locations (This view shows the conceptual design of the WMA 1 excavation and the outline of the building footprint.)

Note that data related to other engineered features (groundwater monitoring wells, wastewater tanks, and underground lines) will be useful only for waste management purposes because they do not provide a potential pathway to deeper groundwater. That is, these engineering features are located within 10 feet of grade in the surficial sand and gravel unit and do not extend into the unweathered Lavery till, the top surface of which is located 25 or more feet below grade. The unweathered Lavery till layer is approximately 40 feet thick beneath the Process Building.

Section 7 presently provides for collecting samples of soil around representative pilings, including several feet below the surface (page 7-26). The pilings are 12-inch steel bearing piles (12BP53). Records indicate that 476 pilings were installed at depths (the piling tip elevations) ranging from approximately 1344 to 1355 feet above mean sea level. (The ground surface in the area is about 1410-1415 feet above mean sea level.) The Characterization Sample and Analysis Plan and the Phase 1 Final Status Survey Plan will provide for systematic sampling of soil around the pilings when they all become accessible during demolition of the Process Building underground structure and excavation of subsurface soil. DOE will provide the Characterization Sample and Analysis Plan to NRC for review (see RAI 9C1).

Changes to the Plan:

Figures 7-6 and 7-8 will be replaced with the figures shown on the following two pages, which show the pilings and better show the underground lines.

The text in Section 7.3.8 on page 7-26 will be changed as follows:

Removal of Underground Structures, Floor Slabs, and Foundations

The demolition of below-grade cells and structures shown in Figure 7-5 would be coordinated with the removal of the three underground tanks, the underground piping, and contaminated soil associated with the source area of the north plateau groundwater plume. All remaining concrete floor slabs and foundations in the area, including those outside of the excavation, would be removed early in the process to facilitate the excavation work. After soil is excavated to expose their structures, the below-grade cells would be demolished with conventional demolition equipment such as diamond wire saws.

The foundation pilings supporting the Process Building would be cut off at the bottom of the excavation or slightly below the bottom and the cut-off portion removed as well. All demolition debris would be characterized and disposed of offsite. In connection with this work, samples of soil would be collected around representative pilings, including at points several feet below the surface in accordance with the Characterization Sample and Analysis Plan and the Phase 1 Final Status Survey Plan. Analytical data from the samples would be used to evaluate the potential for preferential flow paths around the pilings and be considered in the Phase 1 final status surveys described in Section 9 and Appendix G.[1]

[1] Appendix G is provided in the response to RAI 9C4.

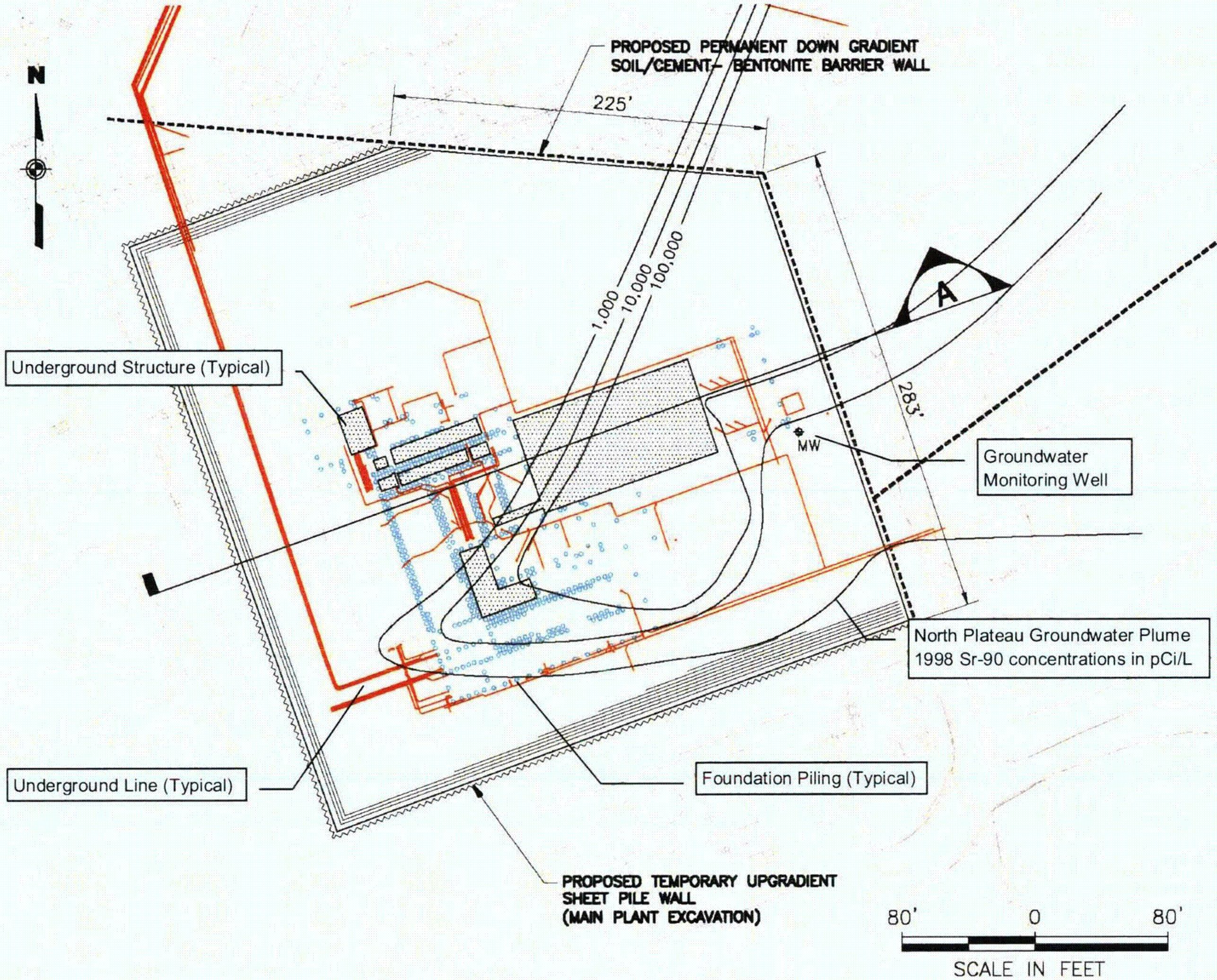

Figure 7-6. Conceptual Layout of WMA 1 Excavation (Showing underground structures and underground lines.)

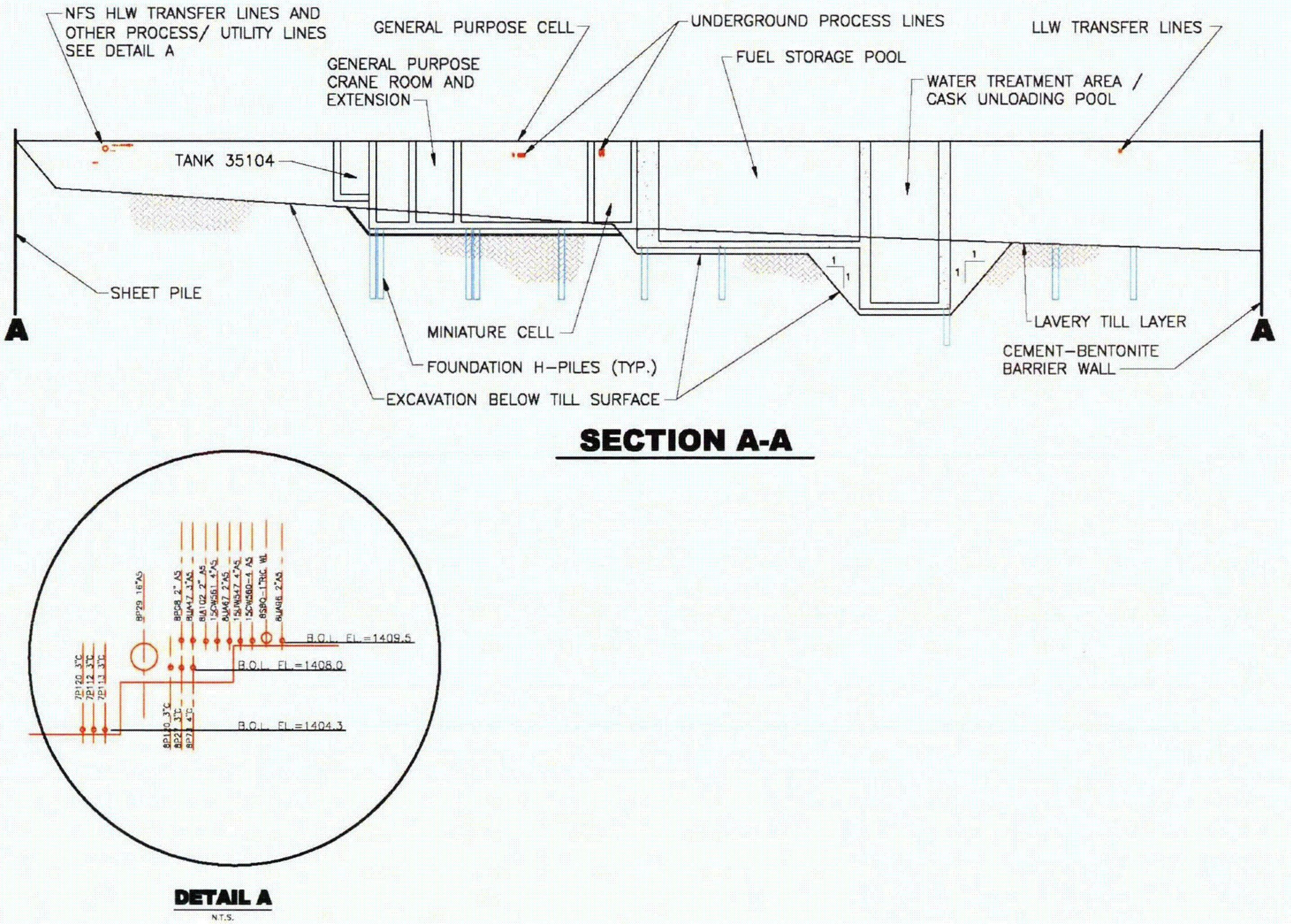

Figure 7-8. Excavation Cross Section

RAI 5C2 (7)

Subject: Radionuclide screening approach

RAI: DOE should provide additional information on the screening approach used to identify radionuclides to be considered in the DCGL calculations. (Section 5.2, Page 5-19)

Basis: The list of eighteen radionuclides for which DCGLs were derived is based on a screening process. Additional risks from radionuclides that were "screened out" were not considered in the dose analysis. Sufficient information on the screening approach should be provided to allow a reviewer to evaluate the merits of the screening process to ensure that a sufficient portion of the site risk is not overlooked.

It is not clear that risk-significant activities of daughter products are not currently present in the environs at the West Valley site. These daughter products may have the most limiting DCGLs and their initial activity may need to be considered in the analysis.

Path Forward: Provide additional information on the screening process and calculations used to show that the residual risk from radionuclides not included in the list of eighteen is less than 1% (page 5-19). Provide a supporting basis for the assumption regarding the initial activity of daughter products that may dominate the DCGL calculations.

****

DOE Response:

The Pacific Northwest National Laboratory characterization report (Jenquin, et al. 1992) discussed on page 4-13 of the DP provides ORIGEN2 activity estimates for a wide range of radionuclides for each of the 27 fuel reprocessing campaigns at West Valley. This report provides the best detailed information on the radionuclides brought to the site for reprocessing, that is, the total initial source term.

Screening Analysis Described in the 1996 DEIS

The 1996 DEIS (DOE and NYSERDA 1996, pages E-1 and E-2) described the screening process that reduced a comprehensive list of radionuclides present to 30. These 30 radionuclides were:

Ac-227	Co-60	Pa-231	Ra-228	Th-232
Am-241	**Cs-137**	**Pu-238**	Sb-125	**U-232**
C-14	Eu-154	**Pu-239**	Sn-126	**U-233**
Cd-113m	H-3	**Pu-240**	**Sr-90**	**U-234**
Cm-243	**I-129**	**Pu-241**	**Tc-99**	**U-235**
Cm-244	**Np-237**	Ra-226	Th-229	**U-238**

The 18 radionuclides of interest in the Phase 1 Decommissioning Plan are shown in boldface.

The screening criteria used to produce the list of 30 radionuclides may be summarized as follows:

- A comprehensive list of radionuclides present at the Center was developed using information from waste characterization reports for each WMA.
- Radionuclides with half-lives of less than one year were eliminated (short-lived progeny of long-lived radionuclides were accounted for in the dose calculations).

- Radionuclides with half-lives ranging from one to three years were eliminated if the quantities at the conclusion of HLW solidification were estimated to be insignificant in relation to similar radionuclides (all such radionuclides were eliminated except Sb-125 and Pm-147).
- Radionuclides that always appear in insignificant quantities with respect to similar radionuclides were eliminated (e.g., Cs-135 was eliminated because it is always several orders of magnitude less than Cs-137).
- Radionuclides with site-wide activities less than 10 µCi were eliminated.
- Generic dose calculations using the RESRAD and GENII computer codes were performed to determine the relative contribution of each radionuclide to estimated population doses. These calculations assumed equal quantities of each radionuclide in air, surface water, or soil. Based on the results of these calculations, radionuclides were eliminated under either of two conditions: (1) for both the air and water scenarios, the resulting doses were more than four orders of magnitude lower than the doses from other radionuclides or (2) the dose from a radionuclide was similar to or less than the dose from a radionuclide that was more abundant by two or more orders of magnitude. Examples of radionuclides eliminated under these criteria were Pd-107 and U-236.

Other Screening Analyses

Several additional screening analyses for selection of key radionuclides to be considered in dose modeling were completed in 2003 for use in developing the Revised DEIS issued in November 2008. These involved postulated releases of radioactivity from the Process Building, Tank 8D-2, the NDA, and the SDA. A total of 71 radionuclides were considered, including the 30 identified in the 1996 DEIS. The list of 71 radionuclides includes 60 fission product and actinide nuclides identified by sampling the supernatant and sludge of Tank 8D-2, as well as the progeny of these 60 nuclides present in the six principal decay chains of the actinide nuclides. The parents of these decay chains are U-232, U-238, Pu-238, Pu-241, Cm-243, and Cm-244.

These screening analyses evaluated a residential groundwater scenario (ingestion of groundwater via a well) and the resident farmer scenario (ingestion of meat, milk, plant, and groundwater). The general approach involved using the available radiological inventory estimates to determine the fraction of the total inventory represented by each nuclide, then estimating the fraction of the total exposure expected from each nuclide.

The intruder scenario made use of the following input data: the ingestion dose conversion factors from Federal Guidance Report 11 (EPA 1998), site-specific K_d values for the vadose and saturated zones, and an assumed 30 year institutional control period. The resident farmer scenario utilized site-specific dose-to-source ratios that were generated for the EIS for a resident farmer to identify the key radionuclides.

The analyses, which made use of the radionuclide inventories for the supernatant and sludge in Tank 8D-2, produced the following results:

- For the resident farmer scenario screening based on sludge inventories, Sr-90 contributed over 99 percent of the relative dose.
- For the resident farmer exposed to supernatant based inventories, Cs-137 (99.8 percent) dominated the relative dose estimate.
- For the residential groundwater scenario, over 97 percent of the relative dose, based on sludge inventories, could be attributed to Np-237 (53 percent) and Pu-239 (44 percent).

- For the supernatant based residential groundwater scenario, 99.9 percent of the relative dose was associated with three radionuclides: Tc-99 (98.7% percent), I-129 (0.6 percent), and C-14 (0.6 percent).

