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2007 Annual Summary Report for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada Test Site Nye County, Nevada

Review of the Performance Assessments and Composite Analyses

Prepared for

National Nuclear Security Administration
Nevada Site Office

Prepared by

National Security Technologies, LLC

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ACRONYMS AND ABBREVIATIONS

BN	Bechtel Nevada
Bq	becquerel
Bq m^{-2} s^{-1}	becquerel per square meter per second
CA	composite analysis
CADD	Corrective Action Decision Document
CAU	Corrective Action Unit
CFR	Code of Federal Regulations
cm	centimeter
DAS	Disposal Authorization Statement
DOE	U.S. Department of Energy
ER	environmental restoration
ET	evapotranspiration
FFACO	*Federal Facility Agreement and Consent Order*
ft	foot
ft^3	cubic feet
FY	fiscal year
GCD	Greater Confinement Disposal
ICMP	Integrated Closure and Monitoring Plan
in.	inch
ISC	Industrial Source Complex
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LHS	Latin hypercube sampling
LLNL	Lawrence Livermore National Laboratory
m	meter
m^3	cubic meter
mSv	millisievert
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NTS	Nevada Test Site
NSTec	National Security Technologies, LLC
PA	performance assessment

ACRONYMS AND ABBREVIATIONS (continued)

R&D	research and development
RaDU	radium disposal unit
RTG	radioisotope thermoelectric generator
RWMS	Radioactive Waste Management Site
SLB	shallow land burial
TBq	terabecquerel
TDR	time-domain reflectometer
TLD	thermoluminescent dosimeter
UGTA	Underground Test Area
WAC	waste acceptance criteria
yr	year

EXECUTIVE SUMMARY

The *Maintenance Plan for the Performance Assessments and Composite Analyses for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada Test Site* (National Security Technologies, LLC [NSTec], 2006) requires an annual review to assess the adequacy of the Performance Assessments (Pas) and Composite Analyses (CAs) for each of the facilities, with the results submitted annually to the U.S. Department of Energy (DOE) Headquarters. The Disposal Authorization Statements for the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) also require that such reviews be made and that secondary or minor unresolved issues be tracked and addressed as part of the maintenance plan (DOE, 2000; 2002).

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) performed an annual review in fiscal year (FY) 2007 by evaluating operational factors and research results that impact the continuing validity of the PAs and CAs. This annual summary report presents data and conclusions from the FY 2007 review, and determines the adequacy of the PAs and CAs. Operational factors (e.g., waste forms and containers, facility design, and waste receipts), closure plans, monitoring results, and research and development (R&D) activities were reviewed in FY 2007 to determine the adequacy of the PAs. Likewise, the environmental restoration activities at the Nevada Test Site relevant to the sources of residual radioactive material that are considered in the CAs, the land-use planning, and the results of the environmental monitoring and R&D activities were reviewed to determine the adequacy of the CAs.

Waste operations, R&D, and monitoring results for FY 2007 were reviewed and compared with the assumptions and conceptual models of the PAs and CAs of the Area 3 and Area 5 RWMSs. Important developments include the following:

- Development of version 4.004 of the A5 RWMS GoldSim PA model
- Development of version 1.000 of the Title 40 Code of Federal Regulations (CFR) Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Waste," Goldsim model
- Development of new closure inventory estimates based on disposals through FY 2007
- Evaluation of transuranic (TRU) waste inadvertently disposed in classified Trench 4 (T04C) in 1986 by special analysis
- Evaluation of new or revised waste streams by special analysis

Analysis of the latest available data using the Area 5 RWMS v4.004 GoldSim PA model indicates that all performance objectives can be met. The results and conclusions of the Area 5 RWMS PA are judged valid and no need to the revise the PA is identified.

The newly developed 40 CFR 191 GoldSim model was used to prepare a special analysis of TRU waste inadvertently disposed in classified T04C before 1988. The TRU inventory had been

evaluated previously for compliance with the CA requirements. The special analysis concludes that the TRU waste in T04C can meet all the requirements of 40 CFR 191.

The Area 3 RWMS has been in inactive status since July 1, 2006, with the last shipment received in April 2006. In FY 2007, there were no operational changes, monitoring results, or R&D results for the Area 3 RWMS that would impact PA validity. Despite the increase in waste volume and inventory at the Area 3 RWMS since 1996 when the PA was approved, the facility performance evaluated with the new version 2.0 GoldSim Area 3 RWMS model (with the final closure inventory) remains well below the DOE Order 435.1, "Radioactive Waste Management," performance objectives (DOE, 2001). The conclusions of the Area 3 PA remain valid. A revision to the combined PA/CA document will be developed in FY 2008.

The continuing adequacy of the CAs was evaluated with the new models, and no significant changes that would alter CA results or conclusions were found. Inclusion of the Frenchman Flat Underground Test Area (UGTA) results in the Area 5 RWMS CA is scheduled for FY 2009, pending the completion of the Corrective Action Decision Document (CADD) for the Frenchman Flat UGTA Corrective Action Unit (CAU), scheduled for FY 2008. The revision of the Area 3 RWMS CA, which will include the UGTA source terms, is expected in FY 2021, following the completion of the Yucca Flat CAU CADD, scheduled for FY 2020.

Near-term R&D efforts will focus on continuing development of the Area 3 and Area 5 RWMS GoldSim PA/CA and inventory models. The Area 5 RWMS GoldSim model will be used to optimize the final closure cover thickness for the site. The consequences of potential subsidence of the disposal units that may impact the Area 3 RWMS will be incorporated into the Area 3 RWMS GoldSim model in FY 2008.

1.0 INTRODUCTION

This report summarizes the results of an annual review of conditions affecting the operation of the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) and a determination of the continuing adequacy of the performance assessments (PAs) and composite analyses (CAs). The Area 5 RWMS PA documentation consists of the original PA (Shott et al., 1998), referred to as the 1998 Area 5 RWMS PA and supporting addenda (Bechtel Nevada [BN], 2001b; 2006a). The Area 5 RWMS CA was issued as a single document (BN, 2001a) and has a single addendum (BN, 2001c). The Area 3 PA and CA were issued in a single document (Shott et al., 2000). The Maintenance Plan for the PAs and CAs (National Security Technologies, LLC [NSTec], 2006) and the Disposal Authorization Statements (DASs) for the Area 3 and 5 RWMSs (U.S. Department of Energy [DOE], 2000; 2002) require preparation of an annual summary and a determination of the continuing adequacy of the PAs and CAs. The annual summary report is submitted to DOE Headquarters.

Following the annual report format in the DOE PA/CA Maintenance Guide (DOE, 1999), this report presents the annual summary for the PAs in Section 2.0 and the CAs in Section 3.0. The annual summary for the PAs includes the following:

- Section 2.1 summarizes changes in waste disposal operations.
- Section 2.1.5 provides an evaluation of the new estimates of the closure inventories derived from the actual disposals through fiscal year (FY) 2007.
- Section 2.2 summarizes the results of the monitoring conducted under the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office's (NNSA/NSO's) *Integrated Closure and Monitoring Plan for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada Test Site* (BN, 2005), and the research and development (R&D) activities.
- Section 2.4 is a summary of changes in facility design, operation, or expected future conditions; monitoring and R&D activities; and the maintenance program.
- Section 2.5 discusses the recommended changes in disposal facility design and operations, monitoring and R&D activities, and the maintenance program.

Similarly, the annual summary for the CAs (presented in Section 3.0) includes the following:

- Section 3.1 presents the assessment of the adequacy of the CAs, with a summary of the relevant factors reviewed in FY 2007.
- Section 3.2 presents an assessment of the relevant site activities at the Nevada Test Site (NTS) that would impact the sources of residual radioactive material considered in the CAs.
- Section 3.3 summarizes the monitoring and R&D results that were reviewed in FY 2007.
- Section 3.4 presents a summary of changes in relevant site programs (including monitoring, R&D, and the maintenance program) that occurred since the CAs were prepared.

- Section 3.5 summarizes the recommended changes to these programs.

1.1 Tracking of Minor Issues

Tracking and resolution of all minor or secondary issues identified in the Low-Level Waste Disposal Facility Federal Review Group (LFRG) review reports for the Area 3 and Area 5 RWMS PAs and CAs continued in FY 2007. Table 1 lists the minor issues that are being tracked and resolved through the maintenance program. The resolution pathway for each issue is included in the third column of Table 1.

Table 1. Minor Issues Identified in the LFRG Review Reports for the Area 3 and Area 5 RWMS PAs and CAs

Identified Issue	Source Document for Issue	Resolution Pathway
An engineered barrier will be added, and the assurance requirements of Title 40 Code of Federal Regulations (CFR) Part 191 must be met for the Greater Confinement Disposal (GCD) boreholes.	GCD PA	An engineered barrier will be added, and the assurance requirements will be met at the time of closure of the Area 5 RWMS, as stated in the Integrated Closure and Monitoring Plan (ICMP) (BN, 2005).
Inconsistencies between conceptual models for the Area 5 RWMS PA and CA, the Area 3 RWMS PA and CA, and the GCD PA	Area 5 RWMS PA, Area 5 RWMS CA, Area 3 RWMS PA/CA, GCD PA	The continuous development of probabilistic performance assessment models using the GoldSim software system is eliminating inconsistencies; this work will continue to be described in annual summary reports.
Conduct site monitoring and site characterization studies, as required, to increase confidence in the results of the PAs.	Area 3 RWMS PA/CA	Monitoring programs at both Area 5 and Area 3 RWMSs are ongoing; data are being incorporated into the GoldSim models to increase confidence in the PA results.
The maintenance program must include periodic assessment of changes in potentially interacting sources' (underground test areas [UGTAs], industrial sites) and impacts on the CAs	Area 5 RWMS CA, Area 3 RWMS PA/CA	Changes in potentially interacting sources will be evaluated through the maintenance program, and results will be presented in the annual summary reports.

Table 1. Minor Issues Identified in the LFRG Review Reports for the Area 3 and Area 5 RWMS PAs and CAs (continued)

Identified Issue	Source Document for Issue	Resolution Pathway
The maintenance program must include periodic assessment of changes in land-use restrictions and impacts on the CAs.	Area 5 RWMS CA; Area 3 RWMS PA/CA	Changes in land-use restrictions will be reviewed through the maintenance program, and results will be presented in the annual summary reports.
Monitoring systems need to be deployed and data gathered and evaluated to distinguish between interacting sources at the Area 3 RWMS.	Area 3 RWMS PA/CA	The monitoring systems deployed at the disposal facilities are described in the ICMP (BN, 2005); monitoring results will be evaluated and presented in the annual summary reports.

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2.0 PERFORMANCE ASSESSMENT

2.1 Waste Disposal Operations

The PA maintenance plan requires an annual review of waste operations including evaluation of waste forms, waste containers, facility design, waste acceptance criteria (WAC), closure design, and waste inventory. The assumptions and conceptual models of the PAs are compared with current operations to assess the continuing validity of the PA and compliance with DAS conditions. Changes in waste inventory, facility design, and closure design occurring during FY 2007 are noted and described below. The impacts of these changes are summarized in Section 2.1.5.

2.1.1 Waste Form and Containers

The Area 3 and Area 5 RWMS PAs do not explicitly model the performance of waste forms and containers. Radionuclides are assumed to be fully available for release and transport at closure. These assumptions remain valid for waste disposed through FY 2007.

2.1.2 Facility Design and Operations

The PAs use assumptions about disposal unit volume, area, and depth of burial that may affect performance. Historical information about these parameters for disposed waste remains unchanged.

The Area 3 RWMS was placed in inactive status in July 2006, with the last waste disposed in April 2006. The two post-1988 disposal units, U-3ah/at and U-3bh, are currently operationally closed. No wastes were disposed at the Area 3 RWMS and no new disposal units were opened in FY 2007.

