

# Inventory Development for the West Valley Probabilistic Performance Assessment (PPA) Model

WVDP Quarterly Public Meeting

November 2018



# Purpose

- Define inventory to be used as input to the West Valley PPA Model from existing data sources
  - Radiological and chemical wastes, other contamination, and residuals
- Structured parallel to the PPA Model
  - Waste Management Areas (12) – each may have zero, one, or multiple Facilities; zero to many Decision Units per WMA
  - Facility (34) – a modeling construct; each has its own contaminant transport and risk exposure calculations
  - Decision Unit (428) – each Decision Unit (DU) needs to have an inventory assigned
    - Inventory is assigned at the WMA and/or Facility level for those having no DUs; additional residual inventory is assigned to each Facility



# WMAs



WMA 11 and 12 not shown.



# Facilities

## Selection of WMA 7 Closure Options

### Instructions

- Select the closure option to be modeled using the drop-down box.
- For the Close-in-Place option, additional engineered controls may be selected, and individual Decision Units may be included/excluded (as in place/excluded/constructed) from the WMA 7 Decision Units dashboard for the SPA North.

Select closure options:

Close-In-Place (with engineered cover) ▾

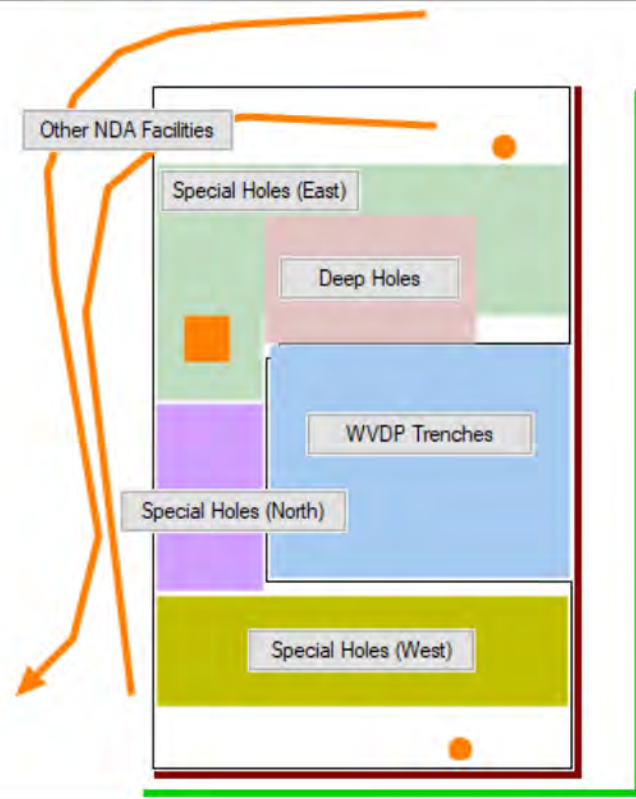
- No Action: All contamination remains in place. The existing geomembrane cover and slurry wall remain in place.

— existing slurry wall

- Close-in-Place: Some or all contamination remains in place, as selected on the NDA Decision Units dashboards. The Close-in-Place cover would be constructed, and additional engineered controls may also be selected.

- Upgradient French drain —
- Grout Interceptor Trench
- Grout Decision Units > 6 m (20 ft)

- Complete removal: All NDA Holes, Trenches, and associated contamination are removed from WMA 7, and are replaced with clean backfill and a simple soil cover. Residual contamination remains in the ULT below the excavation.