Although the relative doses were dominated by a few radionuclides, a comprehensive list of radionuclides was evaluated in the dose modeling. Table 5C2-1 identifies the key radionuclides developed through this screening process.

Table 5C2-1. Summary of Key Radionuclides for Long-Term Performance Assessment[1]

Nuclide	Process Building		HLW Tank 8D-2		NDA		SDA	
	Drinking Water	Intrusion	Drinking Water	Intrusion	Drinking Water	Intrusion	Drinking Water	Intrusion
C-14	yes		yes		yes	yes	yes	yes
Ni-63						yes		yes
Sr-90		yes		yes		yes		yes
Tc-99	yes		yes		yes		yes	
I-129	yes		yes		yes		yes	yes
Cs-137		yes		yes		yes		yes
Ra-226								yes
Th-230								yes
Th-232								yes
U-233	yes		yes		yes		yes	
U-234	yes		yes		yes		yes	yes
U-235					yes		yes	
U-238	yes				yes		yes	yes
Np-237	yes		yes		yes			
Pu-238						yes		yes
Pu-239	yes		yes			yes		yes
Pu-240	yes		yes					yes
Am-241		yes		yes		yes		yes

NOTE: (1) Added Pu-241, Cm-243 and Cm-244 as parents of nuclides on the list; removed Ni-63 as activated metal, and Th-230 and Th-232 as present as small (< 1 % each) contributor to a single scenario.

Four radionuclides identified as key radionuclides in the screening analysis do not appear on the list of 18 radionuclides of interest: Ni-63, Ra-226, Th-232, and Th-234. These radionuclides are important dose contributors only in intrusion scenarios for the waste burial grounds. They are not of concern in soil and sediment contamination on the project premises for the following reasons:

(1) Intrusion scenarios for the NDA and SDA are not relevant to development of Phase 1 DCGLs for soil and streambed sediment because the radionuclide mix in these disposal sites is different from that of contamination found in soil and sediment that could be impacted by proposed Phase 1 activities.

(2) The radioactivity in the SDA is not representative of radioactivity brought to the site for reprocessing. Much of the waste received for burial in the SDA came from offsite sources, such as special purpose reactors, institutions, isotope production facilities, and

industries (Wild 2000). Because of this situation, Ra-226, Th-230, and Th-232, which are important in the SDA intruder analysis but not in the analysis for Tank 8D-2 or the NDA, are unlikely to be radionuclides of concern in soil and sediment contamination on the project premises.

(3) The activation product Ni-63 would have been restricted to the head-end cells in the Process Building and to disposal operations in the NDA. Ni-63 is present in the disposal areas in pieces of activated metal from fuel assembly structural components and cladding in significant amounts (116,000 Ci in the NDA as of 2000 in the estimates in Wild 2000a). However, Ni-63 would not be expected to be of concern in soil and sediment contamination because: (a) It is unlikely that Ni-63 would be present in soil and streambed sediment in significant amounts and (b) Ni-63 emits only low energy beta radiation, and (c) the potential radiological hazard for Ni-63 is much lower than that of Sr-90 (its annual limits on intake in 10 CFR 20 Appendix B are about two orders of magnitude higher than those of Sr-90).

(4) Regarding Ra-226, this radionuclide is naturally occurring and the contribution from decay of uranium processed by NFS would be insignificant.

(5) Regarding Th-230 and Th-232, the total inventory of these radionuclides (<2 Ci) in spent fuel delivered to NFS for reprocessing was insignificant.

After consideration of such matters, it is reasonable to conclude that the screening analyses support selection of the 18 radionuclides of current interest in developing DCGLs for soil and sediment contamination.

Consideration of Progeny

A number of the radionuclides at the site exist in radioactive decay chains, and this factor influences the manner in which their activities change over time. Some radionuclides have very short half-lives and only occur when the parent is present, e.g., Y-90 is only present when its parent Sr-90 is present. In these situations, the daughter radionuclide is not identified separately from the parent, but its contribution to dose and risk is added to that from the parent. This is a commonly used practice in computer codes such as RESRAD.

In other cases, the daughter radionuclide may have a long half-life relative to its parent, such as Am-241 and Pu-241. In addition, both radionuclides may have been initially present in the spent nuclear fuel that was processed at the site. The production of Am-241 from Pu-241 decay is accounted for, of course, by having DCGLs for each radionuclide.

Radioactive progeny for actinide decay chains were considered in the 2003 screening for the Decommissioning EIS and were not retained, as discussed above. As indicated in the note to Table 5C2-1, Pu-241, Cm-243 and Cm-244 were added to the list of radionuclides to capture increased progeny in-growth contributing to radionuclides selected for consideration. The development of DCGLs with RESRAD considers the in-growth of progeny in assessing the dose from the parent, so such progeny are included in the assessment.

Recent analysis using the RESRAD probabilistic mode indicates that in some cases the progeny biotransfer factor is identified as a key parameter through output rank correlations (see Section 8 of the new Appendix E included with the response to RAI 5C15). This analysis identified the influences of three radionuclide/progeny pairs (Pu-241 – Am-241; U-235 – Pa 231; and U-232 – Th-228).

The presence of significant amounts of Pa-231 at the site is unlikely, although this daughter product will be considered in data collection efforts provided for in the Characterization Sample and Analysis Plan.[1] Th-228, which will not be considered in the data collection efforts, will be in secular equilibrium with U-232, and its contribution to dose and risk is accounted for by RESRAD in the development of DCGLs.

Such considerations lead to the conclusion that Am-241 is the only daughter product of interest and its presence is accounted for by having separate DCGLs for Am-241 and Pu-241.

Changes to the Plan: None.

References:

DOE and NYSERDA 1996, *Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center,* DOE/EIS-0226-D. U.S. Department of Energy and New York State Energy Research and Development Administration, West Valley, New York, January 1996.

EPA 1988. Federal Guidance Report No. 11, "*Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion,*" EPA-520/1-88-020, U.S. Environmental Protection Agency, Washington, D.C., September 1988.

Jenquin, et al. 1992, *Characterization of Reactor Fuel Reprocessed at West Valley*, WVDP EIS-014, Revision 0. Jenquin, et al., Pacific Northwest Laboratory, Richland, Washington, February 1992.

Wild 2000, *Estimated Radionuclide Inventory for the NRC Licensed Disposal Area at the West Valley Demonstration Project*. Wild, R. E., URS/Dames & Moore, Orchard Park, New York, August, 2000.

[1] DOE will provide the Characterization Sample and Analysis Plan to NRC for review as indicated in the responses to RAIs 1C1, 4C2, and 9C1. The response to RAI 9C1 states that DOE will solicit input from NRC on the objectives of the Characterization Sample and Analysis Plan. One of these objectives is to identify the presence of other radionuclides of interest beyond the 18 radionuclides specified in the DP. Data will be collected for the twelve other radionuclides from the 1996 DEIS screening analysis to this end.

RAI 5C4 (9)

Subject: Technical basis for no erosion assumption

RAI: A technical basis is needed to support the conclusion that the assumption of no erosion of the contaminated zone is conservative for the development of surface DCGLs. (Section 5.2.1, Page 5-22)

Basis: Surface DCGLs are developed using RESRAD and setting the contaminated zone erosion rate to 0 m/y. It is stated that this approach is conservative because it results in no depletion of the source through erosion. A technical basis for this conclusion, such as a quantitative analysis of exposure pathways and rates of exposure to different receptors, should be provided. Release from erosion processes and deposition and exposure to appropriate receptors should be compared against the current concentrations, exposure pathways, and uptake rates for the resident farmer — zero erosion calculation to demonstrate that the current approach is more limiting.

NRC Path Forward: Provide a technical basis that the use of a resident farmer with no depletion of the source area results in more limiting surface DCGLs than those developed for erosion of the source. The basis should consider the impact of dilution during release and transport that would occur as a result of release from erosion. For example, Figure 2-7 shows the impact of dilution on operational surface water discharges further downstream on Buttermilk Creek. A full erosion analysis is not necessary, but a relative comparison of concentrations, exposure pathways, uptake rates, and exposure times should be provided.

****

DOE Response: Consideration of potential exposure from eroded source material to both onsite and offsite receptors supports the conclusion that the model with no source erosion is conservative for the reasons given below.

The assumption of no source erosion was made to avoid depletion of the source as indicated in Note (3) to Table 5-3. This condition is typically considered to be conservative because source erosion diminishes the radioactivity that can lead to radiation exposure to the resident farmer through the various pathways that are evaluated in the surface soil model.

Erosion on the project premises occurs through several mechanisms as described in Section 5.1.4 of the DP. The erosion rate on the central portion of the north plateau from sheet and rill erosion is small and is expected to amount to a matter of inches over a 1000-year period. The rate of erosion in the stream valleys through gully formation is expected to be much higher.

Potential Impacts From Eroded Source Material to an Onsite Receptor

If erosion were to proceed unchecked, existing gullies on the edges of the north plateau would lengthen and deepen and new gullies would form as time passes. These processes would create conditions where growing crops in this area would not be plausible and continuous occupancy would be unlikely.

A plausible exposure scenario for these conditions would involve a recreational hiker spending time in the area of the gullies, with this hypothetical person being exposed to radioactivity from the hypothetical contaminated garden that was washed into the gullies by precipitation. The recreationist would be exposed to lower concentrations of radioactivity than the resident farmer owing to dilution that would occur as the contamination moved down the gullies to the stream and then downstream.

A second factor of importance would be the amount of time spent in the area during which the receptor would be exposed to the radioactivity. A recreationist would be expected to spend much less time in the area of contamination in a gully than a resident farmer would spend in the area of contamination in a garden. The following table compares these factors and the exposure pathways for the resident farmer and the recreationist.

Table 5C4-1. Resident Farmer – Recreationist Comparison

Factor/Exposure Pathway	Farmer[(1)]	Recreationist	Remarks
Source radionuclide concentrations	At DCGLs	less	Due to dilution effect.
Outdoor time fraction exposed	0.25	less	
External gamma radiation	Yes	less	
Inhalation	Yes	less	
Plant ingestion	Yes	No	
Meat ingestion	Yes	No	
Milk ingestion	Yes	No	
Drinking water ingestion	Yes	No	
Soil ingestion	Yes	less	

NOTES: (1) From Table C-1.

It is evident from the information in this table that the resident farmer scenario with no erosion is more conservative than taking erosion into account by considering a recreationist on the north plateau. This conclusion is reinforced by the results of the analysis described in the response to RAI 5C6 that evaluated the recreationist scenario with regard to subsurface DCGL development.

Consideration could also be given to potential doses to an offsite receptor from radioactivity associated with erosion of the area of interest on the project premises.

Potential Impacts From Eroded Source Material to an Offsite Receptor

Erosion could result in low levels of residual radioactive contamination in surface soil that meets DCGLs entering streams on or near the project premises. Some of this radioactivity could make its way downstream where it could impact offsite receptors. Potential impacts would diminish with distance from the project premises because some of the contamination would be retained in the stream bed.

To estimate such potential impacts, an analysis was performed using methodology used in the Decommissioning EIS[1] for estimating offsite impacts of erosion. For the purpose of this calculation, the eroded soil was assumed to be transported in surface water to a receptor located on Cattaraugus Creek near the confluence with Buttermilk Creek who ingests both the water and fish harvested from the water and uses the water to irrigate a garden. Erosion rates were those estimated for the site and reported in Table F-13 of the Decommissioning EIS for the Water Erosion Prediction Project Model. Drinking water and fish ingestion rates corresponded to the 95th percentile of national use and crop and animal product intake values were those recommended in NUREG/CR-5512, Volume 3 (Beyeler, et al. 1999).

This analysis produced DCGLs that show the concentrations of each of the 18 radionuclides of interest necessary to produce 25 mrem per year to an offsite receptor. The DCGLs for this scenario were are least three orders of magnitude higher than the DCGLs for surface soil developed using the base case resident farmer scenario. Table 5C4-1 shows the calculated DCGLs for key radionuclides compared to the base case.

Table 5C4-1. Key Radionuclide Analysis Results

Radionuclide	Offsite Receptor Dose (mrem/y for 1 pCi/g)	Onsite DCGL (pCi/g Onsite for 25 mrem/y to Offsite Receptor)	Base-Case Resident Farmer DCGL for Surface Soil (pCi/g)(1)
C-14	2.5E-06	1.0E+07	2.0E+01
Sr-90	3.5E-06	7.2E+06	6.2E+00(2)
Tc-99	3.4E-07	7.4E+07	2.4E+01
I-129	4.5E-05	5.5E+05	3.5E-01
Cs-137	4.3E-05	5.9E+05	2.4E+01(2)
U-238	4.8E-06	5.2E+06	2.1E+01
Pu-239	6.6E-05	3.8E+05	4.5E+01

NOTES: (1) Revised deterministic DCGLs developed using revised parameters described in response to RAI 5C12.
(2) With 30 years decay.

This analysis demonstrates that there is a reasonable expectation that the potential dose to an offsite receptor from erosion of radioactivity from an area on the project premises with residual radioactivity at the surface soil DCGLs would be insignificant. The calculation package for this analysis and the associated electronic files will be provided with the RAI responses submitted in September 2009.

Changes to the Plan: Change note (3) to Table 5-3 to read as follows:

(3) This assumption is conservative because it results in no depletion of the source through erosion. The conservative nature of the assumption can be demonstrated by assuming that erosion takes place and evaluating potential doses to a receptor located in a gully where radioactivity has been displaced by erosion. As explained in the discussion of alternate conceptual models below, the receptor in the area of the gully would receive less dose on an annual basis than would the resident farmer due to factors such as source dilution, spending less time in the contaminated area, and receiving exposure through fewer pathways. Consideration of potential doses to an offsite receptor from radioactivity displaced to the stream through erosion indicates that there is a reasonable expectation that offsite doses would not be significant either.

Add the following information on page 5-23:

- DCGLs that reflect 30 years of decay (i.e., apply to the year 2041) are appropriate for Sr-90 and Cs-137. Although a 30-year decay period could have been applied to all radionuclides, Sr-90 and Cs-137 were selected based on their prevalence in surface soil, their expected peak doses at the onset of exposure, and the short half lives of these particular radionuclides, as noted previously.

Another Possible Conceptual Model for Surface Soil DCGL Development

Other conceptual models were considered, even though the resident farmer model with its many exposure pathways is generally considered to be the most conservative model. To confirm that the assumption of no erosion in the contamination zone (one of the key parameters in Table 5-3) is conservative, an analysis was performed to estimate the potential doses to an offsite receptor from radioactivity that could be released from the hypothetical garden used in the base-case model through erosion.

In this analysis, eroded soil was assumed to be transported in surface water to a receptor located on Cattaraugus Creek near the confluence with Buttermilk Creek who ingested both the water and fish harvested from the water and used the water to irrigate a garden. The results showed that doses to this receptor would be insignificant.

Subsurface Soil Conceptual Model

Figure 5-8 illustrates the conceptual model for subsurface soil DCGL development. The basic RESRAD model is used as with development of surface soil DCGLs, with a resident farmer being the average member of the critical group. The hypothetical residence and farm are assumed to be located in the remediated WMA 1 area. Exposure to the subsurface radioactivity occurs following intrusion and surface dispersal when installing a water collection cistem.

Reference:

Beyeler, et al. 1999, *Residual Radioactivity from Decommissioning, Parameter Analysis*, NUREG/CR-5512, Vol 3, Draft Report for Comment. Beyeler, W. E., W. A. Hareland, F. A. Duran, T. J. Brown, E. Kalinina, D. P. Gallegos, and P. A. Davis, Sandia National Laboratories, Albuquerque, New Mexico, October 1999.