No new disposal cells were opened at the Area 5 RWMS in FY 2007. The ramp into Pit 5 (P05U) was enlarged and deepened for the disposal of four strontium-90 (^{90}Sr) radioisotope thermolelectric generators (RTGs). A separation of greater than 4 meters (m) (13 feet [ft]) was maintained between the RTGs and other low-level waste in P05U.

2.1.3 Waste Receipts

The Area 3 and Area 5 RWMS PAs analyze waste inventories that were estimated as the sum of past disposals and estimated future disposals. The estimate of closure inventory changes over time as estimates or records of past disposals are revised or when forecasts of future waste change. Estimates of past disposals may change as disposal records are reviewed, database records are revised, and assumptions used to revise historical records change. Closure inventory uncertainty, however, is dominated by uncertainty in future disposals. Experience has shown that future inventory estimates will change, perhaps significantly, over time as new generators or new waste streams are approved or wastes are sent to other alternative disposal sites.

2.1.3.1 New or Revised Waste Streams

Each new or revised waste stream is evaluated by the Radiological Waste Acceptance Program for its potential impacts on the PA and conformance with WAC. Part of this evaluation includes a comparison of waste concentrations with the WAC action levels using a sum of fractions calculations. Waste streams with a sum of fractions greater than one or a potential to alter PA assumptions or conceptual models require a special analysis for acceptance. Waste streams exceeding inventory screening criteria are evaluated by adding the inventory to the Area 5 RWMS PA model and determining if all performance objectives can be met. Occasionally, waste streams may present issues other than inventory changes that require a special analysis. If the special analysis shows that all performance objectives can be met, the waste stream is recommended for approval.

In FY 2007, special analyses were performed for five waste streams (Table 2). Three waste streams were evaluated due to their potential to increase site inventory. All were accepted without condition. A single waste stream was evaluated because it included a large number of radionuclides not included in the PA model. It was approved for disposal without conditions after a special analysis demonstrated that the new nuclides would have no significant impact on site performance. The Lawrence Livermore National Laboratory (LLNL) RTGs waste stream, consisting of four Model 25F RTGs, was evaluated for its impact on site inventory and potential heat generation effects. The LLNL RTGs were accepted with conditions placed on the spacing between RTGs and between the RTGs and other low-level waste. The spacing conditions were implemented to control heat generation and eliminate the potential of RTG heat to impact other low-level waste.

Table 2. Waste Streams Evaluated by Special Analysis in FY 2007

Waste Stream	Description	Issue	Result
WVDP000000018, Rev. 1	West Valley Drum Cell Cement Solidified Waste	Technitium-99 (^{99}Tc) Inventory	Accepted
BCLALLNLEXSSS_0, Rev. 0	LLNL Excess Sealed Sources	Inventory	Accepted
BCLADOE25FRTG, Rev. 0	LLNL Model 25F RTGs	^{90}Sr Inventory, Heat Generation	Accepted with Conditions
INEL07MP4080N, Rev. 0	Encapsulated Mixed Waste	18 Radionuclides without WAC Action Limits	Accepted
INEL06004727N, Rev. 2	Research and Development Waste	Thorium-230 (^{230}Th) Inventory	Accepted

2.1.3.2 FY 2007 Closure Inventory Estimate for the Area 3 RWMS

The Area 3 RWMS was placed in inactive status at the end of June 2006. The site may be used in the future for disposal of large volume bulk waste streams, but there are currently no waste streams designated for the Area 3 RWMS. The FY 2007 inventory, which is unchanged from the FY 2006 inventory, includes waste disposed through June 30, 2006, and assumes no future inventory.

The Area 3 RWMS inventory model estimates the inventory of wastes disposed before and after September 26, 1988. Pre-1988 waste was disposed mostly in U-3ax/bl, and a small amount was disposed in U-3ah/at (Table 3). The total pre-1988 inventory consists of approximately 326 terabecquerel (TBq) in 2.3 x 10^5 cubic meters (m^3) (8.1 x 10^6 cubic feet [ft^3]) of waste.

Table 3. FY 2006 Estimate of the Area 3 RWMS Inventory Disposed before September 26, 1988 (Estimates are calculated from 500 Latin hypercube sampling [LHS] realizations and decayed to October 1, 2008)

	U3axbl		U3ahat	
Nuclide	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	3.0E+14	2.95	1.8E+12	2.19
C-14	9.3E+10	3.08	9.3E+07	2.89
Al-26	3.4E+06	3.14	3.4E+03	3.06
Cl-36	2.0E+10	3.13	2.0E+07	2.98
Ar-39	9.6E+10	3.15	1.0E+08	2.85
K-40	5.2E+09	3.03	5.6E+06	2.73
Ca-41	1.4E+11	3.11	1.4E+08	2.88
Co-60	1.1E+11	2.85	*Negligible*	
Ni-59	3.7E+09	3.10	3.7E+06	2.96
Ni-63	3.3E+11	3.15	3.7E+08	2.99
Kr-85	1.7E+11	3.05	3.2E+08	2.76
Sr-90	7.0E+12	3.05	1.0E+10	2.60
Zr-93	4.8E+08	3.02	5.2E+05	2.72
Nb-93m	1.4E+11	3.24	2.1E+08	3.04
Nb-94	1.2E+11	3.13	1.1E+08	3.02
Tc-99	1.2E+10	2.22	1.1E+10	3.87
Pd-107	2.2E+07	3.05	2.3E+04	2.74
Cd-113m	1.3E+11	3.17	2.2E+08	2.98
Sn-121m	1.4E+12	3.09	1.7E+09	3.00
Sn-126	2.1E+08	3.03	2.3E+05	2.74
I-129	1.1E+07	3.05	1.2E+04	2.73
Cs-135	4.1E+08	3.03	4.1E+05	2.74
Cs-137	9.3E+12	3.00	1.2E+10	2.68
Sm-151	5.6E+11	3.04	6.3E+08	2.75

Negligible – No disposal recorded, inventory assumed to be negligible

Table 3. FY 2006 Estimate of the Area 3 RWMS Inventory Disposed Before September 26, 1988 (Estimates are calculated from 500 Latin hypercube sampling [LHS] realizations and decayed to October 1, 2008) (continued)

Nuclide	U3axbl		U3ahat	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
Eu-150	2.4E+11	3.35	3.0E+08	3.37
Eu-152	1.1E+12	3.24	1.7E+09	2.91
Eu-154	3.1E+11	3.18	6.7E+08	3.04
Gd-152	1.3E-01	3.20	1.1E-04	2.91
Ho-166m	4.4E+09	3.16	4.8E+06	2.88
Ra-226	5.6E+11	3.71	1.1E+05	2.15
Ra-228	1.3E+09	2.52	3.7E+05	2.73
Ac-227	4.4E+05	2.07	6.3E+05	2.19
Th-228	8.1E+09	2.79	7.4E+06	2.88
Th-229	8.5E+06	2.99	6.3E+03	2.71
Th-230	2.0E+07	1.84	2.5E+07	2.15
Th-232	1.4E+09	2.53	4.1E+05	2.73
Pa-231	1.6E+06	2.10	2.4E+06	2.19
U-232	6.3E+09	3.14	6.7E+06	2.90
U-233	3.0E+09	3.02	3.2E+06	2.70
U-234	8.9E+10	1.99	1.3E+11	2.15
U-235	3.4E+09	2.14	5.6E+09	2.19
U-236	2.4E+09	2.85	2.6E+09	2.89
U-238	4.4E+10	2.07	1.1E+11	2.46
Np-237	4.8E+08	2.35	2.4E+08	2.33
Pu-238	2.0E+11	3.03	2.0E+10	2.53
Pu-239	1.0E+12	2.99	2.0E+09	2.22
Pu-240	2.8E+11	3.01	5.2E+08	2.16
Pu-241	9.3E+11	3.04	3.3E+09	2.05
Pu-242	1.0E+08	3.02	1.4E+05	2.36
Am-241	3.3E+11	2.98	5.6E+08	2.12
Am-243	4.4E+07	3.00	4.8E+04	2.74
Cm-244	1.6E+10	3.06	2.3E+07	2.75
Total	3.3E+14		2.1E+12	

Negligible – No disposal recorded, inventory assumed to be negligible

The post-1988 waste is disposed in U-3ah/at and U-3bh (Table 4). The post-1988 inventory is estimated to consist of approximately 3.2×10^4 TBq in 3.3×10^5 m^3 (1.2×10^7 ft^3) of waste. On an activity basis, the inventory is predominantly ^3H.

Table 4. FY 2006 Estimate of the Area 3 RWMS Inventory Disposed after September 26, 1988 (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2008)

Nuclide	U3ahat		U3bh	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	1.8E+16	2.05	1.2E+16	2.24
C-14	1.0E+11	1.76	3.0E+07	2
Al-26	7.8E+04	3	*Negligible*	
Cl-36	5.2E+08	2.67	*Negligible*	
Ar-39	2.3E+09	2.86	*Negligible*	
Ar-42	6.3E+08	2.03	3.3E+08	2.68
K-40	2.6E+09	1.89	7.0E+08	2.45
Ca-41	3.3E+09	2.88	*Negligible*	
Ti-44	1.4E+10	2.04	7.0E+09	2.5
Co-60	3.3E+10	1.75	2.0E+10	2.15
Ni-59	9.6E+08	2.24	1.8E+08	2.18
Ni-63	2.3E+11	1.77	8.5E+09	2.12
Se-79	2.1E+07	2.47	*Negligible*	
Kr-85	9.3E+09	2.36	*Negligible*	
Sr-90	4.4E+14	2.58	6.7E+10	2
Zr-93	1.2E+07	2.66	*Negligible*	
Nb-93m	4.8E+09	2.93	*Negligible*	
Nb-94	2.7E+09	2.97	1.7E+08	2.17
Tc-99	2.1E+12	1.89	8.1E+10	2.06
Pd-107	5.2E+05	2.65	*Negligible*	
Cd-113m	5.2E+09	2.85	*Negligible*	
Sn-126	5.2E+08	2.38	8.9E+05	2.68
I-129	4.8E+08	1.93	2.4E+08	2.53
Ba-133	1.4E+10	1.98	4.4E+09	2.58
Cs-135	9.3E+06	2.63	*Negligible*	
Cs-137	2.6E+14	1.81	7.0E+10	1.77
Sm-151	1.4E+10	2.64	1.1E+06	2.64
Eu-150	6.3E+09	3.5	*Negligible*	
Eu-152	8.5E+10	1.93	3.0E+09	2.32
Eu-154	3.0E+10	2.18	6.3E+08	2.15
Gd-152	2.9E-03	2.44	3.7E-05	2.39
Ho-166m	1.1E+08	2.86	*Negligible*	
Bi-207	4.8E+05	2.69	2.1E+07	2.75
Pb-210	8.1E+10	2.18	7.4E+07	1.74

Negligible – No disposal recorded, inventory assumed to be negligible

Table 4. FY 2006 Estimate of Area 3 RWMS Inventory Disposed After September 26, 1988 (continued)

Nuclide	U3ahat		U3bh	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
Ra-226	1.0E+11	2.03	3.7E+08	1.85
Ra-228	8.1E+09	1.56	1.1E+11	2.64
Ac-227	3.6E+09	2.33	8.5E+04	1.96
Th-228	6.7E+10	2.18	6.7E+10	2.63
Th-229	1.4E+07	2.21	1.1E+07	2.51
Th-230	4.4E+10	2.03	7.4E+10	2.65
Th-232	1.3E+10	1.63	2.2E+11	2.65
Pa-231	2.4E+08	2.03	1.1E+06	2.06
U-232	6.7E+10	2.38	*Negligible*	
U-233	1.6E+10	2.11	2.2E+10	2.5
U-234	7.4E+12	1.93	1.3E+11	2
U-235	3.4E+11	1.83	1.1E+10	2.14
U-236	3.6E+11	2.5	1.1E+08	2.63
U-238	1.2E+13	1.65	5.9E+11	2.4
Np-237	2.4E+11	2.03	1.5E+08	1.89
Pu-238	5.9E+11	2.05	1.7E+11	2.53
Pu-239	2.7E+12	1.64	5.2E+11	1.9
Pu-240	5.6E+11	1.69	8.9E+10	1.96
Pu-241	3.0E+12	1.69	3.7E+11	1.93
Pu-242	1.1E+08	1.66	4.1E+07	2.19
Pu-244	7.0E-01	2.71	2.5E-06	2.64
Am-241	4.4E+11	1.65	8.1E+10	1.81
Am-242m	2.4E+08	2.18	3.7E+06	2.63
Am-243	5.6E+08	1.89	4.8E+07	2.7
Cm-243	4.8E+06	1.9	1.4E+06	2.67
Cm-244	1.5E+10	1.72	2.2E+08	2.17
Cm-245	5.2E+08	2.12	8.5E+06	2.76
Cm-246	8.5E+07	2.21	*Negligible*	
Cm-247	6.7E+05	2.6	*Negligible*	
Cm-248	5.9E-12	2.83	*Negligible*	
Cf-249	3.5E+03	2.2	*Negligible*	
Cf-250	2.7E+03	2.58	*Negligible*	
Cf-251	1.7E+08	2.56	*Negligible*	
Total	1.9E+16		1.2E+16	

Negligible – No disposal recorded, inventory assumed to be negligible

The volume of waste disposed at the Area 3 RWMS is divided approximately equally between the pre- and post-1988 period (Figure 1). The total activity has been disposed predominately in the post-1988 period since 2000 (Figure 2).