WMA Controls

Run Model



# Decision Units

## Selection of NDA Special Holes, West Group

NDA Facilities

User-Select

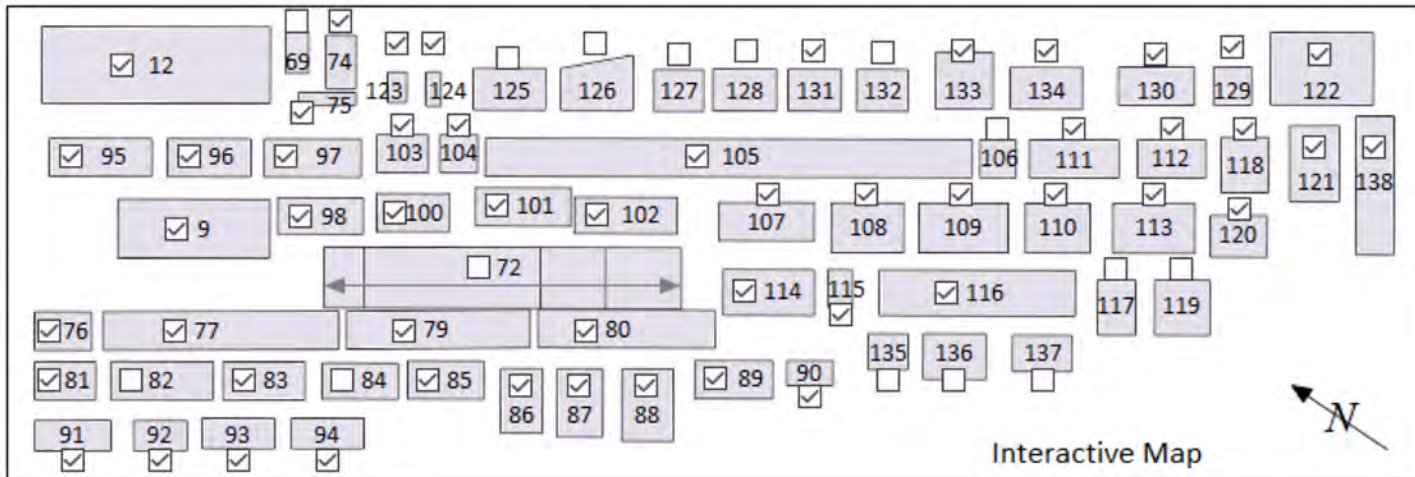
Sp. Holes, West

User-Select

### Instructions

- In order to make selections for all NDA Facilities, just the Special Holes West Group, or individual Special Hole Decision Units using this dashboard, make sure that the NDA Facilities are user-

<input checked="" type="checkbox"/> SH-9	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-79	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-87	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-95	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-104	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-112	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-120	<input checked="" type="checkbox"/>	<input type="checkbox"/> SH-128	<input type="checkbox"/>	<input type="checkbox"/> SH-136	<input type="checkbox"/>
<input checked="" type="checkbox"/> SH-12	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-80	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-88	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-96	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-105	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-113	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-121	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-129	<input checked="" type="checkbox"/>	<input type="checkbox"/> SH-137	<input type="checkbox"/>
<input type="checkbox"/> SH-69	<input type="checkbox"/>	<input checked="" type="checkbox"/> SH-81	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-89	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-97	<input checked="" type="checkbox"/>	<input type="checkbox"/> SH-106	<input type="checkbox"/>	<input checked="" type="checkbox"/> SH-114	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-122	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-130	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-138	<input checked="" type="checkbox"/>
<input type="checkbox"/> SH-72	<input type="checkbox"/>	<input type="checkbox"/> SH-82	<input type="checkbox"/>	<input checked="" type="checkbox"/> SH-90	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-98	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-107	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-115	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-123	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> SH-131	<input checked="" type="checkbox"/>	<input type="checkbox"/> SH-132	<input type="checkbox"/>
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WMA Controls

WMA 7 Closure Options

Run Model

# Primary Data Sources

- SDA – URS 2002
- NDA – URS 2000
- WTF – WVNS 2005 (tanks 8D-1 and 8D-2), WVES 2008 (tank 8D-3) and CH2MHill 2012 (tank 8D-4)
- Residual contamination inventory source data is the WVDP Environmental Monitoring Program
  - Residual contamination: in the PPA Model, this is contamination that would remain after Decision Units are removed, under removal scenarios.



# Chemical Species List

- Risk-based screening based on toxicity and mass – Are chemical risks potentially important relative to radiological risks?
- Human health-based chemical Regional Screening Levels (RSLs) plus ecological lowest observed adverse effect levels (L-ESLs) are compared to Radiological Soil Screening Levels (radSSLs)
- Radiological risk is generally at least 100 times chemical risk
- 4 species carried through to modeling:
  - Chromium
  - Mercury
  - Thallium
  - Uranium (chemical effects) – Radiological activity generated in PPA Model runs will be converted to uranium mass equivalent for assessment