RAI 5C5 (10)

Subject: Well driller acute dose

RAI: Acute dose to a well driller should be evaluated to demonstrate that DCGLs derived for the resident farmer are bounding. (Section 5.2.1, Page 5-28)

Basis: A statement is made on page 5-28 of the DP that, based on the results of the acute worker scenario in the Draft Environmental Impact Statement (DEIS), the dose after 100 years would be insignificant (less than 1 E-08 mrem/y). The text goes on to state that the resident farmer dose would be much higher than the acute worker, but no specific details are provided. The DEIS evaluation includes an acute worker and chronic resident scenario. However, for both cases, the dose is assumed to be negligible (less than 1 E-08 mrem/y). Therefore, the statement that the resident farmer dose is significantly higher than the acute worker dose is not supported by the DEIS analysis, as the predicted doses for both cases are negligible and not reported. In fact, in the case of subsurface contamination at the bottom of the excavations, DOE expects the dose from an intrusion event to be much higher than predicted for a similar scenario evaluated for the North Plateau in the DEIS analysis (i.e., in the range 1 mrem/y according to page 5-51), but it is not clear how this dose would compare to an acute worker for the DP analysis.

An important assumption in the DEIS analysis is that a cuttings pond would be used when drilling a cistern and that the depth of water in the pond would be 0.6 m (2 feet). As the pond would reduce the external exposure to an acute worker by a factor of approximately 75, this assumption should be fully supported, if relied on for the DP analysis.

Path Forward: A quantitative evaluation of acute worker dose should be performed with a representative parameter set to support the assumption that the worker dose is bounded by the chronic resident farmer dose. Parameter assumptions should be consistent with regional practices (e.g., use of a cuttings pond) and shielding factors reflective of the expected shielding for the radionuclides and gamma energies expected to be present at the site.

****

DOE Response: A bounding quantitative analysis of the acute dose to the well driller has been performed using conservative assumptions. The results show that the well driller dose is bounded by the chronic resident farmer dose as expected.

The analysis was performed using RESRAD version 6.4 in the deterministic mode. Key elements in the conceptual model included:

- The drilling worker being exposed to excavated Lavery till material from the bottom of the excavation that was deposited on top of uncontaminated soil in the vicinity of the cistern for a 40 hour period;
- The contamination zone being nine square meters in area and 0.333 meters thick, based on an excavated volume of three cubic meters of contaminated Lavery till material;
- Exposure pathways consisting of inadvertent soil ingestion, inhalation of dust, and external exposure to direct radiation; and
- An assumption of no water shielding, even though water in a cuttings pond would typically provide shielding from direct radiation.

The resulting DCGLs for 25 mrem per year were greater than the subsurface soil DCGLs for all 18 radionuclides of interest developed for the resident farmer scenario. Copies of the calculation package showing details of the analysis and the associated electronic files are provided with the RAI response submittal.

Changes to the Plan: The following changes are being made to Section 5.2.1 on page 5-28. The existing third paragraph in this unnumbered subsection is being deleted.

Other Possible Conceptual Models for Subsurface Soil DCGL Development

Other possible conceptual models were considered, such as a drilling worker. A drilling worker scenario would evaluate dose to a hypothetical individual installing the cistern, such as from contamination brought to the surface in the form of drill cuttings that could be set aside near the cistern.

A well driller scenario was evaluated using RESRAD with conservative assumptions. Key elements in the model included:

- The drilling worker being exposed to excavated Lavery till material from the bottom of the excavation that was deposited on top of uncontaminated soil in the vicinity of the cistern for a 40 hour period, even though the actual exposure period would likely be much shorter;
- The contamination zone being nine square meters in area and 0.333 meters thick, based on an excavated volume of three cubic meters of contaminated Lavery till material; and
- An assumption of no water shielding, even though water in a cuttings pond would typically provide shielding from direct radiation.

The exposure pathways considered included inadvertent ingestion of contaminated soil, inhalation of contaminated dust, and direct exposure to contaminated soil brought to the surface during the drilling. The resulting DCGLs were greater than the subsurface soil DCGLs for all radionuclides developed for the resident farmer scenario, indicating the well driller scenario is less limiting that the residential farmer scenario used in developing the subsurface soil DCGLs.

RAI 5C6 (11)

Subject: Show that the cistern scenario is bounding

RAI: DOE did not provide enough information to show that the subsurface DCGL calculations considering a cistern drilling scenario are bounding. (Section 5.1.4, Page 5-14)

Basis: Subsurface DCGLs are calculated assuming a cistern is drilled throughout the thickness of the sand and gravel unit to the top of the Lavery Till.

DOE acknowledges that gully erosion could intrude upon the lagoon areas (see page 5-14). However, DOE did not provide quantitative support for its assumption that erosion from gully formation/advancement, or stream widening could intercept the WMA 2 source areas and produce greater exposures to an offsite or onsite receptor.

Path Forward: DOE should provide the results of a quantitative analysis that supports its assumption that the subsurface DCGLs calculated assuming a cistern driller scenario bound the potential impacts from erosion.

****

DOE Response: DOE has performed a quantitative analysis of potential doses to an onsite receptor located in the portion of WMA 2 most susceptible to the impacts of unmitigated erosion based on the erosion modeling performed for the Decommissioning EIS. The results show that the cistern scenario is more limiting than the alternate onsite receptor scenario that was analyzed.

DOE has also performed a quantitative analysis of the potential impacts of unmitigated erosion in the area of the backfilled WMA 2 excavation on a representative offsite receptor. Here too, the results show that the cistern scenario is more limiting than the alternate offsite receptor scenario that was analyzed.

These analyses are described below.

Predicted Erosion

Information in Section 5.1.4 of the DP is drawn from erosion analyses performed for the Decommissioning EIS. As indicated in Section 5.1.4, the studies described in Appendix F to the Decommissioning EIS suggest that the central portion of the north plateau where WMA 1 is located will be generally stable for the next 1000 years, but that the portion of WMA 2 near the Erdman Brook stream valley is much more susceptible to erosion, particularly that associated with development of gullies.

Potential Doses to an Onsite Receptor

The predicted gully erosion would produce narrow, deep steep-sided gullies, conditions where building a home and growing crops would not be practical. Consequently, the resident farmer scenario used in development of the subsurface soil DCGLs would no longer be plausible for this part of WMA 2 under these conditions.

A plausible scenario for these conditions would involve a recreationist spending time hiking in the area, which is assumed to be rent by deep gullies that extend to the bottom of the WMA 2 excavation. Figure 5C6-1 illustrates the basic conceptual model. This scenario was analyzed using RESRAD in the deterministic mode with the following key conceptual model input parameters:

- Unmitigated erosion would produce conditions where the recreationist could be exposed to contamination at the bottom of the WMA 2 excavation in the area of Lagoons 1 and 2 in 200 years;
- One or more gullies are assumed to extend through the contamination zone, which is made up of unweathered Lavery till material one-meter thick at the bottom of the WMA 2 excavation;
- The exposed contamination zone area in the gully walls is assumed to be two meters wide and 100 meters long, a reasonable size to represent the likely geometry of the exposed contamination in the gully (modeling a single source area rather than the two illustrated in Figure 5C6-1 was more practical);
- The recreationist is assumed to be walking at a pace of 0.8 kilometers (0.5 mile) per hour on a path where exposed contamination is present, such as going to the stream to hunt or fish and returning home;
- The recreationist would be exposed to the contamination for a total of 28 hours per year (an outdoor time fraction of 0.0032), based on 112 trips per year to and from the stream.

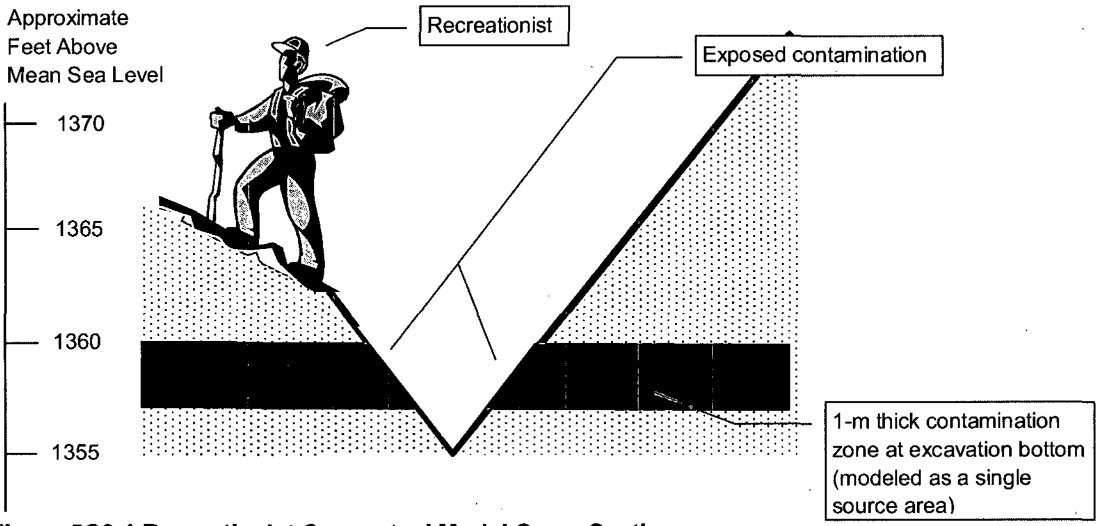

Figure 5C6-1 Recreationist Conceptual Model Cross Section

The modeling of this recreationist scenario produced DCGLs for 25 mrem per year that were more than one order of magnitude greater than the DCGLs produced with the cistern scenario for all 18 radionuclides of interest. These results demonstrate that the cistern scenario is more limiting for an onsite receptor.

Sensitivity analyses of the time to beginning exposure (development of gullies as assumed in the conceptual model) were performed for 100 years and 500 years. These analyses showed that even with an impossibly short period of 100 years to produce the eroded conditions that were analyzed, the DCGLs for the recreationist scenario would still be more than one order of magnitude greater than those for the cistern scenario for all radionuclides. This difference would be even greater using the 500 year time period, as would be expected.

The calculation package describing this analysis and the associated electronic files are being provided to NRC with the RAI responses.

Potential Doses to an Offsite Receptor

The response to RAI 5C4 describes an analysis to determine the values of surface soil DCGLs that would produce 25 mrem per year to an offsite receptor from radioactivity associated with erosion of surface soil. A similar analysis has been performed for residual radioactivity at the bottom of the deep excavation in WMA 2.

The type of erosion described previously in relation to potential doses to an onsite receptor could result in residual radioactivity from the bottom of the backfilled deep excavation in WMA 2 entering Erdman Brook and impacting downstream offsite receptors. To quantitatively estimate such potential impacts, an analysis was performed using methodology used in the Decommissioning EIS for estimating offsite impacts of erosion.

The assumption of erosion by gully intrusion into residual subsurface contamination in WMA 2 is supported by landscape evolution modeling that indicates that the WMA 2 area will be affected by gully erosion over a 10,000-year period as described in the Decommissioning EIS.

In order to evaluate these potential impacts, the largest gully produced in simulations of the landscape evolution model is assumed to intrude into Lagoon 1 (area of 400 m^2) and Lagoon 3 (area of 1,800 m^2). Peak rates of erosion were estimated as 0.012 and 0.0035 m/y for the areas of Lagoons 1 and 3, respectively, based on the erosion modeling done for the Decommissioning EIS. (These peak erosion rates are considered conservative; the next highest erosion rates predicted by this modeling are much less than these values, being on the order of 0.0035 m/y for Lagoon 1 and 0.0012 m/y Lagoon 3.)

Radioactivity in eroded soil is assumed to be transported to surface water used by an offsite receptor. The receptor located on Cattaraugus Creek near the confluence with Buttermilk Creek ingests both the water and fish harvested from the water and uses the water to irrigate a garden.

Drinking water and fish ingestion rates used in the analysis correspond to the 95^{th} percentile of national use and crop and animal product intake values are those recommended in NUREG/CR-5512, Volume 3 (Beyeler, et al. 1999). Doses for the combined pathways due to onsite contamination at a level of one picocurie per gram and the related DCGLs are summarized for key radionuclides in the following tables.

Table 5C6-1. Key Radionuclide Analysis Results for Lagoon 1 Area

Radionuclide	Offsite Receptor Dose (mrem/y for 1 pCi/g)	Onsite DCGL (pCi/g Onsite for 25 mrem/y to Offsite Receptor)	Deterministic DCGL from Cistern Scenario (pCi/g)(1)
C-14	3.0E-06	8.4E+06	5.6E+05
Sr-90	4.2E-06	1.2E+07(1)	4.4E+03(2)
Tc-99	4.1E-07	6.1E+07	1.6E+04
I-129	5.5E-05	4.6E+05	6.5E+02
Cs-137	5.1E-05	9.8E+05(1)	4.4E+02(2)
U-238	5.8E-06	4.3E+06	2.9E+03
Pu-239	7.9E-05	3.2E+05	1.3E+04

NOTE: (1) Revised deterministic $DCGL_W$ values calculated using revised parameters described in the response to RAI 5C12.

(2) With 30-year decay period.

Table 5C6-2. Key Radionuclide Analysis Results for Lagoon 3 Area

Radionuclide	Offsite Receptor Dose (mrem/yr for 1 pCi/g)	Onsite DCGL (pCi/g Onsite for 25 mrem/y to Offsite Receptor)	Deterministic DCGL from Cistern Scenario (pCi/g)(1)
C-14	3.9E-06	6.4E+06	5.6E+05
Sr-90	5.5E-06	9.2E+06(1)	4.4E+03(2)
Tc-99	5.3E-07	4.7E+07	1.6E+04
I-129	7.2E-05	3.5E+05	6.5E+02
Cs-137	6.7E-05	7.4E+05(1)	4.4E+02(2)
U-238	7.6E-06	3.3E+06	2.9E+03
Pu-239	1.0E-04	2.4E+05	1.3E+04

NOTE: (1) Revised deterministic $DCGL_W$ values calculated using revised parameters described in the response to RAI 5C12.

(2) With 30-year decay period.

This analysis produced DCGLs that show the concentrations of each of the 18 radionuclides of interest necessary to produce 25 mrem per year to an offsite receptor. The DCGLs for this scenario were are least one order of magnitude higher than the DCGLs for subsurface soil developed using the base case resident farmer cistern drilling scenario.

This analysis demonstrates that there is a reasonable expectation that the potential dose to an offsite receptor from erosion of radioactivity from the bottom of the deep WMA 2 excavation would be insignificant, even if residual radioactivity concentrations were to approach the DCGLs, which would be a very unlikely circumstance based on available soil data from the unweathered Lavery till. The calculation package for this analysis and the associated electronic files will be provided with the September 2009 RAI responses.

Conclusions

The following conclusions can be drawn from the results of the onsite and offsite dose analyses:

- The subsurface soil DCGLs are protective for onsite receptors, that is, the cistern scenario used to develop the DCGLs is more limiting that the alternate recreationist-hiker scenario analyzed; and
- The subsurface soil DCGLs are also protective for offsite receptors, that is, the cistern scenario used to develop the DCGLs is more limiting that the alternate scenario for an offsite Cattaraugus Creek receptor that was analyzed.

Based on these conclusions, DOE considers that there is a reasonable expectation that remediation of the WMA 2 excavation as planned will ensure that doses to both onsite and offsite receptors will be well below the 25 mrem per year dose limit.