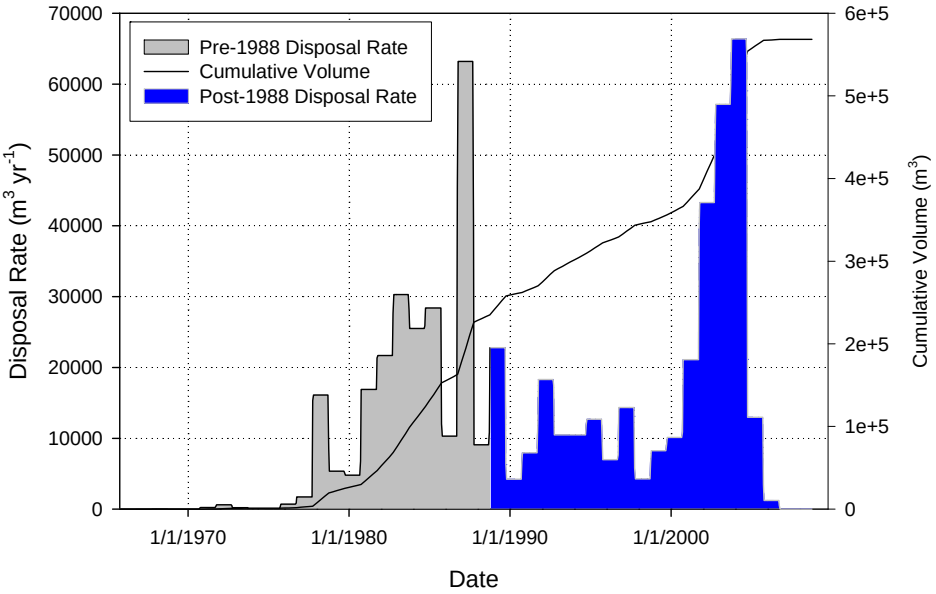

Figure 1. Volume Disposed per Year and the Arithmetic Mean of Cumulative Volume for the Area 3 RWMS

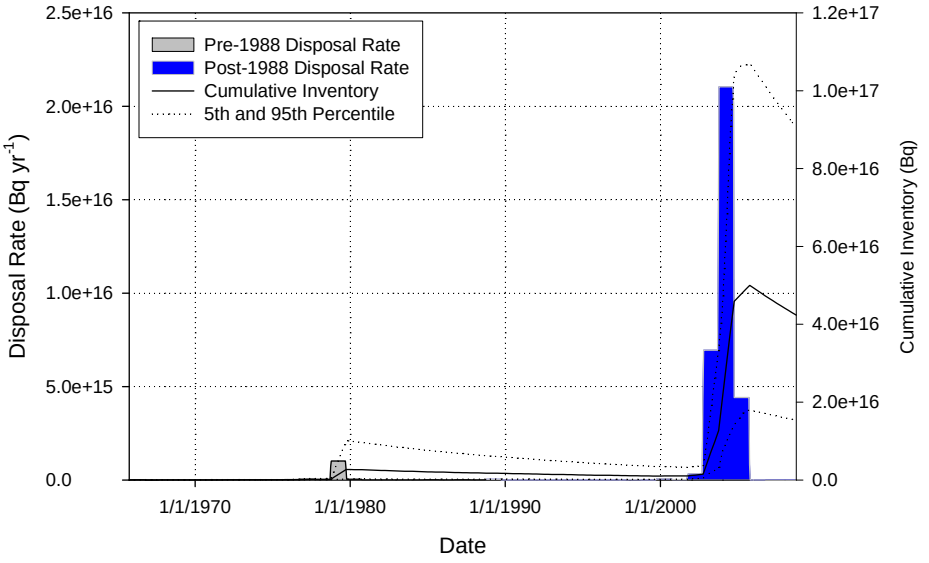

Figure 2. Activity Annual Disposal and Inventory for the Area 3 RWMS

2.1.3.3 FY 2007 Closure Inventory Estimate for the Area 5 RWMS

The Area 5 RWMS PA GoldSim model divides the site inventory into three virtual disposal units based on the depth of burial. Most wastes are disposed in the shallow land burial (SLB) disposal unit below a 4-m (13-ft) cover. Wastes capable of producing significant radon-222 (^{222}Rn) flux densities are disposed below thicker covers in two radium disposal units (RaDUs), the lower cell of Pit 6 (P06U) and Pit 13 (P013U). High-specific-activities wastes have been disposed in Greater Confinement Disposal (GCD) boreholes. The inventory of the three virtual disposal units is further divided into pre-1988, post-1988 disposed, and future portions.

The FY 2007 estimate of the Area 5 RWMS closure inventory was prepared using the Area 5 Inventory v2.022 GoldSim model. The model sums past disposals, revisions, and future inventory estimates probabilistically. Stochastic distributions representing uncertainty in annual activity disposed are sampled each FY during operations. Radioactive decay and ingrowth during the operational period are explicitly included in the model. The estimated inventories are decayed until the assumed date of closure on September 30, 2028.

The SLB inventory is divided into pre-1988, post-1988, and future inventories (Table 5). Closure of the Area 3 RWMS has increased the Area 5 RWMS future SLB inventory and reduced the uncertainty in the future inventory. Previously, the division of future waste between the Area 3 and Area 5 RWMSs was a source of future inventory uncertainty.

Eleven new long-lived radionuclides were disposed in FY 2007. All of these radionuclides have extremely long half-lives and are listed as stable by some nuclear physics databases. Only radionuclides having published dose conversion factors were included in the performance assessment models. Eight radionuclides (^{98}Tc, indium-115 [^{115}In], tellurium-123 [^{123}Te], lanthanum-138 [^{138}La], neodymium-144 [^{144}Nd], samarium-146 [^{146}Sm], ^{147}Sm, and ^{148}Sm) met this criterion. Through FY 2007, these radionuclides have been disposed in insignificant trace quantities. The new radionuclides are tracked in the A5 RWMS Inventory model, but are not implemented in the PA model.

Table 5. FY 2007 Estimate of the Area 5 RWMS SLB Inventory (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2028)

	Pre-1988 SLB		Post-1988 SLB		Future SLB	
Nuclide	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	3.0E+16	1.58	3.2E+16	1.57	3.7E+16	1.89
C-14	2.5E+11	1.59	7.4E+11	1.93	2.0E+11	2.45
Al-26	8.0E+06	1.66	3.7E+04	2.38	*Negligible*	
Cl-36	4.5E+10	1.66	2.2E+08	2.16	5.5E+06	2.77
Ar-39	2.0E+11	1.67	9.8E+08	2.25	0.0E+00	1.01
K-40	1.2E+10	1.60	1.3E+10	1.62	4.2E+09	1.98
Ca-41	3.2E+11	1.66	1.5E+09	2.25	1.2E+05	217

Table 5. FY 2007 Estimate of the Area 5 RWMS SLB Inventory (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2028) (continued)

Nuclide	Pre-1988 SLB		Post-1988 SLB		Future SLB	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
Co-60	2.1E+12	2.22	1.9E+14	2.02	1.3E+14	2.45
Ni-59	8.5E+09	1.64	8.8E+11	1.94	2.4E+11	2.71
Ni-63	6.4E+11	1.66	6.6E+13	2.00	1.6E+13	2.62
Se-79	*Negligible*		2.6E+12	2.19	2.2E+10	1867
Kr-85	4.4E+11	2.25	4.8E+09	1.76	1.4E+09	2.44
Sr-90	1.6E+15	3.55	1.9E+15	2.17	6.3E+14	3.22
Zr-93	1.1E+09	1.61	5.1E+07	1.90	3.6E+06	16.0
Nb-93m	1.1E+11	1.66	1.0E+09	2.26	5.4E+06	4.30
Nb-94	2.7E+11	1.68	1.9E+11	2.17	6.2E+10	3.48
Tc-99	1.1E+13	2.29	3.0E+14	1.93	6.1E+13	2.31
Pd-107	4.9E+07	1.60	5.8E+05	1.75	3.1E+04	10.4
Ag-108m	0.0E+00	1.01	6.6E+06	1.96	1.4E+06	2.39
Cd-113m	8.9E+10	1.66	9.0E+08	2.28	1.8E+06	33.9
Sn-121m	2.4E+12	1.66	1.4E+10	2.22	7.6E+04	11.9
Sn-126	4.7E+08	1.60	2.7E+10	2.17	1.2E+09	51.9
I-129	3.5E+07	1.60	2.0E+09	1.61	4.3E+08	2.02
Ba-133	1.7E+08	2.64	1.2E+09	1.93	2.8E+09	2.93
Cs-135	8.6E+08	1.60	2.3E+07	1.86	1.5E+06	14.3
Cs-137	3.6E+15	2.95	7.2E+14	2.28	1.9E+14	2.67
Pm-145	*Negligible*		8.0E+04	2.15	1.6E+04	47.0
Pm-146	*Negligible*		1.1E+05	1.79	5.1E+04	4.19
Sm-146	*Negligible*		4.8E-02	1.64	4.4E-03	7.72
Sm-151	1.0E+12	1.60	1.4E+10	1.75	2.0E+09	2.55
Eu-150	3.6E+11	1.74	2.1E+09	2.59	*Negligible*	
Eu-152	2.5E+12	2.10	4.8E+13	1.96	1.5E+13	2.61
Eu-154	2.9E+11	1.92	3.6E+13	1.97	1.3E+13	2.37
Gd-148	*Negligible*		1.5E+04	1.73	4.8E+03	2.95
Gd-152	1.5E+00	2.17	3.8E+00	1.96	4.8E-01	3.36
Ho-166m	1.1E+10	1.65	5.0E+07	2.27	*Negligible*	
Bi-207	5.7E+05	2.92	1.2E+07	1.98	2.5E+06	2.61
Pb-210	1.1E+12	2.51	4.8E+10	1.51	2.9E+10	1.74
Ra-226	1.4E+12	2.52	6.3E+10	1.55	3.9E+10	1.84
Ra-228	4.5E+10	2.00	5.4E+11	1.51	2.7E+11	1.91
Ac-227	1.1E+10	1.59	3.4E+09	1.37	8.7E+08	1.48
Th-228	5.9E+10	1.74	7.3E+11	1.44	3.0E+11	1.76
Th-229	1.6E+08	1.82	1.1E+09	1.71	1.7E+08	1.79
Th-230	4.0E+10	1.51	2.4E+11	1.69	1.8E+11	2.19
Th-232	4.5E+10	2.00	5.6E+11	1.51	3.3E+11	1.91
Pa-231	7.1E+09	1.51	5.0E+09	1.42	1.1E+09	1.48
U-232	1.1E+10	1.64	1.6E+11	1.87	3.5E+10	2.00