# Radiological Species List

- Master list of radionuclides (143)
- Ensure progeny are included; adding those not reported (153)
- Screening process defines species to carry through to contaminant transport modeling (66)
  - Short  $T_{1/2}$  cutoff – 5 years, except Po-210, Rn-222, Th-228, Pu-236
  - Long  $T_{1/2}$  cutoff - 1.5E10 years (9 nuclides)
  - Low inventory screen – Si-32, Nb-92, Tc-98, Pt-193, Bi-208
- Dose/risk modeling includes short-lived progeny of long-lived species after contaminant transport





# Radiological Species List

Green cell indicates a species is present in the EIS (18)

H-3	Nb-93m	Pm-146	Ac-227	U-238	Am-242m
Be-10	Nb-94	Sm-146	Th228	Np-236	Am-243
C-14	Mo-93	Sm-151	Th-229	Np-237	Cm-243
Cl-36	Tc-99	Eu-152	Th-230	Pu-236	Cm-244
Co-60	Pd-107	Eu-154	Th-232	Pu-238	Cm-245
Ni-59	Ag-108m	Ho-166m	Pa-231	Pu-239	Cm-246
Ni-63	Cd-113m	Pb-210	U-232	Pu-240	Cm-247
Se-79	Sn-126	Po-210	U-233	Pu-241	Cm-248
Kr-85	I-129	Rn-222	U-234	Pu-242	Cf-249
Sr-90	Cs-135	Ra-226	U-235	Pu-244	Cf-250
Zr-93	Cs-137	Ra-228	U-236	Am-241	Cf-251



# Sources of Uncertainty

- Multiple, sometimes conflicting inventories
- Inherent uncertainty of ~50 year old documentation
- No records of quality assurance checks
- Dose rate measurement methods/instrumentation
- Dose-to-curie conversion
- Profile assignment
- Profile development
- Volume per container/shipment
- Actual disposal location within NDA/SDA



# SDA Burial Log

Shipment Number	Customer	Date Received	H & S Rep.	Cubic Feet	Date Buried	Location Buried	Container Type	Curies Per Load	Curies Total acc.	Remarks SNM, Special handling, Decontamination
E-7030	Tatomhead Company	5-23-67	L.W.	352.90	5-23-67	C+5 565	D	.000	114,726.956	No special handling
E-7031	NFS	5-23-67	L.W.	154.35	5-23-67	C 570	cell	<del>.0255</del>	114,726.956	
E-7032	U.S. AEC	5-23-67	L.W.	107.05	5-23-67	C-10 570	D	.000	114,726.956	
E-7033	uclear waste handling	5-24-67	L.W.	3.00	5-24-67	C-15 570	cell	.003	114,726.959	
E-7034	MacCombs	5-24-67	L.W.	689.00		D-10 55	C+S	1.585	114,728.544	
E-7035	MacCombs	5-25-67	L.W.	365.00		D+5 60	C+S	.146	114,728.690	
E-7036	Langsdland nuclear	5-25-67	L.W.	102.90	5-25-67	C+15 575	D	.091	114,728.781	
E-7037	Niagan Chemical	5-26-67	L.W.	22.00	5-26-67	C-10 580	cell	.000	114,728.781	
E-7038	NFS	5-26-67	L.W.	271.76	5-26-67	C 585	cell	<del>.0363</del>	114,728.781	
E-7039	Do Topen, Inc.	April - May	L.W.	44,305.00		C 560x660	none	3.800	114,732.581	Special handling Decontamination
E-7040	uclear waste handling	5-29-67	L.W.	448.35	5-29-67	C+10 590	D	.100	114,732.681	
E-7041	NFS	5-29-67	L.W.	290.64	5-29-67	C-15 590	cell	.000	114,732.681	
E-7042	NFS	5-31-67	L.W.	73.50	5-29-67	C-5 600	cell	.000	114,732.681	
E-7043	National Lead	5-31-67	L.W.	294.00	5-31-67	C+5 600	S	.000	114,732.681	
F-7001	Westinghouse - Bettis	6-1-67	L.W.	698.25	6-1-67	C 605	D	74.970	114,807.651	No special handling
F-7002	NFS	6-1-67	L.W.	29.40	6-1-67	C-10 625	D	.000	114,807.651	Special handling
F-7003	Westinghouse - Bettis	6-2-67	L.W.	311.19	6-2-67	D-10 55	S	40.110	115,208.761	No special handling
F-7004	Westinghouse - Bettis	6-2-67	L.W.	307.40	6-2-67	D-15 65	S	533.000	115,741.761	No special handling
F-7005	Arthur James & Dry Cop.	6-2-67	L.W.	36.75	6-2-67	C-15 630	D	5.000	115,746.761	No special handling
F-7006	NFS	6-3-67	L.W.	330.75	6-3-67	C+15 610	cell + D	<del>.001</del>	115,746.761	No special handling
F-7007	NFS	6-5-67	L.W.	305.36	6-5-67	C+10 615	D cell	<del>.010</del>	115,746.761	No special handling