Changes to the Plan:

Change note (2) to Table 5-5 to read as follows:

> This assumption is conservative because it results in no depletion of the source through erosion. The conservative nature of the assumption can be demonstrated by assuming that erosion takes place and evaluating potential doses to a receptor located in a gully where radioactivity has been exposed by erosion. As explained in the discussion of alternate conceptual models below, the receptor in the area of the gully would receive less dose on an annual basis than would the resident farmer due to factors such as spending less time in the contaminated area and receiving exposure through fewer pathways. Consideration of potential doses to an offsite receptor from

radioactivity displaced to the stream through erosion indicates that there is a reasonable expectation that offsite doses would not be significant either.

Add the following information to the subsection on page 5-28 labeled **Other Possible Conceptual Models for Subsurface Soil DCGL Development**, coordinating this change with the changes to this subsection identified in the responses to RAI 5C5 and RAI 5C8.

Another alternative scenario was evaluated to determine the potential impact of long-term erosion in WMA 2. This analysis estimated the potential doses to an offsite receptor from radioactivity that could be released from the bottom of the remediated WMA 2 excavation due to formation of a gully that eventually cut through the bottom of the backfilled excavation.

In this analysis, radioactivity in eroded soil from the bottom of the WMA 2 backfilled excavation was assumed to be transported in surface water to a receptor located on Cattaraugus Creek near the confluence with Buttermilk Creek who ingested both the water and fish harvested from the water and used the water to irrigate a garden. Both the area of Lagoon 1 and the area of Lagoon 3 were considered using conservative erosion rates. The results showed that doses to this receptor would be insignificant compared to the onsite receptor doses estimated in the base case model.

Reference:

Beyeler, et al. 1999, *Residual Radioactivity from Decommissioning, Parameter Analysis*, NUREG/CR-5512, Vol 3, Draft Report for Comment. Beyeler, W. E., W. A. Hareland, F. A. Duran, T. J. Brown, E. Kalinina, D. P. Gallegos, and P. A. Davis, Sandia National Laboratories, Albuquerque, New Mexico, October 1999.

RAI 5C7 (12)

Subject: Show cistern scenario bounding

RAI: The approach to developing subsurface DCGLs may not be limiting for all types of contamination sources found and scenarios expected at the WVDP. Two aspects should be more fully assessed: 1) the potential for groundwater contamination by buried sources; and 2) erosion of cover material thereby converting a subsurface source into a surface source and making an excavation scenario applicable. (Section 5.2.1, Page 5-26):

Basis: The approach of using a scenario where a cistern well is installed and a resident is exposed to the contaminated cuttings may be limiting for some types and distributions of contamination, but may not be limiting for certain sources. For example, the old sewage plant drainage was significantly contaminated and covered with three feet of soil. While the old sewage plant drainage is not considered part of the scope of Phase 1 (see Figure 1-5), if contamination is located in a thin lens but in a hydrologically active or previously hydrologically active area to be remediated as part of Phase 1, the dilution and partitioning with soil afforded in the cistern disruption scenario may be larger and result in higher DCGLs than would be developed from exposure to contaminated groundwater or an excavation scenario that would become applicable if the cover was eroded.

Path Forward: Provide the technical basis that the approach to developing subsurface DCGLs is limiting when groundwater transport and erosion processes are considered. Part of the technical basis could be assurance that the subsurface DCGLs will exclusively be used to guide remediation of excavated areas in WMA 1 and 2, adequate characterization will be conducted to ensure any unremediated areas are not impacted, and that erosion is not expected to uncover residual WMA 1 and 2 contamination following remediation over the 1000 year compliance period. If erosion could lead to applicability of an excavation scenario within the 1000 year compliance period (i.e., if erosion could lead to depletion of the cover materials to a thickness of 3 m or less), then an excavation scenario should also be evaluated. Erosion processes may be limited to those that result in landform evolution consistent with the expected future land use scenario.

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DOE Response: Additional evaluation has confirmed that the approach used to develop subsurface soil DCGLs is limiting when groundwater transport and erosion processes are considered.

Limitations on Applicability of Subsurface Soil DCGLs

The subsurface soil DCGLs (that is, the cleanup goals of Table 5-14) apply <u>only</u> to the bottoms and lower sides of the two large excavations to be dug to remove facilities in WMA 1 and WMA 2, as indicated on page 5-4 and in other places in the DP. They will not be used in connection with remediation of any other areas. Changes will be made to the DP to reinforce this point for the sake of clarity.

Potential for Groundwater Contamination by Upgradient Sources

The radiological status of groundwater on the project premises is discussed in Section 4.2.8 of the DP. Figure 4-12 shows routinely monitored groundwater monitoring locations and indicates that the three locations just west of WMA 1 show no radiological constituents in excess of background. These results indicate a low potential for contamination of the remediated WMA 1 excavation from upgradient sources.

The response to RAI 7C1 explains that the conceptual schedule in Figure 7-15 is being changed to provide for installation of the WMA 1 hydraulic barrier before starting the WMA 2 excavation. This sequence will reduce groundwater infiltration in the WMA 2 excavation and prevent contamination from WMA 1 being transported by groundwater into the WMA 2 excavation.

Consideration has also been given to the potential for buried contamination in the old sewage treatment plant drainage impacting either the WMA 1 or WMA 2 excavated areas. The amount of buried contamination in this area is expected to be small based on information provided in Section 2.3.2 of the DP, and since this area is not hydraulically upgradient of WMA 1 or WMA 2, the potential for any impact on those areas by groundwater transport is low.

In summary, available data suggest that there is no significant potential for groundwater contamination from upgradient sources impacting either WMA 1 or WMA 2.

Characterization

The characterization program to be defined in the Characterization Sample and Analysis Plan, coupled with the Phase 1 final status surveys, will verify that unremediated areas are not impacted. The response to RAI 7C1 describes mitigative measures to be taken to minimize potential impacts of contaminated excavated soil on areas that will not undergo remediation during the Phase 1 decommissioning activities.

As explained in the response to RAI 9C1, DOE will solicit NRC input on the Characterization Sample and Analysis Plan objectives and provide the final draft plan to NRC for review.

Potential Erosion Impacts and Excavation Scenario

As explained in the response to RAI 5C4, the predicted sheet and rill erosion rate for the central portion of the north plateau where WMA 1 is located is small, so the excavation scenario associated with constructing a basement for a home in that area would not be applicable. However, unchecked long-term erosion could lead to deep gullies in the area of Lagoons 1, 2, and 3 that could possibly reach the bottom of the backfilled deep excavation. Growing crops or building a home in an area with such gullies would not be plausible. Consequently, the excavation scenario associated with constructing a basement for a home in that area would not be realistic. The recreationist-hiker exposure scenario discussed in connection with RAI 5C4 would be much more plausible. The response to RAI 5C6 provides the results of an analysis of this scenario.

Changes to the Plan:

More information about the limitations of the subsurface soil DCGLs is being added to the plan as follows:

On page ES-18, add the following footnote to Table ES-2, with the footnote tagged to the Subsurface Soil heading:

> (3) The subsurface soil cleanup goals apply only to the bottom of the large WMA 1 and WMA 2 excavations and to the sides of these excavation three feet or more below the surface.

On page 5-49, add the same footnote to Table 5-14. In this case, the footnote will be number (5).

Make the following additional change on page 5-49:

Basis for Cleanup Goals for Subsurface Soil

DOE has established the subsurface soil cleanup goals at 50 percent of subsurface soil DCGLs calculated in the limited site-wide dose assessments for 22.5 mrem per year (Table 5-12). The cleanup goals for subsurface soil would therefore equate to 11.25 mrem per year. DOE is taking this approach to provide additional assurance that remediation of the WMA 1 and WMA 2 excavated areas would support all potential options for Phase 2 of the proposed decommissioning. As indicated previously, these cleanup goals apply only to the bottom of the large WMA 1 and WMA 2 excavations and to the sides of these excavations three feet or more below the surface.

RAI 5C8 (13)

Subject: Natural gas well evaluation

RAI: A cistern development for water usage scenario is used to develop DCGLs for subsurface contamination. A scenario of drilling for natural gas should be more thoroughly considered or shown to not be as limiting as the cistern development scenario. (Section 5.2.1, Page 5-26)

Basis: Natural gas development in areas that were previously not economical to exploit has increased dramatically in many areas of the United States, particularly in those areas with large shale deposits. Section 3.8.1 of the DP indicates that oil and gas development has occurred in Cattaraugus County in 2001, but does not provide multiple years of data to assess the rate of change for energy exploitation. Because the technology for installation of a natural gas well may differ materially from the cistern scenario, technical basis should be provided that the cistern scenario would be generally more limiting than disruption of the contamination from the recovery of natural gas or oil.

Path Forward: Provide the technical basis that the cistern scenario is more limiting for developing subsurface DCGLs than installation of oil or natural gas wells.

****

DOE Response: DOE has analyzed drilling of a natural gas well and compared the resulting DCGLs to those developed for subsurface soil in the deep excavations using the cistern scenario. The results demonstrate that the cistern scenario is more limiting.

Because of the differences between installation of a cistern and a natural gas well – the natural gas well being both much deeper and of smaller diameter – it is evident that the cistern scenario would be more limiting for a residential farmer in the area. This conclusion is based on less contaminated material and more uncontaminated material being brought to the surface during installation of a natural gas well. The natural gas well analysis therefore focused on potential dose to the drilling worker, rather than on a residential farmer growing crops with contaminated drill cuttings in the soil.

In developing the exposure scenario, consideration was given to the presence of Marcellus shale, a source of natural gas reserves, in the vicinity of West Valley, indicating the potential for natural gas well drilling in the future. Information about installation of natural gas wells such as that available on the NYSDEC website (NYSDEC 2009) was used in developing the scenario. Key elements in the conceptual model included:

- A natural gas well is drilled in the north plateau in WMA 1;
- The diameter of the well is assumed to be 0.5 meter (20 inches), a typical diameter for a natural gas well casing;
- The well is assumed to extend to a depth of 100 meters, a conservative value given that many natural gas wells are much deeper (the Marcellus Shale is approximately 650 meters below the project premises);
- The contaminated source material brought to the surface during well installation is considered to be the upper one-meter thick layer of the Lavery till material at the bottom of the WMA 1 or WMA 2 deep excavations;
- The total volume of contaminated material brought to the surface is approximately 0.2 cubic meter (from the one meter thick contaminated layer), which is mixed with

approximately 20 cubic meters of uncontaminated material also brought to the surface during the drilling.

- The excavated material is placed in a cuttings pit near the well, with the contamination zone at the surface consisting of rectangular area five meters by four meters by one meter deep;
- The well is drilled from a concrete pad, with the drilling worker located immediately adjacent to the pad;
- The drilling worker is present onsite for approximately 50 days (approximately 10 weeks) for 10 hours each day; and
- The drilling worker is exposed via inadvertent soil ingestion, inhalation of dust, and external exposure to ionizing radiation.

Figure 5C8-1 illustrates the conceptual model geometry

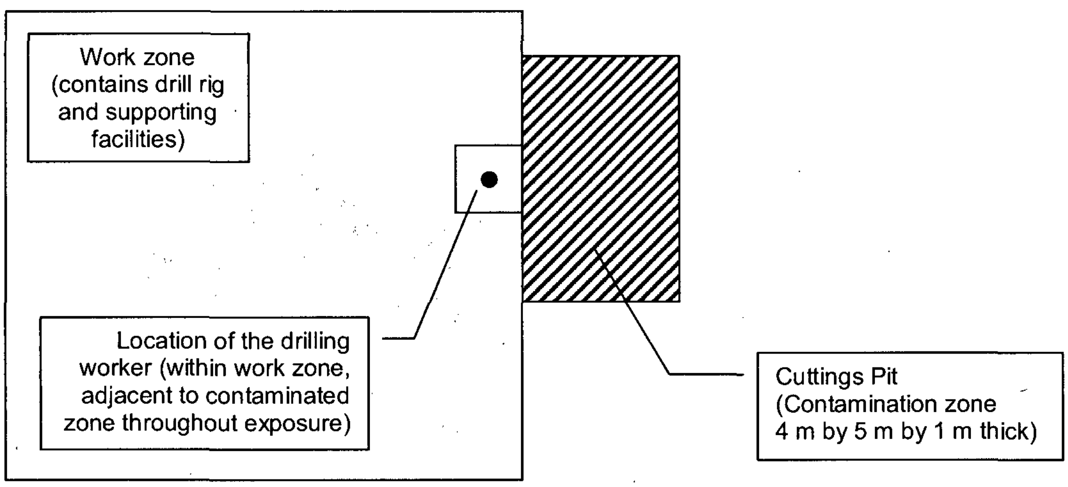

Figure 5C8-1. Conceptual Model

The calculations were executed utilizing RESRAD version 6.4 in the deterministic mode. DCGLs were developed based on a dose limit of 25 mrem per year, with the dose-to-source ratios and the DCGLs adjusted to account for dilution of contaminated material with clean material excavated, with the Cs-137 and Sr-90 DCGL's being adjusted to account for decay during the 30-year institutional control period.

The resulting DCGLs were at least one order of magnitude greater than the deterministic DCGLs developed for subsurface soil in the deep excavations using the cistern scenario for every radionuclide of interest. These results show that the cistern scenario is bounding compared to installation of a natural gas well.

A copy of the calculation package showing details of the analysis and the associated electronic files are provided with the RAI response submittal.

Changes to the Plan: The following information is being added to Section 5.2.1 on page 5-28. These changes will be integrated with the changes to this subsection described in the response to RAI 5C5.

Other Possible Conceptual Models for Subsurface Soil DCGL Development

Other possible conceptual models were considered, such as a drilling worker. A drilling worker scenario would evaluate dose to a hypothetical individual installing the cistern, such as from contamination brought to the surface in the form of drill cuttings that could be set aside near the cistern.

Installation of a natural gas well was also evaluated. Installation of this type of well would take longer than installation of a cistern because the well would be much deeper, would require well/formation development by hydrofracturing, and would require the installation of conveyance piping and valving. The analysis focused on exposure to the drilling worker. Key elements in the model included:

- The natural gas well being 0.5 meter (20 inches) in diameter and 100 meters (330 feet) deep (a conservative estimate given typical depths in excess of 1,000 meters);
- The drilling worker being exposed to excavated Lavery till material from the bottom of the excavation that was deposited in a cuttings pit near the worker's location for 500 hours;

The exposure pathways considered included inadvertent ingestion of contaminated soil, inhalation of contaminated dust, and direct exposure to contaminated soil brought to the surface during the drilling. RESRAD version 6.4 in the deterministic mode was used to perform the calculations. The resulting DCGLs were one or more orders of magnitude greater than the deterministic subsurface soil DCGLs for all radionuclides, demonstrating that the cistern scenario is more limiting.

References:

NYSDEC 2009, New York State Department of Environmental Conservation website http://www.dec.ny.gov/energy/205.html, Oil and Gas.

RAI 5C10 (15)

Subject: subsurface DCGL model contaminated area

RAI: For certain pathways and radionuclides, the assumption that contamination is distributed over a larger area (e.g., 1000 m^2) rather than 100 m^2 would lead to more restrictive DCGLs. Sensitivity analyses currently do not evaluate the impact of area on the DCGL calculations. (Section 5.2.1, Page 5-27)

Basis: For those radionuclides dominated by certain pathways (e.g., plant and water ingestion), the assumption regarding the area (and thickness) of contamination significantly impacts the DCGL calculations. On a footnote on page 5-26 of the DP, there is some discussion regarding use of a 1000 m^2 area of contamination rather than a 100 m^2 area of contamination; however, sensitivity analysis results do not address larger assumed areas of contamination. Assumptions regarding the distribution of contamination brought up from drilling a cistern should be further evaluated as the DCGL for many radionuclides would be more restrictive if a change in assumption regarding the area of contamination is made.