Table 5. FY 2007 Estimate of the Area 5 RWMS SLB Inventory (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2028) (continued)

Nuclide	Pre-1988 SLB		Post-1988 SLB		Future SLB	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
U-233	3.4E+10	1.89	3.7E+11	1.82	8.9E+10	1.93
U-234	8.1E+13	1.66	8.4E+13	1.42	2.5E+13	1.51
U-235	3.3E+12	1.68	3.7E+12	1.38	1.3E+12	1.36
U-236	1.2E+12	2.51	2.5E+12	1.52	4.9E+11	1.89
U-238	8.8E+13	1.86	1.4E+14	1.42	5.7E+13	1.46
Np-237	2.1E+11	1.69	1.1E+11	1.66	2.5E+10	2.28
Pu-238	6.1E+12	1.61	5.5E+12	1.57	2.0E+12	1.74
Pu-239	1.3E+13	1.64	1.0E+13	1.61	3.0E+12	1.80
Pu-240	2.9E+12	1.58	4.5E+12	1.78	1.3E+12	2.25
Pu-241	3.4E+12	1.62	2.6E+13	1.98	1.2E+13	2.28
Pu-242	6.4E+08	1.50	4.7E+11	2.20	2.1E+11	3.36
Pu-244	4.9E+09	3.76	4.6E+04	2.13	2.3E+03	19.4
Am-241	3.9E+12	1.50	6.4E+12	1.66	1.8E+12	1.94
Am-242m	*Negligible*		1.5E+09	1.76	3.6E+08	2.19
Am-243	4.3E+08	2.15	2.9E+10	2.22	8.4E+09	3.11
Cm-243	5.6E+09	2.14	3.0E+08	1.85	9.6E+07	2.56
Cm-244	7.4E+10	2.78	4.4E+11	1.91	1.3E+11	2.06
Cm-245	1.4E+05	2.73	3.7E+11	2.06	1.1E+11	3.41
Cm-246	8.3E+04	2.50	6.5E+10	2.21	2.0E+10	2.96
Cm-247	*Negligible*		1.1E+03	2.01	8.2E+01	16.1
Cm-248	8.1E+04	2.59	2.7E+05	2.22	1.9E+04	11.9
Cf-249	*Negligible*		4.8E+07	1.94	1.2E+07	2.42
Cf-250	2.6E+05	2.14	1.2E+05	2.23	6.6E+03	27.4
Cf-251	*Negligible*		7.4E+07	2.06	5.9E+06	16.1
Total	3.6E+16		3.6E+16		3.8E+16	

Negligible – No disposals recorded, inventory assumed to be negligible

The arithmetic mean SLB volume estimate has increased slightly from 6.3×10^5 to 6.4×10^5 m^3 (2.2×10^7 to 2.3×10^7 ft^3) between FY 2006 and FY 2007 (Figure 3). The arithmetic mean post-1988 SLB volume has increased slightly from 4.6×10^5 to 4.7×10^5 m^3 (1.6×10^7 to 1.7×10^7 ft^3).

The FY 2007 geometric mean closure inventory estimate remains unchanged at 1.2×10^5 TBq (Figure 4). The geometric mean post-1988 closure inventory estimate has increased from 7.8×10^4 to 8.1×10^4 TBq. The FY 2007 SLB inventory shows notable increases in the inventory of carbon-14 (^{14}C), ^{90}Sr, and ^{99}Tc.

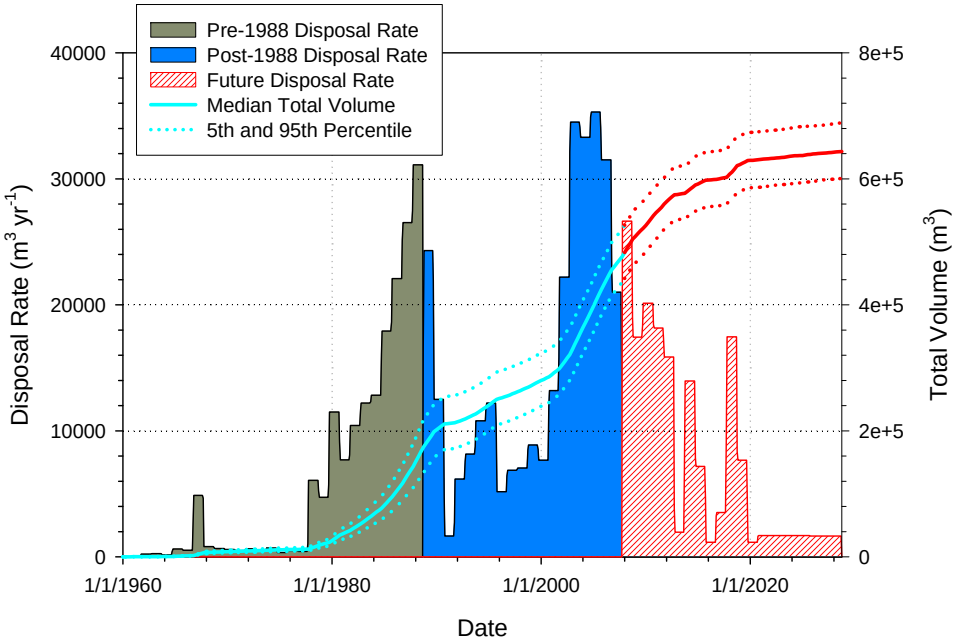

Figure 3. Volume Disposed per Year and Median of Cumulative Volume for the Area 5 RWMS Shallow Land Burial Disposal Units

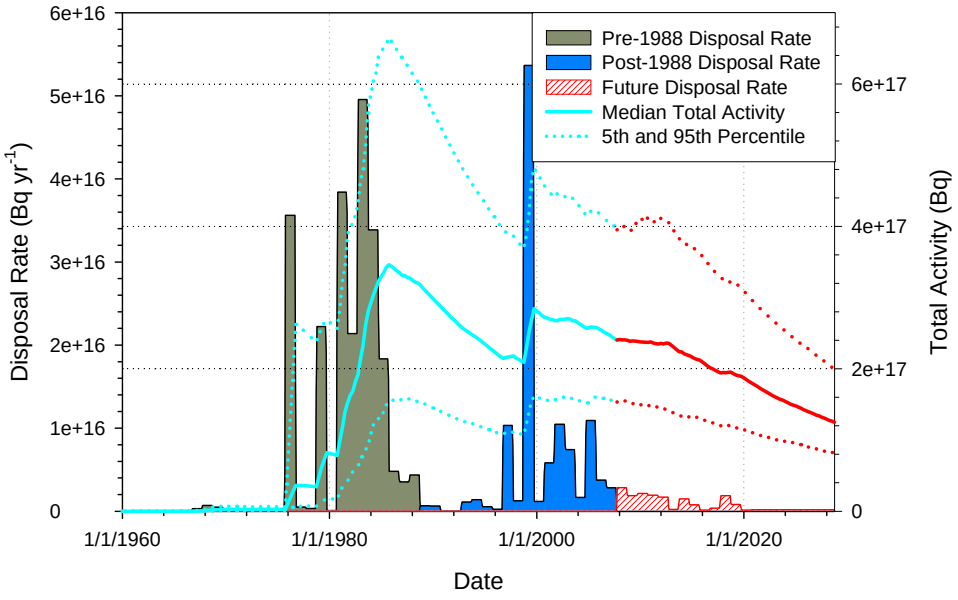

Figure 4. Activity Annual Disposal Rate and Median Inventory for the Area 5 RWMS Shallow Land Burial Disposal Units

RaDU Inventory

The lower cell of Pit 6 (P06U) and Pit 13 (P013U) were excavated to greater depth to contain thorium wastes that have the potential to generate ^{222}Rn in the future as radium-226 (^{226}Ra) is produced by the decay of ^{230}Th. The inventory of both disposal units is predominately thorium-232 (^{232}Th). The lower cell of Pit 6 was operational from FY 1992 until FY 2002. The Pit 6 inventory remains unchanged from previous years. Pit 13 began operations in FY 2004 with disposal of the Defense National Stockpile Center thorium nitrate waste stream. The entire thorium nitrate waste stream was disposed in FY 2004 and 2005. Pit 13 remains open for disposal of additional radium-bearing waste streams and other low-level wastes. The inventory of wastes disposed in Pit 6 and Pit 13 through FY 2007 are summarized in Table 6.

Table 6. FY 2007 Estimate of the Area 5 RWMS RaDU Inventory Disposed (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2028)

	P06U		P013U	
Nuclide	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	*Negligible*		1.6E+12	2.12
C-14	*Negligible*		1.9E+09	2.15
Co-60	*Negligible*		1.1E+09	2.15
Ni-63	*Negligible*		1.3E+10	2.27
Sr-90	1.8E+07	2.64	2.5E+10	1.85
Tc-99	1.1E+09	2.74	2.5E+10	1.83
Sn-126	*Negligible*		1.5E+07	2.22
Cs-137	*Negligible*		3.1E+11	2.22
Eu-152	*Negligible*		7.3E+10	2.26
Eu-154	*Negligible*		1.6E+07	2.19
Gd-152	*Negligible*		5.0E-03	2.26
Pb-210	6.9E+09	1.67	7.3E+10	1.53
Ra-226	2.0E+10	1.68	1.5E+11	1.52
Ra-228	6.0E+12	1.57	5.5E+12	1.05
Ac-227	2.4E+06	1.89	9.0E+08	2.05
Th-228	5.9E+12	1.57	5.4E+12	1.05
Th-229	5.1E+09	2.21	3.2E+02	1.75
Th-230	1.5E+12	1.69	2.0E+12	2.16
Th-232	6.1E+12	1.58	5.9E+12	1.05
Pa-231	6.4E+06	1.89	1.8E+09	2.02
U-232	*Negligible*		1.9E+08	2.25
U-233	1.9E+12	2.21	3.0E+05	1.74

Negligible – No disposal recorded, inventory assumed to be negligible

Table 6
FY 2007 Estimate of the Area 5 RWMS RaDU inventory disposed
(Estimates are calculated from 500 LHS realizations and decayed to October 1, 2028.)
(continued)

	P06U		P013U	
Nuclide	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
U-234	1.8E+11	1.88	8.9E+11	2.15
U-235	9.4E+09	1.89	1.3E+11	2.09
U-236	1.9E+08	2.09	9.4E+09	2.13
U-238	2.1E+11	1.85	5.0E+12	2.18
Np-237	7.9E+05	2.74	3.0E+09	1.74
Pu-238	1.3E+10	1.91	1.3E+09	1.85
Pu-239	3.3E+06	2.23	1.1E+10	1.84
Pu-240	*Negligible*		9.0E+08	1.95
Pu-241	1.1E+10	2.19	1.2E+10	1.79
Pu-242	*Negligible*		4.9E+06	2.13
Am-241	1.0E+09	2.19	5.9E+09	1.93
Am-243	*Negligible*		2.9E+07	2.11
Cm-243	*Negligible*		4.2E+06	2.30
Cm-244	*Negligible*		3.3E+10	2.23
Cm-245	*Negligible*		9.3E+06	2.20
Cm-246	*Negligible*		1.6E+06	2.25
Total	2.2E+13		2.7E+13	

Negligible – No disposal recorded, inventory assumed to be negligible

GCD Inventories

The GCD boreholes have received high specific activity wastes, including TRU waste regulated under Title 40 Code of Federal Regulations (CFR) Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Waste" (CFR, 1994). The GCD boreholes were active from FY 1984 through FY 1991. The PA divides the GCD inventory into pre- and post-1988 portions. The majority of the waste on an activity and volume basis was disposed in the pre-1988 period. The GCD inventories are unchanged from previous years (Table 7).