# WMA 1

- Main Plant Process Building
- All structures and subsurface soil assumed to be removed during Phase 1 decommissioning
- 1 PPA Model Facility
- No Decision Units
- Inventory consists of residual contamination below the excavation
  - Extrapolate from geoprobe investigations
  - Using Phase 1 Decommissioning Plan (DP) subsurface soil cleanup goals as upper bound, since these will drive excavation limits during Phase 1



# WMA 2

- Former LLRW Treatment Facilities
- 2 PPA Model Facilities
  - WMA 2 northwest of groundwater barrier wall
    - 2 Decision Units
      - North Plateau Groundwater Plume (NPGP)
      - Permeable Treatment Wall
    - Additional inventory of residual contamination
  - WMA 2 southeast of groundwater barrier wall
    - No Decision Units – all excavated
    - Inventory consists of residual contamination, based on geoprobe investigations and Phase 1 DP subsurface soil cleanup goals





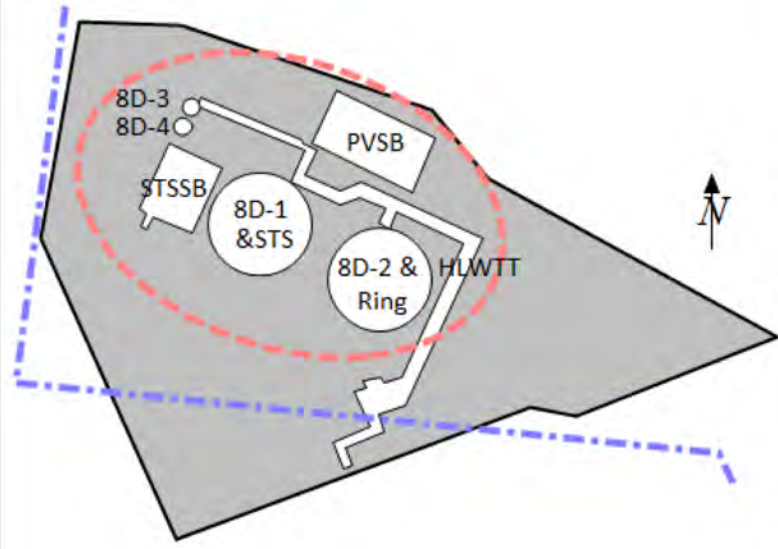
# WMA 3 – Waste Tank Farm

## Selection of WMA 3 Closure Options

**Instructions**

- Select the closure option to be modeled using the drop-down box.
- For the Close-in-Place option, additional engineered controls may be selected, and individual Decision Units may be selected from the selected, unselected, completed, or finished the WMA 3 Decision Units dashboard.

**Waste Management Area 3  
Waste Tank Farm  
Closure Options**



Select closure options:

Close-In-Place (with engineered cover) ▼

- No Action: All contamination remains in place. No cover is constructed, and no additional engineered controls are added.
- Close-in-Place: Some or all contamination remains in place, as selected on the WMA 3 Decision Units dashboard. The Close-in-Place cover would be constructed, and additional engineered controls may also be selected.

Select WMA 3 Decision Units

- Circumferential slurry wall - - -
- Upgradient barrier wall - - -
- Grout all HLW tanks

- Complete removal: All contamination and structures are removed from WMA 3, and are replaced with clean backfill and a simple soil cover. Residual contamination remains in the ULT below the excavation.