NRC Path Forward: Suggest calculating DCGLs considering a 100 m^2 and larger areas (e.g., 1000 m^2) of contamination and use the more limiting DCGL for the list of 18 radionuclides evaluated or provide additional justification for why an assumed 100 m^2 area of contamination is reasonable.

****

DOE Response: The assumed 100 m^2 area of the contamination zone is considered to be reasonable. The size of this area in the model is limited by the relatively small volume of material brought to the surface during construction of the hypothetical cistern, which is approximately 30 m^3.

A sensitivity analysis for the combined contamination zone thickness and area has been performed, using areas of 300 square meters and 50 square meters, compared to the 100 square meters base case, which has a thickness of 0.3 meter. (The area and thickness parameters are positively correlated due to the small volume of material brought to the surface.) Table 5C10-1 shows the results.

Table 5C10-1. Contamination Zone Thickness/Area Sensitivity Analysis Results(1)

Nuclide	0.1 m/300 m^2		0.6 m/50 m^2	
	Year of Peak Dose	DCGL Change (%)	Year of Peak Dose	DCGL Change (%)
Am-241	0	-1%	0	16%
C-14	0	86%	0	-33%
Cm-243	0	4%	0	10%
Cm-244	0	3%	0	22%
Cs-137	0	14%	0	9%
I-129	10.4	-58%	10.5	86%
Np-237	22.5	-61%	22.6	87%
Pu-238	0	3%	0	22%

Table 5C10-1. Contamination Zone Thickness/Area Sensitivity Analysis Results(1)

Nuclide	0.1 m/300 m^2		0.6 m/50 m^2	
	Year of Peak Dose	DCGL Change (%)	Year of Peak Dose	DCGL Change (%)
Pu-239	0	3%	0	22%
Pu-240	0	3%	0	22%
Pu-241	60.7	0%	64.5	15%
Sr-90	0	170%	0	0%
Tc-99	2.06	204%	0	-3%
U-232	3.58	70%	6.69	-4%
U-233	327	-64%	327	91%
U-234	327	-65%	327	98%
U-235	0	9%	0	8%
U-238	327	-65%	0	70%

NOTE: (1) The base case is a 0.3 m thickness with an area of 100 m^2.

The results in the table show that:

- The DCGL for Sr-90, the radionuclide expected to dominate contamination at the bottoms of the deep excavations based on available data, increased as the contaminated material was spread over a larger area and remained unchanged when the contaminated area was reduced.
- The DCGLs for the following radionuclides significantly decreased with the smaller thickness/larger area contamination zone geometry: I-129, Np-237, U-233, U-234, and U-238.
- The DCGLs for most radionuclides increased with the larger thickness/smaller area condition, with only C-14 exhibiting a significant decrease.

Note that the influence of the source geometry on the DCGL is mainly due to external exposure and groundwater pathways. The external exposure dose increases with increases in contaminated zone area. The dilution factor increases with increases in contaminated zone area in the subsurface model, due to increased leachate infiltration rates. However, the reduction in source thickness shortens the travel times to the groundwater receptor. The effect of the combination of these factors is radionuclide specific.

The results showing lower DCGLs for C-14, I-129, Np-237, U-233, U-234, and U-238 are being taken into account in revising the cleanup goals for subsurface soil in the deep excavations. This matter is addressed in the response to RAI 5C15, which describes the probabilistic uncertainty analysis undertaken to evaluate degree of conservatism in conceptual model input parameters. Note that the results of alternate scenario analyses, such as the resident gardener scenario discussed in the response to RAI 5C18, are also being taken into account in revising the cleanup goals.

Changes to the Plan: The changes to the plan related to the sensitivity analysis involve making the following changes to Section 5:

Changing the second data row of Table 5-10 as indicated below (the remainder of the table is unchanged insofar as this RAI response is concerned).

Table 5-10. Summary of Parameter Sensitivity Analyses – Subsurface Soil DCGLs(1)

Parameter (Base Case)	Run	Change Made	Minimum DCGL Change		Maximum DCGL Change	
			Change	Nuclide(s)	Change	Nuclide(s)
Indoor/Outdoor Fraction (0.66/0.25)	1	-32%	-25%	Cs-137	0.1%	U-234
	2	21%	-1%	U-238	35%	U-232
Contaminated Zone thickness/area (0.3 m/100 m^2)	1	-67%/ +200%	-65%	U-234, U-238	204%	Tc-99
	2	+100%/ -50%	-33%	C-14	98%	U-234

NOTES: (1) Information from the $DCGL_{EMC}$ calculations provides additional information on how reductions in the size of the contamination zone affect the DCGLs. DCGLs generally increased with smaller areas.

Add the following new third bullet point in the discussion of the sensitivity analysis results on page 5-39:

- The DCGLs for the following radionuclides significantly decreased with the smaller thickness/larger area contamination zone geometry: I-129, Np-237, U-233, U-234, and U-238.
- The DCGLs for most radionuclides increased with the larger thickness/smaller area contamination zone geometry, with only C-14 exhibiting a significant decrease.

The changes to the plan related to the affect of the sensitivity analysis results on the cleanup goals and the results probabilistic uncertainty analysis are detailed in the response to RAI 5C15.

RAI 5C11 (16)

Subject: Streambed conceptual and mathematical models

RAI: DOE has not provided adequate information on the conceptual model related to exposure of a potential receptor from stream bed contamination and the adequacy of the mathematical model, RESRAD, to represent this conceptual model. (Section 5.2.1, Page 5-28)

Basis: Complex subsurface and surface water interactions are operable at the West Valley site (e.g., stream widening, gully formation, seasonal fluctuations in water-levels, flooding, groundwater seepage/discharge, and surface water runoff). However, the approach used to derive stream bed DCGLs through use of the RESRAD code, which is first and foremost a code that models leaching processes from surface soils to groundwater, considerably simplifies the more complex processes occurring in the real system. DOE has not addressed the limitations of the RESRAD code in modeling ground and surface water interactions or the more complex processes occurring in the real system. Key processes significantly impacting the dose calculations for stream beds should be identified and evaluated to ensure that the DCGLs appropriately bound the exposures to a potential receptor.

NRC Path Forward: For the purposes of Phase 1 DCGL calculations, DOE should evaluate the adequacy of the adaptation of the conceptual model in RESRAD for calculation of stream bed DCGLs. DOE should clarify that the streambed DCGLs only consider *existing* contamination and that future release and transport to streambeds from upgradient sources is considered separately in a combined dose assessment, if DOE performs such a combined dose assessment to address NRC comments (see RAI 5C1 above).

To guide final decisions on decontamination and decommissioning of the site, DOE should consider interactions between contaminated groundwater and surface water in estimating future risks including seepage/discharge concentrations from upgradient sources, and potential accumulation of residual contamination on stream beds from erosion, flooding, seasonal water fluctuations, and other processes.

****

DOE Response: The discussions in Section 5.2.1 and 5.2.2 will be expanded to provide more information on the conceptual model and how RESRAD was adapted to this application. Limitations on the streambed DCGLs and cleanup goals will also be addressed.

In developing the exposure scenario for the streambed conceptual model, DOE considered basic questions about how residual radioactivity enters and moves though the streams, plausible future land uses for the stream valleys, how humans might be exposed to residual contamination in the streams or on the banks, and plausible habits of a person spending time at the streams in the future.

Contamination of the Streams

Streams within the project premises became radioactively contaminated from routine releases of treated wastewater from the Lagoon 3 outfall, surface water runoff from contamination sources during site operations, and from groundwater seeps discharging radioactively contaminated groundwater (Figure 4-6). The routine releases of treated wastewater containing low levels of radioactivity through the Lagoon 3 outfall contributed most. Such releases reached their annual peak in 1969. In that year, gross alpha releases from the Lagoon 3 outfall totaled approximately 0.367 curie and gross beta releases though this outfall totaled approximately 108 curies.

Releases of Sr-90 during the 1967-1970 period amounted to approximately 35.6 curies. While Cs-137 releases were not recorded, the amount of Cs-137 likely exceeded that of Sr-90 given typical radionuclide distributions (Zadins 1992).

Annual releases from the Lagoon 3 outfall are now much lower. In 2007, for example, the total amounts of activity discharged in curies were approximately as follows (WVES and URS 2008):

gross α, 0.0011 gross β, 0.010 Sr-90, 0.0040 Cs-137, 0.0024

Contamination in Erdman Brook upstream of the Lagoon 3 outfall and in Frank's Creek upstream of the confluence with Erdman Brook resulted from a combination of surface water runoff from exposed contaminated source areas and radioactively contaminated groundwater discharging from groundwater seeps. The amount of contamination from these sources could increase in the future if erosion in the waste disposal areas were to proceed unchecked over a long period (assuming that Phase 2 did not involve unrestricted release, that is, the site-wide removal alternative).

Once radioactivity enters Erdman Brook and the part of Franks Creek on the project premises, some activity is deposited in stream sediments. Such deposition results in a dilution effect. That is, downstream areas are generally less contaminated than streambed areas near the source. This pattern was evident in the 1984 aerial radiation survey (see Figure 2-7).

Another factor that impacts the distribution of contamination in the area of the streams is changes in water level in the streams associated with higher stream flow volumes. At times of higher levels, contamination would likely be spread to the stream banks. Figure 5C11-1 shows the radiological control area around the contaminated stream bank along Franks Creek near the project premises boundary fence. The confluence with Erdman Brook lies about 200 feet upstream from where the people are standing in this photograph and the Lagoon 3 outfall is about 500 feet from that location.

Figure 5C11-1. Franks Creek Looking Upstream

Future Land Use and Potential Receptors

Long-term erosion may result in downcutting and rim widening of the streams, as discussed in Section 5.1.4. Considering this factor and the present steep banks, future land use in the area of the streams would be unlikely to include farming or home construction. A residential farmer scenario would therefore not be plausible.

In considering other potential future land uses, some type of recreation use would be most plausible. Such considerations lead to evaluation of a conservative scenario with a hypothetical recreationist fishing and hunting in the area.

Potential Future Impacts of Streams

Another factor germane to the evaluation is the potential for future impacts on the streams that could increase radioactivity concentrations in the water and the residual radioactivity in streambed sediment. Such impacts depend on assumptions regarding the presence of the Phase 2 sources.

In the site-wide removal alternative, Phase 2 sources such as the NDA would be removed with the same unrestricted release criteria for residual radioactivity as is being applied to the Phase 1 source areas. If this alternative were to be selected for Phase 2 of the decommissioning, then it is assumed that the SDA would also be remediated to these criteria. Under these circumstances, there would be no significant future impacts on the streams from Phase 2 sources or the SDA.

However, this would not necessarily be the case for the site-wide close-in-place alternative. If that alternative were to be selected for Phase 2 of the decommissioning, impacts on the streams could occur in the long term from unchecked erosion in the radioactive waste disposal areas, surface water runoff from eroded areas, and increased seepage of contaminated groundwater into the streams, conditions which could develop if institutional controls were not in effect.

After consideration of potential future impacts that could be associated with the site-wide close-in-place alternative, it has been determined that the streambed DCGLs and cleanup goals would support unrestricted release of the project premises in the site-wide removal alternative, and would not apply to the site-wide close-in-place alternative because this alternative would not result in the area in question being released for unrestricted use.

Mathematical Model

DOE considered mathematical models that might be used to develop DCGLs for the streambeds and decided to adapt RESRAD for this use based on its long history of use in developing surface soil DCGLs. The conceptual model was therefore developed to support the use of RESRAD as the mathematical model.

Consideration was given to modeling residual radioactivity in the streambed itself. However, RESRAD cannot be used to model a contaminated zone located within the saturated zone. Moreover, water in the stream would provide radiation shielding that would need to be taken into account.

It was decided to place the contaminated zone on the stream bank instead to reproduce current conditions observed along the stream banks as seen in Figure 5C11-1. This model is conservative compared to locating the contaminated zone in the stream because of the lack of water which would act as shielding for direct radiation dose. Two other factors make this contamination zone location conservative:

- Conceptualizing the source as the stream bank allows for modeling of plant uptake from the source, as well as ingestion by deer of contaminated stream bank sediment and forage growing in the stream bank; and
- The stream bank source conceptual model allows for conservative consideration of incidental ingestion and inhalation, which are not as relevant to stream bottom sediments.

Note that the fish pathway in the model is based on leachate from the contaminated zone discharging from groundwater to a surface water body. The model does not consider partitioning of nuclides between surface water and sediment, which likely provides conservative fish concentrations.

The conceptual model was developed using input parameters for contamination zone geometry that are likely to be conservative, such as the one meter contaminated zone thickness. Typical actual depths of contamination along the stream banks and in the stream itself will be determined during the site-wide characterization program to support Phase 1 decommissioning.

In summary, DOE developed the exposure scenario for the streambed conceptual model considering how radioactivity enters and moves though the streams, the potential future land uses for the stream valleys, and the activities in which a human receptor could be exposed to the residual contamination and adapted RESRAD to this application. This process produced DCGLs that can be applied to contamination on the stream banks and in the sediment in the stream itself.

Changes to the Plan: Add the following information to Section 5.2.1, Streambed Sediment Conceptual Model, following Table 5-6 before the sentence beginning with "Key features of . . ."

> The conceptual model for streambed sediment was developed after consideration of how residual radioactivity enters and moves though the streams, plausible future land uses for the stream valleys, how humans might be exposed to residual contamination in the streams or on the banks, and plausible habits of a person who might spend time at the streams in the future. Such considerations led to selection of a conceptual model compatible with RESRAD. The RESRAD code was determined to be an appropriate mathematical model based on its extensive use in evaluating potential doses from radioactivity in surface soil and its use in the surface soil DCGL and subsurface soil DCGL models for this project.
>
> As shown in Figure 5-9, the contamination zone was assumed to be on the stream bank rather than in the stream itself. This model is consistent with typical conditions observed along Frank's Creek downstream of the Lagoon 3 outfall as shown by the radiological control area in Figure 5-10. It is conservative compared to having the contamination zone in the stream itself where water would act as shielding to reduce the direct radiation dose.

Figure 5-10. Franks Creek Looking Upstream (2008 WVDP photo)

The photograph in Figure 5-10 was taken from just inside the project premises security fence looking upstream toward the southwest. The confluence with Erdman Brook lies about 200 feet upstream from where the people are standing and the Lagoon 3 outfall is about 500 feet from where the people are standing.

Add the following information in Section 5.2.2 on page 5-33 just before the fourth complete paragraph that begins with "RESRAD input parameters . . .":

The RESRAD model has limitations in this application in that it was developed for soil exposures and therefore does not specifically address certain transport mechanisms associated with sediment, such as:

- Periodic saturation of the contaminated zone located along a stream bank flood zone;
- Erosion/scour of stream bank material and subsequent downstream deposition to the stream-bottom;
- Deposition of clean material onto the stream bank, transported downstream from unimpacted upstream locations;
- Variability in surface water concentrations due to fluctuation in flow rates during storm events;
- Partitioning of contaminants between the surface water and stream-bottom sediment; and
- Variability of airborne dust loads due to varying stream bank sediment moisture content.