Table 7. FY 2007 Estimate of the Area 5 RWMS GCD Borehole Inventory (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2028)

Nuclide	Pre-1988 GCD		Post-1988 GCD	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	2.0E+16	2.04	1.9E+14	2.25
C-14	7.0E+04	2.56	*Negligible*	
Al-26	2.6E+00	2.64	*Negligible*	
Cl-36	1.5E+04	2.58	*Negligible*	
Ar-39	7.0E+04	2.58	*Negligible*	
K-40	3.9E+03	2.45	*Negligible*	
Ca-41	1.1E+05	2.56	*Negligible*	
Co-60	8.6E+11	2.20	*Negligible*	
Ni-59	2.7E+03	2.53	*Negligible*	
Ni-63	2.3E+05	2.60	*Negligible*	
Kr-85	6.1E+04	2.46	*Negligible*	
Sr-90	4.8E+15	3.75	1.1E+08	3.83
Zr-93	3.7E+02	2.46	*Negligible*	
Nb-93m	6.3E+04	2.57	*Negligible*	
Nb-94	8.6E+04	2.59	*Negligible*	
Tc-99	7.4E+09	3.06	6.8E+09	3.75
Pd-107	1.6E+01	2.46	*Negligible*	
Cd-113m	5.7E+04	2.63	*Negligible*	
Sn-121m	9.9E+05	2.58	*Negligible*	
Sn-126	1.6E+02	2.46	*Negligible*	
I-129	8.5E+00	2.46	*Negligible*	
Cs-135	2.9E+02	2.45	*Negligible*	
Cs-137	2.6E+14	3.51	*Negligible*	
Sm-151	3.7E+05	2.46	*Negligible*	
Eu-150	1.5E+05	2.92	*Negligible*	
Eu-152	4.4E+05	2.52	*Negligible*	
Eu-154	9.1E+04	2.52	*Negligible*	
Gd-152	1.1E-07	2.51	*Negligible*	
Ho-166m	3.5E+03	2.65	*Negligible*	
Pb-210	2.3E+12	3.68	4.1E+04	2.20
Ra-226	3.1E+12	3.68	1.3E+05	2.20
Ra-228	1.0E+09	2.85	3.4E-08	3.66
Ac-227	7.2E+10	3.75	5.8E+05	2.27

Negligible – No disposal recorded, inventory assumed to be negligible

Table 7. FY 2007 Estimate of the Area 5 RWMS GCD Borehole Inventory (continued)

Nuclide	Pre-1988 GCD		Post-1988 GCD	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
Th-228	1.0E+09	2.85	2.9E-08	3.65
Th-229	7.9E+01	1.69	5.1E+01	2.16
Th-230	5.3E+07	2.85	1.6E+07	2.20
Th-232	1.0E+09	2.85	5.0E-08	3.66
Pa-231	4.5E+06	2.81	1.4E+06	2.27
U-232	4.2E+03	2.55	*Negligible*	
U-233	3.8E+04	1.70	2.7E+04	2.16
U-234	1.3E+11	2.83	4.3E+10	2.20
U-235	4.9E+09	2.79	1.6E+09	2.28
U-236	3.4E+08	3.60	5.2E+01	3.66
U-238	3.7E+10	2.31	7.8E+10	2.16
Np-237	2.3E+08	1.73	1.6E+08	2.16
Pu-238	3.0E+11	2.75	3.7E+06	3.69
Pu-239	1.5E+13	2.81	2.1E+08	3.69
Pu-240	3.7E+12	2.74	4.4E+07	3.66
Pu-241	4.2E+12	3.01	6.1E+07	3.91
Pu-242	3.6E+08	2.75	*Negligible*	
Am-241	5.9E+12	2.13	3.9E+07	3.69
Am-243	3.4E+01	2.47	*Negligible*	
Cm-244	7.5E+03	2.48	*Negligible*	
Total	2.5E+16		1.9E+14	

Negligible – No disposal recorded, inventory assumed to be negligible

2.1.4 Closure

The Area 3 RWMS PA/CA assumes that the disposal units will be closed with a vegetated monolayer evapotranspiration (ET) cover of native alluvium. The cover is assumed to be 3 m (10 ft) thick after subsidence. This was a conservative assumption consistent with closure plans for U-3ax/bl.

A new closure plan was issued for the Area 3 RWMS in FY 2007 (NSTec, 2007a). Important updates in the plan are a new closure date (FY 2025), a new closure inventory, new institutional control policy, and a Title II engineering cover design. The closure inventory is the same inventory summarized in this document. The cover design is for a 3-m (10-ft) monolayer ET cover, consistent with the Area 3 RWMS PA/CA. The new institutional control policy assumes implementation of land-use restrictions consistent with the Underground Test Area (UGTA)/*Federal Facility Agreement and Consent Order* (FFACO) closure strategies for the NTS (NNSA/NSO, 2007a). The planned land-use restrictions will prohibit public use of groundwater for 1,000 years within boundaries negotiated with the state of Nevada. Although these boundaries have not been negotiated, it is very likely that the Area 3 RWMS will be within

the boundaries of the Yucca Flat CAU. The land-use restrictions are assumed to eliminate the possibility of long-term (i.e., chronic) intrusion. The PA models will be modified to include acute intrusion scenarios, and the chronic intrusion scenarios will be removed.

The 1998 Area 5 RWMS PA assumes that the site will be closed with a 2.4-m (8-ft) vegetated monolayer ET cover. This was a conservative assumption consistent with the operational covers that were installed when the PA was prepared. After 100 years of active institutional control, the integrity of the cover is assumed to degrade by erosion and subsidence. The 2006 Area 5 RWMS PA update and the A5 RWMS v4.004 GoldSim model assume that a 4-m- (13-ft)-thick closure cover, consistent with the Area 5 RWMS DAS requirements, will be installed.

A closure strategy was issued for the 92-acre Low-Level Waste Management Unit in the southeast corner of the Area 5 RWMS in FY 2007 (NSTec, 2007b). The closure strategy remains consistent with the Area 5 RWMS PA and CA.

Important developments in closure planning occurred in FY 2007. The PA and CA assumptions continue to be consistent with or more conservative than closure plans. The current closure plan is to use a monolayer ET closure cover at the Area 3 and Area 5 RWMS. Final closure cover thickness will be based on future optimizations studies. The Area 5 RWMS closure cover thickness optimization is planned for FY 2008.

2.1.5 Updated PA Results for FY 2007

Revised PA models and inventories were issued for the Area 5 RWMS in FY 2007. The new models and inventories were used to update the Area 5 RWMS PA results. The Area 3 RWMS was in standby mode during FY 2007. The Area 3 RWMS inventory and PA model was not modified in FY 2007.

2.1.5.1 PA Results for the Area 3 RWMS

The Area 3 RMWS PA results have not been updated in FY 2007. The FY 2006 results are still considered valid because no changes have occurred for the inventory and PA model (NSTec, 2007c).

2.1.5.2 PA Results for the Area 5 RWMS

The FY 2007 Area 5 RWMS inventory was analyzed using the Area 5 RWMS v4.004 GoldSim model to assess the continuing validity of PA conclusions. The geometric mean inventory and standard deviation data listed in Tables 3 through 7 were entered into the inventory elements for the SLB units, Pit 6, Pit 13, and GCD, respectively. The disposal unit area, disposal unit volume, and waste volumes were updated with FY 2007 data. All SLB disposal units were assumed to be closed with a 4-m- (13-ft)-thick cover. The model was run assuming an approximately 250-year median period of active institutional control, 100-year period of passive institutional control, and a 1,000-year compliance period. The model was run in GoldSim version 9.6 with 5,000 LHS realizations.

The results for the FY 2007 inventory indicate that there is reasonable expectation of compliance with the member of public performance objectives (Table 8). The mean and 95th percentile for the atmospheric pathway for all scenarios is less than the 0.1 millisieverts per year (mSv yr^{-1}) limit. The mean and 95th percentile for the all-pathways scenarios are less than the 0.25 mSv yr^{-1} performance objective. Most member of public results show a slight decrease from FY 2006.

Table 8. Area 5 RWMS v4.004 GoldSim Model PA Results for the Member of Public

Pathway/Scenario	Limit (mSv yr^{-1})	Mean (mSv yr^{-1})	95th Percentile (mSv yr^{-1})	Time of Maximum (yr)
Air Pathway/Transient Visitor	0.1	3.3e-6	NA	100
Air Pathway/Resident	0.1	2.7E-6	6.2E-6	1000
Air Pathway/Resident Farmer	0.1	3.7E-6	8.5E-6	1000
Air Pathway/Open Rangeland (Cane Spring)	0.1	1.8E-9	NA	100
Air Pathway/Open Rangeland (NTS Boundary)	0.1	2.4E-8	NA	100
All Pathways/Transient Visitor	0.25	0.0011	0.0025	1000
All Pathways/Resident	0.25	4.6E-5	1.1E-4	1000
All Pathways/Resident Farmer	0.25	0.0023	0.0066	1000
All Pathways/Open Rangeland (Cane Spring)	0.25	9.2E-4	NA	100
All Pathways/Open Rangeland (NTS Boundary)	0.25	0.0038	NA	100

NA – not available; insufficient non-zero realizations

The mean and 95th percentile ^{222}Rn flux density is less than the 0.74 becquerel per square meter per second (Bq m^{-2} s^{-1}) performance objective averaged over the entire site (Table 9). The same is true for all virtual disposal units, except for Pit 13, where the 95th percentile ^{222}Rn flux density exceeds the performance objective.

Table 9. Area 5 RWMS v4.004 GoldSim Model PA ^{222}Rn Flux Density Results

Virtual Disposal Unit	Limit (Bq m^{-2} s^{-1})	Mean (Bq m^{-2} s^{-1})	95th Percentile (Bq m^{-2} s^{-1})	Time of Maximum (yr)
All	0.74	0.041	0.083	1000
SLB	0.74	0.024	0.050	1000
Pit 6	0.74	0.041	0.096	1000
Pit 13	0.74	0.47	1.4	1000
GCD	0.74	3.4E-9	9.0E-4	1000

The mean of the probability weighted intruder total effective dose equivalent is less than the 1 mSv performance objective for the postdrilling and intruder-agriculture scenario (Table 10). The 95th percentile of all scenarios is less than the performance objective. The FY 2007 intruder results show significant increases over the FY 2006 results, mostly due to the increase in the ^{99}Tc inventory.

The FY 2007 PA results are similar to the FY 2006 results, except for the intruder results and the ^{222}Rn flux density for Pit 13, which show increases. Even in the cases where increases were observed, a reasonable expectation of compliance with all the performance objectives remains. Therefore, the Area 5 RWMS PA results are still considered valid and no need to revise the PA is identified.

Table 10. Area 5 RWMS v4.004 GoldSim Model PA Results for Intruders

Disposal Unit/Scenario	Limit (mSv)	Mean (mSv)	95th Percentile (mSv)	Time of Maximum (yr)
SLB/Postdrilling	1	0.033	0.015	950
Pit 6/Postdrilling	1	0.0044	0.0022	1000
Pit 13/Postdrilling	1	0.0011	0.0023	1000
GCD/Postdrilling	1	3.0E-7	9.2E-7	1000
SLB/Intruder-Agriculture	1	0.047	0.17	1000
Pit 6/Intruder-Agriculture	1	0.0016	0.0055	1000
Pit 13/Intruder-Agriculture	1	4.6E-4	1.7E-3	1000
GCD/Intruder-Agriculture	1	1.2E-10	NA	100

NA – not available; insufficient non-zero realizations

2.2 Monitoring and Research and Development Results

2.2.1 Monitoring

Monitoring activities at the Area 3 and 5 RWMSs and at the NTS provide the data necessary to support PA and CA maintenance. The *Nevada Test Site Routine Radiological Environmental Monitoring Plan* (BN, 2003) is the basis for all NTS-wide environmental surveillance, site-specific effluent monitoring, and operational monitoring conducted by various missions, programs, and projects on the NTS. The Integrated Closure and Monitoring Plan (ICMP) (BN, 2005) describes the specific monitoring programs for the waste disposal facilities at the NTS. The program for the RWMSs includes the following monitoring elements:

- Vadose Zone Monitoring
- Groundwater Detection Monitoring (Area 5 RWMS only)
- Radon Monitoring
- Meteorology Monitoring
- Direct Radiation Monitoring
- Biota Monitoring
- Subsidence Monitoring
- Air Monitoring
- Soil Temperature Monitoring around RTGs

The following four reports, published annually, contain details regarding the monitoring program and results:

- *Nevada Test Site Environmental Report* (NSTec, 2007d)
- *National Emissions Standard for Hazardous Air Pollutants Report* (NSTec, 2007e)
- *Annual Waste Management Monitoring Report* (NSTec, 2007f)
- *Annual Area 5 Groundwater Monitoring Report* (NSTec, 2007g)

Monitoring activities are summarized in Table 11.