WMA Controls

Run Model



# WMA 4

- Construction & Demolition Debris Landfill
- 1 PPA Model Facility
  - 1 Decision Unit
    - Construction & Demolition Debris Landfill (CDDL) and North Plateau Groundwater Plume within CDDL footprint
  - Residual contamination, including NPGP outside CDDL footprint



# WMA 5

- Waste Storage Area
- Structures, concrete floor slabs, and foundations removed with Phase 1 decommissioning
- 1 PPA Model Facility
- No Decision Units
- Inventory consists of residual contamination, including NPGP



# WMA 6

- Central Project Premises
- With the exception of the rail spur, all structures, concrete floor slabs, and foundations removed with Phase 1 decommissioning
- 1 PPA Model Facility
- 1 Decision Unit
  - Rail spur (portion within WMA 6)
- Inventory consists of residual contamination







**WMA 7 –  
Dissolver Burial  
in NDA SH-9**



# WMA 7 – NDA

## Selection of WMA 7 Closure Options

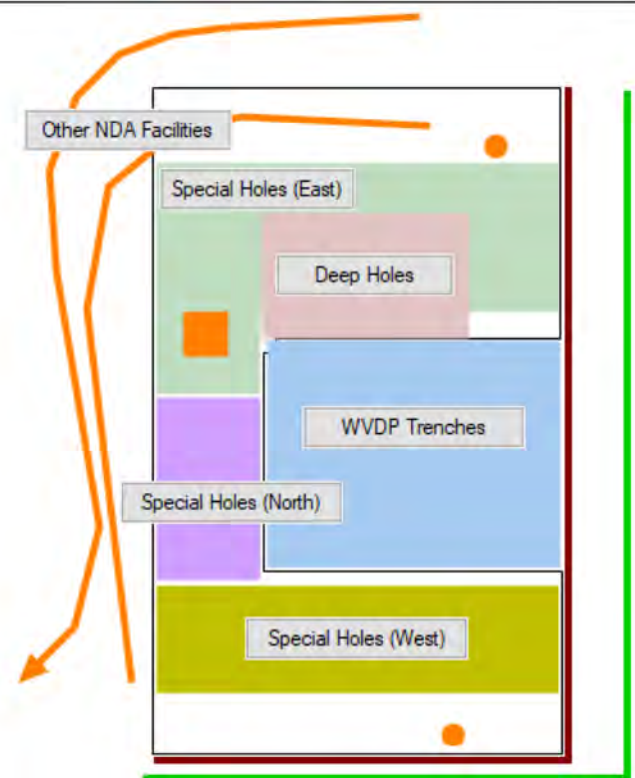
**Instructions**

- Select the closure option to be modeled using the drop-down box.
- For the Close-in-Place option, additional engineered controls may be selected, and individual Decision Units may be included / excluded to select / exclude / exempted / exempting the WMA 7 Decision Units dashboards for the CDA Month.

Select closure options:

Close-In-Place (with engineered cover) ▾

- No Action: All contamination remains in place. The existing geomembrane cover and slurry wall remain in place.  
— existing slurry wall
- Close-in-Place: Some or all contamination remains in place, as selected on the NDA Decision Units dashboards. The Close-in-Place cover would be constructed, and additional engineered controls may also be selected.
  - Upgradient French drain —
  - Grout Interceptor Trench
  - Grout Decision Units > 6 m (20 ft)
- Complete removal: All NDA Holes, Trenches, and associated contamination are removed from WMA 7, and are replaced with clean backfill and a simple soil cover. Residual contamination remains in the ULT below the excavation.



The diagram illustrates the layout of WMA 7 with various closure options and facilities. It includes:

- Other NDA Facilities:** Indicated by orange lines and arrows pointing to specific areas.
- Special Holes (East):** A green rectangular area.
- Deep Holes:** A pink rectangular area within the Special Holes (East).
- WVDP Trenches:** A blue rectangular area.
- Special Holes (North):** A purple rectangular area.
- Special Holes (West):** A yellow-green rectangular area.
- Upgradient French drain:** A green vertical line on the right side.
- Existing slurry wall:** A purple vertical line on the left side.

WMA Controls Run Model

# WMA 7

## NFS Deep Holes

**NDA Facilities**  
User-Select ▾

**NDA Deep Holes**  
User-Select ▾

Examine the list controls in order to see which requested Decision Units are included in the modeling.  
(Use button below.)

Switch to List Controls for the Deep Holes

\*Green disposal units are part of the collection of Special Holes. Disposal units with names in gray have no inventory information.