To address the simplifications of the conceptual model, and still retain conservatism in the results, the following assumptions were made for the sediment model:

- The model will not allow the contaminated zone to be below the water table (as may periodically happen to the stream bank), therefore it was assumed that there was no unsaturated zone, and that the water table exists immediately below the source;

- The inhalation parameter values were conservatively selected to reflect soil on a farm, although stream bank sediment is likely to result in lower respirable dust loadings;
- Contaminated groundwater is assumed to discharge to the stream, where it is impounded and contributes to fish bioaccumulation;
- Fish ingested from the stream are large enough to provide a significant number of meals each year, but are assumed to only be exposed to contaminated water and never swim to uncontaminated sections of the stream; and
- In addition to assuming the fish are never in clean water, the recreationist is assumed to eat only fish that are contaminated when, in actuality, the stream will not support fish at all at the present time owning to the small amount of water typically present as shown in Figure 5-10.

The conceptual model just described represents plausible conditions on the stream banks and in the streambeds. It is considered to be a valid model for the long term in support of a Phase 2 strategy involving unrestricted release, that is, the site-wide removal alternative in the Decommissioning EIS. However, it would not necessarily serve as a valid model if the Phase 2 sources were to be closed in place, as with the site-wide close-in-place alternative.

This limitation results from the model not accounting for processes that could impact the streams in the future under the site-wide close-in-place alternative. For example, impacts on the streams could occur in the long term from unchecked erosion in the radioactive waste disposal areas, surface water runoff from eroded areas, and increased seepage of contaminated groundwater into the streams. Such impacts could include increases in radionuclide concentrations in water in the streams as well as increases in contamination in the sediment.

This limitation would be considered in any decision made by DOE to remediate sediment in the streams and on the stream banks. As noted previously, such remediation during Phase 1 decommissioning activities would require a revision to this plan.

Add the following information to NOTE (1) to Table 5-14:

NOTE: (1) These cleanup goals (CGs) are to be used as the criteria for the remediation activities described in Section 7 of this plan. Note that the streambed sediment cleanup goals would support unrestricted release of the project premises but would not necessarily support restricted release alternatives due to the continued presence of Phase 2 sources as discussed in Section 5.2.2.

References:

Zadins 1992, *Water Quality Environmental Information Document*, WVDP-EIS-006, Revision 0. West Valley Nuclear Services Co., Inc., West Valley, New York, December 17, 1992.

RAI 5C12 (17)

Subject: Inhalation pathway in streambed sediment model

RAI: The streambed sediment DCGL development does not include the inhalation of airborne radioactivity from resuspended contaminated sediment because of the assumed moisture content and limited resuspension. However, this argument may not consider the dynamic aspects of sediment deposition, stream water levels, and soil moisture content. (Section 5.2.1, Page 5-29)

Basis: In general, streambed sediments will have relatively high moisture content and would experience limited resuspension. However, mobilization of contaminants from source areas may increase during storm events and result in deposition of the contaminants in areas that are above the normal water levels, such as a flood plain. Moisture content of these environments will be very dynamic, ranging from saturated to quite dry depending on the frequency the location experiences high water.

Path Forward: Provide an evaluation of the importance of the inhalation pathway relative to the other pathways that have been included in the streambed sediment DCGL development. The evaluation should consider the natural inherent variability in deposition processes and sediment moisture contents.

****

DOE Response: The inhalation pathway has been incorporated into the deterministic model for streambed sediment DCGL development without regard to considerations of moisture content, in the interest of conservatism. This change had no significant impact on the DCGLs, as shown below. The probabilistic uncertainty analysis described in the response to RAI 5C15 also includes the inhalation pathway in the streambed sediment model.

Note that the response to RAI 5C11 discusses the streambed conceptual model and natural inherent variability in deposition processes, including changes in water level.

Table 5C12-1 compares the subsurface soil DCGLs included in Revision 1 to the DP with the deterministic DCGLs with the inhalation pathway active. Note that several other parameter changes were also made as discussed below.

Table 5C12-1. Streambed Sediment DCGL Comparison

Nuclide	$DCGL_W$ Values from Table 5-8 of Revision 1 (pCi/g)	$DCGL_W$ Values With Inhalation Pathway Active (pCi/g)
Am-241	1.6E+04	1.6E+04
C-14	3.4E+03	3.4E+03
Cm-243	3.6E+03	3.6E+03
Cm-244	4.7E+04	4.8E+04
Cs-137(1)	1.3E+03	1.3E+03
I-129	3.7E+03	3.7E+03
Np-237	5.4E+02	5.2E+02

Table 5C12-1. Streambed Sediment DCGL Comparison

Nuclide	$DCGL_W$ Values from Table 5-8 of Revision 1 (pCi/g)	$DCGL_W$ Values With Inhalation Pathway Active (pCi/g)
Pu-238	2.0E+04	2.0E+04
Pu-239	1.8E+04	1.8E+04
Pu-240	1.8E+04	1.8E+04
Pu-241	5.2E+05	5.1E+05
Sr-90(1)	9.5E+03	9.5E+03
Tc-99	2.2E+06	2.2E+06
U-232	2.7E+02	2.6E+02
U-233	5.8E+04	5.7E+04
U-234	6.1E+04	6.0E+04
U-235	2.9E+03	2.9E+03
U-238	1.3E+04	1.2E+04

NOTE: (1) Reflects 30 years decay.

The other parameter changes are identified in the revised Appendix C, which follows. Many of the parameter changes were made for consistency with dose modeling in the Decommissioning EIS. Note that Appendix C is included in its entirety for the sake of completeness, even though only limited portions were changed from Revision 1. The text in blue in Appendix C signifies changes made in Revision 1. The Revision 2 changes are shown in red with change bars in the right margin as with the other RAI responses.

Changes to the Plan: The value for strontium in the sand and gravel layer in Table 3-20 will be changed from 6.16 to 4.5 mL/g (cm^3/g).

Table 5-8 will be changed to reflect the slightly revised $DCGL_W$ values.

The revised Appendix C that follows will be incorporated into the plan.

APPENDIX C

DETAILS OF DCGL DEVELOPMENT AND THE INTEGRATED DOSE ASSESSMENT

PURPOSE OF THIS APPENDIX

The purpose of this appendix is to provide supporting information related to development of derived concentration guideline levels (DCGLs) and the limited integrated dose assessment performed to ensure that cleanup criteria for surface soil, subsurface soil, and streambed sediment used in Phase 1 of the proposed decommissioning would support any decommissioning approach that may be selected for Phase 2.

INFORMATION IN THIS APPENDIX

This appendix provides the following information:

- Table C-1 in Section 1 provides a complete list of RESRAD input parameters, except for distribution coefficients, and the bases for these parameters.
- Table C-2 in Section 1 provides a list of distribution coefficients and their bases.
- Table C-3 in Section 1 provides the exposure pathways considered in the analysis.
- Table C-4 in Section 1 provides data on measured radionuclide concentrations in the Lavery till in the area of the large excavations in Waste Management Area 1 and Waste Management Area 2.
- Section 2 describes the information that comprises Attachment 1, which supports the calculation of DCGL and Cleanup Goal values presented in Section 5 of the Decommissioning Plan.
- Attachment 1 provides electronic RESRAD input and output files for the three base cases (surface soil, subsurface soil, and streambed sediment), the limited integrated dose analysis, and the input parameter sensitivity analyses performed, along with the associated Microsoft Excel spreadsheets.
- Attachment 2 provides an additional electronic file (a Microsoft Excel spreadsheet) used in the preliminary dose assessments.

RELATIONSHIP TO OTHER PLAN SECTIONS

This appendix provides supporting information for Section 5. Information provided in Section 5 and in Section 1 on the project background will help place the information in this appendix into context.

1.0 Tabulated Data

Table C-1 identifies input parameters used in the RESRAD models, except for the distribution coefficients, which are included in Table C-2. Input parameters are provided for the three source exposure scenarios: surface soil (SS), subsurface soil (SB), and stream bank sediment (SD). The RESRAD input parameters presented in Table C-1 were selected as discussed in Section 5.

Distribution coefficients (K_d) are presented in Table C-2 for chemical elements of the 18 radionuclides and their decay progeny for each of the three analyses (SS, SB and SD) for each of the modeled media (contaminated zone, unsaturated zone and saturated zone) used in RESRAD. The conceptual models assume the sand and gravel unit is representative of the three RESRAD zones, except that in the SB and SD analyses, the contaminated zone is assumed to be represented by the Lavery till. The table includes the RESRAD default value, the specific value input into the RESRAD model for $DCGL_W$ calculations, either measured site-specific or reference values (as identified in Note 1 to table C-2), and the range of values used in the sensitivity analysis. The K_d values were selected to represent the central tendency of the site-specific data or were based on specific soil strata characteristics where available. Variability/uncertainty in the K_d values was addressed through the sensitivity analysis.

The exposure pathways presented in Table C-3 were based on the critical groups identified for each of the source media. The resident farmer was the critical receptor for soil exposure and the recreationist was identified as the critical receptor for stream bank sediment exposure. Alternate receptors were considered as discussed in Section 5, including acute dose from subsurface material to a well driller during cistern installation, dose from subsurface material during installation of a natural gas well, and dose from surface and subsurface material to a resident gardener.

The data in Table C-4 are the basis for the maximum radionuclide concentration data in Table 5-1. These data comprise the available characterization data for radionuclides in the Lavery till within the footprints of the large excavations for the Process Building-Vitrification area and the Low-Level Waste Treatment Facility area that are described in Section 7.

Preliminary dose assessments have been performed for the remediated WMA 1 and WMA 2 excavations. These assessments made use of the maximum measured radioactivity concentration in the Lavery till for each radionuclide as summarized in Table C-4, and the maximum detection level concentration for non-detected radionuclides. (It should be noted that the minimum detection levels for non-detected radionuclides may range several orders of magnitude. Use of the maximum detection level concentration for non-detected radionuclides results in added conservatism in the reported preliminary dose assessment.) The results were as follow:

WMA 1, a maximum of 1.3 mrem a year

WMA 2, a maximum of 0.04 mrem a year

Given the limited data available, these results must be viewed as order-of-magnitude estimates. However, they do suggest that actual potential doses from the two remediated areas are likely to be substantially below 25 mrem per year. Table C-4B in Attachment 2 shows how these doses were estimated.

Table C-1. RESRAD Input Parameters

RESRAD Parameter (Units)	Default	Value	Medium	Comment/Reference
Area of contaminated zone (m^2)	1.00E+04	1.00E+04	SS	Assumed area of 10,000 m^2 for subsistence farmer scenario; garden is 2,000 m^2.
	1.00E+04	1.00E+02	SB	Assumed area of 100 m^2 for excavated contaminated cistern cuttings scenario. Alternative configurations were considered in the sensitivity analysis.
	1.00E+04	1.00E+03	SD	Assumed 1000 m^2 area along stream bank (3 m wide by ~330 m length).
Thickness of contaminated zone (m)	2.00E+00	1.00E+00	SS, SD	Assumed surface soil contaminated zone thickness.
	2.00E+00	3.00E-01	SB	Assumed thickness of contaminated cistern cuttings spread on surface over a 100 m^2 area. Alternative configurations were considered in the sensitivity analysis.
Length parallel to aquifer flow (m)	1.00E+02	1.65E+02	SS	Selected to achieve site specific groundwater dilution factor of 0.2, based on DEIS groundwater model correlation. Only applicable for non-dispersion model.
Time since placement of material (y)	0.00E+00	0.00E+00	All	Only non-zero if K_d values are not available. (Site-specific K_ds are available).
Cover depth (m)	0.00E+00	0.00E+00	All	No cover considered.
Density of cover material (g/cm^3)	0.00E+00	not used	All	No cover considered.
Cover depth erosion rate (m/y)	0.00E+00	not used	All	No cover considered.
Density of contaminated zone (g/cm^3)	1.50E+00	1.70E+00	All	WVNSCO 1993a and WVNSCO 1993c.
Contaminated zone erosion rate (m/y)	1.00E-03	0.00E+00	All	Assumed for no source depletion.
Contaminated zone total porosity	4.00E-01	3.60E-01	All	WVNSCO 1993c.
Contaminated zone field capacity	2.00E-01	2.00E-01	All	WVNSCO 1993c.
Contaminated zone hydraulic conductivity (m/y)	1.00E+01	1.40E+02	All	Average for Sand and Gravel Thick Bedded Unit (4.43E-03 cm/s from Table 3-19) divided by 10 to provide vertical conductivity that accounts for potential anisotropy (DEIS Appendix E, Table E-3).
Contaminated zone b parameter	5.30E+00	1.40E+00	All	Yu, et al. 2000, Att. C table 3.5-1, mean for loamy sand (ln(mean)=0.305).
Average annual wind speed (m/sec)	2.00E+00	2.60E+00	All	WVNSCO 1993d.
Humidity in air (g/m^3)	8.00E+00	not used	All	Applicable for tritium exposures only.
Evapotranspiration coefficient	5.00E-01	7.80E-01	All	Evapotranspiration and runoff coefficients selected to achieve infiltration rate of 0.26 m/y.

Table C-1. RESRAD Input Parameters

RESRAD Parameter (Units)	Default	Value	Medium	Comment/Reference
Precipitation (m/y)	1.00E+00	1.16E+00	All	WVNSCO 1993d.
Irrigation (m/y)	2.00E-01	4.70E-01	SS, SB	Beyeler, et al. 1999.
	2.00E-01	0.00E+00	SD	Not applicable for non-farming scenario.
Irrigation mode	overhead	overhead	All	Site-specific.
Runoff coefficient	2.00E-01	4.10E-01	All	Runoff and evapotranspiration coefficients selected to achieve infiltration rate of 0.26 m/y.
Watershed area for nearby stream or pond (m^2)	1.00E+06	1.37E+07	All	Based on drainage area of site of 13.7 km^2 or ~5.2 mi^2 for Buttermilk Creek.
Accuracy for water/soil computations	1.00E-03	1.00E-03	All	Default assumed.
Saturated zone density (g/cm^3)	1.50E+00	1.70E+00	All	WVNSCO 1993a and WVNSCO 1993c.
Saturated zone total porosity	4.00E-01	3.60E-01	All	WVNSCO 1993c.
Saturated zone effective porosity	2.00E-01	2.50E-01	All	WVNSCO 1993c.
Saturated zone field capacity	2.00E-01	2.00E-01	All	WVNSCO 1993c.
Saturated zone hydraulic conductivity (m/y)	1.00E+02	1.40E+03	All	Average for Sand and Gravel Thick Bedded Unit (4.43E-03 cm/s from Table 3-19)
Saturated zone hydraulic gradient	2.00E-02	3.00E-02	All	WVNSCO 1993b.
Saturated zone b parameter	5.30E+00	1.40E+00	All	Yu, et al. 2000, Att. C table 3.5-1, mean for loamy sand (ln(mean)=0.305).
Water table drop rate (m/y)	1.00E-03	0.00E+00	All	Site Specific.
Well pump intake depth (m below water table)	1.00E+01	5.00E+00	SS	Assumption based on site hydrogeology and site-specific groundwater dilution factor. Only applicable to non-dispersion model.
Model: Non-dispersion (ND) or Mass-Balance (MB)	ND	ND	SS	Applicable to areas >1,000 m2 (Yu, et.al. 2001, p.E-18)
	MB	MB	SB, SD	Applicable to areas <1,000 m2 (Yu, et. al. 2001, pE-18)
Well pumping rate (m^3/y)	2.50E+02	5.72E+03	SS, SB	Based on 2.9 m^3/y drinking water (2 L/d per 4 people for 365 days), 329 m^3/y household water (225 L/d per 4 people for 365 day), 385 m^3/y livestock watering (5 beef cattle at 50 L/d, 5 milk cows 160 L/d) and 5,000 m^3/y for irrigation of 10,000 m^2 (at rate of 0.5 m/y) from Yu, et al. 2000, Attachment C, Section 3.10.
	2.50E+02	0.00E+00	SD	Not applicable for non-farming scenario.