Table 11. Summary of Area 3 and Area 5 RWMS Monitoring Programs

Monitoring Element	Area 3 RWMS	Area 5 RWMS
Vadose Zone Monitoring	• Measurements of soil water content in waste disposal unit cover • 8 drainage lysimeters for water balance since 2001	• Measurements of soil water content and water potential in waste disposal unit covers • Measurements of soil water content in waste disposal unit floor • Two weighing lysimeters (vegetated and bare) for water balance since 1994
Groundwater Monitoring	• None	• Resource Conservation and Recovery Act detection monitoring at three wells
Radon Monitoring	• Radon flux measurements from waste covers (various locations)	• Radon flux measurements from waste covers (various locations)
Meteorology Monitoring	• Air temperature at 3 and 10 m (10 and 33 ft) • Relative humidity at two heights • Wind speed at two heights • Wind direction at two heights • Barometric pressure • Solar radiation • Precipitation	• Air temperature at two heights • Relative humidity at two heights • Wind speed at two heights • Wind direction at two heights • Barometric pressure • Solar radiation • Precipitation
Direct Radiation Monitoring	• Nine thermoluminescent dosimeters (TLDs)	• Ten TLDs
Biota Monitoring	• Sampling vegetation for tritium	• Sampling vegetation for tritium
Subsidence Monitoring	• Routine inspection of operational covers	• Routine inspection of operational covers

Table 11. Summary of Area 3 and Area 5 RWMS Monitoring Programs (continued)

Monitoring Element	Area 3 RWMS	Area 5 RWMS
Air Monitoring	• Air particulates sampled at four locations; atmospheric moisture sampling for tritium at two locations	• Air particulates sampled at two locations; atmospheric moisture sampling for tritium at two locations
Soil Temperature Monitoring around RTGs	• None	• Vertical and horizontal sensor arrays

2.2.1.1 Vadose Zone Monitoring

Vadose zone monitoring is conducted at the Area 3 and Area 5 RWMSs to confirm the key assumption of no downward pathway, to detect changes in system performance, to assess and update parameters for the PA models, and to establish baseline data for long-term monitoring. Vadose zone monitoring data continue to confirm the conceptual models used in the Areas 3 and 5 PA/CAs. Calendar year 2006 was drier than average with annual precipitation totals for Areas 3 and 5 that were approximately 53 to 65 percent of their long-term averages, respectively.

Two locations in Area 3 are instrumented with vadose zone monitoring sensors: (1) the closure cover of U-3ax/bl, and (2) a drainage lysimeter facility (Figure 5). U-3ax/bl is instrumented with time-domain reflectometers (TDRs) for volumetric water content measurements. Sensors are located approximately every 0.3 meters (m) (1 ft) to a depth of 2.44 m (8 ft) at four locations within the cover. Readings from these sensors were fit to a statistical distribution. This distribution is included in the Area 3 RWMS PA v2.0 model to describe the near-surface volumetric water content. Due to the drier than average conditions, the U-3ax/bl TDR data from 2006 indicate soil water contents were at baseline values (~10 percent) for the majority of the year with only one wetting front penetrating more than 0.3 m (1 ft).

The Area 3 drainage lysimeters are instrumented with TDR and heat dissipation sensors to measure matric potential. This facility is used to conduct ET cover research. Currently, research is being conducted to assess the performance of ET covers under enhanced precipitation by applying irrigation to one half of the paired lysimeters to achieve a three times natural precipitation treatment.

Three operational covers and two weighing lysimeters are instrumented in Area 5 (Figures 6 and 7). The ten-year vegetated lysimeter data set was used to calibrate a vadose zone flow model. Model simulations are consistent with the conceptual model that there is no downward pathway under vegetated conditions (Desotell et al., 2006). Vegetated weighing lysimeter data were also fit to a statistical distribution and used to describe the near surface water content in the Area 5 RWMS v4.004 PA model. Calendar year 2006 weighing lysimeter data show shallow wetting fronts under vegetated conditions, similar to those observed in the U-3ax/bl cover.

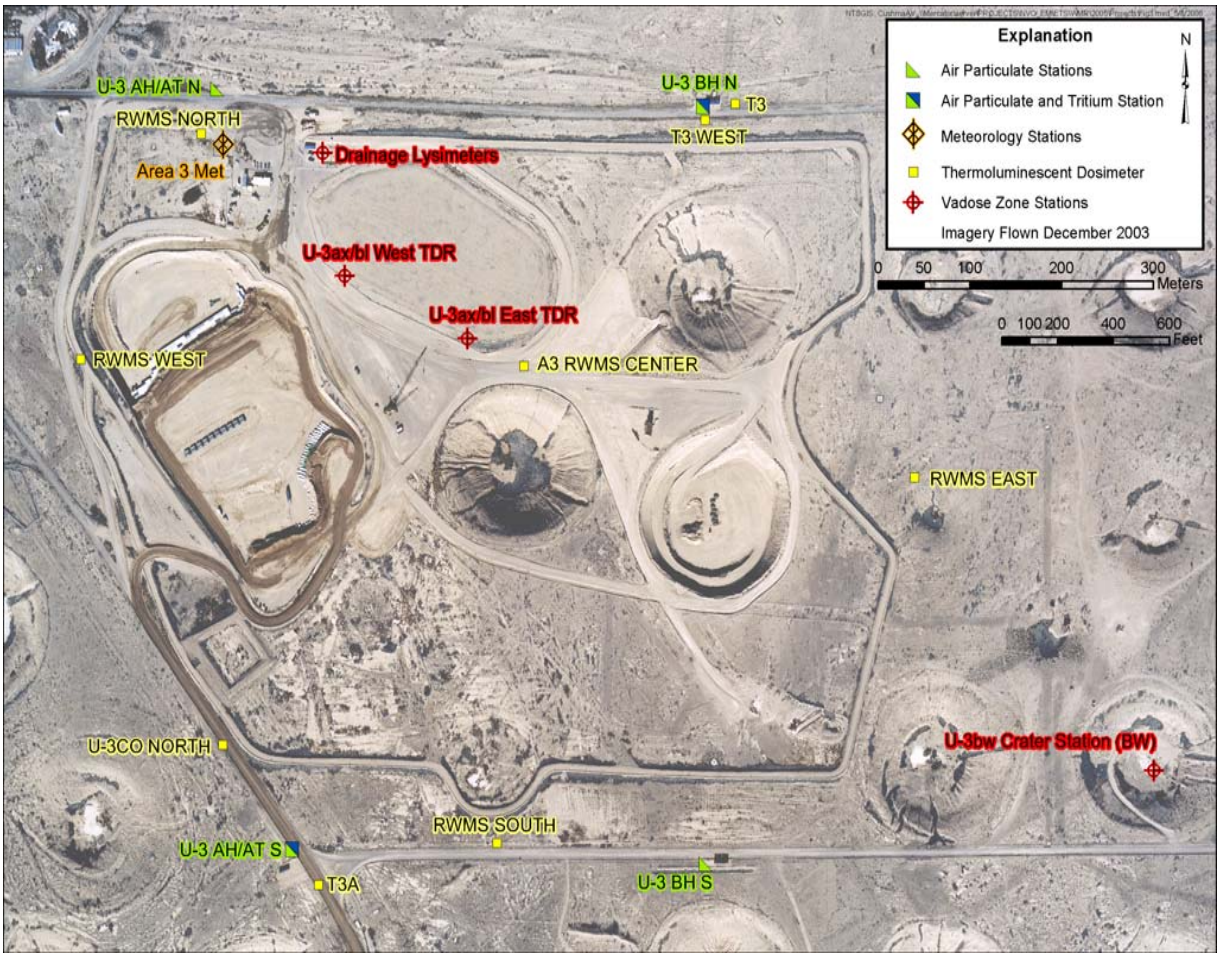

Figure 5. Monitoring Stations at the Area 3 Radioactive Waste Management Site

2.2.1.2 Groundwater Monitoring

Groundwater monitoring has been conducted for a suite of radiological and chemical constituents at the three wells surrounding the Area 5 RWMS since 1993 (Figure 6). All analytical data from these wells continues to support the no groundwater pathway conceptual model used in the Area 5 RWMS PA. Additionally, elevation measurements taken at the three wells surrounding the RWMS, as well as nearby locations, indicate the uppermost aquifer is approximately 235 m (771 ft) below ground surface and is essentially flat, with very low groundwater velocities.

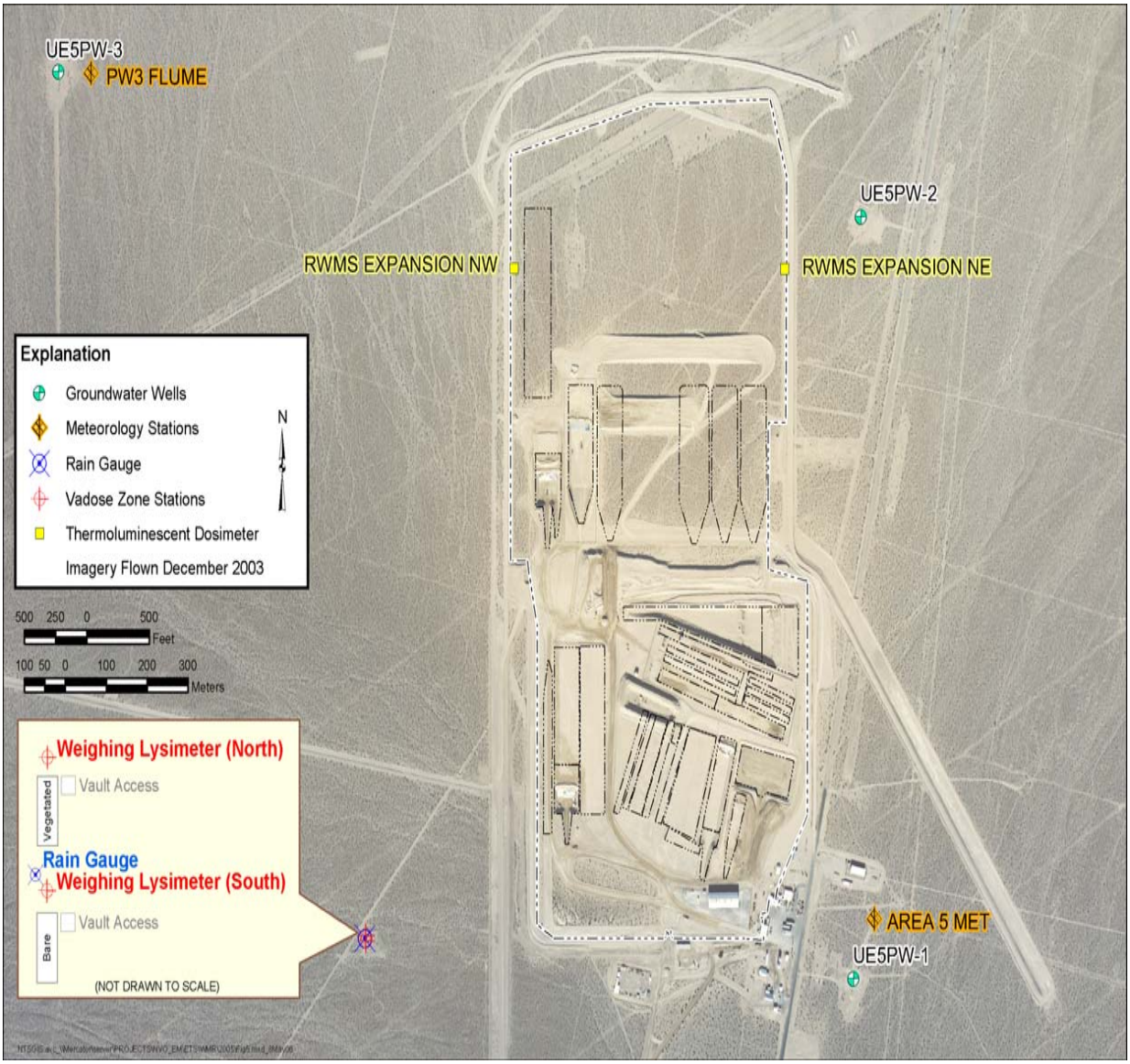

Figure 6. Location of the Area 5 RWMS Pilot Wells and Weighing Lysimeter Facility

Groundwater is not monitored at the Area 3 RWMS. Because of the great depth to the water table (~ 490 m [1,607 ft] below ground surface) and negligible chance of recharge, a groundwater monitoring waiver was granted by the state of Nevada for the mixed waste disposal unit U-3ax/bl, located within the Area 3 RWMS.