### Selection of NDA Deep Holes Decision Units

**Instructions**

- In order to make selections for all NDA Facilities, just the Deep Holes Facility, or individual

**Not located:**

- 2-1
- 3-1
- 11-3

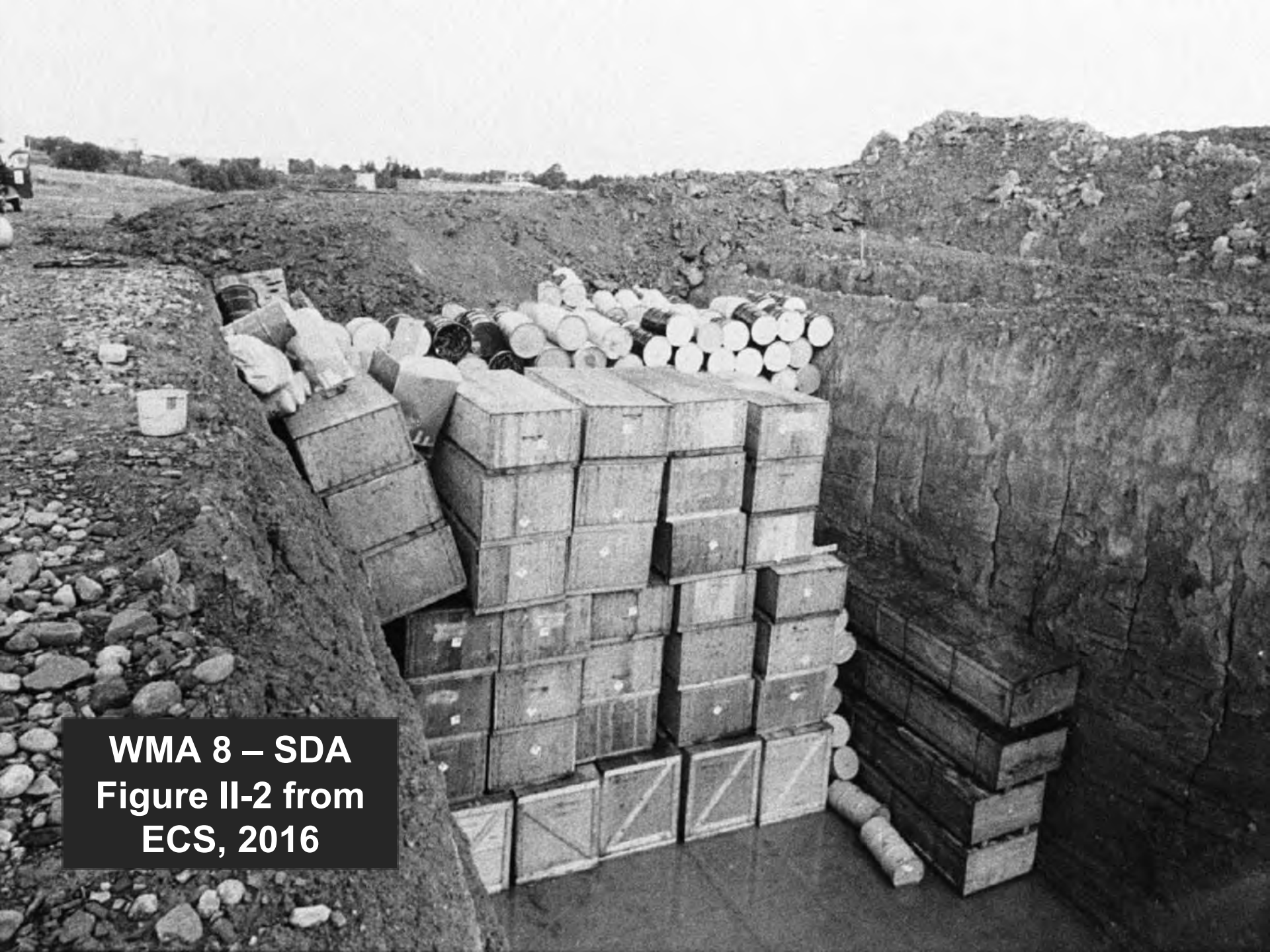
WMA Controls

WMA 7 Closure Options

Run Model







**WMA 8 – SDA  
Figure II-2 from  
ECS, 2016**

# WMA 8

SDA

## Selection of WMA 8 Closure Options

**Instructions**

- Select the closure option to be modeled using the drop-down box.
- For the Close-in-Place option, additional engineered controls may be selected, and individual Decision Units may be included (green) or excluded (orange) from the WMA 8 Decision Units dashboard for the SDA North