Table C-1. RESRAD Input Parameters

RESRAD Parameter (Units)	Default	Value	Medium	Comment/Reference
Number of unsaturated zone strata	1.00E+00	1.00E+00	All	Assumed.
Unsaturated zone thickness (m)	4.00E+00	2.00E+00	SS, SB	Site specific.
	4.00E+00	0.00E+00	SD	Assumed saturated for stream bank.
Unsaturated zone soil density (g/cm^3)	1.50E+00	1.70E+00	SS, SB	WVNSCO 1993a and WVNSCO 1993c.
Unsaturated zone total porosity	4.00E-01	3.60E-01	SS, SB	WVNSCO 1993c.
Unsaturated zone effective porosity	2.00E-01	2.50E-01	SS, SB	WVNSCO 1993c.
Unsaturated zone field capacity	2.00E-01	2.00E-01	SS, SB	WVNSCO 1993c.
Unsaturated zone hydraulic conductivity (m/y)	1.00E+01	1.40E+02	SS, SB	Average for Sand and Gravel Thick Bedded Unit (4.43E-03 cm/s from Table 3-19) divided by 10 to provide vertical conductivity that accounts for potential anisotropy (DEIS Appendix E, Table E-3).
Unsaturated zone b parameter	5.30E+00	1.40E+00	SS, SB	Yu, et al. 2000, Att. C table 3.5-1, mean for loamy sand (ln(mean)=0.305).
Distribution coefficients – radionuclides				
Contaminated zone (mL/g)	varies	Site specific	All	See Table C-2 for distribution coefficients.
Unsaturated zone 1 (mL/g)	varies	Site specific	All	See Table C-2 for distribution coefficients.
Saturated zone (mL/g)	varies	Site specific	All	See Table C-2 for distribution coefficients.
Plant Transfer Factor	varies	Chemical-specific	All	Default values assumed.
Fish Transfer Factor	Varies	Chemical-specific	SD	Default values assumed.
Leach rate (1/y)	varies	not used	All	Using site-specific Kd values instead of assigning leach rate.
Solubility constant	varies	not used	All	Using site-specific Kd values instead of assigning solubility constant.
Inhalation rate (m^3/y)	8.40E+03	8.40E+03	All	Beyeler, et al. 1999.
Mass loading for inhalation (g/m^3)	1.00E-04	1.48E-05	All	Beyeler, et al. 1999. Based on relative time fractions and mean dust loadings. Assumes 288 hours of active farming per year.
Exposure duration (y)	3.00E+01	1.00E+00	All	Yearly dose estimates calculated.

Table C-1. RESRAD Input Parameters

RESRAD Parameter (Units)	Default	Value	Medium	Comment/Reference
Filtration factor, inhalation	4.00E-01	1.00E+00	SS, SB	Beyeler, et. al. 1999.
Shielding factor, external gamma	7.00E-01	2.73E-01	SS, SB	Yu, et al. 2000, Att. C Figure 7.10-1, mean of distribution approximates a frame house with slab or basement.
Fraction of time spent indoors	5.00E-01	6.60E-01	SS, SB	Yu, et al. 2000, Att. C Figure 7.6-2, value represents ~50th percentile of distribution.
	5.00E-01	0.00E+00	SD	Assumed.
Fraction of time spent outdoors	2.50E-01	2.50E-01	SS, SB	RESRAD default value used.
	2.50E-01	1.20E-02	SD	Based on 104 hours/year (2 hours/day, 2 day/week, 26 weeks/y) spent on the stream bank over 8760 residence hours per year (24 hr/day, 365 days/y)
Shape factor flag, external gamma	1.00E+00	1.00E+00	SS, SB	RESRAD default.
Fruits, vegetables and grain consumption (kg/y)	1.60E+02	1.12E+02	SS, SB	Beyeler, et al. 1999.
Leafy vegetable consumption (kg/y)	1.40E+01	2.10E+01	SS, SB	Beyeler, et al. 1999.
Milk consumption (L/y)	9.20E+01	2.33E+02	SS, SB	Beyeler, et al. 1999.
Meat and poultry consumption (kg/y)	6.30E+01	6.50E+01	All	Beyeler, et al. 1999.
Fish consumption (kg/y)	5.40E+00	9.00E+00	SD	Exposure Factors Handbook (EPA, 1999). The value represents the 95th percentile of fish consumption by recreational anglers
Other seafood consumption (kg/y)	9.00E-01	0.00E+00	SD	Assumes only fish consumed from the stream
Soil ingestion rate (g/y)	3.65E+01	1.83E+01	All	Yu, et al. 2000, Att C. Figure 5.6-1, value represents mean of distribution for resident farmer (50 mg/d).
Drinking water intake (L/y)	5.10E+02	7.30E+02	SS, SB	Beyeler, et al. 1999.
	5.10E+02	1.00E+00	SD	Based on 104 hour/year exposure and 10 mL/hr for wading scenario (http://www.epa.gov/Region4/waste/ots/healtbul.htm)
Contamination fraction of drinking water	1.0	1.0	All	Assumed. For streambed sediment, this is 100% of incidental ingestion.
Contamination fraction of household water	1.0	1.0	SS, SB	Assumed.
Contamination fraction of livestock water	1.0	1.0	SS, SB	Assumed.
Contamination fraction of groundwater	1.0	0	SD	All water ingested is from surface water.

Table C-1. RESRAD Input Parameters

RESRAD Parameter (Units)	Default	Value	Medium	Comment/Reference
Contamination fraction of irrigation water	1.0	1.0	SS, SB	Assumed.
Contamination fraction of aquatic food	1.0	1.0	SD	Assumed.
Contamination fraction of plant food	-1	1.0	SS, SB	Assumes all ingestion is from the contaminated source.
Contamination fraction of meat	-1	1.0	All	Assumes all ingestion is from the contaminated source.
Contamination fraction of milk	-1	1.0	SS, SB	Assumes all ingestion is from the contaminated source.
Livestock fodder intake for meat (kg/day)	6.80E+01	2.73E+01	SS, SB	Beyeler, et al. 1999.
	6.80E+01	2.25E+00	SD	Assumption for deer.
Livestock fodder intake for milk (kg/day)	5.50E+01	6.42E+01	SS, SB	Beyeler, et al. 1999.
Livestock water intake for meat (L/day)	5.00E+01	5.00E+01	All	Beyeler, et al. 1999, assumed for venison exposure to sediment source.
Livestock water intake for milk (L/day)	1.60E+02	1.60E+02	SS, SB	RESRAD default value used.
Livestock soil intake (kg/day)	5.00E-01	5.00E-01	All	RESRAD default, assumed for venison exposure to sediment source.
Mass loading for foliar deposition (g/m^3)	1.00E-04	4.00E-04	SS, SB	Beyeler, et al. 1999.
Depth of soil mixing layer (m)	1.50E-01	1.50E-01	SS, SB	Beyeler, et al. 1999.
Depth of roots (m)	9.00E-01	9.00E-01	All	RESRAD default, represents crops with short growing seasons.
Drinking water fraction from ground water	1.0	1.0	All	Assumed.
Household water fraction from ground water	1.0	1.0	SS, SB	Assumed.
Livestock water fraction from ground water	1.0	1.0	SS, SB	Assumed.
Irrigation fraction from ground water	1.0	1.0	SS, SB	Assumed.
Wet weight crop yield for non-leafy (kg/m^2)	7.00E-01	1.75E+00	SS, SB	Yu, et al. 2000, Att. C Figure 6.5-1 value is mean of distribution.
Wet weight crop yield for leafy (kg/m^2)	1.50E+00	1.50E+00	SS, SB	RESRAD default.
Wet weight crop yield for fodder (kg/m^2)	1.10E+00	1.10E+00	SS, SB	RESRAD default.
Growing season for non-leafy (years)	1.70E-01	1.70E-01	SS, SB	RESRAD default.
Growing season for leafy (years)	2.50E-01	2.50E-01	SS, SB	RESRAD default.
Growing season for fodder (years)	8.00E-02	8.00E-02	SS, SB	RESRAD default.

Table C-1. RESRAD Input Parameters

RESRAD Parameter (Units)	Default	Value	Medium	Comment/Reference
Translocation factor for non-leafy	1.00E-01	1.00E-01	SS, SB	RESRAD default.
Translocation factor for leafy	1.00E+00	1.00E+00	SS, SB	RESRAD default.
Translocation factor for fodder	1.00E+00	1.00E+00	SS, SB	RESRAD default.
Dry foliar interception fraction for non-leafy	2.50E-01	2.50E-01	SS, SB	RESRAD default.
Dry foliar interception fraction for leafy	2.50E-01	2.50E-01	SS, SB	RESRAD default.
Dry foliar interception fraction for fodder	2.50E-01	2.50E-01	SS, SB	RESRAD default.
Wet foliar interception fraction for non-leafy	2.50E-01	2.50E-01	SS, SB	RESRAD default.
Wet foliar interception fraction for leafy	2.50E-01	6.70E-01	SS, SB	Yu, et al. 2000, Att. C Figure 6.7-1 represent the most likely value.
Wet foliar interception fraction for fodder	2.50E-01	2.50E-01	SS, SB	RESRAD default.
Weathering removal constant (1/y)	2.00E+01	1.80E+01	SS, SB	Yu, et al. 2000, Att. C Figure 6.6-1 represent the most likely value
Carbon-14-related exposure parameters				
C-12 concentration in water (g/cc)	2.00E-05	2.00E-05	All	RESRAD default.
C-12 concentration in soil (g/g)	3.00E-02	3.00E-02	All	RESRAD default.
Fraction of vegetable carbon from soil	2.00E-02	2.00E-02	All	RESRAD default.
Fraction of vegetable carbon from air	9.80E-01	9.80E-01	All	RESRAD default.
C-14 evasion layer thickness in soil (m)	3.00E-01	3.00E-01	All	RESRAD default.
C-14 evasion flux rate from soil (1/sec)	7.00E-07	7.00E-07	All	RESRAD default.
C-12 evasion flux rate from soil (1/sec)	1.00E-10	1.00E-10	All	RESRAD default.
Fraction of grain in beef cattle feed	0.8	0.8	All	RESRAD default.
Fraction of grain in milk cow feed	0.2	0.2	All	RESRAD default.
Storage times of contaminated foodstuff (days)				
Fruits, non-leafy vegetables, and grain	1.40E+01	1.40E+01	SS, SB	RESRAD default.
Leafy vegetables	1.00E+00	1.00E+00	SS, SB	RESRAD default.
Milk	1.00E+00	1.00E+00	SS, SB	RESRAD default.

Table C-1. RESRAD Input Parameters

RESRAD Parameter (Units)	*Default*	*Value*	*Medium*	*Comment/Reference*
Meat	2.00E+01	2.00E+01	SS, SB	RESRAD default.
Fish	7.00E+00	7.00E+00	SD	RESRAD default.
Crustacea and mollusks	7.00E+00	7.00E+00	Not used	RESRAD default.
Well water	1.00E+00	1.00E+00	SS, SB	RESRAD default.
Surface water	1.00E+00	1.00E+00	SS, SB	RESRAD default.
Livestock fodder	4.50E+01	4.50E+01	SS, SB	RESRAD default
Radon-related exposure parameters				
Thickness of building foundation (m)	1.50E-01	not used	All	Applicable for Radon exposures only
Bulk density of building foundation (g/cc)	2.40E+00	not used	All	Applicable for Radon exposures only.
Total porosity of cover material	4.00E-01	not used	All	Applicable for Radon exposures only.
Total porosity of building foundation	1.00E-01	not used	All	Applicable for Radon exposures only.
Volumetric water constant of the cover material	5.00E-02	not used	All	Applicable for Radon exposures only.
Volumetric water constant of the foundation	3.00E-02	not used	All	Applicable for Radon exposures only.
Diffusion coefficient for radon gas (m^2/sec)				
in cover material	2.00E-06	not used	All	Applicable for Radon exposures only.
in foundation material	3.00E-07	not used	All	Applicable for Radon exposures only.
in contaminated zone soil	2.00E-06	not used	All	Applicable for Radon exposures only.
Radon vertical dimension of mixing (m)	2.00E+00	not used	All	Applicable for Radon exposures only.
Average building air exchange rate (1/hr)	5.00E-01	not used	All	Applicable for Radon exposures only.
Height of building or room (m)	2.50E+00	not used	All	Applicable for Radon exposures only.
Building indoor area factor	0.00E+00	not used	All	Applicable for Radon exposures only.
Building depth below ground surface (m)	-1	not used	All	Applicable for Radon exposures only.
Emanating power of Rn-222 gas	2.50E-01	not used	All	Applicable for Radon exposures only.

Table C-1. RESRAD Input Parameters

RESRAD Parameter (Units)	Default	Value	Medium	Comment/Reference
Emanating power of Rn-220 gas	1.50E-01	not used	All	Applicable for Radon exposures only.

LEGEND: SS = surface soil, SB = subsurface soil, SD = streambed sediment.

Table C-2. Soil/Water Distribution Coefficients[1]

Radionuclide	RESRAD Default (mL/g)	Surface Soil DCGL Contaminated Zone (mL/g)	Subsurface Soil DCGL Contaminated Zone (mL/g)	Sediment DCGL Contaminated Zone (mL/g)	Unsaturated[2] Zone (mL/g)	Saturated[3] Zone (mL/g)
Principal Elements						
Americium	20	1900[4] (420 - 111,000)	4000[5] (420 - 111,000)	4000[5] (420 - 111,000)	1900[4] (420 - 111,000)	1900[4] (420 - 111,000)
Carbon	0	5[4] (0.7 - 12)	7[5] (0.7 - 12)	7[5] (0.7 - 12)	5[4] (0.7 - 12)	5[4] (0.7 - 12)
Curium[6]	calculated	6760 (780 – 22,970)	6760 (780 – 22,970)	6760 (780 – 22,970)	6760 (780 – 22,970)	6760 (780 – 22,970)
Cesium	4600	280[4] (48 - 4800)	480[5] (48 - 4800)	480[5] (48 - 4800)	280[4] (48 - 4800)	280[4] (48 - 4800)
Iodine	calculated	1[4] (0.4 - 3.4)	2[7] (0.4 - 3.4)	2[7] (0.4 - 3.4)	1[4] (0.4 - 3.4)	1[4] (0.4 - 3.4)
Neptunium	calculated	2.3[8] (0.5 - 5.2)	3[5] (0.5 - 5.2)	3[5] (0.5 - 5.2)	2.3[8] (0.5 - 5.2)	2.3[8] (0.5 - 5.2)
Plutonium	2000	2600[8] (5 - 27,900)	3000[5] (5 - 27,900)	3000[5] (5 - 27,900)	2600[8] (5 - 27,900)	2600[8] (5 - 27,900)
Strontium	30	5[9] (1 - 32)	15[5] (1 - 32)	15[5] (1 - 32)	5[9] (1 - 32)	5[9] (1 - 32)
Technetium	0	0.1[4] (0.01 - 4.1)	4.1[7] (1 - 10)	4.1[7] (1 - 10)	0.1[4] (0.01 - 4.1)	0.1[4] (0.01 - 4.1)
Uranium	50	35[4] (10 - 350)	10[9] (1 - 100)	10[9] (1 - 100)	35[4] (10 - 350)	35[4] (10 - 350)

Table C-2. Soil/Water Distribution Coefficients[(1)]

Radionuclide	RESRAD Default (mL/g)	Surface Soil DCGL Contaminated Zone (mL/g)	Subsurface Soil DCGL Contaminated Zone (mL/g)	Sediment DCGL Contaminated Zone (mL/g)	Unsaturated[(2)] Zone (mL/g)	Saturated[(3)] Zone (mL/g)
Progeny Elements[(10)]						
Actinium	20	1740	1740	1740	1740	1740
Lead	100	2400	2400	2400	2400	2400
Protactinium	50	2040	2040	2040`	2040	2040
Radium	70	3550	3550	3550	3550	3550
Thorium	60,000	5890	5890	5890	5890	5890

NOTES: (1) Sources of K_d values considered included Table 3-20; NUREG-5512 (Beyeler, et al. 1999), Table 6.7; RESRAD User's Guide (Yu, et al. 2001), Tables E-3, E-4; Sheppard, et. al. 2006, and Sheppard and Thibault 1990. Values in parentheses are the bounds used in the sensitivity evaluation, selected considering site-specific and literature values to reflect a reasonable range.