2.2.1.3 Radon Monitoring

Radon flux monitoring has been conducted at various locations within the Area 3 and Area 5 RWMSs since 2000. In 2006, over 60 radon flux measurements were conducted with a mean flux of 0.096 and 0.037 Bq $m^{-2}s^{-1}$ for the Area 3 and Area 5 RWMSs, respectively. Results indicate that radon flux from waste covers is similar to undisturbed background locations and well below the 0.74 Bq $m^{-2}s^{-1}$ performance objective. These results are consistent with radon flux calculations in the PA models.

2.2.1.4 Meteorology Monitoring

Detailed meteorological data are collected at both the Area 3 and Area 5 RWMSs (Figures 5 and 7). Measurements include precipitation, air temperature, relative humidity, wind speed and direction, barometric pressure, and incoming solar radiation. These are the basic meteorological parameters required to quantify the exchange of water and heat between the soil and atmosphere. Meteorological measurements are taken to (1) confirm that the RWMSs are sited in arid environments, (2) be used as input in process level models, and (3) refine PA/CA parameter distributions. On-site meteorological data were recently used in process level water balance modeling for the Area 5 RWMS (Desotell et al., 2006). Long-term data are being compiled to refine the wind speed distributions used in the PA/CA models. In 2006, precipitation totals were below average, totaling 8.7 centimeters (cm) (3.4 inches [in.]) and 8.1 cm (3.2 in.) in Areas 3 and 5, respectively. Potential ET to precipitation ratios for 2006 are 18.2 and 20.4 for Areas 3 and 5, respectively.

2.2.1.5 Direct Radiation Monitoring

Exposure rates, as measured with thermoluminescent dosimeters (TLDs), indicate that annual exposures at the Area 5 RWMS are within the range of exposures measured at NTS background locations. The Area 3 RWMS is located within 400 m (1,300 ft) of 14 historic atmospheric nuclear weapons tests. These tests left radioactive surface soil contamination and therefore elevated radiation exposures across the area. During disposal operations, waste is covered with clean soil. The use of clean cover material has resulted in lowering TLD readings within the Area 3 RWMS to background levels.

2.2.1.6 Biota Monitoring

Vegetation growing on and around waste disposal units is periodically sampled. Analyses of water distilled from plant samples typically have detectable amounts of tritium. No biota monitoring was conducted in 2006. In 2005, H^3 results for 12 composite samples from the Area 3 and Area 5 RWMSs ranged from 44 to 7.3 x 10^4 becquerel per liter. These data could be used in conjunction with disposal unit-specific modified PA models to evaluate the accuracy of tritium migration predictions.

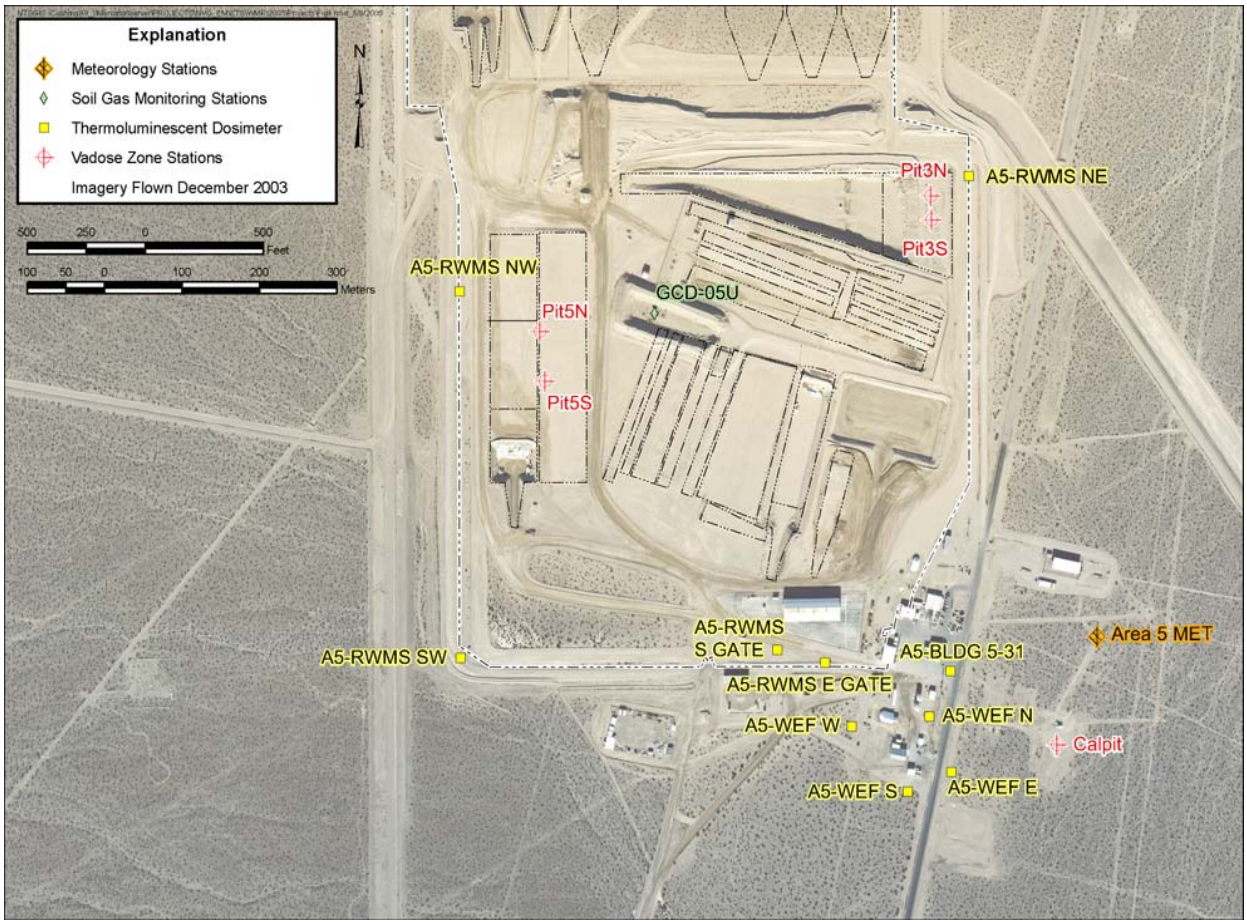

Figure 7. Monitoring Stations at the Area 5 Radioactive Waste Management Site

2.2.1.7 Subsidence Monitoring

Subsidence has been formally monitored since 2000. Subsidence occurs most commonly in recently filled disposal units, especially along the edges where soil backfill may not be completely compacted. Subsided areas are repaired and documented. Prediction of the timing and magnitude of subsidence because of container collapse continues to be an area of high uncertainty where more research is needed. Several subsidence features were identified and repaired on the U-3ax/bl closure cover in 2006. No subsidence was observed at the Area 5 RWMS.

2.2.1.8 Air Monitoring

Air particulate samples are collected at the Area 3 and Area 5 RWMSs. Results indicate that elevated levels of plutonium-239 plus plutonium-240 ($^{239+240}$Pu) are present at the Area 3 RWMS. The source of plutonium is likely the nearby soil contamination areas created by atmospheric nuclear weapons tests. The mean concentration for $^{239+240}$Pu in 2006 (~7.7 x 10^{-6} Bq m^{-3}) is less than any level of public concern. Measured concentrations of

airborne plutonium at the Area 3 RWMS are consistent with CA model calculations of resuspension from contaminated soils sites in Yucca Flat.

Air particulate data collected at the Area 5 RWMS are consistent with the screening analyses conducted for the Area 5 CA, which concluded that the contaminated soil sites in Frenchman Flat and the Area 5 RWMS are not interacting sources. The Frenchman Flat soil sites are therefore not included in the CA.

Tritium in air data are collected at the Area 3 and Area 5 RWMSs. These data could be used in conjunction with modified PA models to evaluate the accuracy of tritium migration predictions.

2.2.1.9 Soil Temperature Monitoring Around RTGs

Four RTGs were disposed in P05U in 2006 in an approximately square configuration. To monitor the heat field generated from these waste packages, vertical and horizontal arrays of temperature sensors were installed adjacent to the largest curie inventory RTG package. Starting at the RTG package, sensors were placed every 0.3 m (1 ft) to a distance of 4 m (13 ft) from the package in each array. Hourly average temperature measurements are collected. Temperature data collected will be used to calibrate a heat flow model and optimize spacing between future RTG disposals and other low-level waste with volatile radionuclides.

2.2.2 Research and Development

The PA/CA Maintenance Plan calls for annual reviews of R&D activities relevant to the PA. Results of both on-site and off-site R&D activities (e.g., those performed at other DOE sites, the national laboratories, the Desert Research Institute, and academic institutions) provide the data necessary to manage uncertainty in conceptual models, mathematical models, model parameters, and evaluation scenarios of the PA and to assure continuing adequacy of the PA.

The DASs require NNSA/NSO to address all secondary issues (e.g., consistency of models and parameters between the Area 3 and 5 RWMSs) noted during the PA/CA reviews as part of the maintenance program. R&D is the mechanism for NNSA/NSO to address these issues and manage uncertainty.

2.2.2.1 Fiscal Year 2007 Research and Development Activities

The major R&D efforts undertaken in FY 2007 were the continuation of the development of the Area 5 RWMS GoldSim model, development of the GoldSim Area 5 RWMS inventory model, and development of a 40 CFR 191 special analysis model. These are summarized below.

Area 5 RWMS GoldSim Model Development

The FY 2007 PA update was performed with the Area 5 RWMS v4.004 PA model. Version 4.004 was developed from the previous baseline version, 4.002 (NNSA/NSO, 2007c). Version 4.002 was approved by NNSA/NSO for all model applications, including waste stream evaluations and compliance determinations, with the exception of the containment requirement

calculations under Title 40 CFR 191 (NNSA/NSO, 2007c). Major developments since version 4.002 of the model include the following:

- The Model is implemented in GoldSim version 9.6.
- All inventories are updated to FY 2007 estimates.
- A residential exposure scenario without agriculture is included in the model.
- The residential exposure scenario is the compliance scenario for the CA.

Area 3 RWMS GoldSim Model Development

Version 2.0 is the current version of the model approved by NNSA/NSO for all model applications, including waste stream evaluations and compliance determinations, with the condition that the model should be run with subsidence for U-3ah/at disabled (NNSA/NSO, 2006). No new versions of the Area 3 RWMS model were approved in FY 2007.

GoldSim Inventory Model Development

The Area 5 RWMS FY 2007 inventory estimate was prepared with the A5 Inventory v2.022 model. The changes to this model from the previous version are updated with FY 2007 disposal data and the use of new cumulative distribution functions for the concentration of future wastes. The future waste concentration cumulative percentiles were estimated from 14 years of mean annual concentration data using the percentile bootstrap method.