Select closure options:

Close-In-Place (with engineered cover) ▾

- No Action:** All contamination remains in place. The existing geomembrane cover, concrete barrier wall, and slurry wall remain in place.
  - existing concrete wall
  - existing slurry wall
- Close-in-Place:** Some or all contamination remains in place, as selected on the SDA North and South Decision Units dashboards. The Close-in-Place cover would be constructed, and additional engineered controls may also be selected.
  - Upgradient French drain
  - Grout Trenches 1 - 5 & 8 - 14
- Complete removal:** All Trenches, Lagoons, existing concrete and slurry walls, and associated contamination within the SDA are removed from WMA 8, and are replaced with clean backfill and a simple soil cover. Residual contamination remains in the ULT below the excavation.

The diagram illustrates the layout of SDA South and North Decision Unit Controls. It features a central area labeled 'I Lagoon' at the top, flanked by 'S Lagoon' and 'N Lagoon'. Below these are several horizontal bars representing decision units, numbered 1 through 14. Units 1-7 are associated with the S Lagoon, and units 8-14 are associated with the SDA South. A legend indicates that green bars represent existing concrete walls and purple bars represent existing slurry walls. The diagram also shows a cross-section of the ground surface with a lagoon and a barrier wall.

WMA Controls

Run Model



# WMA 8

## SDA North

### Selection of SDA Facilities and Decision Units: North Disposal Area

**SDA Facilities**

User-Select v

**Instructions**

- User-selection of individual Decision Units is available only under the Close-in-Place closure option. For No Action, all are included. For Complete Removal, none are included.

SDA South Disposal Area

SDA South v

SDA Trench 1	SDA Trench 2	SDA Trench 3	SDA Trench 4	SDA Trench 5	SDA Trench 6	SDA Trench 7
User-Select <span style="font-size: small;">v</span>	User-Select <span style="font-size: small;">v</span>	User-Select <span style="font-size: small;">v</span>	User-Select <span style="font-size: small;">v</span>	User-Select <span style="font-size: small;">v</span>	User-Select <span style="font-size: small;">v</span>	
User req. Incl.	User req. Incl.	User req. Incl.	User req. Incl.	User req. Incl.	User req. Incl.	User req. Incl.
<input checked="" type="checkbox"/> 0-50 ft <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 0-50 ft <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 0-50 ft <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 0-50 ft <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 0-50 ft <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 1 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 0-75 ft <span style="float: right;">✔</span>
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<input checked="" type="checkbox"/> 100-150 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 100-150 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 100-150 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 100-150 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 100-150 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 3 <span style="float: right;">✔</span>	
<input checked="" type="checkbox"/> 150-200 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 150-200 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 150-200 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 150-200 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 150-200 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 4 <span style="float: right;">✔</span>	
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empty	<input checked="" type="checkbox"/> 250-300 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 250-300 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 250-300 <span style="float: right;">✔</span>	<input type="checkbox"/> 250-300 <span style="float: right;"></span>	<input checked="" type="checkbox"/> SPH 6 <span style="float: right;">✔</span>	
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<input checked="" type="checkbox"/> 350-351 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 350-351 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 350-400 <span style="float: right;">✔</span>	<input type="checkbox"/> 350-400 <span style="float: right;"></span>	<input checked="" type="checkbox"/> 350-400 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 8 <span style="float: right;">✔</span>	
		<input checked="" type="checkbox"/> 400-450 <span style="float: right;">✔</span>	<input type="checkbox"/> 400-450 <span style="float: right;"></span>	<input checked="" type="checkbox"/> 400-450 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 9 <span style="float: right;">✔</span>	
		<input checked="" type="checkbox"/> 450-500 <span style="float: right;">✔</span>	<input type="checkbox"/> 450-500 <span style="float: right;"></span>	<input checked="" type="checkbox"/> 450-500 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 10 <span style="float: right;">✔</span>	
		<input type="checkbox"/> 500-550 <span style="float: right;"></span>	<input checked="" type="checkbox"/> 450-500 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 450-500 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 11 <span style="float: right;">✔</span>	
		<input type="checkbox"/> 550-600 <span style="float: right;"></span>	<input checked="" type="checkbox"/> 500-550 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 450-500 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 12 <span style="float: right;">✔</span>	
		<input type="checkbox"/> 600-650 <span style="float: right;"></span>	<input checked="" type="checkbox"/> 550-600 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 450-500 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 13 <span style="float: right;">✔</span>	
		<input type="checkbox"/> 650-698 <span style="float: right;"></span>	<input checked="" type="checkbox"/> 600-650 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 550-600 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 14 <span style="float: right;">✔</span>	
			<input checked="" type="checkbox"/> 650-675 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> 550-600 <span style="float: right;">✔</span>	<input checked="" type="checkbox"/> SPH 15 <span style="float: right;">✔</span>	
					<input checked="" type="checkbox"/> SPH 16 <span style="float: right;">✔</span>	
					<input checked="" type="checkbox"/> SPH 17 <span style="float: right;">✔</span>	
					<input checked="" type="checkbox"/> SPH 18 <span style="float: right;">✔</span>	
					<input checked="" type="checkbox"/> SPH 19 <span style="float: right;">✔</span>	