(2) Sediment model assumes no unsaturated zone. Values used for surface and subsurface soil evaluation only.

(3) Values presented here are those used for surface soil DCGLs based on the non-dispersion model.

(4) From Sheppard and Thibault 1990, for sand.

(5) Site specific value for the unweathered Lavery till (see Section 3.7.8, Table 3-20).

(6) Beyeler, et. al. 1999

(7) Site specific value for the Lavery till (see Section 3.7.8, Table 3-20).

(8) Site specific value for the sand and gravel unit (see Section 3.7.8, Table 3-20). The value of 5 mL/g is consistent with the value used in the Decommissioning EIS.

(9) Site specific data (Dames and Moore 1995a, 1995b)

(10) Progeny K_ds were not included in the sensitivity analysis; DEIS values were used in all cases.

Table C-3 Scenario exposure pathways for WVDP DCGL development

Exposure Pathways	Resident Farmer (surface soil and Lavery Till source)	Recreationist (sediment source)
Incidental ingestion of source	●	●
External exposure to source	●	●
Inhalation of airborne source	●	●
Ingestion of groundwater impacted by source	●	x
Ingestion of milk impacted by soil and water sources	●	x
Ingestion of beef impacted by soil and water sources	●	x
Ingestion of produce impacted by soil and water sources	●	x
Incidental ingestion of surface water impacted by source	○	●
Ingestion of fish impacted by source	○	●
Ingestion of venison impacted by sediment and water sources	○	●

LEGEND:

● - Pathway is considered complete and is included in DCGL development.

○ - Pathway is considered potentially complete but unlikely, and is not included in DCGL development.

x - Pathway is considered incomplete and is not included in DCGL development.

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas[(1)]

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
BH-17 (WMA 6, 1993) Depth to Lavery till - 27 ft	Sr-90	1.1E-01	26-28
	Cs-137	2.6E-02	26-28
	U-232	< 3.2E-03	26-28
	U-233/234	1.6E-01	26-28
	U-235	< 5.8E-03	26-28
	U-235/236	< 6.9E-03	26-28
	U-238	1.1E-01	26-28
	Pu-238	< 4.3E-03	26-28
	Pu-239/240	< 4.3E-03	26-28
	Pu-241	1.3E+00	26-28
	Am-241	< 9.6E-03	26-28
BH-21A (WMA 1, 1993) Depth to Lavery till - 37.5 ft	Sr-90	4.5E+02	36-38
	Cs-137	< 3.0E-02	36-38
	U-232	< 7.4E-03	36-38
	U-233/234	8.6E-02	36-38
	U-235	< 5.1E-03	36-38
	U-235/236	< 7.2E-03	36-38
	U-238	7.1E-02	36-38
	Pu-238	< 4.8E-03	36-38
	Pu-239/240	< 4.8E-03	36-38
	Pu-241	< 1.1E+00	36-38
	Am-241	< 7.2E-03	36-38
GP3098 (WMA 1, 1998) Depth to Lavery till - 37 ft	Sr-90	6.6E+00	36.5-37
	Sr-90	4.2E+00	37-37.5
	Sr-90	6.3E+00	37.5-38
	Sr-90	5.5E+01	38-38.5
	Sr-90	5.9E+01	38.5-39
	Sr-90	3.4E+01	39-39.5
	Sr-90	2.9E+01	39.5-40
GP3008 (WMA 1, 2008) Depth to Lavery till - 37 ft	C-14	< 3.0E-01	37-39
	Sr-90	1.7E+00	37-39
	Tc-99	< 5.5E-01	37-39
	I-129	< 1.1E-01	37-39
	Cs-137	< 2.0E-02	37-39
	U-232	< 2.2E-02	37-39
	U-233/234	9.7E-01	37-39
	U-235/236	1.3E-01	37-39
	U-238	1.1E+00	37-39

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas(1)

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
	Np-237	< 9.8E-03	37-39
	Pu-238	< 1.1E-02	37-39
	Pu-239/240	< 1.2E-02	37-39
	Pu-241	< 4.8E-01	37-39
	Am-241	< 1.2E-02	37-39
	Cm-243/244	< 1.2E-02	37-39
GP7398 (WMA 1, 1998) Depth to Lavery till - 39 ft	Sr-90	1.9E+00	40-40.5
	Sr-90	1.8E+00	40.5-41
	Sr-90	5.2E+00	41-41.5
	Sr-90	8.4E+00	41.5-42
GP7608 (WMA 1, 2008) Depth to Lavery till - 38 ft	C-14	< 3.4E-01	38-40
	Sr-90	1.8E+01	38-40
	Tc-99	< 3.9E-01	38-40
	I-129	< 2.3E-01	38-40
	Cs-137	7.9E+00	38-40
	U-232	< 2.8E-01	38-40
	U-233/234	1.9E+00	38-40
	U-235/236	< 4.2E-01	38-40
	U-238	8.8E-01	38-40
	Np-237	< 3.6E-01	38-40
	Pu-238	< 3.4E-01	38-40
	Pu-239/240	< 3.1E-01	38-40
	Pu-241	< 3.4E+01	38-40
	Am-241	< 2.0E-01	38-40
	Cm-243/244	< 2.2E-01	38-40
GP7808 (WMA 1, 2008) Depth to Lavery till - 37 ft	C-14	< 2.9E-01	37-39
	Sr-90	8.6E+00	37-39
	Tc-99	< 4.4E-01	37-39
	I-129	< 2.3E-01	37-39
	Cs-137	< 2.2E-02	37-39
	U-232	< 1.3E-02	37-39
	U-233/234	8.2E-01	37-39
	U-235/236	9.2E-02	37-39
	U-238	1.1E+00	37-39
	Np-237	< 2.1E-02	37-39
	Pu-238	< 1.1E-02	37-39
	Pu-239/240	< 1.5E-02	37-39
	Pu-241	< 4.9E-01	37-39
	Am-241	< 1.7E-02	37-39
	Cm-243/244	< 1.6E-02	37-39
GP8098 (WMA 1, 1998) Depth to Lavery till - 41 ft	C-14	< 8.6E-02	40-42
	Sr-90	1.3E+01	40-42

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas[(1)]

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
	Tc-99	< 2.6E-01	40-42
	I-129	< 2.3E-01	40-42
	Cs-137	< 2.2E-02	40-42
	Pu-241	< 2.1E+00	40-42
GP8008 (WMA 1, 2008) Depth to Lavery till - 40 ft	C-14	< 2.8E-01	39-41
	C-14	< 2.8E-01	41-43
	Sr-90	5.3E+00	39-41
	Sr-90	1.4E+00	41-43
	Tc-99	< 3.4E-01	39-41
	Tc-99	< 3.7E-01	41-43
	I-129	< 1.2E-01	39-41
	I-129	< 1.2E-01	41-43
	Cs-137	< 2.3E-02	39-41
	Cs-137	< 2.8E-02	41-43
	U-232	< 1.0E-02	39-41
	U-232	< 1.3E-02	41-43
	U-233/234	5.2E-01	39-41
	U-233/234	1.1E+00	41-43
	U-235/236	3.9E-02	39-41
	U-235/236	1.1E-01	41-43
	U-238	8.2E-01	39-41
	U-238	1.4E+00	41-43
	Np-237	< 1.1E-02	39-41
	Np-237	< 1.2E-02	41-43
	Pu-238	< 1.5E-02	39-41
	Pu-238	< 1.5E-02	41-43
	Pu-239/240	< 1.6E-02	39-41
	Pu-239/240	< 1.5E-02	41-43
	Pu-241	< 4.4E-01	39-41
	Pu-241	< 5.2E-01	41-43
	Am-241	< 1.2E-02	39-41
	Am-241	< 1.5E-02	41-43
	Cm-243/244	< 1.3E-02	39-41
	Cm-243/244	< 1.6E-02	41-43
GP8308 (WMA 1, 2008) Depth to Lavery till - 41.5 ft	C-14	< 3.5E-01	40-42
	Sr-90	1.5E+00	40-42
	Tc-99	< 3.6E-01	40-42
	I-129	2.4E-01	40-42
	Cs-137	< 2.7E-02	40-42
	U-232	< 2.4E-02	40-42
	U-233/234	9.8E-01	40-42
	U-235/236	2.2E-01	40-42
	U-238	1.1E+00	40-42

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas[(1)]

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
	Np-237	< 1.3E-02	40-42
	Pu-238	< 1.1E-02	40-42
	Pu-239/240	< 1.1E-02	40-42
	Pu-241	< 2.7E-01	40-42
	Am-241	< 1.2E-02	40-42
	Cm-243/244	< 1.8E-02	40-42
GP8698 (WMA 1, 1998) Depth to Lavery till - 39 ft	Sr-90	2.2E+00	39-39.5
	Sr-90	1.0E+00	39.5-40
	Sr-90	3.0E+00	40-40.5
	Sr-90	1.0E+01	40.5-41
	Sr-90	4.1E+01	41-41.5
	Sr-90	3.0E+01	41.5-42
GP10008 (WMA 1, 2008) Depth to Lavery till - 37 ft	C-14	< 3.0E-01	37-39
	Sr-90	6.7E+00	37-39
	Tc-99	< 4.0E-01	37-39
	I-129	< 1.4E-01	37-39
	Cs-137	< 2.7E-02	37-39
	U-232	< 1.3E-02	37-39
	U-233/234	7.6E-01	37-39
	U-235/236	7.5E-02	37-39
	U-238	9.5E-01	37-39
	Np-237	< 1.2E-02	37-39
	Pu-238	< 2.2E-02	37-39
	Pu-239/240	< 1.1E-02	37-39
	Pu-241	< 4.3E-01	37-39
	Am-241	< 1.4E-02	37-39
	Cm-243/244	< 2.3E-02	37-39
GP10108 (WMA 1, 2008) Depth to Lavery till - 33 ft	C-14	< 3.1E-01	32-34
	Sr-90	6.3E-01	32-34
	Tc-99	< 5.4E-01	32-34
	I-129	< 9.1E-02	32-34
	Cs-137	< 2.6E-02	32-34
	U-232	< 1.6E-01	32-34
	U-233/234	6.0E-01	32-34
	U-235/236	5.0E-02	32-34
	U-238	7.3E-01	32-34
	Np-237	< 1.0E-02	32-34
	Pu-238	< 9.5E-03	32-34
	Pu-239/240	< 8.8E-03	32-34
	Pu-241	< 4.7E-01	32-34
	Am-241	< 1.1E-02	32-34
	Cm-243/244	< 1.1E-02	32-34

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas(1)

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
GP10408 (WMA 1, on border of WMA 2) Depth to Lavery till - 24 ft	C-14	< 3.6E-01	24-26
	Sr-90	7.4E+00	24-26
	Tc-99	< 5.1E-01	24-26
	I-129	< 1.1E-01	24-26
	Cs-137	< 5.5E-02	24-26
	U-232	4.1E-02	24-26
	U-233/234	8.8E-01	24-26
	U-235/236	1.4E-01	24-26
	U-238	7.9E-01	24-26
	Np-237	< 6.9E-03	24-26
	Pu-238	< 1.2E-02	24-26
	Pu-239/240	< 1.2E-02	24-26
	Pu-241	< 3.1E-01	24-26
	Am-241	< 1.3E-02	24-26
	Cm-243/244	< 1.4E-02	24-26
BH-05 (WMA 2, 1993), located downgradient of Lagoon 1 Depth to Lavery till - 12 ft	Sr-90	8.5E-01	12-14
	Cs-137	4.5E-01	12-14
	U-232	1.2E-02	12-14
	U-233/234	1.8E-01	12-14
	U-235	< 5.9E-03	12-14
	U-235/236	< 8.3E-03	12-14
	U-238	1.1E-01	12-14
	Pu-238	1.0E-02	12-14
	Pu-239/240	< 5.9E-03	12-14
	Pu-241	< 1.3E+00	12-14
	Am-241	3.0E-02	12-14
BH-07 (WMA 2, 1993) Depth to Lavery till - 13 ft	Sr-90	1.3E-01	12-14
	Cs-137	7.5E-02	12-14
	U-232	< 8.7E-03	12-14
	U-233/234	2.2E-01	12-14
	U-235	< 6.6E-03	12-14
	U-235/236	< 7.6E-03	12-14
	U-238	1.5E-01	12-14
	Pu-238	< 4.7E-03	12-14
	Pu-239/240	< 6.2E-03	12-14
	Pu-241	9.5E-01	12-14
	Am-241	< 5.1E-03	12-14
BH-08 (WMA 2, 1993), located downgradient of Lagoon 1	Sr-90	1.8E+02	10-12
	Cs-137	2.5E+02	10-12

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas(1)

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
Depth to Lavery till - 11.5 ft	U-232	1.9E+01	10-12
	U-233/234	9.7E+00	10-12
	U-235	3.2E-01	10-12
	U-235/236	5.0E-01	10-12
	U-238	1.3E+01	10-12
	Pu-238	3.9E+00	10-12
	Pu-239/240	7.6E+00	10-12
	Pu-241	2.7E+01	10-12
	Am-241	1.1E+01	10-12
BH-12 (WMA 2, 1993) Depth to Lavery till - 15.5 ft	Sr-90	1.8E-01	14-16
	Cs-137	< 2.2E-02	14-16
	U-232	< 6.0E-03	14-16
	U-233/234	1.1E-01	14-16
	U-235	< 7.0E-03	14-16
	U-235/236	1.3E-02	14-16
	U-238	9.7E-02	14-16
	Pu-238	< 4.9E-03	14-16
	Pu-239/240	< 4.9E-03	14-16
	Pu-241	< 1.0E+00	14-16
	Am-241	< 4.6E-03	14-16
BH-13 (WMA 2, 1993) Depth to Lavery till - 19 ft	Sr-90	1.8E-01	18-20
	Cs-137	2.7E+00	18-20
	U-232	1.6E-02	18-20
	U-233/234	8.5E-02	18-20
	U-235	< 5.1E-03	18-20
	U-235/236	< 8.2E-03	18-20
	U-238	5.3E-02	18-20
	Pu-238	2.4E-02	18-20
	Pu-239/240	2.6E-02	18-20
	Pu-241	< 8.1E-01	18-20
	Am-241	9.5E-02	18-20
BH-14 (WMA 2, 1993) Depth to Lavery till - 15 ft	Sr-90	1.8E+01	14-16
	Cs-137	1.9E+00	14-16
	U-232	2.0E-02	14-16
	U-233/234	1.9E-01	14-16
	U-235	< 7.9E-03	14-16
	U-235/236	< 1.1E-02	14-16