40 CFR 191 Special Analysis Model

A 40 CFR 191 special analysis model, version 1.000, was developed from the Area 5 RWMS PA model. The model was developed to support the special analysis of TRU waste disposed in classified Trench 4 (T04C) (Shott et al., 2007). The 40 CFR 191 special analysis model was developed from the A5 RWMS PA model, version 4.000, with the following important changes:

- Three climate regimes (i.e., present-day, monsoon, and glacial-transition) based on the Yucca Mountain climate forecast with stochastic durations were added to the model.
- New model parameters for hydrologic conditions, plant uptake, and animal burrowing were added to the model to describe conditions during the monsoon and glacial-transition future climate regimes.
- A residential exposure scenario was added to the model and used for comparison with the 40 CFR 191 individual protection requirements.

2.2.2.2 Fiscal Year 2008 Research and Development Activities

The current R&D activities include the following:

- Performing cover thickness optimization studies in support of design of the closure cover for the original Area 5 RWMS 92-acre disposal area
  Continuing development of the Area 3 RWMS GoldSim model
  - Subsidence will be further evaluated and the consequences of subsidence will be incorporated into the model with the addition of new values for transport and media parameters under subsided conditions when no cover maintenance takes place. The member of public compliance scenario developed for the Area 5 RWMS model will replace the current scenarios implemented in version 2.0 of the model. Acute intruder scenarios will be added to the model to ensure consistency with the new institutional control policies (NNSA/NSO, 2007a).
- Performing sensitivity analyses for the Area 3 RWMS GoldSim model

2.2.2.3 Fiscal Year 2009 Research and Development Activities

Activities beyond FY 2008 will focus on the following:

- Updating the models as more data or information become available
- Using the model to support future disposal, closure, monitoring, and research decisions
- Using sensitivity analysis to simplify the Area 5 RWMS GoldSim model
- Evaluating new and revised waste streams as they are proposed

The GoldSim models will continue to be used to evaluate PA results using revised closure inventories that include current disposals. Based on the results of the sensitivity analyses undertaken in FY 2008, new studies may be undertaken in FY 2009 to reduce the uncertainty of sensitive model parameters, if it is feasible to do so.

2.2.2.4 Research and Development Activities Beyond FY 2009

The long-term goal of the maintenance program is to reduce uncertainty in exposure scenarios (member of public and inadvertent human intrusion), conceptual models, mathematical models, and model parameters. Reduction of uncertainty and associated improvement of the PA model will be accomplished through special studies. In addition, future R&D activities include the development of new waste concentration limits, evaluation of waste forms and containers (both engineering and geochemical properties) for disposal, the refinement of closure cover designs, and evaluation of institutional control and land-use options for optimizing disposal operations.

2.3 Summary of Changes

Changes in the inventories, facility designs, the PA model, and site characterization data for the Area 5 RWMS are described above. The Area 5 PA model results continue to indicate a high probability of compliance with all performance objectives. The Area 3 RWMS is in inactive status and no significant changes occurred in FY 2007. FY 2006 results for the Area 3 RWMS remains valid. Monitoring results for both sites continue to support PA assumptions and conceptual models.

2.4 Recommended Changes

Analysis of the current inventory data with the Area 5 RWMS v4.004 GoldSim model indicates that there is a reasonable expectation of compliance with all performance objectives. No significant changes have occurred since the preparation of the 2006 Area 5 RWMS PA update. Therefore, no new revision to the Area 5 RWMS PA is necessary.

The most significant change at the Area 3 RWMS is the increased inventory since the approved PA in 1996 and its placement in inactive status. The FY 2006 A3 RWMS v2.0 GoldSim model results indicate that there is still a reasonable expectation of compliance with the performance objectives. A revision of the Area 3 RWMS PA is recommended in FY 2008 to update the PA with GoldSim model results as well as with the latest estimate of the closure inventory.

3.0 COMPOSITE ANALYSIS

3.1 Assessment of the Adequacy of the Composite Analysis

The reviews of the Area 3 and Area 5 RWMS inventories, environmental restoration (ER) activities at the NTS (those impacting the sources of residual radioactive materials considered in the CAs), the results of the monitoring and R&D activities, and land-use planning show that the assumptions in the CAs have not changed. Therefore, the results of the CAs remain valid, and revision of the CAs is not necessary at this time.

Of particular importance are the conservative assumptions made in the CAs about institutional control and future land use. Although NNSA/NSO plans to control the NTS boundaries in perpetuity, the CAs assume that, after an institutional control period, the public will have access to lands within 100 m (330 ft) of the disposal sites. Therefore, exposure scenarios evaluated in the CAs provide conservative bounding estimates of future performance.

In FY 2007, a new version of the Area 5 RWMS PA model was released that includes a CA module. The updated Area 5 RWMS CA results are significantly less than the CA results due to selection of a different exposure scenario. All results are significantly less than the 0.3 mSv dose constraint.

3.2 Source Terms

In addition to the PA inventories, the CAs evaluated the pre-1988 inventory of the RWMSs and other sources of residual radioactive materials from ER sites that interact with the RWMSs. The ER sources considered in the CA models remain unchanged for the Area 3 RWMS. The Area 5 RWMS CA showed that there was negligible interaction between the contaminated soil sites in Frenchman Flat and the RWMS. Therefore, the Area 5 RWMS CA model calculates the dose for a future member of public 100 m (330 ft) from the RWMS boundary and does not explicitly include the minor air pathways doses from ER soil sites. No new sources of contamination have been identified, and there is no new information that would reduce the uncertainty of the current sources. The review results for the RWMSs and ER sources are summarized below.

3.2.1 Radioactive Waste Management Sites

There have been no significant changes to the pre-1988 waste inventories evaluated in the CAs. The Area 3 RWMS CA inventory was estimated with the A3 Inventory v 2.010 model in FY 2006. The Area 5 RWMS CA inventory was estimated with the A5 Inventory v 2.022 model (see Section 2.0).

3.2.1.1 Closure

The Area 3 RWMS PA/CA assumes that the site will be closed with a vegetated ET monolayer cover of native alluvium (Shott et al., 2000). The cover is assumed to be 3 m (10 ft) thick after subsidence. The U-3ax/bl disposal unit was closed in FY 2001 with the installation of a monolayer alluvium cover. The existing 2.7-m (8.9-ft) operational cover was supplemented with an additional 0.3 m (1 ft) of soil and sloped to promote drainage off the cover. The installed cover is generally consistent with the CA assumption of a 3-m (10-ft) monolayer cover.

The Area 5 RWMS CA makes similar but slightly less conservative assumptions (BN, 2001a). The CA assumes that the cover is maintained for 100 years and public access is restricted for 250 years. The cover is assumed to be a monolayer ET cover, measuring 2 to 6 m (6 to 20 ft) thick.

The ICMP remains consistent with the PA assumptions for the U-3ah/at and U-3bh units at the Area 3 RMWS and the units in the Area 5 RWMS (BN, 2005). The current plan is to construct monolayer-ET closure covers. Closure cover thickness will be specified in the specific closure plan for the disposal unit. Current closure plans remain consistent with PA and CA assumptions.

3.2.2 Underground Testing Areas

The CAs for the Area 3 and Area 5 RWMSs assumed that land-use controls can control exposure of the public to groundwater contamination from UGTAs on the NTS. There are still no plans to release lands within either Yucca Flat or Frenchman Flat where the Area 3 and Area 5 RWMSs are located, respectively. The results of the flow and transport model that will aid in determining the 1,000-year groundwater contaminant boundaries for Yucca Flat are not expected until FY 2020. The Area 3 RWMS CA assumptions are still consistent with current plans for the Yucca Flat CAU.

Site characterization studies are underway to estimate the extent of groundwater contamination from the Frenchman Flat UGTA. The results of the radionuclide transport model are expected by FY 2009 and require Nevada Department of Environmental Protection approval prior to application. Therefore, the Area 5 RWMS CA is still consistent with the plan to manage the Frenchman Flat UGTA.

3.2.3 Soil Sites

The CAs assume that the NTS Soil Sites will not be remediated. No Soil Sites considered in the CAs have been characterized or remediated since completion of the CAs. The closure of Soil Sites is currently awaiting a regulatory determination of appropriate cleanup levels. Therefore, the results of the CAs remain valid and provide a conservative bounding estimate of site performance.

3.2.4 Industrial Sites

The CAs assume that the impact of the Industrial Sites is insignificant compared with the Soil Sites. No Industrial Sites have been characterized or remediated that impact interacting sources in Frenchman Flat or Yucca Flat since preparation of the CAs. Therefore, the CA assumptions remain unchanged.

3.3 Updated CA Results

The Area 5 RWMS CA results were updated with the A5 RWMS v4.004 GoldSim model. The model was run as described for the PA, except that the model was placed in CA mode. A decrease is observed for the dose at the Area 5 RWMS boundary (Table 12). The decrease is caused by changing from a resident farmer to a resident exposure scenario for the CA. The mean and 95th percentile doses are significantly less than the 0.3 mSv dose constraint. Therefore, the Area 5 RWMS CA results are still considered valid.

Table 12. Area 5 RWMS v4.004 GoldSim Model CA Results

Pathway	Dose Constraint	Area 5 RWMS CA (Resident Framer Scenario)		FY 2007 Summary (Resident Scenario)	
		Mean	95th Percentile	Mean	95th Percentile
All Pathways (mSv)	0.30	8E-3	2E-2	1.1E-4	3.3E-4

3.4 Monitoring and Research and Development Results

3.4.1 Monitoring

The monitoring activities discussed in Section 2.2.1 also pertain to the CAs. As discussed in Section 2.2.1, the results of environmental monitoring across the NTS are reported annually in the Annual Site Environmental Report and NESHAP reports (NSTec, 2007c; d). $^{239+240}$Pu are the only man-made radionuclides routinely detected at the Area 3 RWMS at slightly elevated levels, the sources being the former atmospheric testing sites throughout Yucca Flat, including ground zeros in the immediate vicinity of the RWMS. The mean result for 2006 was 7.7×10^{-6} Bq m^{-3}. This is consistent with previous results and the CA model estimated $^{239+240}$Pu concentration of 7×10^{-6} Bq m^{-3}. Results of the CA resuspension and dispersion models for plutonium are consistent with environmental monitoring results.

3.4.2 Research and Development

There have been no R&D activities in FY 2006 whose results might impact the CA results and conclusions. The discussions of the R&D activities in Section 2.2.2 for PAs are also pertinent for CAs.

The release and transport of radionuclides from the disposal sites and resuspension of radionuclides from the surface soils into the atmosphere are modeled for the CA using the same

models developed in the PA. In the CAs, the Industrial Source Complex (ISC) model was used to evaluate the spatial distribution of the concentration of radionuclides in the atmosphere as a result of resuspension of radionuclides from the disposal units, as well as all other pertinent radionuclide sources. The ISC model was also used to evaluate the deposition of airborne radionuclides on the ground. Aside from updating the ISC model results (air concentration source strength ratios) with recent meteorological data from Frenchman Flat, no further revisions were performed.

3.5 Summary of Changes

There have been no changes in FY 2007 that affect the conclusions of the CAs, as indicated by reviews of the disposal unit closure inventories, estimated inventories of the ER sources of residual radionuclides, the progress of the ER cleanup projects, land-use planning, and the results of the monitoring and R&D activities.

Current inventories have been analyzed with the new Area 5 RWMS CA model. No changes were identified for the Area 3 RWMS CA model. The results indicate a high probability that the doses from all interacting sources are less than the 0.3 mSv dose constraint. Therefore, the results of the CAs appear to remain valid.

3.6 Recommended Changes

There are no recommended changes to the ER programs that could affect the CAs. Likewise, there are no recommended changes to the monitoring and R&D activities. There have been no significant changes that would impact CA results and conclusions. Therefore, the Area 3 and Area 5 RWMS CAs are assumed to still be adequate and revision is not required at this time.

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