**SDA North Disposal Area Lagoons**

User req.	Incl.
<input checked="" type="checkbox"/> SDA Northern Lagoon	✔
<input checked="" type="checkbox"/> SDA Southern Lagoon	✔

WMA Controls

WMA 8 Closure Options

Run Model





# WMA 9

- Radwaste Treatment System Drum Cell
- Structures, concrete pads, and foundations removed with Phase 1 decommissioning
- 1 PPA Model Facility
- No Decision Units
- Inventory consists of residual contamination



# WMA 10

- Support and Services Area
- New Warehouse, concrete pads, and foundations removed with Phase 1 decommissioning; meteorological tower, security gatehouse, security fence remain
- 1 PPA Model Facility
- No Decision Units
- Inventory consists of residual contamination



# Next Steps

- Draft distributions under internal review
- Agency and independent expert review
- Next QPM:
  - Distribution development process and results

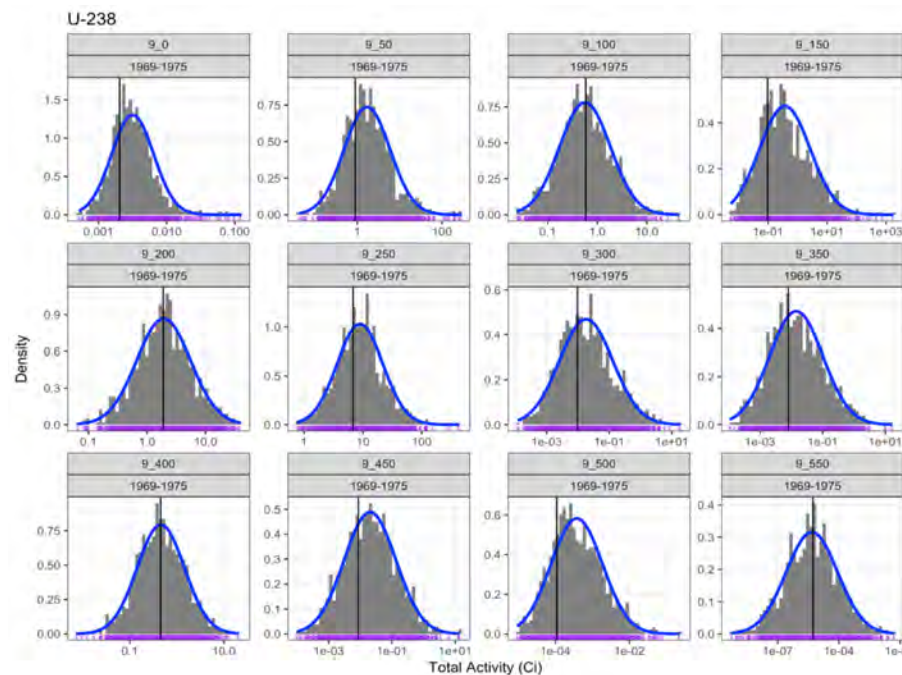


Figure A 12. Histograms displaying total inventory draws for  $^{238}\text{U}$  by trench interval and time period 1969–1975 in Trench 9, on the logarithmic base 10 scale. The parametric curves display the lognormal distributions fit to the draws by maximum likelihood. The black vertical line indicates the variable concentration method estimate (URS 2002; Wild 2000).